

# BUILDER'S Reference Book

Twelfth edition

Edited by  
**Leslie Black**

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# Builder's Reference Book



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Twelfth Edition

*by*  
*Leslie Black*



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# Preface

This book is not, in itself, a complete text book. It's coverage of the industry is so wide that full texts relating to all the subjects and disciplines mentioned would require the space of many volumes. It should be considered more in the nature of a guide to sources of information relevant to the building industry, legislation affecting it, standards of workmanship and materials, and methods.

It is designed to be a tool, for use in the office or on the site, marshalling facts in a handy compendium style to meet the most common requirements of the busy builder.

Readers are advised always to check the facts quoted here against the latest information on the subject—legislation affecting the industry changes frequently and British Standards and Codes of Practice are continuously under review. At the time of going to press all the information in this totally revised and largely rewritten edition was correct and current. Subsequent editions will be thoroughly revised as the relevant facts alter sufficiently to warrant publication.

Finally the Editor wishes to thank all the various associations and trade sources from which the information contained in this volume was selected, for their assistance and co-operation.

LESLIE BLACK  
1980



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# 1. GENERAL OFFICE INFORMATION

## NATIONAL JOINT COUNCIL FOR THE BUILDING INDUSTRY

### TERMS OF SETTLEMENT—JUNE 1985

#### NOTICE No. 1

The National Joint Council at its meeting on 5th June received a report from the Building and Civil Engineering Joint Board which had been considering claims for improvements in wages and conditions by the Operatives Parties to the Joint Board.

On the recommendation of the Joint Board, the Council adopted the following terms of settlement of all outstanding claims. The amendments to give effect to these terms are included in Notice No. 2.

Ratification having been declared by the Adherent Bodies as required by Rule 6.1.3.2 of the Rules and Regulations of the Council, the Management Committee was instructed to promulgate these decisions, and so promulgates. The date of promulgation is 6th June, 1985.

#### 1. WAGES

With effect on and from Monday, 24th June, 1985 and subject to the conditions prescribed in the Working Rule Agreement, guaranteed minimum weekly earnings shall be as follows:

|                            |             |
|----------------------------|-------------|
| Craft Operatives (Grade A) | £107.83 1/2 |
| Labourers (Grade A)        | £ 91.84 1/2 |

The guaranteed minimum earnings shall be made up as follows:

|                                       | Craft Operative<br>£ | Labourer<br>£    |
|---------------------------------------|----------------------|------------------|
| Standard Basic Grade A Rates of Wages | 93.01 1/2            | 79.36 1/2        |
| Guaranteed Minimum Bonus              | 14.82                | 12.48            |
| Guaranteed Minimum Earnings           | <u>107.83 1/2</u>    | <u>91.84 1/2</u> |

Where under the Working Rules, extra payments and other payments are aggregated with the basic rate for the purpose of calculating overtime they shall be adjusted on 24th June, 1985 to maintain the appropriate relationship with the basic rate.

The weekly amounts payable above the labourers' rate under National Working Rule 22.4—Scaffolders—shall be as follows:

|  |       |
|--|-------|
| Trainee Scaffolder                             | £3.12 |
| Basic Scaffolder (on first qualifying as such) | £8.19 |

## 2. SICKNESS AND INJURY PAYMENTS

With effect from 24th June, 1985 the weekly rate of payment during absence due to sickness or injury under National Working Rule 16 shall be increased from £36.75 to £38.70.

## 3. TOOL ALLOWANCES AND EMPLOYERS' LIABILITY

3.1. With effect from 24th June, 1985 the amount of tool allowances and painters' overall allowance payable under National Working Rule 18 shall be increased as follows:

Present allowance of 106p per week to become 112p per week

Present allowance of 82p per week to become 87p per week

Present allowance of 55p per week to become 58p per week

3.2. The employers' maximum liability for tools lost through fire or theft under the conditions of National Working Rule 18.2 shall be increased from £185 to £196 with effect from 24th June, 1985.

## 4. ANNUAL HOLIDAYS SCHEME

By the decision of the four parties to the Annual Holidays Scheme the values of holiday credit stamps shall with effect from 29th July, 1985 be as follows:

|          |         |
|----------|---------|
| Adults   | *£12.15 |
| Under 18 | £8.50   |

This includes a contribution of 90p towards Retirement and Death Benefit under the Benefits Scheme.

## 5. DEATH BENEFIT

The amount of death benefit payable under the Building and Civil Engineering Industry Benefits Scheme to be increased to £4,500 where death occurs on or after 24th June, 1985. With effect also from this date an additional amount of up to £4,500 will be payable if the cause of death is an accident at the place of work or while travelling to or from work.

## 6. PERIOD OF SETTLEMENT

The Council shall not be required to consider any application for a major change in Operatives' pay and conditions which would have effect before 30th June 1986.

## **AMENDMENTS TO NATIONAL WORKING RULES**

At its meeting on 5th June, 1985 the Council decided to make the following alterations to

National Working Rules. The date of Promulgation is 6th June, 1985.

NATIONAL WORKING RULE 1—GUARANTEED MINIMUM BONUS EARNINGS

- Clause 1.6.6 **Add** 'NWR 2.10' after 'NWR 1.6.3'  
 Clause 1.6.8 **Delete** '£14.04' and **Insert** '£14.82'  
**Delete** '£11.89 1/2' and **Insert** '£12.48'

NATIONAL WORKING RULE 2—BASIC RATES

- Clause 2.1 **Delete** '£88.33 1/2 (226 1/2p per hour)' and  
**Insert** '£93.01 1/2 (238 1/2p per hour)'  
**Delete** '£75.27 (193p per hour)' and  
**Insert** '£79.36 1/2 (203 1/2p per hour)'  
 Clause 2.2 **Delete** '£7.02' and **Insert** '£7.41'  
 Clause 2.9 **Delete** '£37.63 1/2 (96 1/2p)' and **Insert** '£39.58 1/2 (101 1/2p)'  
**Delete** '£52.65 (135p)' and **Insert** '£55.57 1/2 (142 1/2p)'  
**Delete** '£75.27 (193p)' and **Insert** '£79.36 1/2 (203 1/2p)'

NATIONAL WORKING RULE 3—EXTRA PAYMENTS FOR CONTINUOUS EXTRA SKILL OR RESPONSIBILITY

Key to Code Letters—**Amend** Key to read as follows:

| Code Letter | Above Labourers' Rate per week (hourly equivalent in brackets) |       |
|-------------|--|-------|
| A           | £3.90  | (10p) |
| B           | £4.29  | (11p) |
| C           | £5.07  | (13p) |
| D           | £7.41  | (19p) |
| E           | £8.19  | (21p) |
| F           | £8.58  | (22p) |
| G           | £9.36  | (24p) |
| H           | £10.14   | (26p) |
| I           | £11.70   | (30p) |
| J           | £12.09   | (31p) |
| K           | £12.87   | (33p) |
| L           | £13.65   | (35p) |
| M           | £14.43   | (37p) |
| N           | £15.99   | (41p) |

NATIONAL WORKING RULE 13—TERMINATION OF EMPLOYMENT

Clauses

13.1.1 **Delete** 'first six normal working days' and  
and 13.1.2 **Insert** 'first five normal working days'

Clause **Amend** existing wording to read:  
13.3.1

'In cases of misconduct an operative is liable to dismissal in accordance with the procedures set out in NWR 13.4.'

NATIONAL WORKING RULE 16—SICKNESS AND INJURY PAYMENTS

Clause 16.4 **Delete** '£36.75' and **Insert** '£38.70'

NATIONAL WORKING RULE 18—TOOL AND CLOTHING ALLOWANCES

Clause **Delete** opening paragraph and **Insert**

18.1 Tool allowances are paid in respect of the provision, maintenance and upkeep of tools provided by the operative and are NOT to be taken into account for the calculation of overtime, travelling time or of guaranteed minimum weekly earnings nor are they to be offset against guaranteed minimum bonus under NWR 1.6. Where employment starts after Monday, or is terminated in accordance with NWR 13 otherwise than on a Friday, the amount of tool allowance to be paid shall be the appropriate proportion of the weekly allowance for each day on which the operative was available for work in accordance with NWR 1.2.

*Note:* Tool allowances, although not forming part of an operative's basic rate, are liable to the deduction of tax and National Insurance contributions in the same way as other earnings.'

Clause **Delete** existing allowances and **Insert**

|      |                        |                 |        |                   |        |
|------|------------------------|-----------------|--------|-------------------|--------|
| 18.1 | Carpenters and Joiners | — <b>Delete</b> | '106p' | and <b>Insert</b> | '112p' |
|      | Banker Masons          | — <b>Delete</b> | '82p'  | and <b>Insert</b> | '87p'  |
|      | Mason Fixers           | — <b>Delete</b> | '55p'  | and <b>Insert</b> | '58p'  |
|      | Plasterers             | — <b>Delete</b> | '55p'  | and <b>Insert</b> | '58p'  |
|      | Bricklayers            | — <b>Delete</b> | '55p'  | and <b>Insert</b> | '58p'  |
|      | Painters               | — <b>Delete</b> | '55p'  | and <b>Insert</b> | '58p'  |
|      | Wall and Floor Tilers  | — <b>Delete</b> | '55p'  | and <b>Insert</b> | '58p'  |

Clause **Delete** '£185' and **Insert** '£196'

18.2

NATIONAL WORKING RULE 19—BENEFITS

Clause **Amend** existing wording to read:

19.1

‘An operative is entitled to be provided by his employer with cover for retirement benefit, of an amount dependent on length of service in the industry, and death benefit of up to £4,500, with an additional amount of up to a further £4,500 payable if the cause of death is an accident at the

place of work or an accident while travelling to or from work, in both cases in accordance with the conditions laid down in the Building and Civil Engineering Benefits Scheme, which is published separately.’

Clause **Amend** existing wording to read:

19.3

‘There is no entitlement to cover in the case of an operative under the age of 18 years or over the age of 65 years, except for death benefit (of up to the sum of the amounts set out in 19.1 above) if the cause of death is an accident at the place of work or an accident while travelling to or from work when the operative is under the age of 18 years, or on or after his 65th birthday.’

#### NATIONAL WORKING RULE 22—SCAFFOLDERS

Clause 22.4 Basic Scaffolder: **Delete** ‘£7.80’ and **Insert** ‘£8.19’

### STANDARD RATES OF WAGES IN ENGLAND, SCOTLAND AND WALES

Under the Terms of Settlement approved by the National Joint Council on 5th June, 1985 and promulgated on 6th June, 1985 the standard basic wages and guaranteed minimum bonus payments (GMB) for building craft operatives and labourers due to be operated with effect on and from MONDAY 24th JUNE, 1985 will be as indicated below.

**Note:** The rates shown below are weekly rates. The hourly equivalents are shown in brackets.

#### 1. *Craft Operatives and Labourers*

##### (i) *London and Liverpool District*

|                  | <i>Rate per week</i> | <i>GMB</i> |
|------------------|----------------------|------------|
| Craft Operatives | £93.21 (239p)        | £14.82     |
| Labourers        | £79.56 (204p)        | £12.48     |

##### (ii) *Grade A and Scotland*

|                  | <i>Rate per week</i>  | <i>GMB</i> |
|------------------|-----------------------|------------|
| Craft Operatives | £93.01 1/2 (238 1/2p) | £14.82     |
| Labourers        | £79.36 1/2 (203 1/2p) | £12.48     |

2. *Watchmen*

|                               | <i>Rate per week</i> |
|-------------------------------|----------------------|
| London and Liverpool District | £92.04               |
| Grade A and Scotland          | £91.84 1/2           |

**Note:** Under the provisions of National Working Rule 2.8. the weekly remuneration for watchmen is a sum equivalent to the labourers' guaranteed minimum weekly earnings provided that not less than five shifts (day or night) are worked in the pay week.

3. *Young Labourers*

(i) London and Liverpool District

| <i>Age</i> | <i>% of Labourers' Rate</i> | <i>Rate per week</i> | <i>GMB</i> |
|------------|-----------------------------|----------------------|------------|
| 16         |                             | £39.78 (102p)        | £6.24      |
| 17         |                             | £55.77 (143p)        | £8.77 1/2  |
| 18         | 100                         | £79.56 (204p)        | £12.48     |

(ii) *Grade A and Scotland*

| <i>Age</i> | <i>% of Labourers' Rate</i> | <i>Rate per week</i>  | <i>GMB</i> |
|------------|-----------------------------|-----------------------|------------|
| 16         | 50                          | £39.58 1/2 (101 1/2p) | £6.24      |
| 17         | 70                          | £55.57 1/2 (142 1/2p) | £8.77 1/2  |
| 18         | 100                         | £79.36 1/2 (203 1/2p) | £12.48     |

4. *Woodworking Establishment Operatives employed under provisions of NWR 2.10.*

|                                      | <i>Rate per week</i>  | <i>GMB</i> |
|--------------------------------------|-----------------------|------------|
| <i>London and Liverpool District</i> | £83.85 (215p)         | £13.26     |
| <i>Grade A and Scotland</i>          | £83.65 1/2 (214 1/2p) | £13.26     |

**NATIONAL WORKING RULE 21—CONDITIONS OF EMPLOYMENT OF APPRENTICES/TRAINEES**

At its meeting on 5th June, 1985 the National Joint Council received a report from its Management Committee which had been considering an Operatives' Side claim for an increase in the amounts payable to apprentices/trainees under National Working Rule 21 who were being trained under the National Joint Training Scheme.

The Council accepted the Report of the Management Committee and decided to make the following alterations to the National Working Rule:

## NATIONAL WORKING RULE 21—CONDITIONS OF EMPLOYMENT OF APPRENTICES/TRAINEES

Clause **Amend** existing wording to read:

21.2

‘The basic rates and guaranteed minimum bonus of apprentices/trainees (including probationers) shall be as set out below. Payment under the scales is due from the date of entry into employment as an apprentice/trainee, whether the apprentice/trainee is working on site or undergoing full-time training on an approved course, subject to the provisions of NWR 21.3. Payments under the scales are due from the beginning of the payweek during which the specified period starts.

**Delete** sections 21.2.1 to 21.2.4 in their entirety and **Insert**:

21.2.1 *Entrants under 19 whose employment as apprentices/trainees began on or after 25th June, 1984 and Building Foundation Training Scheme trainees whose employment as apprentices/ trainees began before that date.*

| <i>Six-month period</i>  | <i>Rate per week</i>     | <i>GMB</i>    |
|--|--------------------------|---------------|
| First  | £43.29 (111p)            | —             |
| Second   | £58.69 1/2<br>(150 1/2p) | —             |
| Third  | £63.96 (164p)            | £10.14        |
| *Thereafter, until skills test is passed                       | £77.22 (198p)            | £12.28<br>1/2 |
| On passing skills test and until completion of training period | £87.16 1/2 (223 1/2p)    | £13.84<br>1/2 |

\*The NJCBI has agreed to the introduction of skills testing under the National Joint Training Scheme. The first practical skills tests will take place in the Spring, 1986.

21.2.2 *Entrants under 19 whose employment as apprentices/trainees began on or after 27th June, 1983 but before 25th June, 1984 (excluding BFTS trainees whose employment as apprentices/ trainees began between those dates, paid under NWR 21.2.1).*

| <i>Six month period</i> | <i>Rate per week</i>  | <i>GMB</i> |
|-------------------------|-----------------------|------------|
| Third                   | £67.27 1/2 (172 1/2p) | £10.14     |
| Fourth                  | £77.07 1/2 (197 1/2p) | £12.28 1/2 |
| Fifth                   | £87.16 1/2 (223 1/2p) | £13.84 1/2 |
| Sixth                   | £92.04 (236p)         | £14.62 1/2 |

21.2.3 *Entrants under 19 whose employment as apprentices/trainees began before 27th June, 1983.*

|                         |                      |            |
|-------------------------|----------------------|------------|
| <i>Six month period</i> | <i>Rate per week</i> | <i>GMB</i> |
| Fifth and sixth         | £83.07 (213p)        | £13.06 1/2 |

21.2.4 *Entrants from approved CITB Vocational Preparation Course 1982/83.*

|                         |                      |            |
|-------------------------|----------------------|------------|
| <i>Six month period</i> | <i>Rate per week</i> | <i>GMB</i> |
| Fourth and fifth        | £83.07 (213p)        | £13.06 1/2 |

*Clause 21.8—Tool Allowances*

**Delete** present allowance of '106p' and **Insert** '112p'

**Delete** present allowances of '55p' and **Insert** '58p'

### NEW WAGE RATES FROM BATJIC EFFECTIVE MONDAY 24th JUNE 1985

The Building and Allied Trades Joint Industrial Council agreed on 31 May 1985 and promulgated the new Wage Rates to apply from Monday 24 June 1985 for a period of twelve months.

#### WORKING RULE 1—STANDARD RATE OF WAGES 39 HOUR WEEK

|                          |   |
|--------------------------|---|
| Craftsmen                | £109.40   |
| Adult General Operatives | £93.79 1/2  |
| The hourly rate shall be | £2.80 1/2 (Craftsmen) and<br>£2.40 1/2 (Adult General Operatives) |

#### APPRENTICE/TRAINEEs AND YOUNG OPERATIVE RATES

The weekly standard rate for **Apprentices under 19 years of age** shall be these proportions of the Craftsman's Rate:

| <b>Age of Entry</b> | <b>1st Year</b> | <b>2nd Year</b> | <b>3rd Year</b> |
|---------------------|-----------------|-----------------|-----------------|
| 16                  | (50%)=£54.70    | (70%)=£76.58    | (90%)=£98.46    |
| 17                  | (60%)=£65.64    | (80%)=£87.52    | (90%)=£98.46    |
| 18                  | (80%)=£87.52    | (85%)=£92.99    | (90%)=£98.46    |

#### Entrants over the age of 19, normal period of 3 years

|                 |                 |                 |
|-----------------|-----------------|-----------------|
| <b>1st Year</b> | <b>2nd Year</b> | <b>3rd Year</b> |
| (85%)=£92.99    | (90%)=£98.46    | (95%)=£103.93   |



**Entrants over the age of 19 who undertake full-time off-site training 1st year**

|                                 |                                      |                                       |
|---------------------------------|--------------------------------------|---------------------------------------|
| <b>1st Year</b><br>(85%)=£92.99 | <b>next 6 months</b><br>(90%)=£98.46 | <b>last 6 months</b><br>(95%)=£103.93 |
|---------------------------------|--------------------------------------|---------------------------------------|

**Trainees who enter industry from Government Training Centre**

|                                     |                                     |                                       |
|-------------------------------------|-------------------------------------|---------------------------------------|
| <b>1st 6 months</b><br>(85%)=£92.99 | <b>2nd 6 months</b><br>(90%)=£98.46 | <b>last 6 months</b><br>(95%)=£103.93 |
|-------------------------------------|-------------------------------------|---------------------------------------|

**Standard Rate of Wages for Young Operatives**

|              |                                   |            |
|--------------|-----------------------------------|------------|
| Age 16 years | (50% of General Operatives Rate)  | £46.90     |
| Age 17 years | (70% of General Operatives Rate)  | £65.66     |
| Age 18 years | (100% of General Operatives Rate) | £93.79 1/2 |

**WORKING RULE 1C**

**Intermittent and Consolidated Rates of Pay for Skill**

(a) **The following are rates of pay per hour which shall be paid in addition to the general operatives' rate of pay to these operatives who apply these skills on an intermittent basis:**

**7 1/2 pence per hour**

Air or electric percussion drill; hammer; rammer etc; cartridge gun operator; compressor driver; concrete-mixer driver; barrow hoist operator; pumpman; handroller operator; mechanical barrow operator; electric operated vibrator and paint sprayer.

**14 pence per hour**

Drag shovel operator; dumper driver (up to 2000 kg); power roller driver (up to 4000 kg); light tyred tractor driver; pipelayer (up to 300mm); concrete screeder/leveller; forklift/sideloader driver (up to 3000 kg).

**21 1/2 pence per hour**

Batching plant driver; dumper driver (over 2000 kg); power roller driver (over 4000 kg); banksmen; watchmen; pipelayer (over 300mm); concrete trowel and planhand; forklift/sideloader driver (over 3000 kg).

(b) **The following shall apply to semi-skilled grades with continuous responsibility:**

**£100.53 per week**

Travelling, overhead, crawler, mobile or tower crane operator (up to 2 tons); wheeled or tracked tractor driver (up to 70 h.p.); trenching machine operator (up to 30 h.p.); excavator driver (up to 3/8 cu.yd.); timberman.

**£103.25 per week**

Travelling, overhead, crawler, mobile or tower crane operator (over 2 tons); wheeled or tracked tractor driver (over 70 h.p.); trenching machine operator (over 30 h.p.); excavator driver (up to 3/4 cu.yd.).

**£106.00 per week**

Travelling, overhead, crawler, mobile or tower crane operator (over 5 tons); excavator driver (over 3/4 cu.yd.).

**(c) Payment for discomfort, inconvenience or risk:**

**(i) Detached Work**

|                   |                         |
|-------------------|-------------------------|
| 15m and up to 30m | = 5 1/2 pence per hour  |
| 30m and up to 45m | = 7 pence per hour      |
| 45m and up to 60m | = 12 1/2 pence per hour |
| 60m and up to 75m | = 19 pence per hour     |
| 75m and up to 90m | = 24 1/2 pence per hour |

**(ii) Exposed Work**

|                         |                        |
|-------------------------|------------------------|
| Above 40m and up to 50m | = 3 1/2 pence per hour |
| Above 50m and up to 60m | = 5 pence per hour     |
| Above 60m and up to 75m | = 6 1/2 pence per hour |

The extra payment to be increased by 4 pence per hour for each 15 metres above 75 metres. All heights to be calculated from ground level.

**(iii) Cranes**

|   |                        |
|---|------------------------|
| Control platform over 15m and up to 30m | = 4 pence per hour     |
| 30m and up to 45m                       | = 5 pence per hour     |
| 45m and above                           | = 6 1/2 pence per hour |

(the above does not apply to Tower Cranes)

**(iv) Work in Swings**

= 14 pence per hour

**(v) Furnace Firebrick Work and Acid Resisting Brickwork**

|                                       |                        |
|---------------------------------------|------------------------|
| Furnace or similar work up to 120°F   | = 5 1/2 pence per hour |
| New Firebrick Work                    | = 14 pence per hour    |
| Repair of Firebrick Work              | = 17 pence per hour    |
| Brickwork using acid bonding material | = 7 1/2 pence per hour |

**WORKING RULE 11—TRAVELLING AND LODGINGS**

**(b) (iii) Daily Travelling Allowance**

This remains at 8p (6p apprentices/trainees and young labourers).

**Daily Fare Allowance**

Delete scale given and substitute:

| Distance (km) | Allowance | Distance (km) | Allowance | Distance (km) | Allowance |
|---------------|-----------|---------------|-----------|---------------|-----------|
| 1-6           | Nil       | 21            | £2.01     | 36            | £2.76     |
| 7             | £0.20     | 22            | £2.08     | 37            | £2.82     |

|           |       |           |       |           |       |
|-----------|-------|-----------|-------|-----------|-------|
| <b>8</b>  | £0.39 | <b>23</b> | £2.13 | <b>38</b> | £2.89 |
| <b>9</b>  | £0.57 | <b>24</b> | £2.18 | <b>39</b> | £2.96 |
| <b>10</b> | £0.74 | <b>25</b> | £2.23 | <b>40</b> | £3.03 |
| <b>11</b> | £0.90 | <b>26</b> | £2.28 | <b>41</b> | £3.11 |
| <b>12</b> | £1.05 | <b>27</b> | £2.33 | <b>42</b> | £3.18 |
| <b>13</b> | £1.20 | <b>28</b> | £2.37 | <b>43</b> | £3.26 |
| <b>14</b> | £1.34 | <b>29</b> | £2.41 | <b>44</b> | £3.33 |
| <b>15</b> | £1.47 | <b>30</b> | £2.45 | <b>45</b> | £3.40 |
| <b>16</b> | £1.58 | <b>31</b> | £2.50 | <b>46</b> | £3.48 |
| <b>17</b> | £1.69 | <b>32</b> | £2.55 | <b>47</b> | £3.55 |
| <b>18</b> | £1.78 | <b>33</b> | £2.60 | <b>48</b> | £3.63 |
| <b>19</b> | £1.87 | <b>34</b> | £2.65 | <b>49</b> | £3.70 |
| <b>20</b> | £1.94 | <b>35</b> | £2.70 | <b>50</b> | £3.77 |

For distances in excess of 50 kilometres a maximum of £3.77 may be paid.

## APPENDIX F

### GUIDE NOTES TO THE BATJIC AGREEMENT

Lodging Allowance, paragraph 1: **delete** £9.45 **substitute** £10.00.  
 paragraph 2: **delete** £8.50 **substitute** £10.00.

### WORKING RULE 12—SICKNESS AND INJURY BENEFIT

Sick pay to be increased to £7.92 per day with a maximum of £39.60 per week.

Please note that in addition to payment under this Rule you are required to pay Statutory Sick Pay due.

### WORKING RULE 13—BENEFITS SCHEMES

Death Benefit Scheme

Line 1 **delete** '£4,000' and **insert** '£4,500'

Line 2 **delete** '£4,000' and **insert** '£4,500'

### BATJIC BENEFIT SCHEME CONTRIBUTIONS

The BATJIC National Council have agreed the following new contribution rates for Holiday Pay and Death Benefit. There is no change to the Retirement Benefit contribution.

#### From Monday 5th August 1985

Death Benefit

Holiday Pay Scheme

Retirement Benefit No Change

#### Under 18

No charge

£7.69 per week

70p per week

#### 18 or over

£1.95 per month

£10.17 per week

70p per week

The Additional Voluntary Contribution from employers and/or employees were extended in January 1985:50p, £1.00, £1.50, £2.00, £3.00, £5.00, £8.00 or £12.00.

**WORKING RULE 18—TOOL ALLOWANCE**

Operatives are required to provide their own tools in order to carry out their duties on behalf of their employers and shall receive a weekly allowance towards the provision and maintenance of their tool-kit as follows:

|                              |                   |
|------------------------------|-------------------|
| Carpenters and Joiners ..... | £1.14 per week    |
| Banker Masons.....           | 87 pence per week |
| Mason Fixers.....            | 59 pence per week |
| Plasterers .....             | 59 pence per week |
| Bricklayers .....            | 59 pence per week |
| Wall and Floor Tilers.....   | 59 pence per week |

Note: Apprentices should receive the full tool allowance when they are required to maintain their own tool-kit.

|                                 |                   |
|---------------------------------|-------------------|
| Painters Overall Allowance..... | 59 pence per week |
|---------------------------------|-------------------|

**Storage of Tools .** The employer's maximum liability for loss of tools shall be increased to £198.

**BUILDING REGULATIONS**

**The Building Act of 1984 consolidated various building control statutes enacted over the last 90 years. It is no longer necessary for a builder to search through a confusing array of enactments concerning buildings and related matters; most are now restated in the new Act. Given here is a summary of the new Act, which at the time of going to press had just been officially published.**

Powers for local authorities to make by-laws controlling construction, air space and drainage were made available in the Public Health Act 1975. For some 50 years this was the basis of building control supported by model by-laws which were variously adjusted to meet local needs or prejudices. Then the power was taken up by the Public Health Act 1936, but by-laws remained in council's hands as before. Another 24 years and a new Public Health Act in 1961 gave authority for the making of building regulations.

The idea was to achieve uniformity and to enable the requirements to be more readily amended to take account of advancements in knowledge and changes in techniques. The new building regulations were first made in 1965 and have been subjected to numerous amendments and metricated.

Additional legislation arrived in the form of the Health and Safety at Work etc., Act 1974, which widened building control powers considerably and for the first time gave a definition of 'building'. Further radical alterations came with the passing of the Housing and Building Control Act 1984.

This legislation has been consolidated into the Building Act 1984 made on 31st October, 1984. So instead of searching about in several elderly Acts for various matters relating to building control we now have an Act of 131 sections with seven schedules.

### **Power to make regulations**

The Secretary of State is given power to make regulations to secure the health, safety, welfare and convenience of people using buildings. Regulations may also cover the conservation of fuel and power, and preventing waste, undue consumption, misuse or the contamination of water.

Building regulations may also be made imposing on owners and occupiers of buildings of a prescribed class a continuing duty to maintain fittings and equipment.

### **Approved documents**

In order to provide practical guidance the Secretary of State, or some other body which he may designate, may approve and issue documents saying how the requirements of building regulations may be achieved.

Such approved documents can be revised from time to time and withdrawn or replaced. In effect these documents will replace the deemed-to-satisfy content of existing regulations.

If a builder fails to comply with an approved document he does not necessarily render himself liable to any civil or criminal proceedings. Where, however it is alleged that a person has contravened a regulation, failure to comply with an approved document may tend to establish liability. Where an approved document has been complied with this may tend to negate liability.

### **Relaxation**

The Secretary of State may give a direction dispensing with or relaxing a requirement of the regulations. Building regulations may also allow local authorities to exercise this power, and also for a public body to dispense with an unreasonable regulation affecting work it proposes to carry out.

Applications for relaxation are to be made to the local authority on a form to be obtained from them.

Where the relaxation of a regulation might have wide ranging effect on health or safety generally it must be advertised in local newspapers. No advertisement is required where the effect on public health or safety will be limited, or where the work only affects an internal part of a building.

### **Type relaxation**

The Secretary of State is enabled to dispense with or relax some requirement of a building regulation, not only in a particular case, but generally. Such a relaxation could be subject to conditions and could be given a time limit. Before deciding to give a type relaxation of this nature the Secretary of State is required to consult such bodies as appear to him to represent the interests concerned. He must publish an account of any relaxation issued.

## **Type approvals**

The principle of giving type approvals may be extended to buildings. The Secretary of State is enabled to issue a certificate of approval of a type of building matter as complying either generally or in any class of case with particular requirements of building regulations.

A type approval may be issued either on application or otherwise, and, where it is granted in consequence of an application a fee may be charged.

This particular power enables some new product or method of construction to be formally assessed for building regulation purposes. It appears that an approval may be made to apply for a limited period only, if necessary.

The availability of a type approval will not operate as a substitute for the normal plan approval process, but will support any plans deposited with a local authority or sent to a person to be known in the future as an approved inspector.

The power to make type approval may be delegated to a person, or body, to such an extent, and subject to such conditions as the Secretary of State may think desirable.

## **Passing plans**

When plans are deposited with a local authority, it has a duty to pass them unless:

- they are defective;
- the proposal would contravene any building regulations.

If the plans are defective, or show that work would contravene any building regulation the council is given two options.

1. The plans may be rejected, or
2. they may be passed subject to conditions.
  - specifying modifications to be made to the plans, and
  - more plans are to be deposited.

In these circumstances the person depositing plans must have previously requested the council to pass plans subject to conditions or have agreed with the council that they may do so.

When passing plans the council is to state that it operates only for approval under the building regulations and any section of the Building Act 1984 that expressly authorises the council in certain cases to reject plans.

If there is a disagreement between a developer and the council as to whether the proposed work is in conformity with the building regulations the matter may be referred to the Secretary of State for a determination.

There may be delay in this coming into operation, and until it does, any question may be determined by a magistrates' court. Any application to the court must be made before the proposed work is substantially commenced.

Plans deposited with a local authority may be accompanied by a certificate from an approved person. An approved person will act within the limitations of prescribed regulations and they must be specified in his certificate. A person must include evidence of his approval and of proper insurance cover. A local authority is barred from rejecting work covered by one of these certificates.

The council must issue a decision on the passing or rejection of plans within five weeks of deposit.

## **Consultation**

The Secretary of State must continue to appoint and consult with a Building Regulation Advisory Committee before making regulations.

Where it is proposed to dispense with or relax a regulation requirement affecting:

- structural fire precautions;
- means of escape in case of fire;
- the availability of means of escape at all material times; then the fire authority must be consulted.

## **Approval of persons to give certificates**

We have seen that under the heading ‘passing of plans’ certain certificates accompanying plans may be accepted as evidence that the matter covered by the certificate is in compliance with the regulations.

Naturally provision is then made for the approval of persons by the Secretary of State or some other body which he appoints. A person who is approved will have limits placed upon the description of work, or the regulations under which he may issue certificates. Fees will be payable to become an approved person, and adequate insurance cover must be provided.

‘Approved persons’ are not to be confused with ‘approved inspectors’ who will be described in a later article.

## **Exemptions**

Certain buildings may be exempt from all or any building regulations. Named in the Act are schools and educational establishments where the plans have been approved by the Secretary of State.

Also included are buildings belonging to:

- statutory undertakers;
- Atomic Energy Authority;
- British Airports Authority;
- Civil Aviation Authority.

Not included in the exemption are:

- (i) houses;
- (ii) houses or hotels owned by British Airports Authority;
- (iii) offices and showrooms not forming part of a railway station;
- (iv) offices and showrooms of British Airports Authority or the Civil

Aviation Authority not on an aerodrome owned by the authority.

Regulations may also be made to exempt from compliance with building regulations that are not substantive requirements:

- a local authority;
- a county council;
- any other public body not working for its own profit.

A ‘substantive requirement’ means regulations regarding the design and construction of buildings, including the provision of services, fittings and equipment. The definition separates technical standards from administrative and procedural requirements of the

regulations.

### **Short lived materials**

If plans are deposited with a local authority showing that a building is to be constructed of materials which are listed as being short lived in building regulations the plans may be rejected.

The council may pass the plans, if it fixes a period after which the building must be removed, or imposes conditions having regard to the nature of materials to be used.

No condition may conflict with any condition contained within a planning consent for the same building.

Should anyone construct a building of short lived materials without first depositing plans, the local authority may fix a period during which it must be removed or impose conditions when allowing it to remain. Original time limits may be extended.

If the owner fails to remove a building subject to a time limit, the council may remove it and recover its costs.

The owner can appeal to the magistrates' court against a council's actions, but if he transgresses, he may be fined and subjected to a further fine of up to £5 per day so long as the offence continues.

### **Materials unsuitable for permanent building**

When this provision is operative, regulations may prescribe:

- a type of material or component;
- a type of service, fitting or equipment likely to be unsuitable in the construction of or provision of services in a permanent building in the absence of conditions with respect to the use of the building, the material or the service.

Buildings to which these regulations may apply are called 'relevant buildings'.

If plans of a relevant building are deposited with a local authority they may be rejected, or if passed contain conditions including a time limit for removal of the building. Other reasonable conditions may be applied but must not conflict with conditions in a planning permission.

Anyone constructing a relevant building without first depositing plans may be required by the local authority to remove the building. A council may allow the building to remain, subject to conditions. Proceedings may be taken against the owner.

Where regulations have not required the deposit of plans with a local authority, but it thinks that the structure is a 'relevant building' it is given 12 months in which to take action. It can require removal of the work within a stated time or agree to retention subject to conditions. Periods may be extended at a local authority's discretion.

A person aggrieved by having his plans rejected, or by the period allowed, or by the conditions may appeal to the Secretary of State.

At the end of the period allowed, and when there has been no extension of time, the owner must remove the work or building.

Anyone contravening the council's requirements may upon conviction be subject to a fine and also a continuing daily penalty of up to £50 for each day the offence continues.

### **Provision of exits**

Plans of buildings listed below must contain such means of ingress and egress and



passages or gangways as a local authority, after consultation with the fire authority, says are necessary. If the plans do not comply then they will be rejected.

- Theatre, hall or other building used as a place of public resort.
- Restaurant, shop, store or warehouse to which members of the public are admitted, and in which more than 20 persons are employed.
- Club registered under the Licensing Act 1964.
- School not exempted from building regulations.
- Church, chapel or other place of public worship.

The requirements do not extend to include:

- Private houses to which members of the public are admitted occasionally or exceptionally.
- Buildings used as a church or chapel or other place of worship before section 36. Public Health Acts Amendment Act 1890 came into force.
- A building used prior to October 1 1937 where the 1980 Act, or any similar local provision, never came into operation.

Once again, disputes may be settled by a magistrates' court.

### **Building over a sewer**

When plans deposited with a local authority indicate that a building or an extension will be erected over a sewer or drain on the council's map of sewers, the plans must be rejected. However, the council has discretion to pass the plans if the circumstances are acceptable, or it may pass the plans subject to conditions. Frequently this involves entering into a legal agreement regarding responsibilities for access and damage to the sewer and the building.

If there is a disagreement this may be placed before a magistrates' court for a decision.

### **Provision of drainage**

Buildings and extensions are to be provided with satisfactory drainage unless the local authority decides that it may properly dispense with any provision for drainage.

'Drainage' includes the conveyance by means of a sink and any other necessary appliance of refuse water. It also includes rainwater from roofs.

To be satisfactory, drainage must be made to connect with a sewer, or discharge into a cesspool or some other suitable place.

The council cannot require connection to a sewer unless it is within 100 ft. of the site of the building or extension. Also if the sewer is not 'public', that the developer has a right to connect. Additionally the developer must be entitled to put his drain through any intervening land.

If a sewer is more than 100 ft. away from a building the local authority may require connection thereto, if it is prepared to make a contribution to the cost, not only of the extra pipework, but of maintenance and repairs in the future.

Differences between developers and the council may be settled in a magistrates' court.

### **Drainage in combination**

If a local authority thinks it would be more economical or advantageous that two or more buildings should be drained in combination it may require the owners to do so. Alternatively it may do the work on behalf of the owners.

When making this arrangement the local authority must:

- fix the proportions in which the cost of constructing, maintaining and repairing the private sewer is to be borne by the owners;
- where the distance of the existing sewer from the site exceeds 100 ft., fix the proportion of costs between owners and the council.

A sewer constructed by a local authority under these arrangements is not automatically a public sewer. An owner who is aggrieved by a local authority's decision may appeal to a magistrates' court.

### **Refuse facilities**

Plans shall be rejected by a local authority if they do not show satisfactory means of access from the building to the street for the purpose of removing refuse. Proper provision must also be made for storing refuse prior to removal.

It is unlawful to block an access provided for the removal of refuse. Any dispute may be determined by a magistrates' court.

### **Water supply**

When plans of a house are deposited they must indicate that a sufficient supply of wholesome water will be available, adequate for domestic purposes.

If the proposals have not been carried into effect and a supply of wholesome water is not available then the local authority may prohibit occupation of the building.

Disagreements may be resolved by recourse to the magistrates' court, and convictions can result in a fine including a continuing fine of £2 per day so long as the offence continues.

### **Closets**

Deposited plans must indicate that sufficient and satisfactory closet accommodation will be provided. Water closets are required unless an adequate supply of water is not available, when earth closets or chemical closets may be used.

In factories or workplaces separate closet accommodation is to be provided for each sex.

Any question arising between the local authority and an applicant may be determined on application to a magistrates' court.

### **Bathrooms**

Plans showing new dwellings or conversions creating dwellings must indicate that each separate dwelling is to be provided with a fixed bath or a shower. There must be suitable provision for hot and cold water to each bath and shower.

### **Larders**

When new dwellings are erected or there is a conversion creating a new dwelling, plans may be rejected unless they show suitable and sufficient accommodation for the storage of food. Alternatively there must be sufficient and suitable space for the provision of such accommodation by the occupier.

### **Offensive material**

When it is proposed to erect a building on ground that has been filled with offensive mater, or ground upon which any faecal, offensive, animal or vegetable matter has been deposited the council must reject the plans.

It is open for the applicant to show that the offensive material has been removed or has become or been rendered, innocuous.

### **Settling disputes**

Disputes between a local authority and a person who has executed, or prooses to execute work may be settled by the Secretary of State.

An application must be made jointly to him and decisions will be made under three heads:

- the application to that work of any building regulation;
- whether the plans are in conformity with the regulations;
- whether the work has been executed in accordance with plans passed by the authority.

### **Departure from plans**

An order may be made to ensure that when plans have been passed it is possible to deposit further plans showing a departure or deviation. The usual procedures will then apply.

### **Lapse of plans**

When work covered by plans which have been approved is not commenced within three years the local authority may serve a notice saying that the plans are of no effect.

### **Tests**

Local authorities are given power to ascertain:

- whether any provision in the building regulations would be contravened by anything done or proposed to be done.

In order to fulfil this power a person may be required to carry out reasonable tests, or the local authority may carry out tests and take samples.

Tests may include:

- soil or subsoil;
- materials or components;
- services, fitting or equipment.

For these purposes a council may require the owner of a building to carry out reasonable tests or itself carry out tests and take samples.

Costs of carrying out the tests are to be borne by the developer although the local authority has a discretion to bear the cost, or part of the cost itself.

Disputes may be referred to a magistrates' court for a ruling.

### **Classification of buildings**

Buildings may be classified by reference to size, description, design, purpose, location or any other characteristic.

### **Penalty**

For contravening building regulations there may, upon conviction, be a fine of up to £1000, and a further fine of £50 per day so long as the default continues.

### **Independent report**

If a local authority has served a notice requiring work to be put right, the recipient may tell the council that he intends to obtain a written report from a suitably qualified person.

When obtained the local authority must consider the independent report. If as a result it withdraws its notice it may pay reasonable expense incurred in obtaining the report.

The action of obtaining a report delays implementation of the council's notice from 28 to 70 days.

### **Offending work**

If any work contravenes building regulations the local authority may take proceedings for a fine, and also may require the owner.

- to pull down or remove the work, or
- if he wishes, to do such alterations as will make it comply with the regulations.

The owner has 28 days in which to comply, after which the council may undertake the work and recover reasonable expenses from him.

A local authority may not require the owner to put work right if:

- the plans were passed by the authority, or
- notice of their rejection was not given within the relevant period from their deposit, and the work has been carried out in accordance with the plans.

This does not prevent the local authority, the Attorney General or any other person from applying for an injunction to have the matter put right. In this event the court may require the council to pay the owner compensation.

### **Civil liability**

A breach of duty imposed by building regulations may be actionable if it causes damage. Compliance with building regulations may provide a defence.

'Damage' in this context includes death of, or injury to any person. This also includes any disease and any impairment of a person's physical or mental health.

### **Refusal to relax regulations**

If a local authority refuses to relax or dispense with the requirements of a building regulation the applicant has one month during which he may appeal to the Secretary of State.

The council must give a decision within two months of the date of the application or such other extended period agreed by the applicant.

An appeal to the Secretary of State must be sent to the local authority who is required then to forward it to the Department of the Environment at once, together with a copy of the application and all the documents furnished by the applicant. The local authority must

also state its case, sending a copy to the applicant.

### **Alteration of offending work**

A person aggrieved by a notice requiring him to pull down or remove work may appeal to the magistrates' court.

If the court decides that the council acted correctly it will confirm the notice. In every other case the local authority will be given a direction to withdraw the notice.

An appeal must be made within 28 days, or 70 days, when an independent report is being obtained.

### **Crown Court**

If a person is aggrieved by a decision of a magistrates' court he may appeal to the Crown court.

### **High Court**

An appeal to the High Court on a point of law may be made following a Secretary of State's decision relating to:

- passing of plans;
- materials unsuitable for a permanent building;
- relaxation of regulations;
- plans certificates.

### **Hearing**

When an appeal is made to the Secretary of State about the use of unsuitable materials in a permanent building or a refusal to relax regulations he may give the council and the applicant the opportunity of stating a case before an Inspector.

### **Crown Buildings**

Generally substantive requirements of building regulations apply to work carried out by or on behalf of the Crown, but there are exceptions.

### **Atomic Energy Authority**

Substantive requirements of building regulations may also apply to United Kingdom Atomic Energy Authority Buildings.

### **Drainage of buildings**

A local authority may require an owner to remedy the matter when any of the following situations arise:

- satisfactory provision has not been made for the taking away by means of a sink or other necessary appliance, refuse water or the conveyance of rainwater from roofs;
- a cesspool, soil pipe or any part of a drainage system is insufficient or so defective as to allow subsoil water to penetrate;
- a cesspool, appliance or drainage system is in such a condition as to be prejudicial to health or a nuisance;
- a cesspool or drainage system not now in use, but which is prejudicial to health or a nuisance.

This does not apply to property belonging to statutory undertakers, the British Airports Authority, or the Civil Aviation Authority, unless:

- it is a house;
- it is a house or a hotel owned by the British Airports Authority;
- it is a building used as offices or showrooms not forming part of a railway station;
- it is a building used as offices or showrooms and not on an aerodrome owned by the British Airports Authority or the Civil Aviation Authority.

### **Soil and vent pipes**

A rainwater downpipe is not to be used for discharging the soil or drainage from sanitary conveniences.

WC soil pipes are to be properly ventilated.

A pipe for surface water must not be used as a vent for a drain or sewer carrying foul water.

### **Drainage repairs**

It is not lawful to repair, reconstruct or alter the course of an underground drain that joins a sewer, or a cesspool without giving the council 24 hours notice of the intention.

This requirement does not apply in the case of genuine emergency. In an emergency the work may be undertaken, but left uncovered for the council to inspect.

### **Disconnecting drains**

When a drain is reconstructed in the same or a new position or the use of a drain is permanently discontinued, the drains which become disused or unnecessary are to be disconnected and sealed.

Questions regarding the reasonableness of a local authority's requirements may be determined by a magistrates' court.

No-one may be required to carry out work on land if he has no right to enter the land for that purpose.

Before undertaking this kind of work at least 24 hours notice must be given to the council.

Non-compliance can attract a fine upon conviction, and also a daily penalty.

### **Improper construction**

If a water closet, drain or soil pipe is so badly constructed or repaired as to give rise to conditions prejudicial to health or a nuisance the person responsible may be charged with an offence and upon conviction, fined.

### **Provision of closets**

Where a building, or a dwelling, is without sufficient closet accommodation, or any closets that have been provided are in such a state as to be prejudicial to health or a nuisance, the local authority may require adequate provision to be made.

Unless an adequate supply of water and a sewer is available, a new water closet may not be required except in substitution of an existing water closet.

This particular requirement of the Building Act does not apply to a factory, a workplace or premises to which the Offices Shops and Railway Premises Act 1963

applies.

### **Workplaces**

A workplace must be provided with sufficient and satisfactory sanitary conveniences for the number of people working in, or in attending at the building.

Separate accommodation is required for the sexes.

This section does not apply to buildings covered by the Offices Shops and Railway Premises Act 1963.

### **Replacing earth closets**

If there is a sufficient water supply and sewer available a local authority may require a water closet to be substituted for an earth closet.

When this happens the council must pay one-half of expenses reasonably incurred.

### **Loan of toilets**

When reconstruction, maintenance or improvement work necessitating disconnection of sanitary conveniences is being carried out, the local authority may supply on loan temporary sanitary conveniences. No charge will be made for the first seven days the toilet is on loan.

### **Public conveniences**

No-one may erect a public sanitary convenience without the prior consent of the local authority, who may require its removal at any time.

Anyone aggrieved by a local authority's refusal, or conditions imposed, may appeal to a magistrates' court.

These limitations do not extend to official bodies including British Rail and Dock undertakings.

### **Water supply**

If an occupied house has not got a supply of wholesome water in pipes in the house, the council may require the house to be connected to a public supply. If a public supply is not available, but another source is, then that water may be taken into the house in pipes.

There is provision for an appeal to a magistrates' court.

### **Food storage**

A local authority may require the provision of sufficient and suitable food storage accommodation in an occupied dwelling. The recipient of a notice requiring the provision of a larder may appeal to a magistrates' court.

### **Entrances and exits**

When a building is not provided with entrances and exits, and passageways or gangways which are necessary, having regard to:

- the activities being carried on in the building, and
- the number of people likely to be present at any one time the local authority may require work to meet their standards.

Before doing so they are obliged to consult the fire authority.

The Fire Precautions Act 1971 section 30 (3) applies.

Buildings affected are:

- theatre, hall or other building used as a place of public resort;
  - restaurant, shop, store or warehouse to which members of the public are admitted, and in which more than twenty persons are employed;
  - club registered under the Licensing Act 1964;
  - school not exempted from building regulations;
  - church, chapel or other place of public worship.
- Disputes may be settled by a magistrates' court.

### **Means of escape**

If a local authority thinks that a building or proposed building has unsatisfactory means of escape in case of fire it may require the owner to make adequate provision.

Before doing so the fire authority is to be consulted, and the work required is limited to those storeys whose floor is more than 20 feet above the ground.

Requirements apply to a building:

- let in flats or tenement dwellings;
- an inn, hotel, boarding house, hospital, nursing home, boarding school, childrens' home or similar institution;
- restaurant, shop, store or warehouse which has sleeping accommodation on an upper floor.

The Fire Precautions Act 1971 section 30(3) applies.

### **Raising chimneys**

When a taller building is erected alongside, or within six feet of chimneys in an existing building, the developer may be required to raise the height of the existing chimneys. The top of the existing chimneys are to be raised to the same height as the top of the chimneys in the taller building or the top of the taller building, whichever is the higher.

There are penalties upon conviction for failure to comply with a council's notice in this connection. There is also facility for appealing to a magistrates' court against the requirement.

### **Cellars**

Anyone wishing to construct a cellar which is lower than the ordinary level of subsoil water as part of a house, shop, inn, hotel or office must get consent from the local authority.

Exceptions are cellars subject to a justices license or which are part of premises on a railway station.

Contraventions may result in a fine upon conviction.

A local authority consent may contain conditions.

There are various powers available to a local authority in the Public Health Act and the Housing Act 1957 dealing with defective premises.

However, the procedures there are very lengthy and where any premises are in such a defective state as to be prejudicial to health or a nuisance, a much faster procedure is available in the Building Act 1984.



The council may serve a notice on the person it considers responsible, stating that it intends to remedy defects and saying what work it intends to undertake. Nine days after giving this notice the council may execute the necessary work and recover its expenses from the person on whom the notice was served.

It is open for the person receiving one of these notices to reply within seven days saying that he will remedy the defects himself, and the local authority must then take no action.

However, if the repairs are not begun within a reasonable time, or having begun, the work does not proceed at a reasonable rate, the local authority may move in.

When it comes to recovering expenses and the matter gets to court the council must establish that the premises were in a defective state, and that repairs had to be undertaken as a matter of urgency. If the defendant had served a counter notice he must establish that he commenced work promptly and made reasonable progress.

Should the court find that the council was not justified in serving the notice, or that the work had progressed satisfactorily, the local authority may not recover its expenses or any part of them.

The local authority must not require or undertake work which would offend a building preservation order affecting the building.

### **Dangerous buildings**

Legislation has existed in several statutes relating to the procedures to be followed when a building becomes dangerous. They were the Public Health Act 1936, sections 58 and 296 and the Public Health Act 1961 sections 24, 25 and Schedule 5.

Now the requirements have been gathered together in the Building Act 1984. When a council thinks that a building or structure, or part of a building or structure is in such a condition or has to carry such loads as to be dangerous it may apply to a magistrates' court for an order that the danger be removed.

Buildings that are dangerous because of defects in the structure may result in the court requiring repairs to be undertaken, or the owner may, if he wishes, demolish part or all of the building and take away all rubbish resulting from the demolition.

The magistrates may make an order restricting the use of a building which is overloaded.

The owner will be given a period during which work will be completed and if this target is not achieved, the local authority may step in and put matters right.

Expenses reasonably incurred are recoverable from the owner.

### **Emergencies**

There are occasions when emergency action is necessary to make safe a dangerous building. In these cases a local authority may take immediate action to undertake work itself without prior reference to a court. If it is reasonably possible it must give notice of its intentions to the owner and the occupier.

Expenses relating to fencing off the building, or arranging for it to be watched, may be recovered from the owner.

Owners not paying the expenses may be taken to court. The court will not allow expenses if they conclude that the condition of the building did not warrant emergency action.

The local authority is required to take care that no one sustains damage by reason of its action.

### **Detrimental to amenity**

Occasionally a building or structure becomes so ruinous or delapidated that its appearance is detrimental to the neighbourhood.

One would expect that powers to remedy such a situation would be included within the Planning Acts, and not a Building Act, which deals with this problem.

A local authority has powers to require that a building be repaired or restored in the interests of amenity. The owner on receiving a notice to do works of repair or restoration may opt to demolish the property and if he does, all rubbish must be removed from the site and any adjoining land.

Any freedom to express a choice of either repair or demolition must be exercised carefully if the building is listed as being of architectural or historic interest, or is within a conservation area. A separate permission to demolish is required.

### **Notice of intended demolition**

Before a building is demolished the local authority must be notified, together with the gas and electricity undertakings.

This gives the local authority the opportunity of responding with any number or all of the requirements in the Act.

The requirements are:

- shore up any adjacent building;
- weatherproof surfaces on adjacent buildings exposed by the demolition;
- repair damage caused on adjacent buildings;
- clear away rubbish and material arising from demolition;
- disconnect and seal any drain or sewer;
- remove sewers or drains and seal any sewer or drain to which they were connected;
- make good disturbed ground surfaces;
- disconnect gas, water and electricity services;
- arrange any burning of structures or materials with the Health and Safety Executive and the fire authority;
- take steps to make site tidy and protect public amenity.

The person undertaking demolition must give the local authority 48 hours notice when undertaking work on drains and sewers, and 24 hours notice before making good ground surfaces.

Notice of demolition is not required when:

- the work is in consequence of a demolition Order under the Housing Act 1957;
- demolishing an internal part of a building which will continue to be occupied;
- building has less than 1750 cu. ft. or when a greenhouse, conservatory, shed or prefabricated garage forms part of a large building;
- an agricultural building is contiguous to another building that is not an agricultural building.

### **Appeals**

Anyone receiving a notice from a local authority that work is required in consequence

of demolishing a building may appeal to a magistrates' court.

Among the reasons for appealing are:

- that the owner of an adjacent building is not entitled to support and ought to pay or contribute towards the cost of shoring;
- that the owner of an adjacent building ought to pay for or contribute towards the cost of waterproofing any exposed surfaces.

Copies of the appeal are to be sent to any person or person named in the appeal.

**The most outstanding change in building control legislation centres around the controversial provisions in the Building Act 1984 relating to surveillance of building work otherwise than by local authorities, although they are involved. In the future it will be possible for the supervision of plans and work to be carried out by 'approved inspectors'.**

These people will be in private practice and may at the option of the person intending to carry out the work, supervise construction instead of a local authority building control staff. Several new terms are introduced into building control vocabulary such as 'initial notice', 'plans certificate' and 'final notice'.

An 'approved inspector' may achieve his status in one of two ways. He may be approved by the Secretary of State, or by a body or organisation which in accordance with regulations is designated by the Secretary of State for that purpose.

Any such approval may limit the work in relation to which the person concerned is an approved inspector.

The Building Act says that regulations may be made to:

- require the payment of a fee to become an approved inspector;
- provide for the withdrawal of approval and also the removal of designation of an approved body;
- provide that lists of designated bodies and approved inspectors are prepared and kept up to date.

The responsibilities of an approved inspector include the duty of consulting any stipulated person before taking any prescribed step in connection with work or other matters to which building regulations are applicable.

Approved inspectors may make charges for carrying out their responsibilities. Fees charged are to be agreed between an approved inspector and the person who intends to carry out the work.

An approved inspector may arrange for another person to inspect plans or work on his behalf. However he may not delegate the giving of 'plans certificates' or 'final certificates' to any other person. Delegation will also not affect his liability whether civil or criminal if it arises out of functions conferred upon him by the Act or by any building regulation.

An approved inspector is also liable for negligence on the part of anyone carrying on any inspection on his behalf as if it were negligence by a servant acting in the course of his employment.

Regulations say that an approved inspector must:

- ensure that the work will achieve reasonable standards for protection of the health and safety of persons in or about the building and that the work will conform with provisions for the conservation of fuel and power, and facilities for disabled persons;

- ensure that there is satisfactory provision for drainage.

A suitably qualified person wanting to be an approved inspector may apply to the Secretary of State or one of the bodies designated by him to undertake the task of examining or vetting applicants.

In practice it is expected that possibly eight of the existing professional bodies will be designated for this purpose. Great care will be necessary to ensure that the standard of acceptance is co-ordinated to some form of common syllabus. It is expected that in addition to professional qualification, demonstration of knowledge of building regulations and several years' experience will be necessary before approval can be achieved.

Initial consultation papers from the DoE suggested that there should, be several degrees of responsibility depending on the experience of an individual. One suggestion was that some inspectors should be able to certify housing up to three storeys. Others could have responsibility for housing above that level, buildings of framed or crosswall construction, buildings where special fire precautions were necessary and buildings with large span roofs.

It has since been recognised that even those people with the highest qualifications and longest experience might in some cases, not have all the specialist skills relevant to all aspects of building regulations.

Therefore it is vital that an approved inspector should recognise the limitations of his own knowledge, and the need to obtain advice from specialists.

Recognition may be withdrawn from an approved inspector, and provision will also be made for the removal of designation from an approved body.

### **Responsibilities**

Approved inspectors may at the option of a person intending to carry out work, supervise construction instead of a local authority.

The person intending to carry out work and his approved inspector are each required to tell the local authority of the arrangement. This is achieved by completing a form called an 'initial notice'. When these notices are sent to a council they must be accompanied by some plans and evidence of insurance cover relating to the work.

If an initial notice is accepted by the council, the approved inspector may then undertake the prescribed functions with respect to the inspection of plans, supervision of the work and the giving of certificates and notices.

A local authority may not reject an initial notice unless it fails to comply with a list of requirements to be set out in regulations. An initial notice must be rejected if it fails to meet any of the prescribed grounds. The council has no discretion in this matter.

### **Initial notice rejection**

Anticipated grounds for the rejection of an initial notice are as follows:

- the forms, plans information and certificates are incomplete. There is no copy of the document showing the person to be an approved inspector.
  - not signed by the approved inspector;
  - does not show satisfactory provision for removal of refuse, or building over a sewer;
  - drainage is not satisfactory;
  - the approved inspector has not signed a declaration that he does not have any direct or indirect financial interest in the work;

- an initial notice has already been given;
- there is not undertaking to consult a fire officer if this is necessary;
- no indication that any local enactment affecting the work is to be complied with.

Certain quite small works are excluded from the requirement that an approved inspector shall not have a direct or indirect professional or financial interests in a project he certifies. These are alterations or extensions of a dwelling house of two storeys or less.

The Public Health Act 1936 enabled a local authority to attach conditions when passing plans, but not actually relating to the implementation of the regulations themselves. They are now listed in the Building Act 1984, sections 18 to 29.

Where, when considering an initial notice, it is apparent to a local authority that they could under the existing plan deposit arrangements have imposed a condition on passing plans, they may impose similar requirements following receipt of an initial notice.

Local authorities are given a minimal time in which to consider an initial notice. This is not stated in the Act but is expected to be prescribed in regulations as ten days. Within this period the local authority must give notice of rejection, specifying the grounds in question to each of the persons by whom the initial notice was given. If they fail to do so within the time allowed the authority shall be conclusively presumed to have accepted the initial notice and have done so without imposing any requirements.

An initial notice comes into effect when it is accepted by a local authority and continues in force until it is cancelled, or until six weeks after completion of the work.

Regulations may empower a local authority to extend the life of an initial notice.

The form of the initial notice has been drafted and both the person undertaking the work and the inspector give the notice and furnish all the information required.

This is:

1. description of the work and its location;
2. use of building;
3. name of approved inspector;
4. name of person intending to carry out the work;
5. to be accompanied by:
  - a. block plan;
  - b. copy of inspectors approval document;
  - c. declaration of insurance;
  - d. drainage outfall details;
  - e. whether proposal is over a sewer or drain;
  - f. relevant local enactments;
  - g. whether the work is minor;
  - h. declaration that the inspector is aware of his obligations.

The form is to be signed by both the inspector and the person intending to carry out the work.

Regulations are to be made imposing requirements with respect to the provision of insurance cover against the occurrence of defects; in particular:

- prescribe the form and content of policies, and
- make provision for the approval of schemes of insurance.

**Professionals in private practice, whether as engineers, architects or surveyors may in the future qualify to become 'approved inspectors' for the purpose of building control. Some may even create practices devoted to building control consultancy. Self certification may only take place where the person is an approved inspector and the works are very minor. According to draft regulations minor works are alterations or extensions to dwelling houses which have two storeys or less.**

Earlier we outlined the appointment of approved inspectors and how a person intending to carry out work, and the approved inspector appointed for the job, had to serve an 'initial notice' on the local authority.

An essential ingredient of this scheme is the possession of adequate insurance cover for each job. Proposals are to be prepared by the insurance industry, and must be approved by the Secretary of State before being used by approved inspectors.

Before a scheme is approved it is suggested that the Secretary of State must be satisfied that at least four requirements are met:

- the cover is provided by an insurer authorised by the Insurance Companies Act 1982;
- there is an indemnity for the owner of the works and his successors, in respect of repairing damage attributable to non-compliance with the building regulations. This cover must last for ten years;
- there is also indemnity for the owner and his successors against the consequences of neglect by the person who gave the initial notice if defects appear within fifteen years of giving the final certificate. Liability must not be less than £500,000 plus the value of work to which the cover relates;
- there must be insurance providing for the increase of the amount of cover by reference to an index of building costs or 15 per cent.

### **Effect of initial notice**

So long as an initial notice remains in force the function of enforcing building regulations conferred on a local authority is removed from work which is specified in the notice.

In consequence a local authority may not:

- give notice requiring the removal or alteration of any work which contravenes building regulations;
- institute proceedings for any contravention of the building regulations which arises out of carrying out the work specified in an initial notice.

The giving of an initial notice covers the developer's responsibilities under several enactments, and for this purpose:

- the giving of an initial notice accompanied by plans, is to be treated as the deposit of plans;
- plans accompanying any initial notice are to be treated as deposited plans;
- the acceptance or rejection of an initial notice is regarded as the passing or rejection of plans;
- should an initial notice cease to be in force it is to be treated as a declaration that the plans are of not effect.

The enactments referred to are as follows:

(a) the power contained in section 36(2) Building Act 1984, which enables a local authority to require work which has been undertaken without the deposit of plans, or notwithstanding the rejection of plans, to be pulled down or removed;

(b) the provision whereby a local authority may not require removal of work shown on plans they have approved;

(c) the power of a local authority, or the Attorney General to obtain an injunction for certain contraventions;

(d) building over sewers;

(e) the advance payments code;

section 219 to 225 of the Highways Act 1980.

For the purposes of section 13 of the Fire Protection Act 1971 the acceptance of an initial notice by a local authority is to be treated as a deposit of plans.

### **Cancellation of initial notice**

Where an initial notice is in force and the approved inspector:

- expects to be unable to carry out his functions, or
- is unable adequately to carry out his functions, or
- is of the opinion that there is a contravention of any provision of building regulations with respect to any of the work, he must cancel the initial notice, by informing the local authority and also the person carrying out the work.

In the event of contraventions the approved inspector must, before cancelling the initial notice, give notice of the contravention to the person carrying out the work. If after three months that person has neither pulled down nor removed the work, nor effected such alterations in it as may be necessary to secure compliance with building regulations, then the approved inspector has no option but to cancel the initial notice.

If at any time it appears to the person carrying out or intending to carry out the work specified in an initial notice that the approved inspector is no longer willing or able to carry out his function he must cancel the initial notice. The cancellation must be sent to the local authority, and where practicable, to the approved inspector. Failure to give this notice to a local authority may result in a fine upon summary conviction.

### **Initial notice ceasing to have effect**

There are provisions which apply when an initial notice ceases to be in force. They are quite involved and apply when an initial notice is no longer operative because:

- it is cancelled by the approved inspector saying that he is unable to carry out his functions, or that he is unable to secure a remedy for defective work;
- it is cancelled by the person carrying out the work when it appears to him that the approved inspector is no longer willing or able to carry out his functions;
- the period covered by an initial notice, if one has been prescribed, has expired.

Building regulations may be made to provide that, if:

(a) a plans certificate was given before the day on which the initial notice ceased to be in force, and

(b) that certificate was accepted by the local authority (before, on or after that day), and

(c) before that day, acceptance was not rescinded by a notice that the work had not been commenced within three years of the date when the plans certificate was accepted, then, with respect to the work set out in the certificate the local authority may not give

notice for the removal or alteration of work contravening the building regulations or institute proceedings in respect of contraventions.

However, draft building regulations say that a local authority may ask for work to be opened for checking when a final certificate does not exist, when a final certificate has been rejected or the building has been occupied six weeks and no final certificate has been received.

When, on occasions before the initial notice ceases to be in force a final certificate was given in respect of part of the work and accepted by a local authority, before on or after that date, the fact that the initial notice has ceased to be in force does not affect the continuing operation of a requirement that the local authority may not give notice for the removal or alteration of work contravening the regulations or institute proceedings in respect of contraventions.

Notwithstanding anything just outlined, the local authority is given powers referring to any part of the work not specified in a plans certificate, or a final certificate. Building regulations may require the submission of plans which relate not only to that part, but also to the part to which the certificate in question relates.

Any notices which may be served and are normally required to be given within twelve months of a contravention are now to be served within twelve months of the date the initial notice ceased to be in force.

Authority is given for new building regulations to provide that if, before the initial notice ceased to be in force a contravention of building regulations was committed with respect to work specified in the notice summary proceedings may be taken. This must be within six months of the initial notice ceasing to be of effect.

If an initial notice has ceased to be in force and no final certificate has been given and accepted it is possible to give a new initial notice.

However, where:

- a plans certificate relates to any of the work, and
- a plans certificate was given before an initial notice ceased, was accepted and not rescinded, or
- the initial notice was given and accepted the responsibilities of an approved inspector do not apply to work contained in the new initial notice which is specified in the plans certificate.

The whole purpose appears to provide that where no final certificate is issued by the approved inspector supervision of any part of the work which has not been certified becomes the responsibility of the local authority. A maximum fine of £1000 is provided for failure to serve certain notices.

**The Building Act 1984 makes provision for building control to be exercised by persons other than building control officers employed by the local authority. Suitably qualified people may become approved inspectors and undertake the checking of plans and inspection of work to secure compliance with the building regulations. They must be adequately insured within schemes which are approved and upon appointment send in 'initial notices' to the local authorities.**

### **Plans certificates**

When an approved inspector has examined plans and is satisfied that they are neither



defective nor show that the work would contravene building regulations, and when he has complied with any prescribed requirements as to consultation or otherwise, he must, if requested to do so by the person intending to carry out the work, give a 'plans certificate' to the local authority and that person.

It may be possible for an approved inspector to give an initial notice and a plans certificate at the same time on a special combined notice form.

A plans certificate:

- may relate either to the whole or part of the work specified in the initial notice, and
- will not have effect unless it is accepted by the local authority to whom it is given.

However a local authority may not reject a plans certificate except on grounds which are set out in regulations. They must reject the certificate if any of the specified grounds are found to exist.

If the rejection is not sent to the approved inspector and the other person to whom the approved inspector gave the certificate within ten working days then the authority shall be conclusively presumed to have accepted the certificate.

Should a dispute arise between the approved inspector and the person proposing to carry out the work, the matter may be referred to the Secretary of State for a determination. A fee may be charged.

When issuing a plans certificate the approved inspector is required to give the following information:

- a description of the work and its location;
- a declaration that he is the approved inspector appointed for this work and referred to in the initial notice;
- a declaration of insurance;
- a statement that he has examined plans of the work and that he is satisfied that they are not defective. He must also say that work carried out in accordance with the plans would not contravene any building regulations;
- indicate whether the fire authority had been consulted;
- a statement that the work is, or is not, minor work;
- a statement that he has no direct or indirect professional or financial interest;
- a list of plans received giving date and reference number of each plan;
- the certificate must be dated and signed.

Draft regulations say a local authority may reject a plans certificate if:

- it is not on the proper form;
- the certificate does not specify the work to which it relates, or the plans to which it relates;
- there is no initial notice in force;
- it is not signed by the inspector who gave the initial notice, or the person is no longer an approved inspector;
- the certificate does not contain a declaration that the fire officer has been consulted, where it is necessary;
- there is no declaration signed by the insurer that a named scheme of insurance relates to the work;
- there is no declaration that the approved inspector does not have any direct or indirect financial investment.

If, following receipt by a local authority of a plans certificate, the work to which it relates has not commenced within a period of three years the authority may rescind acceptance of the certificate.

### **Final certificates**

Local authority enforcement powers cannot be exercised in respect of work which has been supervised by an approved inspector.

When an approved inspector is satisfied that the work contained in an initial notice has been completed he must give to the local authority and the person for whom the work was carried out, a 'final certificate'. This final certificate will indicate completion of the work and the discharge of his functions by the approved inspector.

The form of a final certificate is prescribed in the regulations, and must contain the following:

- a description of the work and its location;
- a declaration that the person completing the form is an approved inspector and that the work was the subject of an initial notice;
- that the work has been completed, that he is satisfied within the limits of professional skill and care that the work:
  - 1) complies with the required standards for health and safety;
  - 2) complies with requirements for fuel and power conservation;
  - 3) meets requirements for facilities for the disabled;
  - 4) has satisfactory provision for drainage;
  - 5) has satisfactory provision for ingress and egress and passages or gangways.
- a declaration of insurance;
- statement that fire authority has been consulted if appropriate;
- whether the work is or is not minor work;
- a certificate that the approved inspector has no direct or indirect professional or financial interest in the work;
- the date, and signature of the approved inspector.

In the same way, and subject to conditions which are to be prescribed, final certificates may be given to and rejected by a local authority. If within ten days which are allowed a local authority does not give notice of rejection the council will be conclusively presumed to have accepted the final certificate.

Draft regulations say a local authority may reject a final certificate if:

- it is not on the proper form;
- the certificate does not specify the work;
- no initial notice applies to the work;
- the certificate was not signed, or the person is no longer an approved inspector;
- the certificate does not contain a declaration that insurance cover exists;
- the certificate does not contain a declaration that the fire officer has been consulted where necessary;
- there is no declaration regarding direct or indirect financial or professional interest.

So long as an initial notice remains in force the local authority may not require the removal of defective work or institute proceedings for contraventions.

Another clause takes this requirement further. It provides that when a final certificate

has been given to and accepted by the local authority, the initial notice will cease to apply to that work. Even so, the local authority may not require the removal of defective work or institute proceedings for contraventions.

**Changes in building control arrangements will enable a developer to employ an approved inspector to check his plans, inspect the work in progress and finally give a certificate that all is in order.**

**Running alongside this arrangement is the facility of sending plans to the local authority. But this is to be varied from the way things have been done for many years. A person intending to carry out work, or to make a material change of use, is to have the option of giving a local authority a ‘building notice’ or deposit full plans.**

An outline of the requirements surrounding a building notice is set out below.

However this procedure cannot be used:

- when the regulations require means of escape to be provided in the building in case of fire;
- when the work is on a building intended to be put to a designated use under section 1 of the Fire Precautions Act 1971, (Compulsory fire certificates).

Anyone deciding to use this procedure is required to send a building notice to the council containing the following information.

- a description of the work or material change of use;
- details of location, the number of storeys and proposed use of the building.

When the proposal is for a new building or an extension, there must also be:

- a block plan to a scale of 1:500 showing size and position of building and its relationship to adjoining boundaries;
- the curtilage, and the size, position and use of every other building or proposed building within the curtilage;
- width and position of any adjoining street;
- details of drainage;
- provision being made for entrances and exits, passages and gangways.

The local authority, upon receipt of a building notice, may ask for plans ‘as may reasonably be required by them in the discharge of their functions’. They must be provided within a reasonable time.

A building notice and any accompanying plans are not to be treated as having been deposited. In this respect section 16 of the Building Act 1984 says that a local authority on receipt of deposited plans must approve them or reject them or approve them in part, within five weeks. The effect of this arrangement is to put the local authority in a position where it is not given the power to approve or reject plans of a minor character, because they will not have been deposited. Neither will they need the services of an inspector.

Examples embrace many small buildings and extensions, including:

- the erection of a dwelling house of not more than two storeys;
- a building containing flats but not of more than two storeys;
- a material change in the use of a building of not more than two storeys for use as a dwelling house;
- loft conversion of a bungalow.

The building must of course be erected to comply with the regulations. The person carrying out the building work is required to give the usual notices of commencement and

at various stages of work and at completion.

The notices to be given are similar to those now in use. However whereas at the present time all notices must be in writing, it will be possible in future for notices to be given by such other means as the builder and local authority may agree.

This idea of an optional deposit of plans, or the giving of a building notice allows developers to choose whether they wish to deposit full plans with the council as they do at the present time, or whether they wish to avoid the routine of getting approval or rejection to their proposal, by providing only outline information.

If a developer chooses to deposit full plans then the authority must deal with them in the same way as in the past. In this respect passed plans give the builder protection against enforcement notices which have been enjoyed under Section 65 Public Health Act 1936; now replaced by Section 36 Building Act 1984.

The builder may think that his project is so straightforward that he does not need the protection of passed plans. He may also be satisfied that informal discussions with the building control officers had solved any possibility of disagreements arising during the progress of his scheme.

In these circumstances the local authority, on receipt of a building notice, would not be able to insist on the supply of full plans. They will nevertheless be able to ask for any extra information reasonably needed to enable them to discharge their functions in enforcing the regulations, and the listed powers in public and local legislation.

The local authority will still be able to take action against contraventions found in the course of the work. It appears that the arrangements are proposed to reduce the need for unnecessary bureaucratic procedures.

This proposal has, in some part, been derived from arrangements in inner London, where for many buildings there is no requirement for prior approval of plans.

### **Full plans**

The alternative to giving a building notice is to deposit full plans with a local authority. Such plans must be approved, rejected or approved in part, as at present.

Full plans may be deposited for any work which could be covered by a building notice, at the builder's option, but there are proposals for which plans must be deposited. They are:

- a dwelling house having more than two storeys;
- addition of a third storey to a two storey dwelling house, and this includes loft conversions;
- buildings having flats in more than two storeys;
- shops;
- offices;
- material change of use in a building or more than two storeys for use as a dwelling;
- work on buildings intended to be put to a use designated by section 1 of the Fire Precautions Act 1971 (compulsory fire certificate).

Full plans are to give a description of the proposed work or material change of use together with: location and number of storeys; proposed use; block plan; size and position of building; boundaries; position of all buildings within the curtilage; details of nearby streets; drainage details; exits; details generally as at present required.

## **Summary**

A person intending to carry out work may engage an approved inspector who is required to:

- send an initial notice to the council;
- check plans and send a plans certificate to the council;
- check the work and send a final notice to the council.

In each instance the council may accept the notice or certificate. If they find any failure to give adequate information it may be rejected.

As an alternative a person intending to carry out work may deal directly with the council.

By sending a building notice he does not get an approval or rejection, but the building control officer will carry out inspections and require compliance with the regulations.

By sending full plans he receives an approval or rejection of his plans and the work is inspected by the building control officer.

## 2. MEASURING DATA AND PRELIMINARIES

### NUMERATION

With the adoption of the metric system, it is probable that Britain will adopt the Continental billion, trillion, etc., but official circles have not yet reached a decision on this point.

|  |           |
|--|-----------|
| Units.....                             | 1         |
| Tens.....                              | 10        |
| Hundreds.....                          | 100       |
| Thousands.....                         | 1,000     |
| Tens of thousands.....                 | 10,000    |
| Hundreds of thousands.....             | 100,000   |
| Millions (thousands of thousands)..... | 1,000,000 |

### ROMAN NUMERALS

|            |    |
|------------|----|
| I.....     | 1  |
| II.....    | 2  |
| III.....   | 3  |
| IV.....    | 4  |
| V.....     | 5  |
| VI.....    | 6  |
| VII.....   | 7  |
| VIII.....  | 8  |
| IX.....    | 9  |
| X.....     | 10 |
| XI.....    | 11 |
| XII.....   | 12 |
| XIII.....  | 13 |
| XIV.....   | 14 |
| XV.....    | 15 |
| XVI.....   | 16 |
| XVII.....  | 17 |
| XVIII..... | 18 |
| XIX.....   | 19 |
| XX.....    | 20 |
| XXX.....   | 30 |

|                |      |
|----------------|------|
| XL .....       | 40   |
| L.....         | 50   |
| LV.....        | 55   |
| LX .....       | 60   |
| LXX.....       | 70   |
| LXXX .....     | 80   |
| LXXXVIII ..... | 88   |
| XC .....       | 90   |
| XCIX.....      | 99   |
| C.....         | 100  |
| CX.....        | 110  |
| CXI.....       | 111  |
| CXC.....       | 190  |
| CC .....       | 200  |
| CCXX .....     | 220  |
| CCXXIV.....    | 224  |
| CCC.....       | 300  |
| CCCXX.....     | 320  |
| CD .....       | 400  |
| D.....         | 500  |
| DC .....       | 600  |
| DCCC .....     | 800  |
| DCCCLXXVI..... | 876  |
| CM.....        | 900  |
| CMXCIX.....    | 999  |
| M .....        | 1000 |
| MD.....        | 1500 |
| MDCCC.....     | 1800 |
| MM.....        | 2000 |

### IMPERIAL SYSTEM OF WEIGHTS AND MEASURES

This system of weights is derived from Roman, Saxon, Old French and other traditional systems. The traditional basis of TROY WEIGHT (the original English system) is 'one grain from the middle of the ear of wheat', which originally was the Troy grain. APOTHECARIES' WEIGHT is a variant of the TROY system. AVOIRDUPOIS WEIGHT, introduced in mediaeval times, took an ancient Greek coin (the *drachma*, or handful) as its basis.

**AVOIRDUPOIS WEIGHT**

27 1/2 Grains Troy = 1 dram or drachm  
 16 drams = 1 ounce  
 1 lb Avoirdupois = 1.2153 lb Troy

| Ounces | Pounds | Stones | Quarters | Cwts | Tons |
|--------|--------|--------|----------|------|------|
| 16     | 1      |        |          |      |      |
| 224    | 14     | 1      |          |      |      |
| 448    | 28     | 2      | 1        |      |      |
| 1,792  | 112    | 8      | 4        | 1    |      |
| 35,840 | 2,240  | 160    | 80       | 20   | 1    |

**MEASURE OF CAPACITY**

Cubic Inch  
 8.665 = 1 Gill  
 34.659 = 4 = 1 Pint  
 69.318 = 8 = 2 = 1 Quart  
 138.637 = 16 = 4 = 2 = 1 Pottle  
 277.274 = 32 = 8 = 4 = 1 Gallon  
 554.548 = 64 = 16 = 8 = 2 = 1 Peck  
 2,218.192 = 256 = 64 = 32 = 8 = 4 = 1 Bushel  
 17,745.536 = 2,048 = 512 = 256 = 64 = 32 = 8 = 1 Or.  
 1 Bushel = 1.284 Feet Cube  
 (1 Cubic Foot = 6.24 Gallons = 7.4805 US Gallons)

**LONG MEASURE**

|        |       |       |          |       |
|--------|-------|-------|----------|-------|
| Inches | Feet  | Yards | Furlongs | Miles |
| 12     | 1     |       |          |       |
| 36     | 3     | 1     |          |       |
| 792    | 66    | 22    | 1        |       |
| 63,360 | 5,280 | 1,760 | 8        | 1     |

**SQUARE MEASURE**

|                 |              |             |         |       |             |
|-----------------|--------------|-------------|---------|-------|-------------|
| Square inch     | Square feet  | Square yard | Rood    | Acre  | Square mile |
| 144 =           | 1 =          |             |         |       |             |
| 1,296 =         | 9 =          | 1 =         |         |       |             |
| 1,568,160 =     | 10,890 =     | 1,210 =     | 1 =     |       |             |
| 6,272,640 =     | 43,560 =     | 4,840 =     | 4 =     | 1 =   |             |
| 4,024,489,600 = | 27,878,400 = | 3,097,600 = | 2,560 = | 640 = | 1 =         |

ALSO

1 Irish acre = 7,840 sq. yards  
 yards

1 Scottish acre = 6,104 sq. yards  
 years

**CUBIC OR SOLID MEASURE**

1,728 cubic inches..... = 1 cubic foot  
 27 cubic feet..... = 1 cubic yard  
 1 ton Freight Measure. .... = 8 Barrels, or 40 cubic feet  
 1 Load rough or round Timber..... = 40 cubic feet  
 1 Load hewn or sawn Timber..... = 50 cubic feet



## THE METRIC SYSTEMS OF WEIGHTS AND MEASURES

The basic system was adopted by the French Government in 1795, and is an arbitrary one, in which all units of length area, capacity and weight are derived from the length of a quadrant of the meridian—that is, the distance from the equator to the pole. One ten-millionth of this is *the metre*. From the metre are derived all the other units of measurement: The *are*, which is 100 square metres and is the unit of area; the *litre* which is one cubic decimetre, and is the unity of capacity; and the *gram*, which is one cubic centimetre of water, and is the unit of weight. The metric system is a decimal one—that is, 10 of one unit always equal one of the next highest, as will be seen from the tables below.

The *Système International des Unités* (International System of Units) which Great Britain is adopting in the changeover to metric, is a modern extension of the original or basic metric system and contains a large number of closely related units of measurement, some of which differ radically from Imperial and older metric units. It has not been adopted by all countries using the basic metric system.

### LINEAR MEASURE

|                |               |                           |
|----------------|---------------|---------------------------|
| 10 millimetres | =1 centimetre | =0.3937 in                |
| 10 centimetres | =decimetre    | =3.9370 in                |
| 10 decimetres  | =1 decimetre  | =3 ft 3.3708 in           |
| 10 metres      | =1 decametre  | 10 yd 2 ft 9.7079 in      |
| 10 decametres  | =hectometre   | =109yd 1 ft 1.0790 in     |
| 10 hectometres | =1 kilometre  | =1,091 yd 1 ft 10.7900 in |

### SQUARE MEASURE

|              |               |                            |
|--------------|---------------|----------------------------|
| 1 centare    | =1.1960sq. yd |                            |
| 100 centares | =1 are        | =119.6033 sq. yd           |
| 100 ares     | =1 hectare    | =2 acres, 2280.3326 sq. yd |

### CUBIC OR SOLID MEASURE

|                |              |                |
|----------------|--------------|----------------|
| 10 centisteres | =1 decistere | =3.5317 cu ft  |
| 10 decisteres  | =1 stere     | =35.3170 cu ft |

### CAPACITY

|                |  |                      |
|----------------|--|----------------------|
| 1 litre        | =1.760 pints                           |                      |
| 10 litres      | =1 decalitre                           | =2 gal 1 .607 pints  |
| 10 decalitres  | =1 hectolitre                          | =22 gal 0.077 pints  |
| 10 hectolitres | =1 kilolitre, or stere, or cubic metre | =220 gal 0.770 pints |

**WEIGHT**

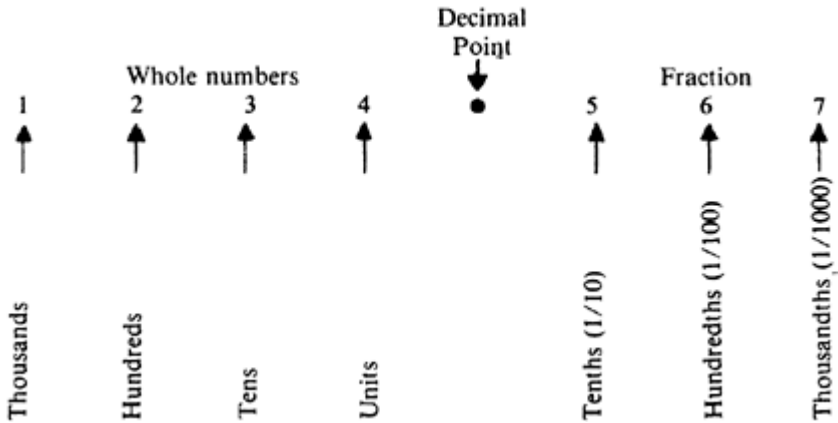
|               |               |                         |
|---------------|---------------|-------------------------|
| 10 centigrams | = 1 gram      | = 0.564 drams           |
| 10 grams      | = 1 decagram  | = 5.643 drams           |
| 10 decagrams  | = 1 hectogram | = 3 oz 6.170 drams      |
| 10 hectograms | = 1 kilogram  | = 2 lb 3 oz 4.380 drams |

**CONVERSION FACTORS**

|                  |   |         |   |                |
|------------------|---|---------|---|----------------|
| Inches           | × | 2.540   | = | cm             |
| Centimetres      | × | 0.394   | = | in             |
| Metres           | × | 3.280   | = | ft             |
| Metres           | × | 39.370  | = | in             |
| Feet             | × | 0.305   | = | m              |
| Square feet      | × | 929.000 | = | sq cm          |
| Cubic feet       | × | 28.300  | = | litres         |
| Feet per second  | × | 30.500  | = | cm per sec     |
| Kilograms        | × | 2.205   | = | lb             |
| Metric tonne     | × | 0.984   | = | ton of 2240 lb |
| Pounds           | × | 0.454   | = | kg             |
| Pounds per sq in | × | 70.300  | = | g per sq cm    |
| Pounds per sq ft | × | 0.488   | = | g per sq cm    |
| Tons per sq in   | × | 157.500 | = | kg per sq cm   |

**METRIC CONVERSION**

What follows are no more than elementary calculations: a textbook on decimal arithmetic would be out of place here, but the basic rules are given because decimal calculations have hitherto not figured in building trade calculations. In the metric system, quantities are expressed thus:



Written out in full, in words, this is one thousand two hundred and thirty four, plus five tenths, six hundredths and seven thousandths.

## WARNINGS

(1) In our new metric system, spaces are used instead of commas to denote groups of three, thus:

670 592.745 001

NOT

670,592.745001, as we previously wrote it.

This is because in Continental usage the comma is used instead of the decimal point and the point is used instead of our former comma and future space, thus:

670.592, 745.001

(2) It has been decided that linear measurements shall be in millimetres (thousandths of a metre) and metres, missing out centimetres (hundredths of a metre) and decimetres (tenths of a metre). It is vital to remember that one metre and five millimetres are not written as 1.5m, but as 1.005m. Similarly, the Continental practice (soon to be our own as well) is to omit the decagrams (10 grams) and hectograms (100 grams) and go straight from grams to kilograms (1,000 grams). Therefore, 1.5kg is 1 kilogram and 500 grams while 1 kilogram and 5 grams is 1.005kg.

## ADDITION

Place the quantities to be added together below each other, taking care (as in the addition of whole numbers only) that units are under units, tens under tens and so on, and that the decimal points and decimal fractions are under each other, as below:

$$\begin{array}{r}
 8\ 765.432\ 1 \\
 1\ 234.567\ 8 \\
 \hline
 9\ 999.999\ 9
 \end{array}$$

First, put in the decimal point and then add as in normal addition of whole numbers.

## SUBTRACTION

Follow the same method of setting out the calculation as in the subtraction of whole numbers. Put in the decimal point and subtract as if the quantities were whole numbers:

$$\begin{array}{r}
 8\ 765.432\ 1 \\
 1\ 234.567\ 8 \\
 \hline
 7\ 530.864\ 3 \\
 \hline
 \end{array}$$

MULTIPLICATION

The method usually taught is:

1. Ignore the decimal points and multiply as if the number were whole numbers,
2. Add up the number of decimal points in both numbers and insert the decimal point before that number of figures in the answer, counting from the right.

Multiply 54.321 by 12.345:

$$\begin{array}{r}
 54321 \\
 12345 \\
 \hline
 271605 \text{ five times} \\
 217284 \text{ four times} \\
 162963 \text{ three times} \\
 651852 \text{ twelve times} \\
 \hline
 670592745 \\
 \hline
 \end{array}$$

Inserting the decimal point after the sixth figure, counting from the right, gives 670.592745 as the answer.

DIVISION

The method usually taught is:

1. Ignore the decimal points and treat as long division of whole numbers.
2. Deduct the number of decimal places in the divisor (see example below) from the number of decimal places in the dividend. Place the decimal point after that number of figures, counting from the right, in the quotient.

Divide 876.54 by 123.4.

$$\begin{array}{r}
 \text{Divisor Dividend} \\
 1234 \ / \ 87654 \ / \ 71 \ \text{Quotient} \\
 \underline{8638} \\
 1274 \\
 \underline{1234} \\
 40 \ \text{Remainder}
 \end{array}$$

There are two decimal points in the dividend and one in the divisor. When the latter is subtracted from the former, one remains. Therefore, the decimal point is placed after the first figure of the quotient, counting from the right, and the answer is 7.1.

**There are two exceptions to the above rule:**

1. If the number of decimal points in the divisor and dividend are equal, the result of the subtraction will be zero, and all the figures in the quotient will be whole numbers.
2. If after subtracting as above (2) there are more decimal points required than figures in the quotient, add zeros to the left of the quotient. For example, if the result of the subtraction is 4 and the quotient is 75, add two zeros to the left of the number, so as to make a four-figure decimal fraction, thus: .007 5.

RECOGNITION POINTS

**(Rough, very approximate equivalents in Imperial and metric weights and measures.)**

|               |  |
|---------------|--|
| 1 oz          | 30 grams (g)                                 |
| 1 lb          | Half a kilogram (kg)                         |
| 1 cwt         | 50kg   |
| 1 ton         | 1 000 kg or 1 metric tonne                   |
| 1 in          | 25 millimetres (mm)                          |
| 1 ft          | 300mm  |
| 3 1/4 ft      | 1 metre (m)                                  |
| 5/8 of a mile | 1 kilometre (km)                             |
| 5 miles       | 8 km   |
| 1 cu.yd       | 3/4 of a m <sup>3</sup>                      |
| 32°F.         | 0° Celsius (Centigrade) (C.) (water freezes) |
| 60°F.         | 15.6°C.—background heating temperature       |
| 70°F.         | 21 °C.—average central heating temperature   |
| 140°F.        | 60°C.—water temperature at boiler            |
| 212°F.        | 100°C.—water boils                           |

For exact conversion factors and conversion tables, see page 55–59.

In the following tables, look for the number required to be converted in the middle column. If it is in Imperial system, its equivalent in metric will be found under the metric

column, and vice versa. The tables can be extended to hundreds by moving the decimal point one place to the right, and to thousands by moving the decimal point two places to the right.

Example: To find the British (Imperial) equivalent of 1 763 millimetres, proceed as follows:

|                |                 |   |
|----------------|-----------------|---|
| 1 000mm        | 39.3in          | (take 10 in table and move decimal point two places to right) |
| 700mm          | 27.51in         | (take 70 in table and move decimal point one place to right)  |
| 60mm           | 2.356in         | (as in table)   |
| 3mm            | 0.117in         | (as in table)   |
| <u>1 763mm</u> | <u>69.283in</u> |   |

The *Système International des Unités* (International System of Units) called S.I. for short, is a very complex one, and conversion tables only for the units used in building are given below. Special conversion tables, of limited use, are included in the Chapters of this work to which they appertain:

|   |      |
|---|------|
|   | page |
| Hours/sq. ft to Hr/m <sup>2</sup>                         | 95   |
| Hr/cu. ft to Hr/m <sup>3</sup>                            | 95   |
| Hr/sq. yd to Hr/m <sup>2</sup>                            | 95   |
| Hr/cu. yd to Hr/m <sup>3</sup>                            | 95   |
| Lb/ft run to Kg/m. run and Lb/sq. ft to Kg/m <sup>2</sup> | 138  |
| Lb/cu. ft to Kg/m <sup>3</sup>                            | 138  |
| Cwt/cu. ft to Kg/m <sup>3</sup>                           | 138  |
| Lb force/sq. ft and kN/m <sup>2</sup>                     | 139  |
| Ton f/sq. ft to kN/m <sup>2</sup>                         | 139  |
| Lb f/sq. in to MN/m <sup>2</sup>                          | 139  |
| In to mm (timber only)                                    | 215  |
| Standards (timber) to m <sup>3</sup>                      | 215  |
| Sq. yd to m <sup>2</sup>                                  | 388  |
| Gallons to litres   | 388  |
| 'K' values—Imperial and metric                            | 342  |

**LENGTH (Long Measure)**

**FRACTIONS OF ONE INCH IN MILLIMETRES THIRTY-SECONDS, SIXTEENTHS, EIGHTHS, QUARTERS AND ONE-HALF**

| In   | Mm    | In    | Mm     |
|------|-------|-------|--------|
| 1/32 | 0.794 | 17/32 | 13.494 |
| 1/16 | 1.588 | 9/16  | 14.288 |

|       |        |        |        |
|-------|--------|--------|--------|
| 3/32  | 2.381  | 19/32  | 15.081 |
| 1/8   | 3.175  | 5/8    | 15.875 |
| 5/32  | 3.969  | 21/32  | 16.668 |
| 3/16  | 4.762  | 11/16  | 17.463 |
| 7/32  | 5.556  | 23/32  | 18.256 |
| 1/4   | 6.350  | 3/4    | 19.050 |
| 9/32  | 7.144  | 25/32  | 19.843 |
| 5/16  | 7.938  | 13/16  | 20.638 |
| 11/32 | 8.731  | 27/32  | 21.431 |
| 3/8   | 9.525  | 7/8    | 22.225 |
| 13/32 | 10.318 | 29/32  | 23.018 |
| 7/16  | 11.112 | 15/16  | 23.812 |
| 15/32 | 11.906 | 31/32  | 24.606 |
| 1/2   | 12.700 | 1 inch | 25.400 |

TWELFTHS, SIXTHS AND THIRDS

| In   | Mm    | In     | Mm    |
|------|-------|--------|-------|
| 1/12 | 2.11  | 7/12   | 14.81 |
| 1/16 | 4.22  | 2/3    | 17.00 |
| 1/4  | 6.35  | 3/4    | 19.05 |
| 1/3  | 8.50  | 5/6    | 21.27 |
| 5/12 | 10.61 | 11/12  | 23.31 |
| 1/2  | 12.70 | 1 inch | 25.40 |

INCHES AND MILLIMETRES

| In     | Mm       | In    | Mm       |
|--------|----------|-------|----------|
| 0.0393 | 1 25.4   | 0.549 | 14 355.6 |
| 0.0786 | 2 50.8   | 0.588 | 15 381.0 |
| 0.1170 | 3 76.2   | 0.627 | 16 406.4 |
| 0.1572 | 4 101.6  | 0.666 | 17 431.8 |
| 0.1965 | 5 127.0  | 0.705 | 18 457.2 |
| 0.2356 | 6 152.4  | 0.744 | 19 482.6 |
| 0.2751 | 7 177.8  | 0.783 | 20 508.0 |
| 0.3154 | 8 203.4  | 0.822 | 21 533.4 |
| 0.3537 | 9 228.6  | 0.861 | 22 558.8 |
| 0.393  | 10 254.0 | 0.900 | 23 584.2 |
| 0.432  | 11 279.4 | 0.939 | 24 609.6 |
| 0.471  | 12 304.8 | 0.978 | 25 635.0 |
| 0.510  | 13 330.2 | 1.017 | 26 660.0 |

FEET AND METRES

| Feet  | Metres  |
|-------|---------|
| 3.280 | 1 0.324 |

YARDS AND METRES

| Yards | Metres  |
|-------|---------|
| 1.093 | 1 0.914 |

|         |     |        |         |     |        |
|---------|-----|--------|---------|-----|--------|
| 6.561   | 2   | 0.648  | 2.187   | 2   | 1.828  |
| 9.842   | 3   | 0.972  | 3.280   | 3   | 2.743  |
| 13.123  | 4   | 1.219  | 4.374   | 4   | 3.657  |
| 16.404  | 5   | 1.524  | 5.468   | 5   | 4.572  |
| 19.685  | 6   | 1.829  | 6.561   | 6   | 5.486  |
| 22.965  | 7   | 2.133  | 7.655   | 7   | 6.400  |
| 26.246  | 8   | 2.484  | 8.748   | 8   | 7.315  |
| 29.527  | 9   | 2.743  | 9.842   | 9   | 8.229  |
| 32.808  | 10  | 3.048  | 10.936  | 10  | 9.144  |
| 65.616  | 20  | 6.096  | 21.872  | 20  | 18.228 |
| 98.425  | 30  | 9.144  | 32.808  | 30  | 27.432 |
| 131.234 | 40  | 12.192 | 43.774  | 40  | 36.576 |
| 164.042 | 50  | 15.240 | 54.680  | 50  | 45.720 |
| 196.850 | 60  | 18.288 | 65.610  | 60  | 54.864 |
| 299.659 | 70  | 21.336 | 76.552  | 70  | 64.008 |
| 262.467 | 80  | 24.384 | 87.489  | 80  | 73.152 |
| 295.276 | 90  | 27.432 | 98.425  | 90  | 82.296 |
| 328.084 | 100 | 30.480 | 109.361 | 100 | 91.440 |

**AREA (Square Measure)**

Because the numbers would be too large and unwieldy for general use, conversion from inches to square centimetres is given, instead of conversion to square millimetres.

| SQUARE INCHES AND SQUARE CENTIMETRES |    |                 | SQUARE FEET AND SQUARE METRES |    |                |
|--------------------------------------|----|-----------------|-------------------------------|----|----------------|
| Sq. in                               |    | Cm <sup>2</sup> | Sq. ft                        |    | M <sup>2</sup> |
| 0.155                                | 1  | 6.457           | 10.763                        | 1  | 0.092          |
| 0.310                                | 2  | 12.903          | 21.527                        | 2  | 0.186          |
| 0.465                                | 3  | 19.355          | 32.291                        | 3  | 0.279          |
| 0.620                                | 4  | 25.806          | 43.055                        | 4  | 0.372          |
| 0.775                                | 5  | 32.258          | 53.820                        | 5  | 0.464          |
| 0.930                                | 6  | 38.709          | 64.583                        | 6  | 0.557          |
| 1.085                                | 7  | 45.161          | 75.347                        | 7  | 0.650          |
| 1.240                                | 8  | 51.613          | 86.111                        | 8  | 0.743          |
| 1.395                                | 9  | 58.064          | 96.875                        | 9  | 0.836          |
| 1.550                                | 10 | 64.516          | 107.639                       | 10 | 0.929          |
| 3.100                                | 20 | 129.032         | 215.278                       | 20 | 1.858          |
| 4.650                                | 30 | 193.548         | 322.917                       | 30 | 2.787          |
| 6.200                                | 40 | 258.064         | 430.556                       | 40 | 3.716          |
| 7.750                                | 50 | 332.580         | 533.20                        | 50 | 4.645          |
| 9.300                                | 60 | 387.096         | 645.83                        | 60 | 5.574          |
| 10.850                               | 70 | 451.612         | 753.47                        | 70 | 6.503          |



|        |     |        |         |     |       |
|--------|-----|--------|---------|-----|-------|
| 12.400 | 80  | 516.13 | 861.11  | 80  | 7.432 |
| 13.95  | 90  | 580.64 | 968.75  | 90  | 8.361 |
| 15.50  | 100 | 645.16 | 1076.39 | 100 | 9.290 |

**SQUARE YARDS AND SQUARE METRES**

| M <sup>2</sup> |     | Sq. yd |
|----------------|-----|--------|
| 0.836          | 1   | 1.196  |
| 1.672          | 2   | 2.392  |
| 2.508          | 3   | 3.588  |
| 3.344          | 4   | 4.784  |
| 4.181          | 5   | 5.980  |
| 5.017          | 6   | 7.176  |
| 5.883          | 7   | 8.372  |
| 6.689          | 8   | 9.568  |
| 7.525          | 9   | 10.764 |
| 8.361          | 10  | 11.900 |
| 16.723         | 20  | 23.92  |
| 25.084         | 30  | 35.88  |
| 33.445         | 40  | 47.84  |
| 41.806         | 50  | 59.80  |
| 50.186         | 60  | 71.76  |
| 58.529         | 70  | 83.72  |
| 66.890         | 80  | 95.68  |
| 75.251         | 90  | 107.64 |
| 83.613         | 100 | 119.61 |

**CAPACITY (Cubic Measure)**

Because the number would be too large and unwieldy for general use, conversion from cubic inches to cubic centimetres is given, instead of conversion to cubic millimetres.

| CUBIC INCHES AND CUBIC CENTIMETRES |   |        | CUBIC FEET AND CUBIC METRES |   |                |
|------------------------------------|---|--------|-----------------------------|---|----------------|
| Cm <sup>3</sup>                    |   | Cu. in | Cu.ft                       |   | M <sup>3</sup> |
| 16.38                              | 1 | 0.06   | 35.31                       | 1 | 0.0283         |
| 32.77                              | 2 | 0.12   | 70.62                       | 2 | 0.0566         |
| 49.16                              | 3 | 0.18   | 105.94                      | 3 | 0.0849         |
| 65.54                              | 4 | 0.24   | 141.25                      | 4 | 0.1132         |
| 81.93                              | 5 | 0.30   | 176.57                      | 5 | 0.1415         |
| 98.32                              | 6 | 0.36   | 211.88                      | 6 | 0.1699         |
| 114.70                             | 7 | 0.42   | 247.20                      | 7 | 0.1982         |
| 131.09                             | 8 | 0.48   | 282.51                      | 8 | 0.2265         |

|         |     |      |         |     |        |
|---------|-----|------|---------|-----|--------|
| 147.48  | 9   | 0.54 | 317.83  | 9   | 0.2548 |
| 163.87  | 10  | 0.61 | 365.14  | 10  | 0.2831 |
| 327.74  | 20  | 1.22 | 706.29  | 20  | 0.5655 |
| 491.61  | 30  | 1.83 | 1059.44 | 30  | 0.8549 |
| 655.48  | 40  | 2.44 | 1412.59 | 40  | 1.1326 |
| 819.35  | 50  | 3.05 | 1765.43 | 50  | 1.4150 |
| 983.22  | 60  | 3.66 | 2118.88 | 60  | 1.6990 |
| 1147.09 | 70  | 4.27 | 2472.03 | 70  | 1.9820 |
| 1310.97 | 80  | 4.38 | 2825.17 | 80  | 2.2650 |
| 1474.84 | 90  | 5.49 | 3178.32 | 90  | 2.5480 |
| 1638.71 | 100 | 6.10 | 3531.32 | 100 | 2.8310 |

| CUBIC YARDS AND CUBIC METRES |        | GALLONS AND LITRES (LIQUID) |        |        |         |
|------------------------------|--------|-----------------------------|--------|--------|---------|
| M <sup>3</sup>               | Cu. yd | Gallons                     |        | Litres |         |
| 0.76                         | 1      | 1.30                        | 0.220  | 1      | 4.545   |
| 1.53                         | 2      | 2.61                        | 0.440  | 2      | 9.091   |
| 2.29                         | 3      | 3.92                        | 0.659  | 3      | 13.637  |
| 3.05                         | 4      | 5.23                        | 0.874  | 4      | 18.183  |
| 3.82                         | 5      | 6.53                        | 1.099  | 5      | 22.729  |
| 4.59                         | 6      | 7.84                        | 1.319  | 6      | 27.275  |
| 5.35                         | 7      | 9.15                        | 1.539  | 7      | 31.821  |
| 6.11                         | 8      | 10.46                       | 1.759  | 8      | 36.367  |
| 6.88                         | 9      | 11.77                       | 1.979  | 9      | 40.913  |
| 7.64                         | 10     | 13.07                       | 2.199  | 10     | 45.459  |
| 15.29                        | 20     | 26.16                       | 4.399  | 20     | 90.918  |
| 22.93                        | 30     | 39.23                       | 6.599  | 30     | 136.377 |
| 30.58                        | 40     | 52.31                       | 8.799  | 40     | 181.836 |
| 38.22                        | 50     | 65.39                       | 10.998 | 50     | 227.395 |
| 45.87                        | 60     | 78.47                       | 13.198 | 60     | 272.754 |
| 53.51                        | 70     | 91.55                       | 15.398 | 70     | 318.213 |
| 61.16                        | 80     | 104.63                      | 17.598 | 80     | 363.662 |
| 68.81                        | 90     | 117.72                      | 19.798 | 90     | 409.131 |
| 76.46                        | 100    | 130.80                      | 21.998 | 100    | 454.780 |

### WEIGHT

| POUNDS AND KILOGRAMS |           |       | IMPERIAL TONS AND METRIC TONNES |   |               |
|----------------------|-----------|-------|---------------------------------|---|---------------|
| Pounds               | Kilograms |       | Imperial tons                   |   | Metric tonnes |
| 2.204                | 1         | 0.453 | 0.984                           | 1 | 1.016         |
| 4.409                | 2         | 0.907 | 1.968                           | 2 | 2.032         |
| 6.613                | 3         | 1.360 | 2.952                           | 3 | 3.048         |
| 8.818                | 4         | 1.813 | 3.962                           | 4 | 4.064         |
| 11.321               | 5         | 2.267 | 4.921                           | 5 | 5.080         |

|         |     |        |        |     |         |
|---------|-----|--------|--------|-----|---------|
| 13.227  | 6   | 2.721  | 5.095  | 6   | 6.096   |
| 15.432  | 7   | 3.175  | 6.889  | 7   | 7.112   |
| 17.637  | 8   | 3.028  | 7.873  | 8   | 8.128   |
| 19.841  | 9   | 4.082  | 8.857  | 9   | 9.144   |
| 22.046  | 10  | 4.535  | 9.842  | 10  | 10.166  |
| 44.092  | 20  | 9.071  | 19.684 | 20  | 20.320  |
| 66.139  | 30  | 13.607 | 29.526 | 30  | 30.481  |
| 88.185  | 40  | 18.143 | 39.360 | 40  | 40.641  |
| 110.231 | 50  | 22.679 | 49.210 | 50  | 50.802  |
| 132.277 | 60  | 27.216 | 59.050 | 60  | 60.902  |
| 154.329 | 70  | 31.753 | 68.890 | 70  | 71.122  |
| 176.370 | 80  | 36.290 | 78.730 | 80  | 81.283  |
| 198.416 | 90  | 40.827 | 88.570 | 90  | 91.442  |
| 220.460 | 100 | 45.358 | 98.420 | 100 | 101.605 |

### TEMPERATURE CONVERSIONS

It has been decided that Great Britain will use the Centigrade scale of temperature, but will in future call it the Celsius scale (after its inventor, Celsius). The S.I. unit of temperature is the degree Kelvin (after its inventor, Lord Kelvin), which is the same size as the degree Celsius (or Centigrade) but the Kelvin scale begins at minus 273 degrees Celsius, because this is thought to be ‘absolute zero’—the lowest possible temperature in the universe. Thus,  $100^{\circ}\text{C}$  equal  $373^{\circ}\text{K}$ . ‘Colour temperature’ of light sources is measured in degrees K.

Find the temperature that you wish to convert (whether it be Celsius or Fahrenheit) in the central column (in bold type). The Celsius equivalent is then given on the same line, in the left-hand column, and the Fahrenheit equivalent is given on the same line, in the right-hand column.

- Examples: (i) What is the Celsius equivalent of 15 F.?  
 Answer: 9.4 C.  
 (ii) What is the Fahrenheit equivalent of 15 C.?  
 Answer: 59.0 F.

### TEMPERATURE CONVERSION

| C.    |            | F.   | C.   |           | F.   |
|-------|------------|------|------|-----------|------|
| -27.2 | <b>-17</b> | 1.4  | -2.2 | <b>28</b> | 82.4 |
| -26.7 | <b>-16</b> | 3.2  | -1.7 | <b>29</b> | 84.2 |
| -26.1 | <b>-15</b> | 5.0  | -1.7 | <b>30</b> | 86.0 |
| -25.6 | <b>-14</b> | 6.8  | -0.6 | <b>31</b> | 87.8 |
| -25.0 | <b>-13</b> | 8.6  | 0    | <b>32</b> | 89.6 |
| -24.4 | <b>-12</b> | 10.4 | 0.6  | <b>33</b> | 91.4 |

|       |            |      |      |           |       |
|-------|------------|------|------|-----------|-------|
| -23.9 | <b>-11</b> | 12.2 | 1.1  | <b>34</b> | 93.2  |
| -23.3 | <b>-10</b> | 14.0 | 1.7  | <b>35</b> | 95.0  |
| -22.8 | <b>-9</b>  | 15.8 | 2.2  | <b>36</b> | 96.8  |
| -22.2 | <b>-8</b>  | 17.6 | 2.8  | <b>37</b> | 98.6  |
| -21.7 | <b>-7</b>  | 19.4 | 3.3  | <b>38</b> | 100.4 |
| -21.1 | <b>-6</b>  | 21.2 | 3.9  | <b>39</b> | 102.2 |
| -20.6 | <b>-5</b>  | 23.0 | 4.4  | <b>40</b> | 104.0 |
| -20.0 | <b>-4</b>  | 24.8 | 5.0  | <b>41</b> | 105.8 |
| -19.4 | <b>-3</b>  | 26.6 | 5.6  | <b>42</b> | 107.6 |
| -18.9 | <b>-2</b>  | 28.4 | 6.1  | <b>43</b> | 109.4 |
| -18.3 | <b>-1</b>  | 30.2 | 6.7  | <b>44</b> | 111.2 |
| -17.8 | <b>0</b>   | 32.0 | 7.2  | <b>45</b> | 113.0 |
| -17.2 | <b>1</b>   | 33.8 | 7.8  | <b>46</b> | 114.8 |
| -16.7 | <b>2</b>   | 35.6 | 8.3  | <b>47</b> | 116.6 |
| -16.1 | <b>3</b>   | 37.4 | 8.9  | <b>48</b> | 118.4 |
| -15.6 | <b>4</b>   | 39.2 | 9.4  | <b>49</b> | 120.2 |
| -15.0 | <b>5</b>   | 41.0 | 10.0 | <b>50</b> | 122.0 |
| -14.4 | <b>6</b>   | 42.8 | 10.6 | <b>51</b> | 123.8 |
| -13.9 | <b>7</b>   | 44.6 | 11.1 | <b>52</b> | 125.6 |
| -13.3 | <b>8</b>   | 46.4 | 11.7 | <b>53</b> | 127.4 |
| -12.8 | <b>9</b>   | 48.2 | 12.2 | <b>54</b> | 129.2 |
| -12.2 | <b>10</b>  | 50.0 | 12.8 | <b>55</b> | 131.0 |
| -11.7 | <b>11</b>  | 51.8 | 13.3 | <b>56</b> | 132.8 |
| -11.1 | <b>12</b>  | 53.6 | 13.9 | <b>57</b> | 134.6 |
| -10.6 | <b>13</b>  | 55.4 | 14.4 | <b>58</b> | 136.4 |
| -10.0 | <b>14</b>  | 57.2 | 15.0 | <b>59</b> | 138.2 |
| -9.4  | <b>15</b>  | 59.0 | 15.6 | <b>60</b> | 140.0 |
| -8.9  | <b>16</b>  | 60.8 | 16.1 | <b>61</b> | 141.8 |
| -8.3  | <b>17</b>  | 62.6 | 16.7 | <b>62</b> | 143.6 |
| -7.8  | <b>18</b>  | 64.4 | 17.2 | <b>63</b> | 145.4 |
| -7.2  | <b>19</b>  | 66.2 | 17.8 | <b>64</b> | 147.2 |
| -6.7  | <b>20</b>  | 68.0 | 18.3 | <b>65</b> | 149.0 |
| -6.1  | <b>21</b>  | 69.8 | 18.9 | <b>66</b> | 150.8 |
| -5.6  | <b>22</b>  | 71.6 | 19.4 | <b>67</b> | 152.6 |
| -5.0  | <b>23</b>  | 73.4 | 20.0 | <b>68</b> | 154.4 |
| -4.4  | <b>24</b>  | 75.2 | 20.6 | <b>69</b> | 156.2 |
| -3.9  | <b>25</b>  | 77.0 | 21.1 | <b>70</b> | 158.0 |
| -3.3  | <b>26</b>  | 78.8 | 21.7 | <b>71</b> | 159.8 |
| -2.8  | <b>27</b>  | 80.6 | 22.2 | <b>72</b> | 161.6 |

|      |           |       |      |            |       |
|------|-----------|-------|------|------------|-------|
| C.   |           | F.    | C.   |            | F.    |
| 22.8 | <b>73</b> | 163.4 | 47.8 | <b>118</b> | 244.4 |
| 23.3 | <b>74</b> | 165.2 | 48.3 | <b>119</b> | 246.2 |

|      |            |       |      |            |       |
|------|------------|-------|------|------------|-------|
| 23.9 | <b>75</b>  | 167.0 | 48.9 | <b>120</b> | 248.0 |
| 24.4 | <b>76</b>  | 168.8 | 49.4 | <b>121</b> | 249.8 |
| 25.0 | <b>77</b>  | 170.6 | 50.0 | <b>122</b> | 251.6 |
| 25.6 | <b>78</b>  | 172.4 | 50.6 | <b>123</b> | 253.4 |
| 26.1 | <b>79</b>  | 174.2 | 51.1 | <b>124</b> | 255.2 |
| 26.7 | <b>80</b>  | 176.0 | 51.7 | <b>125</b> | 257.0 |
| 27.2 | <b>81</b>  | 177.8 | 52.2 | <b>126</b> | 258.8 |
| 27.8 | <b>82</b>  | 179.6 | 52.8 | <b>127</b> | 260.6 |
| 28.3 | <b>83</b>  | 181.4 | 53.3 | <b>128</b> | 262.4 |
| 28.9 | <b>84</b>  | 183.2 | 53.9 | <b>129</b> | 264.2 |
| 29.4 | <b>85</b>  | 185.0 | 54.4 | <b>130</b> | 266.0 |
| 30.0 | <b>86</b>  | 186.8 | 55.0 | <b>131</b> | 267.8 |
| 30.6 | <b>87</b>  | 188.6 | 55.6 | <b>132</b> | 269.6 |
| 31.1 | <b>88</b>  | 190.4 | 56.1 | <b>133</b> | 271.4 |
| 31.7 | <b>89</b>  | 192.2 | 56.7 | <b>134</b> | 273.2 |
| 32.2 | <b>90</b>  | 194.0 | 57.2 | <b>135</b> | 275.0 |
| 32.8 | <b>91</b>  | 195.8 | 57.8 | <b>136</b> | 276.8 |
| 33.3 | <b>92</b>  | 197.6 | 58.3 | <b>137</b> | 278.6 |
| 33.9 | <b>93</b>  | 199.4 | 58.9 | <b>138</b> | 280.4 |
| 34.4 | <b>94</b>  | 201.2 | 59.4 | <b>139</b> | 282.2 |
| 35.0 | <b>95</b>  | 203.0 | 60.0 | <b>140</b> | 284.0 |
| 35.6 | <b>96</b>  | 204.8 | 60.6 | <b>141</b> | 285.8 |
| 36.1 | <b>97</b>  | 206.6 | 61.1 | <b>142</b> | 287.6 |
| 36.7 | <b>98</b>  | 208.4 | 61.7 | <b>143</b> | 289.4 |
| 37.2 | <b>99</b>  | 210.2 | 62.2 | <b>144</b> | 291.1 |
| 37.8 | <b>100</b> | 212.0 | 62.8 | <b>145</b> | 293.0 |
| 38.3 | <b>101</b> | 213.8 | 63.3 | <b>146</b> | 294.8 |
| 38.9 | <b>102</b> | 215.6 | 63.9 | <b>147</b> | 296.6 |
| 39.4 | <b>103</b> | 217.4 | 64.4 | <b>148</b> | 298.4 |
| 40.0 | <b>104</b> | 219.2 | 65.0 | <b>149</b> | 300.2 |
| 40.6 | <b>105</b> | 221.0 | 65.6 | <b>150</b> | 302.0 |
| 41.1 | <b>106</b> | 222.8 | 66.1 | <b>151</b> | 303.8 |
| 41.7 | <b>107</b> | 224.6 | 66.7 | <b>152</b> | 305.6 |
| 42.2 | <b>108</b> | 226.4 | 67.2 | <b>153</b> | 307.4 |
| 42.8 | <b>109</b> | 228.2 | 67.8 | <b>154</b> | 309.2 |
| 43.3 | <b>110</b> | 230.0 | 68.3 | <b>155</b> | 311.0 |
| 43.9 | <b>111</b> | 231.8 | 68.9 | <b>156</b> | 312.8 |
| 44.4 | <b>112</b> | 233.6 | 69.4 | <b>157</b> | 314.6 |
| 45.0 | <b>113</b> | 235.4 | 70.0 | <b>158</b> | 316.4 |
| 45.5 | <b>114</b> | 237.2 | 70.6 | <b>159</b> | 318.2 |
| 46.1 | <b>115</b> | 239.0 | 71.1 | <b>160</b> | 320.0 |
| 46.7 | <b>116</b> | 240.8 | 71.7 | <b>161</b> | 321.8 |
| 47.2 | <b>117</b> | 242.6 | 72.2 | <b>162</b> | 323.6 |

| C.   |            | F.    |  | C.    |            | F.    |
|------|------------|-------|--|-------|------------|-------|
| 72.3 | <b>163</b> | 325.4 |  | 97.8  | <b>208</b> | 406.4 |
| 73.3 | <b>164</b> | 327.2 |  | 98.3  | <b>209</b> | 408.2 |
| 73.9 | <b>165</b> | 329.0 |  | 98.9  | <b>210</b> | 410.0 |
| 74.4 | <b>166</b> | 330.8 |  | 99.4  | <b>211</b> | 411.8 |
| 75.0 | <b>167</b> | 332.6 |  | 100.0 | <b>212</b> | 413.6 |
| 75.6 | <b>168</b> | 334.4 |  | 100.6 | <b>213</b> | 415.4 |
| 76.1 | <b>169</b> | 336.2 |  | 101.1 | <b>214</b> | 417.2 |
| 76.7 | <b>170</b> | 338.0 |  | 101.7 | <b>215</b> | 419.0 |
| 77.2 | <b>171</b> | 339.8 |  | 102.2 | <b>216</b> | 420.8 |
| 77.8 | <b>172</b> | 341.6 |  | 102.8 | <b>217</b> | 422.6 |
| 78.3 | <b>173</b> | 343.4 |  | 103.3 | <b>218</b> | 424.4 |
| 78.9 | <b>174</b> | 345.2 |  | 103.0 | <b>219</b> | 426.2 |
| 79.4 | <b>175</b> | 347.0 |  | 104.4 | <b>220</b> | 428.0 |
| 80.0 | <b>176</b> | 348.8 |  | 105.0 | <b>221</b> | 429.8 |
| 80.6 | <b>177</b> | 350.6 |  | 105.6 | <b>222</b> | 431.4 |
| 81.1 | <b>178</b> | 352.4 |  | 106.1 | <b>223</b> | 433.4 |
| 81.7 | <b>179</b> | 354.2 |  | 106.7 | <b>224</b> | 435.2 |
| 82.2 | <b>180</b> | 356.0 |  | 107.2 | <b>225</b> | 437.0 |
| 82.8 | <b>181</b> | 357.8 |  | 107.8 | <b>226</b> | 438.8 |
| 83.3 | <b>182</b> | 359.6 |  | 108.3 | <b>227</b> | 440.6 |
| 83.9 | <b>183</b> | 361.4 |  | 108.9 | <b>228</b> | 442.4 |
| 84.4 | <b>184</b> | 363.2 |  | 109.4 | <b>229</b> | 444.2 |
| 85.0 | <b>185</b> | 365.0 |  | 110.0 | <b>230</b> | 446.0 |
| 85.6 | <b>186</b> | 366.8 |  | 110.6 | <b>231</b> | 447.8 |
| 86.1 | <b>187</b> | 368.6 |  | 111.1 | <b>232</b> | 449.6 |
| 86.7 | <b>188</b> | 370.4 |  | 111.7 | <b>233</b> | 451.4 |
| 87.2 | <b>189</b> | 372.2 |  | 112.2 | <b>234</b> | 453.2 |
| 87.8 | <b>190</b> | 374.0 |  | 112.8 | <b>235</b> | 455.0 |
| 88.3 | <b>191</b> | 375.8 |  | 113.3 | <b>236</b> | 456.8 |
| 88.9 | <b>192</b> | 377.6 |  | 113.9 | <b>237</b> | 458.6 |
| 89.4 | <b>193</b> | 379.4 |  | 114.4 | <b>238</b> | 460.4 |
| 90.0 | <b>194</b> | 381.2 |  | 115.0 | <b>239</b> | 462.2 |
| 90.6 | <b>195</b> | 383.0 |  | 115.6 | <b>240</b> | 464.0 |
| 91.1 | <b>196</b> | 384.8 |  | 116.1 | <b>241</b> | 465.8 |
| 91.7 | <b>197</b> | 386.6 |  | 116.7 | <b>242</b> | 467.6 |
| 92.2 | <b>198</b> | 388.4 |  | 117.2 | <b>243</b> | 469.4 |
| 92.8 | <b>199</b> | 390.2 |  | 117.8 | <b>244</b> | 471.2 |
| 93.3 | <b>200</b> | 392.0 |  | 118.3 | <b>245</b> | 473.0 |
| 93.9 | <b>201</b> | 393.8 |  | 118.9 | <b>246</b> | 474.8 |
| 94.4 | <b>202</b> | 395.6 |  | 119.4 | <b>247</b> | 476.6 |
| 95.0 | <b>203</b> | 397.4 |  | 120.0 | <b>248</b> | 478.3 |
| 95.6 | <b>204</b> | 399.2 |  | 120.6 | <b>249</b> | 480.2 |

|      |            |       |     |            |     |
|------|------------|-------|-----|------------|-----|
| 96.1 | <b>205</b> | 401.0 | 121 | <b>250</b> | 482 |
| 96.7 | <b>206</b> | 402.8 | 127 | <b>260</b> | 500 |
| 97.2 | <b>207</b> | 404.6 | 132 | <b>270</b> | 518 |

**GEOMETRIC DATA**

**CIRCUMFERENCE OR PERIMETERS OF PLANES**

|              |   |
|--------------|---|
| Circle.....  | $3.1416 \times \text{Diameter}$   |
| Ellipse..... | $3.1416 \times \frac{1}{2} \text{ major axis} + \frac{1}{2} \text{ minor axis}$ |
| Sector.....  | $\frac{\text{Radius} \times \text{Degrees in Arc}}{57.3}$                       |

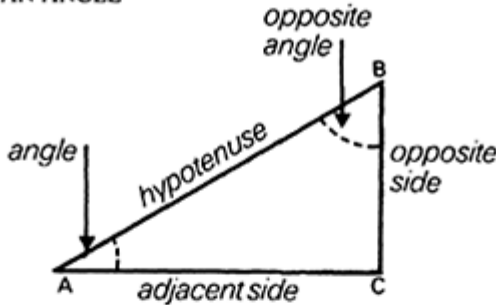
**SURFACE AREAS OF PLANES AND SOLIDS**

|                     |   |
|---------------------|---|
| Circle.....         | $\pi (3.1416) \times \text{Radius}^2$ or $.7854 \times \text{Diameter}^2$   |
| Cone.....           | $\frac{1}{2} \text{ Circumference} \times \text{Slant Height} + \text{Area of Base}$                                  |
| Frustum of Cone..   | $\pi \times \text{Slant Height} \times (\text{radius at top} + \text{radius at base}) + \text{Areas of Top and Base}$ |
| Cylinder.....       | $\text{Circumference} \times \text{Length} + \text{Area of two ends}$   |
| Ellipse (approx.).. | $\text{Product of Axes} \times .7854$   |
| Parabola.....       | $\text{Base} \times \frac{2}{3} \text{ Height}$   |
| Parallelogram....   | $\text{Base} \times \text{Height}$  |
| Pyramid.....        | $\frac{1}{2} \text{ sum of Base Perimeters} \times \text{Slant Height} + \text{Area of Base}$                         |
| Sector of Circle... | $\frac{3.1416 \times \text{Degrees in Arc} \times \text{Radius}^2}{360}$  |
| Segment of Arc...   | $\frac{1}{3} CH + \frac{H^3}{2C}$ Where C = Chord, H = Rise   |
| Segment of Circle   | Area of Sector—Triangle   |
| Sphere.....         | $\text{Diameter}^2 \times 3.1416$   |
| Triangle.....       | $\text{Half Base} \times \text{Perpendicular Height}$   |

*Note:* The above formulae are of general application. They express relationships only, not size. Therefore, they can be used with any system of measurement, whether Imperial, metric or any other. Whatever the system of measurement, numeration remains the same.

TRIGONOMETRY

FUNCTIONS OF AN ANGLE



|                    |   |  |  |  |                                       |  |  |  |
|--------------------|---|--|--|--|---------------------------------------|--|--|--|
|                    |   |  |  |  |                                       |  |  |  |
| Sine . . . . .     | = |  |  |  | <u>Perpendicular or Opposite Side</u> |  |  |  |
|                    |   |  |  |  | Hypotenuse                            |  |  |  |
| Cosine . . . . .   | = |  |  |  | <u>Adjacent Side</u>                  |  |  |  |
|                    |   |  |  |  | Hypotenuse                            |  |  |  |
| Tangent . . . . .  | = |  |  |  | <u>Perpendicular or Opposite Side</u> |  |  |  |
|                    |   |  |  |  | Adjacent Side                         |  |  |  |
| Cotangent : . . .  | = |  |  |  | <u>Adjacent Side</u>                  |  |  |  |
|                    |   |  |  |  | Perpendicular or Opposite Side        |  |  |  |
| Cosecant . . . . . | = |  |  |  | <u>Hypotenuse</u>                     |  |  |  |
|                    |   |  |  |  | Perpendicular or Opposite Side        |  |  |  |
| Secant . . . . .   | = |  |  |  | <u>Hypotenuse</u>                     |  |  |  |
|                    |   |  |  |  | Adjacent Side                         |  |  |  |
| Versed Sine =      |   |  |  |  | 1 — cosine                            |  |  |  |
| Coversed Sine =    |   |  |  |  | 1 — sine                              |  |  |  |

DIAMETERS, CIRCUMFERENCES AND AREAS OF CIRCLES  
in Imperial or Metric sizes.  
(¼ equals 0.25, ½ equals 0.50 and ¾ equals 0.75)

| Dia. | Circum. | Area  | Dia. | Circum. | Area | Dia. | Circum. | Area  |
|------|---------|-------|------|---------|------|------|---------|-------|
| 1    | 3.1416  | .7854 | ¼    | 7.067   | 3.90 | ½    | 10.995  | 9.62  |
| ¾    | 3.927   | 1.23  | ½    | 7.854   | 4.90 | ¾    | 11.781  | 11.04 |
| ½    | 4.712   | 1.77  | ¾    | 8.6394  | 5.94 | 4    | 12.56   | 12.56 |
| ¾    | 5.499   | 2.40  | 3    | 9.425   | 7.06 | ¾    | 13.351  | 14.18 |
| 2    | 6.2832  | 3.14  | ¼    | 10.21   | 8.29 | ½    | 14.137  | 15.9  |



| Dia. | Circum. | Area   | Dia. | Circum. | Area   | Dia. | Circum. | Area   |
|------|---------|--------|------|---------|--------|------|---------|--------|
| 5    | 14.922  | 17.72  | 17   | 53.4    | 226.98 | ¼    | 91.892  | 671.95 |
| 5    | 15.708  | 19.64  | ¼    | 54.19   | 233.7  | ½    | 92.677  | 683.49 |
| ¼    | 16.49   | 21.65  | ½    | 54.98   | 240.53 | ¾    | 93.462  | 695.12 |
| ½    | 17.278  | 23.76  | ¾    | 55.76   | 247.45 | 30   | 94.248  | 706.86 |
| ¾    | 18.064  | 25.97  | 18   | 56.55   | 254.47 | ¼    | 95.033  | 718.69 |
| 6    | 18.85   | 28.27  | ¼    | 57.73   | 261.58 | ½    | 95.819  | 730.61 |
| ¼    | 19.63   | 30.68  | ½    | 58.12   | 268.8  | ¾    | 96.604  | 742.64 |
| ½    | 20.42   | 33.18  | ¾    | 58.91   | 276.05 | 31   | 97.389  | 754.76 |
| ¾    | 21.20   | 35.78  | 19   | 59.69   | 283.53 | ¼    | 98.175  | 766.99 |
| 7    | 21.9    | 38.48  | ¼    | 60.47   | 291.04 | ½    | 98.96   | 779.31 |
| ¼    | 22.77   | 41.28  | ½    | 61.261  | 298.64 | ¾    | 99.746  | 791.73 |
| ½    | 23.56   | 44.18  | ¾    | 62.05   | 306.35 | 32   | 100.53  | 804.24 |
| ¾    | 24.34   | 47.17  | 20   | 62.83   | 314.16 | ¼    | 101.32  | 816.86 |
| 8    | 25.13   | 50.26  | ¼    | 63.62   | 322.06 | ½    | 102.1   | 829.57 |
| ¼    | 25.91   | 53.46  | ½    | 64.403  | 330.06 | ¾    | 102.89  | 842.39 |
| ½    | 26.7    | 56.74  | ¾    | 65.133  | 338.16 | 33   | 103.67  | 855.3  |
| ¾    | 27.49   | 60.13  | 21   | 65.973  | 346.36 | ¼    | 104.46  | 868.3  |
| 9    | 28.27   | 63.61  | ¼    | 66.759  | 354.65 | ½    | 105.24  | 881.41 |
| ¼    | 29.04   | 67.20  | ½    | 67.544  | 363.05 | ¾    | 106.03  | 894.61 |
| ½    | 29.84   | 70.88  | ¾    | 68.33   | 371.54 | 34   | 106.87  | 907.92 |
| ¾    | 30.63   | 74.66  | 22   | 69.115  | 380.13 | ¼    | 107.6   | 921.32 |
| 10   | 31.410  | 78.54  | ¼    | 69.9    | 388.82 | ½    | 108.38  | 934.82 |
| ¼    | 32.2    | 82.52  | ½    | 70.686  | 397.6  | ¾    | 109.17  | 948.41 |
| ½    | 32.98   | 86.59  | ¾    | 71.471  | 406.49 | 35   | 109.96  | 962.11 |
| ¾    | 33.72   | 90.76  | 23   | 72.257  | 415.47 | ¼    | 110.74  | 975.9  |
| 11   | 34.56   | 95.03  | ¼    | 73.042  | 424.55 | ½    | 111.53  | 989.8  |
| ¼    | 35.34   | 99.4   | ½    | 73.827  | 433.73 | ¾    | 112.31  | 1003.8 |
| ½    | 36.128  | 103.87 | ¾    | 74.613  | 443.01 | 36   | 113.1   | 1017.8 |
| ¾    | 36.914  | 108.43 | 24   | 75.398  | 452.39 | ¼    | 113.88  | 1032.0 |
| 12   | 37.7    | 113.09 | ¼    | 76.184  | 461.86 | ½    | 114.67  | 1046.3 |
| ¼    | 38.48   | 117.86 | ½    | 76.696  | 471.43 | ¾    | 115.45  | 1060.7 |
| ½    | 39.27   | 122.72 | ¾    | 77.754  | 481.14 | 37   | 116.24  | 1075.2 |
| ¾    | 40.05   | 127.66 | 25   | 78.54   | 490.87 | ¼    | 117.02  | 1089.8 |
| 13   | 40.84   | 132.73 | ¼    | 79.325  | 500.74 | ½    | 117.81  | 1104.2 |
| ¼    | 41.62   | 137.88 | ½    | 80.111  | 510.7  | ¾    | 118.6   | 1119.2 |
| ½    | 42.41   | 143.14 | ¾    | 80.896  | 520.77 | 38   | 119.38  | 1134.1 |
| ¾    | 43.19   | 148.49 | 26   | 81.681  | 530.93 | ¼    | 120.17  | 1149.0 |
| 14   | 43.98   | 153.94 | ¼    | 82.467  | 541.18 | ½    | 120.95  | 1164.1 |
| ¼    | 44.77   | 159.48 | ½    | 83.252  | 551.54 | ¾    | 121.74  | 1179.3 |
| ½    | 45.55   | 165.13 | ¾    | 84.038  | 562.0  | 39   | 122.52  | 1194.5 |
| ¾    | 46.34   | 170.87 | 27   | 84.823  | 572.55 | ¼    | 123.31  | 1209.9 |
| 15   | 47.12   | 176.72 | ¼    | 85.608  | 583.2  | ½    | 124.09  | 1225.4 |
| ¼    | 47.9    | 182.65 | ½    | 86.394  | 593.95 | ¾    | 124.88  | 1240.9 |
| ½    | 48.69   | 188.69 | ¾    | 87.179  | 604.8  | 40   | 125.66  | 1256.6 |
| ¾    | 49.48   | 194.82 | 28   | 87.965  | 615.75 | ¼    | 125.45  | 1272.4 |
| 16   | 50.26   | 201.06 | ¼    | 88.75   | 626.79 | ½    | 127.23  | 1288.2 |
| ¼    | 51.05   | 207.39 | ½    | 89.535  | 637.94 | ¾    | 128.02  | 1304.2 |
| ½    | 51.83   | 213.82 | ¾    | 90.321  | 649.18 | 41   | 123.81  | 1320.2 |
| ¾    | 52.62   | 220.35 | 29   | 91.106  | 660.52 | ¼    | 129.59  | 1336.1 |

| Dia. | Circum. | Area   | Dia. | Circum. | Area   | Dia. | Circum. | Area   |
|------|---------|--------|------|---------|--------|------|---------|--------|
| ½    | 130.38  | 1352.6 | 44   | 138.23  | 1520.5 | ½    | 146.08  | 1698.2 |
| ¾    | 131.16  | 1369.0 | ¼    | 139.02  | 1537.8 | ¾    | 146.87  | 1716.5 |
| 42   | 131.95  | 1385.4 | ½    | 139.9   | 1555.3 | 47   | 147.65  | 1734.9 |
| ¼    | 132.73  | 1402.0 | ¾    | 140.59  | 1572.8 | ¼    | 148.44  | 1753.4 |
| ½    | 133.52  | 1418.6 | 45   | 141.37  | 1590.4 | ½    | 149.23  | 1772.0 |
| ¾    | 134.3   | 1435.3 | ¼    | 142.16  | 1608.1 | ¾    | 150.01  | 1790.7 |
| 43   | 135.09  | 1452.2 | ½    | 142.94  | 1625.9 | 48   | 150.8   | 1809.5 |
| ¼    | 135.87  | 1469.1 | ¾    | 143.73  | 1643.9 | ¼    | 151.58  | 1828.4 |
| ½    | 136.66  | 1486.1 | 46   | 144.51  | 1661.9 | ½    | 152.37  | 1847.4 |
| ¾    | 137.44  | 1503.3 | ¼    | 145.3   | 1680.0 | ¾    | 153.15  | 1866.5 |

VOLUMES OF CYLINDERS, PIPES, WELLS, ETC.

Length or height or depth in metres or millimetres or in yards or feet or inches

| Diameter |    | ½      | ¾      | 1      | 2       | 3       | 4       | 5       | 6       |
|----------|----|--------|--------|--------|---------|---------|---------|---------|---------|
| 0.125    | ¼  | .04    | .07    | .09    | .17     | .26     | .36     | .44     | .52     |
| 0.500    | ½  | .1     | .15    | .2     | .39     | .59     | .79     | .98     | 1.18    |
| 0.750    | ¾  | .22    | .33    | .44    | .88     | 1.33    | 1.77    | 2.21    | 2.65    |
| 1.000    | 1  | .39    | .59    | .79    | 1.57    | 2.36    | 3.14    | 3.93    | 4.71    |
| 1.250    | 1¼ | .61    | .92    | 1.23   | 2.45    | 3.68    | 4.91    | 6.14    | 7.36    |
| 1.500    | 1½ | .88    | 1.32   | 1.77   | 3.53    | 5.3     | 7.07    | 8.84    | 10.6    |
| 2.000    | 2  | 1.57   | 2.36   | 3.14   | 6.28    | 9.42    | 12.57   | 15.71   | 18.85   |
| 2.500    | 2½ | 2.45   | 3.68   | 4.91   | 9.82    | 14.73   | 19.64   | 24.55   | 29.45   |
| 3.000    | 3  | 3.53   | 5.4    | 7.07   | 14.14   | 21.21   | 28.27   | 35.34   | 42.41   |
| 3.500    | 3½ | 4.81   | 7.22   | 9.62   | 19.24   | 28.86   | 38.48   | 48.11   | 57.73   |
| 4.000    | 4  | 6.28   | 9.42   | 12.57  | 25.13   | 37.7    | 50.26   | 62.83   | 75.4    |
| 4.500    | 4½ | 7.95   | 11.93  | 15.9   | 31.81   | 47.71   | 63.62   | 79.52   | 95.42   |
| 5.000    | 5  | 9.82   | 14.73  | 19.64  | 39.27   | 58.91   | 78.54   | 98.18   | 117.81  |
| 5.500    | 5½ | 11.88  | 17.82  | 23.76  | 47.52   | 71.27   | 95.03   | 118.79  | 142.55  |
| 6.000    | 6  | 14.14  | 21.21  | 28.27  | 56.55   | 84.82   | 113.1   | 141.37  | 169.64  |
| 6.500    | 6½ | 16.59  | 24.89  | 33.18  | 66.37   | 99.55   | 132.73  | 165.92  | 199.1   |
| 7.000    | 7  | 19.24  | 28.86  | 38.48  | 76.97   | 115.45  | 153.94  | 192.42  | 230.9   |
| 7.500    | 7½ | 22.09  | 33.14  | 44.18  | 88.36   | 132.54  | 176.72  | 220.9   | 265.07  |
| 8.000    | 8  | 25.13  | 37.7   | 50.27  | 100.53  | 150.8   | 210.06  | 251.33  | 301.59  |
| 8.500    | 8½ | 28.37  | 42.56  | 56.75  | 113.49  | 170.24  | 226.98  | 283.73  | 340.47  |
| 9.000    | 9  | 31.81  | 47.71  | 63.62  | 127.23  | 190.85  | 254.47  | 318.09  | 381.7   |
| 9.500    | 9½ | 35.44  | 53.16  | 70.88  | 141.76  | 212.65  | 283.53  | 354.41  | 425.29  |
|          | 10 | 39.27  | 58.01  | 78.54  | 157.08  | 235.62  | 314.16  | 392.7   | 471.24  |
|          | 15 | 88.36  | 132.54 | 176.72 | 353.43  | 530.15  | 706.86  | 883.58  | 1060.29 |
|          | 20 | 157.08 | 235.62 | 314.16 | 628.32  | 942.48  | 1256.64 | 1570.8  | 1884.96 |
|          | 25 | 245.44 | 368.16 | 490.88 | 981.75  | 1472.63 | 1963.5  | 2454.38 | 2945.25 |
|          | 30 | 353.43 | 530.15 | 706.86 | 1413.72 | 2120.58 | 2827.44 | 3534.3  | 4241.16 |

| Diameter |   | 7    | 8    | 9    | 10   | 15    | 20    | 25    | 30    |
|----------|---|------|------|------|------|-------|-------|-------|-------|
| 0.125    | ¼ | .61  | .7   | .79  | .87  | 1.31  | 1.75  | 2.18  | 2.62  |
| 0.500    | ½ | 1.37 | 1.57 | 1.77 | 1.96 | 2.95  | 3.93  | 4.91  | 5.89  |
| 0.750    | ¾ | 3.09 | 3.53 | 3.98 | 4.42 | 6.63  | 8.84  | 11.04 | 13.25 |
| 1.000    | 1 | 5.5  | 6.28 | 7.07 | 7.85 | 11.78 | 15.71 | 19.64 | 23.56 |

| Diameter | 7  | 8       | 9       | 10      | 15      | 20      | 25      | 30       |          |
|----------|----|---------|---------|---------|---------|---------|---------|----------|----------|
| 1.250    | 1¼ | 8.59    | 9.82    | 11.04   | 12.27   | 18.41   | 24.54   | 30.68    | 36.8     |
| 1.500    | 1½ | 12.37   | 14.14   | 15.9    | 17.67   | 26.51   | 35.34   | 44.18    | 53.01    |
| 2.000    | 2  | 21.99   | 25.13   | 28.27   | 31.42   | 31.1    | 62.83   | 78.54    | 94.25    |
| 2.500    | 2½ | 34.36   | 39.27   | 44.18   | 49.09   | 73.64   | 98.18   | 122.73   | 147.27   |
| 3.000    | 3  | 49.48   | 56.55   | 63.62   | 70.69   | 106.03  | 141.37  | 176.7    | 212.06   |
| 3.500    | 3½ | 67.35   | 76.97   | 86.59   | 96.21   | 144.32  | 192.42  | 240.53   | 288.63   |
| 4.000    | 4  | 87.96   | 100.53  | 113.1   | 125.66  | 188.5   | 251.32  | 314.15   | 377.0    |
| 4.500    | 4½ | 111.33  | 127.23  | 143.14  | 159.04  | 238.56  | 318.08  | 397.6    | 477.12   |
| 5.000    | 5  | 137.45  | 157.08  | 176.72  | 196.35  | 294.53  | 392.7   | 490.88   | 589.05   |
| 5.500    | 5½ | 166.31  | 190.06  | 213.82  | 237.58  | 356.37  | 475.16  | 593.95   | 712.74   |
| 6.000    | 6  | 197.92  | 226.19  | 254.47  | 282.74  | 424.11  | 565.48  | 706.85   | 848.22   |
| 6.500    | 6½ | 232.28  | 265.46  | 298.65  | 331.83  | 497.75  | 663.66  | 829.58   | 995.49   |
| 7.000    | 7  | 269.39  | 307.87  | 346.36  | 384.84  | 577.26  | 769.68  | 962.1    | 1154.52  |
| 7.500    | 7½ | 309.25  | 353.43  | 397.61  | 441.79  | 662.69  | 883.48  | 1104.48  | 1325.37  |
| 8.000    | 8  | 351.86  | 402.12  | 452.39  | 502.65  | 753.98  | 1005.3  | 1256.6   | 1507.95  |
| 8.500    | 8½ | 397.22  | 453.96  | 510.71  | 567.45  | 851.18  | 1134.9  | 1418.63  | 1702.35  |
| 9.000    | 9  | 445.32  | 508.94  | 572.55  | 636.17  | 954.26  | 1272.34 | 1590.43  | 1908.51  |
| 9.500    | 9½ | 496.17  | 567.06  | 637.94  | 708.82  | 1063.23 | 1417.64 | 1772.05  | 2126.46  |
|          | 10 | 549.78  | 628.32  | 706.86  | 785.4   | 1178.1  | 1570.8  | 1963.5   | 2356.2   |
|          | 15 | 1237.01 | 1413.72 | 1590.44 | 1767.15 | 2650.73 | 3534.3  | 4417.88  | 5301.45  |
|          | 20 | 2199.12 | 2513.28 | 2827.44 | 3141.6  | 4712.4  | 6283.2  | 7854.0   | 9424.8   |
|          | 25 | 3436.13 | 3927.0  | 4417.88 | 4908.75 | 7363.13 | 9817.5  | 12271.88 | 14726.25 |
|          | 30 | 4948.02 | 5654.88 | 6361.74 | 7068.6  | 10602.9 | 14137.2 | 17671.5  | 21205.8  |

**VOLUMES OF SOLIDS OF VARIOUS SHAPES**

- Cone . . . . .  $\text{Area of Base} \times \frac{1}{3} \text{ Perpendicular Height}$
- Frustum of Cone  $\frac{1}{2} \text{ Perpendicular Height} \times \pi (R^2 + r^2 + Rr)$ , where R and r are radii of Base and Top
- Cylinder . . . . .  $3.1416 \times \text{Radius}^2 \times \text{Height}$
- Pyramid . . . . .  $\text{Area of Base} \times \frac{1}{3} \text{ Perpendicular Height}$
- Sphere . . . . .  $\frac{4}{3} \text{ Radius}^3 \times 3.1416$
- Wedge . . . . .  $\text{Area of Base} \times \frac{1}{2} \text{ Perpendicular Height}$

**CAPACITY OF BUILDERS' UTENSILS**

| Utensil        | cu. ft | m <sup>3</sup> | gallons | litres | bushels |      |
|----------------|--------|----------------|---------|--------|---------|------|
| Barrow         |        | 3.00           | 0.085   | 18.75  | 81.82   | 2.33 |
| Bag            |        | 2.57           | 0.065   | 16.00  | 72.75   | 2.00 |
| Hod            |        | 0.64           | 0.017   | 4.00   | 18.18   | 0.50 |
| Pall (approx.) |        | 0.50           | 0.013   | 3.00   | 13.64   | 0.37 |

(Based on 6 1/2 gallons equals 1 cu. ft, and 1 bushel equals 8 gallons, converted to S.I. metric units.)

**MAP SCALES**

| <i>Scale Ratio</i> | <i>One Inch=</i> | <i>One Mile=</i> |
|--------------------|------------------|------------------|
| 1:63360            | 1 Mile           | 1 Inch           |
| 1:25000            | 2083.33 ft       | 2.53 in          |
| 1:12500            | 1041.66 ft       | 5.06 in          |
| 1:10560            | 888 ft           | 6 in             |
| 1:5280             | 440 ft           | 12 in            |
| 1:2500             | 208.33 ft        | 25.34 in         |
| 1:1250             | 104.166 ft       | 50.68 in         |
| 1:1056             | 88 ft            | 5 ft             |
| 1:500              | 41.66ft          | 10 ft-6./2 in    |

These are old ordnance Survey scales: post-war maps are to differing scales and are marked with National Grid lines, but are not to scales used in building work. The maps most used in building are the 1:2500, commonly call the 'twenty-five inch map', and the 1:500 which is available for all large towns. Copies of these maps are held in every local or municipal engineer's office and are kept up-to-date by his staff. It is usual to allow builders and others to make tracings of these maps, or to provide photo-copies gratis or for a small fee. The 1:2500 map is used for key plans and the 1:500 for drainage plans and site plans that have to be included in deposited plans for all new work. In the old L.C.C. area of the Greater London Council, the 1:1056 map is used instead of the 1:2500. It is probable that these maps will continue to be used for many years to come: the task of transferring all the information to new metric maps, if they were available, would be something no local authority could at present face, on the score of cost alone.

However, in the new editions of the 1:2500 sheets, linear measures and levels will be in metric and sizes of fields in acres and hectares. For conversion factors, see page 50 (acres and hectares).

### **DRAWING PAPER AND STATIONERY SIZES**

All printing paper (except paper in rolls) is in metric measurements and to the sizes laid down by the International Standards Organisation (I.S.O.) as reproduced by B.S. 4000. This makes provision for three series of paper sizes: A, B and C. Drawing and note papers will be made to A series sizes. The B series is intended for posters and the C series for envelopes.

The sizes of the A series papers are based on the A0 size, which is the equivalent of 1 metre square in area. Each size is exactly half the size of the preceding one in area and has

1. The long side identical in length with the short side of the preceding size, and
2. The short size equal to half the length of the long side of the preceding size.

| I.S.O. sizes | Millimetres | Inches    | Nearest old size from which A size can be cut | Nearest old drawing-board size |
|--------------|-------------|-----------|---|--------------------------------|
|              |             |           | Name  | size in inches                 |
| 2A           | 1189×1682   | 46.8×66.2 | Emperor                                       | 48×72                          |
| A0           | 841×1189    | 33.1×46.8 | Emperor                                       | 48×72                          |
| A1           | 594×841     | 23.4×33.1 | Atlas   | 26×34                          |
| A2           | 420×594     | 16.5×23.4 | Royal   | 24×19                          |
| A3           | 297×420     | 11.7×16.5 | Foolscap                                      | 17×13 1/2                      |
| A4           | 210×297     | 8.3×11.7  | Quarto  | 8×10                           |
| A5           | 148×210     | 5.8×8.3   | Post 4to                                      | 7 1/4×9                        |
| A6           | 105×148     | 4.1×5.8   | Small 8vo                                     | 4 1/2×7 1/4                    |

It is probable that A0 to A4 will be used for drawings, A 3 for specifications and quantities, A4 for commercial note-headings and trade literature (leaflets) and A5 to A6 for private note-paper.

### ENVELOPES

The C series is for envelopes and folders. Of this and related series only the two following are within the *Post Office preferred range of sizes*. The use of other C and D series will incur higher postage rates if used for items not more than 2 oz (57 g) in weight.

#### ENVELOPE SIZES

| Type | Millimetres | Inches    |
|------|-------------|-----------|
| C6   | 114×162     | 4.49×6.38 |
| D L  | 110×220     | 4.33×8.66 |

#### PLAN SCALES

| Imperial measure    | Fraction | Nearest Metric scale, in mm |
|---------------------|----------|-----------------------------|
| 1/16 in equals 1 ft | 1/192    | 1.200                       |
| 1/8 in equals 1 ft  | 1/96     | 1.100                       |
| 1/4 in equals 1 ft  | 1/48     | 1.50                        |
| 1/2 in equals 1 ft  | 1/24     | 1.20                        |
| 1 in equals 1 ft    | 1/12     | 1.10                        |

*Note:* Oval scales, giving at least three of the above metric scales, and flat section scales, giving two of the above metric scales, are now available.

### ABBREVIATIONS ON PLANS AND DRAWINGS

*Recommended in British Standard Specifications*

#### 1. PRIMARY UNITS

|                     |           |
|---------------------|-----------|
| Centimetre .....    | cm        |
| Chain .....         | ch        |
| Cubic Foot.....     | cu. ft    |
| Cubic Yard.....     | cu. yd    |
| Dozen .....         | doz       |
| Foot .....          | ft or (') |
| Hundredweight ..... | cwt       |
| Inch .....          | in or (") |
| Metres .....        | m         |
| Millimetre .....    | mm        |
| Ounce .....         | oz        |
| Pound .....         | lb        |
| Quarter .....       | qr        |
| Square Inch.....    | sq. in    |
| Square Foot.....    | sq. ft    |
| Square Yard.....    | sq. yd    |
| Ton .....           | t         |
| Yard .....          | yd        |

## 2. MATERIALS AND GENERAL TERMS

|                        |                        |
|------------------------|------------------------|
| Aggregate .....        | agg.                   |
| Air brick. ....        | A.B.                   |
| Approved .....         | appd.                  |
| Approximate.....       | approx.                |
| Asbestos .....         | asb.                   |
| Asphalt .....          | asph.                  |
| Bench Mark. ....       | B.M.                   |
| Birmingham Gauge.....  | B.G.                   |
| Bitumen.....           | bitn.                  |
| Brickwork .....        | bwk, or B              |
| British Standard. .... | B.S.                   |
| Cast-iron.....         | C.I.                   |
| Cement .....           | cem.                   |
| Centre Line.....       | C.L. or <sup>C</sup> L |
| Centre to centre. .... | c/c.                   |
| Checked.....           | ckd.                   |
| Chemical closet.....   | C.C.                   |
| Clearing eye. ....     | C.E.                   |
| Concrete .....         | conc.                  |
| Corrugated .....       | corr.                  |
| Diameter.....          | dia.                   |
| Drawing.....           | drg.                   |

|                             |           |
|-----------------------------|-----------|
| Drinking fountain. ....     | D.F.      |
| Earth Closet.....           | E.C.      |
| Figure .....                | Fig.      |
| Fire hydrant.....           | F.H.      |
| Flushing cistern.....       | F.C.      |
| Fresh air inlet.....        | F.A.I.    |
| Galvanized .....            | galv.     |
| Glazed ware pipe.....       | G.W.P.    |
| Grease trap.....            | G.T.      |
| Ground Level.....           | G.L.      |
| Gully .....                 | G.        |
| Height .....                | ht.       |
| Hose bib. ....              | H.B.      |
| Inspection chamber. ....    | I.C.      |
| Insulated or Insulation.... | insul.    |
| Intercepting trap. ....     | I.T.      |
| Internal .....              | int.      |
| Invert.....                 | inv.      |
| Lavatory basin.....         | L.B.      |
| Left-hand .....             | L.H.      |
| Macadam .....               | mac.      |
| Manhole .....               | M.H.      |
| Mild Steel.....             | M.S.      |
| Not to scale. ....          | N.T.S.    |
| Number.....                 | No.       |
| Petrol interceptor. ....    | P.I.      |
| Radius .....                | rad.      |
| Rain water outlet.....      | R.W.O.    |
| Rain water pipe. ....       | R.W.P.    |
| Reinforced concrete.....    | R.C.      |
| Right-hand .....            | R.H.      |
| Rising main.....            | R.M.      |
| Round .....                 | rd.       |
| Sink .....                  | S.        |
| Sketch .....                | sk.       |
| Sluice or stop valve.....   | S.V.      |
| Soil and vent pipe.....     | S. & V.P. |
| Soil pipe.....              | S.P.      |
| Specification.....          | spec.     |
| Spigot and socket.....      | S. & S.   |
| Square.....                 | sq.       |
| Standard Wire Gauge (Imp)   | S.W.G.    |
| Stand Pipe.....             | St. P.    |

|                          |           |
|--------------------------|-----------|
| Street Gully. ....       | S.G.      |
| Tongued and grooved....  | t. & g.   |
| Traced .....             | Ted.      |
| Urinal .....             | U.        |
| Vent pipe.....           | V.P.      |
| Volume .....             | vol.      |
| Waste pipe.....          | W.P.      |
| Waste and vent pipe..... | W. & V.P. |
| Water closet.....        | W.C.      |
| Weight.....              | wt.       |
| Yard gully.....          | Y.G.      |



### 3.

## BASIC ESTIMATING

The word 'estimate' is derived from the Latin word meaning a guess: this is exactly what an estimate is. It is a prophecy—an inspired guess, if you will—and the art or science of estimating is to make a guess that approximates very nearly to the future reality. To do this with any certainty, it is necessary to limit the field within which the guesswork must operate. The size of the job can be ascertained from drawings, specifications, bills of quantities or measurements on the job. One of these sources of information is essential. To this must be added the quantities of materials required for a job of any given size. Here this book can help you, first by providing unit sizes of building materials, and then by providing easy means of calculating the number of units required for any particular job. It will also give the approximate standard of workmanship for jobs of moderate to good quality, corresponding to the quality of the materials with which it deals. This is, roughly speaking, the field covered by the Codes of Practice and the British Standards. Every builder knows, however, that there are whole ranges of materials, outside the British Standard range of products, that are much cheaper and often as good. Similarly, a lower, but quite serviceable standard of workmanship is often acceptable. It must be remembered that local authorities and supply undertakings now insist on materials to British Standards quality, and workmanship to the standard prescribed by the Codes of Practice. On any job that is subject to inspection, therefore, such as all new work, structural alterations to existing property, and the installation of all services, including drainage, it pays to estimate for materials to British Standards and workmanship to Code standards, since it is probable that these will be insisted upon. A point worth remembering is that these standards of quality are deemed to satisfy the Building Regulations (except in some rare instances those of the G.L.C.) and that better work cannot be demanded.

Having thus limited the field, so far as materials and quality of workmanship are concerned, there remains labour cost. The simplest way to obtain some firm contact with actuality in this matter is to rely on unit times for building operations, and a list (necessarily incomplete) of hours required to execute various quantities of building work of different kinds is appended to these notes.

All these quantities of labour and materials must be translated into sums of money and then combined to give a price, first for one type of work, and then for all types of work combined.

The *Building Trades Journal* publishes a detailed analysis of the cost of employing one craftsman for one week, including wages and all indirect costs.

## COSTS TO EMPLOY BUILDING OPERATIVES AT 'GRADE A' (RATES)

### CURRENT

The tables of 'costs to employ' are based on rates of wages in force from 24 June 1985. An additional 30 per cent incentive bonus has been added but it should be adjusted in light of local experience. The National Insurance contribution is based on April 1985 tables. Holidays with pay rates are from 29th July 1985.

The rates are based on annual calculations in accordance with IOB recommendations. They do not include items usually priced in preliminaries nor do they include travelling time or allowances for overheads or profit.

The total annual wages are divided by 'Productive Hours', i.e. basic hours (1911) less an allowance for inclement weather. 'Productive Hours' total 1,873hrs.

### Appendix 'A'

|  |          | CRAFTSMAN    | LABOURER     |
|--|----------|--------------|--------------|
| Total hours worked per year .....      |          | 1911         | 1911         |
| Inclement weather 2% .....             |          | 38           | 38           |
|  |          |              |              |
| Total productive hours .....           | A        | 1873         | 1873         |
| Non-productive overtime .....          | C        | 89           | 89           |
| Days sick per year .....               | D        | 5            | 5            |
| Days public holiday .....              | F        | 8            | 8            |
| Sick pay per day .....                 | E        | 7.74         | 7.74         |
| Tool money per week .....              |          | .87          | —            |
| Annual holiday with pay .....          | G        | 12.15        | 12.15        |
| Trade supervision per hour .....       | H        | .27          | .23          |
|  |          |              |              |
| Basic hourly rate .....                |          | 238.5        | 203.5        |
| 30% plus rate .....                    |          | 71.5         | 61.0         |
|  |          |              |              |
| <b>TOTAL HOURLY RATE .....</b>         | <b>B</b> | <b>310.0</b> | <b>264.5</b> |
|  |          |              |              |
| Basic wages (A×B) .....                |          | 5806.30      | 4954.09      |
| Non-productive overtime (C×B) . . . .  |          | 275.90       | 235.41       |
| Sick pay (D×E).....                    |          | 38.70        | 38.70        |
| Public holidays (F×B×8) .....          |          | 198.40       | 169.28       |
|  |          |              |              |
| National Insurance 10.45% .....        |          | 6319.30      | 5397.48      |
| Tool money .....                       |          | 660.37       | 564.04       |
| Annual holiday with pay (48×G) . . . . |          | 38.80        | —            |
| CITB levy .....                        |          | 583.20       | 583.20       |
|  |          |              |              |
|  |          | 71.00        | 18.20        |
|  |          |              |              |
|  |          | 7672.67      | 6562.72      |

|   |                |                |
|---|----------------|----------------|
| Severance pay 2% .....                              | 153.45         | 131.25         |
| Employers liability 3rd party insurance<br>2% ..... | 156.52         | 133.88         |
| Trade supervision (A×H) .....                       | 505.71         | 430.79         |
| <b>TOTAL COST .....</b>                             | <b>8488.35</b> | <b>7258.64</b> |
| <b>COST PER HOUR.....</b>                           | <b>4.53</b>    | <b>3.88</b>    |

**COST OF BRICKLAYER WITH ATTENDANT LABOURERS AND  
SCAFFOLDER**

|                         | per hour | rate           |
|-------------------------|----------|----------------|
|                         | £ p      | £ p            |
| Eight bricklayers ..... | 4.53     | 36.24          |
| Three labourers .....   | 3.88     | 11.64          |
| One scaffolder .....    | 4.53     | 4.53           |
|                         |          | <b>8 52.41</b> |

Per bricklayer hour ..... 6.55

**COST OF BRICKLAYER WITH ATTENDANT LABOURERS EXCLUDING  
SCAFFOLDER**

|                         |      |                |
|-------------------------|------|----------------|
| Eight bricklayers ..... | 4.53 | 36.24          |
| Three labourers .....   | 3.88 | 11.64          |
|                         |      | <b>8 47.88</b> |

Per bricklayer hour ..... 5.99

**NJCBI WAGE RATES FOR BUILDING OPERATIVES**

**Rates of wages operative from June 24 1985**

**CRAFTSMEN AND LABOURERS**

|           | London and Liverpool District |          |        | Scotland and Grade 'A' |          |        |
|-----------|-------------------------------|----------|--------|------------------------|----------|--------|
|           | Per week                      | Per hour | GMB    | Per week               | Per hour | GMB    |
| Craftsmen | £93.21                        | 239p     | £14.82 | £93.01 1/2             | 238 1/2  | £14.82 |
| Labourers | £79.56                        | 204p     | £12.48 | £79.36 1/2             | 203 1/2  | £12.48 |

**WATCHMEN**

|                                | Rate per week |
|--------------------------------|---------------|
| London and Liverpool districts | £92.04        |
| Scotland and Grade 'A'         | £91.84 1/2    |

The weekly remuneration for watchmen is a sum equivalent to the labourers' standard weekly rate of wages plus the labourers' GMB provided not less than five shifts (day or night) are worked in the payweek.

**APPRENTICES/TRAINEES**

*Entrants under 19 whose employment as apprentices/trainees began on or after June 25, 1984 and Building Foundation Training Scheme trainees whose employment as apprentices/trainees began before that date*

| Six-month period                        | Rate per week | Per hour | GMB        |
|---|---------------|----------|------------|
| First                                   | £43.29        | 111p     | —          |
| Second                                  | £58.69 1/2    | 150 1/2p | —          |
| Third                                   | £63.96        | 164p     | £10.14     |
| Thereafter, until skills test is passed | £77.22        | 198p     | £12.28 1/2 |
| On passing skills test                  | £87.16 1/2    | 223 1/2p | £13.84 1/2 |

*Entrants under 19 whose employment as apprentices/trainees began on or after June 27, 1983 but before June 25, 1984 (excluding BFTS trainees whose employment as apprentices/trainees began between those dates)*

| Six-month period | Rate per week | Per hour | GMB        |
|------------------|---------------|----------|------------|
| Third            | £67.27 1/2    | 172 1/2p | £10.14     |
| Fourth           | £77.22        | 197 1/2p | £12.28 1/2 |
| Fifth            | £87.16 1/2    | 223 1/2p | £13.84 1/2 |
| Sixth            | £92.04        | 236p     | £14.62 1/2 |

*Entrants under 19 whose employment as apprentices/trainees began before 27th June, 1983*

| Age at entry | Six-month period | Rate per week | Per hour | GMB        |
|--------------|------------------|---------------|----------|------------|
| 16           | Fifth and sixth  | £83.07        | 213p     | £13.06 1/2 |
| 17           | Fifth and sixth  | £83.07        | 213p     | £13.06 1/2 |
| 18           | Fifth and sixth  | £83.07        | 213p     | £13.06 1/2 |

**BATJIC WAGE RATES**

**From June 24, 1985 Craftsmen £109.40 Adult general operative £93.79 1/2**

**WAGE RATES FOR PLUMBERS**

**Rates of wages operative from March 25, 1985.**

|                       | Per week | Per hour         |
|-----------------------|----------|------------------|
| Basic 37 1/2 hrs/week |          |                  |
| Trained plumber       | £116.25  | 310p             |
| Advanced plumber      | £127.50  | 340p             |
| Technical plumber     | £146.25  | 390p             |
| Allowances:           |          |                  |
| Abnormal conditions   |          | 139p per day     |
| Lodging allowance     |          | £10.75 per night |
| Responsibility money  |          | 23p per hour     |
| Welding supplement:   |          |                  |

|                                       |              |
|---------------------------------------|--------------|
| Possession of gas OR arc certificate  | 15p per hour |
| Possession of gas AND arc certificate | 30p per hour |

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### WAGE RATES FOR ELECTRICIANS

#### Rates of wages operative from July 27, 1985.

| Basic 37 1/2 hrs/week | Per week    | per week | London Weighting/hr |
|-----------------------|-------------|----------|---------------------|
| Electrical Technician | £162.75     | 434p     | 18p                 |
| Approved Technician   | £140.62 1/2 | 375p     | 18p                 |
| Qualified Electrician | £129.75     | 346p     | 18p                 |
| Labourer              | £99.00      | 246p     | 18p                 |

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### WAGE RATES FOR HEATING AND VENTILATING OPERATIVES

#### Rates of wages operative from April 2, 1984.

| Basic 38 hrs/week                     | Per week | Per hour      |
|---------------------------------------|----------|---------------|
| Foreman                               | £154.28  | 406p          |
| Chargehand                            | £148.20  | 390p          |
| Advanced Fitter                       | £130.34  | 343p          |
| Fitter                                | £118.56  | 312p          |
| Improver                              | £112.48  | 296p          |
| Assistant                             | £106.78  | 281 p         |
| Mate over 18                          | £95.00   | 250p          |
| Welding supplement:                   |          |               |
| Possession of gas OR arc certificate  |          | 16p per hour  |
| Possession of gas AND arc certificate |          | 31 p per hour |

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### THE COST OF REHABILITATION WORK ON OLDER HOUSES

by RON COOPER F.G.of.S.

The Department of the Environment has authorised even more generous grants for the repairs and rehabilitation of older houses. This move has two purposes; first, to provide more and better housing at an economical cost, and second, to provide a much-needed increase in the volume of work in the construction industry, especially for the small or medium size building firms.

Maximum eligible amounts are laid down for various items or sections of work, i.e., new bath, new sink, conversion of a large house into flats. In housing action areas and general improvement areas grants may be made for repairs only. Generally the amount of the grant is 50 per cent of the eligible amount (not necessarily the maximum) agreed by the local authority. Higher percentages are allowed in general improvement areas 60 per cent and housing action areas 75 per cent.

Local authorities are empowered to agree the amount of the grants and make subsequent payment provided they are satisfied that the estimate of the proposed work is

fair and reasonable.

Application for grants are made on local authority questionnaire forms which should be supported by the contractor's estimate. The contractor must be prepared to explain and/or amplify his estimate if necessary. The following schedule shows the analysis of cost of some of the more usual items to be encountered in rehabilitation and improvement grant work.

Man hours against each item shows the total man hours, tradesmen only, tradesmen and labourers or labourers only, irrespective of whether it is a one-man or 'team of six' operation. Man hours per operation take into consideration the physical difficulties to be met in smaller houses, e.g., terrace houses with small backyard and all material wheeled to and from through the hall passage, semi-detached with a metre wide side-way between each pair of houses.

Wages rates will be based on the estimated current costs to employ a tradesman and labourer based on the June 1985 agreement, viz., tradesmen and labourers: £4.53 and £3.88 per hour respectively. Material costs will be based on the latest available prices (published in BTJ). Margin for overheads and profit has been allowed at 20 per cent.

| Description of work   | Man<br>hours | Nett<br>Labour<br>£ | Nett<br>Material<br>£ | Unit<br>Price<br>£ |
|---|--------------|---------------------|-----------------------|--------------------|
| <b>EXCAVATION</b>   |              |                     |                       |                    |
| Excavate over site average 150 mm deep, including rubbish and hardcore, wheel out, load lorry, m <sup>2</sup>                               | 1.20         | 4.57                | —                     | 5.48               |
| Excavate small trenches, etc, for new foundations, part return fill in and ram, remove as last item, m <sup>3</sup>                         | 4.50         | 17.46               | —                     | 20.95              |
| Hardcore average 150 mm thick to receive oversite concrete, m <sup>2</sup>  | 0.45         | 1.75                | 1.39                  | 3.77               |
| Pulling down existing brickwork, hall brick thick, cleaning sound whole bricks for re-use, set aside remainder for hardcore, m <sup>2</sup> | 0.90         | 3.49                | —                     | 4.19               |
| Ditto one-brick thick, m <sup>2</sup>   | 1.75         | 6.79                | —                     | 8.15               |
| Description of work   | Man<br>hours | Nett<br>Labour<br>£ | Nett<br>Material<br>£ | Unit<br>Price<br>£ |
| <b>CONCRETE WORK</b>  |              |                     |                       |                    |
| Forming precast reinforced concrete lintels and hoisting and setting in position—size 113× 150 mm, lin.m                                    | 0.45         | 1.75                | 1.70                  | 4.14               |
| Ditto, ditto—size 113×225 mm, lin.m   | 0.65         | 2.52                | 2.65                  | 6.20               |
| Ditto, ditto—size 225×150 mm, lin.m   | 0.85         | 3.30                | 5.10                  | 10.08              |
| Ditto, ditto—size 225×225 mm, lin.m   | 1.10         | 4.27                | 6.54                  | 12.97              |
| Concrete (1–2–6) in founds or pier bases, m <sup>3</sup>  | 4.00         | 15.52               | 38.00                 | 64.22              |

|   |      |      |      |       |
|---|------|------|------|-------|
| Ditto oversite or underfloor 100 mm thick, m <sup>2</sup> | 1.20 | 4.66 | 4.00 | 10.39 |
| Ditto 150 mm thick, m <sup>2</sup>                        | 1.75 | 6.79 | 6.00 | 15.35 |

**BRICKWORK**

|   |      |       |       |       |
|---|------|-------|-------|-------|
| Half-brick walls in Flettons cement-lime mortar, m <sup>2</sup>   | 1.90 | 8.61  | 8.00  | 19.93 |
| One brick ditto, ditto, m <sup>2</sup>  | 3.50 | 15.86 | 16.50 | 38.83 |
| One-and-a-half-brick, m <sup>2</sup>  | 4.90 | 22.20 | 26.00 | 57.84 |
| Cavity brick walls, half-brick inner and outer skins, m <sup>2</sup>  | 4.30 | 19.48 | 16.50 | 43.18 |
| Slate damp course in half-brick wall, lin.m   | 0.60 | 2.72  | 1.50  | 5.06  |
| One-brick wall, lin.m   | 1.30 | 5.89  | 3.20  | 10.91 |
| Extra-over brickwork for fair-face one side, m <sup>2</sup>   | 0.70 | 3.17  | —     | —     |
| Extra-over one-brick wall for facing bricks, assuming facing bricks are £50 per m more than commons, m <sup>2</sup> | 1.20 | 5.44  | 3.60  | 10.85 |
| Close cavity wall at openings, including slate damp course, lin.m   | 0.80 | 3.62  | 1.80  | 6.50  |
| 50 mm Clinker concrete—block partition walls, m <sup>2</sup>  | 0.80 | 3.62  | 2.60  | 7.46  |
| 75 mm ditto, ditto, m <sup>2</sup>  | 1.00 | 4.53  | 3.70  | 9.88  |
| 100 mm ditto, ditto, m <sup>2</sup>   | 1.20 | 5.44  | 5.50  | 13.13 |

| Description of work   | Man hours | Nett Labour £ | Nett Material £ | Unit Price £ |
|---|-----------|---------------|-----------------|--------------|
| Cutting out two courses of brickwork in short lengths, insert slate damp course and build over in walls half-brick thick, lin.m                         | 1.30      | 5.89          | 2.50            | 10.07        |
| Ditto, ditto in wall one-brick thick, lin.m   | 2.20      | 9.97          | 5.20            | 18.20        |
| Rake out perished mortar, repoint, including scaffolding to two storeys, m <sup>2</sup>   | 1.20      | 5.44          | 0.30            | 6.89         |
| Ditto in walling exceeding two storeys, m <sup>2</sup>  | 1.40      | 6.34          | 0.30            | 7.97         |
| Cut out fractures in wall lacing in new brickwork in half-brick walls, lin.m  | 2.20      | 9.97          | 1.60            | 13.88        |
| Cutting and forming openings through brick wall, including shoring for new window or door frame half-brick thick, not exceeding 1 m <sup>2</sup> , each | 4.00      | 18.12         | —               | 21.74        |
| Ditto one-brick thick, each   | 7.00      | 31.71         | —               | 38.05        |

|  |      |       |      |       |
|--|------|-------|------|-------|
| Ditto, exceeding 1 m <sup>2</sup> half-brick-thick, m <sup>2</sup>                                       | 3.75 | 16.99 | —    | 20.39 |
| One-brick-thick, m <sup>2</sup>  | 6.00 | 27.18 | —    | 32.62 |
| Reforming jambs, reveals in half-brick wall, fair-face, lin.m  | 2.00 | 9.06  | 1.10 | 12.19 |
| One-brick wall, lin.m  | 2.50 | 11.33 | 2.20 | 16.24 |
| Hoist and build—in wood or metal door-frame and point externally not exceeding 0.5 m <sup>2</sup> , each | 1.10 | 4.98  | 0.20 | 6.22  |
| Ditto 0.5–1.0 m <sup>2</sup> , each  | 1.45 | 6.57  | 0.30 | 8.24  |
| Area exceeding 1.5 m <sup>2</sup> , each   | 2.25 | 10.19 | 0.35 | 12.65 |
| Cutting openings in one-brick wall for and including terracotta air brick, size 225×225 mm, each         | 1.50 | 6.80  | 3.60 | 12.48 |

### ROOFWORK

|  |      |      |   |      |
|--|------|------|---|------|
| Strip existing roof slates and clear away, m <sup>2</sup>                                  | 0.30 | 1.36 | — | 1.63 |
| Strip slated roof, clean and set aside sound slates for re-use, clear away, m <sup>2</sup> | 0.40 | 1.81 | — | 2.17 |

| Description of work   | Man hours | Nett Labour £ | Nett Material £ | Unit Price £ |
|---|-----------|---------------|-----------------|--------------|
| Strip slated roof, re-slate using 50 per cent existing sound slates and providing 50 per cent new slates, size 406×203 mm, m <sup>2</sup> | 1.20      | 5.44          | 12.60           | 21.65        |
| Ditto 508×254 mm, m <sup>2</sup>  | 0.80      | 3.62          | 11.70           | 18.38        |
| Ditto 610×305 mm, m <sup>2</sup>  | 0.60      | 2.72          | 17.00           | 23.66        |
| Take off and renew single slate, including clips size 406×203 mm, each slate  | 0.50      | 2.27          | 0.90            | 3.80         |
| Ditto 508×254 mm, each  | 0.55      | 2.49          | 1.90            | 5.27         |
| Ditto 610×305 mm, each  | 0.60      | 2.72          | 3.00            | 6.86         |
| Ditto up to 30 No. in any one patch, size 406×203 mm, each slate  | 0.22      | 1.00          | 0.90            | 2.28         |
| Ditto 508×254 mm, each  | 0.23      | 1.04          | 1.90            | 3.53         |
| Ditto 610×305 mm, each  | 0.24      | 1.09          | 3.00            | 4.91         |
| Strip and remove tile, slate batten and nails, m <sup>2</sup>   | 0.35      | 1.59          | —               | 1.91         |
| Strip and remove roof felt and remove all nails, m <sup>2</sup>   | 0.35      | 1.59          | —               | 1.91         |
| Underfelt laid and fixed on rafters, m <sup>2</sup>   | 0.13      | 0.59          | 0.90            | 1.79         |
| Slate or tile batten to 100 mm gauge, m <sup>2</sup>  | 0.20      | 0.91          | 1.90            | 3.37         |
| Ditto 200 mm gauge, m <sup>2</sup>  | 0.15      | 0.68          | 1.05            | 2.08         |
| Ditto 300 mm gauge, m <sup>2</sup>  | 0.10      | 0.45          | 0.88            | 1.60         |



|  |       |        |       |        |
|--|-------|--------|-------|--------|
| Concrete plain tiles to roof slopes, m <sup>2</sup>  | 1.40  | 6.34   | 12.00 | 22.01  |
| Slates size 406×203 mm to ditto, m <sup>2</sup>  | 1.10  | 4.98   | 20.20 | 30.22  |
| Ditto 508×254 mm, m <sup>2</sup>   | 0.70  | 3.17   | 18.90 | 26.48  |
| Ditto 610×305 mm, m <sup>2</sup>   | 0.50  | 2.27   | 27.00 | 35.12  |
| Half-round or angle hip and ridge tiles, lin.m   | 0.90  | 4.08   | 3.80  | 9.46   |
| Lead stepped flashings 300 mm wide over slates or tiles, lin.m   | 1.60  | 7.25   | 5.60  | 15.42  |
| Zinc flashings 300 mm wide, lin.m  | 1.00  | 4.53   | 3.90  | 10.12  |
| Taking-off tiling (or slating) and timbers for removal of water storage cistern, afterwards refixing and reinstating, each | 40.00 | 181.20 | 10.00 | 229.44 |

| Description of work  | Man hours | Nett Labour £ | Nett Material £ | Unit Price £ |
|--|-----------|---------------|-----------------|--------------|
| <b>CARPENTRY AND JOINERY</b>   |           |               |                 |              |
| Take up defective softwood floor and joists, remove, m <sup>2</sup>  | 0.66      | 2.99          | —               | 3.59         |
| Take up existing floor-boards and prepare joists to receive new floorboard, m <sup>2</sup>                       | 0.32      | 1.45          | —               | 1.74         |
| 50×100 mm joists, lin.m  | 0.75      | 3.40          | —               | 4.08         |
| 50×150 mm ditto, lin.m   | 0.85      | 3.85          | —               | 4.62         |
| 25×150 mm plain edge floor supply and fix, m <sup>2</sup>  | 0.80      | 3.62          | 9.00            | 15.14        |
| Take up ditto and fix new flooring in patches not exceeding 1 m <sup>2</sup> , each patch                        | 2.20      | 9.97          | 9.00            | 22.76        |
| Ditto in patches 1–3 m <sup>2</sup> , m <sup>2</sup>   | 2.00      | 9.06          | 9.00            | 21.67        |
| Take up shrunk or worn softwood plain edge flooring relay and cramp, make good with new flooring, m <sup>2</sup> | 0.90      | 4.08          | 1.50            | 6.70         |
| Take down softwood roof timbers not exceeding 63×175 mm, lin.m   | 0.33      | 1.49          | —               | 1.79         |
| Ditto exceeding 63×175 mm, lin.m   | 0.40      | 1.81          | —               | 2.17         |
| Rafters 50×100 mm, lin.m   | 0.20      | 0.91          | 1.20            | 2.53         |
| Ditto 50×150 mm, lin.m   | 0.26      | 1.18          | 1.80            | 3.58         |
| 25 mm boards to rafters 50×100 mm, lin.m   | 0.44      | 1.99          | 9.80            | 14.15        |
| Ditto small quantities, m <sup>2</sup>   | 0.70      | 3.17          | 9.80            | 15.56        |
| Taking down skeleton stud partition, m <sup>2</sup>  | 0.30      | 1.36          | —               | 1.63         |
| Ditto partition covered with wall board both sides, m <sup>2</sup>   | 0.40      | 1.81          | —               | 2.17         |
| Ditto covered with match board both sides, m <sup>2</sup>  | 0.60      | 2.72          | —               | 3.26         |

|  |      |      |      |       |
|--|------|------|------|-------|
| Alter studs to form new door opening size<br>755×1950 mm in partition plaster and lath<br>both sides, m <sup>2</sup> | 1.20 | 5.44 | 1.30 | 8.09  |
| Ditto covered with wall board both sides, m <sup>2</sup>   | 1.40 | 6.34 | 2.10 | 10.13 |
| Ditto covered with matchboard both sides, m <sup>2</sup>   | 1.60 | 7.25 | 1.90 | 10.98 |
| Stud partition framed with 50×100 mm studs<br>left clean for plaster both sides, m <sup>2</sup>                      | 0.55 | 2.49 | 3.45 | 7.13  |

| Description of work  | Man<br>hours | Nett<br>Labour £ | Nett<br>Material £ | Unit<br>Price £ |
|--|--------------|------------------|--------------------|-----------------|
| Ditto, ditto covered with hardboard both sides,<br>m <sup>2</sup>  | 1.50         | 6.79             | 10.25              | 20.45           |
| Ditto, ditto covered with matchboard both<br>sides, m <sup>2</sup>   | 2.35         | 10.65            | 18.45              | 34.92           |
| Remove skirting, lin.m   | 0.10         | 0.45             | —                  | 0.54            |
| Stock section softwood skirting up to size<br>25×150 mm and fixing to block wall partition,<br>lin.m                                 | 0.15         | 0.68             | 1.85               | 3.04            |
| Ditto to brickwork, lin.m  | 0.40         | 1.81             | 1.85               | 4.39            |
| Take down door, take out lining or frame,<br>realign and re-fix. Ease, adjust and re-hang<br>door, re-fix existing architraves, each | 5.20         | 23.56            | 3.50               | 32.47           |
| Take down door and set aside for re-use each   | 0.50         | 2.27             | —                  | 2.72            |
| Take down door and re-hang in new opening,<br>each   | 2.00         | 9.06             | —                  | 10.87           |
| Take down door, ease, adjust and re-hang,<br>each  | 1.80         | 8.15             | —                  | 9.78            |
| Take down door, cut and fit fire-resisting<br>board to one side, each  | 2.30         | 10.42            | 9.00               | 23.30           |
| Ditto, ditto both sides, each  | 3.30         | 14.95            | 18.00              | 39.54           |
| Take down frame or linning, set aside for re-<br>use, each   | 0.50         | 2.27             | —                  | 2.72            |
| Take frame or lining and re-fix each   | 1.25         | 5.66             | —                  | 6.79            |
| Standard door lining fixed in wood partition,<br>each  | 0.70         | 3.17             | 15.90              | 21.80           |
| In brick partition ditto in brick wall, each   | 1.10         | 4.98             | 15.00              | 23.98           |
| Standard plywood flush door and hanging<br>including butt hinges, mortice lock and<br>furniture, each                                | 5.00         | 22.65            | 22.00              | 53.58           |
| Standard hardboard flush door and ditto ditto,<br>each   | 5.00         | 22.65            | 16.00              | 46.38           |
| External part glazed door, hang, including<br>hinges, cylinder lock, door bolt, each   | 6.50         | 29.44            | 47.00              | 91.73           |

|  |      |      |   |      |
|--|------|------|---|------|
| Take down, ease and adjust casement sash, each | 1.20 | 5.44 | — | 6.53 |
|--|------|------|---|------|

| Description of work  | Man hours | Nett Labour £ | Nett Material £ | Unit Price £ |
|--|-----------|---------------|-----------------|--------------|
| Take out double lining sashes, ease, re-hang, new cords, each frame                                  | 1.60      | 7.25          | 4.00            | 13.50        |
| Standard casement frame 1.23 m × 0.77 m and building in brickwork, each                              | 1.50      | 6.80          | 41.00           | 57.36        |
| Ditto 1.23 × 0.92 m, each  | 1.80      | 8.15          | 43.00           | 61.38        |
| Ditto 1.23 × 1.38 m, each  | 2.20      | 9.97          | 46.00           | 67.16        |
| Take down, set aside for re-use staircase item. Spandril framed panelling up to 4 m wide × 3 m, each | 2.00      | 9.06          | —               | 10.87        |
| Newell posts, each   | 1.00      | 4.53          | —               | 5.44         |
| Handrail and balusters, each flight  | 3.00      | 13.59         | —               | 16.31        |
| Dog-leg stair flight, each   | 10.00     | 45.30         | —               | 54.36        |
| Straight stair flight, each  | 8.00      | 36.24         | —               | 43.49        |
| Provide and fix new stair flight 1 m wide 3 m rise with balustrade, each                             | 45.00     | 203.85        | 347.00          | 661.02       |
| Ditto, ditto with one-quarter space landing, each  | 50.00     | 226.50        | 387.00          | 736.20       |
| Ditto, ditto no landing but with three winders, each   | 53.00     | 240.09        | 437.00          | 812.51       |
| Strengthen handrail and balusters, renew defective balusters, lin.m                                  | 1.25      | 5.66          | 3.00            | 10.39        |
| Cutting out defective and worn portion of tread and piecing in new wood, each                        | 1.00      | 4.53          | 1.50            | 7.24         |
| Renew ironmongery to softwood, 75 mm cast iron butt hinges, pair                                     | 0.65      | 2.94          | 1.60            | 5.45         |
| 100 mm ditto, pair   | 0.70      | 3.17          | 1.90            | 6.08         |
| 75 mm steel butts, pair  | 0.40      | 1.81          | 0.60            | 2.89         |
| 100 mm ditto, pair   | 0.45      | 2.04          | 1.07            | 3.73         |
| Barrel bolts 200 mm, each  | 0.60      | 2.72          | 2.85            | 6.68         |
| Casement stay and pegs   | 0.50      | 2.27          | 1.87            | 4.97         |
| Sash fastener, each  | 0.75      | 3.40          | 1.95            | 6.42         |
| Sash fasteners (sliding sashes), each  | 0.75      | 3.40          | 2.30            | 6.84         |
| Rim lock and furniture   | 0.80      | 3.62          | 5.20            | 10.58        |
| Mortise lock and furniture   | 1.60      | 7.25          | 8.90            | 19.38        |
| Cylinder night latch   | 1.40      | 6.34          | 9.84            | 19.42        |

| Description of work | Man hours | Nett Labour £ | Nett Material £ | Unit Price £ |
|---------------------|-----------|---------------|-----------------|--------------|
|---------------------|-----------|---------------|-----------------|--------------|

**PLUMBING**

|  |      |       |       |       |
|--|------|-------|-------|-------|
| Taking down and removing existing gutters or pipes up to two storeys high, lin.m | 0.40 | 1.81  | —     | 2.17  |
| Ditto exceeding two storeys, lin.m   | 0.50 | 2.27  | —     | 2.72  |
| 100 mm cast-iron half-round gutter including brackets, lin.m                     | 0.75 | 3.40  | 6.75  | 12.18 |
| Extra for angles, each   | 0.40 | 1.81  | 4.50  | 7.57  |
| Extra for outlets, each  | 0.40 | 1.81  | 4.55  | 7.63  |
| 75 mm ci down pipe, lin.m  | 0.75 | 3.40  | 11.51 | 17.89 |
| Extra for swan neck, each  | 0.65 | 2.94  | 9.54  | 14.98 |
| Extra for shoe, each   | 0.40 | 1.81  | 10.16 | 14.36 |
| 100 mm plastic hr gutter and brackets, lin.m                                     | 0.50 | 2.27  | 2.69  | 5.95  |
| Extra for angles, each   | 0.40 | 1.81  | 1.83  | 4.37  |
| Extra for outlets, each  | 0.40 | 1.81  | 1.83  | 4.37  |
| 63 mm plastic RWD, lin.m   | 0.50 | 2.27  | 2.20  | 5.36  |
| Extra for shoe, each   | 0.33 | 1.49  | 0.88  | 2.84  |
| Take down, remove ci soil and vent pipes, lin.m                                  | 0.55 | 2.49  | —     | 2.99  |
| 100 mm ci soil and vent pipes including caulked lead joints, lin.m               | 1.70 | 7.70  | 16.00 | 28.44 |
| Extra-over for bends and extra lead joints, each                                 | 1.00 | 4.53  | 15.00 | 23.44 |
| Ditto for single junctions   | 2.00 | 9.06  | 24.00 | 39.67 |
| Ditto for swan neck  | 2.00 | 9.06  | 22.00 | 37.27 |
| Ditto for sanitary junctions   | 2.40 | 10.87 | 38.00 | 58.64 |
| Cut into ci stack pipe, insert new junction and extra lead joints, each          | 4.00 | 18.12 | 44.00 | 74.54 |
| Joint iron pipe to clayware drain socket, each                                   | 0.30 | 1.36  | 0.10  | 1.75  |
| Take down and remove lead waste or service pipes up to 50 mm, lin.m              | 0.40 | 1.81  | —     | 2.17  |
| Ditto iron ditto, lin.m  | 0.50 | 2.27  | —     | 2.72  |
| Cut into iron or copper service pipe and fit new 13 mm stop-valve                | 1.30 | 5.89  | 3.80  | 11.63 |

| Description of work  | Man hours | Nett Labour £ | Nett Material £ | Unit Price £ |
|--|-----------|---------------|-----------------|--------------|
| 13 mm lead service pipe to walls, bends, sockets and one tee (or branch) every 4 lin.m pipe, lin.m | 1.20      | 5.44          | 4.30            | 11.69        |
| 13 mm galv iron pipe, lin.m  | 1.00      | 4.53          | 1.65            | 7.42         |
| 13 mm copper pipe, lin.m   | 0.80      | 3.62          | 1.43            | 6.06         |
| 13 mm polythene pipe, lin.m  | 0.90      | 4.08          | 0.90            | 5.98         |

|  |      |       |        |        |
|--|------|-------|--------|--------|
| 18 mm lead pipe, lin.m   | 1.50 | 6.80  | 7.20   | 16.80  |
| 18 mm galv iron pipe, lin.m  | 1.10 | 4.98  | 2.80   | 9.34   |
| 18 mm copper pipe, lin.m   | 0.90 | 4.08  | 2.33   | 7.69   |
| 18 mm polythene pipe, lin.m  | 1.00 | 4.53  | 1.43   | 7.15   |
| Disconnect and take down sanitary fittings, overflows, waste pipes, cap off service pipes, we suite, each  | 2.75 | 12.46 | —      | 14.95  |
| Lavatory basin, each   | 1.75 | 7.93  | —      | 9.52   |
| Bath, each   | 3.00 | 13.59 | —      | 16.31  |
| Glazed ware sink, each   | 2.00 | 9.06  | —      | 10.87  |
| Sanitary fittings supply and fix to copper or iron service and waste pipes, we suite low level (PC £45.00) | 6.00 | 27.18 | 48.00  | 90.22  |
| Lavatory basin (PC £24.00)   | 5.80 | 26.27 | 28.00  | 65.12  |
| Bath less panels (PC £90.00)   | 5.80 | 26.27 | 100.00 | 151.52 |
| Ditto with panels (PC £120.00)   | 8.00 | 36.24 | 135.00 | 205.49 |
| White glazed Belfast sink (PC £35.00), each  | 4.60 | 20.84 | 40.00  | 73.90  |
| Steel sink and drainer (PC £110.00), each  | 5.00 | 22.65 | 115.00 | 165.18 |
| Ditto cupboard under (PC £170.00)  | 7.50 | 33.96 | 176.00 | 251.95 |
| 273 litre capacity water storage cistern including ball valve and overflow and connect to services, each   | 4.50 | 20.39 | 101.92 | 146.77 |

**PLASTERWORK**

|  |      |      |      |      |
|--|------|------|------|------|
| Hack down ceiling plaster, laths and ceiling joists for new plasterboard, m <sup>2</sup> | 0.85 | 3.85 | —    | 4.62 |
| Plaster baseboard and set ceiling, m <sup>2</sup>  | 0.70 | 3.17 | 2.20 | 6.44 |
| Hack off wall plaster to brick walls, and rake out joints to form key, m <sup>2</sup>    | 0.70 | 3.17 | —    | 3.80 |

| Description of work  | Man hours | Nett Labour £ | Nett Material £ | Unit Price £ |
|--|-----------|---------------|-----------------|--------------|
| Render and set on brickwork, m <sup>2</sup>  | 0.85      | 3.85          | 1.04            | 5.87         |
| Expanded metal lathing on wood and plaster finish                                    | 1.50      | 6.80          | 3.60            | 12.48        |
| 56 mm paramount or similar plasterboard partition walls, m <sup>2</sup>              | 1.05      | 4.76          | 14.50           | 23.11        |
| Hack off wall tiles and screed and rake out brick joints to form key, m <sup>2</sup> | 0.75      | 3.40          | —               | 4.08         |
| Cement mortar screed on walls to receive tiling, m <sup>2</sup>                      | 0.50      | 2.27          | 0.66            | 3.52         |
| 150×150 mm wall tiles bedded in mortar, m <sup>2</sup>                               | 2.80      | 12.68         | 8.48            | 25.39        |

|  |      |       |       |       |
|--|------|-------|-------|-------|
| Ditto fixed with adhesive, m <sup>2</sup>  | 2.30 | 10.42 | 8.48  | 22.68 |
| 19 mm cement mortar screen on concrete to receive other pavings, m <sup>2</sup>                          | 0.60 | 2.72  | 1.60  | 5.18  |
| 19 mm ditto with dustproofing solution and trowelled to smooth finish, m <sup>2</sup>                    | 0.70 | 3.17  | 1.75  | 5.90  |
| Hack off rendering, pebble dash, etc., to outside walls, and rake out joints to form key, m <sup>2</sup> | 0.60 | 2.72  | —     | 3.26  |
| Cement mortar render and pebble dash, ditto, m <sup>2</sup>  | 1.40 | 6.34  | 1.40  | 9.29  |
| <b>GLAZING</b>   |      |       |       |       |
| Hacking out old glass and cleaning rebates to receive new glass, m                                       | 2.50 | 11.33 | —     | 13.60 |
| 3.0 mm clear sheet glass ready cut to size in medium squares to wood, m <sup>2</sup>                     | 0.90 | 4.08  | 10.50 | 17.50 |
| 3.0 mm obscured glass ditto to wood, m <sup>2</sup>  | 0.90 | 4.08  | 12.83 | 20.29 |
| Remove temporary coverings to sashes stopping all nail holes, etc., m <sup>2</sup>                       | 1.10 | 4.98  | —     | 5.98  |
| <b>PAINTWORK</b>   |      |       |       |       |
| Strip wall or ceiling paper, stop, prepare surface, m  | 0.30 | 1.36  | —     | 1.63  |
| Burn off paintwork to wood surfaces, m <sup>2</sup>  | 0.80 | 3.62  | —     | 4.34  |

| Description of work   | Man hours | Nett Labour £ | Nett Material £ | Unit Price £ |
|---|-----------|---------------|-----------------|--------------|
| Two coats emulsion paint on ceilings, m <sup>2</sup>  | 0.30      | 1.36          | 0.40            | 2.11         |
| Ditto on walls, m <sup>2</sup>  | 0.25      | 1.13          | 0.40            | 1.84         |
| Two coats oil colour on ceiling, m <sup>2</sup>   | 0.40      | 1.81          | 0.50            | 2.77         |
| Ditto on walls, m <sup>2</sup>  | 0.35      | 1.59          | 0.50            | 2.51         |
| Ditto wood surfaces, m <sup>2</sup>   | 0.40      | 0.75          | 1.81            | 3.40         |
| Ditto on windows in medium squares, m <sup>2</sup>  | 0.50      | 0.35          | 2.77            | 4.50         |
| Clean prepare two coats oil colour on ci gutters, down pipes, etc., lin.m   | 0.50      | 2.27          | 0.40            | 3.20         |
| <b>DRAINAGE</b>   |           |               |                 |              |
| Excavate trench for new drains average 600 mm deep and refill and cart away surplus, lin.m                        | 2.00      | 7.26          | —               | 9.31         |
| Extra over last trenches for breaking up concrete paving 100 mm thick and reforming surfaces on completion, lin.m | 3.00      | 11.64         | 3.90            | 18.65        |
| Excavating to search for existing clayware  | 5.00      | 19.40         | —               | 23.28        |

drains up to 1 m deep and break out and remove old drains and concrete bed, lin.m

|   |      |      |      |       |
|---|------|------|------|-------|
| 150 mm concrete bed under 100 mm drain, lin.m | 0.70 | 2.72 | 5.85 | 10.28 |
|---|------|------|------|-------|

|  |      |      |       |       |
|--|------|------|-------|-------|
| 150 mm bed and surround to 100 mm drain, lin.m | 2.00 | 7.76 | 11.70 | 23.35 |
|--|------|------|-------|-------|

|   |      |      |      |      |
|---|------|------|------|------|
| 100 mm clayware drain laid and jointed, lin.m | 0.35 | 1.36 | 2.85 | 5.05 |
|---|------|------|------|------|

|                                     |      |      |      |      |
|-------------------------------------|------|------|------|------|
| Extra over ditto for junction, each | 0.30 | 1.16 | 2.75 | 4.69 |
|-------------------------------------|------|------|------|------|

|                          |      |      |      |      |
|--------------------------|------|------|------|------|
| Extra over for bed, each | 0.15 | 0.58 | 1.60 | 2.61 |
|--------------------------|------|------|------|------|

|  |       |       |   |       |
|--|-------|-------|---|-------|
| The following work in providing drain connection from new inside we to existing manhole. | 12.00 | 46.56 | — | 55.87 |
|--|-------|-------|---|-------|

Cut hole through 150 mm concrete, excavate about 600 mm deep in hardcore and subsoil from new drain including cutting hole through footing, each

| Description of work  | Man hours | Nett Labour £ | Nett Material £ | Unit Price £ |
|--|-----------|---------------|-----------------|--------------|
| Build in one vertical length and one horizontal length of 100 mm clayware drain and one bend, make good floor concrete, each | 4.50      | 17.46         | 9.35            | 32.17        |
| Cut into 225 mm brick side of manhole to receive new pipe, cut away benching and insert new branch channel, make good, each  | 4.00      | 15.52         | 7.24            | 27.31        |

For materials, prices depend very much on the quantity of materials required and any delivery charges, such as cartage and handling, on and off the site. For small quantities of materials, the prices published monthly in the *Building Trades Journal* are a good guide. Handling and delivery charges will vary for every job, and must be ascertained afresh for each job.

Combined, these two figures will give the cost of labour and materials. Three other additions must be made to this price.

1. Cost of site supervision, either by charge-hand, working foreman, walking foreman, site agent and directors. On a medium size to large job, this will amount to *about 18 per cent of labour costs*.

2. Cost of plant for the job, including transport and erection of machinery, store huts and site offices, and a charge for use and waste of timber and depreciation of static plant and machinery, together with fuel costs for the operation of the machines. This can vary so much from job to job that no approximate percentage can be given.

3. A percentage to cover the cost of maintaining the builder's organisation, such as head office and office staff, yards and depots and their staffs, and the materials consumed in the operation of that organisation. In these days, one of the heavy items that must be included is interest on money borrowed to finance works, not only while the jobs are

actually going on, but including retention periods.

This is the cost of the work, made up as follows:

1. Materials: including cartage, unloading, stacking, etc. From quotations, catalogue prices or published lists.
2. Labour: Basic agreed rates, plus bonuses, plus overtime. To this add the following indirect costs: VAT, Industrial injuries, NHS, National Insurance contribution, Redundancy fund, Graduated pension, Holidays with Pay, Sick pay scheme, Training levy, Redundancy disbursement (averaged allowance), Guaranteed week and accident and public liability insurance.
3. Site supervision: As a calculated percentage of actual wages paid, plus indirect costs, as above, where applicable.
4. Plant, etc, (sometimes called 'prelims'): Hire, depreciation, erection, etc.
5. Management, etc (sometimes called 'overheads'): Usually as a percentage.
6. Profit: Usually as a percentage.

Included in materials are *P.C. sums* (prime cost sums), which do not include *fixing provisional sums*, which include labour and materials, the sums should not be exceeded except with written authority

In certain types of work, however, such as sub-contracting for one type of work only, or work in one trade, an experienced man may be able to 'spot price' a job merely by looking at it, and perhaps taking rough overall measurements. For general building work, this is not to be recommended.

Many estimators (but many more quantity surveyors) make extensive use of published books and lists of 'labour and materials' prices. These should be used with caution; there are differences amounting to 25 per cent in the prices for such everyday work as brickwork, block partitions and plastering in the best-known of these publications: the principal trouble being that the reader is never sure what is included in these prices, or—more important—what is omitted. Unloading and stacking, National Insurance, scaffolding and other plant are usually not included and, of course, these prices cannot take account of bonus systems or plus rates. Some of these works include sections giving prices of materials and proprietary goods from suppliers. These are invariably minimum prices, and sometimes extras for cartage, etc., are not included.

Even greater caution will be needed in the next few years, because the metric prices for metric quantities appearing in trade journals and technical works (including this one) are straight conversions from existing rates in Imperial measure and old money. They have not been proved in practice. All works on estimating published before 1969 should be used with great caution. Immense errors can be made when trying to adapt old-money prices for old measurements to new-money prices for metric quantities. Even with modern conversion tables, much extra work must be involved; because there is extra work, it will be done in a hurry—a prolific source of errors. Unfamiliarity with the new coinage and the new measuring units must, nevertheless, cause the work to be done more slowly, and the very element of unfamiliarity must cause some errors. It is vital that one extra check be made of both measurements and prices, and this may be necessary for some years, until everyone has learned to think in the new factors and has begun to forget the old ones.



## LABOUR ONLY CONSTANTS

The following are straight conversions from Imperial measure and weight: they should be used with caution because they have not been tried out in practice. Indeed, it will be several years before completely reliable sets of estimating constants or prices are available.

For those who wish to convert estimating data in Imperial sizes and weights to metric, a brief set of conversion tables are given on page 95.

|   |              | Hours | Metric unit    |
|---|--------------|-------|----------------|
| <b>Excavator</b>                                    |              |       |                |
| Surface, trenches etc.                              | Labourer     | 2.275 | m <sup>3</sup> |
| Deep trenches                                       | ..           | 3.245 | ..             |
| Load lorries  | ..           | 0.162 | ..             |
| Return, fill and ram                                | ..           | 1.300 | ..             |
| <b>Concretor</b>                                    |              |       |                |
| Mixing and depositing by hand                       | ..           | 0.200 | ..             |
| Mixer and dump trucks                               |              | 2.600 | ..             |
| <b>Bricklayer</b>                                   |              |       |                |
| 11" cavity wall                                     | { Bricklayer | 2.392 | m <sup>2</sup> |
|   | { Labourer   | 0.089 | ..             |
| 4 ½" wall   | { Bricklayer | 1.196 | ..             |
|   | { Labourer   | 0.347 | ..             |
| DPC   | { Bricklayer | 0.800 | m run          |
|   | { Labourer   | 0.200 | ..             |
| Breeze partitions:                                  |              |       |                |
| 2"  | { Bricklayer | 0.347 | m <sup>2</sup> |
|   | { Labourer   | 0.299 | ..             |
| 3"  | { Bricklayer | 0.347 | ..             |
|   | { Labourer   | 0.591 | ..             |
| 4"  | { Bricklayer | 0.809 | ..             |
|   | { Labourer   | 0.596 | ..             |
| <b>Drainlayer</b>                                   |              |       |                |
| Stoneware, laying and jointing                      |              |       |                |
| 4" Bricklayer and labourer, each                    |              | 1.000 | 4.50m run      |
| 6" Bricklayer and labourer, each                    |              | 1.000 | 3.15m run      |
| (Testing, 4hr per length not over 100ft)            |              | 4.000 | 30.5m          |
| Agricultural  |              |       |                |
| Agricultural labourer (cut, lay and cover)          |              | 0.600 | m run          |
| <b>Asphalter</b>                                    |              |       |                |
| (Labour constants are for asphalter and mate, each) |              |       |                |
| Fine gritted asphalt, 2-coat work                   |              | 1.434 | m <sup>2</sup> |
| Underfelting  |              | 0.038 | ..             |
| Vertical work                                       |              | 2.340 | ..             |
| Skirtings (6")                                      |              | 0.050 | ..             |
| Dampcourse on narrow walls                          |              | 0.050 | m run          |

|                                   |   |   |        | Hours       | Metric unit                               |                |
|-----------------------------------|---|---|--------|-------------|---|----------------|
| <b>Mason</b>                      | (Labour constants are for crafts – men only)  |   |        |             |   |                |
|                                   | Ashlar (1' to 2' cube) 0.28 to 0.56m  |   |        | 3.750       | 3.75m run                                 |                |
|                                   | Ditto (over 2' cube) over 0.56m   |   |        | 3.200       | 3.20m run                                 |                |
|                                   | (The above is for Portland Stone; deduct 50% for Bath Stone; add 50% for medium sandstone, and 100% for hard sandstone, 140% for marbles and 300% for granite.) |   |        |             |   |                |
|                                   | Hoisting, setting and pointing stonework from ¼ hr to ¾ hr, according to size, ranging from 6in (150mm) bed to 15in (375mm) bed.                                |   |        |             |   |                |
| <b>Roofer</b>                     | (Labour constants are for roofer and mate, each).....   |   |        |             |   |                |
|                                   | Corrugated sheets .....   | 3 hrs   |        |             | per square of 100ft or 9.3mm <sup>2</sup> |                |
|                                   | Plain tiling .....  | 3 ..  |        |             |   |                |
|                                   | Interlocking tiles .....  | 2½ ..   |        |             |   |                |
|                                   | Slating (20" × 10" slates) .....  | 2¾ ..   |        |             |   |                |
|                                   | Battening for tiles or slates .....   | 2½ ..   |        |             |   |                |
| <b>Carpenter</b>                  | Underfeltng .....   |   |        | 0.38        | m <sup>2</sup>                            |                |
|                                   | General work in roofs, floor joists, etc.   |   |        |             |   |                |
|                                   |   | Carpenter                                       | 1 hr   | ft cube     | 1.00                                      |                |
|                                   |   | Labourer  | 1/10,, | ft cube     | .10                                       |                |
|                                   | Doors—hanging   | Carpenter                                       | 2 hrs  | per door    | 2.00                                      | each           |
|                                   | Gates—hanging   | "   | 1 hr   | per gate    | 1.00                                      | each           |
|                                   | Doors frames—making   | "   | 2½ hrs | per ft cube | 1.75                                      | each           |
|                                   | Doors frames—fixing   | "   | ¾ hr   | ft cube     | 0.75                                      | each           |
|                                   | Draining boards   | "   | ½,,    | ft super    | 6.07                                      | m <sup>2</sup> |
|                                   | Sashes—casement, making,,   | "   | ¾,,    | ft super    | 4.86                                      |                |
|                                   | Sashes, casement, hanging,,   | "   | 1/10,, | ft super    | 1.07                                      | m <sup>2</sup> |
|                                   | <b>Ironworker</b>   | (Labour constants are for smith and mate, each) |        |             |   |                |
| Fixing half-round or ogee gutters |   |   | 1/7hr  | ft run      | 0.05                                      | m run          |
| Fixing rainwater pipe.....        |   |   | ¼,,    | " "         | 0.25                                      | " "            |
| Steelwork—up to 10' .....         |   |   | 2 hrs  | cwt         | 2.00                                      | 50kg           |
| Steelwork—up to 30' .....         |   |   | 2½ ..  | "           | 2.50                                      | 50kg           |
| <b>Plasterer</b>                  |   |   |        | Hours       | Metric unit                               |                |
|                                   | Fixing plasterboard   | Craftsman                                       | ¾hr    | yd super    | 0.347                                     | m <sup>2</sup> |
|                                   |   | Labourer  | ¾ ..   | " "         | 0.347                                     | m <sup>2</sup> |
|                                   | Metal lathing   | "   | 1/3,,  | " "         | 0.569                                     | m <sup>2</sup> |
|                                   | Render 1 coat (Portland cement)   |   |        |             |   |                |
|                                   |   | Craftsman & Labourer, each                      | 1/5,,  | " "         | 0.238                                     | m <sup>2</sup> |
|                                   | Render 2 coats, Portland cement   |   |        |             |   |                |
|                                   |   | Craftsman & Labourer, each                      | ¾,,    | " "         | 0.347                                     | m <sup>2</sup> |
| Skim in gypsum plaster            |   |   |        |             |   |                |
|                                   | Craftsman   | ½,,   | " "    | 0.149       | m <sup>2</sup>                            |                |
|                                   | Labourer  | 1/6..   | " "    | 0.098       | m <sup>2</sup>                            |                |

|                                |   |          |           | Hours          | Metric unit      |                  |
|--------------------------------|---|----------|-----------|----------------|------------------|------------------|
| <b>Plumber</b>                 | (Labour constants are for plumber and mate, each) |          |           |                |                  |                  |
|                                | Sheet lead in roofwork generally                  | 5 hrs    | cwt       | 5.00           | 50kg             |                  |
|                                | ditto in gutters.....                             | 6 "      | "         | 6.00           | 50kg             |                  |
|                                | ditto in stepped flashings                        | 7½,,     | "         | 7.50           | 50kg             |                  |
|                                | angles to safes, etc..                            | 1/5hr    | each      | 0.20           | each             |                  |
|                                | soldered dots.....                                | ¼,,      | "         | 0.25           | each             |                  |
|                                | Lead pipe, fixing, with holdfasts                 |          |           |                |                  |                  |
|                                | ½in, ¾in and light                                |          |           |                |                  |                  |
|                                | wastes.....                                       | 1/5,,    | ft run    | 0.65           | m run            |                  |
|                                | 4in soil pipe.....                                | ½,,      | " "       | 1.60           | m run            |                  |
|                                | ditto bends                                       | 1½hrs    | each      | 1.50           | each             |                  |
|                                | Wiped joints ½in, ¾.....                          | 2/5hr    | "         | 0.47           | each             |                  |
|                                | 1½in and 1 in....                                 | 2/3,,    | "         | 0.76           | each             |                  |
|                                | 4in.....  | 1 "      | "         | 1.19           | each             |                  |
|                                | Zinc and copper sheet in roofs..                  | ¼,,      | ft super  | 2.63           | m <sup>2</sup>   |                  |
| ditto ditto in gutters,        |   |          |           |                |                  |                  |
| etc....                        | ¾,,   | " "      | 3.123     | m <sup>2</sup> |                  |                  |
| <b>Glazier</b>                 | (Labour constants are for glazier only)           |          |           |                |                  |                  |
|                                | Sheet glass in large squares                      | 1/5hr    | ft super  | 1.196          | m <sup>2</sup>   |                  |
| ditto in small squares....     | ¼,,   | " "      | 0.299     | m <sup>2</sup> |                  |                  |
| <b>Painter</b>                 | Burning off                                       | Painter  | 1 "       | yd super       | 1.196            | m <sup>2</sup>   |
|                                | Plain painting, 1st coat                          | "        | 1/5,,     | " "            | 0.238            | m <sup>2</sup>   |
|                                | 2nd coat  | "        | 1/6,,     | " "            | 0.228            | m <sup>2</sup>   |
|                                | Finish  | "        | 1/5,,     | " "            | 0.238            | m <sup>2</sup>   |
|                                | Distemper   | "        | 1 "       | 11yds sup      | 1.000            | 10m <sup>2</sup> |
| <b>Paperhanging</b>            | Stripping (labourer).....                         | ½ to 1hr | per piece |                |                  |                  |
|                                | Stopping and preparing (crafts-                   |          |           |                |                  |                  |
|                                | man).....   | ½ to ¾hr | " "       |                |                  |                  |
|                                | Hanging lining paper (crafts-                     | 1 hr     | " "       |                |                  |                  |
|                                | man).....   | 1.1/5hrs | " "       |                | 5 m <sup>2</sup> |                  |
| ditto ordinary papers (crafts- |   |          |           |                |                  |                  |
| man).....                      | 1.1/5hrs  | " "      |           |                |                  |                  |
| ditto ceiling paper (crafts-   |   |          |           |                |                  |                  |
| man).....                      | 1½hrs   | " "      |           |                |                  |                  |

### THE CRITICAL PATH METHOD

The 'critical path method' (called CPM in most of the literature about it) is a highly systematized procedure that aims to ensure the best possible allocations of time and money to each operation (or activity or trade) on a job. If properly carried out, it should enable a job to be completed for the least possible money and in the shortest possible time. Plainly, it involves job planning and job management as well as estimating. This is perhaps more logical than treating estimating as a subject on its own, without much reference to any other factors.

In the first stage of the CPM, the separate activities or operations are arranged in a sequence, in the order that they occur on a job. From this, an arrow diagram is drawn up, showing this sequence. The second stage consists in adding to this arrow diagram estimates of the time each activity will take, and in selecting the 'critical' operations, that

must follow in immediate succession if the job is to finish without loss of time. It is these activities that form the 'critical path'. Leeway or 'float' on non-critical operations—that is, the length of time for which they can be delayed without affecting the 'critical path'—is also determined. The general pattern of the job is now revealed. The contractor already knows that, in order to make the best of the job, delays must not occur in the progress of any of the critical operations, nor between the end of one critical activity and the next in sequence. He now knows which are his critical operations, and just where delays must not be allowed to occur: he also knows by how much non-critical operations can be delayed without affecting the finishing time of the job as a whole.

In stage three—the costing stage—several cost estimates are made. The first is based on normal times for the operations, as set out in the CPM schedule. The second is for a 'crash' programme, involving cuts in time allowed for critical operations (even if this means overtime and flooding the job with men) so far as 'float' on non-critical operations will allow. Then, several programmes intermediate between Stage 1 and Stage 2 are estimated. These different combinations of time and cost are plotted as two time-cost curves; one for direct and the other for indirect costs. From these, a total cost curve is constructed, giving the best programme, in time and cost, for the job. With this information in his possession, the contractor can watch the job's progress closely. If he sees signs of a breakdown in the scheduled time for any operation, he will know how much it will cost him to catch up, and will further know whether it would be profitable to initiate a 'crash' programme, or one of the intermediate ones, or to allow the job to fall behind schedule.

It is obvious that there is an enormous number of calculations involved. These are, however, quite straightforward ones, and a computer need only be used if a lot of time and tedious effort cannot be spent. Some authorities estimate that 75 activities is the greatest number that can be dealt with without a computer, while others put the number at 1,500.

This method is now in use on large contracts, and one Government Department specifies its use on a number of its contracts. A fuller introduction to the subject is given in Building Research Station Digest No. 53 (Second Series) available from H.M.S.O. Courses are now available in some evening institutes and technical colleges.

### ESTIMATOR'S CONVERSION TABLES

#### HOURS PER SQUARE FOOT TO HOURS PER SQUARE METRE

| Hr per sq. ft | Hr per sq. m |
|---------------|--------------|
| 1/8           | 1.341        |
| 1/5           | 2.142        |
| 1/4           | 2.682        |
| 3/8           | 3.123        |
| 1/2           | 4.864        |
| 5/8           | 6.705        |
| 3/4           | 7.281        |

#### HOURS PER CUBIC FOOT TO HOURS PER CUBIC METRE

| Hr per cu. ft | Hr per cu. m |
|---------------|--------------|
| 1/8           | 4.414        |
| 1/4           | 8.828        |
| 1/2           | 17.657       |
| 3/4           | 26.485       |
| 1             | 35.315       |
| 2             | 70.630       |
| 3             | 105.945      |

|                          |                          |                         |                       |
|--------------------------|--------------------------|-------------------------|-----------------------|
| 7/8                      | 9.387                    |                         |                       |
| 1                        | 10.764                   |                         |                       |
| HOURS PER SQUARE FOOT TO |                          | HOURS PER CUBIC FOOT TO |                       |
| HOUR PER SQUARE METRE    |                          | HOURS PER CUBIC METRE   |                       |
| Hr per sq. yd            | Hr per sq.m <sup>2</sup> | Hr per cu. yd           | Hr per m <sup>3</sup> |
| 1/8                      | 0.149                    | 1/8                     | 0.162                 |
| 1/5                      | 0.238                    | 1/4                     | 0.325                 |
| 1/4                      | 0.299                    | 1/2                     | 0.650                 |
| 3/8                      | 0.347                    | 3/4                     | 0.975                 |
| 1/2                      | 0.596                    | 1                       | 1.300                 |
| 5/8                      | 0.745                    | 2                       | 2.600                 |
| 3/4                      | 0.809                    | 3                       | 3.900                 |
| 1                        | 1.196                    | 4                       | 5.200                 |
| 2                        | 2.392                    | 5                       | 6.500                 |
| 3                        | 3.588                    |                         |                       |
| 4                        | 4.784                    |                         |                       |
| 5                        | 5.980                    |                         |                       |

### MODULAR CO-ORDINATION

'Dimensional co-ordination' or 'modular co-ordination' has been defined as Nationalization of theoretical dimensions of a structure to ensure that all are as far as possible multiples in whole numbers of a basic unit of measurement known as the module or where necessary rational and limited subdivisions of the module' (*Specification*, vol. 1). Put another way, it means that all components such as windows and doors should be multiples of the basic unit (which in Britain is the brick), in length and height. All lesser units, such as widths of door frame members, should be simple subdivisions of the length of a brick.

A truly 'modular' building should be designed on a modular grid of 300 mm squares, and it follows that the basic measure (or dimension, or module) should be a simple subdivision of 300 mm in all its three dimensions.

At first sight the idea is an attractive one because it seems to bring order out of chaos, substituting simplicity for diversity. The whole system of building would seem to be a planned co-ordinated one, instead of a heterogeneous collection of unrelated traditional sizes. When translated from theory into practice, drawbacks appear and the theory begins to lose its attractiveness. Architects find that planning to a grid limits scope and hinders good planning. On the building site, joint thicknesses, variations in manufactured sizes and tolerances for 'going in' have to be taken into account. These necessitate various clumsy expedients and compromises, such as 'formats' in brickwork and blockwork, which result in numerous departures from the simplicity of the theory. In fact, the result is just another heterogeneous collection of dimensions. In short, the theory does not work in practice.

Nevertheless, it has an attraction for some: it is sufficiently popular for some

brickmakers to manufacture special 'modular bricks', but it is never likely to supersede the existing system. Builders and especially their estimators should remember that 'modular' construction is a different sort of work than the normal, and can be very expensive.

### **THE EUROPEAN ECONOMIC COMMUNITY**

Entry into the Common Market imposed some conditions that affect firms tendering for large contracts. *EEC Directive 71/305*, operative since July 1973, lays down that all public bodies (Government, Local Authorities, housing and new town corporations or associations) must advertise the contract to be let in the *Official Journal of the EEC*, if that contract is for £415,000 or over. Firms wishing to tender must submit a 'request to participate' to the public body letting the tender, and this 'request to participate' must be supported by financial and technical evidence of capability to carry out the work. A 'short list' may be selected from the applicants by the public body concerned: a firm already on that authority's approved list need not supply the particulars detailed above. In theory, this throws open a number of large contracts in the UK to foreign competition, but gives an opportunity to British firms to tender for a much greater number of jobs in the European states in the EEC.

## 4.

# THE STANDARD METHOD OF MEASUREMENT OF BUILDING WORKS (SMM6-SIXTH EDITION)

This method of measuring building works was agreed between the Royal Institution of Chartered Surveyors and the National Federation of Building Trades Employers, now Building Employers Confederation.

The *Fifth Edition of the Standard Method of Measurement* was published in the Autumn of 1962, and became operative on 1 March 1963. The *Fifth Edition Metric*, published in 1968, was a conversion of the basic Imperial edition and not a revision.

The *Sixth Edition* is an interim edition in which the work sections have been developed in varying degrees, some considerably and some only sufficiently to accommodate them to the general pattern.

SMM6 is accompanied by a non-mandatory *Practice Manual*, which is intended to be read and used in conjunction with the SMM. It has two basic purposes: first, it is intended to give guidance on the communication of information relative to quantities of finished work where their value is modified by position, complexity, simplicity, repetition, eccentric distribution or other cost significant factors: secondly, it is intended to encourage good practice in the measurement of building works. **The sixth edition became operative on 1 March 1979.**

SMM6 deals with methods of measurement and not, with a few exceptions, methods of billing. The general format and design of bills is left to the discretion of the surveyor. However, from the tenderer's point of view it is convenient if all work which will be carried out by one specialist is brought together in one section of the bills of quantities. For example: lead and copper damp-proof courses and flashings could conveniently be grouped with plumbing.

Work such as filler joist floors, thatching, etc, which are types of construction seldom measured nowadays, have been omitted. It is suggested that the surveyor uses his discretion in the measurement of this kind of work. He could refer to previous editions of SMM, or refer to local custom in the area in which the work is to be carried out, or consult with specialists who may be involved.

The same principle applies to new forms of construction or finish or to those which are seldom used. An example would be the formation of simulated beams and timbers in glass fibre.

## **PLANT ITEMS**

The SMM requires items to be given in the bill for the provision and maintenance of plant on site. The reason for giving plant separately from the ordinary items for permanent work is in recognition of the fact that plant costs often depend upon factors other than the quantities and nature of the various items of permanent work in the section.

For example: in erecting precast concrete, the plant cost would include the cost of a crane for erecting precast concrete units. The cost of the crane would depend upon what size of crane was provided and how long it was likely to be required on site. The choice of the crane would depend upon the heaviest duty required, usually the heaviest unit at greatest radius, and this would govern the daily charge for keeping the crane on site and the charges for haulage to and from the site.

The length of time would be governed by other factors such as the rate at which the work becomes available and the number and type of precast units as a whole.

The total plant cost consequently has a fixed element (the cost of providing the plant) and a time-related element (the cost of maintaining the plant on the site for the duration required).

These elements of cost are normally considered separately when estimating and it is helpful if they can also be considered separately when valuing variations.

The plant items enable these cost elements to be priced separately instead of being spread over other groups of items, which should contribute to more realistic pricing generally. It is not the intention that tenderers should be forced to vary their method of pricing. If the items are left unpriced, the plant cost will be assumed to have been included elsewhere.

## **SECTION A. GENERAL RULES**

The major innovation in this section is the definition of drawn information included in clause A5.

The three types of drawn information referred to are location drawings, component details, and bill diagrams.

The location drawings are further defined (A.5.1a) and are referred to in the majority of work sections which follow. Component details are working drawings (referred to mainly in the 'composite items' section of Section N) and bill diagrams which are used throughout the rules as an adjunct to a brief description.

### **A.5. DRAWN INFORMATION**

1. Drawn information where required to be provided for the full implementation of this document is defined as follows:
  - (a) Location drawings.



- (i) Block plan; To identify site and outline of buildings in relation to Town Plan or other wider context.
  - (ii) Site plan; To locate the position of buildings in relation to setting out point, means of access and general layout of site.
  - (iii) General locating drawing; To show the position occupied by the various spaces in a building and the general construction and location of principal elements.
- (b) Component details. To show all the information necessary for the manufacture and assembly of the component.
  - (c) Bill diagram. To be drawn information which may be provided with the bills of quantities to aid the description of the item. Information by way of dimensions or detail may be indicated; alternatively such information shall be included in the relevant description that accompanies the bill diagram.

#### A.7. QUANTITIES

1. Where the unit of billing is the metre, quantities shall be billed to the nearest whole unit. Fractions of a unit less than half shall be disregarded and all other fractions shall be regarded as whole units.
2. Where the unit of billing is the tonne, quantities shall be billed to the nearest two places of decimals.
3. Where the application of clauses A.7. 1, and A.7. 2, would cause an entire item to be eliminated, such an item shall be enumerated, stating the size or weight appropriate.

### SECTION B. PRELIMINARIES

A list is now required of the drawings from which the bill of quantities has been prepared (B.3. 1.) and the general location drawings (previously defined in clause A.5. 1(a) (iii) are required to accompany the tender documents.

A check list of example obligations and restrictions which might be imposed by the employer is now included (B.8. 1.). A similar list for the convenience of pricing by the contractor (B.13) indicates that drying the works is not to be the responsibility of the contractor, unless specific temperature and humidity levels are required.

The attendances required on nominated subcontractors have been amplified and now include particulars of the weight and size of significant pieces of equipment (B.9. 3(c)).

#### B.3. DRAWINGS AND OTHER DOCUMENTS

1. A list shall be given of the drawings from which the bills of quantities have been prepared and which will be available for inspection by the contractor. The list shall indicate the location drawings as clause A.5. 1(a) (i)–(iii) which shall accompany the bills of quantities.

## B.8. OBLIGATIONS AND RESTRICTIONS IMPOSED BY THE EMPLOYER

1. Particulars shall be given of any obligations or restrictions to be imposed by the employer in respect of the following, unless they are covered by the schedules given in accordance with clause B.4.
  - (a) Access to and possession or use of the site.
  - (b) Limitations of working space.
  - (c) Limitations of working hours.
  - (d) The use or disposal of any materials found on site.
  - (e) Hoardings, fences, screens, temporary roofs, temporary name boards and advertising rights.
  - (f) The maintenance of existing live drainage, water, gas and other mains or power services on or over the site.
  - (g) The execution or completion of the work in any specific order or in sections or phases.
  - (h) Maintenance of specific temperatures and humidity levels. Alternatively a provisional or prime cost sum shall be given.
  - (j) Temporary accommodation and facilities for the use of the employer including heating, lighting, furnishing and attendance.
  - (k) The installation of telephones for the use of the employer and the cost of his telephone calls shall be given as a provisional sum.
  - (l) Any other obligation or restriction.

## B.13. PRICING

1. For convenience in pricing, items for the following shall be given. Maintaining temporary works; adapting, clearing away and making good shall be deemed to be included with the items. Notices and fees to local authorities and public undertakings related to the following items shall be deemed to be included with the items.
  - (a) Plant, tools and vehicles.
  - (b) Scaffolding.
  - (c) Site administration and security.
  - (d) Transport for workpeople.
  - (e) Protecting the works from inclement weather.
  - (f) Water for the works. Particulars shall be given if water will be supplied by the employer.
  - (g) Lighting and power for the works. Particulars shall be given if current will be supplied by the employer.
  - (h) Temporary roads, hardstandings, crossings and similar items.
  - (j) Temporary accommodation for the use of the contractor.
  - (k) Temporary telephones for the use of the contractor.

- (l) Traffic regulations.
- (m) Safety, health and welfare of workpeople.
- (n) Disbursements arising from the employment of workpeople.
- (p) Maintenance of public and private roads.
- (q) Removing rubbish, protective casings and coverings and cleaning the works on completion.
- (r) Drying the works.
- (s) Temporary fencing, hoardings, screens, fans, planked footways, guardrails, gantries and similar items.
- (t) Control of noise, pollution and all other statutory obligations.

## **SECTION C. DEMOLITION**

This section has remained much as SMM5, but alteration work is now measured under the appropriate trade heading.

One innovation, which also occurs throughout the works sections, is the introduction of a requirement to include an item for bringing to, maintaining on, and removing from, site, any plant required for the work (C.2.). This clause is intended to provide for the contractor to price, if he so wishes, the relevant plant in the relevant work section.

### **C.2. PLANT**

1. An item shall be given for bringing to site and removing from site all plant required for this section of the work.
2. An item shall be given for maintaining on site all plant required for this section of the work.

## **SECTION D. EXCAVATION AND EARTHWORK**

Rules for this section have been drafted on the assumption that excavation and earthwork will be carried out by mechanical plant. This explains the disappearance of the term 'get out' in relation to excavation.

Where it would be difficult or impractical to carry out excavation by mechanical means, e.g. alongside existing services or in small pits, the rules have been drawn up to identify these situations.

A soil description (D.3.), is now required, including details of over or underground services. Also, a pre-contract water level must be established from which the bill measurement will be prepared.

The water level will be re-established at the time the excavations are carried out and the measurements adjusted accordingly. Guidance on the application of this rule is given in the *Practice Manual*.

### D.3. SOIL DESCRIPTION

1. Particulars of the following shall be given:

- (a) Ground water level and the date when it was established, hereinafter described as the pre-contract water level. The ground water level shall be re-established at the time the various excavation works are carried out and is described hereinafter as the post-contract water level.

Where ground water levels are subject to periodic changes due to tidal or similar effects they shall be so described and the average of the mean high and low levels given.

- (b) Trial pits or bore holes, stating their location.
- (c) Over or underground services.

(2) If the above information is not available a description of the ground and strata which is to be assumed shall be stated.

**D.3.1(a):** Such variations in ground water level are not intended to include temporary fluctuations in level which arise as a result of those items at the contractor's risk under Clause D.25. It is not intended that several water levels, with only minor variations, be established for each site but the water level could well differ substantially from one excavation to another (e.g. pits at opposite ends of the site) or from one part to another of an individual excavation (e.g. a very large basement) especially in those instances where springs are encountered. It should be possible, in most cases, to agree a common post-contract ground water level for the whole site.

**D.3.1(b):** The particulars required to be given will be the information by way of trial hole data that is available. Such information, if given in accordance with the relevant British Standard Code of Practice, would ensure that a reasonable indication of what can be expected has been given.

*(Excerpt from Practice Manual)*

Excavation is now required to be classified in terms of maximum depth of excavation (D.11) rather than in 1.50 m stages.

### D.11. DEPTH CLASSIFICATION

Depths of excavation shall unless otherwise required by this document be classified as follows:

|         |       |     |           |        |
|---------|-------|-----|-----------|--------|
| Maximum | depth | not | exceeding | 0.25 m |
| ”       | ”     | ”   | ”         | 1.00m  |
| ”       | ”     | ”   | ”         | 2.00m  |
| ”       | ”     | ”   | ”         | 4.00m  |

and thereafter in 2.00 m stages.

The working space rules (D.12.) are similar in principle to SMM5 but have been

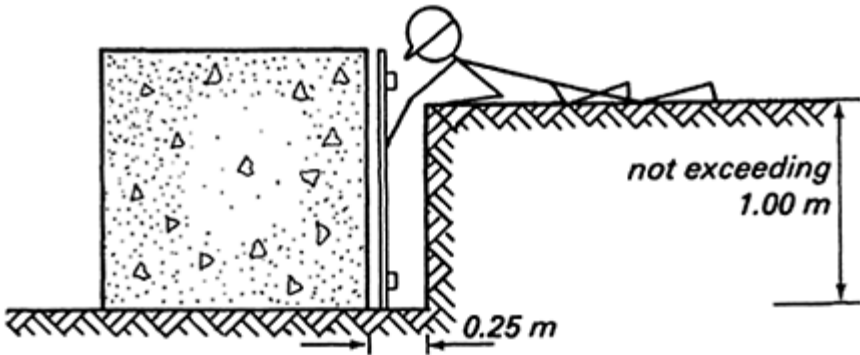
clarified and amplified by sketches in the practice manual (reproduced here). Excavation and filling of working space must now be given as a separate item.

### D.12. WORKING SPACE

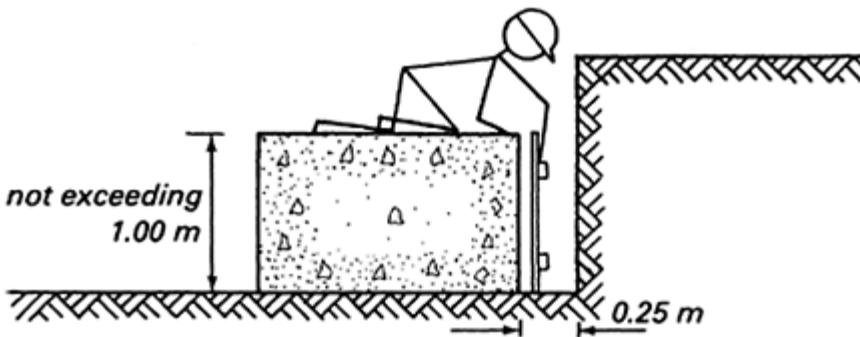
1. Working space (which shall not be subject to adjustment if more or less space is actually required) shall be measured from the face of the finished work as follows;

(a) Formwork

(i) 0.25 m from the face of any work which requires formwork where the bottom of the formwork does not exceed 1.00 m below the starting level of the excavation.

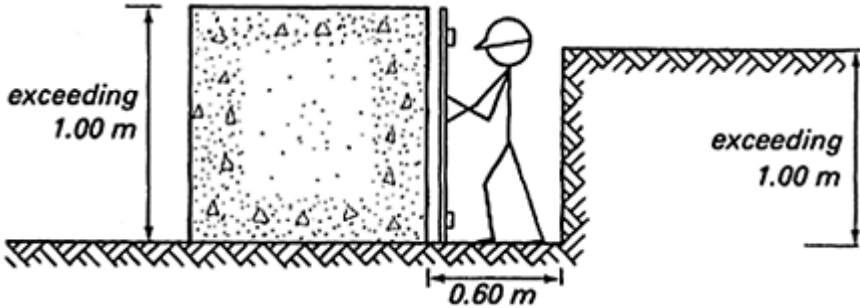


(ii) 0.25 m from the face of any work which requires formwork where the height of the formwork does not exceed 1.00 m and the bottom of the formwork exceeds 1.00 m below the starting level of the excavation.

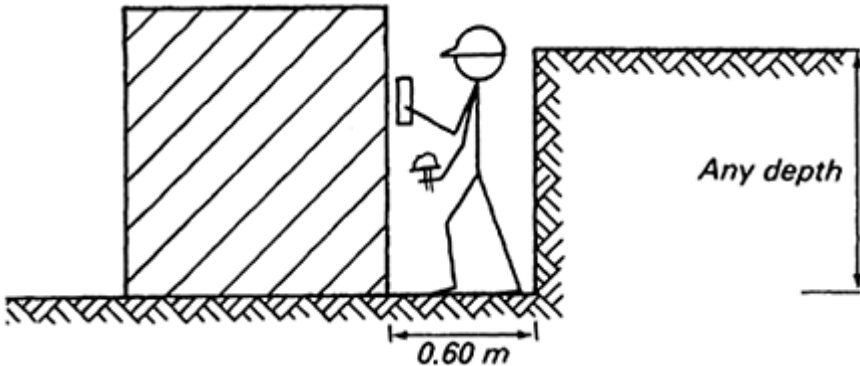


(iii) 0.60 m from the face of any work which requires formwork where the height of the formwork exceeds 1.00 m and where the bottom of the

formwork exceeds 1.00 m below the starting level of the excavation.



- (b) Work which requires workmen to operate from the outside. 0.60 m from the face of any work which requires workmen to operate from the outside at any depth below the starting level of the excavation.



*Note:* The 'face of any work' would be the outside face of any asphalt tanking or of any brick protective skin if one were provided.

- (c) Post tensioned concrete.

1.50 m from the face which requires post tensioning.

2. Excavation and filling of working space shall be classified by depth in accordance with Clause D.11, and given in cubic metres, as a single item, for each of the types of excavation given in clause D.13.  
Additional earthwork support and disposal of surface treatment arising from the measurement of working space shall be deemed to be included.
3. Disposal of excavated material from working space shall be described in accordance with clauses D.27 to D.29.
4. Filling of working space shall be described in accordance with clauses D.33 and

D.37.

*Note:* If filling to working space is to be other than excavated material, this should be given in the description stating the material (e.g. type of hardcore or mix of concrete).

5. The number of pits shall be given when measuring working spaces around pits.

### D.13. TYPES OF EXCAVATION

This section introduces a new concept of narrow trenches measured lineal (D.13.6(a)) and additional classes of excavation for excavating around pile caps and around services have been included (D.13.7 and D.13.9). Amplification of the meaning of the term 'special plant' in relation to excavation in rock is included in the *Practice Manual*.

6 Trenches not exceeding 0.30 m in width, given in metres stating the average (a) depth to the nearest 0.25 m.

7 Excavating for pile caps and trenches for ground beams between piles shall be (a) given in cubic metres stating the starting level.

(b) A location drawing showing the pile sizes and layout shall be provided as clause E.1.1.

9. Excavating around services crossing an excavation shall be enumerated and given as extra over the various descriptions of excavation and working space; details of type, size, depth of service and length exposed shall be given. Any temporary support to services shall be deemed to be included with the item.

**D.13.1.** Examples of 'special plant' in this context would include:

(a) Power operated hammers, drills and chisels.

(b) Special attachments to mechanical plant such as rock buckets, rippers, hammers and chisels.

*(Excerpt from Practice Manual)*

### EARTHWORK SUPPORT

The term 'earthwork support' (D.14 to D.24) is now used instead of 'planking and strutting' in recognition of the wide variety of materials available for this purpose. Earthwork support now includes all shoring, including the special shoring required under SMM5, but does not include interlocking driven sheet steel piling. Earthwork support is now classified by distance between the faces to be supported rather than by types of excavation.

#### D.14. GENERALLY

1. Interlocking driven sheet steel piling shall be given in accordance with Section E.
2. Curved earthwork support shall be so described irrespective of radius.

#### D.15. DEFINITIONS

1. Earthwork support shall be deemed to mean providing everything requisite to uphold the sides of excavation by whatever means are necessary (other than interlocking driven sheet steel piling) and shall be measured to all faces of excavation whether or not any is in fact required except to:
  - (a) Faces not exceeding 0.25 m in height;
  - (b) Sloping face of any excavation where the angle of inclination does not exceed 45 degrees from the horizontal.
  - (c) Face of any excavation which abuts an existing wall, pier or other structure:
  - (d) Face of any additional excavation which results from the measurement of working space.

#### D.16. UNIT OF MEASURE AND DEPTH CLASSIFICATION

Earthwork support shall be given in square metres and classified by maximum depth as clause D.11, irrespective of starting level.

#### D.17. CLASSIFICATION BY DISTANCE BETWEEN FACES

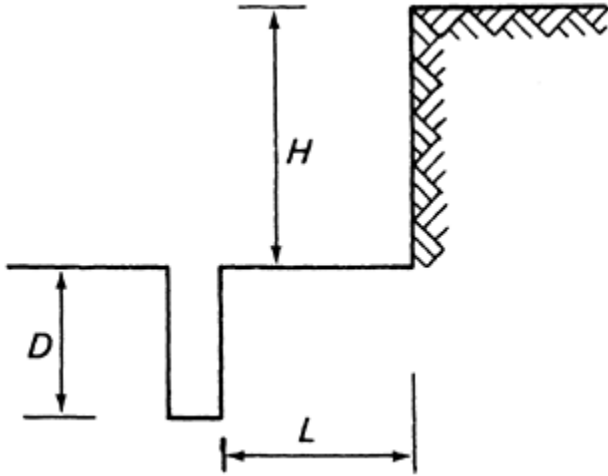
Earthwork support shall be classified by distance between opposing faces, excluding measurement for working space, as follows;

|               |             |
|---------------|-------------|
| not exceeding | 2.00 m      |
|               | 2.00–4.00 m |
| exceeding     | 4.00 m.     |

#### D.18. TRENCHES ETC., BELOW FACES OF EXCAVATION

Earthwork support to trenches, pits and the like occurring below the face of an excavation should be so described, where the horizontal distance from the face of the excavation above, including any measurement for working space in accordance with clause D.12, is less than the depth of the trench, pit, etc. The height of the excavation face above the top of the trench, pit etc, shall be given.

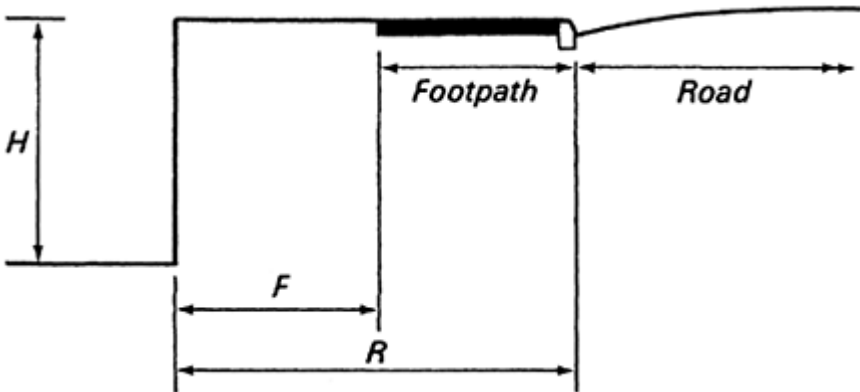




*When  $L$  (after measurement of working space) is less than  $D$  the earthwork support shall be described as below the face of the excavation and the height of the excavated face above ( $H$ ) shall be given.*

**D.19. NEXT TO ROADWAY**

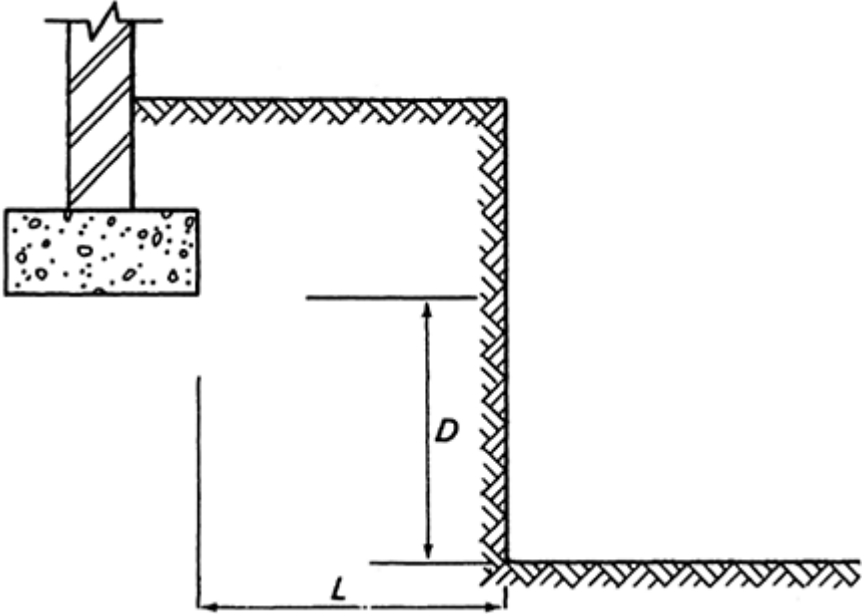
Earthwork support next to roadways shall be so described if the horizontal distance from the face to be supported to the edge of the roadway or footpath, including any measurement for working space in accordance with clause D.12, is less than the depth of the excavated face below the edge of the roadway or footpath.



*When  $F$  or  $R$  (after measurement of working space) is less than  $H$  the earthwork support shall be described as next roadway.*

## D.20. NEXT TO EXISTING BUILDINGS

Earthwork support next to existing buildings shall be so described if the horizontal distance from the face to be supported to the nearest part of the foundations of the building, including any measurement for working space in accordance with clause D.12, is less than the depth of the excavated face below the bottom of the foundations.



*When  $L$  (after measurement of working space) is less than  $D$  the earthwork support shall be described as next to existing buildings.*

## D.22. UNSTABLE GROUND

Earthwork support to excavations in running silt, running sand and the like shall be so described and measured from the starting level of the excavation to the full depth.

The words 'and the like' (D.22) have been added to the *Fifth Edition's* wording of 'running silt or running sand' in an attempt to avoid the many arguments that have arisen by limiting the application of the rule quite literally to running silt or running sand when the same problems pertain with such materials as loose gravel, fly ash, etc. It is suggested, as a guideline, that strata could be said to fall within the intended category only when the newly excavated face will not remain unsupported sufficiently long to allow the necessary support to be inserted.

*(Excerpt from Practice Manual)*

The terms 'general water', 'ground water', 'spring or running water', used in SMM5 are replaced by the terms 'surface water' and 'ground water'. Surface water is intended to deal with rainwater, disposal of which is required to be given as an item (D.25). A similar item (D.26) will be given for the disposal of ground water where the pre-contract water level indicates that the excavation work will be affected by ground water. Such an item would be introduced into the variation account, should there be a difference between a change following the recording of the post-contract water level and the pre-contract water level.

## SECTION E. PILING AND DIAPHRAGM WALLING

This section has been redrafted to follow the civil engineering standard method of measurement. E.1 requires that location drawings adequately indicate nature of work being measured and what plant items are required (E.3). Rules for measuring diaphragm walling (E. 10 to E.13) are included for the first time.

### E.13. DIAPHRAGM WALL DESCRIPTION

1. Items for work in diaphragm walls shall be grouped together under an appropriate heading.
2. Excavation for diaphragm walls shall be given in cubic metres stating the thickness. The volume of excavation shall be calculated from the nominal lengths and depths of the walls. The depths shall be taken from the level at which the work of excavation is expected to begin and in accordance with clause E.2.3. Additional excavation to accommodate guide walls or to provide working space and disposal of material so excavated shall be deemed to be included.
3. Excavation for diaphragm walls shall be classified into the following ranges of maximum depth:

not exceeding 5.00 m

5.00–10.00 m

10.00–15.00 m

15.00–20.00 m

20.00–25.00 m

25.00–30.00 m

Exceeding 30.00 m stating the depth.

4. Excavation in rock and excavation in artificial hard material shall each be given separately in cubic metres stating the nature of the anticipated strata and of the material. Alternatively such work shall be given as extra over the excavation. Standing time and associated labour in connection with such items shall be deemed to be included.
5. Disposal of excavated material shall be given in cubic metres.

Diaphragm walls are concrete walls constructed using Bentonite slurry or other fluids to support a trench which is then filled with concrete to form the wall, the concrete being placed through the support fluid which is thereby displaced.

Excavated material which has been in contact with Bentonite or other support fluid may be contaminated and not fit to be used as filling material. Descriptions for disposal of such excavated material should draw attention to any restrictions imposed in this respect.

*(Excerpt from Practice Manual)*

## SECTION F. CONCRETE WORK

This section has been altered both in the rules for measurement of concrete and form work. The work is required to be classified (F.3.) into concrete-framed structures, steel-framed structures and other concrete work.

### F.4. IN-SITU CONCRETE

2. Reinforced work shall be so described. Members having a reinforcement content in excess of 5 per cent by volume shall be so described.

The requirement (F.4.2) to distinguish members having a reinforcement content in excess of 5 per cent by volume is intended to indicate which members (slabs, columns, beams, etc) are excessively heavily reinforced resulting in problems in placing concrete. It is the total reinforcement in a complete member which has to be considered and not a small isolated part of a member which is particularly congested, e.g. where the laps occur in the reinforcement.

The selection of 5 per cent is a deliberately high proportion in that it will only apply to exceptional cases and usage will identify the rare instances where this occurs. As a rule of thumb, this will apply where the steel exceeds 0.41 tonnes per cubic metre of the measured member.

*(Excerpt from Practice Manual)*

### F.6. CONCRETE CATEGORIES

1. All members, unless otherwise stated, shall be given in cubic metres and described in the categories set out in clauses F.6. 2–21.

The concrete categories (F.6) follow SMM5 with certain grouping having taken place, i.e. foundations in trenches, pier and column bases will be measurable as one item. Attached beams are no longer separated, but are measured as part of the floor

slab.

As retaining walls are not a separate category they will come under walls (F.6.12(a)).

## F.8. FINISHES CAST ON TO CONCRETE

Finishes (measured on the exposed face) which are cast on to concrete by lining formwork shall be so described, distinguishing between sides, soffits and upper surfaces and given in square metres as extra over the concrete, stating the mix and the thickness of the finish.

Examples of finishes which are cast on to concrete would include granolithic, cast stone, terrazzo, mosaic, etc.

*(Excerpt from Practice Manual)*

Measurement of reinforcement in tonnes follows SMM5, except that maximum lengths and vertical bars are separated.

## F.11. BAR REINFORCEMENT

6. Horizontal bars and bars sloping not more than 30 degrees from the horizontal (grouped together) and over 12.00 m long, shall be so described stating the length in further stages of 3.00 m.
7. Vertical bars and bars sloping more than 30 degrees from the horizontal (grouped together) and over 5.00 m long, shall be so described stating the length in further stages of 3.00 m.

The major change in the concrete section occurs in the measurement of formwork (F.13 to F.17).

To highlight the cost significance of this work formwork to soffits (F.15.1–2), and to walls (F.16.1) require the number of separate surfaces to be stated.

Formwork to beams and columns, both isolated and attached, is to be measured lineally (F.15.5 and F.16.6).

In the case of beams and columns of irregular shape the suggestion is made that a bill diagram should accompany the description.

## SECTION G. BRICKWORK AND BLOCKWORK

### G.4. MEASUREMENT

1. Brickwork and blockwork shall be measured the mean length by the average height. Fair face and facework shall be measured on the exposed face. No deduction shall be made for the following:
  - (a) Voids not exceeding 0.10 m<sup>2</sup>.

- (b) Flues, lined flues and flue-blocks where the voids and the work displaced do not together exceed  $0.25 \text{ m}^2$ .
2. Labours on different kinds of work shall be given separately. Labours on existing work shall be so described.
  3. Curved work shall be so described stating the mean radius. Curved fair face and curved facework shall be so described stating the radius on face. The provision of curved bricks or curved blocks shall be given in the description of curved work. Rough cutting within the thickness shall be deemed to be included with the curved brickwork or curved block work.
  4. Work in underpinning shall be given in accordance with Section H.

The major change in Section G is the elimination of reduced brickwork, all walls will now be measured their actual thickness and rules requiring measurement of cutting labours have largely disappeared.

Location drawings are required (G.1) to indicate the nature and extent of the work.

Brickwork and blockwork are to be classified as in foundations, load bearing and non load bearing work (G.3).

Brickwork in deep trenches is now required to be separated (G.5.3) and the categories of brickwork generally have been collected together in one clause (G.5).

The cutting in brickwork is now restricted to fair work (G.15), all other cutting having been eliminated.

## **SECTION H. UNDERPINNING**

Drawings are required (H.1) and plant items (H.2). Other changes follow those in other relevant sections.

## **SECTION J. RUBBLE WALLING; SECTION K. MASONRY**

Sections J and K have remained basically as SMM5. Location drawing items are included (J.1 and K.1), and plant items (J.2 and K.2).

## **SECTION L. ASPHALT WORK**

L.1 to give drawn information includes a need to provide plans at each level of the work and sections if tanking is involved. Other than this, and plant items (L.2), the section remains virtually as SMM5.

## **SECTION M. ROOFING**

Rules for the measurement of roofing follow very closely the requirements of SMM5.

Location drawings are required (M.1) to show the extent of the work and the height above ground level. M.6 requires that, when measuring slate or tile roofing, the pitch or pitches (grouped together) shall be stated.

## SECTION N. WOODWORK

This section is an amalgam of the old carpentry and joinery sections in SMM5. The rules have been drafted on the assumption that the majority of woodworking is now a shop process using machinery rather than a site craft process.

### N.1. INFORMATION

2. All sizes shall be deemed to be basic (nominal) sizes unless stated to finished sizes. Limits on planing margins shall be given. Where deviation from the stated sizes will not be permitted, this shall be stated. The intention is that timber sizes shown on drawings should be the sizes measured. When basic (nominal) sizes are given, the size expected in the finished work will be the basic size subject to planing margins and tolerance.  
If, however, finished sizes are given, the contractor will be expected to decide the size of timber required before planing, taking into account either stated planing margins or his own assumptions. The size expected in the finished work will be the finished size subject only to normal tolerance.  
Planing margins required to be stated in the bill of quantities should either be specific to the works or refer to a standard specification.  
Maximum lengths of timbers (N.1.6) have been changed to align with the maximum marketable lengths currently obtainable.

There is a requirement (N.1.7) that labours shall be related to the items to which they refer. There is also (N.1.11) a requirement to indicate the number of differing cross section shapes, even where the overall sectional dimensions are identical.

The 'carcassing' subsection (N.2 and N.3) replaces the structural element of the former carpentry. There has been considerable grouping of items. Purlins, rafters, struts, etc., providing they are the same cross section, can be collected together and described 'as in pitched roofs'.

In the 'first fixings' section, boarding and flooring are required to be measured as before with the introduction of a height requirement (N.4.1(c)) and restricted areas (N.4.6).

#### N.4. BOARDINGS AND FLOORINGS

1 (c) Ceilings and beams, stating whether internal or external, whether horizontal or sloping and where over 3.50 m above floor (measured to ceiling level in both cases), shall each be so described stating the height in further stages of 1.50 m.

6. Areas not exceeding 1.00 m<sup>2</sup> shall be enumerated.

Sheet linings and casings appear in the 'second fixings' section (N.15) and cover woodbased products formerly measured under the rules 'floor, wall and ceiling finishes'.

Examples of such sheeting would include plywood, chipboard, fibreboard, asbestos cement, plastics, and any applied finish (N.15.1).

*(Excerpt from Practice Manual)*

A major change from SMM5 is the introduction of 'composite' items.

#### N.17. GENERALLY

1. Composite items, which shall be deemed to mean all items which may be fabricated off-site, shall be described in the form they are likely to be delivered to the work. Unless otherwise stated, their incorporation into the works shall be deemed to be included in the items.

Framed rafters and trusses (N.18)—a bill diagram and an abbreviated description may be the best way to describe the item. A similar suggestion is made for such items as windows, screens and staircases.

Door frames (N.20) although measured lineal, require an indication of the total number, drawing special attention to any repetition.

Fittings are now to be subject of full drawings (N.26) or a provisional sum and the fixing (N.27) to be a separate item.

Unless otherwise stated, spacing of plugs shall be at the contractor's discretion (N.28).

Holes are now given irrespective of size (N.29), the controlling factor being the thickness of the item which contains the hole.

Ironmongery is dealt with as in SMM5, with the requirement that details of any constraints, such as off-site fixing of door fittings, shall be indicated.

### SECTION P. STRUCTURAL STEELWORK

Information required to be shown on the location drawings, which will often be the engineer's framing diagrams (P.2), includes:

- (a) The position of the work in relation to other parts of the work and of the proposed



building.

- (b) The types and sizes of structural steel members and their positions in relation to each other.
- (c) Details of connections or particulars of the reactions, moments and axial loads at connection points.

In single and built up members, length of units defined (P.7) shall be given in addition to the weight (P.4.3(b)).

Item to be given for the erection of structural steel work in each building or independent structure (P.10).

Off-site painting is now measured in m<sup>2</sup> (P.9.1) but off-site galvanising is measured in tonnes.

## **SECTION Q. METALWORK**

In this section, there is a greater emphasis on enumeration particularly of composite items.

Except for standard items, detail drawings shall be provided and referred to in the description, or they may be subject to a provisional sum (Q.2.2).

Wire mesh coverings over 300 mm wide are to be measured in square metres; but widths under 300 mm are now required to be measured lineal, stating the exact width (Q.8.1) rather than banded as previously.

## **SECTION R. PLUMBING AND MECHANICAL ENGINEERING INSTALLATIONS**

When mechanical engineering is to be measured, a detailed specification and drawings indicating scope of the work should accompany tender documents (R.1.2).

Plant items are required to be given (R.2).

New classifications of work are introduced (R.4).

### **R.4. CLASSIFICATIONS OF WORK**

1. Work, together with its metalwork, supports and the like (unless associated with more than one installation), shall be classified as follows and given under an appropriate heading:
  - (a) Rainwater installation.
  - (b) Sanitary installation.
  - (c) Cold water installation identifying whether treated water, boosted water, cooling water, chilled water, or domestic cold water.
  - (d) Fire fighting installation identifying hose reel system, dry riser system, sprinkler system, foam inlets, or hand appliances.

- (e) Heated water installation identifying whether steam and condensate, heating (high pressure), heating (medium pressure), heating (low pressure), or domestic hot water.
- (f) Fuel oil installation.
- (g) Fuel gas installation,
- (h) Refrigeration installation,
- (j) Compressed air installation,
- (k) Hydraulic installation.
- (l) Chemical installation.
- (m) Special gas installation which shall be deemed to include medical and laboratory installations.
- (n) Medical suction installation,
- (p) Pneumatic tube installation,
- (q) Vacuum installation,
- (r) Refuse disposal installation.
- (s) Air handling installation, identifying whether ventilation supply, ventilation extract, ventilation with heating (air heated centrally), ventilation with heating (air heated locally), air conditioning (air heated centrally), air conditioning (air heated locally), or foul air extract.
- (t) Automatic control installation.
- (u) Special equipment identifying whether incinerator and flues, kitchen equipment, laundry equipment, etc, except that where appropriate it may be clarified in accordance with Section S.
- (v) Any other installation.
- (w) Metal work, supports and the like associated with more than one installation.

Work is also required to be identified by location, internally, externally and in plant rooms.

## R.5. LOCATION OF WORK

1. Work shall be identified in respect of location as follows:

- (a) Internally.
- (b) Externally.
- (c) In plant rooms.

Work internal and external to a building is required to be kept separate as are plant rooms, which would include heating chambers, ventilation machinery rooms, tank rooms, etc. It should be borne in mind that work in existing buildings is required to be separated in accordance with the general rules.

*(Excerpt from Practice Manual)*

An alternative method of measuring ductwork by weight has been introduced (R.20 to

R.21) and for measuring insulation to ductwork in square metres rather than in metres stating the size of the pipe (R.35 to R.36).

### R.38. BUILDERS' WORK

1. Unless otherwise stated, all items of builders' work shall be given in accordance with the appropriate sections.
2. Builders' work in connection with plumbing and mechanical engineering installations shall be grouped together under an appropriate heading.

### R.39. ELECTRICAL WORK

1. Electrical work in connection with plumbing and mechanical engineering installations shall be given in accordance with:

## SECTION S. ELECTRICAL INSTALLATIONS

Similar requirements to Section R, include specification and drawings (S.1.2) and plant (S.2). Classifications of work (S.4) have been extended from those previously required.

A new clause for final sub-circuits (S.21) has been introduced and is a change from measuring in detail to enumeration by points. This is made in response to current practice whereby the layout of the final sub-circuits is often determined by the electrical contractor.

As in the previous section, unless otherwise stated, all items of builders' work (S.26.1–2) are given as in the appropriate sections and grouped together under appropriate headings.

### (S.27) BUILDERS' WORK

1. Excavating trenches for cables and pipe ducts not exceeding 55 mm nominal size shall be given in accordance with clause D.13.8. Excavating trenches for pipe ducts exceeding 55 mm nominal size shall be given in accordance with clause W.3. Sand for bedding cables in trenches shall be given in metres stating the average width and depth of the sand.

### D.13.8: NOTES

'Excavating trenches to receive service pipes, cables and the like shall each be given separately in metres, stating the starting level and the average depth to the nearest 0.25 m. Details of type and size of service, earthwork support, grading bottoms if required, filling in, compaction and disposal of surplus soil shall be given in the description of such trenches. If the trench is next to a roadway, or next to existing buildings or made in unstable ground, each as defined in clauses D.19, 20 and 22, then these details shall be included in the description.'

## W.3: NOTES

- '1. Excavating pipe trenches shall be given in metres stating the starting level, the depth-range in increments of 2.00 m and the average depth within the depth range to the nearest 0.25 m.
- '2. Excavating around trenches shall be so described irrespective of radius.
- '3. Trenches to receive pipes not exceeding 200 mm nominal size may be grouped together and so described. Trenches to receive pipes exceeding 200 mm nominal size shall be given separately stating the size of the pipe.
- '4. Earthwork support, treating bottoms, filling in, compaction and disposal of surplus spoil shall be given in the descriptions.
- '5. Excavation below ground water shall be given in accordance with clause D.13.13 and any adjustment to earthwork support shall be deemed to be included.
- '6. Trenches next to roadway, next to existing buildings or in unstable ground as defined in clauses D.19, 20 and 22 shall each be so described.
- '7. Trenches in rock as defined in clause D.13.1 shall be so described. Alternatively rock may be given in metres as extra over the trench in which it occurs.
- '8. Breaking up concrete, reinforced concrete, brickwork, tarmacadam and the like shall each be given separately in metres as extra over the trench in which it occurs, stating the pipe diameter as clause W.3.3.'

**SECTION T. FLOOR, WALL AND CEILING FINISHINGS**

A major change is the disappearance of detailed measurement by bands of work under 300 mm wide. Such work is now required to be kept separate from the general measurement but measured in m<sup>2</sup>.

This general rule applies to all the subsections which follow the previous lay-out, except that plain sheet finishings have become flexible sheet finishings, the non-flexible variety are either covered by a new subsection for dry-linings and partitions or are removed to the woodwork section.

Work to walls, ceilings and floors in compartments not exceeding 4.00 m<sup>2</sup> on plan is now required to be given separately, as is work to staircases.

The rules in this section have been drawn up on the assumption that an indication of the type and complexity of the work is more important than the detailed measurement of labours and minor items. It is therefore important to bear in mind that as much information as possible should be given in the bill of quantities.

*(Excerpt from Practice Manual)*

## T.3. GENERALLY

2. Work to walls, ceilings or floors in compartments not exceeding 4.00 m<sup>2</sup> on plan shall be given separately.

Compartments, in the context of this clause, would include not only rooms but also cupboards, halls, lobbies, walk-in ducts and the like. It would not include areas which are divided up after completion of finishing by patent partitions, etc., e.g. W.C. cubicles.

*(Excerpt from Practice Manual)*

3. Work and labour carried out over hand shall be so described.
4. Work shall be grouped according to the kind of material and each group with its associated labours shall be given under an appropriate heading. Mastic asphalt floor finishing shall be given in accordance with Section L.
5. Work to a pattern or in more than one colour shall be so described stating the nature thereof.

Work to a pattern would include isolated panels within a general wall or other surface notwithstanding the requirement in Clause T.3.10.

*(Excerpt from Practice Manual)*

6. The nature of the base to which finishings are to be applied shall be described. Work on differing bases shall be kept separate. Work on existing surfaces shall be so described.
7. Preparatory work to the base shall be measured separately. Preparation of existing work shall be so described.
8. Curved work shall be given separately stating the radius or radii and indicating:
  - (a) If conical or spherical.
  - (b) Whether concave or convex.
  - (c) Whether to more than one radius (elliptical or parabolic).
9. Work to ceilings and beams, except in staircase areas, where over 3.50 m above floors (measured to ceiling level in both cases) shall be so described stating the height in further stages of 1.50 m. Where walls exceed 3.50 m in height and the ceiling is of dissimilar finish then particulars shall be given in the general description of the work as clause T.1 stating the maximum height.

Work to ceilings and beams in staircase areas has been excluded from the general requirement to keep separate work over 3.50 m above floor level as it is considered that the identification of such work as in staircase areas is sufficient to draw attention to the likelihood of varying heights, particularly over staircase flights.

*(Excerpt from Practice Manual)*

10. Work of a repairing nature and to isolated areas not exceeding 1.00 m<sup>2</sup> shall each be kept separate. Labours as defined in clause T.11 shall be included in the description of such items.

11. Temporary rules, temporary screeds and templets shall be deemed to be included with the items. Temporary support work to the face of risers and the like shall be given in accordance with clause F.15.8.

This clause is intended to cover such items as granolithic finish to risers and strings of staircases where formwork is required, and is in addition to the formwork required to be measured to the concrete riser or string.

*(Excerpt from Practice Manual)*

12. No deduction from the areas of finishings shall be made for grounds.

## SECTION U. GLAZING

Little change has been made to this section except that the rules for measuring leaded lights and copper lights have been curtailed as a reflection of modern practice.

Also, there is a greater emphasis on enumeration, particularly of the very thick glasses and the speciality glasses (U.5).

### U.5 SPECIAL GLASS

1. The following glass shall be enumerated stating the size of the pane. Where exact thicknesses are required they shall be so described.
  - (a) Glass less than 10 mm thick where the size of the pane exceeds 4.00 m<sup>2</sup>.
  - (b) Glass 10 mm thick and over.
  - (c) Toughened or laminated glass.
  - (d) Solar control and other speciality glass.
  - (e) Acrylic, polycarbonate and similar material.

Repetition is recognised by a requirement to keep separate glass where 50 or more panes are identical (U.4.3).

Repetition of large numbers of identical glass panes provides a significant cost saving and it is considered the indication of any number over 50 provides for this saving to be passed on.

*(Excerpt from Practice Manual)*

The reference to lining up wired glass panes both ways has disappeared, recognising the impracticability of this requirement. Now the rule (V.3.3) is restricted to aligning within the limits of manufacture between adjacent panes.

## SECTION V. PAINTING AND DECORATING

The general description of the work required by clause V.1.1, should give an outline of the work—drawing attention to any variety of colour, and such specification items as to whether or not the ironmongery or other fittings are to be removed and refixed, etc.

### V.1. GENERALLY

2. Work shall be classified as follows and given under an appropriate heading:
  - (a) New work internally.
  - (b) New work externally.
  - (c) Repainting and redecoration work internally.
  - (d) Repainting and redecoration work externally.

Work is internal or external according to its position in the finished building, e.g. painting steelwork after fixing but before it is clad is internal work.

*(Excerpt from Practice Manual)*

A height requirement has been introduced for ceilings and beams over 3.50 m high and for walls where the finish is dissimilar.

5. Work to ceilings and beams over 3.50 m above the floor (measured to ceiling level in both cases) shall be so described stating the height in further stages of 1.50 m. Where walls exceed 3.50 m in height and the decoration of the ceiling is dissimilar, particulars shall be given in the general description of the work as clause V.1.1, stating the maximum height.

Unless wallpapering can be fully described, it is to be the subject of a p.c. sum.

### V.12. DECORATIVE PAPER, SHEET PLASTIC, OR FABRIC BACKING AND LINING.

1. The supply and delivery to site of paper, fabric or plastic wall coverings, unless they can be fully described shall be included as a prime cost sum and the hanging or fixing shall be given in square metres, stating the number of pieces giving the following particulars:
  - (a) Kind of material.
  - (b) Nature of base.
  - (c) Preparatory work.
  - (d) Method of fixing and jointing.

The width of rolls and type of pattern would both need to be stated before wallpaper

could be considered fully described. In describing the method of fixing and jointing (V.12.1d), it would be necessary to draw attention to rolls of paper hung horizontally on walls or other vertical surfaces.

*(Excerpt from Practice Manual)*

2. Classification shall be as follows:

- (a) Walls and columns (grouped together).
- (b) Ceilings and beams (grouped together).

- 3. Border-strips shall be given in metres. Cutting strips to profile shall be given in the description. Mitres and intersections shall be deemed to be included.
- 4. Corners and motifs shall each be enumerated separately. Cutting units to profile shall be given in the description.
- 5. Raking and curved cutting (grouped together) shall be given in metres. All cutting and fitting around wants on projections shall be deemed to be included.

Wants (V.12.5.) would include openings for air bricks, etc., and projections would include pipes, switches, sockets, brackets and the like.

*(Excerpt from Practice Manual)*

## SECTION W. DRAINAGE

Rules for measuring drainage have been redrafted to align with similar work in other sections. Plant items have been introduced (W.2) and rules for the disposal of water are repeated from the excavation section.

### W.6. PIPEWORK

- 1. Pipes (measured overall pipe fittings) shall each be given in metres stating the kind and quality of pipe, the nominal size and the method of jointing. Any pipes not laid in the bottom of the trench shall be given separately, and the depth stated in accordance with the depth-range stages as in W.3.1.

*Note:* W.3.1 states; 'Excavating pipe trenches shall be given in metres stating the starting level, the depth-range in increments of 2.00 m and the average depth within the depth-range to the nearest 0.25 m.'

- 2. Suspended pipes shall be so described and the supports enumerated separately. Classification shall be as follows:



- (a) In ducts in the ground or below a floor.
  - (b) Bracketed off walls, stating the average height above the floor.
  - (c) Suspended from soffits, stating the average height above the floor.
3. Pipes in runs not exceeding 3.00 m long shall be so described stating the number.
  4. Vertical pipes shall be so described.
  5. Pipe fittings shall each be described and enumerated as extra over the pipes in which they occur. Cutting and jointing pipes to fittings and providing everything necessary for jointing shall be deemed to be included.
  6. Accessories shall each be described and enumerated stating the kind, quality and size of the accessory and the nominal size of each inlet and outlet. Jointing pipes to such accessories, bedding in concrete and providing gratings, sealing plates and the like shall be given in the description of the item.

Pipes not laid in the bottom of the trench (W.6.1) are usually those found in a multi-purpose trench. The requirements to give depths does not apply to those laid on a bed in the bottom of the trench.

Types of fittings (W.6.5) should be clearly described and in cast iron work special consideration should be given to cost significant items; e.g. long radius and short radius bends being kept separate.

It could be considered good practice to identify items by reference to a manufacturer's catalogue number. Examples of

accessories (W.6.6) would include gullies, traps, inspection shoes, fresh air inlets, non-return flaps, etc.

*(Excerpt from Practice Manual)*

## **SECTION X. FENCING**

A general description (X.1.1) is required unless location drawings indicate scope of the work, otherwise the section follows the previous rules.

*Note:* Copies of the *Standard Method of Measurement of Building Works* 6th Edition and the *Practice Manual* are available from the Royal Institution of Chartered Surveyors, 12 Great George Street, London W1.

## 5. STRUCTURAL DATA

This section is intended to facilitate very simple calculations, such as simple beams in timber and steel. Builders should not attempt anything more ambitious without much more information than is contained in this section. In any event, it is quicker, safer, and usually less expensive to consult a civil or structural engineer, if more than a simple beam or lintel is required.

### CODES OF PRACTICE

**CP 3:** Code of basic data for the design of buildings: Chapter I Lighting  
Chapter II Thermal insulation in relation to the control of the environment  
Chapter III Sound insulation and noise reduction  
Chapter IV Precautions against fire (in three parts)  
Chapter V Loading (in two parts)  
Chapter VII Engineering and utility services  
Chapter VIII Heating and thermal insulation  
Chapter IX Durability  
Chapter X Precautions against vermin and dirt

**CP 110:** The structural use of concrete:

**Part 1:** design, materials and workmanship.

**Part 2:** design charts for singly reinforced beams, doubly reinforced beams and rectangular columns.

**Part 3:** design charts for circular columns and prestressed beams.

**CP 111:** Structural recommendations for loadbearing walls: for loadbearing walls of brickwork and blockwork.

**CP 112:** The structural use of timber:

**Part 1:** (Imperial units, now withdrawn).

**Part 2:** deals with design of structures in timber and plywood.

**Part 3:** Trussed rafters for roofs of dwellings: recommends materials, functional requirements, manufacture, design, testing, permissible spans, etc.

**CP 114:** Structural use of reinforced concrete in buildings: deals with reinforced concrete design applied to beams, slabs, columns, flat slab construction, walls and bases in buildings, also floors, roofs and stairs.

**CP 115:** Structural use of prestressed concrete in buildings: covers design and construction of prestressed concrete as applied to buildings; also manufacture of precast, prestressed concrete units.

**CP 116:** The structural use of precast concrete: reinforced and prestressed concrete units.

Addendum No. 1: large panel structures and structural connections in precast concrete.

**CP 117:** Composite construction in structural steel and concrete:

**Part 1:** simply supported beams in building.

**Part 2:** beams for bridges.

## BRITISH STANDARDS

**B.S. 4:** Structural steel sections: deals with channels, channel beams, equal and unequal angles, and "T" bars. Sizes of ranges, thicknesses of members and weights are given.

**B.S. 449:** The use of structural steel in building:

**Part 1:1970:** Imperial units (obsolescent).

Supplement No. 1, Recommendations for design.

**Part 2:1969:** Metric units: relates to the use in building of hot rolled steel sections and plates, and normalised tubular shapes.

Addendum No. 1, The use of cold formed steel sections in building: relates to the use in building of cold formed steel sections, formed from plate, sheet and strip steel 6 mm thick and under.

**B.S. 6323:** Steel tubes for mechanical, structural and general engineering purposes: covers eight types; hot finished welded, hot finished seamless, cold drawn seamless, electric resistance welded, cold drawn electric resistance welded, oxy-acetylene welded, hydraulic lap welded, electric fusion welded. Straightness, lengths, galvanising, methods of inspection and test are described.

**B.S. 2994:** Specification for cold rolled steel sections: gives dimensions and properties (moments of inertia, section moduli, radii of gyration) of the basic ranges of sections. Covers angles, channels, tees, zeds and compound sections made from channels.

**B.S. 4483:** Steel fabric for the reinforcement of concrete: preferred dimensions and properties. Quality of steel, tolerances on mass, size of mesh, sheet and roll (supersedes B.S. 1221).

**B.S. 4848:** Hot rolled structural steel sections:

**Part 2:** Hollow sections: in B.S. range of metric sizes.

**Part 4:** Equal and unequal angles: dimensions, rolling tolerances and properties of a co-ordinated metric range of equal and unequal angles.

For British Standards concerning concrete, see 'Concretor'; and for timber see 'Carpenter and Joiner'.

## APPROXIMATE WEIGHTS OF MATERIALS

This table is divided into three parts, marked A, B and C, according to the unit of measurement used. The section indexes give references to tables in other sections of this work, where weights of other materials are given.

PART A: WEIGHTS IN POUNDS PER CUBIC FOOT AND IN KILOGRAMS PER  
CUBIC METRE

| Material                            | lb per cu. ft | kg per m <sup>3</sup> |
|-------------------------------------|---------------|-----------------------|
| Ashes                               | 50            | 800                   |
| Aluminium                           | 162           | 2559                  |
| Asphalt:                            |               |                       |
| Block, without grit                 | 111           | 1922                  |
| " fine gritted                      | 196           | 3139                  |
| coarse gritted                      | 147           | 2254                  |
| Brass                               | 525           | 8129                  |
| Brickwork:                          |               |                       |
| Common fletton                      | 125           | 1822                  |
| Glazed brick                        | 130           | 2080                  |
| Staffordshire blue in cement mortar | 135           | 2162                  |
| Red engineering                     | 140           | 2240                  |
| Bronze                              | 524           | 8113                  |
| Cement, Portland                    | 90            | 1441                  |
| Chalk                               | 140           | 2240                  |
| Chippings (stone)                   | 110           | 1762                  |
| Clay (dry)                          | 100           | 1601                  |
| Clay (wet)                          | 125           | 1822                  |
| Clinker (furnace)                   | 50            | 800                   |
| Coal                                | 50            | 800                   |
| Coke breeze                         | 40            | 640                   |
| Concrete:                           |               |                       |
| Reinforced steel 2%                 | 150           | 2400                  |
| Ballast or stone                    | 140           | 2241                  |
| Brick                               | 115           | 1841                  |
| Clinker                             | 90            | 1441                  |
| Pumice                              | 70            | 1121                  |
| Copper                              | 550           | 8810                  |
| Cork bark                           | 5             | 80                    |
| Gravel                              | 110           | 1762                  |
| Gunmetal                            | 528           | 8475                  |
| Iron:                               |               |                       |
| cast                                | 450           | 7207                  |
| wrought                             | 480           | 7687                  |
| Lead                                | 708           | 11260                 |
| Lime:                               |               |                       |
| chalk (lump)                        | 44            | 704                   |
| ground                              | 60            | 961                   |
| quick                               | 55            | 880                   |
| Peat (hard)                         | 55            | 880                   |

| Material | lb per cu. ft | kg per m <sup>3</sup> |
|----------|---------------|-----------------------|
|----------|---------------|-----------------------|

|                      |         |           |
|----------------------|---------|-----------|
| Pitch                | 72      | 1152      |
| Sand:                |         |           |
| dry                  | 100     | 1601      |
| wet                  | 88      | 1281      |
| Snow                 | 3 to 10 | 48 to 160 |
| Stone:               |         |           |
| artificial           | 140     | 2242      |
| Bath                 | 140     | 2242      |
| Blue Pennant         | 168     | 2682      |
| Cragleith            | 145     | 2322      |
| Darley Dale          | 148     | 2370      |
| Forest of Dean       | 149     | 2386      |
| Granite              | 166     | 2642      |
| Marble               | 170     | 2742      |
| Portland             | 135     | 2170      |
| Slate                | 180     | 2882      |
| York                 | 150     | 2402      |
| Terra-cotta          | 132     | 2116      |
| Timber:              |         |           |
| Ash                  | 50      | 800       |
| Baltic spruce        | 30      | 480       |
| Beech                | 51      | 816       |
| Birch                | 45      | 720       |
| Box                  | 60      | 961       |
| Cedar                | 30      | 480       |
| Chestnut             | 40      | 640       |
| Ebony                | 76      | 1217      |
| Elm                  | 39      | 624       |
| Greenheart           | 60      | 961       |
| Jarrah               | 51      | 816       |
| Maple                | 47      | 752       |
| Mahogany:            |         |           |
| Honduras             | 36      | 576       |
| Spanish              | 66      | 1057      |
| Oak:                 |         |           |
| English              | 53      | 848       |
| American             | 45      | 720       |
| Austrian and Turkish | 44      | 704       |
| Pine:                |         |           |
| Pitchpine            | 50      | 800       |
| Red Deal             | 36      | 576       |
| Yellow Deal          | 33      | 528       |
| Spruce               | 31      | 496       |
| Sycamore             | 38      | 530       |

|          |    |     |
|----------|----|-----|
| Teak:    |    |     |
| African  | 60 | 961 |
| Indian   | 41 | 656 |
| Moulmein | 46 | 736 |
| Walnut:  |    |     |
| English  | 41 | 496 |
| Black    | 45 | 720 |

| Material    | lb per cu. ft | kg per m <sup>3</sup> |
|-------------|---------------|-----------------------|
| Tin         | 465           | 7448                  |
| Water       | 62            | 933                   |
| White lead: |               |                       |
| dry         | 400           | 6407                  |
| in oil      | 250           | 4003                  |
| Zinc        | 466           | 7464                  |

## PART B: POUNDS PER SQUARE FOOT AND KILOGRAMS PER SQUARE METRE

| Material                                    | lb per sq. ft | kg per m <sup>2</sup> |
|---|---------------|-----------------------|
| Asbestos flat sheet                         | 2.30          | 11.22                 |
| Blockboard per inch (25.4mm) of thickness   | 2.50          | 12.20                 |
| Cement screed per 1/2in (13mm) of thickness | 6.00          | 29.29                 |
| Flooring:                                   |               |                       |
| hardwood                                    | 3.30          | 16.10                 |
| softwood                                    | 2.30          | 11.22                 |
| Plasterboard 3/8in (9.5mm)                  | 2.00          | 9.76                  |
| Plasterboard plus setting coat              | 3.00          | 14.64                 |
| Plywood per mm of thickness                 | 0.14          | 0.67                  |
| Plaster (fibrous)                           | 6.00          | 29.29                 |
| Roofing materials:                          |               |                       |
| Asbestos corrugated sheet:                  |               |                       |
| ‘Trafford Tile’                             | 2.48          | 12.04                 |
| ‘Big Six’                                   | 2.76          | 13.46                 |
| Standard                                    | 2.50          | 12.20                 |
| Asphalt per in (25.4mm) of thickness        | 11.00         | 53.70                 |
| Glazed roofing                              | 6.00          | 29.29                 |
| Copper sheet (24g)                          | 1.33          | 6.34                  |
| Felt  | 1.00          | 4.88                  |
| Slating:                                    |               |                       |
| Cornish                                     | 7.50          | 36.61                 |
| Welsh                                       | 11.50         | 56.14                 |
| Westmorland                                 | 15.50         | 75.67                 |
| Asbestos (diamond)                          | 3.30          | 16.10                 |

|                               |       |       |
|-------------------------------|-------|-------|
| Asbestos (rectangular)        | 2.90  | 14.05 |
| Tiling (plain)                | 14.50 | 70.78 |
| Weatherboarding, 3/4in (19mm) | 1.50  | 7.29  |
| Zinc sheet (0.025 in)         | 0.94  | 4.48  |
| Zinc sheet (0.031 in)         | 1.19  | 9.17  |
| Zinc sheet (0.041in)          | 1.56  | 7.58  |

## PART C: POUNDS PER FOOT RUN AND KILOGRAMS PER LINEAR METRE

| Pipes         |                | lb per ft run | kg per linear run |
|---------------|----------------|---------------|-------------------|
| Asbestos:     |                |               |                   |
| Soil and vent | 3 1/2in (95mm) | 3.75          | 0.58              |
| Rainwater     | 2 1/2in (69mm) | 2.00          | 0.28              |
| "             | 2 1/2in (69mm) | 2.00          | 0.28              |

| Pipes        |                | lb per ft run | kg per linear m |
|--------------|----------------|---------------|-----------------|
| Rainwater    | 4in (100mm)    | 4.25          | 0.59            |
| "            | 2 1/2in (69mm) | 3.25          | 0.49            |
| "            | 3in (75mm)     | 4.00          | 0.56            |
| "            | 4in (100mm)    | 6.00          | 0.84            |
| Soil, heavy  | 3in (75mm)     | 7.00          | 0.98            |
| "            | 4in (100mm)    | 9.00          | 1.26            |
| Soil, medium | 2in (50mm)     | 4.00          | 0.56            |
| "            | 3in (75mm)     | 6.00          | 0.84            |
| "            | 4in (100mm)    | 8.00          | 1.12            |
| "            | 6in (150mm)    | 12.00         | 1.68            |

## WEIGHTS OF MATERIALS IN HUNDREDWEIGHTS PER CUBIC FOOT: AS ASSUMED BY THE LONDON DISTRICT SURVEYORS ASSOCIATION AND METRIC EQUIVALENTS STRUCTURAL STEELWORK

| Materials                        | Cwt/cu. ft | tonnes/m <sup>3</sup> |
|----------------------------------|------------|-----------------------|
| Stone, blue and glazed brickwork | 1 1/2      | 2.7                   |
| Ordinary brickwork               | 1          | 1.8                   |
| Concrete                         |            |                       |
| Stone ballast aggregate          | 1 1/4      | 2.2                   |
| Brick aggregate                  | 1          | 1.8                   |
| Clinker aggregate                | 1/2        | 0.89                  |
| Reinforced concrete              | 1 3/8      | 1.9                   |
| Timber                           | 1/2        | 0.89                  |

## STRUCTURAL STEELWORK

### NOTES

1. Generally, tabular loads are based on a flexural stress of  $165 \text{ N/mm}^2$  assuming adequate lateral support. Tabular loads printed in bold face type exceed the buckling capacity of the unstiffened web without allowance for actual length of bearing.

2. Tables on pages 134–137 are reproduced from the *Handbook on Structural Steelwork* by permission of the British Constructional Steelwork Association Ltd. and the Constructional Steelwork Research and Development Association. Copies of the *Handbook* can be had from the BCSA, 1 Vincent Square, London SW1P 2PJ.





# UNIVERSAL BEAMS

## SAFE LOADS FOR GRADE 55 STEEL

| Serial size | Mass per metre | Safe distributed loads in kilonewtons for spans in metres and deflection coefficients |       |       |       |       |       |       |       |       |       |       |       |       |      | Critical span $L_c$ |
|-------------|----------------|---|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|---------------------|
|             |                | 4.00  | 5.00  | 6.00  | 7.00  | 8.00  | 9.00  | 10.00 | 11.00 | 12.00 | 13.00 | 14.00 | 15.00 | 16.00 |      |                     |
| mm          | kg             | 28.00   | 17.92 | 12.44 | 8.143 | 7.000 | 5.631 | 4.480 | 3.702 | 3.111 | 2.651 | 2.296 | 1.991 | 1.750 | m    |                     |
| 914 x 419   | 388            |   | 15729 | 10719 | 7488  | 5364  | 3879  | 3491  | 3174  | 2909  | 2686  | 2494  | 2328  | 2182  | 6.96 |                     |
|             | 343            |   | 14012 | 9111  | 6381  | 4633  | 3408  | 3067  | 2788  | 2556  | 2369  | 2191  | 2045  | 1917  | 6.71 |                     |
| 914 x 305   | 289            | 8089  | 4872  | 4080  | 3480  | 3045  | 2706  | 2436  | 2214  | 2030  | 1874  | 1740  | 1624  | 1522  | 4.66 |                     |
|             | 253            | 5314  | 4282  | 3543  | 3037  | 2657  | 2382  | 2126  | 1933  | 1771  | 1635  | 1518  | 1417  | 1329  | 4.51 |                     |
|             | 224            | 4815  | 3892  | 3077  | 2637  | 2307  | 2051  | 1846  | 1678  | 1538  | 1420  | 1319  | 1231  | 1154  | 4.32 |                     |
|             | 201            | 4028  | 3222  | 2686  | 2301  | 2014  | 1790  | 1611  | 1465  | 1343  | 1239  | 1151  | 1074  | 1007  | 4.10 |                     |
| 838 x 292   | 226            | 4464  | 3571  | 2976  | 2651  | 2232  | 1984  | 1786  | 1623  | 1488  | 1373  | 1275  | 1190  | 1116  | 4.41 |                     |
|             | 194            | 3714  | 2972  | 2478  | 2123  | 1857  | 1651  | 1486  | 1351  | 1238  | 1143  | 1061  | 991   | 929   | 4.15 |                     |
|             | 176            | 3292  | 2634  | 2195  | 1891  | 1646  | 1463  | 1317  | 1197  | 1097  | 1013  | 941   | 878   | 823   | 3.98 |                     |
| 762 x 267   | 197            | 3485  | 2788  | 2323  | 1991  | 1742  | 1549  | 1394  | 1267  | 1162  | 1072  | 996   | 929   |       | 4.05 |                     |
|             | 173            | 3009  | 2408  | 2008  | 1720  | 1505  | 1338  | 1204  | 1094  | 1003  | 926   | 860   | 803   |       | 3.86 |                     |
|             | 147            | 2504  | 2003  | 1689  | 1431  | 1252  | 1113  | 1002  | 910   | 836   | 770   | 715   | 668   |       | 3.65 |                     |
| 688 x 254   | 170            | 2745  | 2186  | 1830  | 1569  | 1373  | 1220  | 1098  | 998   | 915   | 845   |       |       |       | 3.93 |                     |
|             | 152            | 2444  | 1965  | 1628  | 1396  | 1222  | 1086  | 977   | 889   | 815   | 752   |       |       |       | 3.82 |                     |
|             | 140            | 2229  | 1783  | 1485  | 1273  | 1114  | 990   | 891   | 810   | 743   | 686   |       |       |       | 3.71 |                     |
|             | 125            | 1944  | 1568  | 1296  | 1111  | 972   | 864   | 778   | 707   | 648   | 598   |       |       |       | 3.54 |                     |
| 914 x 419   | 388            |   | 15729 | 10719 | 7488  | 5372  | 3887  | 3498  | 3180  | 2915  | 2691  | 2499  | 2332  | 2186  | 7.20 |                     |
|             | 343            |   | 14012 | 9123  | 6391  | 4642  | 3415  | 3074  | 2794  | 2561  | 2364  | 2196  | 2049  | 1921  | 6.97 |                     |
| 914 x 305   | 289            | 8089  | 4879  | 4066  | 3485  | 3049  | 2711  | 2440  | 2218  | 2033  | 1877  | 1743  | 1626  | 1525  | 4.78 |                     |
|             | 253            | 5324  | 4259  | 3549  | 3042  | 2662  | 2366  | 2130  | 1936  | 1775  | 1638  | 1521  | 1420  | 1331  | 4.64 |                     |
|             | 224            | 4826  | 3700  | 3083  | 2643  | 2313  | 2056  | 1850  | 1682  | 1542  | 1423  | 1321  | 1233  | 1156  | 4.47 |                     |
|             | 201            | 4038  | 3230  | 2692  | 2307  | 2019  | 1794  | 1615  | 1468  | 1346  | 1242  | 1154  | 1077  | 1009  | 4.28 |                     |
| 838 x 292   | 226            | 4472  | 3578  | 2981  | 2558  | 2238  | 1988  | 1789  | 1626  | 1491  | 1376  | 1278  | 1193  | 1118  | 4.55 |                     |
|             | 194            | 3723  | 2978  | 2482  | 2127  | 1861  | 1655  | 1489  | 1354  | 1241  | 1146  | 1064  | 993   | 931   | 4.32 |                     |
|             | 176            | 3301  | 2641  | 2200  | 1888  | 1650  | 1467  | 1320  | 1200  | 1100  | 1016  | 943   | 880   | 825   | 4.16 |                     |
| 762 x 267   | 197            | 3491  | 2793  | 2327  | 1995  | 1746  | 1552  | 1396  | 1269  | 1164  | 1074  | 997   | 931   |       | 4.17 |                     |
|             | 173            | 3018  | 2412  | 2010  | 1723  | 1508  | 1340  | 1206  | 1097  | 1005  | 928   | 862   | 804   |       | 4.00 |                     |
|             | 147            | 2510  | 2008  | 1674  | 1435  | 1259  | 1116  | 1004  | 913   | 837   | 772   | 717   | 669   |       | 3.81 |                     |
| 688 x 254   | 170            | 2750  | 2200  | 1833  | 1572  | 1375  | 1222  | 1100  | 1000  | 917   | 846   |       |       |       | 4.06 |                     |
|             | 152            | 2448  | 1959  | 1632  | 1399  | 1224  | 1088  | 979   | 890   | 816   | 753   |       |       |       | 3.95 |                     |
|             | 140            | 2233  | 1787  | 1489  | 1276  | 1117  | 993   | 893   | 812   | 744   | 687   |       |       |       | 3.86 |                     |
|             | 125            | 1949  | 1569  | 1300  | 1114  | 975   | 866   | 780   | 709   | 650   | 600   |       |       |       | 3.71 |                     |
| 910 x 305   | 238            | 3673  | 2938  | 2449  | 2099  | 1837  | 1632  | 1469  | 1336  | 1224  |       |       |       |       | 5.70 |                     |
|             | 179            | 2750  | 2200  | 1833  | 1572  | 1375  | 1222  | 1100  | 1000  | 917   |       |       |       |       | 5.29 |                     |
|             | 149            | 2290  | 1832  | 1527  | 1309  | 1145  | 1018  | 916   | 833   | 763   |       |       |       |       | 5.09 |                     |
| 910 x 229   | 140            | 2031  | 1624  | 1354  | 1160  | 1015  | 902   | 812   | 738   | 677   |       |       |       |       | 3.72 |                     |
|             | 125            | 1804  | 1443  | 1203  | 1031  | 902   | 802   | 722   | 656   | 601   |       |       |       |       | 3.61 |                     |
|             | 113            | 1612  | 1290  | 1075  | 921   | 806   | 717   | 645   | 586   | 537   |       |       |       |       | 3.51 |                     |
|             | 101            | 1408  | 1127  | 939   | 805   | 704   | 626   | 563   | 512   | 469   |       |       |       |       | 3.37 |                     |
| 533 x 210   | 122            | 1587  | 1254  | 1045  | 896   | 784   | 697   | 627   |       |       |       |       |       |       | 3.50 |                     |
|             | 109            | 1385  | 1108  | 924   | 792   | 693   | 616   | 554   |       |       |       |       |       |       | 3.38 |                     |
|             | 101            | 1287  | 1030  | 858   | 735   | 643   | 572   | 515   |       |       |       |       |       |       | 3.32 |                     |
|             | 92             | 1163  | 930   | 778   | 664   | 581   | 517   | 465   |       |       |       |       |       |       | 3.25 |                     |
|             | 82             | 1007  | 806   | 671   | 575   | 503   | 448   | 403   |       |       |       |       |       |       | 3.11 |                     |

For explanation of table see page 16.  
 Values in the shaded area relate to Universal Beams with tapered flanges. See page 9.  
 The loads listed are based on a bending stress of 280 N/mm<sup>2</sup>, and assume adequate lateral support. Without such support the span must not exceed

$L_c$  unless the compressive stress is reduced in accordance with clause 19a of BS 449.  
 Loads printed in bold type may cause overloading of the unslitened web, the capacity of which should be checked. See page 14.  
 See also footnotes to page 233.

# UNIVERSAL BEAMS



## SAFE LOADS FOR GRADE 55 STEEL

| Serial size | Mass per metre | Safe distributed loads in kilonewtons for spans in metres and deflection coefficients |       |       |       |       |       |       |       |       |       |       |       | Critical span $L_c$ |      |
|-------------|----------------|---|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|---------------------|------|
|             |                | 2.00  | 2.50  | 3.00  | 3.50  | 4.00  | 4.50  | 5.00  | 5.50  | 6.00  | 7.00  | 8.00  | 10.00 |                     |      |
| mm          | kg             | 112.0   | 71.88 | 48.78 | 38.57 | 28.00 | 22.12 | 17.92 | 14.81 | 12.44 | 9.143 | 7.000 | 5.531 | 4.480               | m    |
| 467 x 191   | 96             | 17812   | 1753  | 1480  | 1252  | 1095  | 974   | 876   | 797   | 730   | 626   | 548   | 487   | 438                 | 3.29 |
|             | 89             | 11671   | 1586  | 1322  | 1133  | 991   | 881   | 793   | 721   | 661   | 566   | 496   | 441   | 396                 | 3.19 |
|             | 82             | 11549   | 1444  | 2104  | 1032  | 903   | 802   | 722   | 657   | 602   | 516   | 451   | 401   | 361                 | 3.11 |
|             | 74             | 11415   | 1309  | 1091  | 935   | 818   | 727   | 655   | 595   | 545   | 468   | 409   | 364   | 327                 | 3.04 |
|             | 67             | 11311   | 1181  | 968   | 829   | 728   | 645   | 581   | 528   | 484   | 415   | 363   | 323   | 290                 | 2.96 |
| 457 x 152   | 82             | 11892   | 1395  | 1183  | 996   | 872   | 775   | 698   | 634   | 581   | 498   | 436   | 388   |                     | 2.50 |
|             | 74             | 11563   | 1280  | 1060  | 900   | 787   | 700   | 630   | 573   | 525   | 450   | 394   | 350   |                     | 2.42 |
|             | 67             | 1400  | 1120  | 933   | 800   | 700   | 622   | 560   | 509   | 467   | 400   | 350   | 311   |                     | 2.34 |
|             | 60             | 11237   | 1004  | 836   | 717   | 627   | 558   | 502   | 456   | 418   | 358   | 314   | 279   |                     | 2.33 |
|             | 52             | 1063  | 850   | 709   | 607   | 531   | 472   | 425   | 387   | 354   | 304   | 266   |       |                     | 2.21 |
| 406 x 178   | 74             | 11381   | 1188  | 989   | 847   | 741   | 659   | 593   | 539   | 494   | 424   | 371   |       |                     | 3.01 |
|             | 67             | 11225   | 1084  | 887   | 780   | 685   | 591   | 532   | 484   | 444   | 380   | 333   |       |                     | 2.94 |
|             | 60             | 11078   | 948   | 790   | 677   | 582   | 527   | 474   | 431   | 395   | 339   | 298   |       |                     | 2.88 |
|             | 54             | 1036  | 829   | 691   | 582   | 518   | 461   | 415   | 377   | 345   | 296   | 259   |       |                     | 2.75 |
| 406 x 140   | 46             | 871   | 697   | 581   | 488   | 436   | 387   | 348   | 317   | 290   | 249   | 218   |       |                     | 2.17 |
|             | 39             | 702   | 582   | 488   | 401   | 351   | 312   | 281   | 256   | 234   | 201   |       |       |                     | 2.04 |
| 356 x 171   | 67             | 11128   | 981   | 801   | 687   | 601   | 534   | 481   | 437   | 401   | 343   |       |       |                     | 3.05 |
|             | 57             | 1975  | 803   | 689   | 574   | 502   | 446   | 402   | 365   | 335   | 287   |       |       |                     | 2.90 |
|             | 51             | 1883  | 713   | 594   | 510   | 446   | 396   | 357   | 324   | 297   | 255   |       |       |                     | 2.82 |
|             | 45             | 788   | 615   | 513   | 440   | 385   | 342   | 308   | 280   | 256   | 220   |       |       |                     | 2.71 |
| 356 x 127   | 39             | 640   | 512   | 427   | 368   | 320   | 285   | 256   | 233   | 213   | 183   |       |       |                     | 1.94 |
|             | 33             | 527   | 422   | 351   | 301   | 264   | 234   | 211   | 192   | 176   |       |       |       |                     | 1.84 |
| 306 x 185   | 54             | 1814  | 675   | 562   | 482   | 422   | 375   | 337   | 307   | 281   |       |       |       |                     | 3.02 |
|             | 48             | 1700  | 581   | 484   | 415   | 363   | 323   | 290   | 264   | 242   |       |       |       |                     | 2.81 |
|             | 40             | 628   | 503   | 418   | 359   | 314   | 279   | 251   | 229   | 209   |       |       |       |                     | 2.82 |
| 306 x 127   | 48             | 688   | 549   | 457   | 392   | 343   | 305   | 274   | 249   | 229   |       |       |       |                     | 2.12 |
|             | 42             | 595   | 476   | 397   | 340   | 297   | 264   | 238   | 216   | 198   |       |       |       |                     | 2.03 |
|             | 37             | 528   | 422   | 352   | 302   | 264   | 235   | 211   | 192   | 176   |       |       |       |                     | 1.97 |
| 306 x 102   | 33             | 486   | 372   | 310   | 268   | 232   | 207   | 186   | 169   | 156   |       |       |       |                     | 1.58 |
|             | 28             | 393   | 316   | 262   | 225   | 197   | 175   | 157   | 143   | 131   |       |       |       |                     | 1.50 |
|             | 25             | 322   | 258   | 215   | 184   | 161   | 143   | 129   | 117   | 107   |       |       |       |                     | 1.38 |
| 254 x 148   | 43             | 588   | 463   | 377   | 323   | 283   | 252   | 226   |       |       |       |       |       |                     | 2.78 |
|             | 37             | 488   | 389   | 324   | 278   | 243   | 216   | 194   |       |       |       |       |       |                     | 2.64 |
|             | 31             | 395   | 316   | 264   | 226   | 198   | 178   | 158   |       |       |       |       |       |                     | 2.46 |
| 254 x 102   | 28             | 346   | 276   | 230   | 197   | 172   | 153   | 138   |       |       |       |       |       |                     | 1.88 |
|             | 25             | 297   | 236   | 198   | 170   | 149   | 132   | 119   |       |       |       |       |       |                     | 1.68 |
|             | 22             | 253   | 202   | 169   | 144   | 126   | 112   | 101   |       |       |       |       |       |                     | 1.47 |
| 203 x 133   | 30             | 313   | 250   | 209   | 179   | 156   |       |       |       |       |       |       |       |                     | 2.47 |
|             | 25             | 280   | 208   | 173   | 148   | 130   |       |       |       |       |       |       |       |                     | 2.32 |

Loads printed in italic type do not cause overloading of the unstiffened web, and do not cause deflection exceeding span/360.

Loads printed in ordinary type should be checked for deflection. See page 15.

† Load is based on allowable shear of web and is less than allowable load in bending.

‡ Load exceeds buckling capacity of unstiffened web.

See also footnote to page 232.



## JOISTS

## SAFE LOADS FOR GRADE 55 STEEL

| Nominal size     | Mass per metre | Safe distributed loads in kilonewtons for spans in metres and deflection coefficients |            |            |            |            |            |            |            |            |            |            |            | Critical span L <sub>c</sub> |      |
|------------------|----------------|---|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------------------------|------|
|                  |                | 1.00  | 1.25       | 1.50       | 1.75       | 2.00       | 2.25       | 2.50       | 2.75       | 3.00       | 3.25       | 3.50       | 4.00       |                              | 4.25 |
| mm               | kg             | 448   | 297        | 199        | 148        | 112        | 88.5       | 71.7       | 59.2       | 49.8       | 42.4       | 36.6       | 29.0       | 24.8                         | m    |
| <i>254 × 203</i> | <i>81.65</i>   |   |            |            |            |            | <b>881</b> | <b>848</b> | <b>771</b> | <b>706</b> | <b>652</b> | <b>606</b> | <b>530</b> | <b>499</b>                   | 4.46 |
| <i>254 × 114</i> | <i>37.20</i>   |   | <b>456</b> | <b>589</b> | <b>613</b> | <b>448</b> | <b>399</b> | <b>359</b> | <b>277</b> | <b>299</b> | <b>276</b> | <b>257</b> | <b>225</b> | <b>211</b>                   | 1.90 |
| <i>203 × 152</i> | <i>52.09</i>   |   |            | <b>615</b> | <b>603</b> | <b>528</b> | <b>489</b> | <b>422</b> | <b>384</b> | <b>352</b> | <b>325</b> | <b>302</b> | <b>264</b> | <b>248</b>                   | 3.43 |
| <i>203 × 102</i> | <i>25.33</i>   |   | <b>401</b> | <b>337</b> | <b>289</b> | <b>253</b> | <b>225</b> | <b>202</b> | <b>184</b> | <b>169</b> | <b>156</b> | <b>144</b> | <b>126</b> | <b>119</b>                   | 1.79 |
| <i>178 × 102</i> | <i>21.54</i>   | <b>320</b>  | <b>306</b> | <b>255</b> | <b>219</b> | <b>191</b> | <b>170</b> | <b>153</b> | <b>139</b> | <b>128</b> | <b>118</b> | <b>109</b> | <b>96</b>  | <b>90</b>                    | 1.79 |
| <i>152 × 127</i> | <i>37.20</i>   | <b>535</b>  | <b>428</b> | <b>356</b> | <b>305</b> | <b>267</b> | <b>238</b> | <b>214</b> | <b>194</b> | <b>178</b> | <b>164</b> | <b>153</b> | <b>134</b> | <b>126</b>                   | 2.88 |
| <i>152 × 89</i>  | <i>17.09</i>   | <b>254</b>  | <b>207</b> | <b>173</b> | <b>140</b> | <b>130</b> | <b>115</b> | <b>104</b> | <b>94</b>  | <b>86</b>  | <b>80</b>  | <b>74</b>  | <b>65</b>  | <b>61</b>                    | 1.61 |
| <i>152 × 76</i>  | <i>17.85</i>   | <b>257</b>  | <b>205</b> | <b>177</b> | <b>147</b> | <b>128</b> | <b>114</b> | <b>103</b> | <b>93</b>  | <b>86</b>  | <b>79</b>  | <b>73</b>  | <b>64</b>  | <b>60</b>                    | 1.40 |
| <i>127 × 114</i> | <i>29.76</i>   | <b>348</b>  | <b>276</b> | <b>230</b> | <b>197</b> | <b>173</b> | <b>153</b> | <b>138</b> | <b>126</b> | <b>115</b> | <b>106</b> | <b>99</b>  | <b>86</b>  | <b>81</b>                    | 2.69 |
| <i>127 × 114</i> | <i>26.79</i>   | <b>320</b>  | <b>267</b> | <b>222</b> | <b>190</b> | <b>167</b> | <b>148</b> | <b>133</b> | <b>121</b> | <b>111</b> | <b>103</b> | <b>95</b>  | <b>83</b>  | <b>78</b>                    | 2.74 |
| <i>127 × 76</i>  | <i>16.37</i>   | <b>201</b>  | <b>161</b> | <b>134</b> | <b>115</b> | <b>100</b> | <b>89</b>  | <b>80</b>  | <b>73</b>  | <b>67</b>  | <b>62</b>  | <b>57</b>  | <b>50</b>  | <b>47</b>                    | 1.59 |
| <i>127 × 76</i>  | <i>13.36</i>   | <b>188</b>  | <b>134</b> | <b>112</b> | <b>96</b>  | <b>84</b>  | <b>75</b>  | <b>67</b>  | <b>61</b>  | <b>56</b>  | <b>52</b>  | <b>48</b>  | <b>42</b>  | <b>39</b>                    | 1.45 |
| <i>114 × 114</i> | <i>26.79</i>   | <b>288</b>  | <b>231</b> | <b>192</b> | <b>165</b> | <b>144</b> | <b>128</b> | <b>115</b> | <b>105</b> | <b>96</b>  | <b>89</b>  | <b>82</b>  | <b>72</b>  | <b>68</b>                    | 2.74 |
| <i>102 × 102</i> | <i>23.07</i>   | <b>214</b>  | <b>172</b> | <b>143</b> | <b>123</b> | <b>107</b> | <b>95</b>  | <b>86</b>  | <b>78</b>  | <b>71</b>  | <b>66</b>  | <b>61</b>  | <b>54</b>  | <b>50</b>                    | 2.61 |
| <i>102 × 84</i>  | <i>9.65</i>    | <b>96</b>   | <b>77</b>  | <b>64</b>  | <b>55</b>  | <b>48</b>  | <b>43</b>  | <b>38</b>  | <b>35</b>  | <b>32</b>  | <b>30</b>  | <b>27</b>  | <b>24</b>  | <b>23</b>                    | 1.24 |
| <i>102 × 44</i>  | <i>7.44</i>    | <b>67</b>   | <b>54</b>  | <b>45</b>  | <b>38</b>  | <b>34</b>  | <b>30</b>  | <b>27</b>  | <b>24</b>  | <b>22</b>  | <b>21</b>  | <b>19</b>  | <b>17</b>  | <b>16</b>                    | 0.76 |
| <i>89 × 89</i>   | <i>19.35</i>   | <b>155</b>  | <b>124</b> | <b>103</b> | <b>88</b>  | <b>77</b>  | <b>69</b>  | <b>62</b>  | <b>56</b>  | <b>52</b>  | <b>48</b>  | <b>44</b>  | <b>39</b>  | <b>36</b>                    | 2.48 |
| <i>76 × 76</i>   | <i>14.67</i>   | <b>101</b>  | <b>81</b>  | <b>67</b>  | <b>58</b>  | <b>51</b>  | <b>45</b>  | <b>40</b>  | <b>37</b>  | <b>34</b>  | <b>31</b>  | <b>29</b>  | <b>25</b>  | <b>24</b>                    | 2.17 |
| <i>76 × 76</i>   | <i>12.65</i>   | <b>93</b>   | <b>75</b>  | <b>62</b>  | <b>53</b>  | <b>47</b>  | <b>41</b>  | <b>37</b>  | <b>34</b>  | <b>31</b>  | <b>29</b>  | <b>27</b>  | <b>23</b>  | <b>22</b>                    | 2.20 |

For explanation of table see page 16.

Sections with mass shown in *italics* are, although frequently rolled, not in BS 4. Availability should be checked with BSC Sections Product Unit. Flanges of BS 4 joists have a 5° taper; all others taper at 8°.

The loads listed are based on a bending stress of 280 N/mm<sup>2</sup>, and assume adequate lateral support. Without such support the span must not exceed L<sub>0</sub> unless the compressive stress is reduced in accordance with clause 19 a of BS 449.

Loads printed in bold face type may cause overloading of the unstiffened web, the capacity of which should be checked (see p. 14).

Loads printed in *italic* type do not cause overloading of the unstiffened web, and do not cause deflection exceeding span/360.

Loads printed in ordinary type should be checked for deflection (see p. 15).

† Load is based on allowable shear of web and is less than allowable load in bending.

# CHANNELS



## SAFE LOADS FOR GRADE 55 STEEL

| Nominal size     | Mass per metre | Safe distributed loads in kilonewtons for spans in metres and deflection coefficients |             |            |            |            |            |            |            |            |            |            |            |       | Critical span $L_c$ |
|------------------|----------------|---|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------|---------------------|
|                  |                | 1.60  | 2.00        | 2.60       | 3.00       | 3.50       | 4.00       | 4.50       | 5.00       | 5.50       | 6.00       | 7.00       | 8.00       | 9.00  |                     |
| mm               | kg             | 199.1   | 112.0       | 71.68      | 49.78      | 38.57      | 28.00      | 22.12      | 17.92      | 14.81      | 12.44      | 9.143      | 7.000      | 5.531 | m                   |
| <b>432 × 102</b> | 65.54          | <i>1480</i>   | <i>1170</i> | <i>888</i> | <i>740</i> | <i>634</i> | <i>555</i> | <i>493</i> | <i>444</i> | <i>404</i> | <i>370</i> | <i>317</i> | <i>278</i> |       | 2.156               |
| <b>381 × 102</b> | 55.10          | <i>1168</i>   | <i>876</i>  | <i>701</i> | <i>584</i> | <i>500</i> | <i>438</i> | <i>389</i> | <i>350</i> | <i>318</i> | <i>292</i> | <i>250</i> |            |       | 2.293               |
| <b>306 × 102</b> | 46.18          | <i>805</i>  | <i>604</i>  | <i>483</i> | <i>402</i> | <i>345</i> | <i>302</i> | <i>268</i> | <i>241</i> | <i>220</i> | <i>201</i> |            |            |       | 2.405               |
| <b>306 × 89</b>  | 41.69          | <i>692</i>  | <i>519</i>  | <i>415</i> | <i>346</i> | <i>297</i> | <i>259</i> | <i>231</i> | <i>208</i> | <i>189</i> | <i>173</i> |            |            |       | 1.999               |
| <b>264 × 89</b>  | 35.74          | <i>523</i>  | <i>392</i>  | <i>314</i> | <i>261</i> | <i>224</i> | <i>196</i> | <i>174</i> | <i>157</i> |            |            |            |            |       | 2.196               |
| <b>264 × 76</b>  | 28.29          | <i>396</i>  | <i>297</i>  | <i>238</i> | <i>198</i> | <i>170</i> | <i>148</i> | <i>132</i> | <i>119</i> |            |            |            |            |       | 1.696               |
| <b>229 × 89</b>  | 32.76          | <i>443</i>  | <i>332</i>  | <i>266</i> | <i>221</i> | <i>190</i> | <i>166</i> | <i>148</i> |            |            |            |            |            |       | 2.299               |
| <b>229 × 76</b>  | 26.06          | <i>341</i>  | <i>256</i>  | <i>205</i> | <i>170</i> | <i>146</i> | <i>128</i> | <i>114</i> |            |            |            |            |            |       | 1.810               |
| <b>203 × 89</b>  | 29.78          | <i>366</i>  | <i>275</i>  | <i>220</i> | <i>183</i> | <i>157</i> | <i>137</i> |            |            |            |            |            |            |       | 2.412               |
| <b>203 × 76</b>  | 23.82          | <i>287</i>  | <i>215</i>  | <i>172</i> | <i>143</i> | <i>123</i> | <i>107</i> |            |            |            |            |            |            |       | 1.924               |
| <b>178 × 89</b>  | 26.81          | <i>294</i>  | <i>221</i>  | <i>177</i> | <i>147</i> | <i>126</i> |            |            |            |            |            |            |            |       | 2.532               |
| <b>178 × 76</b>  | 20.84          | <i>225</i>  | <i>168</i>  | <i>135</i> | <i>112</i> | <i>96</i>  |            |            |            |            |            |            |            |       | 1.973               |
| <b>152 × 89</b>  | 23.84          | <i>228</i>  | <i>171</i>  | <i>137</i> | <i>114</i> |            |            |            |            |            |            |            |            |       | 2.678               |
| <b>152 × 76</b>  | 17.88          | <i>167</i>  | <i>125</i>  | <i>100</i> | <i>83</i>  |            |            |            |            |            |            |            |            |       | 1.978               |
| <b>127 × 64</b>  | 14.90          | 113   | 85          | 68         |            |            |            |            |            |            |            |            |            |       | 1.840               |
| <b>102 × 51</b>  | 10.42          | 61  | 46          |            |            |            |            |            |            |            |            |            |            |       | 1.474               |
| <b>76 × 38</b>   | 6.70           | 29  |             |            |            |            |            |            |            |            |            |            |            |       | 1.248               |

For explanation of table see page 16.

The loads listed are based on a bending stress of 280 N/mm<sup>2</sup>, and assume adequate lateral support. Without such support the span must not exceed  $L_c$  unless the compressive stress is reduced in accordance with clause 19a of BS 449.

Loads printed in bold face type may cause overloading of the unstiffened web, the capacity of which should be checked (see p. 16).

Loads printed in italic type do not cause overloading of the unstiffened web, and do not cause deflection exceeding span/360.

Loads printed in ordinary type should be checked for deflection (see p. 17).

## CONVERSION TABLES

POUNDS PER FOOT RUN TO  
KILOGRAMS PER METRE RUN

| lb/ft run | kg/lin. m |
|-----------|-----------|
| 1         | 1.488     |
| 2         | 2.976     |
| 3         | 4.464     |
| 4         | 5.952     |
| 5         | 7.443     |
| 6         | 8.929     |
| 7         | 10.417    |
| 8         | 11.905    |
| 9         | 13.393    |
| 10        | 14.886    |

POUNDS PER SQUARE FOOT TO  
KILOGRAMS PER SQUARE METRE

| lb/sq. ft | kg/m <sup>3</sup> |
|-----------|-------------------|
| 1         | 4.882             |
| 2         | 9.764             |
| 3         | 14.647            |
| 4         | 19.528            |
| 5         | 24.412            |
| 6         | 29.294            |
| 7         | 34.177            |
| 8         | 38.116            |
| 9         | 42.998            |
| 10        | 48.824            |

POUNDS PER CUBIC FOOT TO KILOGRAMS PER CUBIC METRE

| lb/cu. ft | kg/m <sup>3</sup> | lb/cu. ft | kg/m <sup>3</sup> |
|-----------|-------------------|-----------|-------------------|
| 1         | 16.015            | 90        | 1441.660          |
| 2         | 32.037            | 100       | 1601.850          |
| 3         | 48.052            | 110       | 1762.030          |
| 4         | 64.074            | 120       | 1922.220          |
| 5         | 80.092            | 125       | 2002.312          |
| 6         | 96.110            | 130       | 2084.404          |
| 7         | 112.127           | 135       | 2164.496          |
| 8         | 128.148           | 140       | 2242.580          |
| 9         | 134.166           | 145       | 2322.672          |
| 10        | 160.184           | 150       | 2402.770          |
| 20        | 140.368           | 200       | 3203.700          |
| 30        | 480-530           | 300       | 4805.350          |
| 40        | 640.739           | 400       | 6407.140          |
| 50        | 800.923           | 500       | 8009.234          |
| 60        | 961.108           | 550       | 8810.150          |
| 70        | 1121.290          | 600       | 9071.084          |
| 80        | 1281.480          | 700       | 11132.318         |

HUNDREDWEIGHTS PER CUBIC FOOT TO TONNES PER CUBIC METRE

| cwts/cu. ft | tonnes/m <sup>3</sup> |
|-------------|-----------------------|
| 1/4         | 0.45                  |
| 3/8         | 0.67                  |
| 1/2         | 0.89                  |
| 3/4         | 1.35                  |
| 1           | 1.8                   |
| 1 1/4       | 2.24                  |
| 1 1/2       | 2.7                   |

2

3·6

KILONEWTONS PER SQUARE METRE AND POUNDS FORCE PER SQUARE FOOT

| kN/m <sup>2</sup> | 1  | lb f/sq. ft | kN/m <sup>2</sup> | 1   | lb f/sq. ft |
|-------------------|----|-------------|-------------------|-----|-------------|
| 0·05              | 1  | 20          | 1·00              | 20  | 400         |
| 0·10              | 2  | 40          | 1·50              | 30  | 600         |
| 0·15              | 3  | 60          | 2·00              | 40  | 800         |
| 0·20              | 4  | 80          | 2·50              | 50  | 1000        |
| 0·25              | 5  | 100         | 3·00              | 60  | 1200        |
| 0·30              | 6  | 120         | 3·50              | 70  | 1400        |
| 0·35              | 7  | 140         | 4·00              | 80  | 1600        |
| 0·40              | 8  | 160         | 4·50              | 90  | 1800        |
| 0·45              | 9  | 180         | 5·00              | 100 | 2000        |
| 0·50              | 10 | 200         |                   |     |             |

APPLICATION—Floor loading

KILONEWTONS PER SQUARE METRE AND TONS FORCE PER SQUARE FOOT

| tons f/sq. ft | kN/m <sup>2</sup> | tons f/sq. ft | kN/m <sup>2</sup> |
|---------------|-------------------|---------------|-------------------|
| 1             | 107·25            | 7             | 749·75            |
| 2             | 214·50            | 8             | 848·00            |
| 3             | 321·75            | 9             | 965·25            |
| 4             | 429·00            | 10            | 1072·50           |
| 5             | 535·25            | 20            | 2145·00           |
| 6             | 642·50            |               |                   |

APPLICATION—Safe bearing capacity of soils, etc.

POUNDS FORCE PER SQUARE INCH MEGANEWTONS PER SQUARE METRE

| lb f/sq. in | MN/m <sup>2</sup> | lb f/sq. in | MN/m <sup>2</sup> |
|-------------|-------------------|-------------|-------------------|
| 50          | 0·33              | 1200        | 8·00              |
| 100         | 0·66              | 1350        | 9·00              |
| 150         | 1·00              | 1500        | 10·00             |
| 300         | 2·00              | 3000        | 20·00             |
| 450         | 3·00              | 4500        | 30·00             |
| 600         | 4·00              | 6000        | 40·00             |
| 750         | 5·00              | 7500        | 50·00             |
| 900         | 6·00              | 9000        | 60·00             |
| 1050        | 7·00              |             |                   |

APPLICATION—reinforced concrete, etc.

## STEEL CHANNELS TO B.S. 4: Part 1; 1972

| DESIGNATION       |                  | Depth of section <i>D</i> | Width of section <i>B</i> | Thickness    |                 |
|-------------------|------------------|---------------------------|---------------------------|--------------|-----------------|
| Nominal size      | Mass/unit length |                           |                           | Web <i>t</i> | Flange <i>T</i> |
| mm (in)           | kg/m (lb/ft)     | mm                        | mm                        | mm           | mm              |
| 432×102 (17×4)    | 66.54 (44.0)     | <b>431.8</b>              | <b>101.6</b>              | 12.2         | 16.8            |
| 381×102 (15×4)    | 55.10 (37.0)     | <b>381.0</b>              | <b>101.6</b>              | 10.4         | 16.3            |
| 305×102 (12×4)    | 46.18 (31.0)     | <b>304.8</b>              | <b>101.6</b>              | 10.2         | 14.8            |
| 305×89 (12×3 1/2) | 41.69 (28.0)     | <b>304.8</b>              | <b>88.9</b>               | 10.2         | 13.7            |
| 254×89 (10×3 1/2) | 35.74 (24.0)     | <b>254.0</b>              | <b>88.9</b>               | 9.1          | 13.6            |
| 254×76 (10×3)     | 28.29 (19.0)     | <b>254.0</b>              | <b>76.2</b>               | 8.1          | 10.9            |
| 229×89 (9×3 1/2)  | 32.76 (22.0)     | <b>228.6</b>              | <b>88.9</b>               | 8.6          | 13.3            |
| 229×76 (9×3)      | 26.06 (17.5)     | <b>228.6</b>              | <b>76.2</b>               | 7.6          | 11.2            |
| 203×89 (8×3 1/2)  | 29.78 (20.0)     | <b>203.2</b>              | <b>88.9</b>               | 8.1          | 12.9            |
| 203×76 (8×3)      | 23.82 (16.0)     | <b>203.2</b>              | <b>76.2</b>               | 7.1          | 11.2            |
| 178×89 (7×3 1/2)  | 26.81 (18.0)     | <b>177.8</b>              | <b>88.9</b>               | 7.6          | 12.3            |
| 178×76 (7×3)      | 20.84 (14.0)     | <b>177.8</b>              | <b>76.2</b>               | 6.6          | 10.3            |
| 152×89 (6×3 1/2)  | 23.84 (16.0)     | <b>152.4</b>              | <b>88.9</b>               | 7.1          | 11.6            |
| 152×76 (6×3)      | 17.88 (12.0)     | <b>152.4</b>              | <b>76.2</b>               | 6.4          | 9.0             |
| 127×64 (5×2 1/2)  | 14.90 (10.0)     | <b>127.0</b>              | <b>63.5</b>               | 6.4          | 9.2             |
| 102×51 (4×2)      | 10.42 (7.0)      | <b>101.6</b>              | <b>50.8</b>               | 6.1          | 7.6             |
| 76×38 (3×1 1/2)   | 6.70 (4.5)       | <b>76.2</b>               | <b>38.1</b>               | 5.1          | 6.8             |

STEEL ANGLES (EQUAL SIDED) TO B.S.4: Part 1; 1972

| DESIGNATION          |                   | Leg lengths<br>A | Thickness<br>t |       | Mass/unit length |         |
|----------------------|-------------------|------------------|----------------|-------|------------------|---------|
| Nominal size         | Nominal thickness |                  |                |       | kg/m             | (lb/ft) |
| mm (in)              | mm (in)           | mm               | mm             |       |                  |         |
| 203 x 203<br>(8 x 8) | 25 (1)            | 203.2            | 25.3           | ....  | 76.00            | (51.02) |
|                      | 24 (1 1/8)        |                  | 23.7           |       | 71.51            | (48.01) |
|                      | 22 (7/8)          |                  | 22.1           |       | 67.05            | (45.01) |
|                      | 21 (1 1/4)        |                  | 20.5           |       | 62.56            | (42.00) |
|                      | 19 (3/4)          |                  | 18.9           |       | 57.95            | (38.90) |
|                      | 17 (1 1/8)        |                  | 17.3           |       | 53.30            | (35.78) |
|                      | 16 (5/8)          |                  | 15.8           |       | 48.68            | (32.68) |
| 152 x 152<br>(6 x 6) | 22 (7/8)          | 152.4            | 22.1           |       | 49.32            | (33.11) |
|                      | 21 (1 1/8)        |                  | 20.5           |       | 46.03            | (30.90) |
|                      | 19 (3/4)          |                  | 19.0           |       | 42.75            | (28.70) |
|                      | 17 (1 1/4)        |                  | 17.3           |       | 39.32            | (26.40) |
|                      | 16 (5/8)          |                  | 15.8           |       | 36.07            | (24.22) |
|                      | 14 (3/4)          |                  | 14.2           |       | 32.62            | (21.90) |
|                      | 13 (1/2)          |                  | 12.6           |       | 29.07            | (19.52) |
|                      | 11 (3/4)          |                  | 11.0           |       | 25.60            | (17.18) |
|                      | 9 (3/4)           |                  | 9.4            | 22.02 | (14.79)          |         |
| 127 x 127<br>(5 x 5) | 19 (3/4)          | 127.0            | 19.0           |       | 35.16            | (23.61) |
|                      | 17 (1 1/8)        |                  | 17.4           |       | 32.47            | (21.80) |
|                      | 16 (5/8)          |                  | 15.8           |       | 29.66            | (19.91) |
|                      | 14 (3/4)          |                  | 14.2           |       | 26.80            | (18.00) |
|                      | 13 (1/2)          |                  | 12.6           |       | 23.99            | (16.10) |
|                      | 11 (3/4)          |                  | 11.0           |       | 21.14            | (14.19) |
|                      | 10 (3/4)          |                  | 9.5            | 18.30 | (12.29)          |         |

| DESIGNATION                |                   | Leg lengths<br>A | Thickness<br>t |       | Mass/unit length |         |
|----------------------------|-------------------|------------------|----------------|-------|------------------|---------|
| Nominal size               | Nominal thickness |                  |                |       | kg/m             | (lb/ft) |
| mm (in)                    | mm (in)           | mm               | mm             |       |                  |         |
| 102 x 102<br>(4 x 4)       | 19 (3/4)          | 101.6            | 19.0           | ....  | 27.57            | (18.51) |
|                            | 17 (1 1/8)        |                  | 17.4           |       | 25.48            | (17.10) |
|                            | 16 (5/8)          |                  | 15.8           |       | 23.37            | (15.69) |
|                            | 14 (3/4)          |                  | 14.2           |       | 21.17            | (14.21) |
|                            | 13 (1/2)          |                  | 12.6           |       | 18.91            | (12.70) |
|                            | 11 (3/4)          |                  | 11.0           |       | 16.69            | (11.21) |
|                            | 9 (3/4)           |                  | 9.4            |       | 14.44            | (9.69)  |
|                            | 8 (3/4)           |                  | 7.8            | 12.06 | (8.10)           |         |
| 89 x 89<br>(3 1/2 x 3 1/2) | 16 (5/8)          | 89.9             | 15.8           |       | 20.10            | (13.50) |
|                            | 14 (3/4)          |                  | 14.2           |       | 18.31            | (12.29) |
|                            | 13 (1/2)          |                  | 12.6           |       | 16.38            | (11.00) |
|                            | 11 (3/4)          |                  | 11.0           |       | 14.44            | (9.70)  |
|                            | 9 (3/4)           |                  | 9.4            |       | 12.50            | (8.39)  |
|                            | 8 (3/4)           |                  | 7.9            |       | 10.58            | (7.10)  |
|                            | 6 (3/4)           |                  | 6.3            | 8.49  | (5.70)           |         |
| 76 x 76<br>(3 x 3)         | 14 (3/4)          | 76.2             | 14.3           |       | 15.50            | (10.41) |
|                            | 13 (1/2)          |                  | 12.6           |       | 13.85            | (9.30)  |
|                            | 11 (3/4)          |                  | 11.0           |       | 12.20            | (8.19)  |
|                            | 9 (3/4)           |                  | 9.4            |       | 10.57            | (7.10)  |
|                            | 8 (3/4)           |                  | 7.8            |       | 8.93             | (5.99)  |
|                            | 6 (3/4)           |                  | 6.2            | 7.16  | (4.81)           |         |
| 64 x 64<br>(2 1/2 x 2 1/2) | 12 (1/2)          | 63.5             | 12.5           |       | 11.31            | (7.60)  |
|                            | 11 (3/4)          |                  | 11.0           |       | 10.12            | (6.79)  |
|                            | 9 (3/4)           |                  | 9.4            |       | 8.78             | (5.89)  |
|                            | 8 (3/4)           |                  | 7.9            |       | 7.45             | (5.00)  |
|                            | 6 (3/4)           |                  | 6.2            | 5.96  | (4.00)           |         |



| DESIGNATION          |                   | Leg lengths |          | Thickness<br><i>t</i> | Mass/unit length |              |
|----------------------|-------------------|-------------|----------|-----------------------|------------------|--------------|
| Nominal size         | Nominal thickness | <i>A</i>    | <i>B</i> |                       | kg/m             | (lb/ft)      |
| mm (in)              | mm (in)           | mm          | mm       | mm                    | mm               | kg/m (lb/ft) |
| 57 × 57<br>(2¼ × 2¼) | 9 (¾)             | 57.2        | 57.2     | 9.3                   | 7.74 (5.19)      |              |
|                      | 8 (⅝)             |             |          | 7.8                   | 6.55 (4.40)      |              |
|                      | 6 (½)             |             |          | 6.2                   | 5.35 (3.59)      |              |
|                      | 5 (⅞)             |             |          | 4.6                   | 4.01 (2.69)      |              |
| 51 × 51<br>(2 × 2)   | 9 (¾)             | 50.8        | 50.8     | 9.4                   | 6.85 (4.60)      |              |
|                      | 8 (⅝)             |             |          | 7.8                   | 5.80 (3.90)      |              |
|                      | 6 (½)             |             |          | 6.3                   | 4.77 (3.20)      |              |
|                      | 5 (⅞)             |             |          | 4.6                   | 3.58 (2.40)      |              |
| 44 × 44<br>(1¾ × 1¾) | 8 (⅞)             | 44.5        | 44.5     | 7.9                   | 5.06 (3.40)      |              |
|                      | 6 (½)             |             |          | 6.1                   | 4.02 (2.70)      |              |
|                      | 5 (⅞)             |             |          | 4.7                   | 3.13 (2.10)      |              |
| 38 × 38<br>(1½ × 1½) | 8 (⅞)             | 38.1        | 38.1     | 7.8                   | 4.24 (2.85)      |              |
|                      | 6 (½)             |             |          | 6.3                   | 3.50 (2.35)      |              |
|                      | 5 (⅞)             |             |          | 4.7                   | 2.68 (1.80)      |              |
| 32 × 32<br>(1¼ × 1¼) | 6 (½)             | 31.8        | 31.8     | 6.2                   | 2.83 (1.90)      |              |
|                      | 5 (⅞)             |             |          | 4.6                   | 2.16 (1.45)      |              |
|                      | 3 (¾)             |             |          | 3.1                   | 1.49 (1.00)      |              |
| 26 × 26*<br>(1 × 1)  | 6 (½)             | 25.4        | 25.4     | 6.4                   | 2.23 (1.50)      |              |
|                      | 5 (⅞)             |             |          | 4.7                   | 1.72 (1.15)      |              |
|                      | 3 (¾)             |             |          | 3.1                   | 1.19 (0.80)      |              |

\* This metric designation of 26 mm × 26 mm has been given for the 1 in × 1 in size to avoid confusion with the metric size of 23 mm × 23 mm chosen for the co-ordinated metric range of sizes.

NOTE 1. Some of the thicknesses given in this table are obtained by rolling the rolls. (Practice in this respect is not uniform throughout the industry. In such cases the legs will be slightly longer and the backs of the toes will be slightly rounded.)  
NOTE 2. Finished sections in which the angle between the legs is not less than 89° and not more than 91° shall be deemed to comply with the requirements of this British Standard.

## STEEL ANGLES (UNEQUAL SIDED) TO B.S. 4: Part 1: 1972

| DESIGNATION          |                   | Leg lengths |          | Thickness<br><i>t</i> | Mass/unit length |              |
|----------------------|-------------------|-------------|----------|-----------------------|------------------|--------------|
| Nominal size         | Nominal thickness | <i>A</i>    | <i>B</i> |                       | kg/m             | (lb/ft)      |
| mm (in)              | mm (in)           | mm          | mm       | mm                    | mm               | kg/m (lb/ft) |
| 229 × 102<br>(9 × 4) | 22 (¾)            | 228.6       | 101.6    | 22.1                  | 53.77 (36.10)    |              |
|                      | 21 (⅞)            |             |          | 20.6                  | 50.21 (33.71)    |              |
|                      | 19 (¾)            |             |          | 18.9                  | 46.45 (31.18)    |              |
|                      | 17 (⅞)            |             |          | 17.4                  | 42.87 (28.78)    |              |
|                      | 16 (¾)            |             |          | 15.8                  | 39.20 (26.32)    |              |
|                      | 14 (⅞)            |             |          | 14.2                  | 35.43 (23.78)    |              |
|                      | 13 (½)            |             |          | 12.6                  | 31.56 (21.18)    |              |
| 203 × 152<br>(8 × 6) | 22 (¾)            | 203.2       | 152.4    | 22.1                  | 58.09 (39.00)    |              |
|                      | 21 (⅞)            |             |          | 20.5                  | 54.22 (36.40)    |              |
|                      | 19 (¾)            |             |          | 18.9                  | 50.32 (33.78)    |              |
|                      | 17 (⅞)            |             |          | 17.3                  | 46.30 (31.09)    |              |
|                      | 16 (¾)            |             |          | 15.8                  | 42.32 (28.41)    |              |
|                      | 14 (⅞)            |             |          | 14.2                  | 38.29 (25.71)    |              |
|                      | 13 (½)            |             |          | 12.6                  | 34.10 (22.89)    |              |
| 203 × 102<br>(8 × 4) | 19 (¾)            | 203.2       | 101.6    | 19.0                  | 42.75 (28.70)    |              |
|                      | 17 (⅞)            |             |          | 17.3                  | 39.32 (26.40)    |              |
|                      | 16 (¾)            |             |          | 15.8                  | 36.07 (24.22)    |              |
|                      | 14 (⅞)            |             |          | 14.2                  | 32.62 (21.90)    |              |
|                      | 13 (½)            |             |          | 12.6                  | 29.07 (19.52)    |              |
|                      | 9 (¾)             |             |          | 9.4                   | 19.22 (12.90)    |              |
| 178 × 89<br>(7 × 3½) | 16 (¾)            | 177.8       | 88.9     | 15.8                  | 31.30 (21.01)    |              |
|                      | 14 (⅞)            |             |          | 14.2                  | 28.28 (18.98)    |              |
|                      | 13 (½)            |             |          | 12.6                  | 25.31 (16.99)    |              |
|                      | 11 (⅞)            |             |          | 11.1                  | 22.36 (15.01)    |              |
|                      | 9 (¾)             |             |          | 9.4                   | 19.22 (12.90)    |              |
|                      | .....             |             |          | .....                 | .....            | .....        |

| DESIGNATION          |                   | Leg lengths |       | Thickness<br>t | Mass/unit length |
|----------------------|-------------------|-------------|-------|----------------|------------------|
| Nominal size         | Nominal thickness | A           | B     |                |                  |
| mm (in)              | mm (in)           | mm          | mm    | mm             | kg/m (lb/ft)     |
| 152 × 102<br>(6 × 4) | 19 (¾)            | 152.4       | 101.6 | 19.0           | 35.16 (23.61)    |
|                      | 17 (1⅜)           |             |       | 17.4           | 32.47 (21.80)    |
|                      | 16 (⅝)            |             |       | 15.8           | 29.66 (19.91)    |
|                      | 14 (⅝)            |             |       | 14.2           | 26.80 (17.99)    |
|                      | 13 (½)            |             |       | 12.6           | 23.99 (16.10)    |
|                      | 11 (⅞)            |             |       | 11.0           | 21.14 (14.19)    |
| 152 × 89<br>(6 × 3½) | 9 (¾)             | 152.4       | 88.9  | 9.5            | 18.30 (12.29)    |
|                      | 16 (⅝)            |             |       | 15.7           | 27.99 (18.79)    |
|                      | 14 (⅞)            |             |       | 14.2           | 25.46 (17.09)    |
|                      | 13 (½)            |             |       | 12.6           | 22.77 (15.28)    |
|                      | 11 (⅞)            |             |       | 11.1           | 20.12 (13.51)    |
|                      | 9 (¾)             |             |       | 9.4            | 17.26 (11.59)    |
| 152 × 76<br>(6 × 3)  | 8 (⅝)             | 152.4       | 76.2  | 7.8            | 14.44 (9.70)     |
|                      | 16 (⅝)            |             |       | 15.8           | 26.52 (17.80)    |
|                      | 14 (⅞)            |             |       | 14.2           | 23.99 (16.10)    |
|                      | 13 (½)            |             |       | 12.6           | 21.45 (14.40)    |
|                      | 11 (⅞)            |             |       | 11.0           | 18.92 (12.70)    |
|                      | 9 (¾)             |             |       | 9.5            | 16.39 (11.00)    |
| 127 × 89<br>(5 × 3½) | 8 (⅝)             | 127.0       | 88.9  | 7.8            | 13.69 (9.19)     |
|                      | 16 (⅝)            |             |       | 15.8           | 24.86 (16.69)    |
|                      | 14 (⅞)            |             |       | 14.2           | 22.64 (15.20)    |
|                      | 13 (½)            |             |       | 12.6           | 20.26 (13.60)    |
|                      | 11 (⅞)            |             |       | 11.1           | 17.89 (12.01)    |
|                      | 9 (¾)             |             |       | 9.4            | 15.35 (10.31)    |
| 127 × 76<br>(5 × 3)  | 8 (⅝)             | 127.0       | 76.2  | 7.8            | 12.94 (8.69)     |
|                      | 14 (⅞)            |             |       | 14.2           | 21.17 (14.21)    |
|                      | 13 (½)            |             |       | 12.6           | 18.91 (12.70)    |
|                      | 11 (⅞)            |             |       | 11.0           | 16.69 (11.21)    |
|                      | 9 (¾)             |             |       | 9.4            | 14.44 (9.69)     |
|                      | 8 (⅝)             |             |       | 7.8            | 12.06 (8.10)     |

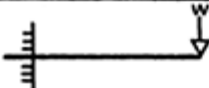
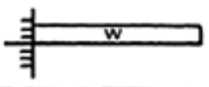
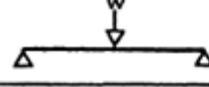
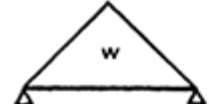
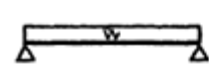
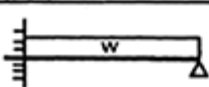
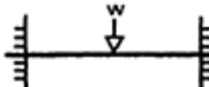
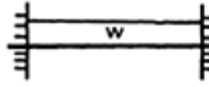
| DESIGNATION          |                      | Leg lengths |              | Thickness<br>t | Mass/unit length |      |      |               |
|----------------------|----------------------|-------------|--------------|----------------|------------------|------|------|---------------|
| Nominal size         | Nominal thickness    | A           | B            |                |                  |      |      |               |
| mm (in)              | mm (in)              | mm          | mm           | mm             | kg/m (lb/ft)     |      |      |               |
| 102 × 89<br>(4 × 3½) | 16 (⅝)               | 101.6       | 88.9         | 15.8           | 21.75 (14.60)    |      |      |               |
|                      | 14 (⅞)               |             |              | 14.2           | 19.67 (13.21)    |      |      |               |
|                      | 13 (½)               |             |              | 12.6           | 17.72 (11.89)    |      |      |               |
|                      | 11 (⅞)               |             |              | 11.0           | 15.62 (10.49)    |      |      |               |
|                      | 9 (¾)                |             |              | 9.5            | 13.55 (9.10)     |      |      |               |
|                      | 8 (⅝)                |             |              | 7.8            | 11.31 (7.59)     |      |      |               |
| 102 × 76<br>(4 × 3)  | 14 (⅞)               | 101.6       | 76.2         | 14.2           | 18.31 (12.29)    |      |      |               |
|                      | 13 (½)               |             |              | 12.6           | 16.38 (11.00)    |      |      |               |
|                      | 11 (⅞)               |             |              | 11.0           | 14.44 (9.70)     |      |      |               |
|                      | 9 (¾)                |             |              | 9.4            | 12.50 (8.39)     |      |      |               |
|                      | 8 (⅝)                |             |              | 7.9            | 10.58 (7.10)     |      |      |               |
|                      | 102 × 64<br>(4 × 2½) |             |              | 11 (⅞)         | 101.6            | 63.5 | 11.0 | 13.40 (8.99)  |
| 9 (¾)                |                      | 9.5         | 11.61 (7.79) |                |                  |      |      |               |
| 8 (⅝)                |                      | 7.8         | 9.69 (6.51)  |                |                  |      |      |               |
| 6 (⅝)                |                      | 6.3         | 7.89 (5.30)  |                |                  |      |      |               |
| 89 × 76<br>(3½ × 3)  |                      | 14 (⅞)      | 88.9         | 76.2           |                  |      | 14.2 | 16.83 (11.30) |
|                      |                      | 13 (½)      |              |                |                  |      | 12.7 | 15.20 (10.20) |
|                      | 11 (⅞)               | 11.0        |              |                | 13.40 (8.99)     |      |      |               |
|                      | 9 (¾)                | 9.5         |              |                | 11.61 (7.79)     |      |      |               |
|                      | 8 (⅝)                | 7.8         |              |                | 9.69 (6.51)      |      |      |               |
|                      | 6 (⅝)                | 6.3         |              |                | 7.89 (5.30)      |      |      |               |
| 89 × 64<br>(3½ × 2½) | 11 (⅞)               | 88.9        | 63.5         | 11.0           | 12.20 (8.19)     |      |      |               |
|                      | 9 (¾)                |             |              | 9.4            | 10.57 (7.10)     |      |      |               |
|                      | 8 (⅝)                |             |              | 7.8            | 8.93 (5.99)      |      |      |               |
|                      | 6 (⅝)                |             |              | 6.2            | 7.16 (4.81)      |      |      |               |

| DESIGNATION          |                   | Leg lengths |          | Thickness<br><i>t</i> | Mass/unit length |         |
|----------------------|-------------------|-------------|----------|-----------------------|------------------|---------|
| Nominal size         | Nominal thickness | <i>A</i>    | <i>B</i> |                       | kg/m             | (lb/ft) |
| 76 × 64<br>(3 × 2½)  | 11<br>(¾)         | 76.2        | 63.5     | 11.0                  | 11.17 (7.50)     |         |
|                      | 9<br>(¾)          |             |          | 9.4                   | 9.68 (6.50)      |         |
|                      | 8<br>(¾)          |             |          | 7.9                   | 8.19 (5.50)      |         |
| 76 × 51<br>(3 × 2)   | 6<br>(¾)          | 76.2        | 50.8     | 6.2                   | 6.56 (4.40)      |         |
|                      | 11<br>(¾)         |             |          | 11.0                  | 10.12 (6.79)     |         |
|                      | 9<br>(¾)          |             |          | 9.4                   | 8.78 (5.89)      |         |
|                      | 8<br>(¾)          |             |          | 7.9                   | 7.45 (5.00)      |         |
| 64 × 51<br>(2½ × 2)  | 6<br>(¾)          | 63.5        | 50.8     | 6.2                   | 5.96 (4.00)      |         |
|                      | 5<br>(¾)          |             |          | 4.7                   | 4.62 (3.10)      |         |
|                      | 9<br>(¾)          |             |          | 9.3                   | 7.74 (5.19)      |         |
|                      | 8<br>(¾)          |             |          | 7.8                   | 6.55 (4.40)      |         |
| 64 × 38<br>(2½ × 1½) | 6<br>(¾)          | 63.5        | 38.1     | 6.2                   | 5.35 (3.59)      |         |
|                      | 5<br>(¾)          |             |          | 4.6                   | 4.01 (2.69)      |         |
|                      | 8<br>(¾)          |             |          | 7.8                   | 5.80 (3.90)      |         |
|                      | 6<br>(¾)          |             |          | 6.3                   | 4.77 (3.20)      |         |
| 51 × 38<br>(2 × 1½)  | 5<br>(¾)          | 50.8        | 38.1     | 4.7                   | 3.58 (2.40)      |         |
|                      | 6<br>(¾)          |             |          | 6.1                   | 5.06 (3.40)      |         |
|                      | 8<br>(¾)          |             |          | 7.9                   | 4.02 (2.70)      |         |
|                      |                   |             |          |                       | 3.13 (2.10)      |         |


NOTE 1. Some of the thicknesses given in this table are obtained by rolling the rolls. (Practice in this respect is not uniform throughout the industry.) In such cases the legs will be slightly longer and the backs of the toes will be slightly rounded.

NOTE 2. Finished sections in which the angle between the legs is not less than 89° and not more than 91° shall be deemed to comply with the requirements of this British Standard.

**BENDING MOMENTS AND DEFLECTION FORMULAE**

| Loading Diagram   | Maximum Bending Moment | Maximum Shear  | Deflection                        |
|---|------------------------|----------------|-----------------------------------|
|    | $W.l$                  | $W$            | $\frac{1}{3} \frac{W.l^3}{E.I}$   |
|    | $\frac{W.l}{2}$        | $W$            | $\frac{1}{8} \frac{W.l^3}{E.I}$   |
|    | $\frac{W.l}{4}$        | $\frac{W}{2}$  | $\frac{1}{48} \frac{W.l^3}{E.I}$  |
|    | $\frac{W.l}{6}$        | $\frac{W}{2}$  | $\frac{1}{60} \frac{W.l^3}{E.I}$  |
|    | $\frac{W.l}{8}$        | $\frac{W}{2}$  | $\frac{5}{384} \frac{W.l^3}{E.I}$ |
|    | $\frac{W.l}{8}$        | $\frac{5}{8}W$ | $0.0054 \frac{W.l^3}{E.I}$        |
|   | $\frac{W.l}{8}$        | $\frac{W}{2}$  | $\frac{1}{192} \frac{W.l^3}{E.I}$ |
|  | $\frac{W.l}{12}$       | $\frac{W}{2}$  | $\frac{1}{384} \frac{W.l^3}{E.I}$ |

|   |                    |   |                         |
|---|--------------------|---|-------------------------|
| w | = Total Load       | l   | = Length                |
| ▽ | = Point load       | E   | = Modulus of elasticity |
| ▬ | = Distributed load | I   | = Moment of inertia     |
| △ | = Free support     |  | = Fixed support         |

**SIZES: ISO METRIC BLACK HEXAGON BOLTS, SCREWS AND NUTS, B.S. 4190**

|              |          |             |   |       |   |              |   |           |    |
|--------------|----------|-------------|---|-------|---|--------------|---|-----------|----|
| 1            | 2        | 3           | 4 | 5     | 6 | 7            | 8 | 9         | 10 |
| Nominal size | Pitch of | Diameter of |   | Width |   | Width across |   | Height of |    |

| and thread diameter | thread                | unthreaded shank |       | across flats |       | corners |        | head  |       |
|---------------------|-----------------------|------------------|-------|--------------|-------|---------|--------|-------|-------|
| $d$                 | (Coarse pitch series) | $d$              |       | $e$          |       | $s$     |        | $k$   |       |
|                     |                       | max.             | min.  | max.         | min.  | max.    | min.   | max.  | min.  |
| M5                  | 0.8                   | 15.48            | 4.52  | (8.00        | 7.64  | 9.2     | 8.63   | 3.875 | 3.125 |
| M6                  | 1                     | 6.48             | 5.52  | 10.00        | 9.64  | 11.5    | 10.89  | 4.375 | 3.625 |
| M8                  | 1.25                  | 8.58             | 7.42  | 13.00        | 12.57 | 15.0    | 14.20  | 5.875 | 5.125 |
| M10                 | 1.5                   | 10.58            | 9.42  | 17.00        | 16.57 | 19.6    | 18.72  | 7.45  | 6.55  |
| M12                 | 1.75                  | 12.70            | 11.30 | 19.00        | 18.48 | 21.9    | 20.88  | 8.45  | 7.55  |
| M16                 | 2                     | 16.70            | 15.30 | 24.00        | 23.16 | 27.7    | 26.17  | 10.45 | 9.55  |
| M20                 | 2.5                   | 20.84            | 19.16 | 30.00        | 29.16 | 34.6    | 32.95  | 13.90 | 12.10 |
| (M22)               | 2.5                   | 22.84            | 21.16 | 32.00        | 31.00 | 36.9    | 35.03  | 14.90 | 13.10 |
| M24                 | 3                     | 24.84            | 23.16 | 36.00        | 35.00 | 41.6    | 39.55  | 15.90 | 14.10 |
| (M27)               | 3                     | 27.84            | 26.16 | 41.00        | 40.00 | 47.3    | 45.20  | 17.90 | 16.10 |
| M30                 | 3.5                   | 30.84            | 29.16 | 46.00        | 45.00 | 53.1    | 50.85  | 20.05 | 17.95 |
| (M33)               | 3.5                   | 34.00            | 32.00 | 50.00        | 49.00 | 57.7    | 55.37  | 22.05 | 19.95 |
| M36                 | 4                     | 37.00            | 35.00 | 55.00        | 53.80 | 63.5    | 60.79  | 24.05 | 21.95 |
| (M39)               | 4                     | 40.00            | 38.00 | 60.00        | 58.80 | 69.3    | 66.44  | 26.05 | 23.95 |
| M42                 | 4.5                   | 43.00            | 41.00 | 65.00        | 63.80 | 75.1    | 72.09  | 27.05 | 24.95 |
| (M45)               | 4.5                   | 46.00            | 44.00 | 70.00        | 68.80 | 80.8    | 77.74  | 29.05 | 26.95 |
| M48                 | 5                     | 49.00            | 47.00 | 75.00        | 73.80 | 86.6    | 83.39  | 31.05 | 28.95 |
| (M52)               | 5                     | 53.20            | 50.80 | 80.00        | 78.80 | 92.4    | 89.04  | 34.25 | 31.75 |
| M56                 | 5.5                   | 57.20            | 54.80 | 85.00        | 83.60 | 98.1    | 94.47  | 36.25 | 33.75 |
| (M60)               | 5.5                   | 61.20            | 58.80 | 90.00        | 88.60 | 103.9   | 100.12 | 39.25 | 36.75 |
| M64                 | 6                     | 65.20            | 62.80 | 95.00        | 93.60 | 109.7   | 105.77 | 41.25 | 38.75 |
| (M68)               | 6                     | 69.20            | 66.80 | 100.00       | 98.60 | 115.5   | 111.42 | 44.25 | 41.75 |

| 1                                | 2                                     | 3                      | 4     | 5                        | 6     | 7                    | 8     | 9              | 10    | 11   | 12   |
|----------------------------------|---------------------------------------|------------------------|-------|--------------------------|-------|----------------------|-------|----------------|-------|--|------|
| Nominal size and thread diameter | Pitch of thread (Coarse pitch series) | Width across flats $s$ |       | Width across corners $e$ |       | Thickness of nut $m$ |       |                |       | Thickness of thin nut (faced both sides) $t$ |      |
|                                  |                                       | max.                   | min.  | max.                     | min.  | Black                |       | Faced one side |       |  |      |
|                                  |                                       | max.                   | min.  | max.                     | min.  | max.                 | min.  | max.           | min.  | max.   | min. |
| M5                               | 0.8                                   | 8.00                   | 7.64  | 9.2                      | 8.63  | 4.375                | 3.625 | 4.0            | 3.52  | —  | —    |
| M6                               | 1                                     | 10.00                  | 9.64  | 11.5                     | 10.89 | 5.375                | 4.625 | 5              | 4.52  | —  | —    |
| M8                               | 1.25                                  | 13.00                  | 12.57 | 15.0                     | 14.20 | 6.875                | 5.125 | 6.5            | 5.92  | 5.00   | 4.52 |
| M10                              | 1.5                                   | 17.00                  | 16.57 | 19.6                     | 18.72 | 8.45                 | 7.55  | 8              | 7.42  | 6.00   | 5.52 |
| M12                              | 1.75                                  | 19.00                  | 18.48 | 21.9                     | 20.88 | 10.45                | 9.55  | 10             | 9.42  | 7.00   | 6.42 |
| M16                              | 2                                     | 24.00                  | 23.16 | 27.7                     | 26.17 | 13.55                | 12.45 | 13             | 12.30 | 9.00   | 8.42 |
| M20                              | 2.5                                   | 30.00                  | 29.16 | 34.6                     | 32.95 | 16.55                | 15.45 | 16             | 15.30 | 9.00   | 8.42 |
| (M22)                            | 2.5                                   | 32.00                  | 31.00 | 36.9                     | 35.03 | 18.55                | 17.45 | 18             | 17.30 | 10.00  | 9.42 |
| M24                              | 3                                     | 36.00                  | 35.00 | 41.6                     | 39.55 | 19.65                | 18.35 | 19             | 18.16 | 10.00  | 9.42 |

|       |     |             |       |        |            |         |       |       |
|-------|-----|-------------|-------|--------|------------|---------|-------|-------|
| (M27) | 3   | 41.0040.00  | 47.3  | 45.20  | 22.6521.35 | 2221.16 | 12.00 | 11.30 |
| M30   | 3.5 | 46.0045.00  | 53.1  | 50.85  | 24.6523.35 | 2423.16 | 12.00 | 11.30 |
| (M33) | 3.5 | 50.0049.00  | 57.7  | 55.37  | 26.6525.35 | 2625.16 | 14.00 | 13.30 |
| M36   | 4   | 55.0053.80  | 63.5  | 60.79  | 29.6528.35 | 2928.16 | 14.00 | 13.30 |
| (M39) | 4   | 60.0058.80  | 69.3  | 66.44  | 31.8030.20 | 31 30.0 | 16.00 | 15.30 |
| M42   | 4.5 | 65.0063.80  | 75.1  | 72.09  | 34.8033.20 | 34 33.0 | 16.00 | 15.30 |
| (M45) | 4.5 | 70.0068.80  | 80.8  | 77.74  | 36.8035.20 | 36 35.0 | 18.00 | 17.30 |
| M48   | 5   | 75.0073.80  | 86.6  | 83.39  | 38.8037.20 | 38 37.0 | 18.00 | 17.30 |
| (M52) | 5   | 80.0078.80  | 92.4  | 89.04  | 42.8041.20 | 42 41.0 | 20.00 | 19.16 |
| M56   | 5.5 | 85.0083.60  | 98.1  | 94.47  | 45.8044.20 | 45 44.0 | —     | —     |
| (M60) | 5.5 | 90.0088.60  | 103.9 | 100.12 | 48.8047.20 | 48 47.0 | —     | —     |
| M64   | 6   | 95.0093.60  | 109.7 | 105.77 | 51.9550.05 | 5149.80 | —     | —     |
| (M68) | 6   | 100.0098.60 | 115.5 | 111.42 | 54.9553.05 | 5452.80 | —     | —     |

NOTE. Sizes shown in brackets are non-preferred.

### BEARING PRESSURES OF MATERIALS

The following may be taken as the average safe pressures that various materials will withstand:

| Description in Bearing                 | Average Safe Pressure |                        |
|--|-----------------------|------------------------|
|  | Tons per sq. ft       | Tonnes/ m <sup>3</sup> |
| Ordinary brick in lime mortar . .      | 2-4 (very variable)   | 3-6-7-2                |
| Ordinary brick in cement mortar . .    | 5                     | 10-8                   |
| Hard brick in cement mortar . .        | 8                     | 14-4                   |
| Blue brick in cement mortar . .        | 12                    | 21-5                   |
| Lime concrete (good) . . . .           | 8                     | 14-4                   |
| Portland cement concrete (1:2 4)       | 12                    | 21-5                   |
| Granolithic bearing blocks . .         | 12                    | 21-5                   |
| Freestone bearing blocks . .           | 12                    | 21-5                   |
| Freestone ashlar masonry in cement . . | 15                    | 26-9                   |
| Granite ashlar masonry in cement . .   | 25                    | 34-1                   |

### SAFE LOADS ON BRICKWORK

No disengaged pier in brick should have a height of more than 6 times its least width without lateral supports. With such proper supports, a pier may have a height between such supports of not more than 12 times its least width, the latter to be not less than one and a half bricks.

Brickwork in English bond is generally accepted as being stronger than Flemish or other bonds.

Three courses of engineering bricks in cement mortar are accepted in lieu of hard stone for padstones.

Reinforcing brickwork with 'Brickforce' or other mesh greatly increases its strength and allows thinner walls. To avoid cracking below window openings in domestic work, the three courses immediately above the dampcourse should be reinforced and cement mortar should always be used. Reinforcing meshes can also be used instead of lintels over small openings and the manufacturers will be glad to supply details on application. Quarter-inch steel rods (generally two are sufficient) can also be used instead of steel mesh for lintels, but the bottom course should always be brick-on-end and stirrups of 1/8 in wire should be inserted in every perpend.

SAFE DISTRIBUTED LOADS P.S.I. ON ORDINARY CARCASSING TIMBERS, 2" WIDE (SOFTWOOD, CLASS "B", STRESSED TO 800 LB PER SQUARE INCH)

| Depth of beam<br>mm | inches | CLEAR SPAN  |             |             |             |             |              |              |
|---------------------|--------|-------------|-------------|-------------|-------------|-------------|--------------|--------------|
|                     |        | 1.5m<br>5ft | 1.8m<br>6ft | 2.1m<br>7ft | 2.4m<br>8ft | 2.7m<br>9ft | 3.0m<br>10ft | 3.6m<br>12ft |
| 75                  | 3      | 320         | —           | —           | —           | —           | —            | —            |
| 100                 | 4      | 569         | 474         | —           | —           | —           | —            | —            |
| 125                 | 5      | 888         | 740         | 635         | 555         | —           | —            | —            |
| 150                 | 6      | 1280        | 1066        | 914         | 800         | 711         | 640          | —            |
| 175                 | 7      | 1742        | 1452        | 1244        | 1089        | 965         | 871          | —            |
| 200                 | 8      | 2275        | 1895        | 1625        | 1420        | 1265        | 1137         | 950          |
| 225                 | 9      | 2880        | 2408        | 2057        | 1800        | 1600        | 1440         | 1200         |

For 1 in timber, divide by 2: for 3 in timber, take 1 1/2 times the above values. For a point load, at midspan, take half the above values.

The formula used in calculating the above table is

$$DB^2 = \frac{3WL}{4f}$$

When B equals breadth, D equals depth, W equals weight in pounds, L equals span and f is a constant, which for class B timber is 800 lb per sq. in. For Class A timber, such as Douglas fir or western hemlock (CLS) f equals 1,000 lb per sq. in.

(Basis for conversion of length of span and depth of beam: 25 mm=1 in).

METRIC VERSION IN KILONEWTONS PER M<sup>2</sup>

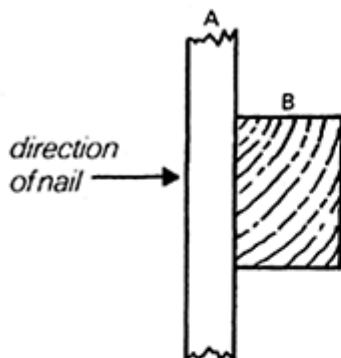
| Beam depth in mm | CLEAR SPAN IN METERS |       |     |     |     |     |     |
|------------------|----------------------|-------|-----|-----|-----|-----|-----|
|                  | 1.5                  | 1.8   | 2.1 | 2.4 | 2.7 | 3.0 | 3.6 |
| 75               | 16.00                | —     | —   | —   | —   | —   | —   |
| 100              | 28.45                | 23.70 | —   | —   | —   | —   | —   |

|     |        |        |        |       |       |       |       |
|-----|--------|--------|--------|-------|-------|-------|-------|
| 125 | 44.40  | 37.00  | 36.75  | 27.70 | —     | —     | —     |
| 150 | 61.60  | 53.30  | 40.70  | 40.00 | 40.00 | 32.00 | —     |
| 175 | 89.10  | 92.60  | 62.20  | 54.50 | 48.20 | 43.80 | —     |
| 200 | 113.75 | 100.00 | 81.21  | 91.00 | 63.20 | 56.80 | 47.50 |
| 225 | 144.00 | 120.40 | 101.30 | 90.00 | 80.00 | 92.00 | 60.00 |

NAIL SIZES FOR DIFFERING THICKNESSES OF TIMBER

| Thickness of Timbers |    | Length of Nail | Gauge of Nail |
|----------------------|----|----------------|---------------|
| A                    | B  |                |               |
| *                    | 3" | 3"             | 16            |
|                      | 1" | 1"             | 14            |





1. Thickness A is the maximum, and thickness B the minimum which can be used if the full strength of the nails is to be developed in a joint.
2. \*These two sizes of nails are only suitable for the structural purpose of fixing thin metal gusset plates (say 20g) to timber.
3. Where a metal component or plate is nailed to a timber member the value of the recommended load may be increased by 25%.
4. Where the minimum penetration (shown in previous table) cannot be obtained, the load per nail should be reduced by the factor:

$$\frac{\text{Actual Penetration}}{\text{Minimum Penetration}}$$

| Thickness of Timbers |                  | Length of Nail   | Gauge of Nail |
|----------------------|------------------|------------------|---------------|
| A                    | B                |                  |               |
| $\frac{1}{8}$ "      | $\frac{3}{8}$ "  | $\frac{3}{4}$ "  | 17            |
|                      | $\frac{7}{8}$ "  | 1"               | 15            |
| $\frac{1}{4}$ "      | $\frac{1}{2}$ "  | $\frac{3}{4}$ "  | 18            |
|                      | $\frac{3}{4}$ "  | 1"               | 16            |
|                      | 1"               | $1\frac{1}{4}$ " | 14            |
|                      | $1\frac{1}{2}$ " | $1\frac{1}{2}$ " | 12            |
| $\frac{3}{8}$ "      | $\frac{7}{8}$ "  | $1\frac{1}{4}$ " | 15            |
|                      | $1\frac{1}{8}$ " | $1\frac{1}{2}$ " | 13            |
| $\frac{1}{2}$ "      | 1"               | $1\frac{1}{2}$ " | 14            |
|                      | $1\frac{1}{4}$ " | $1\frac{1}{2}$ " | 12            |
|                      | $1\frac{1}{2}$ " | 2"               | 10            |
| $\frac{5}{8}$ "      | $1\frac{1}{8}$ " | $1\frac{3}{4}$ " | 13            |
|                      | $1\frac{3}{8}$ " | 2"               | 11            |
| $\frac{3}{4}$ "      | 1"               | $1\frac{3}{4}$ " | 14            |
|                      | $1\frac{1}{4}$ " | 2"               | 12            |
|                      | $1\frac{1}{2}$ " | $2\frac{1}{4}$ " | 10            |
|                      | $1\frac{3}{4}$ " | $2\frac{1}{2}$ " | 9             |
| $\frac{7}{8}$ "      | $1\frac{3}{8}$ " | $2\frac{1}{4}$ " | 11            |
| 1"                   | $1\frac{1}{2}$ " | $2\frac{1}{2}$ " | 10            |
|                      | 2"               | 3"               | 8             |
| $1\frac{1}{8}$ "     | $1\frac{3}{8}$ " | $2\frac{1}{2}$ " | 11            |
| $1\frac{1}{4}$ "     | $1\frac{3}{4}$ " | 3"               | 9             |
|                      | $2\frac{1}{4}$ " | $3\frac{1}{2}$ " | 7             |
| $1\frac{3}{8}$ "     | $2\frac{3}{8}$ " | 4"               | 6             |
| $1\frac{1}{2}$ "     | $1\frac{3}{4}$ " | 3"               | 10            |
|                      | 2"               | $3\frac{1}{2}$ " | 8             |
| $1\frac{3}{4}$ "     | $2\frac{1}{4}$ " | 4"               | 7             |
| $1\frac{7}{8}$ "     | $2\frac{3}{8}$ " | $4\frac{1}{2}$ " | 6             |
| 2"                   | 3"               | 5"               | 5             |
| $2\frac{3}{8}$ "     | $2\frac{3}{8}$ " | 5"               | 6             |
| $2\frac{1}{4}$ "     | $3\frac{1}{4}$ " | 6"               | 4             |

|  | Thickness of Timbers |                   | Length of Nail | Gauge of Nail   |
|--|----------------------|-------------------|----------------|-----------------|
|  | A                    | B                 |                |                 |
|  | 3"                   | 3"                | 6"             | 5               |
|  | 3 $\frac{3}{8}$ "    | 3 $\frac{3}{8}$ " | 7"             | 3               |
|  | 3 $\frac{3}{8}$ "    | 4 $\frac{3}{8}$ " | 8"             | $\frac{5}{8}$   |
|  | 4 $\frac{3}{8}$ "    | 4 $\frac{3}{8}$ " | 9"             | $\frac{5}{8}$   |
|  | 4 $\frac{3}{8}$ "    | 5 $\frac{1}{2}$ " | 10"            | $\frac{3}{8}$ " |

(By courtesy of the Timber Research and Development Association)

THE SPACING OF NAILS IN NAILED JOINTS In Softwood

| Gauge of Nails | Minimum Penetration | End Distance      |                   | Edge Distance     |                   | Spacing across the grain |                   | Spacing between Nails along the grain |           | Permissible Lateral Load per Nail (lb) |        | Permissible With drawal Load (lb) per inch of penetration |        |
|----------------|---------------------|-------------------|-------------------|-------------------|-------------------|--------------------------|-------------------|---------------------------------------|-----------|--|--------|---|--------|
|                |                     | (1)               | (2)               | (3)               | (4)               | (5)                      | (6)               | (7)                                   | (8)       | (9)                                    | (10)   | (11)  | (12)   |
|                |                     | Un-bored          | Pre-bored         | Un-bored          | Pre-bored         | Un-bored                 | Pre-bored         | Un-bored                              | Pre-bored | Group*                                 | Group* | Group*  | Group* |
| 18             | 1"                  | 1"                | 1"                | 1"                | 1"                | 1"                       | 1"                | 1"                                    | 17        | 14                                     | 12     | 7   |        |
| 17             | 1 $\frac{1}{8}$ "   | 1 $\frac{1}{8}$ " | 1 $\frac{1}{8}$ " | 1 $\frac{1}{8}$ " | 1 $\frac{1}{8}$ " | 1 $\frac{1}{8}$ "        | 1 $\frac{1}{8}$ " | 1 $\frac{1}{8}$ "                     | 22        | 18                                     | 14     | 8   |        |
| 16             | 1 $\frac{1}{4}$ "   | 1 $\frac{1}{4}$ " | 1 $\frac{1}{4}$ " | 1 $\frac{1}{4}$ " | 1 $\frac{1}{4}$ " | 1 $\frac{1}{4}$ "        | 1 $\frac{1}{4}$ " | 1 $\frac{1}{4}$ "                     | 27        | 22                                     | 16     | 9   |        |
| 15             | 1 $\frac{1}{2}$ "   | 1 $\frac{1}{2}$ " | 1 $\frac{1}{2}$ " | 1 $\frac{1}{2}$ " | 1 $\frac{1}{2}$ " | 1 $\frac{1}{2}$ "        | 1 $\frac{1}{2}$ " | 1 $\frac{1}{2}$ "                     | 32        | 26                                     | 18     | 10  |        |
| 13             | 1 $\frac{3}{4}$ "   | 1 $\frac{3}{4}$ " | 1 $\frac{3}{4}$ " | 1 $\frac{3}{4}$ " | 1 $\frac{3}{4}$ " | 1 $\frac{3}{4}$ "        | 1 $\frac{3}{4}$ " | 1 $\frac{3}{4}$ "                     | 37        | 31                                     | 19     | 11  |        |
| 12             | 2"                  | 2"                | 2"                | 2"                | 2"                | 2"                       | 2"                | 2"                                    | 46        | 38                                     | 22     | 13  |        |
| 11             | 2 $\frac{1}{8}$ "   | 2 $\frac{1}{8}$ " | 2 $\frac{1}{8}$ " | 2 $\frac{1}{8}$ " | 2 $\frac{1}{8}$ " | 2 $\frac{1}{8}$ "        | 2 $\frac{1}{8}$ " | 2 $\frac{1}{8}$ "                     | 55        | 45                                     | 25     | 15  |        |
| 10             | 2 $\frac{1}{4}$ "   | 2 $\frac{1}{4}$ " | 2 $\frac{1}{4}$ " | 2 $\frac{1}{4}$ " | 2 $\frac{1}{4}$ " | 2 $\frac{1}{4}$ "        | 2 $\frac{1}{4}$ " | 2 $\frac{1}{4}$ "                     | 65        | 53                                     | 28     | 16  |        |
| 9              | 2 $\frac{1}{2}$ "   | 2 $\frac{1}{2}$ " | 2 $\frac{1}{2}$ " | 2 $\frac{1}{2}$ " | 2 $\frac{1}{2}$ " | 2 $\frac{1}{2}$ "        | 2 $\frac{1}{2}$ " | 2 $\frac{1}{2}$ "                     | 76        | 62                                     | 31     | 18  |        |
| 8              | 3"                  | 3"                | 3"                | 3"                | 3"                | 3"                       | 3"                | 3"                                    | 90        | 74                                     | 35     | 20  |        |
| 7              | 3 $\frac{1}{8}$ "   | 3 $\frac{1}{8}$ " | 3 $\frac{1}{8}$ " | 3 $\frac{1}{8}$ " | 3 $\frac{1}{8}$ " | 3 $\frac{1}{8}$ "        | 3 $\frac{1}{8}$ " | 3 $\frac{1}{8}$ "                     | 106       | 86                                     | 39     | 22  |        |
| 6              | 3 $\frac{1}{4}$ "   | 3 $\frac{1}{4}$ " | 3 $\frac{1}{4}$ " | 3 $\frac{1}{4}$ " | 3 $\frac{1}{4}$ " | 3 $\frac{1}{4}$ "        | 3 $\frac{1}{4}$ " | 3 $\frac{1}{4}$ "                     | 122       | 100                                    | 43     | 25  |        |
| 5              | 3 $\frac{1}{2}$ "   | 3 $\frac{1}{2}$ " | 3 $\frac{1}{2}$ " | 3 $\frac{1}{2}$ " | 3 $\frac{1}{2}$ " | 3 $\frac{1}{2}$ "        | 3 $\frac{1}{2}$ " | 3 $\frac{1}{2}$ "                     | 139       | 114                                    | 47     | 27  |        |
| 4              | 4"                  | 4"                | 4"                | 4"                | 4"                | 4"                       | 4"                | 4"                                    | 161       | 132                                    | 52     | 30  |        |
| 3              | 4 $\frac{1}{8}$ "   | 4 $\frac{1}{8}$ " | 4 $\frac{1}{8}$ " | 4 $\frac{1}{8}$ " | 4 $\frac{1}{8}$ " | 4 $\frac{1}{8}$ "        | 4 $\frac{1}{8}$ " | 4 $\frac{1}{8}$ "                     | 184       | 151                                    | 57     | 32  |        |
| 2              | 4 $\frac{1}{4}$ "   | 4 $\frac{1}{4}$ " | 4 $\frac{1}{4}$ " | 4 $\frac{1}{4}$ " | 4 $\frac{1}{4}$ " | 4 $\frac{1}{4}$ "        | 4 $\frac{1}{4}$ " | 4 $\frac{1}{4}$ "                     | 209       | 171                                    | 61     | 35  |        |
| 1              | 4 $\frac{1}{2}$ "   | 4 $\frac{1}{2}$ " | 4 $\frac{1}{2}$ " | 4 $\frac{1}{2}$ " | 4 $\frac{1}{2}$ " | 4 $\frac{1}{2}$ "        | 4 $\frac{1}{2}$ " | 4 $\frac{1}{2}$ "                     | 288       | 236                                    | 76     | 44  |        |
| 1              | 5"                  | 5"                | 5"                | 5"                | 5"                | 5"                       | 5"                | 5"                                    | 379       | 319                                    | 91     | 52  |        |

\*Note—Group 1—Douglas fir. Group 2—All other softwoods.  
(By courtesy of the Timber Research and Development Association)

## NAILING TIMBERS

The following points should be taken into consideration:

1. The holding power of nails, as thus calculated, depends on the density and dryness of the wood. A timber that has, for its species, large rings of summer growth, and is in consequence “open” in grain and light in weight, will not hold nails as tightly as a good average specimen on the behaviour of which the tables are based. Wet unseasoned timber, as it dries out, will tend to warp and shrink and will thereby reduce the strength of nailed joints by three-fourths when straight withdrawal from side grain is involved and by one-third where lateral resistance is concerned.
2. Joints involving lateral resistance of nails in end grain have 25 % less strength than the values given in the table on page 154.
3. Joints should never be so designed that they involve the straight withdrawal of nails from end grain.
4. For calculating the resistance to lateral stresses or to withdrawal, only the length of the nail imbedded in the larger timber should be taken into account (see diagram).
5. For nails that pass completely through both timbers, and are clenched, 25% should be added to the permissible lateral load, when the nails are driven without boring. If driven through bored holes, clinching gives no added strength.

The above tables and formulae are for two pieces of wood connected together, with nails not clenched. If three pieces are connected together with nails that are clenched with the ends lying across the grain, research has shown that the joint is increased by about 50%, if the nails are not driven through bored holes. If driven through bored holes, only a 10% increase is given. Generally, if nails are driven into pre-bored timber, joints are stronger by about 14%.

From the values given in the tables, it will be seen, that nailed joints are most suitable for light loads—which, however, include the normal loads on structures designed as domestic dwellings. Moreover light loads do not always mean small structures: the Belfast truss, made entirely from thin boards, is well known, and can be made for large spans.

## TIMBER CONNECTORS

Timber connectors are really stress plates, which spread the load on a joint over a greater area of the timbers connected than does a bolt. Approximately 80% of the strength of the timber can thus be utilised, whereas with plain bolted joints, the efficiency may be as low as 15%. The safe loads in the tables below can be compared with those for the lateral withdrawal of nails in a foregoing table, when it will be seen how many nails will be needed to provide a joint as strong as one made with a bolt and a timber connector. These connectors are coming more and more into use in structural work. Washers larger than the commercial size should be used: 1 1/2in square washers for 2in connectors, 2in for 2

1/2in connectors, and 2 1/2in for 3in connectors, placed under both bolt head and nut.

B.S. 1579 gives dimensions and sizes of heavy pressed steel and malleable cast-iron connectors, in addition to light round and square toothed connectors. The table below applies to a light, round, toothed connector. Heavy pressed and cast-iron connectors are used only in structures incorporating very heavy timbers. For design data, see CP 112.

ALLOWABLE LOADS FOR ONE "BULLDOG" CONNECTOR UNIT

| Dia of connector    | Thickness of member             |  | Load parallel to grain (lbs)                |          | Load perpendicular to grain (lbs) |          |
|---------------------|---------------------------------|--|---|----------|-----------------------------------|----------|
|                     | Connector on one side of member | Connector on both sides of member (on same bolt) | Group I                                     | Group II | Group I                           | Group II |
| 2"                  | 3/4"                            | 1 1/2"   | 1,150                                       | 830      | 880                               | 640      |
|                     | 1"                              | 2"   | 1,225                                       | 905      | 925                               | 670      |
|                     | 1 1/2"                          | 3"   | 1,280                                       | 1,010    | 1,065                             | 750      |
|                     | 2" and over                     | 4" and over                                      | 1,280                                       | 1,010    | 1,135                             | 820      |
| 2 1/2"              | 1"                              | 2"   | 1,385                                       | 1,035    | 1,085                             | 800      |
|                     | 1 1/2"                          | 3"   | 1,440                                       | 1,140    | 1,225                             | 880      |
|                     | 2" and over                     | 4" and over                                      | 1,440                                       | 1,140    | 1,295                             | 950      |
| 3"                  | 1"                              | 2"   | 1,550                                       | 1,165    | 1,250                             | 930      |
|                     | 1 1/2"                          | 3"   | 1,605                                       | 1,270    | 1,390                             | 1,010    |
|                     | 2" and over                     | 4" and over                                      | 1,605                                       | 1,270    | 1,460                             | 1,080    |
| 1 1/2"              | —                               | —  | Test results not yet available on this size |          |                                   |          |
| 3 3/4" single sided | 1"                              | 2"   | 2,365                                       | 1,775    | 1,885                             | 1,415    |
|                     | 1 1/2"                          | 3"   | 2,450                                       | 1,935    | 2,095                             | 1,535    |
|                     | 2" and over                     | 4" and over                                      | 2,450                                       | 1,935    | 2,205                             | 1,650    |

METRIC VERSION—LOAD IN KILOGRAMS

| Depth of beam (mm) | Connector on one side of member | Connector on both sides of member (on same bolt) | Group I |     | Group II |     |
|--------------------|---------------------------------|--|---------|-----|----------|-----|
|                    |                                 |  | I       | II  | I        | II  |
| 50                 | 19                              |  | 38      | 679 | 377      | 398 |
|                    | 25                              |  | 50      | 544 | 411      | 419 |
|                    | 38                              |  | 76      | 579 | 579      | 458 |
|                    | 50                              |  | 101     | 579 | 579      | 573 |

|    |    |     |       |     |     |     |
|----|----|-----|-------|-----|-----|-----|
| 62 | 25 | 50  | 627   | 468 | 544 | 363 |
|    | 38 | 76  | 652   | 473 | 866 | 369 |
|    | 50 | 101 | 652   | 473 | 583 | 431 |
| 75 | 25 | 50  | 701   | 468 | 525 | 422 |
|    | 38 | 76  | 726   | 527 | 633 | 457 |
|    | 50 | 101 | 726   | 527 | 651 | 489 |
| 81 | 25 | 50  | 1,061 | 793 | 563 | 422 |
|    | 38 | 76  | 1,149 | 877 | 947 | 699 |
|    | 50 | 101 | 1,149 | 877 | 998 | 747 |

### MINIMUM TIMBER DIMENSIONS FOR "BULLDOG" TIMBER CONNECTORS

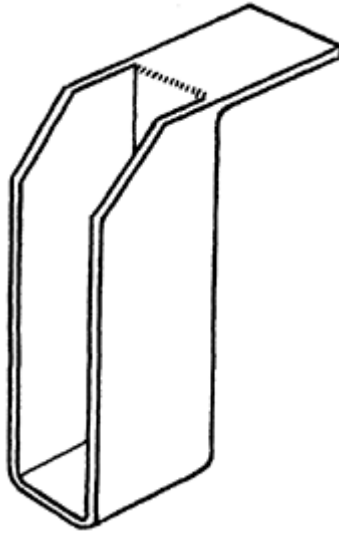
| Diameter of connector                                      | 1½      | 2       | 2½      | 3       | 3½       | inches |
|--|---------|---------|---------|---------|----------|--------|
|  | 38      | 50      | 68      | 75      | 94       | mm     |
| Minimum nominal size of member for connector on one side   | ¾ × 2   | ¾ × 2½  | ¾ × 3   | 1 × 3½  | 1 × 4½   | inches |
|  | 19 × 50 | 19 × 68 | 22 × 75 | 25 × 94 | 25 × 113 | mm     |
| Minimum nominal size of member for connector on both sides | 1½ × 2  | 1½ × 2½ | 1½ × 3  | 2 × 3½  | 2 × 4½   | inches |
|  | 35 × 50 | 38 × 68 | 44 × 75 | 50 × 94 | 50 × 113 | mm     |

(Basis for conversion : 25mm equals 1 in)

### JOIST HANGERS

The illustration shows a type of joist hanger that can be built into walls instead of leaving pockets or, in alteration work, cutting out pockets to take joists. There is also a modification that can be hung over rolled steel or timber or concrete beams, and which provides a simple method of inserting floors or platforms in existing framed structures. The sizes available are shown in the table overleaf:

|       | Breadth of joist |                    | Depth of joist        |    |
|-------|------------------|--------------------|-----------------------|----|
|       | in               | mm                 | in                    | mm |
| 1     | 25               | 7, 8               | 175–200               |    |
| 1 1/2 | 38               | 3–8 in 1 in steps  | 75–200 in 25 mm steps |    |
| 2     | 50               | 3–11               | 75–275                |    |
| 2 1/2 | 63               | 4–10               | 100–250               |    |
| 3     | 75               | 3–12               | 75–300                |    |
| 3 1/2 | 88               | 7, 9               | 175, 225              |    |
| 4     | 100              | 4–12 in 1 in steps | 100–300 in 25mm steps |    |
| 4 1/2 | 113              | 7                  | 175                   |    |
| 5     | 125              | 12                 | 300                   |    |



**FRAMING ANCHORS**

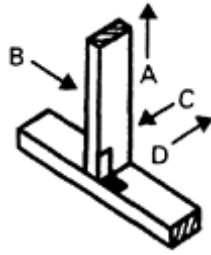
Framing anchors, long employed in the USA, are steel plates and angles that can be employed, with special nails, instead of framing joints in carpentry, and in place of the skew-nailed and other nailed joints that are so often used instead of true carpentry joints, such as the mortise and tenon in its many varieties. They have the advantage that, after many laboratory tests, the safe working loads of these anchors are known with tolerable certainty.

Design loads for many possible applications may be determined from the following data. The recommendations are for use with softwood comparable to Douglas Fir. In general, when two or more anchors are used in combination, the allowable load will be the sum of the individual loads.

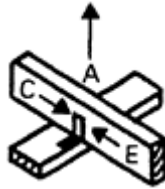
**RECOMMENDED SAFE WORKING VALUES**

|   | Timber Group | Load Direction (Figs. 1-3)           |              |              |    |    |    |    |    |    |    |    |    |
|---|--------------|--------------------------------------|--------------|--------------|----|----|----|----|----|----|----|----|----|
|   |              | lb                                   | kg           | lb           | kg | lb | kg | lb | kg | lb | kg | lb | kg |
|   |              | A                                    | B            | C            | D  | E  | F  |    |    |    |    |    |    |
| Dead load plus superimposed load                          | 1            | 30013553023929013120090              | 300135450203 |              |    |    |    |    |    |    |    |    |    |
| Dead load plus superimposed load plus snow plus wind load | 2            | 24010942419218483                    | 16072        | 240109360163 |    |    |    |    |    |    |    |    |    |
|   | 1            | 450203825373420191300135450203675305 |              |              |    |    |    |    |    |    |    |    |    |
|   | 2            | 360163660300266119240303360163540144 |              |              |    |    |    |    |    |    |    |    |    |

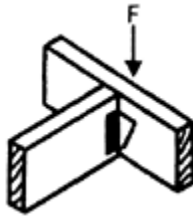
*(By courtesy of Messrs. Macandrews & Forbes, Ltd.)*



*Fig. 1*



*Fig. 2*



*Fig. 3*

### CONCRETE LINTELS

A large range of concrete lintels for 4 1/2in walls, to span openings for standard windows and doors, is given in B.S. 1239, from which the table below is abstracted.

Precast lintels to B.S. 1239, and pre-stressed concrete-cum-hollow brick lintels, of not more than 3in depth for moderate openings, can be purchased from concrete products manufacturers.

( $4\frac{1}{2}$ in=113mm  $3$ in=76mm)

LINTELS: DETAILS OF SIZES, ETC.

| Clear span<br>meters—feet | Depth<br>inches—mm | Reinforcing bars: |                          |
|---------------------------|--------------------|-------------------|--------------------------|
|                           |                    | Number            | size                     |
| 0.696—2                   | $5\frac{3}{8}$     | 1                 | $\frac{5}{8}$ in 0.312mm |
| 0.914—3                   | $5\frac{3}{8}$     |                   |                          |
| 1.219—4                   | $8\frac{3}{8}$     | 2                 | $\frac{1}{2}$ in 0.250mm |
| 1.524—5                   | $8\frac{3}{8}$     |                   |                          |
| 1.828—6                   | $11\frac{3}{8}$    | 2                 | $\frac{5}{8}$ in 0.312mm |
| 2.438—8                   | $11\frac{3}{8}$    |                   |                          |

Reinforcement to have 1in of cover. Top or handling steel (three  $\frac{1}{2}$ in bars) required in 8ft spans.

(in=25mm 8ft=2.44m)



# 6.

## THE EXCAVATOR

### CODES OF PRACTICE

#### **CP 101:1972:** Foundations and Substructures

Concrete in good ground is not to be leaner than 1–4–8 or 1–8 ‘all-in’ ballast. In weak ground, where mass concrete footings are stressed in bending as well as in compression, concrete mix is not to be leaner than 1–3–6 or 1–6 ‘all-in’ ballast. Excavation and filling should be done as soon as possible after clearing site. Filling should be placed in layers not more than 6 in/150 mm deep. Excavations to be cleared of water before placing concrete. In soils affected by exposure to the atmosphere, place 3 in/75 mm thickness of ‘blinding’ concrete immediately after excavation. For reinforced concrete foundations, place 3 in/75 mm of ‘blinding’ concrete before placing the foundation proper. Remove datum pegs and fill holes with concrete. Depth of foundations and type depend on type of soil and load to be taken. In some clays, known as ‘shrinkable clays’, footings must be at least 3 ft/900 mm below ground.

For further information consult CP 101.

### GOOD PRACTICE GUIDE

#### ***Strip Foundations***

*If the foundations of a building are constructed as strip foundations of plain concrete situated centrally under the walls, good practice will be satisfied if-*

- (a) there is no made ground or wide variation in the type of subsoil within the loaded area and no weaker type of soil exists below the soil on which the foundations rest within such a depth as may impair the stability of the structure;*
- (b) the width of the foundations is not less than the width specified in the Table to this regulation in accordance with the related particulars specified in the Table;*
- (c) the concrete is composed of cement and fine and coarse aggregate conforming to BS882: Part 2:1973 in the proportion of 50 kg of cement to not more than 0.1 m<sup>3</sup> of fine aggregate and 0.2 m<sup>3</sup> of coarse aggregate;*
- (d) the thickness of the concrete is not less than its projection from the base of the wall or footing and is in no case less than 150 mm;*
- (e) where the foundations are laid at more than one level, at each change of level the higher foundations extend over and unite with the lower foundations for a distance of not less than the thickness of the foundations and in no case less than 300 mm; and*
- (f) where there is a pier, buttress or chimney forming part of a wall, the foundations*

*project beyond the pier, buttress or chimney on all sides to at least the same extent as they project beyond the wall.*

**Table: Minimum width of strip foundations**

| Type of subsoil | Condition of subsoil                                 | Field test applicable  | Minimum width in millimetres for total load in kilonewtons per lineal metre of loadbearing walling of not more than- |               |               |               |               |               |
|-----------------|--|--|--|---------------|---------------|---------------|---------------|---------------|
| (1)             | (2)  | (3)  | 20kN/m<br>(4)  | 30kN/m<br>(5) | 40kN/m<br>(6) | 50kN/m<br>(7) | 60kN/m<br>(8) | 70kN/m<br>(9) |
| <b>I</b>        |  |  |  |               |               |               |               |               |
| Rock            | Not inferior to sandstone or limestone or firm chalk | Requires at least a pneumatic or other mechanically operated pick for excavation   | In each case equal to the width of wall  |               |               |               |               |               |
| <b>II</b>       |  |  |  |               |               |               |               |               |
| Gravel Sand     | Compact Compact                                      | Requires pick for excavation. Wooden peg 50 mm square in cross-section hard to drive beyond 150mm                        | 250  | 300           | 400           | 500           | 600           | 650           |
| <b>III</b>      |  |  |  |               |               |               |               |               |
| Clay Sandy clay | Stiff Stiff  | Cannot be moulded with the fingers and requires a pick or pneumatic or other mechanically operated spade for its removal | 250  | 300           | 400           | 500           | 600           | 650           |
| <b>IV</b>       |  |  |  |               |               |               |               |               |
| Clay            | Firm   | Can be   | 300  | 350           | 450           | 600           | 750           | 850           |

Sandy Firm  
clay moulded by  
substantial  
pressure with  
the fingers  
and can be  
excavated  
with graft or  
spade

V

|             |       |  |     |     |  |
|-------------|-------|--|-----|-----|--|
| Sand        | Loose | Can be excavated with a spade. Wooden peg 50 mm square in cross-section can be easily driven | 400 | 600 | Note: Foundations do not fall within the provisions of regulation D7 if the total load exceeds 30 kN/m |
| Silty sand  | Loose |  |     |     |  |
| Clayey sand | Loose |  |     |     |  |
|             |       |  |     |     |  |

**Minimum width of strip foundations**

| Type of subsoil | Condition of subsoil | Field test applicable | Minimum width in millimetres for total load in kilonewtons per lineal metre of loadbearing walling of not more than— |            |            |            |            |            |
|-----------------|----------------------|-----------------------|--|------------|------------|------------|------------|------------|
| (1)             | (2)                  | (3)                   | 20kN/m (4)   | 30kN/m (5) | 40kN/m (6) | 50kN/m (7) | 60kN/m (8) | 70kN/m (9) |

VI

|            |      |  |     |     |   |  |  |  |
|------------|------|--|-----|-----|---|--|--|--|
| Silt       | Soft | Fairly easily moulded in the fingers and readily excavated | 450 | 650 | Note: In relation to types VI and VII, foundations do not fall within the provisions of regulation D7 if the total load exceeds 30 kN/m |  |  |  |
| Clay       | Soft |  |     |     |   |  |  |  |
| Sandy clay | Soft |  |     |     |   |  |  |  |
| Silty clay | Soft |  |     |     |   |  |  |  |

VII

|            |           |  |     |     |
|------------|-----------|--|-----|-----|
| Silt       | Very soft | Natural sample in winter conditions exudes between fingers when squeezed in fist | 600 | 850 |
| Clay       | Very soft |  |     |     |
| Sandy clay | Very soft |  |     |     |
| Silty clay | Very soft |  |     |     |

**EXCAVATING DATA**

**TRANSPORT CAPACITIES**

| Type of Vehicle                         | cu. yds solid | m <sup>3</sup> solid |
|---|---------------|----------------------|
| Wheelbarrow                             | 0.10          | 0.08                 |
| 2 ton (2.03 t) lorry                    | 1.50          | 1.15                 |
| 3 ton (3.05 t) lorry                    | 2.25          | 1.72                 |
| 4 ton (4.06 t) lorry                    | 2.90          | 2.22                 |
| 5 ton (5.08 t) lorry                    | 3.50          | 2.68                 |
| 6 ton (6.10 t) lorry                    | 4.50          | 3.44                 |
| 2 cu. yd (1.53 m <sup>3</sup> ) dumper  | 1.50          | 1.15                 |
| 3 cu. yd (2.29 m <sup>3</sup> ) dumper  | 2.25          | 1.72                 |
| 6 cu. yd (4.59 m <sup>3</sup> ) dumper  | 4.50          | 3.44                 |
| 10 cu. yd (7.65 m <sup>3</sup> ) dumper | 7.50          | 5.73                 |

**INCREASE IN BULK AFTER EXCAVATION**

| 1 cu. ft or<br>1 cu. yd or<br>1 m <sup>3</sup> | becomes after excavation | cu. ft,<br>cu. yds or<br>m <sup>3</sup> |
|--|--------------------------|---|
| Chalk  | "                        | 1.6                                     |
| Clay   | "                        | 1.2                                     |
| Clay (stiff)                                   | "                        | 1.5                                     |
| Earth (ordinary)                               | "                        | 1.25                                    |
| Gravel   | "                        | 1.1                                     |
| Rock   | "                        | 1.5                                     |
| Sand   | "                        | 1.05                                    |

**PLANKING AND STRUTTING**

**AVERAGE DEPTHS OF EXCAVATIONS OF VARIOUS SOILS WITHOUT USE OF TIMBERING**

| Type of Soil    | Feet | Metres |
|-----------------|------|--------|
| Clay, stiff     | 10   | 3.05   |
| Earth, ordinary | 3    | 0.91   |
| Gravel          | 2    | 0.61   |
| Loam, drained   | 6    | 1.83   |
| Sand, dry       | 1    | 0.30   |
| Soil, compact   | 12   | 3.66   |

*Note:* Each case must be taken on its merits, and, as the limiting distances given above are approached, careful watch must be kept for the slightest signs of caving-in.

| TIMBER REQUIRED FOR VARIOUS TYPES OF PLANKING AND STRUTTING SITUATION |               |         |             |          |             |             |
|---|---------------|---------|-------------|----------|-------------|-------------|
|   | Poling boards | Walings | Struts      | Uprights | Shores      | Sole plates |
| <b>TRENCHES</b>   |               |         |             |          |             |             |
| inches  | 1½×7          | 2×6     | 4×4         | —        | —           | —           |
| mm  | 38×175        | 50×150  | 100×100     | —        | —           | —           |
| <b>BASEMENTS</b>  |               |         |             |          |             |             |
| inches  | 9½×1½         | 6×8     | 9×1½        | 9×6      | 9×9         | 11×3        |
| mm  | 232×38        | 150×200 | 225×38      | 225×150  | 225×225     | 275×75      |
| <b>PIER HOLES</b>   |               |         |             |          |             |             |
|   | Poling boards | Walings | Angle posts | Hangers  | Cross beams | —           |
| inches  | 9×1½          | 4×4     | 4×4         | 9×3      | 11×9        | —           |
| mm  | 225×38        | 100×100 | 100×100     | 225×75   | 275×225     | —           |

*Note 1:* The timber sizes given for poling boards for trenches are for open or close poling boards. Basements and pier holes require close poling boards. (Conversion factor: 25 mm equals 1 in.)

*Note 2:* 14 g corrugated steel sheets may be used for poling boards and telescopic (screw) struts for struts, in trenches.

## EMBANKMENTS

### SAFE HEIGHTS OF EMBANKMENTS

| Type of Soil   | Height in Feet | Metres    |
|--|----------------|-----------|
| Compact gravel or sand   | 120–100        | 36.5–30.5 |
| Loamy sand   | 70–55          | 21.3–16.7 |
| Damp clay  | 30–25          | 9.1–7.6   |
| Sandy clays and clay loams   | 30–15          | 9.1–4.5   |
| Clay soil of river beds  | 20–6           | 6.0–1.8   |
| Peat moss, marsh earth, consolidated mud and silt, soft pasty clay or marsh clay | 7–0            | 2.1–0.0   |

### SAFE SLOPES OF EARTH IN EMBANKMENTS

The Usual slopes for cuttings and embankments range from 1 to 1 for firm earth, to 4 to 1. The most frequent is from 1 to 1 up to 1 1/2 to 1 for firm earth in cuttings, and 1 1/2 to 1 in embankments. Clays, from 3 to 1 for solid blue clays, to 12 to 1 for soft, mushy

clays. Chalk in cuttings may be from nearly vertical to 1/2 to 1, but 1 to 1 in embankments. In the ratios given above, the first figure is the length of the base and the second the vertical height, which is always 1.

### BEARING CAPACITIES OF FOUNDATIONS

A table of typical bearing capacities; from British Standard Code of Practice **CP 101:172**: Foundations and substructures.

#### TABLE 1. TYPICAL BEARING CAPACITIES

NOTE. Due care should be paid to ensuring an adequate depth of the given soil, and in certain cases, in order to limit the amount of settlement, consideration may have to be given to restricting the allowable bearing pressure to a lower value than the bearing capacity.

*Sand and gravel.* Table 1 assumes that the width of the foundation is of the order of 1 m. For narrower foundations on sand and gravel, the permissible bearing capacity decreases as the width decreases. In such cases the permissible bearing capacity should be the value given in Table 1 multiplied by the width of the foundation in metres. In such soils the permissible bearing capacity can be increased by 12.5 kN/m<sup>2</sup> for every 0.3 m depth of the loaded area below the lowest ground surface immediately adjacent. If the ground water-level in sand or gravel is likely to be at a depth of less than the foundation width below the base of the foundation, then the submerged value given in Table 1 should be used.

*Clay soils.* For the types of building considered in this code, the width and depth of the foundations do not have an appreciable influence on the permissible bearing capacity on clay soils. If a clay is examined under dry summer conditions the probable deterioration under winter conditions should be borne in mind. Mud stones and clay shales may deteriorate very rapidly if exposed to the weather or to ground water.

| Group | Types of rocks and soils                          | Bearing capacity kN/m <sup>2</sup> | Remarks  |
|-------|---|------------------------------------|--|
| I     | 1 Igneous and gneissic rocks in sound condition   | 10000                              | These values are based on the assumption that the foundations are carried down to unweathered rock |
| Rocks | 2 Massively-bedded limestones and hard sandstones | 4000                               |  |
|       | 3 Schists and slates                              | 3000                               |  |
|       | 4 Hard shales, mud-stones and soft sandstones     | 2000                               |  |

|   |   |   |      |                                 |
|---|---|---|------|---------------------------------|
| 5 | Clay shales                                   | } | 1000 | To be assessed after inspection |
| 6 | Hard solid chalk                              |   | 600  |                                 |
| 7 | Thinly-bedded limestones and sandstones       |   |      |                                 |
| 8 | Heavily-shattered rocks and the softer chalks |   |      |                                 |

| Group                        | Types of rocks and soils                               | Bearing capacity kN/m <sup>2</sup> |            | Remarks  |
|------------------------------|--|------------------------------------|------------|--|
|                              |  | Dry                                | Submerged  |  |
| II<br><br>Non-cohesive soils | 9 Compact gravel or compact sand and gravel            | > 600                              | > 300      | Width of foundation not less than 1 m. Ground water level assumed to be a depth not less than the width of foundation below the base of the foundation |
|                              | 10 Medium dense gravel or medium dense gravel and sand | 200 to 600                         | 100 to 300 |  |
|                              | 11 Loose gravel or loose sand and gravel               | < 200                              | < 100      |  |
|                              | 12 Compact sand  | > 300                              | > 150      |  |
|                              | 13 Medium dense sand                                   | 100 to 300                         | 50 to 150  |  |
|                              | 14 Loose sand  | < 100                              | < 50       |  |
| III                          | 15 Very stiff boulder clays and hard clays             | 300 to 600                         |            | This group is susceptible to long-term consolidation settlement  |
|                              | 16 Stiff clays   | 150 to 300                         |            |  |
|                              | 17 Firm clays  | 75 to 150                          |            |  |
|                              | 18 Soft clays and silts                                | 75                                 |            |  |
|                              | 19 Very soft clays and silts                           | < 75                               |            |  |
| IV                           | 20 Peat  |                                    |            | Foundations should be carried down through peat and organic soil to a reliable bearing stratum below   |
| V                            | 21 'Made' ground                                       |                                    |            | It should be investigated with   |

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extreme care

*Mixed soils.* Soils intermediate between the main types given in Table 1 may need to be assessed by test.

*Peat and 'made' ground.* If the bedding slopes appreciably, special measures may be necessary for these soils (see also 3.7.3 and 3.7.4).



## HARDCORE AND PITCHING

### APPROXIMATE COVERING CAPACITIES

| Consolidated thickness laid in inches | Yards super to one ton covered  |                              |   |               |              |           |       |       |
|---------------------------------------|---------------------------------|------------------------------|---|---------------|--------------|-----------|-------|-------|
|                                       | Stone Pitching (roughly thrown) | Stone Pitching (hand packed) | Hardcore rubbish (brick, concrete or stone) | Clinker Ashes | Broken Stone | Whinstone | Slag  | Shale |
| 1                                     | —                               | —                            | —   | 33            | 28           | 24        | 32    | 24    |
| 2                                     | —                               | —                            | —   | 16½           | 14           | 12        | 16    | 12    |
| 3                                     | —                               | —                            | 10  | 11            | 9            | 8         | 10½   | 8     |
| 4                                     | —                               | —                            | 7½  | 8½            | 7            | 6         | 8     | 6     |
| 5                                     | —                               | —                            | 6   | 6½            | 5½           | 5         | 6½    | 5     |
| 6                                     | 4½                              | 4                            | 5   | 5½            | 4½           | 4         | 5½    | 4     |
| 7                                     | 3¾                              | 3½                           | 4½  | —             | —            | —         | —     | —     |
| 8                                     | 3¼                              | 3                            | 3¾  | —             | —            | —         | —     | —     |
| 9                                     | 2¾                              | 2½                           | 3½  | —             | —            | —         | —     | —     |
| 10                                    | 2½                              | 2¼                           | 3   | —             | —            | —         | —     | —     |
| Basis in tons per cu. yd consolidated | 1.4                             | 1.45                         | 1.2   | 1.09          | 1.28         | 1.5       | 1.125 | 1.5   |

### METRES SQUARE PER METRIC TONNE COVERED

| in | mm  | Stone Pitching (roughly thrown) | Stone Pitching (hand packed) | Hardcore rubbish (brick concrete or stone) | Clinker Ashes | Broken Stone | Whinstone | Slag | Shale |
|----|-----|---------------------------------|------------------------------|--|---------------|--------------|-----------|------|-------|
| 1  | 25  | —                               | —                            | —  | 27.5          | 23.4         | 20.0      | 26.7 | 20.0  |
| 2  | 50  | —                               | —                            | —  | 13.7          | 11.7         | 10.0      | 13.3 | 10.0  |
| 3  | 75  | —                               | —                            | 8.3  | 9.2           | 7.5          | 6.6       | 8.7  | 6.6   |
| 4  | 100 | —                               | —                            | 6.2  | 6.8           | 5.8          | 5.2       | 6.6  | 5.2   |
| 5  | 125 | —                               | —                            | 5.0  | 5.4           | 4.5          | 4.1       | 5.2  | 4.1   |
| 6  | 150 | 3.5                             | 3.3                          | 4.1  | 4.5           | 4.3          | 3.3       | 4.3  | 3.3   |
| 7  | 175 | 2.8                             | 2.9                          | 3.7  | —             | —            | —         | —    | —     |
| 8  | 200 | 2.7                             | 2.5                          | 3.1  | —             | —            | —         | —    | —     |
| 9  | 225 | 2.4                             | 2.3                          | 2.9  | —             | —            | —         | —    | —     |
| 10 | 250 | 1.8                             | 1.8                          | 2.7  | —             | —            | —         | —    | —     |

(Based on 25 mm equals 1 inch, 1 ton equals 1 tonne)

**APPROXIMATE WEIGHTS OF SOILS AND ROCKS**

| Material  | Weight         |                       |
|-----------|----------------|-----------------------|
|           | cwt per cu. yd | kg per m <sup>3</sup> |
| Chalk     | 36             | 1400                  |
| Clay      | 31             | 1200                  |
| Granite   | 42             | 1600                  |
| Gravel    | 30             | 1150                  |
| Marl      | 26             | 1000                  |
| Mud       | 25             | 950                   |
| Quartz    | 41             | 550                   |
| Sand      | 30             | 150                   |
| Sandstone | 39             | 500                   |
| Shale     | 40             | 535                   |
| Slate     | 43             | 650                   |
| Trap      | 42             | 600                   |

*Note:* 1,000 kilograms equals 1 tonne.

**TRENCH EXCAVATION**

For estimating the quantity of excavation in a trench tapering in depth (or width), use this formula:

The sum of the area of the two end sections *plus* four times the area of the middle section *multiplied* by one-sixth of the length.

$$\frac{(A + a + 4 m)}{6}$$

**ANGLE OF REPOSE OF VARIOUS SOILS**

| Material                          | Angle of repose in degrees from the horizontal |
|-----------------------------------|--|
| Mud                               | 1 to 0   |
| Gravel and Sand (natural mixture) | 25 to 30                                       |
| Rubble stone                      | 45   |
| Gravel                            | 40   |
| Ashes                             | 40   |
| Sand                              |  |
| dry                               | 30   |
| moist                             | 35   |
| wet                               | 25   |
| Clay                              |  |
| dry                               | 30   |
| moist                             | 45   |

|                |    |
|----------------|----|
| wet            | 15 |
| Vegetable soil |    |
| dry            | 30 |
| moist          | 45 |
| wet            | 20 |

WIDTHS REQUIRED FOR TRENCHES FOR VARIOUS DIAMETERS OF PIPES

| Diameter of pipe—      | 4 in & under         | 5–6 in               | 7–9 in               | 10–12 in             | 13–15 in             | 16–18 in             | 19–24 in             |
|------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
|                        | 101 mm & under       | 127–152 mm           | 177–228 mm           | 254–304 mm           | 330–381 mm           | 406–457 mm           | 482–609 mm           |
| Depth up to            |                      |                      |                      |                      |                      |                      |                      |
| 5ft 0 in (1.5m)        | 1 ft 6 in<br>0.456 m | 1 ft 9 in<br>0.496 m | 2 ft 0 in<br>0.609 m | 2 ft 3 in<br>0.649 m | 2 ft 6 in<br>0.761 m | 3 ft 0 in<br>0.914 m | 3 ft 9 in<br>1.096 m |
| Over 5 ft 0 in (1.5 m) | 2 ft 0 in<br>0.609 m | 2 ft 3 in<br>0.649 m | 2 ft 6 in<br>0.761 m | 2 ft 9 in<br>0.801 m | 3 ft 0 in<br>0.912 m | 3 ft 6 in<br>1.06m   | 4ft 0 in<br>1.284 m  |

## 7. BUILDERS' PLANT AND MACHINERY

### CONVERSION TABLE

#### HORSEPOWER AND KILOWATTS

|        |     |        |
|--------|-----|--------|
| 1.34   | 1   | 0.75   |
| 2.68   | 2   | 1.49   |
| 4.02   | 3   | 2.24   |
| 5.36   | 4   | 2.98   |
| 6.71   | 5   | 3.73   |
| 8.05   | 6   | 4.48   |
| 9.39   | 7   | 5.22   |
| 10.73  | 8   | 5.96   |
| 12.07  | 9   | 6.71   |
| 13.41  | 10  | 7.45   |
| 26.82  | 20  | 14.91  |
| 40.23  | 30  | 22.37  |
| 53.64  | 40  | 29.83  |
| 67.05  | 50  | 37.21  |
| 134.10 | 100 | 74.59  |
| 268.20 | 200 | 149.41 |

(A rough conversion is 1 hp equals 3/4 kw, or 3 kw equals 4 hp)

### PLANT ECONOMICS

Today the builder has a bewildering variety of machines at his disposal for a large variety of operations. These are largely earth-moving machines and transport: the trades that have become largely mechanized are excavator, concretor and joiner. There are also a large variety of portable powered tools, from the well-known drill to intricate machines that can be used with profit on site work or in site workshops. Much time can be saved by the use of machines and this can lead to considerable savings in costs, if the plant is well maintained and well managed.

Machines for their own sake do not make sense. Machines that are not used must nonetheless be maintained and are a wasting asset; being a drain on capital without providing any return. In these days of credit restriction and high interest rates, the locking-up of capital in plant is something to be avoided if possible.

It is always as well, when thinking about buying a machine, to consider if it would not be more profitable to buy its end-product. For instance, ready-mixed concrete and ready-

mixed mortar could be cheaper than investing in a large concrete mixer, and factory-made joinery can easily work out cheaper than setting up and maintaining a joiner's shop to make it for one's self. Specialist sub-contractors, too, can often quote prices that are lower than one's own costs. There is, too, the danger that the possession of machines will lead to their use on jobs for which they are not suited; and this results in inflated costs.

Nevertheless, there is no doubt that plant pays. Many jobs on modern sites would be impossible or too costly without it. What is more, the use of plant is often forced on the builder by the operatives or by the architects. Labourers will no longer carry the hod (even if we could try to let them do it) and hoists or lifts must be installed. The architect may specify large, prefabricated panels and a tower crane is needed to handle them. Machines we must have; but the question is, shall they be bought or hired?

### HIRING OR BUYING

Hiring has much to commend it. The machines are always in good condition. There is no worry about breakdowns—the hire firm attends to them. The latest type of machine can be had and one can always be certain of the right machine for the job, instead of having to make do with something from one's own limited range. The plant-hire industry is fiercely competitive, which keeps hire charges from being excessive. Good plant-hire firms have specialists who can give valuable advice as to which machine to use, and how best to use it on any particular site.

Against this, many builders, especially those in the medium and large categories, find it more profitable to buy their own plant. A survey of plant-users conducted by the Building Research Establishment, shows that most plant-users reckon on having each machine on site for 200 days a year and working for 150 days of that time. This may serve as a preliminary guide to intending purchasers. Unless a firm can judge from past experience that it will have something like this quantity of work for a machine, hiring is likely to be better than buying.

### THE COST OF A MACHINE

Besides the cost of the machine itself (the capital cost) there are the annual recurring costs of:

1. insurance;
2. maintainance;
3. licence;
4. administrative costs.

These generally amount to about 30 per cent per annum of the capital cost. To these must be added:

5. depreciation or replacement costs;
6. daily running costs;

7. labour costs; and
8. transport and erection costs.

For daily running costs, which is fuel etc., see page 176. For labour costs, see the estimating section of this book.

Transport and erection costs can be a considerable item. Most excavators and tractors need carrying on a low-loader. The erection of a tower crane is an engineering job that can take 50 hours for a small rail-mounted crane and several hundred hours for a very large tower crane.

When the above eight items have been costed out, the exact comparison between hiring and buying costs can be made, by totalling the items 1 to 6, dividing by 200 and comparing with the daily hire rate. If fuel and driver are included, add items 6 to 7. Item 8 is sometimes classed as an extra.

## MACHINERY DATA

### HORSEPOWER REQUIRED TO DRIVE BUILDERS' MACHINERY

| <b>Cranes</b>  | hp          |
|--|-------------|
| Overhead cranes (a) hoist                                      | 12 1/2–20   |
| 12–15 tons (b) travel  | 7 1/2–20    |
| Tower cranes, each movement separately motorised; per movement | 3–7         |
| <b>Static Woodworking Machinery</b>                            |             |
| Circular saw, 15–36 in   | 2 1/2–15    |
| Crosscut 24 in–36 in   | 3–10        |
| Universal woodworker, 5 in–7 in rip saw                        | 3–5         |
| Surfacer, 6–24 in width  | 2–5         |
| Planer and thicknesser, up to 30 in×9 in                       | 4–10        |
| Spindle Moulder, up to 6 in                                    | 2–4         |
| Mortising machine, up to 3 in×1 1/4 in                         | 2–7 1/2     |
| Tenoning machine   | 5–7 1/2     |
| Dovetailing machine  | 1           |
| Router   | 2           |
| Three-drum sander, 6 in width                                  | 20–30       |
| Disc sander, up to 48 in disc                                  | 6–7 1/2     |
| Belt sander, up to 20 in belt width                            | 5–7 1/2     |
| Woodturning lathe  | 1 1/2–2 1/2 |

*Note:* The above horsepower ratings apply to individually-motorized machines powered by electric motors. For belt-driven machines, connected by shafting to one central power source, and for machines individually powered by petrol or diesel engines, other ratings obviously apply.

## FUEL CONSUMPTION OF MACHINES

| Machine                 | Size          | Petrol gals | Diesel gals |
|-------------------------|---------------|-------------|-------------|
| Mixer                   | 5/3½          | 1           | ½           |
|                         | 7/5           | 1½          | 1           |
|                         | 10/7          | 2           | 1½          |
| Hoist                   | (cwt)         |             |             |
|                         | 5             | 2           | 1           |
|                         | 7/10          | 2½          | 1½          |
|                         | 12/15         | 2½          | 1½          |
|                         | 20            | 2½          | 1½          |
|                         | 30            | —           | 2½          |
| Dumper                  | (cu. yd)      |             |             |
|                         | ½/1           | 1½          | ¾           |
|                         | 1½            | —           | 1           |
|                         | 2             | —           | 1½          |
|                         | 3             | —           | 1½          |
|                         | 4             | —           | 1½          |
| Excavator               | (cu. yd)      |             |             |
|                         | ⅝             | —           | 5½          |
|                         | ¾             | —           | 7½          |
|                         | 7/8           | —           | 9½          |
|                         | 1             | —           | 11½         |
| Tractor                 | (bhp)         |             |             |
|                         | 25            | 5½          | 2½          |
|                         | 40            | 7½          | 5           |
|                         | 60            | —           | 8½          |
| Shovel and Loader       | (cu. yd)      |             |             |
|                         | ⅝             | 7           | 2           |
|                         | ¾             | 8           | 3           |
|                         | 1             | 10          | 5           |
| Trencher<br>Pump (bore) | (16 to 60 in) | —           | 6           |
|                         | inches        |             |             |
|                         | 3             | 2           | 1½          |
|                         | 4             | 2½          | 2           |
|                         | 5             | 2½          | 2½          |
|                         | 6             | —           | 2½          |
| Compressor              | (cu. ft)      |             |             |
|                         | 150           | 7           | 4½          |
|                         | 200           | 8           | 5½          |
|                         | 250           | 9½          | 7           |
|                         | 315           | 10½         | 8½          |
|                         | 510           | —           | 12½         |

**AVERAGE OUTPUT IN CUBIC YARDS OF BUILDERS' MACHINES**

| Type of machine            | Surface Soil | Soft clay | Heavy clay | Sand Gravel | Soft rock |
|----------------------------|--------------|-----------|------------|-------------|-----------|
| <b>EXCAVATOR</b>           |              |           |            |             |           |
| <b>Skimmer</b>             |              |           |            |             |           |
| 1/4 yard bucket            | 11           | 9         | 7          | 11          | 5         |
| 3/8 yard bucket            | 18           | 14        | 12         | 19          | 9         |
| 1/2 yard bucket            | 24           | 19        | 16         | 26          | 14        |
| 3/4 yard bucket            | 42           | 33        | 28         | 46          | 23        |
| <b>Face Shovel</b>         |              |           |            |             |           |
| 1/4 yard bucket            | 14           | 11        | 9          | 15          | 7         |
| 3/8 yard bucket            | 23           | 18        | 16         | 25          | 12        |
| 1/2 yard bucket            | 32           | 26        | 22         | 34          | 17        |
| 3/4 yard bucket            | 55           | 44        | 37         | 59          | 30        |
| <b>Backactor</b>           |              |           |            |             |           |
| 1/4 yard bucket            | 10           | 8         | 7          | 10          | 5         |
| 3/8 yard bucket            | 16           | 13        | 11         | 17          | 9         |
| 1/2 yard bucket            | 22           | 17        | 14         | 23          | 13        |
| 3/4 yard bucket            | 37           | 29        | 25         | 39          | 20        |
| <b>Dragline</b>            |              |           |            |             |           |
| 1/4 yard bucket            | 14           | 12        | 10         | 15          | 6         |
| 3/8 yard bucket            | 23           | 19        | 16         | 26          | 11        |
| 1/2 yard bucket            | 33           | 25        | 21         | 35          | 16        |
| 3/4 yard bucket            | 55           | 44        | 36         | 60          | 28        |
| <b>TRENCHER</b>            |              |           |            |             |           |
| <b>John Allen 16/60</b>    |              |           |            |             |           |
| Depth 1-3 ft               | 40           | 28        | 24         | 40          | 13        |
| 3-5 ft                     | 48           | 34        | 28         | 48          | 16        |
| 5-7 1/2 ft                 | 60           | 42        | 36         | 60          | 16        |
| 7 1/2-10 ft                | 55           | 38        | 33         | 55          | 13        |
| 10-12 ft                   | 48           | 34        | 28         | 48          | 12        |
| <b>John Allen 12/21</b>    |              |           |            |             |           |
| Depth 1-3 ft               | 25           | 18        | 15         | 25          | 8         |
| 3-5 ft                     | 25           | 18        | 14         | 25          | 9         |
| <b>John Allen 140</b>      |              |           |            |             |           |
| Depth 1-3 ft               | 66           | 53        | 33         | 66          | 20        |
| 3-5 ft                     | 60           | 50        | 30         | 60          | 19        |
| <b>Cleveland 110 (USA)</b> |              |           |            |             |           |
| Depth 1-3 ft               | 20           | 16        | 13         | 22          | 11        |
| 3-5 ft                     | 22           | 18        | 15         | 24          | 12        |
| <b>BULLDOZER</b>           |              |           |            |             |           |
| D.4 50 ft push             | 36           | 30        | 27         | 39          | —         |
| 100 ft push                | 22           | 18        | 16         | 24          | —         |
| 200 ft push                | 13           | 10        | 9          | 13          | —         |
| D.6 50 ft push             | 45           | 37        | 33         | 49          | —         |



|                |     |    |    |     |    |   |
|----------------|-----|----|----|-----|----|---|
| 100 ft push    | 30  | 24 | 21 | 33  | 28 | — |
| 200 ft push    | 16  | 14 | 12 | 18  | 15 | — |
| D.8 50 ft push | 100 | 82 | 72 | 110 | 94 | — |
| 100 ft push    | 70  | 57 | 50 | 75  | 65 | — |
| 200 ft push    | 35  | 28 | 25 | 37  | 32 | — |

### PUMP PERFORMANCES

(IN GALLONS PER HOUR)

| Bore | Type of Pump                    | Average gallons per hour |
|------|---------------------------------|--------------------------|
| 3 in | Single Diaphragm, engine-driven | 3,600                    |
| 4 in | Single Diaphragm, engine-driven | 6,000                    |
| 4 in | Double Diaphragm, engine-driven | 12,000                   |
| 5 in | Centrifugal Pump                | 24,000                   |
| 6 in | Centrifugal Pump                | 36,000                   |
| 8 in | Centrifugal Pump                | 48,000                   |
| 3 in | Hand Pump                       | 18,000                   |

### STEEL SCAFFOLDING

TUBES AND FITTINGS REQUIRED TO COVER 30 ft LONG×30 ft HIGH OR  
100 yds SUPER (9·1 m×9·1 m, 83 m<sup>2</sup>)

|   | Tubing | Double<br>couplers | Putlog<br>couplers | Putlog<br>heads | Base<br>plates |
|---|--------|--------------------|--------------------|-----------------|----------------|
|   | Feet   | No off             | No off             | No off          | No off         |
| Bricklayers'—                                     |        |                    |                    |                 |                |
| Putlog scaffolding                                | 710    | 35                 | 70                 | 70              | 5              |
| Independent scaffolding                           | 1130   | 80                 | 70                 | —               | 10             |
| Plasterers' or Painters'—                         |        |                    |                    |                 |                |
| Putlog scaffolding                                | 470    | 20                 | 40                 | 40              | 5              |
| Independent scaffolding                           | 800    | 50                 | 80                 | —               | 10             |
| Birdcage scaffolding (30 ft<br>square×30 ft high) | 1860   | 144                | 40                 | 16              |                |

# 8.

## THE CONCRETOR

### THE DESIGN OF CONCRETE MIXES

Within the last few years, a revolution in concrete making has taken place. The advent of high-strength concrete, and the general introduction of prestressed concrete, has led to greater control over the production of concrete on the site and in the factory. It has long been the complaint of engineers that concrete made in a laboratory could be up to ten times stronger than the same mix when made into concrete on a building site. "Quality control" of concrete is, however, expensive and can only be applied economically to large works: it does, however, produce a concrete of higher and more consistent strength from the same mix than can be achieved by ordinary methods, or will permit the use of a leaner mix to obtain the same strength as a concrete of uncontrolled quality. Very high strength concretes are required for prestressed concrete, and the achievement, under factory conditions and site conditions also, of such high and consistent strengths has led to the introduction, into civil engineers' specifications, of the concept of "guaranteed-strength concrete". The strength that the concrete is required to attain in 28 days is specified, and the contractor is allowed to use whatever mix will produce concrete of that required strength. Sometimes, a mix is suggested by the engineer, but the onus rests with the builder. He is free to adapt that mix, or use another. The secrets of such good concrete production are:

1. Batching by weight;
2. Strict control of water-cement ratio;
3. Correct grading of aggregate;
4. Care in placing and curing.

To achieve a high-strength concrete the mix should be designed in accordance with the instructions given in *Road Research Note No. 4—The Design of Concrete Mixes* (H.M.S.O.). Readers are warned that this implies some familiarity with test procedure and the handling of a few simple scientific instruments.

The subject is too vast to summarize in these pages, and for the majority of concreting work would be too costly to put into practice. However, it has taken the place of the "absolute volume" method for large jobs.

Normal conversions, as given in the tables in previous sections, can be employed: but in some instances, the numbers will be so large as to be cumbersome and time-wasting when used in calculations. To avoid this as far as possible, some of the tables in this section have been worked to the following approximations: 50 kg=1 cwt. 1 ton=1 metric tonne. 1 cu. yd=3/4 cu. metre.

These approximations are sufficiently close for all practical purposes. A building site is

not a cement-chemists' laboratory, and the values assumed will make no difference to the strength of the concrete.

For maximum strength concrete must be:

1. Adequately mixed;
2. Properly placed;
3. Consolidated by hand or vibration;
4. Adequately cured.

These are key operations: failure to observe any one of them can result in immense losses in final strength. Meticulous accuracy in proportioning can never be attained on site, unfortunately, but it is in no way as important as the four operations listed above.

**APPROXIMATE AVERAGE WEIGHTS OF MATERIALS**

| Material                                  | Voids | Loose weight |           |                    |
|---|-------|--------------|-----------|--------------------|
|   |       | per cu.ft    | per cu.yd | per m <sup>3</sup> |
|   | %     | lb           | tons      | kg                 |
| Sand . . . . .                            | 39    | 100          | 1.2       | 1661               |
| Gravel 3/8"-1" . . . . .                  | 45    | 90           | 1.1       | 1441               |
| Gravel 1 1/2"-3" . . . . .                | 42    | 97           | 1.2       | 1553               |
| Crushed stone . . . . .                   | 50    | 83           | 1.0       | 1329               |
| Crushed granite (under 3/4") . . . . .    | 50    | 84           | 1.0       | 1345               |
| Crushed granite (3/4" and over) . . . . . | 47    | 90           | 1.1       | 1441               |
| "All-in" ballast . . . . .                | 32    | 112          | 1.3       | 1794               |
| Portland cement . . . . .                 | 54    | 90           | 1.1       | 1441               |
| Lime (lump) . . . . .                     | 73    | 45           | .55       | 720                |
| Lime (hydrated) . . . . .                 | 60    | 35           | .42       | 560                |
| Plaster (heavy) . . . . .                 | 57    | 62           | .75       | 993                |
| Plaster (light) . . . . .                 | 65    | 50           | .60       | 880                |

**MIXES FOR VARIOUS TYPES OF WORK**

| Mix | Class of work suitable for Recommended  | Mix          |
|-----|---|--------------|
| A.  | Roughest type of mass concrete, such as footings, road haunching over 12in thick, etc.      | 1:3:6        |
| B.  | Mass concrete of better class than A, such as bases for machinery, walls below ground, etc. | 1:2<br>1/2:5 |

| Mix | Class of work suitable for  | Recommended Mix |
|-----|---|-----------------|
| C.  | Most ordinary uses of concrete (usually specified 1:2:4), such as mass walls above ground, road slabs, etc., and general reinforced concrete work | 1:2:4           |
| D.  | Watertight floors, pavements and walls, tanks, pits, steps,   | 1:1 1/2:3       |

paths, surface of 2-course roads, reinforced concrete where extra strength is required.

- E. Work of thin section, such as fence posts and small precast work. 1:1:2

*Note:*The above mixes are by proportions, by volume. The cement is given first, the fine aggregate next and the coarse aggregate last.

**MIXES FOR VERY SMALL JOBS**

| Cement (loose)<br>Buckets | Sand (damp)<br>Buckets | Coarse Aggregate<br>Buckets | Water (net)<br>Buckets   |
|---------------------------|------------------------|-----------------------------|--------------------------|
| A                         | 4                      | 6                           | 3/4                      |
| B                         | 3 1/4                  | 5                           | } between<br>3/4 and 1/2 |
| C                         | 2 1/2                  | 4                           |                          |
| D                         | 2                      | 3                           |                          |
| E                         | 1 1/4                  | 2                           | 1/2                      |

**MIXES FOR A ONE BAG BATCH**

| MIX | Cement (bags) |      | Sand (damp) |                   | Coarse Agg. |                   | Water (net) |          |
|-----|---------------|------|-------------|-------------------|-------------|-------------------|-------------|----------|
|     | cwt           | (kg) | cu.ft       | (m <sup>3</sup> ) | cu.ft       | (m <sup>3</sup> ) | gals        | (litres) |
| A   | 1             | 50   | 5           | 0.14              | 7 1/2       | 0.21              | 6           | 27       |
| B   | 1             | 50   | 4           | 0.11              | 6 1/4       | 0.17              | 5 1/2       | 24       |
| C   | 1             | 50   | 3 1/4       | 0.09              | 5           | 0.14              | *5          | *22      |
| D   | 1             | 50   | 2 1/2       | 0.07              | 3 3/4       | 0.11              | *4 1/2      | *20      |
| E   | 1             | 50   | 1 1/2       | 0.03              | 2 1/2       | 0.06              | 4           | 18       |

\* Increase slightly for reinforced concrete if not fluid enough for easy placing around reinforcement.

*Note:*If the proportions suggested do not give a 'workable mix' with the materials used vary slightly the quantities of sand and coarse aggregate, but do not add more water, except in the case noted above.

**MAXIMUM AGGREGATE SIZE**

For all reinforced concrete the coarse material should be graded from 3/4in to 1 1/4in. For plain concrete the larger particles of coarse material should not be greater in diameter than one quarter of the thickness of the work. Maximum sizes usually suitable are: Mix A—2 1/2in, Mix B—2in, Mix C—1in (roads 1 1/2in), Mix D—3/4in, Mix E—1/2in (or less if work is very thin). All sand should be graded from 3/16in down with a good proportion of the larger particles.

PRECAUTIONS

Use clean water, clean sand and clean aggregate. Mix the materials thoroughly before adding the water and again afterwards. Place the concrete within 30 minutes of mixing; tamp and spade it well. Protect the concrete from sun and wind and keep it damp for 10 days.

The table is based on loose cement weighing 90lb per cu. ft; damp sand (30% bulked) 84lb per cu. ft; broken stone 90lb per cu. ft.

*(By courtesy of the Cement and Concrete Association)*

MATERIALS REQUIREMENTS

MATERIALS REQUIRED PER CU. YD OF CONCRETE

Based on Absolute Volume method, with cement weighing 90 lb per cu ft, sand 84 lb per cu. ft when damp and bulked 30 per cent gravel or shingle 109 lb per cu. ft, and broken stone 90 lb per cu. ft.

| Type of Mix | Type of Aggregate | Coarse Cement | Sand (Damp) |      | Coarse Aggregate |      | Bags of cement per cu. yd of combined aggregates |
|-------------|-------------------|---------------|-------------|------|------------------|------|--|
|             |                   | lb            | cu. yd      | tons | cu. yd           | tons |  |
| A           | Shingle           | 335           | 0.54        | 0.55 | 0.83             | 1.09 | 3  |
|             | Broken stone      | 370           | 0.59        | 0.60 | 0.91             | 0.99 | 3 1/2  |
| B           | Shingle           | 392           | 0.52        | 0.53 | 0.81             | 1.06 | 3 1/2  |
|             | Broken stone      | 432           | 0.58        | 0.59 | 0.89             | 0.96 | 4  |
| C           | Shingle           | 481           | 0.15        | 0.52 | 0.79             | 1.04 | 4  |
|             | Broken stone      | 524           | 0.56        | 0.57 | 0.86             | 0.93 | 4 1/2  |
| D           | Shingle           | 596           | 0.48        | 0.49 | 0.74             | 0.97 | 5 1/2  |
|             | Broken stone      | 653           | 0.52        | 0.53 | 0.80             | 0.87 | 6  |
| E           | Shingle           | 813           | 0.43        | 0.44 | 0.67             | 0.88 | 7 1/2  |
|             | Broken stone      | 880           | 0.47        | 0.48 | 0.72             | 0.78 | 8  |

MATERIALS REQUIRED PER CUBIC METER OF CONCRETE

| Type of Mix | Type of coarse aggregate | Cement kg | Sand m <sup>3</sup> | Coarse Aggregate m <sup>3</sup> | No. of 50 kg bags of cement per m <sup>3</sup> of combined aggregates |
|-------------|--------------------------|-----------|---------------------|---------------------------------|---|
| A           | Shingle                  | 203       | 0.54                | 0.83                            | 4   |
|             | Broken stone             | 213       | 0.59                | 0.91                            | 4 1/4   |
| B           | Shingle                  | 237       | 0.52                | 0.81                            | 4 3/4   |
|             | Broken stone             | 261       | 0.58                | 0.89                            | 5 1/4   |
| C           | Shingle                  | 291       | 0.55                | 0.79                            | 6   |

|   |              |     |      |      |       |
|---|--------------|-----|------|------|-------|
|   | Broken stone | 317 | 0.56 | 0.86 | 6 1/4 |
| D | Shingle      | 361 | 0.48 | 0.74 | 7 1/4 |
|   | Broken stone | 380 | 0.52 | 0.80 | 7 3/4 |
| E | Shingle      | 491 | 0.43 | 0.67 | 10    |
|   | Broken stone | 531 | 0.47 | 0.72 | 11    |

Note: A rough approximation of these mixes is obtained by using the number of bags of cement given in the last column, to 1 cu. yd of combined aggregates or "all-in" ballast. To use this table, multiply the cubic yardage of concrete required by the amount of cement in pounds, and the amount of coarse aggregate and cement in yards or tons.

**APPROXIMATE STRENGTH AND WATER CONTENT**  
of concrete with a workable slump of 2-4in

| Nominal Mix | Water/cement Ratio by weight | Compressive Strength (28 days) | WATER                 |                   | MN/m <sup>2</sup> | Litres per 50 kg bag of cement |
|-------------|------------------------------|--------------------------------|-----------------------|-------------------|-------------------|--------------------------------|
|             |                              |                                | per cu yd of concrete | per bag of cement |                   |                                |
|             |                              | lb/sq.in                       | gals                  | gals              |                   |                                |
| 1 : 1 : 2   | .40                          | 5300                           | 35½                   | 4½                | 38.66             | 20.4                           |
| 1 : 3       | .44                          | 5000                           | 34                    | 5                 | 33.33             | 22.7                           |
| 1 : 1½ : 2½ | .45                          | 4850                           | 33½                   | 5                 | 32.33             | 22.7                           |
| 1 : 3½      | .47                          | 4700                           | 32½                   | 5½                | 31.33             | 23.8                           |
| 1 : 1½ : 3  | .49                          | 4500                           | 31½                   | 5½                | 30.00             | 24.9                           |
| 1 : 4       | .50                          | 4400                           | 31                    | 5½                | 29.33             | 24.9                           |
| 1 : 2 : 3   | .52                          | 4250                           | 30½                   | 5½                | 28.33             | 26.1                           |
| 1 : 1½ : 4  | .54                          | 4000                           | 30                    | 6                 |                   |                                |
| 1 : 1½ : 4½ | .57                          | 3800                           | 29½                   | 6½                | 25.33             | 29.5                           |
| 1 : 5       |                              |                                |                       |                   |                   |                                |
| 1 : 2 : 4   |                              |                                |                       |                   |                   |                                |
| 1 : 2½ : 4  | .60                          | 3500                           | 28½                   | 6¾                | 23.33             | 29.75                          |
| 1 : 6       | .63                          | 3250                           | 28                    | 7                 | 21.66             | 31.8                           |

| Nominal Mix | Water/cement Ratio by weight | Compressive Strength (28 days) | WATER                 |                   | MN/m <sup>2</sup> | Litres per 50 kg bag of cement |
|-------------|------------------------------|--------------------------------|-----------------------|-------------------|-------------------|--------------------------------|
|             |                              |                                | per cu yd of concrete | per bag of cement |                   |                                |
|             |                              | lb/sq.in                       | gals                  | gals              |                   |                                |
| 1 : 2½ : 5  | .65                          | 3100                           | 28                    | 7½                | 20.66             | 32.3                           |
| 1 : 3 : 5   | .68                          | 2800                           | 27½                   | 7¾                | 18.33             | 34.8                           |
| 1 : 7       | .70                          | 2650                           | 27½                   | 7¾                | 17.66             | 35.2                           |
| 1 : 3 : 6   | .73                          | 2400                           | 26½                   | 8½                | 16.00             | 37.5                           |
| 1 : 9       | .83                          | 1500                           | 26                    | 9½                | 10.00             | 42.0                           |
| 1 : 3 : 9   | .89                          | 1000                           | 25½                   | 10                | 6.66              | 45.4                           |
| 1 : 10      |                              |                                |                       |                   |                   |                                |
| 1 : 4 : 8   |                              |                                |                       |                   |                   |                                |
|             | .90                          | 800                            | 25½                   | 10                | 5.33              | 45.4                           |

*Note* The compressive strength is related to the water/cement ratio. The water/ cement ratio remains the same for metric as for imperial quantities.

*Note* If strength is important and it is desired to gain greater workability, it is better to increase the proportions of cement and sand in the mix than to increase the water content.

*Note* The nearest 'All-in' mix to a given three-part mix is that which gives the nearest equivalent water/cement ratio.

*Note* The strengths of 'All-in' mixes should be assumed as being lower than shown, because of the variability of aggregate grading.

**TABLE 1. PREFERRED TYPES OF STEEL FABRIC**

| BS reference                  | Mesh sizes (nominal pitch of wires) |       | Wire Sizes |       | Cross-sectional area per metre width |                 | Nominal mass per square metre |
|-------------------------------|-------------------------------------|-------|------------|-------|--------------------------------------|-----------------|-------------------------------|
|                               | Main                                | Cross | Main       | Cross | Main                                 | Cross           |                               |
| <b>SQUARE MESH FABRIC</b>     |                                     |       |            |       |                                      |                 |                               |
|                               | mm                                  | mm    | mm         | mm    | mm <sup>2</sup>                      | mm <sup>2</sup> | kg                            |
| A393                          | 200                                 | 200   | 10         | 10    | 393                                  | 393             | 6.16                          |
| A252                          | 200                                 | 200   | 8          | 8     | 252                                  | 252             | 3.95                          |
| A193                          | 200                                 | 200   | 7          | 7     | 193                                  | 193             | 3.02                          |
| A142                          | 200                                 | 200   | 6          | 6     | 142                                  | 142             | 2.22                          |
| A 98                          | 200                                 | 200   | 5          | 5     | 98.0                                 | 98.0            | 1.54                          |
| <b>STRUCTURAL MESH FABRIC</b> |                                     |       |            |       |                                      |                 |                               |
| B1131                         | 100                                 | 200   | 12         | 8     | 1131                                 | 252             | 10.9                          |
| B 785                         | 100                                 | 200   | 10         | 8     | 785                                  | 252             | 8.14                          |
| B 503                         | 100                                 | 200   | 8          | 8     | 503                                  | 252             | 5.93                          |
| B 385                         | 100                                 | 200   | 7          | 7     | 385                                  | 193             | 4.53                          |
| B 283                         | too                                 | 200   | 6          | 7     | 283                                  | 193             | 3.73                          |
| B 196                         | 100                                 | 200   | 5          | 7     | 196                                  | 193             | 3.05                          |
| <b>LONG MESH FABRIC</b>       |                                     |       |            |       |                                      |                 |                               |
| C785                          | 100                                 | 400   | 10         | 6     | 785                                  | 70.8            | 6.72                          |
| C503                          | 100                                 | 400   | 8          | 5     | 503                                  | 49.0            | 4.34                          |
| C385                          | 100                                 | 400   | 7          | 5     | 385                                  | 49.0            | 3.41                          |
| C283                          | 100                                 | 400   | 6          | 5     | 283                                  | 49.0            | 2.61                          |
| <b>WRAPPING FABRIC</b>        |                                     |       |            |       |                                      |                 |                               |
| D98                           | 200                                 | 200   | 5          | 5     | 98.0                                 | 98.0            | 1.54                          |
| D49                           | 100                                 | 100   | 2.5        | 2.5   | 49.1                                 | 49.1            | 0.770                         |

NOTE 1. Cross wires for all types of long mesh may be of plain hard drawn steel wire.

NOTE 2.5 mm size is available in hard drawn wire only. The 6, 7, 8, 10 and 12 mm sizes are available in either hard drawn wire or in bar form. The 7 mm size is not a preferred size of cold worked bar.

**TABLE 2. RECOMMENDED FABRIC FOR CARRIAGEWAYS**

| BS<br>reference | Mesh sizes<br>(nominal pitch of<br>wires) |       | Wire Sizes |       | Cross-sectional<br>area per metre<br>width |                 | Nominal mass<br>per square<br>metre |
|-----------------|---|-------|------------|-------|--|-----------------|-------------------------------------|
|                 | Main                                      | Cross | Main       | Cross | Main                                       | Cross           |                                     |
|                 | mm  | mm    | mm         | mm    | mm <sup>2</sup>                            | mm <sup>2</sup> |                                     |
| C636            | 80-130                                    | 400   | 8-10       | 6     | 636  | 70.8            | kg<br>5.55                          |

**STEEL BARS**

**SIZES AND PROPERTIES**  
(B.S. 4449M;1969)

| Size mm | Cross-sectional area mm <sup>2</sup> | Weight per meter run kg |
|---------|--------------------------------------|-------------------------|
| 6       | 28.3                                 | 0.222                   |
| 8       | 50.3                                 | 0.395                   |
| 10      | 78.5                                 | 0.616                   |
| 12      | 113.1                                | 0.888                   |
| 16      | 201.1                                | 1.597                   |
| 20      | 314.2                                | 2.466                   |
| 25      | 490.9                                | 3.854                   |
| 32      | 804.2                                | 6.313                   |
| 40      | 1256.6                               | 9.864                   |
| 50      | 1963.5                               | 15.413                  |

*Note:* B.S. 4461 M "Cold worked steel bars for the reinforcement of concrete" gives identical data with above, except that the 50 mm size is not included.



**WEIGHT IN POUNDS PER FOOT RUN OF ROUND REINFORCING BARS**

| Diam<br>in<br>inches | Weight<br>in lbs<br>per foot | Diam<br>in<br>inches | Weight<br>in lbs<br>per foot | Diam<br>in<br>inches | Weight<br>in lbs<br>per foot | Diam<br>in<br>inches | Weight<br>in lbs<br>per foot |
|----------------------|------------------------------|----------------------|------------------------------|----------------------|------------------------------|----------------------|------------------------------|
| $\frac{1}{8}$        | ·094                         | $\frac{1}{8}$        | ·845                         | $1\frac{1}{8}$       | 3·015                        | $1\frac{3}{8}$       | 6·52                         |
| $\frac{1}{4}$        | ·167                         | $\frac{3}{8}$        | 1·043                        | $1\frac{1}{4}$       | 3·380                        | $1\frac{1}{2}$       | 7·05                         |
| $\frac{3}{8}$        | ·211                         | $\frac{1}{2}$        | 1·262                        | $1\frac{3}{8}$       | 3·77                         | $1\frac{3}{4}$       | 7·6                          |
| $\frac{1}{2}$        | ·261                         | $\frac{5}{8}$        | 1·502                        | $1\frac{1}{2}$       | 4·172                        | $1\frac{1}{2}$       | 8·18                         |
| $\frac{5}{8}$        | ·316                         | $\frac{3}{4}$        | 1·763                        | $1\frac{5}{8}$       | 4·6                          | $1\frac{3}{4}$       | 8·77                         |
| $\frac{3}{4}$        | ·376                         | $\frac{7}{8}$        | 2·044                        | $1\frac{3}{4}$       | 5·05                         | $1\frac{7}{8}$       | 9·39                         |
| $\frac{7}{8}$        | ·511                         | $1\frac{1}{8}$       | 2·347                        | $1\frac{7}{8}$       | 5·52                         | 2                    | 10·68                        |
| 1                    | ·668                         | 1                    | 2·670                        | $1\frac{1}{2}$       | 6·008                        | —                    | —                            |

**HOOKS AND PASSINGS IN REINFORCEMENT**

The girth of a standard hook is 12d, where d=the diameter of the rod.

The length of overlap, or passing, to secure adequate bond in 1:2:4 concrete (bond stress 100lb per sq. in and steel stress 18,000lb per sq. in) is 59d. The minimum overlap in longitudinal steel in columns is 24d.

The necessary bond length (with or without hook) depends upon the mix of the concrete and the local stress on the steel. Minimum end length is 14d straight, or a hook equivalent to 12d.

**B.S. 4466:** Bending dimensions and scheduling of bars for the reinforcement of concrete: gives minimum hook and bend allowances as 9d, taken to the nearest 10 mm over or not less than 100 mm, to be added to the overall length of the bar as when bent. These dimensions are hooks with radius of 2d for mild steel and 3d for high-yield bars. The Standard gives illustrations of some 35 different shapes, with full details of bending dimensions, and a suggested form of bar schedule.

**REMOVAL OF FORMWORK**

| Formwork in parts of<br>building    | Days before formwork should be struck       |                  |  |                   |
|-------------------------------------|---|------------------|--|-------------------|
|                                     | Ordinary concrete<br>Just above<br>freezing |                  | Rapid-hardening concrete<br>Just above<br>freezing |                   |
|                                     |   | 60° F<br>(15·6C) |  | 60° F (15·6<br>C) |
| Beams (except soffits)<br>and waits | 6   | 2                | 5  | 1                 |
| Beam soffits                        | 14  | 7                | 10   | 4                 |
| Slabs                               | 10  | 3                | 7  | 2                 |

Props should be left under beam soffits and slabs, and be removed 1 week after. When temperature drops below freezing point, add the days of such temperature

to the times given above.

### **READY-MIXED CONCRETE**

Concrete can now be obtained, in any quantity from 1 1/3 cubic yards upwards, delivered ready-mixed to the building site. Any type of mix, containing any variety of cement or aggregate, can be now obtained from upwards of 100 firms in the larger cities in Great Britain. The cement and aggregate are loaded into mobile mixers at the factory; during the journey from factory to site the mix is agitated, water is added and freshly-mixed concrete is thus ready when the mixer-lorry reaches its destination. Cost is often greater than materials mixed on site, but for "rush" jobs, confined sites or contractors with small labour-forces, there is often a great saving in time, and therefore in cost. It should be remembered that this material can only be used profitably by very careful pre-planning, and working out, with the supplier, a schedule of arrivals of truck-mixers.

This pre-planning must also be carried out on the building site. Arrangements should be made to have sufficient labourers to cope with the placing of the concrete, as it arrives. Suppliers allow a 20 minute wait for their trucks, after which they charge waiting time. A truck-mixer is 8 ft wide, 11 ft high, 24 ft long and weighs 20 tons. Adequate access must be provided on the site including bridging and metallised ("Sommerfield track") or sleeper roads, if necessary. It is well to remember that the discharge chute allows concrete to be deposited 9 ft from the mixer.

Special mixes, suitable for pumping can be supplied. Concrete can be lifted 5 to 6 storeys by concrete pumps. If used in conjunction with ready-mixed concrete, spectacular results can be obtained. For example, over 150 cubic yards of pumped concrete have been placed in one day, using only two of the builder's own men. Most suppliers have technicians and engineers on their staff, who can advise on the type of mix and on problems that arise on the site also.

### **PRESTRESSED CONCRETE**

Prestressed concrete is concrete compressed by an initial tension given to the reinforcement. Steel thus tensioned or stretched tends to return to its normal, unstretched length, just as does a piece of elastic. This tendency induces, by reason of the position of the reinforcement in the slab or beam, tension in the top half of the beam or slab and compression in the bottom. These stresses must be reversed before the beam or slab begins to act as a normal reinforced concrete unit: in practice, the load is never enough to reverse the stresses completely.

Prestressing makes better use of the strength of the concrete than does normal reinforcement. Concrete, though strong in compression, is weak in tension and a normal concrete beam always tends to crack at the bottom because, when loaded, the reinforcing steel stretches as it takes up tension and thus allows the bottom of the beam to crack. Prestressing so compresses the concrete that, when under load, there will be no tension in

it, so that the concrete will not crack. In short, the concrete will always be acting in compression, where it is strongest. This means that full advantage is taken of the strength of concrete in compression, so that a prestressed concrete beam will always be smaller in size than a reinforced concrete one, designed to take the same load. The weight of concrete and steel will be less and this reduction in the dead or self-load of a structure may well reduce the size of foundations and supports. Because they are smaller, prestressed components will weigh less than normally reinforced ones and this is a vital consideration in the handling of components in industrialised building and of large beams used in bridge construction.

Two methods of prestressing are currently employed; pre-tensioning and post-tensioning. For pre-tensioning, cold-drawn steel wires of very high tensile strength are used. These wires are stretched very tightly, by means of jacks, between two fixed abutments and concrete is then poured round them. When the concrete is set and hardened, the wires are released from the abutments. They immediately try to return to their original length, but are prevented from so doing by the grip or bond of the concrete on them, with the result that the concrete is powerfully compressed.

In post-tensioning, the concrete is cast first, either in one piece or in several units. Holes are formed for the insertion of high-tensile steel wire cables or rods of special alloy steel. When the concrete is set or, if in units, when these are assembled to form a beam, the cables or rods are inserted, stretched by jacks and then anchored in this stretched condition to the concrete. The steel then acts to compress the concrete or concrete units.

## 9. THE MASON

### WATERPROOFING STONE AND OTHER WALLING

The application of waterproofing compounds to stonework or to old brickwork, especially if pointed or laid in lime mortar, should be done only after consultation with an expert technician, either an architect well versed in the subject, or a building scientist or consultant. Care must be taken to see that all work is pointed and that the walling is sound, before applying waterproofing liquids. The best of these preparations have a life of approximately five years, when the treatment must be renewed. They can sometimes be used with effect to waterproof porous window-sills and other projections, but the treatment should be renewed every three years. Much was expected of liquids containing silicone compounds. These are very successful for about three to six months, after which their efficacy is much reduced, and then is generally no better than the best of the older type of liquid waterproofers.

Damp walls can only be waterproofed by eliminating the source of moisture, which often entails inserting a dampcourse in the wall itself, or flashing all projections where water lodges with lead. Crumbling stone, due to being set on its wrong bed, or to being worked after the “quarry sap” has dried, cannot easily be waterproofed.

### BRITISH STANDARDS

**B.S. 1240:** Natural stone lintels. Gives breadths and depths, for stone of three ranges of hardness, for openings up to 8ft.

**B.S. 3798:** Coping units (of clayware, unreinforced cast concrete, unreinforced cast stone, natural stone and slate) specifies material, workmanship, functional requirements and dimensions.

**B.S. 4374:** Sills of clayware, cast concrete, cast stone, slate and natural stone. (See table overleaf.)

*Note:* The Standards are designed for housing and similar work, using standard door-frames and windows. The finish is specified as sawn or rubbed.

### CLASSIFICATION OF STONE

Natural stones can be broadly classified as:

1. Granites and other igneous rocks;
2. Limestones, including marbles;
3. Sandstones.

The only valid guide to the suitability of stones in classes 2 and 3 is by inspection of buildings constructed with such stone. Every quarrymaster will be glad to provide a list of buildings in which his stone has been used. Granites and other like rocks are suitable for plinth courses. Stone for

**TABLE 1. MINIMUM DIMENSIONS**

| Material      | AA*     |    | A     |    | B   |    | C   |    | D   |    | E    |    | F    |    |
|---------------|---------|----|-------|----|-----|----|-----|----|-----|----|------|----|------|----|
|               | in      | mm | in    | mm | in  | mm | in  | mm | in  | mm | in   | mm | in   | mm |
| Clayware      | 2 1/8   | 54 | 2     | 51 | 1/2 | 13 | 1/2 | 13 | 1/2 | 13 | 5/16 | 8  | 1/2  | 13 |
| Cast concrete | 1 7/8   | 48 | 1 3/4 | 44 | 5/8 | 16 | 1/2 | 13 | 1/2 | 13 | 5/16 | 8  | 1/2  | 13 |
| Cast stone    | 1 7/8   | 48 | 1 3/4 | 44 | 5/8 | 16 | 1/2 | 13 | 1/2 | 13 | 5/16 | 8  | 1/2  | 13 |
| Natural stone | 1 13/16 | 46 | 1 3/4 | 44 | 1/2 | 13 | 1/2 | 13 | 1/2 | 13 | 5/16 | 8  | 1/2  | 13 |
| Slate         | 13/16   | 21 | 3/4   | 19 | 5/8 | 16 | 1/2 | 13 | 1/2 | 13 | 5/16 | 8  | 1/2† | 13 |

\*The dimensions given in column AA allow for the tolerances specified for each particular material and ensure the minimum finished dimension shown in Column A.

† This upstand may be made of other material approved by the purchaser.

parapets, cornices, string courses, sill and buttress weatherings should be chosen with care, and must withstand frost. CP 121:201 gives a large number of excellent illustrations of stonework details, which illustrate its requirements in detail, but which cannot be reproduced here.

### MASONRY DATA

Ashlar masonry requires about one-eighth its bulk of mortar in laying and rubble masonry about one-fifth its bulk.

About one-sixth waste is an average figure allowed in the laying of rubble masonry.

One ton or tonne of flints will face an average of 33 sq. ft 3.06 m<sup>2</sup> if used whole and 50 sq. ft 4.6 m<sup>2</sup> if split or knapped.

One ton of Kentish ragstone, as hammer-dressed random squared rubble or random coursed rubble, will cover about 3 yds super/2.6 m<sup>2</sup> (without backing).

A cu. yd/0.76 m<sup>3</sup> of walling (usually 18 in thick/450 mm) requires 32 cu. ft/0.93 m<sup>3</sup> undressed stone for rubble walling, 36 cu. ft/1.02 m<sup>3</sup> for coursed rubble walling and 30 cu. ft/0.85 m<sup>3</sup> or rough flints for flint walling.

The most satisfactory cramps and keys used in masonry work are made of copper, bronze, gunmetal or slate.

For external work, a good building stone should be dense, hard and comparatively non-absorbent.

As a general rule, a stone that absorbs more than 10 per cent of its own weight in twenty-four hours is undesirable, as most of the impurities in the atmosphere are soluble in water. They can therefore attack the stone and cause disintegration.

### THE LAYING OF MASONRY

Laminated stones (*i.e.* ordinary stones other than granite) are liable to flake off along the lines of lamination and should therefore be laid, as a general rule, with the lines of lamination horizontal in ordinary walling, thus providing the greatest resistance, as the load to be carried will be at right angles to the lines of lamination.

In stone voussoirs for arches the lines of lamination are laid normal to the curve of the arch and at right angles to the face, again giving the greatest resistance to the line of thrust of the arch.

In cornices, mouldings and undercut work, however, it is more usual to edge-bed the stone, that is, to lay the stone with the lines of lamination vertical and at right angles to the face. In this way the spalling off of small areas on the face of the work is prevented, but this method exposes the ends of the lines of lamination on the upper and projecting surface, and to prevent the penetration of moisture such surfaces should always be covered with lead.

#### DETAILS OF STONES

| Stone             | Descriptions   | Crushing Strength in tons per sq ft |
|-------------------|--|-------------------------------------|
| <b>Sandstones</b> |  |                                     |
| Robin             | Bluish-grey in colour—even grained, weathers well;   | 574                                 |
| Hood              | suitable for sills, etc.   |                                     |
| Bramley           | Coarse grained—hard and of excellent quality for   | 552                                 |
| Full              | heavy work   |                                     |
| Darley            | Very hard and close grained—light grey in colour and   | 517                                 |
| Dale              | of fine weathering qualities. Also known as “Stancliffe”.  |                                     |
| <b>Limestones</b> |  |                                     |
| Portland          | <i>Basebed.</i> Pale cream in colour, moderately weatherproof  | 205                                 |
|                   | <i>Whitbed.</i> Has a white or brown hue—harder than basebed. Takes a good arris and weathers exceptionally well | 218                                 |
|                   | <i>Roachbed.</i> Harder than other two but gives a broken appearance in mass                                     |                                     |

|               |  |           |
|---------------|--|-----------|
| Bath          | General colour creamy buff, but in several varieties. Harder stone, suitable for most classes of building work                         | 223 to 62 |
| Ancaster      | “ <i>Free Bed</i> ”. Fine grained, working—cream coloured. “ <i>Weather Bed</i> ”. Dark brown bluish-grey—a good general purpose stone | 218       |
| Clipsham      | A lime stone quarried in Rutland. The shelly variety is darker, and suitable for external work   | 272       |
| Bolsover Moor | A magnesian limestone, yellowish-brown, quarried in Derbyshire   | 484       |

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**Granites**

|           |   |       |
|-----------|---|-------|
| Rubislaw  | Generally very hard and durable and very suitable for plinths and lower courses of a building. Its hardness | 1,290 |
| Peterhead | makes it costly to work. Will take a high polish.   | 1,208 |
| Cornwall  |   | 1,060 |

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Collections of building stone samples can be seen at the Science Museum, London, the Building Centre, London, and at Cambridge.

# 10. THE BRICKLAYER

## CODES OF PRACTICE

**CP 101:1972:** Foundations and substructures for non-industrial buildings of not more than four storeys.

Information on site exploration, effects of weather, ground movement, bearing capacities and types of foundation.

**CP 102:1973:** Protection of buildings against water from the ground.

**Part 1:** prevention at or below ground floor level.

**Part 2:** damp-proofing walls and floors at ground level by use of dpc materials to B.S. 743.

**CP 111:1970:** Structural recommendations for loadbearing walls.

Covers walls of brickwork and blockwork. Requirements for loading, load dispersion, lateral support, effective height, length and thickness. (See tables, pages 197–199.)

**CP 121: Part 1:1973:** Brick and block masonry.

Covers erection of brick and block walls. Gives data on fire resistance, thermal transmittance and sound insulation and makes recommendations on excluding rain, reducing cracking, durability, mixing mortars, jointing and pointing.

**CP 122:** Walls and partitions of blocks and slabs.

**Part 1:1966:** deals with hollow glass blocks forming walls and partitions.

**CP 131:1974:** Chimneys and flues for domestic appliances burning solid fuel.

Design and construction of natural draught chimneys and flues built of brick.

**B.S. 5628:1979:** Code of Practice for the structural use of masonry.

**Part 1:** the use of blocks and brickwork as structural material (can be used as an alternative to CP 111).

## BRITISH STANDARDS

**B.S. 187:** Calcium silicate (sandlime and flintlime) bricks.

Covers materials, sizes (standard and dimensionally co-ordinated) appearance and methods of sampling and testing.



**REQUIREMENTS FOR CALCIUM SILICATE BRICKS (SANDLIME AND FLINTLIME) B.S. 187**

| Class | Use  | Minimum mean compressive strength (wet) of 10 bricks N/mm <sup>2</sup> | Minimum predicted lower limit of compressive strength. N/mm <sup>2</sup> | Maximum* Average drying test shrinkage of 3 bricks. % | Appearance   |
|-------|--|--|--|---|--|
| 7     | Brickwork that will be                           | 48.5   | 40.5   | 0.04  | All faces reasonably free from visible cracks and noticeable balls of clay, loam and lime. Bricks specified as for facing purposes to be of agreed colour and texture with the arrises of one face and end free from damage. |
| 6     | heavily loaded,                                  | 41.5   | 34.5   |   |  |
| 5     | repeatedly exposed to frost                      | 34.5   | 28.0   |   |  |
| 4     | while in a saturated condition                   | 27.5   | 21.5   |   |  |
| 3     | or continuously wet (e.g. normal under-building) | 20.5   | 15.5   |   |  |
| 2     | General use, external and internal.              | 14.0   | 10.0   |   |  |

\*No limit where the bricks are to be used under permanently damp conditions or for Class 2 commons.

*(Published by Calcium Silicate Brick Association)*

**TABLE 1. STIFFENING COEFFICIENT FOR WALLS STIFFENED BY PIERS**

| Pier spacing<br>(centre to centre)<br><u>Pier width</u> | Pier thickness<br><u>Effective wall thickness</u><br>(see Subclause 307a) |     |     |
|---|---|-----|-----|
|   | 1   | 2   | 3   |
| 6   | 1.0   | 1.4 | 2.0 |
| 10  | 1.0   | 1.2 | 1.4 |
| 20  | 1.0   | 1.0 | 1.0 |

Linear interpolation between the values given in this table is permissible, but not extrapolation outside the limits given.

**TABLE 2. SPACING OF TIES**

| Least leaf thickness (one or both) | Cavity width | Spacing of ties |            |
|------------------------------------|--------------|-----------------|------------|
|                                    |              | Horizontally    | Vertically |
| mm                                 | mm           | mm              | mm         |
| 75                                 | 50-75        | 450             | 450        |
| 90 or more                         | 50-75        | 900             | 450        |
| 90 or more                         | 75-100       | 750             | 450        |
| 90 or more                         | 100-150      | 450             | 450        |

The spacing may be varied provided that the number of ties per unit area is maintained.

**TABLE 3b. BASIC COMPRESSIVE STRESSES FOR BLOCKWORK MEMBERS (AT AND AFTER THE STATED TIMES)**

| Description of mortar    | Mix (parts by volume) |        |       | Hardening time after completion of work† | Basic stress in MN m <sup>2</sup> correspond to units whose crushing strength MN/m <sup>3</sup> ‡ is: |      |      |      |      |      |      |      |
|--------------------------|-----------------------|--------|-------|--|---|------|------|------|------|------|------|------|
|                          | Cement                | Lime   | Sand  |  | 2·8   | 3·5  | 7·0  | 10·5 | 14·0 | 21·0 | 28·0 | 35·0 |
|                          |                       |        |       |  | days  |      |      |      |      |      |      |      |
| Cement                   | 1                     | 0-1/4* | 3     | 7  | 0·28  | 0·35 | 0·70 | 1·05 | 1·25 | 1·70 | 2·10 | 2·50 |
|                          | 1                     | 1/2    | 4 1/2 | 14                                       | 0·28  | 0·35 | 0·70 | 0·95 | 1·15 | 1·45 | 1·75 | 2·10 |
| Cement-lime              | 1                     | 1      | 6     | 14                                       |   |      |      |      |      |      |      |      |
| Cement with plasticizer§ | 1                     | —      | 6     |  | 0·28  | 0·35 | 0·70 | 0·95 | 1·10 | 1·35 | 1·60 | 1·90 |
| Masonry cement           | —                     | —      | —     |  |   |      |      |      |      |      |      |      |
| Cement-lime              | 1                     | 2      | 9     | 14                                       |   |      |      |      |      |      |      |      |
| Cement with plasticizer§ | 1                     | —      | 8     |  | 0·28  | 0·35 | 0·55 | 0·85 | 1·00 | 1·20 | 1·45 | 1·70 |
| Masonry cement           | —                     | —      | —     |  |   |      |      |      |      |      |      |      |
| Cement-lime              | 1                     | 3      | 12    | 14                                       | 0·21  | 0·23 | 0·49 | 0·70 | 0·80 | 1·00 | 1·20 | 1·40 |
| Hydraulic lime           | —                     | 1      | 2     | 14                                       | 0·21  | 0·23 | 0·49 | 0·70 | 0·80 | 1·00 | 1·20 | 1·40 |
| Non-                     | —                     | 1      | 3     | 28¶                                      | 0·21  | 0·23 | 0·42 | 0·55 | 0·60 | 0·70 | 0·75 | 0·85 |

hydraulic

\*The inclusion of lime in cement mortars is optional.

† These periods should be increased by the full amount of any time during which the air temperature remains below 4.4°C, plus half the amount of any time during which the temperature is between 4.4°C and 10°C.

‡ Linear interpolation is permissible for units whose crushing strengths are intermediate between those given in the table.

§ Plastisicers must be used according to manufacturers' instructions.

|| Masonry cement mortars must be used according to manufacturers' instructions, mix proportions of masonry cement to sand should be such as to give comparable mortar crushing strengths with the cement: lime: sand mix of the grade.

¶ A longer period should ensue where hardening conditions are not very favourable.

**B.S. 493:** Airbricks and gratings for wall ventilation.

Part 1:1967: imperial units.

Part 2:1970: metric units, types and dimensions, wall-hold, etc.

**B.S. 743:1970:** Materials for damp-proof courses.

Selection and laying of damp-proof courses; mortar for bedding or laying of courses.

**TABLE 1. COMPOSITION OF BITUMEN DAMP-PROOF COURSES AND SHEETING**

| 1    | 2                         | 8   |
|------|---------------------------|---|
| Ref. | Type of damp-proof course | Minimum weight of complete material excluding packaging |
|      |                           | kg/m <sup>2</sup>                                       |
| A    | Hessian base              | 3.8   |
| B    | Fibre base                | 3.3   |
| C    | Asbestos base             | 3.8   |
| D    | Hessian base and lead     | 4.4   |
| E    | Fibre base and lead       | 4.4   |
| F    | Asbestos base and lead    | 4.9   |
| G    | Bitumen sheeting          | 5.4   |

**B.S. 1180:1972:** Concrete bricks and fixing bricks.

Bricks from natural and lightweight aggregates and cement.

**B.S. 1181:1971:** Clay flue linings and flue terminals.

Materials, workmanship, design, construction, dimensions, and tests etc.

**B.S. 1198:1199: and 1200:1976:** Building sands from natural sources.

B.S. 1200 covers sands for mortar for plain and reinforced brickwork.

Mortars for brickwork and blockwork.

Table 1 Choosing the mortar

| Type of construction   | *Time of construction | Mortar designation |    |     |    |   |                                     |    |     |    |   |  |   |   |
|--|-----------------------|--------------------|----|-----|----|---|-------------------------------------|----|-----|----|---|--|---|---|
|  |                       | For clay units     |    |     |    |   | For calcium silicate concrete units |    |     |    |   |  |   |   |
|  |                       | I                  | II | III | IV | V | I                                   | II | III | IV | V |  |   |   |
| External walls<br>outer leaf of cavity walls –<br>above dpc      | Winter<br>Summer      |                    |    | •   |    |   |                                     |    | •   |    |   |  | • |   |
| External walls –<br>below dpc                                    | All                   |                    | •  | •   |    |   |                                     |    | •   |    |   |  |   |   |
| Backing to external<br>solid walls                               | Winter<br>Summer      |                    |    | •   | •  |   |                                     |    | •   | •  |   |  | • |   |
| Internal walls and<br>inner leaf of cavity walls –<br>facing     | Winter<br>Summer      |                    |    | •   | •  |   |                                     |    | •   | •  |   |  | • |   |
| Internal walls and<br>inner leaf of cavity walls –<br>non facing | Winter<br>Summer      |                    |    | •   | •  | • |                                     |    | •   | •  |   |  | • | • |
| Copings and eills  | All                   | •                  |    |     |    |   |                                     |    | •   |    |   |  |   |   |
| Parapets and<br>domestic chimneys –<br>rendered                  | Winter<br>Summer      |                    | •  | •   |    |   |                                     |    |     | •  |   |  | • |   |
| Parapets and<br>domestic chimneys –<br>not rendered              | Winter<br>Summer      | •                  | •  | •   |    |   |                                     |    |     | •  |   |  | • |   |
| Retaining walls  | All                   | •                  |    |     |    |   |                                     |    | •   |    |   |  |   |   |
| External free-<br>standing walls                                 | All                   |                    | •  | •   |    |   |                                     |    |     |    |   |  | • |   |
| Manholes   | All                   |                    | •  |     |    |   |                                     |    |     |    |   |  | • |   |

\*as a general guide summer is April to October, winter is November to March

Table 2 Equivalent mortar mixes

| Mortar designation | Cement: lime: sand | Cement: coarse stuff* | Masonry cement: sand | Cement: sand with plasticizer |
|--------------------|--------------------|-----------------------|----------------------|-------------------------------|
| I                  | 1:0-1/4:3          | 1:3                   | –                    | –                             |
| II                 | 1:1/2:4-4 1/2      | 1:4-4 1/2             | 1:2 1/2-3 1/2        | 1:3-4                         |
| III                | 1:1:56             | 1:56                  | 1:4-5                | 1:5-6                         |
| IV                 | 1:2:8-9            | 1:8-9                 | 1:5 1/2-6 1/2        | 1:7-8                         |
| V                  | 1:3:10-12          | 1:10-12               | 1:6 1/2-7            | 1:8                           |

\* Coarse stuff may be purchased as ready mixed lime sand for mortar. Where alternative proportions of sand are shown eg 44 1/2 these relate to the grading of the sand. Use the lower limit if the sand is either coarse or uniformity fine use the higher limit if the sand is well-graded.

**P.D. 6472:1974:** Guide to specifying the quality of building mortars.

General considerations, forms of specification, storing, batching, mixing, use of mortar, choice of proportions, performance, specifications, etc.

**B.S. 1758:1966:** Fireclay refractories (bricks and shapes).

Chemical composition, dimensional and warpage limits.

**B.S. 2028:1364:1968:** Precast concrete blocks.

Specifies precast solid, hollow and cellular blocks and gives intended uses.

**TABLE 1 . DIMENSIONS**

| 1      | 2                   | 3          | 4                             |
|--------|---------------------|------------|-------------------------------|
| Block  | Length×Height       |            | Thickness (Work size)         |
|        | Co-ordinating* size | Work† size |                               |
| Type A | mm                  | mm         | mm                            |
|        | 400×100             | 390×90     | 75, 90, 100, 140 and 190      |
|        | 400×200             | 390×190    |                               |
|        | 450×225             | 440×215    | 75, 90, 100, 140, 190 and 215 |
| Type B | 400×100             | 390×90     | 75, 90, 100, 140 and 190      |
|        | 400×200             | 390×190    |                               |
|        | 450×200             | 440×190    | 75, 90, 100, 140, 190 and 215 |
|        | 450×225             | 440×215    |                               |
|        | 450×300             | 440×290    |                               |
|        | 600×200             | 590×190    |                               |
|        | 600×225             | 590×215    |                               |

| Block | Length×Height       |            | Thickness (Work size) |
|-------|---------------------|------------|-----------------------|
|       | Co-ordinating* size | Work† size |                       |
| TypeC | mm                  | mm         | mm                    |
|       | 400×200             | 390×190    | 60 and 75             |
|       | 450×200             | 440×190    |                       |
|       | 450×225             | 440×215    |                       |
|       | 450×300             | 440×290    |                       |
|       | 600×200             | 590×190    |                       |
|       | 600×225             | 590×215    |                       |

NOTE 1. Blocks of work size 448 mm×219 mm×51, 64, 76, 102, 152 or 219 mm thick, and 397 mm×194 mm×75, 92, 102, 143 and 194 mm thick will be produced as long as they are required.

NOTE 2. If blocks of entirely non-standard dimensions or design are required the limits of size or the design shall be agreed. Such blocks shall then be deemed to comply with this standard provided they comply with the other requirements.

\* Co-ordinating size. A size of the space, bounded by co-ordinating planes, allocated to a component, including the allowance for joints and tolerances.

† Work size. A size of a building component specified for its manufacture to which its actual size should conform within specified permissible deviations.

**B.S. 3679:1963:** Acid resisting bricks and tiles.

Dimensions and limits of porosity.

**2. SIZES**

Standard sizes of finished bricks and tiles shall be as follows:

| Bricks: | in   | mm             |
|---------|--|----------------|
|         | $8\frac{5}{8} \times 4\frac{1}{8} \times 2\frac{5}{8}$ | 219 × 105 × 67 |
|         | $8\frac{5}{8} \times 4\frac{1}{8} \times 2\frac{7}{8}$ | 219 × 105 × 73 |
|         | $8\frac{5}{8} \times 4\frac{1}{8} \times 2$            | 219 × 105 × 51 |
|         | $8\frac{5}{8} \times 4\frac{1}{8} \times 1\frac{1}{2}$ | 219 × 105 × 38 |
| Tiles:  |  |                |
|         | $8\frac{5}{8} \times 4\frac{1}{8} \times \frac{3}{8}$  | 219 × 105 × 22 |
|         | $6 \times 6 \times \frac{3}{8}$                        | 152 × 152 × 22 |
|         | $6 \times 6 \times \frac{1}{2}$                        | 152 × 152 × 13 |
|         | $6 \times 6 \times \frac{3}{4}$                        | 152 × 152 × 19 |
|         | $6 \times 6 \times 1$                                  | 152 × 152 × 25 |
|         | $6 \times 6 \times 1\frac{1}{4}$                       | 152 × 152 × 32 |

The manufacturer shall be permitted to correct dimensional faults by machining if necessary.

**B.S. 3798:1964:** Coping units (of clayware, unreinforced cast concrete, unreinforced cast stone, natural stone and slate).

Requirements, materials, workmanship and dimensions.

**B.S. 3921:1974:** Clay bricks and blocks.

Requirements for clay bricks and blocks (See tables overleaf.)

**TABLE 1. STANDARD FORMAT (BRICKS)**

| Designation  | Work size |       |        |
|--------------|-----------|-------|--------|
|              | Length    | Width | Height |
|              | mm        | mm    | mm     |
| 225×112.5×75 | 215       | 102.5 | 65     |

**TABLE 2. STANDARD FORMATS (BLOCKS)**

| Designation | Work size |       |        |
|-------------|-----------|-------|--------|
|             | Length    | Width | Height |
|             |           |       |        |

|              |     |      |     |
|--------------|-----|------|-----|
|              | mm  | mm   | mm  |
| 200×62.5×225 | 290 | 62.5 | 215 |
| 300×75×225   | 290 | 75   | 215 |
| 300×100×225  | 290 | 100  | 215 |
| 300×150×225  | 290 | 150  | 215 |

In addition, half blocks, 140 mm long, and three-quarter blocks, 215 mm long, shall be available for bonding.

**TABLE 3. LIMITS OF SIZE (24 BRICKS)**

| Work size (see Table 1) | Overall measurement of 24 bricks | Limits of size |         |
|-------------------------|----------------------------------|----------------|---------|
|                         |                                  | Maximum        | Minimum |
| mm                      | mm                               | mm             | mm      |
| 215                     | 5160                             | 5235           | 5085    |
| 102.5                   | 2460                             | 2505           | 2415    |
| 65                      | 1560                             | 1605           | 1515    |

NOTE 1. This method of measurement is also recommended for non-standard bricks. The limits applied to the length, width and height sizes should then be directly proportional to those specified for the corresponding dimensions of the standard brick.

NOTE 2. In the past certain manufacturers have, by special arrangement, supplied bricks to closer limits than those quoted. Where for special reasons closer limits are required it is therefore suggested that this can best be done by agreement between the user and the manufacturer on the basis of the latter's routine control charts of brick sizes.

NOTE 3. See also Appendices A† and B‡.

**D.D. 34:1974:** Clay bricks with modular dimensions.

Requirements for clay bricks with modular dimensions.

**TABLE 1. MODULAR FORMATS**

| Designation | Work size |       |        |
|-------------|-----------|-------|--------|
|             | Length    | Width | Height |
|             | mm        | mm    | mm     |
| 300×100×100 | 288       | 90    | 90     |
| 200×100×100 | 190       | 90    | 90     |
| 300×100×75  | 288       | 90    | 65     |
| 200×100×75  | 190       | 90    | 65     |

**TABLE 2. LIMITS OF SIZE (24 BRICKS)**

| Work size (see Table | Overall measurement of 24 | Limits of size |
|----------------------|---------------------------|----------------|
|----------------------|---------------------------|----------------|

| 1)  | bricks | Maximum | Minimum |
|-----|--------|---------|---------|
| mm  | mm     | mm      | mm      |
| 65  | 1560   | 1605    | 1515    |
| 90  | 2160   | 2205    | 2115    |
| 190 | 4560   | 4626    | 4494    |
| 288 | 6912   | 7012    | 6812    |

*Notes* It is apparent from the evidence of control charts made available to the committee that some bricks such as hand made and stock bricks which are sought after for their other properties have some difficulty in meeting the present dimensional specification consistently. Others could meet a closer specification, although not 100% of the time; manufacturers of these bricks have sometimes, in the past, supplied bricks to closer tolerance by special arrangement with the user.

The limits and acceptance clauses in B.S. 3921:1974 have been based on notional tolerances for individual bricks of  $\pm 6.4$  mm on length and  $\pm$  mm on width and thickness. In this Draft for Development the tolerances and standard deviations for the 65 mm and 90 mm work sizes have been assumed to be equal to those for the 65 mm and 102.5 mm work sizes in B.S. 3921:1974. The tolerances and standard deviations for the 190 mm and 288 mm work sizes have been calculated from those for the 215 mm work size by assuming that the parameters concerned are proportional to work size. This assumption appears reasonable.

If in the light of future experience the assumption is found to be incorrect, the tolerances may then be altered. In the meantime manufacturers may still, as in the past, supply bricks to closer tolerances by special arrangement with the user.

**B.S. 4729:1971:** Shapes and dimensions of special bricks.

Shapes and dimensions for a special range of bricks.

**BRICK REQUIREMENTS**

**PER UNIT AREA OF HALF BRICK THICK WALL SURFACE**

|                 | Per square yard |       |       | Per square metre |               |               |
|-----------------|-----------------|-------|-------|------------------|---------------|---------------|
| Joint thickness | 6 mm            | 10 mm | 13 mm | 6 mm (0.24")     | 10 mm (0.39") | 13 mm (0.51") |

**BRICK FACE**



|              |      |      |      |      |      |      |
|--------------|------|------|------|------|------|------|
| 215 mm×65 mm | 53.3 | 49.5 | 47.0 | 63.7 | 59.3 | 56.2 |
| 290 mm×65 mm | 39.8 | 37.2 | 35.4 | 47.7 | 44.5 | 42.4 |
| 215 mm×70 mm | 49.8 | 46.5 | 44.2 | 59.5 | 55.6 | 52.9 |
| 290 mm×90 mm | 29.4 | 27.9 | 26.8 | 35.3 | 33.3 | 32.0 |
| 215 mm×50 mm | 67.6 | 61.9 | 58.2 | 80.8 | 74.1 | 69.6 |
| 190 mm×90 mm | 44.4 | 41.8 | 40.0 | 53.1 | 50   | 47.8 |
| 190 mm×65 mm | 60.1 | 55.7 | 52.8 | 71.9 | 66.7 | 63.3 |

(No allowance for cutting and wastage)

(Source: The Brick Development Association)

For walls of more than one thickness the number of bricks required can be obtained by multiplying the appropriate value in the above table, by the thickness multiple, e.g.:

$$\text{Wall thickness 327 mm using } 215 \times 102.5 \times 65 \text{ mm brick} = \frac{327}{102.5}$$

=3 approx. allowing for collar joint thickness. Therefore number of bricks required per m<sup>2</sup>=59.5×3.

### MORTAR REQUIRED FOR WALLS OF HALF OR WHOLE BRICK THICKNESS

|                    |             | Cubic Metre of Mortar per Metre Super of Brickwork |         |             |         |
|--------------------|-------------|--|---------|-------------|---------|
| Size of Brick (mm) | Joints (mm) | Half Brick   |         | Whole Brick |         |
|                    |             | Wirecut  | Frogged | Wirecut     | Frogged |
| 215×102.5×65       | 6           | 0.011  | 0.016   | 0.035       | 0.040   |
| 215×102.5×70       | 6           | 0.011  | 0.015   | 0.034       | 0.045   |
| 215×102.5×50       | 6           | 0.013  | 0.021   | 0.040       | 0.055   |
| 190×90×90          | 6           | 0.008  | 0.013   | 0.029       | 0.040   |
| 190×90×65          | 6           | 0.010  | 0.017   | 0.033       | 0.047   |
| 215×102.5×65       | 10          | 0.018  | 0.024   | 0.048       | 0.060   |
| 215×102.5×70       | 10          | 0.017  | 0.022   | 0.046       | 0.056   |
| 215×102.5×50       | 10          | 0.021  | 0.028   | 0.055       | 0.068   |

|                    |             | Cubic Metre of Mortar per Metre Super of Brickwork |         |             |         |
|--------------------|-------------|--|---------|-------------|---------|
| Size of Brick (mm) | Joints (mm) | Half Brick   |         | Whole Brick |         |
|                    |             | Wirecut  | Frogged | Wirecut     | Frogged |
| 190×90×90          | 10          | 0.013  | 0.017   | 0.039       | 0.048   |
| 190×90×65          | 10          | 0.016  | 0.022   | 0.045       | 0.057   |

|              |    |       |       |       |       |
|--------------|----|-------|-------|-------|-------|
| 215×102.5×65 | 13 | 0.022 | 0.027 | 0.057 | 0.067 |
| 215×102.5×70 | 13 | 0.021 | 0.026 | 0.056 | 0.066 |
| 215×102.5×50 | 13 | 0.026 | 0.033 | 0.040 | 0.054 |
| 190×90×90    | 13 | 0.016 | 0.021 | 0.046 | 0.055 |
| 190×90×65    | 13 | 0.020 | 0.025 | 0.052 | 0.063 |

**APPROXIMATE WEIGHTS OF DRY AND WET BRICKWORK IN 1:3  
CEMENT: SAND: MORTAR**

| Types of brick                                     | DRY  |                   | SATURATED          |                   |
|--|--|-------------------|--------------------|-------------------|
|  | lb/ft <sup>3</sup>   | kg/m <sup>3</sup> | lb/ft <sup>3</sup> | kg/m <sup>3</sup> |
| Cellular Flettons                                  | App. 80  | 1280              | App. 90            | 1440              |
| Most clay and sand-lime,<br>common & facing bricks | 105–121  | 1680–1940         | 124–134            | 1980–2150         |
| Most clay engineering<br>bricks                    | 124–146  | 1980–2340         | 134–149            | 2150–2390         |
| Concrete bricks                                    | Weight varies over wide range according to whether bricks are made with normal or lightweight aggregates |                   |                    |                   |

(No allowance made for wastage)

*(Source: The Brick Development Association)*

**QUANTITIES OF BRICKS AND MORTAR USED IN WALLING**

The following quantities have been arrived at by calculation assuming joints to be filled. Only two cases are given, one for a solid wirecut and the other for a single frog brick laid frog up. The frog volume is taken as 73.7 cm<sup>3</sup>.

In the case of double frog bricks, the mortar quantity should be increased by about 5 per cent. It is difficult to estimate how much mortar enters perforations in the case of perforated bricks since this depends on the pattern and size of perforations.

Modular metric bricks of the 300 module are perforated although one manufacturer has produced a solid brick experimentally in the 300×100×75 format. In the 200 module, the bricks may be either solid or perforated. In the case of the modular metric range therefore, it has been assumed that as much mortar would enter the perforations of the 300 format as would be present in a single frog brick of standard size (*e.g.* about 75 cm<sup>3</sup>). For the 200 format perforated brick, the mortar entering the perforations has been assumed to be 50 cm<sup>3</sup>.

No allowance has been made for wastage, nor are the figures applicable to deep frog or calculon or cellular bricks.

**1. QUANTITY OF MORTAR PER 1000 BRICKS (m<sup>3</sup>)**

|      |                 |               |             |
|------|-----------------|---------------|-------------|
| 1.1. | Standard bricks | Solid wirecut | Single frog |
|      | 102.5 mm wall   | 0.30          | 0.37        |

|        |                       |       |            |
|--------|-----------------------|-------|------------|
|        | 215 mm wall           | 0.38  | 0.46       |
|        | 327.5 mm wall         | 0.41  | 0.48       |
|        | 440 mm wall           | 0.42  | 0.50       |
| 1.2.   | Modular metric bricks | Solid | Perforated |
| 1.2.1. | 90 mm wall            |       |            |
|        | 300×100×100 format    | —     | 0.44       |
|        | 300×100×75 format     | 0.34  | 0.41       |
|        | 200×100×100 format    | 0.26  | 0.31       |
|        | 200×100×75 format     | 0.24  | 0.29       |
| 1.2.2. | 190 mm wall           |       |            |
|        | 200×100×100 format    | 0.36  | 0.41       |
|        | 200×100×75 format     | 0.31  | 0.36       |

## 2. QUANTITIES OF BRICKS AND MORTAR PER m<sup>2</sup> OF WALLING

| 2.1.   | Standard bricks       | Bricks | Mortar—m <sup>3</sup> |                |
|--------|-----------------------|--------|-----------------------|----------------|
|        |                       |        | Solid wirecut         | Single frog    |
|        | 102.5 mm wall         | 59.26  | 0.018                 | 0.022          |
|        | 215 mm wall           | 118.52 | 0.045                 | 0.054          |
|        | 327.5 mm wall         | 117.78 | 0.073                 | 0.086          |
|        | 440 mm wall           | 237.04 | 0.101                 | 0.118          |
| 2.2.   | Modular metric bricks | Bricks | Mortar—m <sup>3</sup> |                |
|        |                       |        | Solid                 | Perforated     |
| 2.2.1. | 90 mm wall            |        |                       |                |
|        | 300×100×100 format    | 33.33  | —                     | 0.015          |
|        | 300×100×75 format     | 44.44  | 0.015                 | 0.018          |
|        | 200×100×100 format    | 50.00  | 0.013                 | 0.016          |
|        | 200×100×75 format     | 66.67  | 0.016                 | 0.019          |
| 2.2.2. | 190 mm wall           |        |                       |                |
|        | 200×100×100 format    | 100.00 | 0.036                 | 0.041          |
|        | 200×100×75 format     | 133.33 | 0.042                 | 0.048          |
| 2.2    | Modular metric bricks | Bricks | Mortar                | m <sup>3</sup> |
|        |                       |        | Solid                 | Perforated     |
| 2.2.3. | 290 mm wall           |        |                       |                |
|        | 200×100×100 format    | 150.00 | 0.059                 | 0.067          |
|        | 200×100×75 format     | 200.00 | 0.068                 | 0.078          |

## 3. QUANTITY OF CONSTITUENTS PER m<sup>3</sup> WET MORTAR

| Nominal mix properties | Cement (tonne) | Hydrated lime (tonne) | Sand (m <sup>3</sup> ) |
|------------------------|----------------|-----------------------|------------------------|
| 1:3                    | 0.50           | —                     | 1.04                   |
| 1:4                    | 0.40           | —                     | 1.12                   |

|        |      |      |      |
|--------|------|------|------|
| 1:1:6  | 0.26 | 0.12 | 1.10 |
| 1:2:9  | 0.19 | 0.17 | 1.13 |
| 1:3:12 | 0.13 | 0.19 | 1.14 |

(Source: *The Brick Development Association*)

### MORTAR FOR POINTING

- One yard super of brick facings and mortar for pointing equals
  - 64 bricks and 1/5 cu. ft of mortar in Flemish bond.
  - 72 bricks and 1/4 cu. ft of mortar in English bond.
  - 48 bricks and 1/6 cu. ft of mortar in stretcher bond (as in hollow walls).
- One yard super of half-brick walling equals
  - 48 bricks and 3/4 cu. ft mortar.
- One yard super of brick-nogging equals
  - 48 bricks and 3/4 cu. ft of mortar if laid flat.
  - 32 bricks and 1/2 cu. ft of mortar if laid on edge.

### METRIC

Metric equivalents using the 225×112.5×75 mm brick, which is not exactly divisible into square metre units, would be:

- 79 bricks and .0056 m<sup>3</sup> mortar using Flemish bond.
- 89 bricks and .007 m<sup>3</sup> mortar using English bond.
- 59 bricks and .0037 m<sup>3</sup> mortar using stretcher bond.
- One square metre of half-brick walling equals
  - 59 bricks and .021 m<sup>3</sup> mortar.
- One square metre of brick nogging equals
  - 59 bricks and .021 m<sup>3</sup> mortar laid flat.
  - 40 bricks and .014 m<sup>3</sup> mortar laid on edge.
- One load of mortar equals 1 cu. yd or 27 cu. ft or 1 m<sup>3</sup>.

(Source: *The Brick Development Association*)

**TABLE 1. MATERIALS FOR DAMP-PROOF COURSES**

| Material          | Weight<br>kg/m <sup>2</sup> | Thickness<br>mm | Joint treatment to<br>prevent water<br>moving: |          | Structural<br>Performance | Durabilit                  |
|-------------------|-----------------------------|-----------------|--|----------|---------------------------|----------------------------|
|                   |                             |                 | upward   | downward |                           |                            |
| <b>GROUP A:</b>   |                             |                 |  |          |                           |                            |
| <b>FLEXIBLE</b>   |                             |                 |  |          |                           |                            |
| Lead to<br>BS1173 | Code<br>No. 4               |                 | Lapped at<br>least 100                         | weltd    | Will not<br>extrude under | Very suitable<br>high-rise |

mm preferably 150 mm pressures met in normal construction. construction. Corrodes when built in with freshly laid lime or cement mortar.

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|   |                   |  |        |  |                                |
|---|-------------------|--|--------|--|--------------------------------|
| Copper to BS2670, Grade A annealed condition. | Approx.0.25 2.28* | Lapped at least 100 mm preferably 150 mm | welted | Will not extrude under pressures met in normal construction. | Highly resistant to corrosion. |
|---|-------------------|--|--------|--|--------------------------------|

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|                              |     |   |                        |                 |   |   |
|------------------------------|-----|---|------------------------|-----------------|---|---|
| Bitumen to BS743.            |     |   |                        |                 |   |   |
| A—hessian base               | 3.8 | — | Lapped at least 100 mm | Lapped & sealed | Likely to extrude under heavy pressure but this is unlikely to affect water resistance. | The hessian or felt may decay but this does not affect efficiency if the bitumen remains undisturbed. Types D, E & F are most suitable for buildings where life is extended have a very long life or where there is risk of movement. |
| B—fibre base                 | 3.3 | — | mm                     |                 |   |   |
| C—asbestos base              | 3.8 | — |                        |                 |   |   |
| D—hessian base and lead      | 4.4 | — |                        |                 |   |   |
| E—fibre base and lead        | 4.4 | — |                        |                 |   |   |
| F—asbestos base and lead     | 4.9 | — |                        |                 |   |   |
| G—sheeting with hessian base | 5.4 | — |                        |                 |   |   |

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|   |   |   |                                      |  |  |
|---|---|---|--------------------------------------|--|--|
| Generally to BS743: Type A based but with aluminium, copper, or plastic core. | — | — | As for other bitumen based materials |  |  |
|---|---|---|--------------------------------------|--|--|

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| Material                               | Minimum                     | Joint treatment to prevent water moving: |   | Structural Performance   | Durability   | co   |
|--|-----------------------------|--|---|--|--|--|
|  | Weight<br>kg/m <sup>2</sup> | Thickness<br>mm                          | upward  |  |  |  |
| Polythene, black, low density—to BS743 | Approx.0.46<br>0.5          | Lapped                                   | weltd<br>for<br>distance<br>at least<br>equal to<br>width<br>of dpc | Will not<br>extrude underof<br>pressures met<br>in normal<br>construction. | No evidence<br>of<br>deterioration<br>in contact<br>with other<br>building<br>materials. | W<br>m<br>co<br>W<br>ca<br>ex<br>ele<br>ma<br>ne<br>in<br>the<br>thi<br>the<br>of<br>pr<br>pe<br>dri |

**AGREEMENT CERTIFICATES:**

|  |      |        |                              |   |  |   |
|--|------|--------|------------------------------|---|--|---|
| **No. 73/159-1.67<br>Black<br>polythene<br>sheet     | 1.14 | Lapped | weltd<br>at least<br>100 mm  | Will not<br>extrude under<br>load up to<br>point of<br>compressive<br>failure of the<br>wall. | Tough,<br>remains<br>flexible over<br>temperature<br>range likely<br>to occur in<br>service<br>when used<br>in orthodox<br>manner. | At<br>and be<br>lia<br>overda<br>likely<br>in<br>ortho<br>manner.<br>Ac<br>co<br>lat<br>m<br>wi<br>pe<br>be<br>im<br>rec<br>rei |
| **No. 73/173-1.5<br>Black<br>pitch /polymer<br>sheet | 1.3  | Lapped | Lapped &<br>sealed<br>100 mm | as above  | Unlikely to<br>be impaired<br>by any of<br>the<br>movements<br>normally<br>occurring up<br>to point of<br>failure of<br>the wall   | At<br>co<br>lat<br>m<br>wi<br>pe<br>be<br>im<br>rec<br>rei  |

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|-------------------|------|--------------------------|----------|----------|-----|
| **No. 73/174-1.45 | 1.19 | Lapped Lapped & as above | as above | as above | He  |
| Black             |      | at least sealed          |          |          | ex  |
| Ditch/polymer     |      | 100 mm                   |          |          | el: |
| sheet             |      |                          |          |          | rec |
|                   |      |                          |          |          | ch  |
|                   |      |                          |          |          | Di  |
|                   |      |                          |          |          | for |
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|                   |      |                          |          |          | to  |
|                   |      |                          |          |          | sat |
|                   |      |                          |          |          | se: |

|  | Minimum                     | Joint treatment to prevent water moving: | Structural Performance                                  | Durability   | O consid   |  |
|--|-----------------------------|--|---|--|--|--|
| Material   | Weight<br>kg/m <sup>2</sup> | Thickness<br>mm                          | upward  | downward   |  |  |
| **No. 73/197-Black low density polythene sheet, both faces knurled | 0.87                        | 0.84                                     | Lapped for distance at least equal to width of dpc—min. | weltd<br>Will not extrude compressive loads when a wall. | Tough, underresilient and remains inflexible over the temperature range likely to occur under servicesliding | The kr surface increa: friction and we and in: resista |

|           |      |       |                 |               |               |
|-----------|------|-------|-----------------|---------------|---------------|
|           |      | 100mm |                 | conditions.   | wet m         |
|           |      |       |                 |               | Must r        |
|           |      |       |                 |               | laid or       |
|           |      |       |                 |               | mortar        |
| **No.     | 2.35 | 2.0   | Lapped Lapped & | Resistance to | Resistance to |
| 73/201-   |      |       | at least sealed | extrusion     | damage due    |
| Asbestos  |      |       | 100 mm          | under load    | to normal     |
| based     |      |       |                 | better than   | structural    |
| sheet,    |      |       |                 | traditional   | movement      |
| with      |      |       |                 | bitumen felt  | similar to    |
| coarse    |      |       |                 | dpc           | traditional   |
| sand      |      |       |                 |               | bitumen felt  |
| finish on |      |       |                 |               | dpc. Sanded   |
| each side |      |       |                 |               | surfaces      |
|           |      |       |                 |               | increase      |
|           |      |       |                 |               | bond          |
|           |      |       |                 |               | between dpc   |
|           |      |       |                 |               | and mortar,   |
|           |      |       |                 |               | and           |
|           |      |       |                 |               | increased     |
|           |      |       |                 |               | resistance to |
|           |      |       |                 |               | both shear    |
|           |      |       |                 |               | and tensile   |
|           |      |       |                 |               | loading       |
|           |      |       |                 |               | when          |
|           |      |       |                 |               | compared to   |
|           |      |       |                 |               | conventional  |
|           |      |       |                 |               | bitument felt |
|           |      |       |                 |               | dpc.          |

**GROUP B: SEMI-RIGID**

|            |   |   |                   |                     |                     |         |
|------------|---|---|-------------------|---------------------|---------------------|---------|
| Mastic     | — | — | No joint problems | Liable to           | No                  | To pro  |
| asphalt to |   |   |                   | extrude             | underdeterioration. | for mc  |
| BS1097     |   |   |                   | pressures           |                     | below   |
| or         |   |   |                   | above 65            |                     | course  |
| BS1418     |   |   |                   | KN/m <sup>2</sup> . |                     | brickw  |
|            |   |   |                   | Material of         |                     | should  |
|            |   |   |                   | hardness            |                     | beaten  |
|            |   |   |                   | appropriate         |                     | asphal  |
|            |   |   |                   | to conditions       |                     | immec   |
|            |   |   |                   | should be           |                     | after   |
|            |   |   |                   | used.               |                     | applic: |
|            |   |   |                   |                     |                     | left pr |
|            |   |   |                   |                     |                     | surface |
|            |   |   |                   |                     |                     | Altern  |



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**GROUP C: RIGID**

|  |   |   |   |                 |  |                      |   |
|--|---|---|---|-----------------|--|----------------------|---|
| Brick to<br>BS3921<br>maximum<br>water<br>absorption<br>4.5% | — | — | — | Not<br>suitable | Has tensile<br>bending<br>strength<br>equal to that<br>of main wall. | No<br>deterioration. | Use tw<br>course<br>break ;<br>bedded<br>Portlan<br>cemen |
|--|---|---|---|-----------------|--|----------------------|---|

| Material   | Minimum                     | Joint treatment to<br>prevent water<br>moving: |        | Structural<br>Performance  | Durability           | O<br>consic |
|--|-----------------------------|--|--------|--|----------------------|-------------|
|  | Weight<br>kg/m <sup>2</sup> | Thickness<br>mm                                | upward |  |                      |             |
| Slates at<br>least 230<br>mm long;<br>should<br>pass<br>wetting<br>and<br>drying test<br>and acid-<br>immersion<br>test of<br>BS3798 | —                           | 5.0  | —      | Not<br>suitable,<br>although<br>they may<br>sometimes<br>be used to<br>resist<br>lateral<br>movement<br>of water | No<br>deterioration. | as abo      |

*\*Where copper is to form in one piece a dpc and a projecting drip of flashing it sh weigh at least 4.12 kg/m2.*

*\*\* Proprietary material.*

(Source: BDA Practical Note 'Damp-proofing courses and flashings with brick blockwork'. Published by the Brick Development Association.)

# 11. THE CARPENTER AND JOINER

## CONVERSION TABLES (FOR TIMBER ONLY)

| Inches | Millimetres | Feet | Metres |       |
|--------|-------------|------|--------|-------|
| 1      |             | 25   | 1      | 0.300 |
| 2      |             | 50   | 2      | 0.600 |
| 3      |             | 75   | 3      | 0.900 |
| 4      |             | 100  | 4      | 1.200 |
| 5      |             | 125  | 5      | 1.500 |
| 6      |             | 150  | 6      | 1.800 |
| 7      |             | 175  | 7      | 2.100 |
| 8      |             | 200  | 8      | 2.400 |
| 9      |             | 225  | 9      | 2.700 |
| 10     |             | 250  | 10     | 3.000 |
| 11     |             | 275  | 11     | 3.300 |
| 12     |             | 300  | 12     | 3.600 |
| 13     |             | 325  | 13     | 3.900 |
| 14     |             | 350  | 14     | 4.200 |
| 15     |             | 375  | 15     | 4.500 |
| 16     |             | 400  | 16     | 4.800 |
| 17     |             | 425  | 17     | 5.100 |
| 18     |             | 450  | 18     | 5.400 |
| 19     |             | 475  | 19     | 5.700 |
| 20     |             | 500  | 20     | 6.000 |
| 21     |             | 525  | 21     | 6.300 |
| 22     |             | 550  | 22     | 6.600 |
| 23     |             | 575  | 23     | 6.900 |
| 24     |             | 600  | 24     | 7.200 |

(Basics: 25mm=1 in. 0.300m=1 ft.)

## STANDARDS (TIMBER) TO CUBIC METERS AND CUBIC METRES TO STANDARDS (TIMBER)\*

| Cu. metres | Standards |
|------------|-----------|
| 5          | 0.2       |
| 9          | 0.4       |
| 14         | 0.6       |
| 19         | 0.9       |
| 23         | 1.1       |

|     |     |      |
|-----|-----|------|
| 28  | 6   | 1.3  |
| 33  | 7   | 1.5  |
| 37  | 8   | 1.7  |
| 42  | 9   | 1.9  |
| 47  | 10  | 2.1  |
| 93  | 20  | 4.3  |
| 140 | 30  | 6.4  |
| 187 | 40  | 8.6  |
| 234 | 50  | 10.7 |
| 280 | 60  | 12.8 |
| 327 | 70  | 15.0 |
| 374 | 80  | 17.1 |
| 421 | 90  | 19.3 |
| 467 | 100 | 21.4 |

\*Note: The above are approximate values. The cubic metres have been rounded off to the nearest whole number. Factors for use on calculating machines are:

1 cu. metre—35.3148 cu. ft—0.21403 std.

1 cu. ft—0.028317 cu. metre 1 std—4.67227 cu. metres.

**BASIC METRIC TIMBER SIZES WITH IMPERIAL EQUIVALENTS AND RUNNING FEET AND METERS PER CUBIC METRE SOFTWOOD**

| Thickness<br>in. | mm | WIDTH   |          |              |          |          |          |          |          |           |               |        |
|------------------|----|---------|----------|--------------|----------|----------|----------|----------|----------|-----------|---------------|--------|
|                  |    | 3<br>75 | 4<br>100 | 4 5/8<br>115 | 5<br>125 | 6<br>150 | 7<br>175 | 8<br>200 | 9<br>225 | 10<br>250 | 12in<br>300mm |        |
| 5/8              | 16 | 2467    | 1851     |              | 1480     | 1234     |          |          |          |           |               | ft     |
|                  |    | 751     | 563      |              | 551      | 376      |          |          |          |           |               | metres |
| 3/4              | 19 | 2256    | 1692     |              | 1393     | 1128     |          |          |          |           |               | ft     |
|                  |    | 687     | 514      |              | 424      | 343      |          |          |          |           |               | metres |
| 7/8              | 22 | 1905    | 1428     |              | 1152     | 952      |          |          |          |           |               | ft     |
|                  |    | 583     | 434      |              | 351      | 282      |          |          |          |           |               | metres |
| 1                | 25 | 1694    | 1296     |              | 1038     | 864      | 726      | 648      | 564      | 519       | 432           | ft     |
|                  |    | 516     | 394      |              | 316      | 263      | 221      | 197      | 171      | 156       | 131           | metres |
| 1 1/4            | 32 | 1272    | 925      | 887          | 740      | 636      | 545      | 462      | 424      | 370       | 318           | ft     |
|                  |    | 387     | 282      | 270          | 255      | 193      | 166      | 140      | 129      | 112       | 96            | metres |
| 1 1/2            | 38 | 1128    | 846      | 720          | 677      | 564      | 483      | 423      | 379      | 338       | 282           | ft     |
|                  |    | 344     | 257      | 219          | 206      | 162      | 147      | 128      | 115      | 103       | 85            | metres |
| 1 3/4            | 44 | 952     | 735      | 627          | 588      | 476      | 408      | 367      | 314      | 294       | 238           | ft     |
|                  |    | 290     | 224      | 191          | 179      | 145      | 124      | 111      | 95       | 89        | 72            | metres |
| 2                | 50 | 864     | 648      | 551          | 518      | 432      | 370      | 324      | 288      | 259       | 216           | ft     |
|                  |    | 263     | 197      | 167          | 157      | 131      | 112      | 98       | 84       | 79        | 65            | metres |
| 2 1/2            | 63 |         | 475      |              | 380      | 318      | 272      | 247      | 212      |           |               | ft     |
|                  |    |         | 144      |              | 115      | 96       | 82       | 75       | 64       |           |               | metres |
| 3                | 75 |         | 432      |              | 345      | 282      | 240      | 216      | 188      | 172       | 141           | ft     |
|                  |    |         | 131      |              | 105      | 85       | 73       | 65       | 57       | 52        | 42            | metres |

|    |     |     |     |     |     |          |
|----|-----|-----|-----|-----|-----|----------|
| 4  | 100 | 324 | 211 | 162 | 129 | 105ft    |
|    |     | 98  | 64  | 49  | 39  | 32metres |
| 6  | 150 |     | 141 | 108 |     | 71ft     |
|    |     |     | 42  | 32  |     | 21metres |
| 8  | 200 |     |     | 81  |     | ft       |
|    |     |     |     | 24  |     | metres   |
| 10 | 250 |     |     |     | 47  | ft       |
|    |     |     |     |     | 14  | metres   |
| 12 | 300 |     |     |     |     | 36ft     |
|    |     |     |     |     |     | 10metres |

*Note:*The sizes in the table opposite are basic sizes, as imported, and can of course be resawn to other dimensions and/or surfaced as required. The sizes given above are calculated on the basis of 25 mm to 1 inch. As imported, some timbers will be over these sizes, being calculated on the basis of 25.4mm to 1 inch.

### BASIC METRIC TIMBER SIZES

#### HARDWOOD

Thickness, in mm

19, 25, 32, 38, 50, 63, 75, 100, rising by 25mm stages.

150mm and up, by increments of 10mm "Strips" and "narrows".

50mm and up, by increments of 10mm.

Length, in metres

1.80m, rising by increments of 10cm "Shorts" (regularly imported of certain species only). Falling from 1.70m by stages of 10cm.

#### PRICES PER STANDARD AND PER CUBIC METRE

| per standard £ | per m <sup>3</sup> £ | per standard £ | per m <sup>3</sup> £ |
|----------------|----------------------|----------------|----------------------|
| 1              | 0.21                 | 20             | 4.35                 |
| 2              | 0.43                 | 30             | 6.52                 |
| 3              | 0.65                 | 40             | 8.70                 |
| 4              | 0.87                 | 50             | 10.88                |
| 5              | 1.08                 | 100            | 21.76                |
| 10             | 2.17                 | 200            | 43.52                |

**PLYWOOD: COMPARATIVE THICKNESS**

Table showing standard thicknesses in millimeters of plywood and block boards and the equivalent in parts of an inch.

| Milli-<br>metres | Inches              | Milli-<br>metres | Inches              | Milli-<br>metres | Inches             | Milli-<br>metres | Inches               |
|------------------|---------------------|------------------|---------------------|------------------|--------------------|------------------|----------------------|
| .8               | $\frac{1}{32}$ full | 5                | $\frac{3}{16}$ full | 15               | $\frac{5}{8}$ bare | 25               | 1                    |
| 1.5              | $\frac{1}{8}$       | 6                | $\frac{1}{4}$       | 16               | $\frac{5}{8}$ full | 26               | 1 full               |
| 2.5              | $\frac{3}{16}$ full | 9                | $\frac{3}{8}$       | 18               | $\frac{3}{4}$      | 32               | 1 $\frac{1}{2}$ full |
| 3.0              | $\frac{1}{4}$ bare  | 10               | $\frac{3}{8}$ full  | 19               | $\frac{3}{4}$ full | 38               | 1 $\frac{1}{2}$ full |
| 4.0              | $\frac{1}{4}$ bare  | 12               | $\frac{1}{2}$ bare  | 22               | $\frac{7}{8}$ full | —                | —                    |
| 4.5              | $\frac{3}{8}$       | 12.5             | $\frac{1}{2}$       | 24               | 1 bare             | —                | —                    |

**MARKING OUT**

Full-size working drawings or ‘rods’ are not difficult to read if plans’ elevations, sections and projections are not super-imposed one on top of the other. This is very often done with half-inch and such details supplied by architects, but this practice can lead to costly error, unless the craftsman is conversant with the methods employed by the technician, draughtsman or foreman who sets out the ‘rods’.

It is an invariable rule when reading a rod that the face side is to the front (or bottom) and the top is to the left. Paper rods, as used by shop-fitters, are often dyeline prints. They should always be dimensioned. Never ‘offer up’ any piece of work to a paper rod, because it is often inaccurate, due to expansion of the paper in the printing process.

Joints are not always fully or accurately shown; it is safe to take established dimensions or proportions. Dovetails are traditionally 1/6 of the thickness of the material at the root and 1/2 that thickness at the broadest part. Tenons are usually 1/3 the thickness of the stuff, and double tenons are 1/5 of the thickness.

**SUPERFICIAL AREAS PER STANDARD**

| Thickness in | mm | sq ft | m <sup>2</sup> |
|--------------|----|-------|----------------|
| 1/2          | 13 | 3690  | 342.7          |
| 5/8          | 16 | 3168  | 285.9          |
| 3/4          | 19 | 2640  | 245.0          |
| 7/8          | 22 | 2263  | 210.4          |
| 1            | 25 | 1980  | 183.7          |
| 1 1/4        | 32 | 1584  | 147.1          |
| 1 1/2        | 38 | 1320  | 122.9          |
| 2            | 50 | 990   | 92.0           |
| 2 1/2        | 63 | 792   | 73.6           |
| 3            | 75 | 660   | 49.3           |

METRES RUN PER CUBE METRE: TIMBER IN SIZES AVAILABLE EX STOCK

| Thickness           | Width mm | in    | m run per m <sup>3</sup> |
|---------------------|----------|-------|--------------------------|
| 12 1/2mm<br>(1/2in) | 38       | 1 1/2 | 2064                     |
|                     | 75       | 3     | 1032                     |
|                     | 100      | 4     | 788                      |
| 19mm<br>(3/4in)     | 25       | 1     | 2056                     |
|                     | 38       | 1 1/2 | 1372                     |
|                     | 50       | 2     | 1028                     |
|                     | 100      | 4     | 514                      |
|                     | 150      | 6     | 343                      |

| Thickness         | Width mm      | in         | m run per m <sup>3</sup> |
|-------------------|---------------|------------|--------------------------|
| 25mm<br>(1in)     | 25            | 1          | 1336                     |
|                   | 38            | 1 1/2      | 1032                     |
|                   | 50            | 2          | 688                      |
|                   | 75            | 3          | 516                      |
|                   | 100           | 4          | 394                      |
|                   | 150           | 6          | 258                      |
|                   | 225           | 9          | 172                      |
| 38mm<br>(1 1/2in) | 38            | 1 1/2      | 688                      |
|                   | 50            | 2          | 516                      |
|                   | 75            | 3          | 344                      |
|                   | 100           | 4          | 257                      |
|                   | 155           | 6 1/4 full | 190                      |
| 50mm<br>(2in)     | 50            | 2          | 394                      |
|                   | 75            | 3          | 263                      |
|                   | 100           | 4          | 197                      |
|                   | 150           | 6          | 131                      |
|                   | 175           | 7          | 112                      |
|                   | 225           | 9          | 84                       |
|                   | 75mm<br>(3in) | 75         | 3                        |
| 100mm<br>(4in)    | 100           | 4          | 131                      |
|                   | 150           | 6          | 85                       |
|                   | 255           | 9          | 57                       |
| 100mm<br>(4in)    | 100           | 4          | 98                       |

CALCULATING TIMBER COSTS

In the metric system, the thickness and the width of scantlings are measured in

millimetres while the length is given in metres.

The basis of all metric timber calculations, the cube metre, contains one million (one thousand times one thousand) pieces of timber, each 1 mm thick, 1 mm wide and 1 m long.

If the price is given in  $m^3$  (cubic metres), the cost of any quantity of any particular sectional area (*i.e.* thickness times width) proceed as follows:

1. Look up (page 218), the number of running metres per  $m^3$  of the sectional area of the timber. (If the sectional area is not given, multiply the thickness by the width and divide this into 1 million.) This will give the number of running metres per  $m^3$ .
2. Divide the price per  $m^3$  (reduced to pence) by the number of running metres, as found in Stage 1. This gives the price per m run in pence.
3. Multiply this price per running metre by the number of running metres in the quantity being considered. This gives the price in pence: divide by 100 to obtain the price in pounds sterling.

If the price is given in 10 or 100 m run, reduce to price per m run and proceed as stage 3 above.

If the price is given per standard, reduce to  $m^3$  by using table on page 218 and proceed as stages 1, 2 and 3 above.

If the price is given per cubic foot, divide by 35.3 and proceed as per stages 1 2 and 3 above.

## CODES OF PRACTICE

**CP 112:** The structural use of timber.

**Part 2:1971:** Metric units: deals with the design of structures in timber and plywood. Covers selection of timber and plywood species and grades, giving tables of strengths and elastic moduli for visual and stress grades, the use of adhesives and mechanical fasteners the design of members and joints workmanship, testing and maintenance.

**Part 3:1973:** Trussed rafters for roof of dwellings: materials, functional requirements, manufacture, design, testing, permissible spans, handling and erection of Fink and Fan type trussed rafters.

**B.S. 5395:1977:** Code of practice for stairs.

Design and construction of stairs in different materials for all types of buildings.

**CP 151:** Doors and windows including frames and linings.

**Part 1:1957:** Wooden doors: deals with wooden doors of all types and with different methods of hanging doors and fixing their frames and linings. Guidance on economy, strength, rigidity and dimensional stability.

**CP 152:1972:** Glazing and fixing of glass for buildings.

Numerical values in SI units. Account has been taken of a better understanding of the strength of float glass (supersedes B.S. 973).

**CP 201:** Flooring of wood and wood products.

**Part 1:1967:** imperial units.

**Part 2:1972:** metric units: recommends bases.

**CP 209:** Care and maintenance of floor surfaces.





|     |  |   |   |   |   |   |   |   |   |
|-----|--|---|---|---|---|---|---|---|---|
| 63  |  | x | x | x | x | x | x |   |   |
| 75  |  | x | x | x | x | x | x | x | x |
| 100 |  | x |   | x |   | x |   | x | x |
| 150 |  |   |   | x |   | x |   |   | x |
| 200 |  |   |   |   |   | x |   |   |   |
| 250 |  |   |   |   |   |   |   | x |   |
| 300 |  |   |   |   |   |   |   |   | x |

\* For 40 mm thickness. designers and users should check availability.

NOTE. The smaller sizes contained within the dotted lines are normally but not exclusively of European origin. The larger sizes outside the dotted lines are normally but not exclusively of North and South American origin.

**TABLE 3. REDUCTIONS FROM BASIC SIZE TO FINISHED SIZE BY PROCESSING OF TWO OPPOSED FACES**

(All dimensions are in millimetres)

| Purpose                                | Reduction from basic size to finished size |                          |                              |                               |          |
|--|--|--------------------------|------------------------------|-------------------------------|----------|
|  | for sawn sizes of width or thickness       |                          |                              |                               |          |
|  | 15 to and including 22                     | Over 22 to and including | Over 35 to and including 100 | Over 100 to and including 150 | Over 150 |
| (1) Constructional timber surfaced     | 3  | 3                        | 3                            | 5                             | 6        |
| (2) *Floorings                         | 3  | 4                        | 4                            | 6                             | 6        |
| (3) *Matchings and interlocking boards | 4  | 4                        | 4                            | 6                             | 6        |
| (4) Planed all round                   |  |                          |                              |                               |          |
| (5) Trim                               | 5  | 5                        | 7                            | 7                             | 9        |
| (6) Joinery and cabinet work           | 7  | 7                        | 9                            | 11                            | 13       |

\* The reduction of width it overall the extreme size and is exclusive of any reduction of the face by machining of a tongus or lap joint

**Part 2:1971:** Small resawn sections: dimensions of small resawn sections for floor fillets, fixing grounds, noggins, and other uses.

**TABLE 1. CROSS-SECTIONAL SIZES**

(All dimensions are in millimetres)

**Finished widths**

| <b>Finished thickness</b> | <b>22</b> | <b>30</b> | <b>36</b> | <b>44</b> | <b>48</b> |
|---------------------------|-----------|-----------|-----------|-----------|-----------|
| 6                         | X         |           | X         |           |           |
| 14                        |           |           | X         |           | X         |
| 17                        | X         |           | X         |           | X         |
| 22                        | X         | X         | X         | X         | X         |
| 30                        |           |           | X         | X         | X         |
| 36                        |           |           | X         |           | X         |
| 44                        |           |           |           |           | X         |
| 48                        |           |           |           |           | X         |

**B.S. 5450:1977:** Specification for sizes of hardwoods and methods of measurement.

Range of basic sizes of sawn hardwood at 15 per cent moisture content. Measurement of moisture content and sizes.

**STAIRS****B.S. 585:1972:** Wood stairs.

Interior stairs and close strings for use in houses. Quality, design and construction.

**DOORS****B.S. 459:** Doors.**Part 1:1954:** Panelled and glazed wood doors: design, dimensions and construction of doweled and morticed-and-tenoned panelled and glazed wood doors for internal, external and garage.**Part 2:1962:** Flush doors: internal and external, dimensions, timber, facings, plywood, hardboard, adhesives, lippings, provision for glazing, hinges, locks, etc.**Part 3:1951:** fire-check flush doors and wood and metal frames (half-hour and one-hour types), for internal and external use to provide effective barriers to the passage of fire for the time stated. Materials and construction.**Part 4:1965:** Matchboarded doors: ledged and braced, framed ledged and braced; timber, adhesives, construction and sizes.**B.S. 1567:1953:** Wood door frames and linings. For external doors opening inwards and outwards, and for internal door frames and linings.**B.S. 4787:** Internal and external wood doorsets, door leaves and frames.**Part 1:1972:** Dimensional requirements: sizes for dimensionally co-ordinated internal and external wood doorsets, door leaves and frames for traditional and industrialised forms of construction.

**TABLE 1. SIZES OF INTERNAL DOORSETS AND THEIR COMPONENT PARTS**

| <b>Dimension</b>  | <b>Size in mm</b>  | <b>Permissible deviation in mm</b> |
|---|--|------------------------------------|
| <b>Description</b>  |  |                                    |
| Co-ordinating dimension: height of door leaf height sets                                    | 2100   |                                    |
| Co-ordinating dimension: height of ceiling height set                                       | 2300<br>2350<br>2400<br>2700<br>3000   |                                    |
| Co-ordinating dimension: length of all doorsets<br>(S. single leaf set, D. double leaf set) | 600S<br>700 S<br><br>800 S and D<br>900 S and D<br>1000 S and D<br>1200 D<br>1500 D<br>1800 D<br>2100 D  |                                    |
| Thickness   | This dimension is not of great importance in the doorset, but consideration should be given to its relationship to standardised sizes of sawn timber and to partition thicknesses. |                                    |
| Work size: height of door leaf height set   | 2090   | 2.0                                |

| <b>Dimension</b>  | <b>Size in mm</b>                         | <b>Permissible deviation in mm</b> |
|---|---|------------------------------------|
| <b>Description</b>  |   |                                    |
| Work size: height of ceiling height set                                       | 2285<br>2335<br>2385<br>2685<br>2985      | 2.5                                |
| Work size; length of all doorsets<br>(S. single leaf set, D. double leaf set) | 590 S<br>690 S<br>790 S<br>and D<br>890 S |                                    |

|  |  |            |
|--|--|------------|
|  | and D<br>990 S<br>and D<br>1190 D<br>1490 D<br>1790 D<br>2090 D                                      | 2.5        |
| Door leaf height for all doorsets  | 2040   | 1.5        |
| Length of door leaf used in single leaf sets<br><br>(F. flush leaf, P. panel leaf)   | 526 F<br>626 F<br>726 F<br>and P<br>826 F<br>and P<br>926 F<br>and P                                 | 1.5        |
| Length of one leaf of an equal double leaf doorset<br><br>(F. flush leaf, P. panel leaf)   | 362 F<br>412 F<br><br>462 F<br>562 F<br>and P<br>712 F<br>and P<br>862 F<br>and P<br>1012 F<br>and P | 1.5        |
| (Dimensions of pairs of doors assume square meeting stiles with 2 mm clearance between leaves. If rebated meeting stiles are required, then leaf length will be 6 mm longer than stated to allow for a 12 mm rebate) |  |            |
| Door leaf thickness  | 40   | +0<br>-2.0 |
| Doorstop width (solid or otherwise)  | 13   | 2.0        |
| Rebate depth   | 42   | 0.5        |
| Threshold (sill) height (see also (3) in Appendix A) of all doorsets   | 15   | 1.0        |
|  |  |            |

**TABLE 2. SIZES OF EXTERNAL DOORSETS AND THEIR COMPONENT PARTS**

| Dimension | Size in mm | Permissibl |
|-----------|------------|------------|
|-----------|------------|------------|

| <b>Description</b>                                       |   | <b>deviation in</b> |
|--|---|---------------------|
| Co-ordinating dimension: height of door leaf height sets | 2100<br>(if required, may be provided with packing at head to give 25 mm positive boundary condition at sill)   |                     |
| Co-ordinating dimension: height of ceiling height set    | 2300, 2400, 2700, 3000<br>(if required may be provided with packing at head to give 25 mm positive boundary condition at sill)<br>2350<br>(intended for protected positions and recommended for use with zero boundary condition) |                     |

| <b>Dimension</b>                                | <b>Size in mm</b>   | <b>Permissible deviation in mm</b> |
|---|---|------------------------------------|
| <b>Description</b>                              |   |                                    |
| Co-ordinating dimension: length of all doorsets | 900S<br>1000 S  |                                    |
| (S. single leaf set, D. double leaf set)        | 1200 D<br>1500 D<br>1800 D<br>2100 D  |                                    |
| Thickness                                       | This dimension is not of great importance in the doorset, but consideration should be given to its relationship to standardised sizes of sawn timber and to partition thicknesses |                                    |
| Worksize: height of door leaf height set        | Zero boundary condition 2090    25 mm boundary condition (see A*) 2155  | 2.0                                |
| Work size: height of ceiling height set         | Zero boundary condition 2290<br>2340<br>2390<br>2690<br>2990    25 mm boundary condition (see G*) 2315<br>2415<br>2715<br>3015  | 2.5                                |
| Work size: length of all door sets              | 890 S<br>990 S  |                                    |
| (S. single leaf set, D. double leaf set)        | 1190 D<br>1490 D  | 2.5                                |

|  |                             |     |
|--|-----------------------------|-----|
|  | 1790 D<br>2090 D            |     |
| Door leaf height for all doorsets  | 2000                        | 1.5 |
| Length of door leaf in single leaf sets  | 807                         | 1.5 |
| (F. flush leaf, P. panel leaf)   | 907                         |     |
| Length of one leaf of a double leaf doorset  | 552 F and P<br>702 F and P  | 1.5 |
| (F. flush leaf, P. panel leaf)   | 852 F and P<br>1002 F and P |     |
| (Dimensions of pairs of doors assume square meeting stiles with 2 mm clearance between leaves<br>If rebated meeting stiles are required, then leaf length will be 9 mm longer than stated, to allow for an 18 mm rebate) |                             |     |
| Door leaf thickness  | 40<br>44                    | 1.5 |
| Doorstop width (solid or otherwise)  | 18                          | 1.0 |
| Rebate depth   | 42<br>46                    | 0.5 |
| Threshold (sill) height (see also (3) in Appendix A) for all doorsets  | 45<br>20†                   | 1.0 |

\* *Co-ordinating dimension: height of ceiling height set.* † Intended for protected positions, with packing at head.

**B.S. 5277:1976:** Doors: Measurement of defects of general flatness of door leaves.

**B.S. 5278:1976:** Doors: Measurement of dimensions and defects of squareness of door leaves.

B.S. 5278 and B.S. 5277 determine methods to use to measure twist and bending, etc.

## WINDOWS

**B.S. 644:** Wood windows.

**Part 1:1951:** Wood casement windows: types, sizes, construction with requirements

for normal and easy-clean hinges.

**TABLE 2. REBATE SIZES OF WINDOW UNITS**

|                               | Widths |        | Height<br>(For key to these reference letters, see Fig. 2) |                    |         |  |         |  |         |         |
|-------------------------------|--------|--------|--|--------------------|---------|--|---------|--|---------|---------|
|                               | A      | B      | C  | D                  | E       | F                                      | G       | H  |         |         |
| Frames                        | 13%    | 21%    | 10%  | 14%                | 25%     | 32%                                    | 38%     | 44%  | 44%     | 50%     |
| Casement and<br>ventlights    | 11%    | 19%    | 8%   | (11%) <sub>a</sub> | 23%     | (29%) <sub>a</sub>                     | 35%     | 41%  | 41%     | 47%     |
| Rebate sizes,<br>no-bar types | 11%    | 19%    | 8%   | 11%                | 23%     | 29%                                    | 35%     | 41%  | 41%     | 47%     |
| Rebate sizes,<br>bar types    | 11%    | 2 x 9% | 8%   | 11%                | 2 x 11% | { 1 x 8% }<br>{ 2 x 10% } <sup>b</sup> | 3 x 11% | { 1 x 9% } <sub>a</sub><br>{ 3 x 10% } <sub>a</sub> <sup>b</sup> | 4 x 10% | 4 x 11% |

NOTES. a. In the standard range this size of opening is not fitted with a no-bar casement.  
 b. This modification is necessary where the opening occurs below a ventlight or over a sub-light and is adjacent to a full-height opening, so as to ensure that the glazing bars are suitably aligned. The smaller pane is that immediately under the ventlight, or over the sub-light.

**Part 2:1958:** Wood double-hung sash windows: types, sizes, construction of weight and spring balanced windows.

**Part 3:1951:** Wood double-hung sash windows (Scottish type).

**B.S. 990:** Steel windows generally for domestic and similar buildings.

**Part 1:1967:** Imperial units.

**Part 2:1972:** Metric units: co-ordinating sizes, work sizes, tolerances and deviations.

**B.S. 1285:1963:** Wood surrounds for steel windows and doors.

Sizes of surrounds complying with B.S. 990.

**B.S. 4873:1972:** Aluminium alloy windows.

Specifies materials, construction, finishes, hardware and performance.

FLOORING\*

**B.S. 1187:1959:** Wood blocks for floors.

Hardwood and softwood blocks for laying on level bases.

**B.S. 1297:1970:** Grading and sizing of softwood flooring.

Tongued and grooved flooring; species, grading moisture content, sapwood, decay and dimensions, etc.

**TABLE 1. TRANSVERSE DIMENSIONS**

|                         |          |          |          |          |
|-------------------------|----------|----------|----------|----------|
| Finished thicknesses    | mm<br>16 | mm<br>19 | mm<br>21 | mm<br>28 |
| Finished widths of face | 65       | 90       | 113      | 137      |

**TABLE 2. TONGUE DIMENSIONS**

|                    |   |          |          |          |          |
|--------------------|---|----------|----------|----------|----------|
| Finished thickness | A | mm<br>16 | mm<br>19 | mm<br>21 | mm<br>28 |
|--------------------|---|----------|----------|----------|----------|

|                                |   |     |   |   |    |
|--------------------------------|---|-----|---|---|----|
| Finished tongue thickness      | B | 4.5 | 6 | 6 | 6  |
| Finished tongue top width      | C | 7   | 7 | 7 | 7  |
| Face of board to top of tongue | D | 7   | 7 | 8 | 12 |

FENCING

B.S. 1722: Fences:

Part 4:1972: Cleft chestnut pale fences.

TABLE 1. CLEFT CHESTNUT PALE FENCES: GENERAL CHARACTERISTICS

| Fence types         |                   | Height of top of pale | Applicability   | Number of lines of wiring | Spacing between pales | Maximum distance between intermediate concrete posts | Maximum distance between intermediate wooden posts |
|---------------------|-------------------|-----------------------|---|---------------------------|-----------------------|--|--|
| With concrete posts | With wooden posts |                       |   |                           |                       | m  | m  |
| CC 90               | CW 90             | 0.90                  | Housing<br>Housing and inner fences of parks, etc.            | 2                         | 75                    | 3.0  | 2.50   |
| CC 105A             | CW 105A           | 1.05                  |   |                           | 75                    |  |  |
| CC 105B             | CW 105B           | 1.20                  | Miscellaneous<br>General purposes                             | 3                         | 100                   | 2.75   | 2.25   |
| CC 120              | CW 120            | 1.35                  |   |                           | 75                    |  |  |
| CC 135              | CW 135            | 1.50                  | Road boundaries<br>Outer fences of parks and other boundaries | 3                         | 50                    | 2.25   | 2.0  |
| CC 150              | CW 150            | 1.50                  |   |                           |                       |  |  |
| CC 180              | CW 180            | 1.80                  | Factories and security  |                           |                       |  |  |

NOTE. If barbed wire is to be fixed above the fencing, the length of the posts shall be increased by 150 mm for each line of barbed wire.

TABLE 2. CONCRETE POSTS FOR CLEFT CHESTNUT PALE FENCING

| Fence types | No. of holes for lines of wiring | Intermediate posts |                 | Straining posts |           | Struts |          |
|-------------|----------------------------------|--------------------|-----------------|-----------------|-----------|--------|----------|
|             |                                  | Length             | Base dimension* | Length          | Section   | Length | Section  |
|             |                                  | m                  | mm              | m               | mm        | m      | mm       |
| CC 90       | 2                                | 1.50               | 100 x 100       | 1.50            | 125 x 125 | 1.50   | 100 x 75 |
| CC 105A     | 2                                | 1.65               |                 | 1.80            |           | 1.65   |          |
| CC 105B     | 3                                | 1.65               | 125 x 125       | 1.95            | 125 x 125 | 1.82   | 100 x 83 |
| CC 120      | 3                                | 1.87               |                 | 2.10            |           | 1.90   |          |
| CC 135      | 3                                | 1.95               |                 | 2.25            |           | 2.20   |          |
| CC 150      | 3                                | 2.25               |                 | 2.63            |           | 2.59   |          |
| CC 180      | 3                                | 2.63               |                 |                 |           |        |          |

NOTE. If barbed wire is to be fixed above the fencing, the length of the posts shall be increased by 150 mm for each line of barbed wire.

\* A demoulding draw allowance of 3 mm on each of two sides is permissible in addition to permissible deviations specified in 2.6.1.



**TABLE 3. WOODEN POSTS FOR CLEFT CHESTNUT PALE FENCING**

| Fence types | Intermediate posts |                     | Straining posts |                      | Struts     |                               |
|-------------|--------------------|---------------------|-----------------|----------------------|------------|-------------------------------|
|             | Length             | Girth at mid-length | Length          | Girth at top (round) | Length     | Girth at top (round or cleft) |
|             | m                  | mm                  | m               | mm                   | m          | mm                            |
| CW 90       | 1.52               | 190 to 230          | 1.52            | 230 to 250           | 1.52       | 190 to 230                    |
| CW 105A     | 1.67               |                     | 1.67            |                      | 1.67       |                               |
| CW 105B     | 1.67               |                     | 1.67            |                      | 1.67       |                               |
| CW 120      | 1.82               | 230 to 250          | 1.82            | 250 to 290           | 1.82       | 250 to 250                    |
| CW 135      | 1.95               |                     | 2.10            |                      | 1.95       |                               |
| CW 150      | 2.10               |                     | 2.25            |                      | 2.10       |                               |
| CW 180      | 2.43               |                     | 2.58            |                      | 2.43       |                               |
|             |                    |                     |                 |                      | 280 to 350 |                               |

NOTE. If barbed wire is to be fixed above the fencing the lengths of the posts shall be increased by 150 mm for each bar of barbed wire.

**Part 5:1972:** Close boarded fences: including oak pale fences.

See table opposite.

**TABLE 4. PRESERVATIVE TREATMENTS ACCORDING TO SPECIES**

| Species  | Use             | Treatment  |
|--|-----------------|--|
| Oak (European and English), sweet chestnut, European larch, yew, western red cedar | Rails and posts | Treatment only if specified by the purchaser.... |
| Spruce, Douglas fir and hemlock  | Rails<br>Posts  | <i>Appropriate treatments are specified</i>      |
| Hardwoods or softwoods other than spruce and Douglas fir                           | Rails<br>Posts  |  |
| Imported hardwoods   | Posts           |  |

**Part 6:1972:** Wooden pallisade fences.

**TABLE 1. WOODEN PALISADE FENCES**

| Type references     |                   | Height of top of pales | Applicability      | No. of arris rails | Concrete posts Length | Wooden posts |         |
|---------------------|-------------------|------------------------|--------------------|--------------------|-----------------------|--------------|---------|
| With concrete posts | With wooden posts |                        |                    |                    |                       | Length       | Section |
|                     |                   | m                      |                    |                    | m                     | m            | mm      |
| WPC 100             | WPW 100A          | 1.0                    | Housing            | 2                  | 1,525                 |              | 100×100 |
| WPC 100             | WPW 100B          | 1.0                    | Parks inner fences | 2                  |                       | 1.60         | 100×125 |
| WPC 120             | WPW 120           | 1.20                   | General purposes   | 2                  | 1.725                 | 1.80         | 100×125 |
| WPC 140             | WPW               | 1.40                   | Roads and          | 3                  | 1,925                 | 2.00         | 100×125 |

|         |         |      |  |    |       |               |
|---------|---------|------|--|----|-------|---------------|
|         | 140     |      | railways                               |    |       |               |
| WPC 160 | WPW 160 | 1.60 | Housing flank fences and parks         | 3  | 2.275 | 2.425 100×125 |
| WPC 180 | WPW 180 | 1.80 | Parks, commercial and public buildings | 3* | 2.475 | 2.65 100×150  |

\* For size of arris rails see 2.5.

**TABLE 1. CLOSE BOARDED FENCES**

| Type reference                               |                   |  |                         |  |                    | Height of top of filling | Applicability                                    | No. of rails |
|--|-------------------|--|-------------------------|--|--------------------|--------------------------|--|--------------|
| Oak pale fences                              |                   |  | Fences in other timbers |  |                    |                          |  |              |
| With concrete posts<br>Recessed*<br>Morticed | With wooden posts | With concrete posts<br>Recessed*<br>Morticed | With wooden posts       | With concrete posts<br>Recessed*<br>Morticed | With wooden posts  |                          |  |              |
| PCR 100                                      | PCM 100           | PW 100A<br>PW 100B                           | BCR 100                 | BCM 100                                      | BW 100A<br>BW 100B | 1.0<br>1.0               | m<br>m<br>Housing<br>Parks inner fences          | 2            |
| PCR 120                                      | PCM 120           | PW 120                                       | BCR 120                 | BCM 120                                      | BW 120             | 1.20                     | General purposes                                 | 2            |
| PCR 140                                      | PCM 140           | PW 140                                       | BCR 140                 | BCM 140                                      | BW 140             | 1.40                     | Roads and railways                               | 3            |
| PCR 160                                      | PCM 160           | PW 160                                       | BCR 160                 | BCM 160                                      | BW 160             | 1.60                     | Housing, flank fences                            | 3            |
| PCR 180A                                     | PCM 180A          | PW 180A                                      | BCR 180A                | BCM 180A                                     | BW 180A            | 1.80                     |  | 3            |
| PCR 180B                                     | PCM 180B          | PW 180B                                      | BCR 180B                | BCM 180B                                     | BW 180B            | 1.80                     | Parks, railways, commercial and public buildings | 3            |

\* For use without cappings.

For use with cappings or gravel boards or both, for size of rails, see 2.5.

For barbed wire, see 3.9.

If barbed wire is not specified, the length shall be 2.65 m.

**TABLE 4. PRESERVATIVE TREATMENTS ACCORDING TO SPECIES**

|  |  |
|--|--|
|  |  |
|--|--|

| Species  | Use             | Treatment  |
|--|-----------------|--|
| Oak (European and English), sweet chestnut, European larch, yew, western red cedar | Rails and posts | Treatment only if specified by the purchaser.... |
| Spruce, Douglas fir and hemlock  | Rails<br>Posts  | <i>Appropriate treatments are specified</i>      |
| Hardwoods or softwoods other than spruce and Douglas fir                           | Rails<br>Posts  |  |
| Imported hardwoods   | Posts           |  |
| ...  |                 |  |

**Part 7:1972:** Wooden post and rail fences.

**TABLE 1. WOODEN POST AND RAIL FENCING**

| Type reference       | Height to top of top rail | Main posts length | Prick posts length | Clear spacing between rails top to bottom |
|----------------------|---------------------------|-------------------|--------------------|---|
|                      | m                         | m                 | m                  | mm  |
| <b>Morticed type</b> |                           |                   |                    |   |
| MPR 11/3 (3 rail)    | 1.1                       | 1.8               | 1.6                | 325–275–240 (to ground)                   |
| MPR 11/4 (4 rail)    | 1.1                       | 1.8               | 1.6                | 225–200–175–150 (to ground)               |
| MPR 13/4 (4 rail)    | 1.3                       | 2.1               | 1.8                | 250–250–225–225 (to ground)               |
| <b>Nailed type</b>   |                           |                   |                    |   |
| SPR 11/3 (3 rail)    | 1.1                       | 1.8               | —                  | 325–275–240 (to ground)                   |
| SPR 11/4 (4 rail)    | 1.1                       | 1.8               | —                  | 225–200–175–150 (to ground)               |
| SPR 13/4 (4 rail)    | 1.3                       | 2.1               | —                  | 250–250–225–225 (to ground)               |

**Part 11:1972:** Woven wood fences.

All parts of this British Standard (B.S. 1722) cover construction workmanship, types, height, selection and preservation of materials.

**TABLE 1. DIMENSIONS OF PANELS**

| Type reference | Height |
|----------------|--------|
|                | m      |
| WW 60          | 0.6    |
| WW 90          | 0.9    |

|        |     |
|--------|-----|
| WW 120 | 1.2 |
| WW 150 | 1.5 |
| WW180  | 1.8 |

**TABLE 2. LENGTHS OF POSTS**

| Type reference | Height of fence | Length of posts |
|----------------|-----------------|-----------------|
|                | m               | m               |
| WW 60          | 0.6             | 1.2             |
| WW 90          | 0.9             | 1.6             |
| WW 120         | 1.2             | 1.8             |
| WW 150         | 1.5             | 2.1             |
| WW 180         | 1.8             | 2.5             |

**B.S. 4092:** Domestic front entrance gates.

**Part 2:1966:** Wooden gates: sizes, design requirements, construction, finished sizes of components, quality of timber, workmanship and hanging.

**TABLE 1. MINIMUM FINISHED SIZES OF COMPONENTS**

|                                   | in      | mm      |
|-----------------------------------|---------|---------|
| Hanging stiles for pairs of gates | 3¼ × 1¾ | 95 × 45 |
| Hanging stiles for single gates   | 2¾ × 1¾ | 70 × 45 |
| Shutting stiles                   | 2¾ × 1¾ | 70 × 45 |
| Rails behind infilling            | 2¾ × 1  | 70 × 25 |
| Other rails                       | 2¾ × 1¾ | 70 × 45 |
| Brace                             | 2¾ × 1  | 70 × 25 |
| Thickness of infilling            | ⅝       | 14      |

**3.2 Widths**

The standard widths of gates, measured overall of the stiles, shall be:

|                 |                     |
|-----------------|---------------------|
| Single gates:   | 2 ft 8 in (810 mm)  |
|                 | 3 ft 4 in (1020 mm) |
| Pairs of gates: | 7 ft 0 in (2130 mm) |
|                 | 7 ft 8 in (2340 mm) |
|                 | 8 ft 8 in (2640 mm) |

These widths shall be subject to a tolerance of +0–1/4 in (6 mm).

## WOOD TRIM

**B.S. 584:1967:** Wood trim (softwood).

Quality, design and dimensions of architraves, skirtings, picture rails, cover fillets, quadrants, half-round beads and scotias.

## BOARDS AND SHEETS

**B.S. 1142:** Fibre building boards.

**Part 1:1971:** Methods for testing.

**Part 2:1971:** Medium board and hardboard: types defined, coding scheme for testing, performance levels.

### 3. REQUIREMENTS FOR SPECIAL PURPOSE BOARDS

#### 3.1 General

As their classification implies, fibre building boards within the scope of this section have been manufactured or modified after manufacture to fulfil a specific use. The physical requirements of these boards shall be as agreed between the manufacturer or his representative and the purchaser.

#### 3.2 Type FR Flame retardant hardboards

**3.2.1 Surface spread of flame classification.** The boards shall be tested in accordance with the requirements of Clause 2 of BS 476: Part 7‡: 1971, and they shall be classified into one of the following groups:

(1) Boards giving the same flame spread classification on both faces in the 'Surface spread of flame test'. Class 1A, both faces comply

|   |   |
|---|---|
| Class 1A, both faces comply<br>with Class 1 | } in Table 1<br>of<br>BS 476 : Part 7‡ : 1971 |
| Class 2A, both faces comply<br>with Class 2 |   |
| Class 3A, both faces comply<br>with Class 3 |   |
| Class 4A, both faces comply<br>with Class 4 |   |

(2) Boards giving a higher flame spread classification on one face than on the other in the 'Surface spread of flame test'. Class 1B, one face complies

Class 1B, one face complies with Class 1  
 Class 2B, one face complies with Class 2  
 Class 3B, one face complies with Class 3  
 Class 4B, one face complies with Class 4

} in-Table 1 of BS 476 : Part 7\* : 1971

With these Type 'B' boards, the face having the superior performance shall be the unmarked face.

NOTE. Boards which have been treated or processed to improve their flame retardant properties may require the application of special type sealers or primers prior to decoration. Possible reduction of original flame retardant properties after applying surface treatments should be considered.

**TABLE 1. TEST LEVELS FOR MEDIUM BOARD**

| Type       | Specified manufacturing thickness                               | Minimum mean bending strength    | Changes after water immersion     |                                 | Effect of relative humidity change from 33% to 90% |                                    |
|------------|---|----------------------------------|-----------------------------------|---------------------------------|--|------------------------------------|
|            |   |                                  | Maximum mean absorption by weight | Maximum mean thickness swelling | Maximum mean increase in length and width          | Maximum mean increase in thickness |
| <b>HME</b> | mm<br>equal to or greater than 6.4 but equal to or less than 10 | N/mm <sup>2</sup><br>(MPa)<br>20 | %                                 | %                               | %  | %                                  |
|            | greater than 10 but equal to or less than 13                    | 17                               | 20                                | 10                              | 0.25   | 7                                  |
|            | greater than 13 but equal to or less than 16                    | 15                               |                                   |                                 |  |                                    |
|            | greater than 16   | 13                               |                                   |                                 |  |                                    |
|            | equal to or greater than 6.4 but equal to or less than 10       | 15                               |                                   |                                 |  |                                    |
| <b>HMN</b> | greater than 10 but equal to or                                 | 12                               | 40                                | 20                              | 0.30   | 10                                 |

|            |   |    |    |    |      |   |
|------------|---|----|----|----|------|---|
|            | less than 13  |    |    |    |      |   |
|            | greater than 13<br>but equal to or<br>less than 16  | 10 |    |    |      |   |
|            | greater than 16                                     | 8  |    |    |      |   |
| <b>LME</b> | 6.4   | 14 | 25 | 13 | 0.30 | 5 |
|            | greater than 6.4<br>but equal to or<br>less than 10 | 11 | 20 | 10 |      |   |
|            | greater than 10                                     | 9  | 15 | 8  |      |   |
| <b>LMN</b> | 6.4   | 12 | 35 | 18 | 0.40 | 8 |
|            | greater than 6.4<br>but equal to or<br>less than 10 | 10 | 30 | 15 |      |   |
|            | greater than 10                                     | 8  | 25 | 12 |      |   |

**Part 3:1972:** Insulating board (softboard) and tiles: types defined and performance levels.

### 3. REQUIREMENTS FOR SPECIAL PURPOSE BOARDS OR TILES

#### 3.1 General

Fibre building boards within the scope of this section shall be those manufactured or modified after manufacture for a specific use. The permissible deviations in squareness, size and straightness of boards or tiles shall comply with the definitions given in 1.3 and qualified in Clause 2.

#### 3.2 Flame retardant insulating boards and tiles (type FL.R.)

The physical requirements of these materials shall be agreed between the supplier and the purchaser.

**3.2.1 Surface spread of flame classification.** FL.R. boards or tiles shall be tested, after applying any decorative effects or treatments during manufacture, in accordance with the requirements of BS 476: Part 7‡, and they shall be classified as one of the following types:

(1) Boards giving the same classification (from Table 1 of BS 476: Part 7‡) on both faces in the surface spread of flame test.

Type 1A Both faces are within the limits of Class 1

Type 2A Both faces are within the limits of Class 2

Type 3A Both faces are within the limits of Class 3

(2) Boards giving a higher classification (from Table 1 of

BS 476: Part 7‡) on one face than the other in the surface spread of flame test.

Type 1B2 One face falls within Class 1 and the other within Class 2

Type 1B3 One face falls within Class 1 and the other within Class 3

Type 1B4 One face falls within Class 1 and the other within Class 4

Type 2B3 One face falls within Class 2 and the other within Class 3

Type 2B4 One face falls within Class 2 and the other within Class 4

Type 3B4 One face falls within Class 3 and the other within Class 4

The face of these Type B boards having the superior performance shall be the unmarked face.

NOTE. Boards which have been treated or processed to improve their flame retardant properties may require the application of special sealers or primers prior to decoration. Possible reduction of original flame retardant properties after applying surface treatments should be considered.

**B.S. 1455:1972:** Plywood manufactured from tropical hardwoods.

Describes grades and qualities.

**B.S. 2604:** Resin-bonded wood chipboard.

**Part 2:1970:** Metric units: basic levels of quality and minimum acceptance limits.

**TABLE 1. BASIC LEVELS OF QUALITY**

| 1   | 2                                  | 3           |     |
|---|------------------------------------|-------------|-----|
| Property  | Clause in BS 1811:<br>Part 2:1969* | Mean<br>(X) |     |
| <b>12 mm thickness</b>  |                                    |             |     |
| Density, kg/m <sup>3</sup>  | 7                                  | 480         |     |
| Bending strength, N/mm <sup>2</sup> §   | 8                                  | 13.8        |     |
| Tensile strength perpendicular to the plane of the board, N/mm <sup>2</sup> § | 11                                 | 0.34        |     |
| Surface soundness, N  | 12                                 | 1100        |     |
| Edge screw holding, N   | 13                                 | 360         |     |
| Thickness swelling (1 hour) (%)   | 19.1                               | 12          | ... |
| <b>19 mm thickness</b>  |                                    |             |     |
| Density, kg/m <sup>3</sup>  | 7                                  | 480         |     |
| Bending strength, N/mm <sup>2</sup> §   | 8                                  | 13.8        |     |
| Tensile strength perpendicular to the plane of the board, N/mm <sup>2</sup> § | 11                                 | 0.34        |     |
| Surface soundness, N  | 12                                 | 1100        |     |
| Edge screw holding, N   | 13                                 | 360         |     |
| Thickness swelling (1 hour) (%)   | 19.1                               | 12          |     |

\* BS 1811, 'Methods of test for wood chipboards and other particle boards', Part 2, 'Metric units'.

† BS 476, 'Fire tests on building materials and structures', Part 7, 'Surface spread of flame test for materials'.

‡ i.e., for swelling the mean value shall not be greater; for the other properties the mean values shall not be less.

§ In the original standard these values are expressed in MN/m<sup>2</sup>. Numerically



they are identical.

**TABLE 3. CONSUMERS' MINIMUM ACCEPTANCE LIMITS**

| 1<br>Property  | 2<br>Clause in BS<br>1811: Part<br>2:1969† | 3<br>Limit for sample means<br>thicknesses complying with<br>the standard |
|--|--|---|
| Density, kg/m <sup>3</sup>   | 7  | 460   |
| Bending strength, N/mm <sup>3‡</sup>   | 8  | 13.1  |
| Tensile strength perpendicular<br>to the plane of the board,<br>N/mm <sup>3‡</sup> | 11   | 0.31  |
| Surface soundness, N   | 12   | 1020  |
| Edge screw holding, N  | 13   | 310   |
| Thickness swelling (1 hour)<br>(%)   | 19.1                                       | 13  |

**B.S. 3444:1972:** Block board and laminboard.

Defines grades and qualities.

**B.S. 3794:1973:** Decorative laminated plastics sheet.

Describes four classes of aminoplastic phenolic laminated sheet.

**B.S. 4965:1974:** Decorative laminated plastics sheet veneered boards or panels.

Specifies requirements for eight types made from various core materials veneered on one or both sides with cured aminoplastic faced phenol laminated sheet.

## GLULAM

**B.S. 4169:1970:** Glued-laminated timber structural members.

Covers structural components manufactured from separate pieces of timber arranged in laminations parallel to the axis of the member, individual pieces being assembled with the grain approximately parallel and glued together to form a member which functions as a single structural unit.

Design requirements are given in CP 112: The structural use of timber.

## FASTENINGS—NAILS, SCREWS AND CONNECTORS

**B.S. 1202:** Nails.

**Part 1:1974:** Steel nails.

TABLE 1. DIMENSIONS AND APPROXIMATE COUNT OF ROUND PLAIN HEAD NAILS

| <b>Length</b><br><i>L</i> | <b>Shank diameter</b><br><i>D</i> | <b>Approx. no. of nails per kg</b> |
|---------------------------|-----------------------------------|------------------------------------|
| mm                        | mm                                |                                    |
| 200                       | 8.00                              | 13                                 |
| 180                       | 6.70                              | 22                                 |
| 150                       | 6.00                              | 29                                 |
| 150                       | 5.60                              | 35                                 |
| 125                       | 5.60                              | 42                                 |
| 125                       | 5.00                              | 53                                 |
| 115                       | 5.00                              | 57                                 |
| 100                       | 5.00                              | 66                                 |
| 100                       | 4.50                              | 77                                 |

| <b>Length</b><br><i>L</i> | <b>Shank diameter</b><br><i>D</i> | <b>Approx. no. of nails per kg</b> |
|---------------------------|-----------------------------------|------------------------------------|
| mm                        | mm                                |                                    |
| 100                       | 4.00                              | 88                                 |
| 100                       | 3.75                              | 110                                |
| 90                        | 4.50                              | 88                                 |
| 90                        | 4.00                              | 106                                |
| 90                        | 3.75                              | 123                                |
| 90                        | 3.35                              | 152                                |
| 75                        | 4.00                              | 121                                |
| 75                        | 3.75                              | 154                                |
| 75                        | 3.35                              | 194                                |
| 75                        | 3.00                              | 236                                |
| 65                        | 3.75                              | 175                                |
| 65                        | 3.35                              | 230                                |
| 65                        | 3.00                              | 275                                |
| 65                        | 2.65                              | 350                                |
| 60                        | 3.35                              | 255                                |
| 60                        | 3.00                              | 310                                |
| 60                        | 2.65                              | 385                                |
| 50                        | 3.35                              | 290                                |
| 50                        | 3.00                              | 340                                |
| 50                        | 2.65                              | 440                                |
| 50                        | 2.36                              | 550                                |
| 45                        | 2.65                              | 510                                |
| 45                        | 2.36                              | 640                                |
| 45                        | 2.00                              | 840                                |

|    |      |      |
|----|------|------|
| 40 | 2.65 | 575  |
| 40 | 2.36 | 750  |
| 40 | 2.00 | 970  |
| 30 | 2.36 | 840  |
| 30 | 2.00 | 1170 |
| 30 | 1.80 | 1410 |
| 25 | 2.00 | 1430 |
| 25 | 1.80 | 1720 |
| 25 | 1.60 | 2120 |
| 20 | 1.60 | 2710 |
| 20 | 1.40 | 3750 |
| 15 | 1.40 | 4400 |

TABLE 2. DIMENSIONS AND APPROXIMATE COUNT OF ROUND LOST HEAD NAILS

| Length <i>L</i> | Shank diameter<br><i>D</i> | Approx. no. of nails per kg |
|-----------------|----------------------------|-----------------------------|
| mm              | mm                         |                             |
| 75              | 3.75                       | 160                         |
| 65              | 3.35                       | 240                         |
| 65              | 3.00                       | 270                         |
| 60              | 3.35                       | 270                         |
| 60              | 3.00                       | 330                         |
| 50              | 3.00                       | 360                         |
| 50              | 2.65                       | 420                         |
| 40              | 2.36                       | 760                         |
| 30              | 2.00                       | 1190                        |
| 25              | 1.00                       | 6100                        |
| 20              | 1.00                       | 8030                        |
| 15              | 1.00                       | 9400                        |

TABLE 7. DIMENSIONS AND APPROXIMATE COUNT OF PANEL PINS

| Length<br><i>L</i> | Shank diameter<br><i>D</i> | Approx. no. of nails per kg |
|--------------------|----------------------------|-----------------------------|
| mm                 | mm                         |                             |
| 75                 | 2.65                       | 290                         |
| 65                 | 2.65                       | 345                         |
| 50                 | 2.00                       | 770                         |
| 40                 | 1.60                       | 1590                        |
| 30                 | 1.60                       | 1900                        |
| 25                 | 1.60                       | 2340                        |

|    |      |      |
|----|------|------|
| 25 | 1.40 | 3090 |
| 20 | 1.60 | 3140 |
| 20 | 1.40 | 3970 |
| 20 | 1.25 | 5290 |
| 15 | 1.25 | 6400 |
| 15 | 1.00 | 8800 |

TABLE 12. DIMENSIONS AND APPROXIMATE COUNT OF OVAL BRAD HEAD NAILS

| Length<br><i>L</i> | Shank dimensions<br><i>D</i> × <i>d</i> | Approx. no. of nails per kg |
|--------------------|---|-----------------------------|
| mm                 | mm                                      |                             |
| 150                | 7.10×5.00                               | 31                          |
| 125                | 6.70×4.50                               | 44                          |
| 100                | 6.00×4.00                               | 64                          |
| 90                 | 5.60×3.75                               | 90                          |
| 75                 | 5.00×3.35                               | 125                         |
| 65                 | 4.00×2.65                               | 230                         |
| 60                 | 3.75×2.36                               | 340                         |
| 50                 | 3.35×2.00                               | 470                         |
| 45                 | 3.35×2.00                               | 655                         |
| 40                 | 2.65×1.60                               | 940                         |
| 30                 | 2.65×1.60                               | 1480                        |
| 25                 | 2.00×1.25                               | 2530                        |
| 20                 | 2.00×1.25                               | 4500                        |

TABLE 24. DIMENSIONS AND APPROXIMATE COUNT OF CUT CLASP NAILS

| Length<br><i>L</i> | Shank dimension<br><i>D</i> | Approx. no. of nails per kg |
|--------------------|-----------------------------|-----------------------------|
| mm                 | mm                          |                             |
| 200                | 6.00                        | 11                          |
| 175                | 5.60                        | 13                          |
| 150                | 5.60                        | 19                          |
| 125                | 5.00                        | 30                          |
| 100                | 4.00                        | 48                          |
| 90                 | 3.75                        | 66                          |
| 75                 | 3.35                        | 103                         |
| 65                 | 3.00                        | 171                         |
| 60                 | 2.65                        | 202                         |
| 50                 | 2.65                        | 286                         |

|    |      |      |
|----|------|------|
| 40 | 2.00 | 616  |
| 30 | 1.80 | 858  |
| 25 | 1.60 | 1384 |

TABLE 25. DIMENSIONS AND APPROXIMATE COUNT OF CUT FLOOR BRADS

| Length<br><i>L</i> | Shank dimension<br><i>D</i> | Approx. no. of nails per kg |
|--------------------|-----------------------------|-----------------------------|
| mm                 | mm                          |                             |
| 75                 | 3.35                        | 100                         |
| 65                 | 3.35                        | 154                         |
| 60                 | 3.00                        | 198                         |
| 50                 | 2.65                        | 264                         |
| 45                 | 2.36                        | 330                         |
| 40                 | 2.36                        | 396                         |

**Part 2:1974:** Copper nails.

TABLE 4. DIMENSIONS AND APPROXIMATE COUNT OF FLAT COUNTERSUNK AND ROSE-HEAD SQUARE SHANK BOAT NAILS (ROUND OR DIAMOND POINT)

| Length<br><i>L</i> | Shank dimension<br><i>D</i> | Approx. no. of nails per kg |
|--------------------|-----------------------------|-----------------------------|
| mm                 | mm                          |                             |
| 150                | 6.00                        | 22                          |
| 150                | 5.00                        | 33                          |
| 125                | 5.60                        | 31                          |
| 125                | 4.50                        | 44                          |
| 100                | 5.00                        | 46                          |
| 100                | 4.00                        | 66                          |
| 90                 | 4.00                        | 81                          |
| 75                 | 4.00                        | 88                          |
| 75                 | 3.75                        | 108                         |
| 75                 | 3.35                        | 132                         |
| 65                 | 4.00                        | 103                         |
| 65                 | 3.35                        | 163                         |
| 65                 | 3.00                        | 198                         |
| 65                 | 2.65                        | 246                         |
| 50                 | 3.35                        | 193                         |
| 50                 | 3.00                        | 255                         |
| 50                 | 2.65                        | 308                         |

|    |      |     |
|----|------|-----|
| 45 | 3.35 | 220 |
|----|------|-----|

| Length<br><i>L</i> | Shank diameter<br><i>D</i> | Approx. no. of nails per kg |
|--------------------|----------------------------|-----------------------------|
| mm                 | mm                         |                             |
| 45                 | 2.65                       | 330                         |
| 40                 | 2.65                       | 412                         |
| 40                 | 2.36                       | 494                         |
| 40                 | 2.00                       | 688                         |
| 30                 | 2.65                       | 490                         |
| 30                 | 2.36                       | 659                         |
| 30                 | 2.00                       | 862                         |
| 25                 | 2.36                       | 774                         |
| 25                 | 2.00                       | 939                         |
| 25                 | 1.80                       | 1336                        |
| 20                 | 2.00                       | 1237                        |
| 20                 | 1.80                       | 1740                        |

**Part 3:1974:** Aluminium nails.

TABLE 1. DIMENSIONS AND APPROXIMATE COUNT OF ROUND PLAIN HEAD NAILS

| Length<br><i>L</i> | Shank diameter<br><i>D</i> | Approx. no. of nails per kg |
|--------------------|----------------------------|-----------------------------|
| mm                 | mm                         |                             |
| 115                | 5.00                       | 159                         |
| 100                | 5.00                       | 184                         |
| 100                | 4.50                       | 215                         |
| 90                 | 4.50                       | 246                         |
| 90                 | 4.00                       | 296                         |
| 75                 | 4.00                       | 338                         |
| 75                 | 3.75                       | 431                         |
| 75                 | 3.35                       | 543                         |
| 65                 | 3.75                       | 490                         |
| 65                 | 3.35                       | 644                         |
| 65                 | 3.00                       | 770                         |
| 60                 | 3.35                       | 714                         |
| 60                 | 3.00                       | 868                         |
| 50                 | 3.35                       | 812                         |
| 50                 | 3.00                       | 952                         |

| Length | Shank diameter | Approx. no. of nails per kg |
|--------|----------------|-----------------------------|
|--------|----------------|-----------------------------|

| <i>L</i> | <i>D</i> |      |
|----------|----------|------|
| mm       | mm       |      |
| 50       | 2.65     | 1232 |
| 45       | 2.65     | 1428 |
| 45       | 2.36     | 1792 |
| 40       | 2.65     | 1610 |
| 40       | 2.36     | 2100 |
| 40       | 2.00     | 2716 |
| 30       | 2.00     | 3276 |
| 30       | 1.80     | 2948 |
| 25       | 2.00     | 4004 |
| 25       | 1.80     | 4816 |
| 25       | 1.60     | 5936 |
| 20       | 1.60     | 7588 |

TABLE 2. DIMENSIONS AND APPROXIMATE COUNT OF ROUND LOST HEAD NAILS

| Length<br><i>L</i> | Shank diameter<br><i>D</i> | Approx. no. of nails per kg |
|--------------------|----------------------------|-----------------------------|
| mm                 | mm                         |                             |
| 75                 | 3.75                       | 448                         |
| 65                 | 3.35                       | 672                         |
| 60                 | 3.35                       | 756                         |
| 50                 | 3.35                       | 860                         |
| 50                 | 3.00                       | 1008                        |
| 40                 | 2.64                       | 1390                        |
| 40                 | 2.36                       | 2128                        |

**B.S. 1210:** Wood screws.

Materials, dimensions, tolerances and other criteria for screws of steel, stainless steel, brass, aluminium, silicon bronze and nickel copper alloy.

TABLE 1. SLOTTED COUNTERSUNK HEAD WOOD SCREWS

| 1  | 2                | 5                          | 6                |
|--|------------------|----------------------------|------------------|
| Size of screw and diameter of unthreaded shank |                  | Number of threads per inch | Diameter of head |
| Screw gauge                                    | <i>D</i><br>Nom. |                            | V*               |
|  | in               |                            | in               |
|  | 0                | 30                         | 0.126            |
|  | 1                | 28                         | 0.147            |

|    |       |       |           |
|----|-------|-------|-----------|
| 2  | 0.082 | 26    | 0.174     |
| 3  | 0.094 | 24    | 0.199     |
| 4  | 0.108 | 22    | 0.230     |
| 5  | 0.122 | 20    | 0.261     |
| 6  | 0.136 | 18    | 0.291     |
| 7  | 0.150 | 16    | 0.323.... |
| 8  | 0.164 | 14    | 0.353     |
| 9  | 0.178 | 12    | 0.384     |
| 10 | 0.192 | 12    | 0.414     |
| 12 | 0.220 | 10    | 0.476     |
| 14 | 0.248 | 9     | 0.538     |
| 16 | 0.276 | 8     | 0.599     |
| 18 | 0.304 | 7 1/2 | 0.660     |
| 20 | 0.332 | 7     | 0.721     |
| 24 | 0.388 | 6     | 0.845     |
| 28 | 0.444 | 5 1/2 | 0.967     |
| 32 | 0.500 | 5     | 1.088     |

\* The dimensions for 'V' are the theoretical diameters of head to sharp corners and are given for design purposes only.

**TABLE 1M. METRIC EQUIVALENTS OF TABLE 1**

NOTE. The metric conversions are approximate; the figures in British units in Table 1 are to be regarded as the standard.

| 1  |      | 2        |      | 5                        |                  | 6        |    |
|--|------|----------|------|--------------------------|------------------|----------|----|
| Size of screw and diameter of unthreaded shank |      | D        |      | Number of threads per cm | Diameter of head |          | V* |
| Screw gauge                                    | Nom. | mm       | Nom. |                          | mm               |          |    |
| 0  |      | 1.52     |      | 12                       |                  | 3.20     |    |
| 1  |      | 1.78     |      | 11                       |                  | 3.73     |    |
| 2  |      | 2.08     |      | 10                       |                  | 4.42     |    |
| 3  |      | 2.39     |      | 9 1/2                    |                  | 5.05     |    |
| 4  |      | 2.74     |      | 8 1/2                    |                  | 5.84     |    |
| 5  |      | 3.10     |      | 8                        |                  | 6.63     |    |
| 6  |      | 3.45     |      | 7                        |                  | 7.39     |    |
| 7  |      | 3.81.... |      | 6 1/2                    |                  | 8.20.... |    |
| 8  |      | 4.17     |      | 5 1/2                    |                  | 8.97     |    |
| 9  |      | 4.52     |      | 4 1/2                    |                  | 9.75     |    |
| 10   |      | 4.88     |      | 4 1/2                    |                  | 10.52    |    |
| 12   |      | 5.59     |      | 4                        |                  | 12.09    |    |
| 14   |      | 6.30     |      | 3 1/2                    |                  | 13.67    |    |



|    |       |       |       |
|----|-------|-------|-------|
| 16 | 7.01  | 3     | 15.21 |
| 18 | 7.72  | 3     | 16.76 |
| 20 | 8.43  | 2 1/2 | 18.31 |
| 24 | 9.86  | 2 1/2 | 21.46 |
| 28 | 11.28 | 2     | 24.56 |
| 32 | 12.70 | 2     | 27.64 |

\* The dimensions for 'V' are the theoretical diameters of head to sharp corners and are given for design purposes only.

**TABLE 2. STANDARD SIZES OF STEEL SLOTTED COUNTERSUNK HEAD WOOD SCREWS\***

| Length |       | Screw gauge                   |   |   |   |   |   |   |   |   |   |    |  |  |  |  |  |
|--------|-------|-------------------------------|---|---|---|---|---|---|---|---|---|----|--|--|--|--|--|
| in     | mm    |                               |   |   |   |   |   |   |   |   |   |    |  |  |  |  |  |
| 3/16   | 4.8   | 1                             |   |   |   |   |   |   |   |   |   |    |  |  |  |  |  |
| 1/4    | 6.4   | 0                             | 1 | 2 | 3 | 4 | 5 |   |   |   |   |    |  |  |  |  |  |
| 5/16   | 7.9   | 1 2 3 4 5 6                   |   |   |   |   |   |   |   |   |   |    |  |  |  |  |  |
| 3/8    | 9.5   | 0                             | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |   |    |  |  |  |  |  |
| 7/16   | 11.1  | 4 6                           |   |   |   |   |   |   |   |   |   |    |  |  |  |  |  |
| 1/2    | 12.7  | 0                             | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |  |  |  |  |  |
| 5/8    | 15.9  | 1 2 3 4 5 6 7 8 9 10 12       |   |   |   |   |   |   |   |   |   |    |  |  |  |  |  |
| 3/4    | 19.1  | 2 3 4 5 6 7 8 9 10 12 14      |   |   |   |   |   |   |   |   |   |    |  |  |  |  |  |
| 7/8    | 22.2  | 3 4 5 6 7 8 9 10 12 14        |   |   |   |   |   |   |   |   |   |    |  |  |  |  |  |
| 1      | 25.4  | 2 3 4 5 6 7 8 9 10 12 14 16   |   |   |   |   |   |   |   |   |   |    |  |  |  |  |  |
| 1 1/4  | 31.8  | 4 5 6 7 8 9 10 12 14 16 18    |   |   |   |   |   |   |   |   |   |    |  |  |  |  |  |
| 1 1/2  | 38.1  | 4 5 6 7 8 9 10 12 14 16 18 20 |   |   |   |   |   |   |   |   |   |    |  |  |  |  |  |
| 1 3/4  | 44.5  | 4 5 6 7 8 9 10 12 14 16 18    |   |   |   |   |   |   |   |   |   |    |  |  |  |  |  |
| 2      | 50.8  | 4 5 6 7 8 9 10 12 14 16 18 20 |   |   |   |   |   |   |   |   |   |    |  |  |  |  |  |
| 2 1/4  | 57.2  | 6 7 8 9 10 12 14 * 16         |   |   |   |   |   |   |   |   |   |    |  |  |  |  |  |
| 2 1/2  | 63.5  | 6 7 8 9 10 12 14 16 18 20     |   |   |   |   |   |   |   |   |   |    |  |  |  |  |  |
| 2 3/4  | 69.9  | 6 8 10 12 14 16               |   |   |   |   |   |   |   |   |   |    |  |  |  |  |  |
| 3      | 76.2  | 6 7 8 9 10 12 14 16 18 20     |   |   |   |   |   |   |   |   |   |    |  |  |  |  |  |
| 3 1/4  | 82.6  | 10 12 14                      |   |   |   |   |   |   |   |   |   |    |  |  |  |  |  |
| 3 1/2  | 88.9  | 8 10 12 14 16 18              |   |   |   |   |   |   |   |   |   |    |  |  |  |  |  |
| 4      | 101.6 | 8 10 12 14 16 18 20           |   |   |   |   |   |   |   |   |   |    |  |  |  |  |  |
| 4 1/2  | 114.3 | 10 12 14 16 20                |   |   |   |   |   |   |   |   |   |    |  |  |  |  |  |
| 5      | 127.0 | 10 12 14 16 18 20             |   |   |   |   |   |   |   |   |   |    |  |  |  |  |  |
| 6      | 152.4 | 12 14 16 18                   |   |   |   |   |   |   |   |   |   |    |  |  |  |  |  |

\* Preferred standard sizes, in bold type, should be used whenever possible, as they are the sizes normally stocked. Supplementary standard sizes, in light type, are less likely to be obtained from local stockists than the preferred standard sizes shown in bold type.

**B.S. 1579:1960:** Connectors for timber.

Split rings, shear plates, round and square-toothed plates, appropriate bolts and special washers.

LOCKS, HINGES AND HARDWARE

**B.S. 455:1957:** Schedule of sizes of locks and latches for doors in buildings.

**TABLE 8. SLOTTED ROUND HEAD WOOD SCREWS**

| 1                             |  | 2             | 5                |                            | 6                |           |
|-------------------------------|--|---------------|------------------|----------------------------|------------------|-----------|
| Size of screw and diameter of |  | <i>D</i> Nom. | unthreaded shank | Number of threads per inch | Diameter of head |           |
| Screw gauge                   |  |               |                  |                            | <i>V</i> *       |           |
|                               |  | in            |                  |                            |                  | in        |
| 0                             |  | 0.060         |                  | 30                         |                  | 0.126     |
| 1                             |  | 0.070         |                  | 28                         |                  | 0.147     |
| 2                             |  | 0.082         |                  | 26                         |                  | 0.174     |
| 3                             |  | 0.094         |                  | 24                         |                  | 0.199     |
| 4                             |  | 0.108         |                  | 22                         |                  | 0.230     |
| 5                             |  | 0.122         |                  | 20                         |                  | 0.261     |
| 6                             |  | 0.136         |                  | 18                         |                  | 0.291     |
| 7                             |  | 0.150         |                  | 16                         |                  | 0.323.... |
| 8                             |  | 0.164         |                  | 14                         |                  | 0.353     |
| 9                             |  | 0.178         |                  | 12                         |                  | 0.384     |
| 10                            |  | 0.192         |                  | 12                         |                  | 0.414     |
| 12                            |  | 0.220         |                  | 10                         |                  | 0.476     |
| 14                            |  | 0.248         |                  | 9                          |                  | 0.538     |
| 16                            |  | 0.276         |                  | 8                          |                  | 0.599     |
| 18                            |  | 0.304         |                  | 7 1/2                      |                  | 0.660     |
| 20                            |  | 0.332         |                  | 7                          |                  | 0.721     |
| 24                            |  | 0.388         |                  | 6                          |                  | 0.845     |
| 28                            |  | 0.444         |                  | 5 1/2                      |                  | 0.967     |
| 32                            |  | 0.500         |                  | 5                          |                  | 1.088     |

\* The dimensions for 'V' are the theoretical diameters of head to sharp corners and are given for design purposes only.

**TABLE 1M. METRIC EQUIVALENTS OF TABLE 1**

NOTE. The metric conversions are approximate; the figures in British units in Table 1 are to be regarded as the standard.

| 1  |  | 2             | 5                        |                  | 6 |      |
|--|--|---------------|--------------------------|------------------|---|------|
| Size of screw and diameter of unthreaded shank |  | <i>D</i> Nom. | Number of threads per cm | Diameter of head |   |      |
| Screw gauge                                    |  |               |                          | <i>V</i> *       |   |      |
|  |  | mm            |                          |                  |   | mm   |
| 0  |  | 1.52          |                          | 12               |   | 3.20 |

|    |       |       |       |
|----|-------|-------|-------|
| 1  | 1.78  | 11    | 3.73  |
| 2  | 2.08  | 10    | 4.42  |
| 3  | 2.39  | 9 1/2 | 5.05  |
| 4  | 2.74  | 8 1/2 | 5.84  |
| 5  | 3.10  | 8     | 6.63  |
| 6  | 3.45  | 7     | 7.39  |
| 7  | 3.81  | 6 1/2 | 8.20  |
| 8  | 4.17  | 5 1/2 | 8.97  |
| 9  | 4.52  | 4 1/2 | 9.75  |
| 10 | 4.88  | 4 1/2 | 10.52 |
| 12 | 5.59  | 4     | 12.09 |
| 14 | 6.30  | 3 1/2 | 13.67 |
| 16 | 7.01  | 3     | 15.21 |
| 18 | 7.72  | 3     | 16.76 |
| 20 | 8.43  | 2 1/2 | 18.31 |
| 24 | 9.86  | 2 1/2 | 21.46 |
| 28 | 11.28 | 2     | 24.56 |
| 32 | 12.70 | 2     | 27.64 |

\* The dimensions for 'V' are the theoretical diameters of head to sharp corners and are given for design purposes only.

**TABLE 20. RECESSED COUNTERSUNK HEAD WOOD SCREWS (FOR STANDARD SIZES, SEE TABLES 21 AND 22)**

| 1  |  | 2     |      | 5                          |  | 6                |      | 9                |      |
|--|--|-------|------|----------------------------|--|------------------|------|------------------|------|
| Size of screw and diameter of unthreaded shank |  |       |      | Number of threads per inch |  | Diameter of head |      | Depth of head C† |      |
| Screw gauge                                    |  | D     |      |                            |  | V*               |      | Max.             |      |
|  |  | Nom.  |      |                            |  |                  |      |                  |      |
|  |  | in    |      |                            |  | in               |      | in               |      |
| 3  |  | 0.094 |      | 24                         |  | 0.199            |      | 0.055            |      |
| 4  |  | 0.108 |      | 22                         |  | 0.230            |      | 0.064            |      |
| 5  |  | 0.122 |      | 20                         |  | 0.261            |      | 0.073            |      |
| 6  |  | 0.136 | .... | 18                         |  | 0.291            | .... | 0.082            | .... |
| 7  |  | 0.150 |      | 16                         |  | 0.323            |      | 0.091            |      |
| 8  |  | 0.164 |      | 14                         |  | 0.353            |      | 0.100            |      |
| 9  |  | 0.178 |      | 12                         |  | 0.384            |      | 0.109            |      |
| 10   |  | 0.192 |      | 12                         |  | 0.414            |      | 0.117            |      |
| 12   |  | 0.220 |      | 10                         |  | 0.476            |      | 0.135            |      |
| 14   |  | 0.248 |      | 9                          |  | 0.538            |      | 0.153            |      |
| 16   |  | 0.276 |      | 8                          |  | 0.599            |      | 0.170            |      |

\* The dimensions for 'V' are the theoretical diameters of head to sharp corners and are given for design purposes only.

† The maximum depth of head 'C' on a nominal size shank is given for the convenience of users only.

**TABLE 20M. METRIC EQUIVALENTS OF TABLE 20**

NOTE. The metric conversions are approximate; the figures in British units in Table 20 are to be regarded as the standard.

| 1  | 2    | 5                          | 6                | 9                |
|--|------|----------------------------|------------------|------------------|
| Size of screw and diameter of unthreaded shank |      | Number of threads per inch | Diameter of head | Depth of head C† |
| Screw gauge                                    | D    |                            | V*               | Max.             |
|  | Nom. |                            |                  |                  |
|  | in   |                            | in               | in               |
| 3  | 2.39 | 9 1/2                      | 5.05             | 1.40             |
| 4  | 2.74 | 8 1/2                      | 5.84             | 1.63             |
| 5  | 3.10 | 8                          | 6.63             | 1.85             |
| 6  | 3.45 | 7                          | 7.39             | 2.08             |
| 7  | 3.81 | 6 1/2                      | 8.20             | 2.31             |
| 8  | 4.17 | 5 1/2                      | 8.97             | 2.54             |
| 9  | 4.52 | 4 1/2                      | 9.75             | 2.77             |
| 10   | 4.88 | 4 1/2                      | 10.52            | 2.97             |
| 12   | 5.59 | 4                          | 12.09            | 3.43             |
| 14   | 6.30 | 3 1/2                      | 13.67            | 3.89             |
| 16   | 7.01 | 3                          | 15.21            | 4.32             |

\* The dimensions for 'V' are the theoretical diameters of head to sharp corners and are given for design purposes only.

† The maximum depth of head 'C' on a nominal size shank is given for the convenience of users only.

**TABLE 1. DIMENSIONS...OF STEEL BROAD BUTT HINGES**

| 1<br>BS type<br>reference<br>No. | 2<br>Length of<br>joint | 3                        |           | .... | 6  | 7   | .... |
|----------------------------------|-------------------------|--------------------------|-----------|------|--|---|------|
|                                  |                         | Open width over<br>flaps |           |      | Holes<br>countersunk<br>for screw<br>gauge No. | Number of<br>screw holes in<br>each hinge |      |
|                                  |                         | in                       |           |      | min.   |   |      |
| 1A/101                           | 2 ± 0.008               | min.<br>1 1/4            | max.<br>2 | 7    | 4  | ....                                      |      |
| 1A/102                           | 2 1/2 ± 0.008           | 2 1/4                    | 2 1/2     | 7    | 6  |   |      |
| 1A/103                           | 3 ± 0.008               | 2 1/4                    | 3         | 8    | 6  |   |      |
| 1A/104                           | 3 1/2 ± 0.008           | 3 1/4                    | 3 1/2     | 8    | 6  |   |      |
| 1A/105                           | 4 ± 0.008               | 3 1/4                    | 4         | 10   | 8  |   |      |

**Metric equivalents**

| 1A/101<br>1A/102<br>1A/103<br>1A/104<br>1A/105 | mm           |       | ....  | min. |   | .... |
|--|--------------|-------|-------|------|---|------|
|  | min.         | max.  |       |      |   |      |
| 1A/101   | 50.8 ± 0.19  | 49.2  | 50.8  | 7    | 4 | .... |
| 1A/102   | 63.5 ± 0.19  | 61.9  | 63.5  | 7    | 6 |      |
| 1A/103   | 76.2 ± 0.19  | 74.6  | 76.2  | 8    | 6 |      |
| 1A/104   | 88.9 ± 0.19  | 87.3  | 88.9  | 8    | 6 |      |
| 1A/105   | 101.6 ± 0.19 | 100.0 | 101.6 | 10   | 8 |      |

Standard finish: Bright, self colour. Other finishes available if specially ordered

NOTE: It is recommended that loose headed pins should be designated by adding 'L' to the BS type reference number in Column 1, e.g. '1A/101L'.

**TABLE 2. DIMENSIONS...OF STRONG STEEL BUTT HINGES**

| 1<br>BS type<br>reference<br>No. | 2<br>Length of<br>joint | 3                        |               | .... | 6  | 7   | .... |
|----------------------------------|-------------------------|--------------------------|---------------|------|--|---|------|
|                                  |                         | Open width over<br>flaps |               |      | Holes<br>countersunk<br>for screw<br>gauge No. | Number of<br>screw holes in<br>each hinge |      |
|                                  |                         | in                       |               |      | min.   |   |      |
| 1A/201                           | 1 1/2 ± 0.008           | min.<br>1 1/8            | max.<br>1 7/8 | 7    | 4  | ....                                      |      |
| 1A/202                           | 2 ± 0.008               | 1 7/8                    | 1 7/8         | 8    | 4  |   |      |
| 1A/203                           | 2 1/2 ± 0.008           | 1 7/8                    | 2 1/2         | 8    | 6  |   |      |
| 1A/204                           | 3 ± 0.008               | 2 3/4                    | 2 3/4         | 10   | 6  |   |      |
| 1A/205                           | 3 1/2 ± 0.008           | 2 3/4                    | 2 3/4         | 10   | 6  |   |      |
| 1A/206                           | 4 ± 0.008               | 2 3/4                    | 2 3/4         | 10   | 8  |   |      |
| 1A/207                           | 5 ± 0.008               | 3 3/4                    | 3 3/4         | 12   | 8  |   |      |
| 1A/208                           | 6 ± 0.008               | 3 3/4                    | 3 3/4         | 12   | 8  |   |      |

**Metric equivalents**

| 1A/201<br>1A/202<br>1A/203<br>1A/204<br>1A/205<br>1A/206<br>1A/207<br>1A/208 | mm           |      | .... | min. |   | .... |
|--|--------------|------|------|------|---|------|
|  | min.         | max. |      |      |   |      |
| 1A/201   | 38.1 ± 0.19  | 35.7 | 37.3 | 7    | 4 | .... |
| 1A/202   | 50.8 ± 0.19  | 46.8 | 48.4 | 8    | 4 |      |
| 1A/203   | 63.5 ± 0.19  | 50.0 | 51.6 | 8    | 6 |      |
| 1A/204   | 76.2 ± 0.19  | 60.3 | 61.9 | 10   | 6 |      |
| 1A/205   | 88.9 ± 0.19  | 68.3 | 69.9 | 10   | 6 |      |
| 1A/206   | 101.6 ± 0.19 | 73.0 | 74.6 | 10   | 8 |      |
| 1A/207   | 127.0 ± 0.19 | 87.3 | 88.9 | 12   | 8 |      |
| 1A/208   | 152.4 ± 0.19 | 90.5 | 92.1 | 12   | 8 |      |

Standard finish: Bright, self colour. Other finishes available if specially ordered.

**TABLE 3. DIMENSIONS...OF NARROW STEEL BUTT HINGES**

| 1<br>BS type<br>reference<br>No. | 2<br>Length of<br>joint | 3<br>Open width over<br>flaps |                 |      | 6  | 7   |      |
|----------------------------------|-------------------------|-------------------------------|-----------------|------|--|---|------|
|                                  |                         |                               |                 |      | Holes<br>countersunk<br>for screw<br>gauge No. | Number of<br>screw holes in<br>each hinge |      |
|                                  |                         |                               |                 |      | min.   |   |      |
|                                  | in                      | in                            |                 |      | min.   |   |      |
| 1A/301                           | 1 + .005 - .009         | min.                          | max.            | .... | 4  | 4   | .... |
| 1A/302                           | 1½ + .005 - .012        | 2½ <sub>2</sub>               | 3¼ <sub>2</sub> |      | 4  | 4   |      |
| 1A/303                           | 1¾ + .005 - .014        | 2¾ <sub>2</sub>               | 3½ <sub>2</sub> |      | 5  | 4   |      |
| 1A/304                           | 2 + .005 - .014         | 3¼                            | 3¾ <sub>2</sub> |      | 6  | 4   |      |
| 1A/305                           | 2¼ + .008 - .014        | 3¾ <sub>2</sub>               | 4½ <sub>2</sub> |      | 6  | 6   |      |
| 1A/306                           | 3 + .008 - .020         | 4¾ <sub>2</sub>               | 5½ <sub>2</sub> |      | 7  | 6   |      |
| 1A/307                           | 3¾ + .008 - .022        | 5¾ <sub>2</sub>               | 6½              |      | 8  | 6   |      |
| 1A/308                           | 4 + .008 - .026         | 6¾ <sub>2</sub>               | 7½              |      | 8  | 8   |      |
| 1A/309                           | 5 + .008 - .026         | 7¾ <sub>2</sub>               | 8½              |      | 10   | 8   |      |
| 1A/310                           | 6 + .008 - .026         | 8¾                            | 9               |      | 10   | 8   |      |

| Metric equivalents |                     |      |       |      |      |   |      |
|--------------------|---------------------|------|-------|------|------|---|------|
|                    | mm                  | mm   |       |      | min. |   |      |
| 1A/301             | 25.4 + 0.13 - 0.23  | min. | max.  | .... | 4    | 4 | .... |
| 1A/302             | 31.8 + 0.13 - 0.31  | 27.8 | 29.4  |      | 4    | 4 |      |
| 1A/303             | 38.1 + 0.13 - 0.36  | 34.1 | 35.7  |      | 5    | 4 |      |
| 1A/304             | 50.8 + 0.13 - 0.36  | 38.1 | 39.7  |      | 6    | 4 |      |
| 1A/305             | 63.5 + 0.19 - 0.36  | 42.1 | 43.7  |      | 6    | 6 |      |
| 1A/306             | 76.2 + 0.19 - 0.51  | 48.4 | 50.8  |      | 7    | 6 |      |
| 1A/307             | 88.9 + 0.19 - 0.56  | 57.9 | 60.3  |      | 8    | 6 |      |
| 1A/308             | 101.6 + 0.19 - 0.56 | 70.0 | 73.0  |      | 8    | 8 |      |
| 1A/309             | 127.0 + 0.19 - 0.66 | 81.0 | 84.1  |      | 10   | 8 |      |
| 1A/310             | 152.4 + 0.19 - 0.66 | 98.4 | 101.6 |      | 10   | 8 |      |

Standard finish : Bright, self colour. Other finishes available if specially ordered

NOTE: It is recommended that loose headed pins should be designated by adding 'L' to the BS type reference, e.g. '1A/301 L'.

**TABLE 6. DIMENSIONS...OF STEEL RISING BUTT HINGES**

| 1<br>BS type<br>reference<br>No. | 2<br>Length of joint  | 3<br>Open width over<br>flaps |                 |     | 6  | 7   |      |
|----------------------------------|-----------------------|-------------------------------|-----------------|-----|--|---|------|
|                                  |                       |                               |                 |     | Holes<br>countersunk<br>for screw<br>gauge No. | Number of<br>screw holes in<br>each hinge |      |
|                                  |                       |                               |                 |     | min.   |   |      |
|                                  | in                    | in                            |                 |     | min.   |   |      |
| 1A/601                           | 3 + 0.008<br>- 0.020  | 2¾ <sub>2</sub>               | 2¾ <sub>2</sub> | ... | 8  | 6   | .... |
| 1A/602                           | 3½ + 0.008<br>- 0.022 | 2¾ <sub>2</sub>               | 2¾ <sub>2</sub> |     | 10   | 8   |      |
| 1A/603                           | 4 + 0.008<br>- 0.026  | 2¾ <sub>2</sub>               | 3¼ <sub>2</sub> |     | 10   | 8   |      |

| Metric equivalents |                        |      |      |      |      |   |      |
|--------------------|------------------------|------|------|------|------|---|------|
|                    | mm                     | mm   |      |      | min. |   |      |
| 1A/601             | 76.2 + 0.19<br>- 0.51  | min. | max. | .... | 8    | 6 | .... |
| 1A/602             | 88.9 + 0.19<br>- 0.56  | 72.2 | 73.8 |      | 10   | 8 |      |
| 1A/603             | 101.6 + 0.19<br>- 0.66 | 75.4 | 77.0 |      | 10   | 8 |      |

Standard finish : Bright, self colour. Other finishes available if specially ordered

NOTE: These hinges are handed and it is essential that purchasers indicate, when ordering, whether left-hand or right-hand hinges are required.

**TABLE 18. DIMENSIONS...OF CAST IRON BUTT HINGES**

| 1                         | 2                               | 3                               | .... | 4                                     | 7                                   | .... |
|---------------------------|---------------------------------|---------------------------------|------|---------------------------------------|-------------------------------------|------|
| BS type reference No.     | Length of joint                 | Open width over flaps           |      | Holes countersunk for screw gauge No. | Number of screw holes in each hinge |      |
|                           | in                              | in                              |      | min.                                  |                                     |      |
| 1A/1801                   | $2\frac{1}{2} \pm \frac{1}{16}$ | $1\frac{3}{4} \pm \frac{1}{16}$ |      | 10                                    | 6                                   |      |
| 1A/1802                   | $3 \pm \frac{1}{16}$            | $2 \pm \frac{1}{16}$            |      | 10                                    | 6                                   |      |
| 1A/1803                   | $4 \pm \frac{1}{16}$            | $2\frac{3}{4} \pm \frac{1}{16}$ |      | 12                                    | 8                                   |      |
| <b>Metric equivalents</b> |                                 |                                 |      |                                       |                                     |      |
|                           | mm                              | mm                              | .... | min.                                  |                                     | .... |
| 1A/1801                   | $63.5 \pm 1.59$                 | $44.5 \pm 1.59$                 |      | 10                                    | 6                                   |      |
| 1A/1802                   | $76.2 \pm 1.59$                 | $50.8 \pm 1.59$                 |      | 10                                    | 6                                   |      |
| 1A/1803                   | $101.6 \pm 1.59$                | $60.3 \pm 1.59$                 |      | 12                                    | 8                                   |      |

**TABLE 19. DIMENSIONS...OF CAST IRON RISING BUTT HINGES**

| 1                         | 2                    | 3                               | .... | 8                                     | 9                                   | .... |
|---------------------------|----------------------|---------------------------------|------|---------------------------------------|-------------------------------------|------|
| BS type reference No.     | Length of joint      | Open width over flaps           |      | Holes countersunk for screw gauge No. | Number of screw holes in each hinge |      |
|                           | in                   | in                              |      | min.                                  |                                     |      |
| 1A/1901                   | $3 \pm \frac{1}{16}$ | $2\frac{1}{2} \pm \frac{1}{16}$ |      | 12                                    | 6                                   |      |
| 1A/1902                   | $4 \pm \frac{1}{16}$ | $2\frac{3}{4} \pm \frac{1}{16}$ |      | 12                                    | 6                                   |      |
| <b>Metric equivalents</b> |                      |                                 |      |                                       |                                     |      |
|                           | mm                   | mm                              | .... | min.                                  |                                     | .... |
| 1A/1901                   | $76.2 \pm 1.59$      | $58.7 \pm 1.59$                 |      | 12                                    | 6                                   |      |
| 1A/1902                   | $101.6 \pm 1.59$     | $69.9 \pm 1.59$                 |      | 12                                    | 6                                   |      |

NOTE. These hinges are handed and it is essential that purchasers indicate, when ordering, whether left-hand or right-hand hinges are required.

**BUILDERS' HARDWARE**

**B.S. 1331:1954:** Builders' hardware for housing.

**1. SCOPE**

...materials, main dimensions, minimum weights and fixing accessories for....

**Schedule One**

**Door and gate equipment**

- Knobs*
- Lever handles*
- Lock sets*
- Pull handles*
- Finger plates*
- Thumb latches*
- Cabin hooks*
- Gate latches*

**Schedule Two**

**Window equipment**

|                       |                           |
|-----------------------|---------------------------|
|                       | <i>Casement stays</i>     |
|                       | <i>Casement fasteners</i> |
|                       | <i>Cremorne bolts</i>     |
|                       | <i>Sash pulleys</i>       |
|                       | <i>Sash lifts</i>         |
|                       | <i>Sash fasteners</i>     |
|                       | <i>Sash pivots</i>        |
| <b>Schedule Three</b> | <b>Fanlight equipment</b> |
|                       | <i>Catches</i>            |
|                       | <i>Stays</i>              |
| <b>Schedule Four</b>  | <b>Cupboard equipment</b> |
|                       | <i>Thread escutcheon</i>  |
|                       | <i>Knobs</i>              |
|                       | <i>Turns</i>              |
|                       | <i>Catches</i>            |
|                       | <i>Buttons</i>            |
|                       | <i>Bales catches</i>      |
|                       | <i>Ball catches</i>       |
|                       | <i>Hat and coat hooks</i> |
|                       | <i>Wardrobe hooks</i>     |
| <b>Schedule Five</b>  | <b>Drawer equipment</b>   |
|                       | <i>Pulls</i>              |

#### ADHESIVES

**B.S. 745:1969:** Animal glue for wood (joiner's glue) (dry glue; jelly or liquid glue).

Specifies dry glue supplied in cakes, pieces, granules, pearl, cubes or powder, and jelly or liquid glue.

**B.S. 1204:** Synthetic resin adhesives (phenolic and aminoplastic) for wood.

**Part 1:1964:** Gap-filling adhesives: three groups, according to weathering and a fourth group for interior use.

**Part 2:1965:** Close-contact adhesives: four groups in terms of weathering.

**B.S. 1444:1970:** Cold-setting casein adhesive powders for wood.

Selection of samples, instructions for use, etc.

**B.S. 4071:1966:** Polyvinyl acetate (PVA) emulsion adhesives for wood.

Close contact adhesives for interior use.

**B.S. 4643:1970:** Glossary of terms relating to joints and jointing in building.

Defines terms for jointing products, joint dimensions and functions.



## WOOD JOISTS—FLOOR, CEILING AND ROOF

### STRESS GRADED SOFTWOOD

The following excerpts are taken from TRADA Wood Information Sheet 7, *Guide to stress graded softwood*. Copies of this, and other publications in the series are available from the Timber Research and Development Association.

#### HOW TO COMPLY WITH THE BUILDING REGULATIONS 1976

There are several methods deemed to satisfy the main body of the regulations, the most usual of which are listed below:

1. Use the permissible span tables in Schedule 6 of the Building Regulations 1976. Table to Rule 2 of Schedule 6 gives the species, origin and grade of timber to which the span tables in Schedule 6 relate. The span tables are divided into two sets and the Table to Rule 2 lists the species and grades which are appropriate for use in accordance with each set of span tables.
2. Design to CP 112:1971 (including amendment slips 1, 2 and 3) using timber graded and marked GS, MGS, M50, SS, MSS, M75 in accordance with B.S. 4978:1973.
3. Design to CP 112:1971 (including amendment slips 1, 2 and 3) using timber visually graded in Canada to the NLGA 1978 rules. Amendment slip No. 2 to CP 112 also introduced grade stresses for light framing and studs.
4. Design trussed rafters in accordance with CP 112: Part 3:1973: Trussed rafters for roofs of dwellings: using the grades as defined in B.S. 4978 or CP 112: Part 2:1971.

*Notes*In addition to the methods listed above, a structure can be prototype tested in accordance with CP 112; 1971. It should be noted that any species or grade, the stresses for which are not less than those given for the Schedule 6 species and grades, can be safely used to the permissible spans given in that Schedule. Stress values should be compared in CP 112; 1971 (including amendment slips 1, 2 and 3).

The so-called 'numbered grades' defined in Appendix A of CP 112:1971 are being phased out in favour of B.S. 4978:1973: grades. However these grades (40, 50, 65, 75 or composite 40/50 grade) will continue to be *deemed-to-satisfy* in the Building Regulations until CP 112:1971 is amended.

**Table 1: Floor Joists**

| GS, MGS, M50, M75 or No.2 grade timber |   |      |      |                                   |      |      |                                    |      |      |
|--|---|------|------|-----------------------------------|------|------|------------------------------------|------|------|
| Size of joist (in mm)                  | Dead load (in kg/m <sup>2</sup> ) supported by joist, excluding the mass of the joist |      |      |                                   |      |      |                                    |      |      |
|  | Not more than 25  |      |      | More than 25 but not more than 50 |      |      | More than 50 but not more than 125 |      |      |
| Spacing of joists (in mm)              |   |      |      |                                   |      |      |                                    |      |      |
|  | 400   | 450  | 600  | 400                               | 450  | 600  | 400                                | 450  | 600  |
| Maximum span of joist (in m)           |   |      |      |                                   |      |      |                                    |      |      |
| 38×75                                  | 1.05  | 0.95 | 0.72 | 0.99                              | 0.90 | 0.69 | 0.87                               | 0.79 | 0.62 |
| 38×100                                 | 1.77  | 1.60 | 1.23 | 1.63                              | 1.48 | 1.16 | 1.36                               | 1.24 | 1.00 |
| 38×125                                 | 2.53  | 2.35 | 1.84 | 2.33                              | 2.12 | 1.69 | 1.88                               | 1.73 | 1.40 |
| 38×150                                 | 3.02  | 2.85 | 2.48 | 2.83                              | 2.67 | 2.26 | 2.41                               | 2.23 | 1.83 |
| 38×175                                 | 3.51  | 3.32 | 2.89 | 3.29                              | 3.11 | 2.71 | 2.82                               | 2.66 | 2.27 |
| 38×200                                 | 4.00  | 3.78 | 3.30 | 3.75                              | 3.55 | 3.09 | 3.21                               | 3.03 | 2.64 |
| 38×225                                 | 4.49  | 4.24 | 3.70 | 4.21                              | 3.98 | 3.47 | 3.61                               | 3.41 | 2.96 |
| 44×75                                  | 1.20  | 1.08 | 0.83 | 1.13                              | 1.02 | 0.79 | 0.98                               | 0.89 | 0.70 |
| 44×100                                 | 2.01  | 1.82 | 1.41 | 1.83                              | 1.67 | 1.31 | 1.51                               | 1.39 | 1.12 |
| 44×125                                 | 2.71  | 2.56 | 2.09 | 2.54                              | 2.38 | 1.90 | 2.08                               | 1.92 | 1.56 |
| 44×150                                 | 3.24  | 3.06 | 2.67 | 3.04                              | 2.87 | 2.50 | 2.60                               | 2.45 | 2.03 |
| 44×175                                 | 3.77  | 3.56 | 3.10 | 3.53                              | 3.34 | 2.91 | 3.02                               | 2.86 | 2.48 |
| 44×200                                 | 4.29  | 4.06 | 3.54 | 4.02                              | 3.80 | 3.31 | 3.45                               | 3.26 | 2.83 |
| 44×225                                 | 4.81  | 4.55 | 3.97 | 4.51                              | 4.27 | 3.72 | 3.87                               | 3.66 | 3.18 |

| GS, MGS, M50, M75 or No.2 grade timber |   |      |      |                                   |      |      |                                    |      |      |
|--|---|------|------|-----------------------------------|------|------|------------------------------------|------|------|
| Size of joist (in mm)                  | Dead load (in kg/m <sup>2</sup> ) supported by joist, excluding the mass of the joist |      |      |                                   |      |      |                                    |      |      |
|  | Not more than 25  |      |      | More than 25 but not more than 50 |      |      | More than 50 but not more than 125 |      |      |
| Spacing of joists (in mm)              |   |      |      |                                   |      |      |                                    |      |      |
|  | 400   | 450  | 600  | 400                               | 450  | 600  | 400                                | 450  | 600  |
| Maximum span of joist (in m)           |   |      |      |                                   |      |      |                                    |      |      |
| 50×75                                  | 1.35  | 1.22 | 0.93 | 1.26                              | 1.14 | 0.89 | 1.08                               | 0.99 | 0.78 |
| 50×100                                 | 2.22  | 2.03 | 1.58 | 2.03                              | 1.85 | 1.46 | 1.66                               | 1.53 | 1.23 |
| 50×125                                 | 2.84  | 2.72 | 2.33 | 2.70                              | 2.55 | 2.10 | 2.27                               | 2.09 | 1.71 |
| 50×150                                 | 3.40  | 3.26 | 2.84 | 3.23                              | 3.05 | 2.66 | 2.76                               | 2.61 | 2.21 |
| 50×175                                 | 3.95  | 3.78 | 3.30 | 3.75                              | 3.55 | 3.09 | 3.22                               | 3.04 | 2.64 |
| 50×200                                 | 4.51  | 4.31 | 3.76 | 4.27                              | 4.04 | 3.52 | 3.67                               | 3.46 | 3.01 |
| 50×225                                 | 5.06  | 4.83 | 4.22 | 4.79                              | 4.53 | 3.95 | 4.11                               | 3.89 | 3.39 |
| 63×150                                 | 3.66  | 3.52 | 3.17 | 3.50                              | 3.38 | 2.97 | 3.09                               | 2.92 | 2.54 |

|        |      |      |      |      |      |      |      |      |      |
|--------|------|------|------|------|------|------|------|------|------|
| 63×175 | 4.25 | 4.10 | 3.68 | 4.07 | 3.93 | 3.45 | 3.59 | 3.40 | 2.96 |
| 63×200 | 4.84 | 4.67 | 4.20 | 4.64 | 4.48 | 3.93 | 4.09 | 3.87 | 3.37 |
| 63×225 | 5.43 | 5.24 | 4.70 | 5.21 | 5.02 | 4.41 | 4.59 | 4.34 | 3.78 |
| 75×200 | 5.10 | 4.93 | 4.51 | 4.90 | 4.72 | 4.27 | 4.43 | 4.20 | 3.67 |
| 75×225 | 5.72 | 5.52 | 5.06 | 5.49 | 5.30 | 4.79 | 4.97 | 4.71 | 4.11 |

**SS or MSS grade timber**

| Size of joist<br>(in mm)            | Dead load (in kg/m <sup>2</sup> ) supported by joist, excluding the mass of the joist |      |      |                                   |      |      |                                    |      |      |
|-------------------------------------|---|------|------|-----------------------------------|------|------|------------------------------------|------|------|
|                                     | Not more than 25  |      |      | More than 25 but not more than 50 |      |      | More than 50 but not more than 125 |      |      |
| Spacing of joists (in mm)           |   |      |      |                                   |      |      |                                    |      |      |
| 400 450 600 400 450 600 400 450 600 |   |      |      |                                   |      |      |                                    |      |      |
| Maximum span of joist (in m)        |   |      |      |                                   |      |      |                                    |      |      |
| 38×75                               | 1.41  | 1.32 | 1.01 | 1.35                              | 1.23 | 0.96 | 1.15                               | 1.05 | 0.84 |
| 38×100                              | 2.11  | 2.00 | 1.71 | 2.00                              | 1.90 | 1.57 | 1.77                               | 1.63 | 1.32 |
| 38×125                              | 2.74  | 2.63 | 2.39 | 2.62                              | 2.52 | 2.25 | 2.34                               | 2.23 | 1.83 |
| 38×150                              | 3.28  | 3.15 | 2.87 | 3.14                              | 3.02 | 2.75 | 2.82                               | 2.72 | 2.35 |
| 38×175                              | 3.81  | 3.67 | 3.35 | 3.65                              | 3.52 | 3.20 | 3.29                               | 3.17 | 2.76 |
| 38×200                              | 4.35  | 4.19 | 3.82 | 4.16                              | 4.01 | 3.66 | 3.76                               | 3.62 | 3.16 |
| 38×225                              | 4.88  | 4.70 | 4.29 | 4.68                              | 4.51 | 4.11 | 4.22                               | 4.06 | 3.54 |
| 44×75                               | 1.51  | 1.43 | 1.16 | 1.45                              | 1.37 | 1.09 | 1.29                               | 1.18 | 0.94 |
| 44×100                              | 2.25  | 2.13 | 1.87 | 2.13                              | 2.02 | 1.77 | 1.89                               | 1.80 | 1.47 |
| 44×125                              | 2.87  | 2.76 | 2.52 | 2.74                              | 2.64 | 2.40 | 2.47                               | 2.37 | 2.02 |
| 44×150                              | 3.43  | 3.31 | 3.01 | 3.29                              | 3.16 | 2.88 | 2.96                               | 2.85 | 2.55 |
| 44×175                              | 3.99  | 3.85 | 3.51 | 3.83                              | 3.68 | 3.36 | 3.45                               | 3.32 | 2.97 |
| 44×200                              | 4.55  | 4.39 | 4.00 | 4.36                              | 4.20 | 3.83 | 3.94                               | 3.79 | 3.39 |
| 44×225                              | 5.11  | 4.93 | 4.50 | 4.90                              | 4.72 | 4.31 | 4.42                               | 4.26 | 3.81 |

**SS or MSS grade timber**

| Size of joist<br>(in mm)            | Dead load (in kg/m <sup>2</sup> ) supported by joist, excluding the mass of the joist |      |      |                                   |      |      |                                    |      |      |
|-------------------------------------|---|------|------|-----------------------------------|------|------|------------------------------------|------|------|
|                                     | Not more than 25  |      |      | More than 25 but not more than 50 |      |      | More than 50 but not more than 125 |      |      |
| Spacing of joists (in mm)           |   |      |      |                                   |      |      |                                    |      |      |
| 400 450 600 400 450 600 400 450 600 |   |      |      |                                   |      |      |                                    |      |      |
| Maximum span of joist (in m)        |   |      |      |                                   |      |      |                                    |      |      |
| 50×75                               | 1.60  | 1.51 | 1.30 | 1.53                              | 1.45 | 1.21 | 1.39                               | 1.30 | 1.04 |
| 50×100                              | 2.38  | 2.26 | 1.98 | 2.25                              | 2.14 | 1.89 | 1.99                               | 1.90 | 1.61 |
| 50×125                              | 2.99  | 2.88 | 2.62 | 2.86                              | 2.75 | 2.51 | 2.58                               | 2.48 | 2.21 |
| 50×150                              | 3.57  | 3.44 | 3.14 | 3.42                              | 3.30 | 3.01 | 3.09                               | 2.97 | 2.71 |

|        |      |      |      |      |      |      |      |      |      |
|--------|------|------|------|------|------|------|------|------|------|
| 50×175 | 4.16 | 4.01 | 3.66 | 3.98 | 3.84 | 3.50 | 3.60 | 3.46 | 3.15 |
| 50×200 | 4.74 | 4.57 | 4.17 | 4.54 | 4.38 | 3.99 | 4.10 | 3.95 | 3.60 |
| 50×225 | 5.32 | 5.13 | 4.68 | 5.10 | 4.91 | 4.49 | 4.61 | 4.44 | 4.05 |
| 63×150 | 3.84 | 3.70 | 3.38 | 3.68 | 3.55 | 3.24 | 3.32 | 3.20 | 2.92 |
| 63×175 | 4.47 | 4.31 | 3.94 | 4.28 | 4.13 | 3.77 | 3.87 | 3.73 | 3.40 |
| 63×200 | 5.09 | 4.91 | 4.49 | 4.88 | 4.71 | 4.30 | 4.41 | 4.25 | 3.88 |
| 63×225 | 5.71 | 5.51 | 5.04 | 5.48 | 5.28 | 4.83 | 4.95 | 4.77 | 4.36 |
| 75×200 | 5.37 | 5.18 | 4.74 | 5.15 | 4.97 | 4.54 | 4.66 | 4.49 | 4.10 |
| 75×225 | 6.02 | 5.81 | 5.32 | 5.78 | 5.57 | 5.10 | 5.23 | 5.04 | 4.61 |

**Table 2: Ceiling joists**

GS, MGS, M50, M75 or No.2 grade timber

| Size of joist (in mm)        | Dead load (in kg/m <sup>2</sup> ) supported by joist, excluding the mass of the joist |      |      |                                   |      |      |
|------------------------------|---|------|------|-----------------------------------|------|------|
|                              | Not more than 25  |      |      | More than 25 but not more than 50 |      |      |
| Spacing of joists (in mm)    |   |      |      |                                   |      |      |
|                              | 400   | 450  | 600  | 400                               | 450  | 600  |
| Maximum span of joist (in m) |   |      |      |                                   |      |      |
| 38×75                        | 1.88  | 1.80 | 1.57 | 1.71                              | 1.61 | 1.40 |
| 38×100                       | 2.50  | 2.39 | 2.08 | 2.27                              | 2.14 | 1.86 |
| 38×125                       | 3.11  | 2.97 | 2.59 | 2.82                              | 2.67 | 2.32 |
| 38×150                       | 3.72  | 3.55 | 3.10 | 3.37                              | 3.19 | 2.78 |
| 38×175                       | 4.32  | 4.12 | 3.60 | 3.92                              | 3.71 | 3.23 |
| 38×200                       | 4.92  | 4.69 | 4.10 | 4.46                              | 4.22 | 3.68 |
| 38×225                       | 5.51  | 5.25 | 4.60 | 4.99                              | 4.73 | 4.13 |
| 44×75                        | 1.97  | 1.90 | 1.68 | 1.83                              | 1.73 | 1.51 |
| 44×100                       | 2.61  | 2.52 | 2.23 | 2.43                              | 2.30 | 2.00 |
| 44×125                       | 3.25  | 3.14 | 2.78 | 3.03                              | 2.86 | 2.49 |
| 44×150                       | 3.89  | 3.75 | 3.32 | 3.62                              | 3.42 | 2.98 |
| 44×175                       | 4.52  | 4.36 | 3.86 | 4.20                              | 3.97 | 3.47 |
| 44×200                       | 5.14  | 4.96 | 4.39 | 4.77                              | 4.52 | 3.95 |
| 44×225                       | 5.76  | 5.56 | 4.92 | 5.34                              | 5.06 | 4.43 |

GS, MGS, M50, M75 or No.2 grade timber

| Size of joist (in mm)     | Dead load (in kg/m <sup>2</sup> ) supported by joist, excluding the mass of the joist |     |     |                                   |     |     |
|---------------------------|---|-----|-----|-----------------------------------|-----|-----|
|                           | Not more than 25  |     |     | More than 25 but not more than 50 |     |     |
| Spacing of joists (in mm) |   |     |     |                                   |     |     |
|                           | 400   | 450 | 600 | 400                               | 450 | 600 |

|        | Maximum span of joist (in m) |      |      |      |      |      |
|--------|------------------------------|------|------|------|------|------|
| 50×75  | 2.05                         | 1.98 | 1.79 | 1.91 | 1.84 | 1.60 |
| 50×100 | 2.72                         | 2.62 | 2.38 | 2.53 | 2.44 | 2.13 |
| 50×125 | 3.39                         | 3.26 | 2.95 | 3.15 | 3.04 | 2.65 |
| 50×150 | 4.04                         | 3.90 | 3.53 | 3.77 | 3.63 | 3.17 |
| 50×175 | 4.70                         | 4.53 | 4.10 | 4.38 | 4.22 | 3.68 |
| 50×200 | 5.34                         | 5.16 | 4.66 | 4.99 | 4.79 | 4.19 |
| 50×225 | 5.98                         | 5.78 | 5.22 | 5.59 | 5.37 | 4.70 |

**Table 3: Ceiling joists**

**SS or MSS grade timber**

| Size of joist (in mm) | Dead load (in kg/m <sup>2</sup> ) supported by joist, excluding the mass of the joist |      |      |                                   |      |      |
|-----------------------|---|------|------|-----------------------------------|------|------|
|                       | Not more than 25  |      |      | More than 25 but not more than 50 |      |      |
|                       | Spacing of joists (in mm)   |      |      |                                   |      |      |
|                       | 400   | 450  | 600  | 400                               | 450  | 600  |
|                       | Maximum span of joist (in m)  |      |      |                                   |      |      |
| 38×75                 | 1.98  | 1.90 | 1.73 | 1.84                              | 1.77 | 1.61 |
| 38×100                | 2.62  | 2.53 | 2.30 | 2.44                              | 2.35 | 2.14 |
| 38×125                | 3.27  | 3.15 | 2.87 | 3.04                              | 2.93 | 2.67 |
| 38×150                | 3.91  | 3.77 | 3.44 | 3.64                              | 3.51 | 3.20 |
| 38×175                | 4.54  | 4.38 | 4.00 | 4.23                              | 4.08 | 3.72 |
| 38×200                | 5.17  | 4.99 | 4.56 | 4.82                              | 4.65 | 4.25 |
| 38×225                | 5.80  | 5.59 | 5.12 | 5.41                              | 5.22 | 4.77 |
| 44×75                 | 2.07  | 1.99 | 1.82 | 1.93                              | 1.85 | 1.69 |
| 44×100                | 2.75  | 2.65 | 2.42 | 2.56                              | 2.46 | 2.24 |
| 44×125                | 3.42  | 3.30 | 3.01 | 3.19                              | 3.07 | 2.80 |
| 44×150                | 4.09  | 3.94 | 3.60 | 3.81                              | 3.67 | 3.35 |
| 44×175                | 4.75  | 4.58 | 4.19 | 4.43                              | 4.27 | 3.90 |
| 44×200                | 5.41  | 5.22 | 4.78 | 5.05                              | 4.87 | 4.45 |
| 44×225                | 6.06  | 5.85 | 5.36 | 5.66                              | 5.46 | 4.99 |

**SS or MSS grade timber**

| Size of joist (in mm) | Dead load (in kg/m <sup>2</sup> ) supported by joist, excluding the mass of the joist |     |     |                                   |     |     |
|-----------------------|---|-----|-----|-----------------------------------|-----|-----|
|                       | Not more than 25  |     |     | More than 25 but not more than 50 |     |     |
|                       | Spacing of joists (in mm)   |     |     |                                   |     |     |
|                       | 400   | 450 | 600 | 400                               | 450 | 600 |
|                       | Maximum span of joist (in m)  |     |     |                                   |     |     |

|        |      |      |      |      |      |      |
|--------|------|------|------|------|------|------|
| 50×75  | 2.16 | 2.08 | 1.89 | 2.01 | 1.93 | 1.76 |
| 50×100 | 2.86 | 2.76 | 2.52 | 2.66 | 2.57 | 2.34 |
| 50×125 | 3.56 | 3.43 | 3.14 | 3.32 | 3.20 | 2.92 |
| 50×150 | 4.25 | 4.10 | 3.75 | 3.97 | 3.82 | 3.49 |
| 50×175 | 4.94 | 4.77 | 4.36 | 4.61 | 4.45 | 4.06 |
| 50×200 | 5.62 | 5.42 | 4.97 | 5.25 | 5.06 | 4.63 |
| 50×225 | 6.29 | 6.08 | 5.57 | 5.88 | 5.68 | 5.20 |

**Table 4: Joists for flat roofs with access not limited to the purposes of maintenance or repair**

GS, MGS, M50, M75 or No.2 grade timber

| Size of joist (in mm)     | Dead load (in kg/m <sup>2</sup> ) supported by joist, excluding the mass of the joist |      |      |                                   |      |      |                                    |      |      |
|---------------------------|---|------|------|-----------------------------------|------|------|------------------------------------|------|------|
|                           | Not more than 25  |      |      | More than 25 but not more than 75 |      |      | More than 75 but not more than 100 |      |      |
| Spacing of joists (in mm) | Maximum span of joist (in m)  |      |      |                                   |      |      |                                    |      |      |
|                           | 400   | 450  | 600  | 400                               | 450  | 600  | 400                                | 450  | 600  |
| 38×75                     | 1.29  | 1.16 | 0.89 | 1.14                              | 1.03 | 0.81 | 1.09                               | 0.99 | 0.78 |
| 38×100                    | 1.96  | 1.86 | 1.51 | 1.79                              | 1.65 | 1.31 | 1.70                               | 1.55 | 1.24 |
| 38×125                    | 2.60  | 2.50 | 2.22 | 2.38                              | 2.27 | 1.87 | 2.28                               | 2.16 | 1.75 |
| 38×150                    | 3.11  | 3.00 | 2.73 | 2.87                              | 2.76 | 2.45 | 2.77                               | 2.67 | 2.28 |
| 38×175                    | 3.63  | 3.49 | 3.18 | 3.34                              | 3.22 | 2.85 | 3.23                               | 3.11 | 2.71 |
| 38×200                    | 4.14  | 3.98 | 3.63 | 3.81                              | 3.67 | 3.26 | 3.68                               | 3.55 | 3.09 |
| 38×225                    | 4.64  | 4.47 | 4.08 | 4.28                              | 4.12 | 3.66 | 4.14                               | 3.98 | 3.47 |
| 44×75                     | 1.40  | 1.33 | 1.02 | 1.29                              | 1.17 | 0.92 | 1.22                               | 1.11 | 0.88 |
| 44×100                    | 2.10  | 1.99 | 1.72 | 1.91                              | 1.81 | 1.48 | 1.83                               | 1.73 | 1.39 |
| 44×125                    | 2.73  | 2.63 | 2.38 | 2.51                              | 2.41 | 2.09 | 2.42                               | 2.31 | 1.95 |
| 44×150                    | 3.26  | 3.14 | 2.87 | 3.01                              | 2.90 | 2.63 | 2.91                               | 2.80 | 2.50 |
| 44×175                    | 3.80  | 3.66 | 3.34 | 3.50                              | 3.37 | 3.06 | 3.38                               | 3.26 | 2.91 |
| 44×200                    | 4.33  | 4.17 | 3.81 | 4.00                              | 3.85 | 3.50 | 3.86                               | 3.72 | 3.32 |
| 44×225                    | 4.86  | 4.68 | 4.28 | 4.49                              | 4.32 | 3.93 | 4.34                               | 4.18 | 3.73 |

GS, MGS, M50, M75 or No.2 grade timber

| Size of joist (in mm)     | Dead load (in kg/m <sup>2</sup> ) supported by joist, excluding the mass of the joist |      |      |                                   |      |      |                                    |      |      |
|---------------------------|---|------|------|-----------------------------------|------|------|------------------------------------|------|------|
|                           | Not more than 25  |      |      | More than 25 but not more than 75 |      |      | More than 75 but not more than 100 |      |      |
| Spacing of joists (in mm) | Maximum span of joist (in m)  |      |      |                                   |      |      |                                    |      |      |
|                           | 400   | 450  | 600  | 400                               | 450  | 600  | 400                                | 450  | 600  |
| 38×75                     | 1.29  | 1.16 | 0.89 | 1.14                              | 1.03 | 0.81 | 1.09                               | 0.99 | 0.78 |
| 38×100                    | 1.96  | 1.86 | 1.51 | 1.79                              | 1.65 | 1.31 | 1.70                               | 1.55 | 1.24 |
| 38×125                    | 2.60  | 2.50 | 2.22 | 2.38                              | 2.27 | 1.87 | 2.28                               | 2.16 | 1.75 |
| 38×150                    | 3.11  | 3.00 | 2.73 | 2.87                              | 2.76 | 2.45 | 2.77                               | 2.67 | 2.28 |
| 38×175                    | 3.63  | 3.49 | 3.18 | 3.34                              | 3.22 | 2.85 | 3.23                               | 3.11 | 2.71 |
| 38×200                    | 4.14  | 3.98 | 3.63 | 3.81                              | 3.67 | 3.26 | 3.68                               | 3.55 | 3.09 |
| 38×225                    | 4.64  | 4.47 | 4.08 | 4.28                              | 4.12 | 3.66 | 4.14                               | 3.98 | 3.47 |
| 44×75                     | 1.40  | 1.33 | 1.02 | 1.29                              | 1.17 | 0.92 | 1.22                               | 1.11 | 0.88 |
| 44×100                    | 2.10  | 1.99 | 1.72 | 1.91                              | 1.81 | 1.48 | 1.83                               | 1.73 | 1.39 |
| 44×125                    | 2.73  | 2.63 | 2.38 | 2.51                              | 2.41 | 2.09 | 2.42                               | 2.31 | 1.95 |
| 44×150                    | 3.26  | 3.14 | 2.87 | 3.01                              | 2.90 | 2.63 | 2.91                               | 2.80 | 2.50 |
| 44×175                    | 3.80  | 3.66 | 3.34 | 3.50                              | 3.37 | 3.06 | 3.38                               | 3.26 | 2.91 |
| 44×200                    | 4.33  | 4.17 | 3.81 | 4.00                              | 3.85 | 3.50 | 3.86                               | 3.72 | 3.32 |
| 44×225                    | 4.86  | 4.68 | 4.28 | 4.49                              | 4.32 | 3.93 | 4.34                               | 4.18 | 3.73 |

|                              | 400  | 450  | 600  | 400  | 450  | 600  | 400  | 450  | 600  |
|------------------------------|------|------|------|------|------|------|------|------|------|
| Maximum span of joist (in m) |      |      |      |      |      |      |      |      |      |
| 50×75                        | 1.49 | 1.41 | 1.15 | 1.38 | 1.30 | 1.02 | 1.34 | 1.23 | 0.98 |
| 50×100                       | 2.22 | 2.11 | 1.85 | 2.01 | 1.91 | 1.63 | 1.94 | 1.84 | 1.54 |
| 50×125                       | 2.84 | 2.74 | 2.49 | 2.62 | 2.52 | 2.26 | 2.53 | 2.43 | 2.14 |
| 50×150                       | 3.40 | 3.27 | 2.99 | 3.13 | 3.02 | 2.75 | 3.03 | 2.92 | 2.66 |
| 50×175                       | 3.95 | 3.81 | 3.48 | 3.65 | 3.51 | 3.20 | 3.53 | 3.40 | 3.09 |
| 50×200                       | 4.51 | 4.34 | 3.97 | 4.16 | 4.01 | 3.66 | 4.02 | 3.87 | 3.53 |
| 50×225                       | 5.06 | 4.88 | 4.45 | 4.67 | 4.50 | 4.11 | 4.52 | 4.35 | 3.96 |
| 63×150                       | 3.66 | 3.52 | 3.22 | 3.37 | 3.25 | 2.96 | 3.26 | 3.14 | 2.86 |
| 63×175                       | 4.25 | 4.10 | 3.74 | 3.93 | 3.78 | 3.45 | 3.79 | 3.66 | 3.33 |
| 63×200                       | 4.84 | 4.67 | 4.27 | 4.47 | 4.31 | 3.94 | 4.33 | 4.17 | 3.80 |
| 63×225                       | 5.43 | 5.24 | 4.79 | 5.02 | 4.84 | 4.42 | 4.86 | 4.68 | 4.27 |
| 75×200                       | 5.10 | 4.93 | 4.51 | 4.72 | 4.55 | 4.16 | 4.57 | 4.40 | 4.02 |
| 75×225                       | 5.72 | 5.52 | 5.06 | 5.30 | 5.11 | 4.67 | 5.12 | 4.94 | 4.52 |

**Table 6: Joists for flat roofs with access only for the purposes of maintenance or repair**

| SS or MSS grade timber       |   |      |      |                                   |      |      |                                    |      |      |
|------------------------------|---|------|------|-----------------------------------|------|------|------------------------------------|------|------|
| Size of joist (in mm)        | Dead load (in kg/m <sup>2</sup> ) supported by joist, excluding the mass of the joist |      |      |                                   |      |      |                                    |      |      |
|                              | Not more than 25  |      |      | More than 25 but not more than 75 |      |      | More than 75 but not more than 100 |      |      |
| Spacing of joists (in mm)    |   |      |      |                                   |      |      |                                    |      |      |
|                              | 400   | 450  | 600  | 400                               | 450  | 600  | 400                                | 450  | 600  |
| Maximum span of joist (in m) |   |      |      |                                   |      |      |                                    |      |      |
| 38×75                        | 1.98  | 1.90 | 1.73 | 1.73                              | 1.66 | 1.51 | 1.64                               | 1.58 | 1.44 |
| 38×100                       | 2.62  | 2.53 | 2.30 | 2.30                              | 2.21 | 2.02 | 2.19                               | 2.10 | 1.92 |
| 38×125                       | 3.27  | 3.15 | 2.87 | 2.87                              | 2.76 | 2.52 | 2.73                               | 2.62 | 2.39 |
| 38×150                       | 3.91  | 3.77 | 3.44 | 3.43                              | 3.31 | 3.01 | 3.27                               | 3.14 | 2.86 |
| 38×175                       | 4.54  | 4.38 | 4.00 | 3.99                              | 3.85 | 3.51 | 3.80                               | 3.66 | 3.34 |
| 38×200                       | 5.17  | 4.99 | 4.56 | 4.55                              | 4.39 | 4.00 | 4.34                               | 4.18 | 3.81 |
| 38×225                       | 5.80  | 5.59 | 5.12 | 5.11                              | 4.93 | 4.50 | 4.87                               | 4.69 | 4.28 |
| 44×75                        | 2.07  | 1.99 | 1.82 | 1.81                              | 1.75 | 1.59 | 1.72                               | 1.66 | 1.51 |
| 44×100                       | 2.75  | 2.65 | 2.42 | 2.41                              | 2.32 | 2.11 | 2.29                               | 2.21 | 2.01 |
| 44×125                       | 3.42  | 3.30 | 3.01 | 3.01                              | 2.89 | 2.64 | 2.86                               | 2.75 | 2.51 |
| 44×150                       | 4.09  | 3.94 | 3.60 | 3.60                              | 3.46 | 3.16 | 3.42                               | 3.30 | 3.00 |
| 44×175                       | 4.75  | 4.58 | 4.19 | 4.18                              | 4.03 | 3.68 | 3.98                               | 3.84 | 3.50 |

|        |      |      |      |      |      |      |      |      |      |
|--------|------|------|------|------|------|------|------|------|------|
| 44×200 | 5.41 | 5.22 | 4.78 | 4.77 | 4.60 | 4.20 | 4.54 | 4.38 | 3.99 |
| 44×225 | 6.06 | 5.85 | 5.36 | 5.35 | 5.16 | 4.71 | 5.10 | 4.91 | 4.48 |

**SS or MSS grade timber**

| Size of joist<br>(in mm)     | Dead load (in kg/m <sup>2</sup> ) supported by joist, excluding the mass of the joist |      |      |                                   |      |      |                                    |      |      |
|------------------------------|---|------|------|-----------------------------------|------|------|------------------------------------|------|------|
|                              | Not more than 25  |      |      | More than 25 but not more than 75 |      |      | More than 75 but not more than 100 |      |      |
| Spacing of joists (in mm)    |   |      |      |                                   |      |      |                                    |      |      |
|                              | 400   | 450  | 600  | 400                               | 450  | 600  | 400                                | 450  | 600  |
| Maximum span of joist (in m) |   |      |      |                                   |      |      |                                    |      |      |
| 50×73                        | 2.16  | 2.08 | 1.89 | 1.89                              | 1.82 | 1.66 | 1.80                               | 1.73 | 1.57 |
| 50×100                       | 2.86  | 2.76 | 2.52 | 2.51                              | 2.42 | 2.20 | 2.39                               | 2.30 | 2.09 |
| 50×125                       | 3.56  | 3.43 | 3.14 | 3.13                              | 3.01 | 2.75 | 2.98                               | 2.87 | 2.61 |
| 50×150                       | 4.25  | 4.10 | 3.75 | 3.74                              | 3.61 | 3.29 | 3.56                               | 3.43 | 3.13 |
| 50×175                       | 4.94  | 4.77 | 4.36 | 4.35                              | 4.20 | 3.83 | 4.15                               | 4.00 | 3.65 |
| 50×200                       | 5.62  | 5.42 | 4.97 | 4.96                              | 4.78 | 4.37 | 4.73                               | 4.56 | 4.16 |
| 50×225                       | 6.29  | 6.08 | 5.57 | 5.56                              | 5.37 | 4.91 | 5.30                               | 5.11 | 4.67 |

**Table 7: Common or jack rafters for roofs having a pitch more than 10° but not more than 22 1/2° with access only for the purposes of maintenance or repair**

| GS, MGS, M50, M75 or No.2 grade timber |   |      |      |                                   |      |      |                                    |      |      |
|--|---|------|------|-----------------------------------|------|------|------------------------------------|------|------|
| Size of rafter<br>(in mm)              | Dead load (in kg/m <sup>2</sup> ) supported by rafter, excluding the mass of the rafter |      |      |                                   |      |      |                                    |      |      |
|  | Not more than 50  |      |      | More than 50 but not more than 75 |      |      | More than 75 but not more than 100 |      |      |
| Spacing of rafters (in mm)             |   |      |      |                                   |      |      |                                    |      |      |
|  | 400   | 450  | 600  | 400                               | 450  | 600  | 400                                | 450  | 600  |
| Maximum span of rafter (in m)          |   |      |      |                                   |      |      |                                    |      |      |
| 38×100                                 | 2.42  | 2.28 | 1.97 | 2.20                              | 2.08 | 1.79 | 2.03                               | 1.92 | 1.65 |
| 38×125                                 | 3.01  | 2.84 | 2.46 | 2.74                              | 2.59 | 2.23 | 2.53                               | 2.39 | 2.06 |
| 38×150                                 | 3.60  | 3.39 | 2.94 | 3.28                              | 3.09 | 2.67 | 3.03                               | 2.86 | 2.46 |
| 44×75                                  | 1.96  | 1.85 | 1.60 | 1.79                              | 1.68 | 1.45 | 1.65                               | 1.55 | 1.34 |
| 44×100                                 | 2.60  | 2.45 | 2.12 | 2.37                              | 2.24 | 1.93 | 2.19                               | 2.06 | 1.78 |
| 44×125                                 | 3.23  | 3.05 | 2.65 | 2.95                              | 2.78 | 2.41 | 2.73                               | 2.57 | 2.22 |
| 44×150                                 | 3.86  | 3.65 | 3.16 | 3.53                              | 3.33 | 2.88 | 3.26                               | 3.08 | 2.66 |



|        |      |      |      |      |      |      |      |      |      |
|--------|------|------|------|------|------|------|------|------|------|
| 50×75  | 2.09 | 1.97 | 1.71 | 1.91 | 1.80 | 1.55 | 1.76 | 1.66 | 1.43 |
| 50×100 | 2.77 | 2.61 | 2.27 | 2.53 | 2.38 | 2.06 | 2.34 | 2.20 | 1.90 |
| 50×125 | 3.44 | 3.25 | 2.82 | 3.14 | 2.97 | 2.57 | 2.91 | 2.74 | 2.37 |
| 50×150 | 4.10 | 3.88 | 3.37 | 3.75 | 3.54 | 3.07 | 3.48 | 3.28 | 2.84 |

**Table 8: Common or jack rafters for roofs having a pitch more than 22 1/2° but not more than 30° with access only for the purposes of maintenance or repair**

| GS, MGS, M50, M75 or No.2 grade timber |   |      |      |                                   |      |      |                                    |      |      |
|--|---|------|------|-----------------------------------|------|------|------------------------------------|------|------|
| Size of rafter (in mm)                 | Dead load (in kg/m <sup>2</sup> ) supported by rafter, excluding the mass of the rafter |      |      |                                   |      |      |                                    |      |      |
|  | Not more than 50  |      |      | More than 50 but not more than 75 |      |      | More than 75 but not more than 100 |      |      |
| Spacing of rafters (in mm)             | Maximum span of rafter (in m)   |      |      |                                   |      |      |                                    |      |      |
|  | 400   | 450  | 600  | 400                               | 450  | 600  | 400                                | 450  | 600  |
| 38×100                                 | 2.68  | 2.53 | 2.19 | 2.44                              | 2.30 | 1.99 | 2.25                               | 2.12 | 1.84 |
| 38×125                                 | 3.33  | 3.15 | 2.73 | 3.04                              | 2.87 | 2.48 | 2.80                               | 2.65 | 2.29 |
| 38×150                                 | 3.98  | 3.76 | 3.27 | 3.63                              | 3.43 | 2.97 | 3.35                               | 3.16 | 2.74 |
| 44×75                                  | 2.17  | 2.05 | 1.78 | 1.97                              | 1.86 | 1.61 | 1.82                               | 1.72 | 1.49 |
| 44×100                                 | 2.88  | 2.72 | 2.36 | 2.62                              | 2.47 | 2.14 | 2.42                               | 2.28 | 1.98 |
| 44×125                                 | 3.58  | 3.38 | 2.94 | 3.26                              | 3.08 | 2.67 | 3.01                               | 2.84 | 2.47 |
| 44×150                                 | 4.27  | 4.04 | 3.51 | 3.89                              | 3.68 | 3.20 | 3.60                               | 3.40 | 2.95 |
| 50×75                                  | 2.31  | 2.18 | 1.89 | 2.10                              | 1.98 | 1.72 | 1.94                               | 1.83 | 1.59 |
| 50×100                                 | 3.06  | 2.89 | 2.51 | 2.79                              | 2.63 | 2.29 | 2.58                               | 2.43 | 2.11 |
| 50×125                                 | 3.80  | 3.59 | 3.13 | 3.47                              | 3.28 | 2.85 | 3.21                               | 3.03 | 2.63 |
| 50×150                                 | 4.53  | 4.29 | 3.74 | 4.14                              | 3.91 | 3.40 | 3.83                               | 3.62 | 3.14 |

**Table 9: Softwood floor boards (tongued and grooved)**

| Finished thickness of board (in mm)<br>(1) | Maximum span of board (in mm)<br>(2) |
|--|--------------------------------------|
| 16   | 505                                  |
| 19   | 600                                  |
| 21   | 635                                  |
| 28   | 790                                  |

# 12.

## TIMBER PESTS AND PRESERVATION

### WOOD PRESERVATION

To combat the spread of the house longhorn beetle, special treatment of softwood timber used in building is required in the following areas; the Urban District Councils of Chertsey, Esher, Farnborough, Farnham, Frimley and Camberley, Staines, Sunbury, Walton and Weybridge and Woking, and in the Rural District Councils of Easthampstead, Guildford, Hartley, Wintney and Hambledon. The following treatments are regarded as good practice.

1. Impregnation under pressure with copper-chrome solution to B.S. 3452 or with copper-chrome-arsenate solution, or
2. Total immersion for ten minutes in:
  - (a) chlorinated phenols, metallic naphthenates or chlorinated naphthalenes in a solution, or
  - (b) a coal-tar oil.

Few, if any, building contractors have the plant to carry out these treatments. Readers intending to build or to tender for building in these areas are advised to contact one of the firms specialising in wood preservation.

### TIMBER PESTS

Timber is a natural material: it was man's first building material and in many of its properties is superior to all man-made materials, such as reinforced concrete or steel, which are used in load-bearing frames.

When we use it in building, it is dead and is subject to all manner of attack by insects, birds and fungi. In nature these serve a useful purpose, by replenishing the soil through breaking-down dead timber into what the gardeners call humus.

In houses, insects and plants that prey on dead timber are unmitigated nuisances. They are expensive nuisances also: their activities cost the country millions of pounds every year. It is safe to say that every house-owner has had to spend a considerable sum on repairs necessitated by the activities of these pests. Some have become wholly parasitic on timber structures and, like the "dry rot" fungus, can no longer be found under natural conditions.

### DRY ROT

Attack by fungi is today far more widespread than ever before, in spite of most houses built since 1945 having solid ground floors. The principal fungus, which is responsible for 80 per cent of damage by fungal attack is *Merulius Lachrymans*. Largely confined to timber ground floors, it can infest a whole house, including its roof timbers, if it be left shut up and untenanted for a year or so. It produces its own moisture, soaking the timber around it and so preparing the way for further spread. Instances are known of its travelling 15ft along a steel joist in search of further timber. Walls, 3ft to 5ft thick, have become honeycombed with it. It cannot live in a current of air until it produces a fruiting body that liberates 3 million spores or seeds, each so fine as to be properly visible only through a microscope. Thus the attack goes on, out of sight, until the damage has reached most serious proportions. Special surveying techniques have been devised to detect attacks in their early stages, but these can only be applied by trained experts.

When an attack is discovered:

1. Remove and burn all infected timber.
2. Remove all loose rubble, shavings and such (this particularly applies to attacks in ground floors).
3. Cut off all affected timbers to 2ft beyond the point of visible attack.
4. Brush down all walls.
5. Extract all dust by vacuum, or by brushing.
6. Apply a reliable and appropriate fungicide to walls and timber (both new and old).

Do not attempt to sterilize walls with a blowlamp. Unless the wall is brought up to 120°–130° F the fungus will still live. If brought up to this temperature the building will probably be set on fire in the process. Spend the money on a good water-soluble fungicide and use it liberally on the walling. Similarly, use a good fungicide liberally on all timbers of the original construction and on all timber used in replacement. “Liberally” means using the fungicide like water; drenching the walling and timber.

Everyone in building has seen the dry-rot fungus; if in doubt send a sample to the Timber Research and Development Association for a free identification. There are other fungi, such as the *Poria* or mine fungus, and *Coniophora Cerebella*, the cellar fungus. But, in the average attack, do not be pedantic about identification. Treat them all as if they were the dry-rot fungus and all will be well. Only in large attacks by the cellar fungus can this advice be varied with safety, and this should only be done under expert guidance.

Generally, the average medium-sized or small builder should be able to cope with minor attacks of fungal decay, such as a decayed ground floor. For larger attacks, or for attacks involving historic or valuable woodwork, the work of rectification should be placed in the hands of members of the British Wood Preserving Association. They have immense experience, special equipment and trained workmen. Moreover, many of these firms will guarantee to eradicate the trouble—which no general builder is in a position to do—and will back their guarantees with insurance policies.

## WOODWORM

If fungal attack is most likely to be found at ground floor level, infestation by beetles is

most common in upper storeys and in roofs. Here, well out of sight in dark roof spaces or beneath linoleum, the attack goes on, year after year, until a chance visit or a little pile of dust on the floor reveals the danger.

Beetles have a complex life-history. They begin as eggs, laid in cracks in timber, or old wormholes: then they become grubs or "worms", changing to a sort of hibernation (called pupation), in which they undergo fundamental changes, emerging finally as beetles, to lay eggs and start the life cycle all over again. The first and last two states are very short, almost the whole existence being spent as a grub or "worm". It is in this state, lasting from three to seven years and sometimes longer, according to the type of beetle, that the insect feeds on timber, tunnelling through it and reducing it to a hollow shell, or, at least, greatly impairing its strength.

Common in Great Britain are two beetles. One is the furniture beetle, *Anabium punctatum*, which is responsible for between 80 and 85 per cent of all damage. The death-watch beetle (*Xestabium rufovillosum*) is responsible for only 10 per cent of the damage, contrary to popular supposition.

Everyone knows the small round holes made by the furniture beetle. Those of the death-watch beetle are considerably larger, being 1/8in in diameter. Even larger are those of the house longhorn beetle, which are oval and 3/16 in across the major axis. As yet, this beetle is not common in England.

An active attack is indicated by flying beetles in late spring and early summer, and by piles of bore dust found below timbers being attacked. The furniture beetle excretes a sandy sort of dust, but the death-watch beetle makes little oval, bun-shaped pellets, as well as bore dust.

Treatment is much the same for all types of beetle attack:

1. Remove all bore dust and loosened particles of wood dust by scraping, and then by vacuum cleaner.
2. Apply a suitable insecticide, during the emergence and breeding season (April to June). For the furniture beetle, one application is enough, but for all others two should be given.
3. Renew this application every year for three years in the case of the furniture beetle, five to seven years in the case of death-watch beetle, and up to nine years for the house longhorn beetle.

Here again, the medium-sized and small builder should confine his efforts to small outbreaks: for anything serious that threatens the structural stability of a floor or roof, or involves panelling or joinery, a specialist firm should be engaged.

## PREVENTION

It is more than ever necessary to consider the prevention of decay and insect attack. Since the war, the danger to timber structures has increased. The house longhorn beetle, which can destroy a roof in five years, is now established at Camberley, in Surrey, and has been recently found in Middlesex—on its way to London. The termite, or white ant, the scourge of tropical climates, is now firmly established in Germany and on the Atlantic

seaboard of France. At least one outbreak has been reported in Britain. It is but common sense to take precautions against these actual and threatened dangers by applying preservative to the new timber we build into our structures. Impregnation of timber under pressure with a suitable preservative gives complete protection against fungal and insect attack. The cost is a cheap form of insurance against having to spend at least twenty times that sum.

The following notes on the choice of a preservative, both for new and old work, are a very brief introduction to the subject.

## **PRESERVATIVES—THEIR CHOICE AND APPLICATION**

Preservatives are classified in three types:

1. Tar oil;
2. Organic solvent, and
3. Water solution type.

They are applied to timber in three ways:

1. By pressure impregnation;
2. By the open-tank method, and
3. By brushing or spraying.

*Pressure impregnation.* The timber is impregnated with the preservative in closed tanks or autoclaves under pressure alone (the “full-cell” process) or under pressure, followed by vacuum which draws out the superfluous preservative left in the cells of the timber after impregnation (the “empty-cell” process). The latter makes the material easier to handle when an oil preservative has been used, and easier to reseason when a water-solution preservative has been employed. Pressure impregnation can only be executed by firms possessing the necessary special equipment.

*The open-tank method.* In the “hot and cold” process, the timber is immersed in a tank of preservative, which is afterwards heated, and is left there until the preservative has cooled. This gives a far greater depth of penetration than simple immersion and subsequent drainage, which is the “cold dip” process. Both these processes can be undertaken by building contractors, but the “hot and cold” method will only be economic when large amounts of timber are to be treated.

*Brushing and spraying.* While this method affords the least protection, it is often the only possible treatment, as in repair work or when very small amounts of timber are to be treated. The preservative should be applied liberally and should coat all surfaces and joints. It should not be applied to wet or frozen timber. In many instances, hands and clothing must be protected against contamination by the preservative, and in others ample ventilation must be provided, since some preservatives give off toxic or irritant vapours.

*Choice of a preservative.* Some water-solution preservatives, such as mercuric chloride, attack ironwork. Tar oil and organic solvent types stain plaster and paint and have a solvent effect on linoleum. Tar oil preservatives cause damage to carpets both by contact and by the fumes they give off. In confined situations, and when labour unused to

the work is employed, caustic solutions and preservatives that give off toxic or irritant gases should be avoided.

# 13. THE ROOFER

## CODES OF PRACTICE

**CP 142:** Slating and tiling.

**Part 1:** Imperial units: materials, concrete and clay in two sections, recommends lap and pitch, and batten sizes.

**Part 2:** Metric units: superseded by B.S. 5534: Part 1.

**B.S. 5534:** Code of Practice for slating and tiling.

**Part 1:1978:** Design: brought into line the wind code (CP 3).

**CP 143:** Sheet roof and wall coverings.

**Part 1:1958:** aluminium corrugated and troughed.

**Part 2:1961:** galvanised corrugated steel.

**Part 3:1960:** lead (imperial units).

**Part 5:1964:** zinc.

**Part 6:1962:** corrugated asbestos-cement.

**Part 8:1970:** semi-rigid asbestos bitumen sheets.

**Part 10:1973:** galvanised corrugated steel (metric units).

**Part 11:1970:** lead (metric units).

**Part 15:1973:** aluminium (metric units).

**Part 16:1974:** semi-rigid asbestos bitumen sheet (metric units).

**CP 144:** Roof coverings.

**Part 1:1968:** built-up bitumen felt (imperial units).

**Part 2:1966:** mastic asphalt (imperial units).

**Part 3:1970:** built-up bitumen felt (metric units).

**CP 199:** Roof deckings.

**Part 1:1973:** asbestos-cement; design of roof decks with units complying with B.S. 3717; information on thermal insulation, and fire hazard, etc.

## BRITISH STANDARDS

**B.S. 402:** Clay plain roofing tiles and fittings.

**Part 1:1945:** imperial units: plain tiles, eaves and top course tiles, tile-and-a-half tiles, various hip, valley and ridge tiles, external and internal angle tiles.

**Part 2:1970:** Metric units.

## TABLE 1. SIZE OF CLAY PLAIN TILES

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|                                   | Co-ordinating sizes... |       | Maximum manufacturing size |       | Minimum manufacturing size |       | Work size |       | mm |
|-----------------------------------|------------------------|-------|----------------------------|-------|----------------------------|-------|-----------|-------|----|
|                                   | length                 | width | length                     | width | length                     | width | length    | width |    |
|                                   | mm                     | mm    | mm                         | mm    | mm                         | mm    | mm        | mm    |    |
| Standard roof tile                | —                      | —     | 268                        | 168   | 262                        | 162   | 265       | 165   |    |
| Standard tile for vertical tiling | —                      | 150   | 268                        | 150   | 262                        | 145   | 265       | 148   |    |
|                                   | —                      | 200   | 268                        | 200   | 262                        | 196   | 265       | 198   |    |

**B.S. 473 and B.S. 550:** Concrete roofing tiles and fittings.

Part 1:1967: imperial units.

Part 2:1971: metric units.

**TABLE 1. GROUP A. DOUBLE-LAP (NON-INTERLOCKING CONCRETE TILES AND CONCRETE SLATES**

| Maximum limit of manufacturing size |          | Minimum limit of manufacturing size |          | Overall work size |          |
|-------------------------------------|----------|-------------------------------------|----------|-------------------|----------|
| Length mm                           | Width mm | Length mm                           | Width mm | Length mm         | Width mm |
| 270                                 | 168      | 264                                 | 162      | 267               | 165      |
| 462                                 | 335      | 452                                 | 325      | 457               | 330      |

**TABLE 2. GROUP B. SINGLE-LAP (INTERLOCKING) CONCRETE TILES AND CONCRETE SLATES**

| Maximum limit of manufacturing size |          | Minimum limit of manufacturing size |          | Overall work size |          |
|-------------------------------------|----------|-------------------------------------|----------|-------------------|----------|
| Length mm                           | Width mm | Length mm                           | Width mm | Length mm         | Width mm |
| 386                                 | 234      | 376                                 | 224      | 381               | 229      |
| 418                                 | 335      | 408                                 | 325      | 413               | 330      |
| 425                                 | 335      | 415                                 | 325      | 420               | 330      |
| 435                                 | 385      | 425                                 | 375      | 430               | 380      |

**B.S. 680:** Roofing slates.

Part 1:1944: Imperial units.

Part 2:1971: Metric units; with dimensions of slates in work sizes, maximum and minimum manufacturing sizes.



**TABLE 1. STANDARD LENGTHS AND WIDTHS OF SLATES**

All dimensions are in millimetres.

| Maximum manufacturing size |       | Minimum manufacturing size |       | Work size |       |
|----------------------------|-------|----------------------------|-------|-----------|-------|
| Length                     | Width | Length                     | Width | Length    | Width |
| 615                        | 340   | 605                        | 350   | 610       | 355   |
| 615                        | 310   | 605                        | 300   | 610       | 305   |
| 565                        | 310   | 555                        | 300   | 560       | 305   |

| Maximum manufacturing size |       | Minimum manufacturing size |       | Work size |       |
|----------------------------|-------|----------------------------|-------|-----------|-------|
| Length                     | Width | Length                     | Width | Length    | Width |
| 565                        | 285   | 555                        | 275   | 560       | 280   |
| 515                        | 310   | 505                        | 300   | 510       | 305   |
| 515                        | 260   | 505                        | 250   | 510       | 255   |
| 465                        | 310   | 455                        | 300   | 460       | 305   |
| 465                        | 260   | 455                        | 250   | 460       | 255   |
| 465                        | 235   | 455                        | 225   | 460       | 230   |
| 410                        | 310   | 400                        | 300   | 405       | 305   |
| 410                        | 260   | 400                        | 250   | 405       | 255   |
| 410                        | 235   | 400                        | 225   | 405       | 230   |
| 410                        | 210   | 400                        | 200   | 405       | 205   |
| 340                        | 310   | 350                        | 300   | 355       | 305   |
| 340                        | 230   | 350                        | 250   | 355       | 255   |
| 340                        | 210   | 350                        | 200   | 355       | 205   |
| 340                        | 185   | 350                        | 175   | 355       | 180   |
| 335                        | 285   | 325                        | 275   | 330       | 280   |
| 335                        | 260   | 325                        | 250   | 330       | 255   |
| 335                        | 210   | 325                        | 200   | 330       | 205   |
| 335                        | 185   | 325                        | 175   | 330       | 180   |
| 310                        | 230   | 300                        | 250   | 305       | 255   |
| 310                        | 210   | 300                        | 200   | 305       | 205   |
| 310                        | 155   | 300                        | 145   | 305       | 150   |
| 300                        | 300   | 250                        | 250   | 255       | 255   |
| 300                        | 210   | 250                        | 200   | 255       | 205   |
| 300                        | 155   | 250                        | 145   | 255       | 150   |

**TABLE 2. RANGE OF LENGTHS FOR RANDOMS AND PEGGIES**

All dimensions are in millimetres.

| Length range | Length range | Length range | Length range |
|--------------|--------------|--------------|--------------|
| 610 to 355   | 560 to 355   | 510 to 305   | 460 to 305   |
| 610 to 305   | 560 to 305   | 510 to 255   | 460 to 255   |
| 405 to 305   | 560 to 255   | 510 to 230   | 460 to 230   |

|            |            |            |            |
|------------|------------|------------|------------|
| 405 to 225 | 355 to 255 | 305 to 230 | 255 to 230 |
| 405 to 230 | 355 to 230 | 305 to 205 | 255 to 205 |
|            |            |            | 255 to 150 |

**B.S. 690:** Asbestos-cement slates and sheets.

**Part 1:1963:** Imperial units: slates, corrugated sheets and semi-compressed flat sheets.

**Part 2:1971:** flat sheets and fully compressed.

**Part 3:1973:** corrugated sheets.

**Part 4:1974:** slates.

**Part 5:1975:** lining sheets and panels.

**Part 6:1976:** fittings for use with corrugated sheets.

**B.S. 747:1977:** Specification for roofing felts.

Felts for use in the British Isles and similar climates.

**TABLE 1. WEIGHTS...AND LENGTHS OF ROLLS OF CLASS 1 BITUMEN FELTS (FIBRE BASE)**

| Type of felt                    | Nominal weight*       | Nominal length of roll |      |
|---------------------------------|-----------------------|------------------------|------|
|                                 | kg/ 10 m <sup>2</sup> | m                      |      |
| 1A Saturated bitumen            | 7.0                   | 20                     |      |
| 1B Fine sanded surface bitumen  | 17.0                  | 20                     |      |
| 1C Self-finished bitumen        | 9.0                   | 10†                    | .... |
|                                 | 13.0                  | 10†                    |      |
|                                 | 18.0                  | 10†                    |      |
|                                 | 23.0                  | 10†                    |      |
|                                 | 20.0                  | 10                     |      |
| 1D Coarse sand surfaced bitumen | 30.0                  | 10                     |      |
|                                 | 36.0                  | 10                     |      |
| 1E Mineral surfaced bitumen     | 11.0                  | 20                     |      |
| IF Reinforced bitumen           |                       |                        |      |

NOTE 1. Type 1B and Type 1C felts (13 kg/m<sup>3</sup>), when used in built-up roofing, are regarded as equivalent and interchangeable.

\* *Exclusive of wrappings and accessories.*

† *Or multiples thereof.*

**TABLE 2. WEIGHTS...AND LENGTHS OF ROLLS OF CLASS 2 BITUMEN FELTS (ASBESTOS BASE)**

| Type of felt                  | Nominal weight*       | Nominal length of roll |
|-------------------------------|-----------------------|------------------------|
|                               | kg/ 10 m <sup>2</sup> | m                      |
| 2A Saturated bitumen asbestos | 7.0                   | 20                     |
| 2B Fine sand surfaced bitumen | 16.0                  | 20                     |

|                                      |      |     |      |
|--------------------------------------|------|-----|------|
| asbestos                             |      |     |      |
| 2C Self-finished bitumen asbestos    | 13.0 | 10† |      |
|                                      | 18.0 | 10† |      |
|                                      | 23.0 | 10† | .... |
| 2E Mineral surfaced bitumen asbestos | 36.0 | 10  |      |

NOTE. Type 2B and Type 2C felts ( $13 \text{ kg}/10^2$ ), when used in built-up roofing, are regarded as equivalent and interchangeable.

\* *Exclusive of wrappings and accessories.*

† *Or multiples thereof.*

**B.S. 849:1939:** Plain sheet zinc roofing.

Construction and method of laying.

**B.S. 1178:1969:** Milled lead sheet and strip for building purposes.

Dimensions, thickness, tolerances on thickness, marking. In sheets width 2.40m, length up to 12m. Coded for thickness:

|                                    |                   |
|------------------------------------|-------------------|
| Code 3, colour of marking; Green,  | thickness 1.25mm. |
| Code 4, colour of marking; Blue,   | thickness 1.80mm. |
| Code 5, colour of marking; Red,    | thickness 2.24mm. |
| Code 6, colour of marking; Black,  | thickness 2.50mm. |
| Code 7, colour of marking; White,  | thickness 3.15mm. |
| Code 8, colour of marking; Orange, | thickness 3.55mm. |

**B.S. 2717:1956:** Glossary of terms applicable to roof coverings.

Main headings include: (1) general terms (2) asphalt (3) corrugated sheets (4) flexible sheets (5) patent glazing (6) shingles, slates and tiles (7) thatch.

**B.S. 3083:1959:** Hot-dipped galvanised corrugated steel sheets.

Types of materials and weights of zinc coating.

**B.S. 3717:1972:** Asbestos-cement decking.

Requirements for non-combustible decking of two types.

**B.S. 5247:** Code of practice for sheet roof and wall coverings.

**Part 14:1975:** corrugated asbestos-cement.

## CONVERSION TABLE

### SQUARES AND SQUARE METRES

|       |   |        |
|-------|---|--------|
| 0.108 | 1 | 9.290  |
| 0.216 | 2 | 18.580 |
| 0.324 | 3 | 27.870 |
| 0.432 | 4 | 37.161 |
| 0.540 | 5 | 46.451 |
| 0.648 | 6 | 55.741 |

|       |    |         |
|-------|----|---------|
| 0.756 | 7  | 65.032  |
| 0.864 | 8  | 74.324  |
| 0.972 | 9  | 83.612  |
| 1.080 | 10 | 92.903  |
| 2.160 | 20 | 185.806 |
| 3.240 | 30 | 278.709 |
| 4.320 | 40 | 371.612 |
| 5.400 | 50 | 464.515 |

### SLATES

A good slate should give a sharp metallic ring when struck and should not splinter under the slater's axe. It should be easily holed without fracture. If a clayey odour is emitted when the slate is breathed upon, it will not weather well.

#### THICKNESSES OF SLATES

|                       |       |
|-----------------------|-------|
| First quality ... ..  | 3/16" |
| Second quality ... .. | 1/4"  |

To determine the gauge of Slates the following formula can be used:

#### HEAD NAILING

$$\text{Gauge} = \frac{\text{Length of Slate} - 1'' - \text{Lap}}{2}$$

#### CENTRE NAILING

$$\text{Gauge} = \frac{\text{Length of Slate} - \text{Lap}}{2}$$

| Name            | Size<br>In | Number of<br>sq. yd covered<br>by 1000            |          |           |          |           |          |           |          | Ap-<br>prox.<br>wgt.<br>per<br>1,000<br>cwts. |
|-----------------|------------|---|----------|-----------|----------|-----------|----------|-----------|----------|---|
|                 |            | Number to<br>cover one square<br>(100 feet super) |          |           |          |           |          |           |          |   |
|                 |            | Lp<br>2½"   | Lp<br>3" | Lp<br>3½" | Lp<br>4" | Lp<br>2½" | Lp<br>3" | Lp<br>3½" | Lp<br>4" |   |
| Empresses       | ..26×16    | 144½  | 140½     | 138½      | 135½     | 77        | 79       | 80        | 82       | 68½   |
| Princesses      | ..24×14    | 115½  | 113½     | 110       | 108      | 96        | 98       | 101       | 103      | 55½   |
| Duchesses       | ..24×12    | 99  | 96½      | 94        | 92½      | 112       | 115      | 118       | 120      | 47½   |
| Small Duchesses | 22×12      | 89½   | 87½      | 85½       | 83       | 124       | 127      | 130       | 134      | 43½   |
| Marchionesses   | 22×11      | 82½   | 80½      | 78½       | 76       | 135       | 138      | 142       | 146      | 40  |
| Wide Countesses | 20×12      | 80½   | 78½      | 76        | 74       | 138       | 142      | 146       | 150      | 40  |
| Countesses      | ..20×10    | 67½   | 65       | 63½       | 61½      | 165       | 170      | 175       | 180      | 31½   |
| Viscountesses   | ..18× 9    | 53½   | 52       | 50½       | 48½      | 207       | 214      | 221       | 229      | 27  |
| Wide Ladies     | ..16×10    | 52  | 50       | 48        | 46½      | 214       | 222      | 231       | 240      | 24½   |
| Ladies ..       | ..16× 8    | 41  | 40       | 38½       | 37       | 267       | 277      | 288       | 300      | 19½   |
| Wide Headers    | ..14×12    | 53  | 50½      | 48½       | 46½      | 209       | 219      | 229       | 240      | 26½   |
| Headers         | ..14×10    | 44½   | 42½      | 40½       | 38½      | 251       | 262      | 275       | 288      | 21½   |
| Small Ladies    | ..14× 8    | 35½   | 33½      | 32½       | 30½      | 314       | 328      | 343       | 360      | 17½   |
| Doubles         | ..13× 7    | 28½   | 26½      | 25½       | 24½      | 392       | 412      | 434       | 458      | 14½   |
| Wide Doubles    | ..12×10    | 36½   | 34½      | 32½       | 30½      | 304       | 320      | 339       | 360      | 20  |

No allowance has been made for waste. Suggest 5 per cent

The traditional names for slates are going out of use and more and more slates are being quoted by size, instead of the traditional names. Suppliers are still quoting in Imperial measure only, but since some specifications are bound to be in metric, metric equivalents are also given.

SLATES (MODERN SIZES)

| IMPERIAL      |              | METRIC      |                 |
|---------------|--------------|-------------|-----------------|
| Length (ins.) | Widths (ins) | Length (mm) | Widths (mm)     |
| 24            | 14:12        | 600         | 350:300         |
| 22            | 12:11        | 550         | 300:280         |
| 20            | 12:10        | 500         | 300:250         |
| 18            | 12:10:9      | 450         | 300:250:230     |
| 16            | 12:10:9:8    | 400         | 300:250:230:200 |
| 14            | 12:10:8      | 350         | 300:250:200     |
| 13            | 10:8:7       | 330         | 250:200:180     |
| 12            | 8            | 300         | 200             |

RUN OF SLATING BATTENS REQUIRED PER SQUARE

| Lengths of slate<br>in | Lap centre nailed |      |       |      |        |      |       |       |       |
|------------------------|-------------------|------|-------|------|--------|------|-------|-------|-------|
|                        | 2 1/2"            | 64mm | 3"    | 76mm | 3 1/2" | 89mm | 4"    | 102mm |       |
| 12                     | 305               | 253  | 82-90 | 267  | 87-57  | 284  | 93-14 | 300   | 98-39 |
| 13                     | 330               | 229  | 75-10 | 240  | 78-71  | 253  | 82-90 | 266   | 87-22 |

|    |     |     |       |     |       |     |       |     |       |
|----|-----|-----|-------|-----|-------|-----|-------|-----|-------|
| 14 | 356 | 209 | 68.54 | 219 | 71.82 | 229 | 75.10 | 240 | 78.71 |
| 16 | 406 | 178 | 58.38 | 185 | 60.68 | 192 | 62.97 | 200 | 65.59 |
| 18 | 457 | 153 | 50.18 | 160 | 52.48 | 166 | 54.45 | 172 | 56.41 |
| 20 | 508 | 138 | 45.26 | 142 | 46.57 | 146 | 47.88 | 150 | 49.19 |
| 22 | 559 | 123 | 40.24 | 127 | 41.65 | 130 | 42.64 | 134 | 43.95 |
| 24 | 610 | 112 | 36.74 | 115 | 37.72 | 118 | 38.70 | 120 | 39.36 |
| 26 | 660 | 102 | 33.46 | 105 | 34.54 | 107 | 35.10 | 109 | 35.75 |

Add 10 per cent for waste

**SLATE NAILS: NUMBER PER POUND/KILOGRAM**

| Type       | 1 1/2 in. | 1 3/4 in. | 2 in | 28.5 mm | 34.4 mm | 50.8 mm |
|------------|-----------|-----------|------|---------|---------|---------|
| Plain Wire | 148       | 130       | 112  | 325     | 286     | 242     |
| Galvd Wire | 140       | 121       | 102  | 305     | 256     | 224     |
| Copper     | 148       | 120       | 88   | 325     | 254     | 194     |
| Zinc       | 190       | 133       | 91   | 415     | 292     | 200     |

Note: Two nails are required to each slate, but add 5 per cent for waste.

**NAILS FOR BATTENS REQUIREMENTS IN LB/KG PER SQUARE**

| Length of Slate in |     | Lap Centre Nailed |       |     |       |        |       |      |       |
|--------------------|-----|-------------------|-------|-----|-------|--------|-------|------|-------|
| in                 | mm  | 2 1/2"            | 62 mm | 3"  | 75mm  | 3 1/2" | 87mm  | 4"   | 100mm |
| 12                 | 312 | 1.6               | 0.725 | 1.7 | 0.771 | 1.8    | 0.816 | 1.9  | 0.861 |
| 13                 | 338 | 1.4               | 0.635 | 1.5 | 0.703 | 1.6    | 0.725 | 1.7  | 0.771 |
| 14                 | 363 | 1.3               | 0.589 | 1.4 | 0.635 | 1.45   | 0.680 | 1.6  | 0.725 |
| 16                 | 414 | 1.1               | 0.498 | 1.2 | 0.544 | 1.2    | 0.544 | 1.25 | 0.589 |
| 18                 | 464 | .9                | 0.408 | 1.0 | 0.453 | 1.05   | 0.476 | 1.1  | 0.498 |
| 20                 | 515 | .85               | 0.385 | .9  | 0.408 | .92    | 0.417 | .95  | 0.430 |
| 22                 | 566 | .75               | 0.340 | .8  | 0.362 | .82    | 0.371 | .85  | 0.385 |
| 24                 | 616 | .65               | 0.294 | .7  | 0.317 | .75    | 0.340 | .75  | 0.340 |
| 26                 | 667 | .6                | 0.272 | .65 | 0.294 | .67    | 0.303 | .7   | 0.317 |

Add 5 per cent for waste

**ASBESTOS SLATES**

TABLE FOR DIAGONAL PATTERN, STANDARD SIZE 15 3/4x15 3/4"

| Lap .. . . .             | 2 3/4" | 3"     | 3 1/2" | 4"     |
|--------------------------|--------|--------|--------|--------|
| Gauge .. . . .           | 8 7/8" | 8 1/2" | 8 1/4" | 7 5/8" |
| Number per square .. .   | 90     | 93     | 102    | no     |
| Feet run of battens .. . | 134    | 140    | 216    | 166    |
| Rivets (number) .. .     | 90     | 93     | 102    | 110    |
| Nails (number)           | 180    | 186    | 204    | 220    |

Waste has been allowed for in the above. For rectangular pattern asbestos slates, see page 289. They are made in the following sizes: 24×12, 20×10, 16×8 and 12×6. 200 rivets weigh approx. 1lb.

### CEDAR SHINGLES

- Length ... 16in.
- Width ... Random, varying from 4in to 12in.
- Thickness ... 25in at butt and taper to top.
- Weight ... 144lb per square when laid at 5in gauge.

### GAUGE

All pitches down to 30 degrees, 5in. Under 30 degrees but not less than 20 degrees, 3 3/4in.

Unusually steep pitches, 5 1/2in or 6in.

Walls 6in, 6 1/2 or 7 1/2in (first two recommended).

(Cedar shingles are imported, not metricated).

### COVERING CAPACITIES OF CEDAR SHINGLES

|                        |       |      |       |      |       |       |        |
|------------------------|-------|------|-------|------|-------|-------|--------|
| Gauge ... ..           | 3 3/4 | 5    | 5 1/2 | 6    | 6 1/2 | 7 1/2 | in     |
| Lap ... ..             | 9     | 6    | 5     | 4    | 3     | 2     | in     |
| Bundles per square ... | 5.3   | 3.9  | 3.5   | 3.25 | 3     | 2.6   |        |
| One bundle covers ...  | 19.2  | 25.7 | 28.3  | 30.8 | 33.4  | 38.5  | sq. ft |

*Note:* One bundle contains tiles of random widths which should be laid in no special order but just as they come from the bundle.

LAP, NUMBER AND AVERAGE WEIGHT PER SQUARE OF PLAIN TILES AND AVERAGE WEIGHT PER THOUSAND

| Tile Dimensions   | Standard<br>10 1/2" × 6 1/2" |       |       |       | 11" × 7" |      |       |       | 10" × 6" |       |       |       | Unit |      |
|-------------------|------------------------------|-------|-------|-------|----------|------|-------|-------|----------|-------|-------|-------|------|------|
|                   | 4                            | 3 1/2 | 3 1/4 | 3 1/8 | 4 1/2    | 4    | 3 1/2 | 3 1/4 | 3 1/8    | 3 1/2 | 3 1/4 | 3 1/8 |      | 3    |
| Gauge             | 4                            | 3 1/2 | 3 1/4 | 3 1/8 | 4 1/2    | 4    | 3 1/2 | 3 1/4 | 3 1/8    | 3 1/2 | 3 1/4 | 3 1/8 | 3    | ins  |
| Lap               | 2 1/2                        | 3     | 3 1/2 | 4     | 2 1/2    | 3    | 3 1/2 | 4     | 2 1/2    | 3     | 3 1/2 | 4     | 4    | ins  |
| Tiles per square  | 550                          | 590   | 635   | 680   | 485      | 515  | 550   | 590   | 640      | 685   | 740   | 800   | —    |      |
| Weight per square |                              |       |       |       |          |      |       |       |          |       |       |       |      |      |
| Hand-made         | 12.7                         | 13.6  | 14.7  | 15.7  | 13.0     | 13.8 | 14.7  | 15.8  | 12.6     | 13.5  | 14.5  | 15.7  | —    | cwts |
| Machine-made      | 11.6                         | 12.5  | 13.4  | 14.4  | 11.9     | 12.6 | 13.4  | 14.5  | —        | —     | —     | —     | —    | cwts |
| Average weight    |                              |       |       |       |          |      |       |       |          |       |       |       |      |      |
| Hand-made         |                              |       |       | 23.0  |          |      | 26.0  |       |          |       | 19.6  |       |      | cwts |
| Machine-made      |                              |       |       | 21.1  |          |      | 23.8  |       |          |       | —     |       |      | cwts |

| Tile Dimensions             | Standard<br>165 × 165 mm |     |     |       |     |     |       |     |     |     |     |     |       |
|-----------------------------|--------------------------|-----|-----|-------|-----|-----|-------|-----|-----|-----|-----|-----|-------|
|                             | 102                      | 95  | 89  | 83    | 115 | 102 | 95    | 89  | 95  | 89  | 83  | 76  |       |
| Gauge                       | 102                      | 95  | 89  | 83    | 115 | 102 | 95    | 89  | 95  | 89  | 83  | 76  | mm    |
| Lap                         | 63                       | 76  | 83  | 102   | 63  | 76  | 89    | 102 | 63  | 76  | 89  | 162 |       |
| Tiles per 10m <sup>2</sup>  | 592                      | 635 | 604 | 732   | 522 | 554 | 592   | 635 | 609 | 737 | 796 | 862 | hand  |
| Weight per 10m <sup>2</sup> |                          |     |     |       |     |     |       |     |     |     |     |     | kg    |
| Hand-made                   | 645                      | 692 | 747 | 798   | 660 | 700 | 747   | 803 | 640 | 686 | 736 | 798 | mach. |
| Machine-made                | 595                      | 635 | 681 | 750   | 605 | 640 | 681   | 736 | —   | —   | —   | —   | kg    |
| Average weight              |                          |     |     |       |     |     |       |     |     |     |     |     |       |
| Hand-made                   |                          |     |     | 1 170 |     |     | 1 320 |     |     |     | 995 |     |       |
| Machine-made                |                          |     |     | 1 073 |     |     | 1 210 |     |     |     | —   |     |       |

*Above information by the courtesy of Clay Products Technical Bureau of Great Britain. Allow approximately 2 cubic feet of mortar per square if bedded.*

**BATTENS REQUIRED PER SQUARE (9.29m<sup>2</sup>) OF TILING**

|                    |     |     |     |     |     |     |           |
|--------------------|-----|-----|-----|-----|-----|-----|-----------|
| Gauge              | 3   | 3½  | 3½  | 3½  | 4   | 4½  | inches    |
| Battens per square | 400 | 370 | 343 | 320 | 300 | 283 | ft run    |
| Gauge              | 83  | 89  | 95  | 102 |     |     | metre run |
| Battens per square | 113 | 103 | 98  | 92  |     |     |           |
| Nails              | 1.4 | 1.5 | 2.2 | 2   | 1.9 | 1.8 | lbs       |

Add for waste: 10 per cent. timber, 5 per cent nails.

| Description                 | Sizes     |           | No. of Tiles | Lap (75mm)     |               |
|-----------------------------|-----------|-----------|--------------|----------------|---------------|
|                             | in        | mm        |              | Battens ft run | Battens m run |
| Pantiles                    | 13½ × 9½  | 343 × 240 | 173          | 126            | 39            |
| Roman Tiles                 | 16½ × 13½ | 418 × 343 | 93           | 98             | 30            |
| Somerset Interlocking Tiles | 15½ × 8½  | 393 × 210 | 162          | 104            | 32            |

**ALUMINIUM ROOFING SHEETS**

**CORRUGATED SHEETS**

| Pitch | Depth of Corrugation | Width in Corrugation |
|-------|----------------------|----------------------|
| 3 in  | ¾ in                 |                      |
| 3 in  | ⅝ in                 | 9½, 12 & 14          |
| 2½ in | ¾ in                 | 9 & 11               |
| 2½ in | ½ in                 | 8, 10 & 12           |

**LENGTHS**

6–12ft, in 1ft increments. Sheets up to 35ft can be obtained to order.

**TROUGHED SHEETS**

|    | Pitch | Crown Width | Valley Width | Depth |
|----|-------|-------------|--------------|-------|
| A. | 5 in  | ¾ in        | 2½ in        | 1½ in |
| B. | 5½ in | ¾ in        | ¾ in         | 1½ in |
| C. | 5 in  | 1 in        | 2 in         | 1½ in |



WIDTHS

- A—2ft 2 3/4in: 2ft 7 3/4in: 3ft 0 3/4in.
- B—2ft 4in:2ft 9in:3ft 2in.
- C—2ft 6in:2ft 11in.

LENGTHS

As for corrugated sheets, with the exception of C, which is obtainable in sheets 4–12ft, in 1ft increments.

MANSARD SHEETS

Have a 4in flat valley and a 2in half-round ridge. Widths are 2ft 6in and 3ft; Lengths are 4–12ft in 1ft increments.

RECOMMENDED LOADING FOR TROUGHED ALUMINIUM SHEETS

| Span in ft Gauge | Loading, lb per sq. ft |    |    |    |
|------------------|------------------------|----|----|----|
|                  | 18                     | 19 | 20 | 22 |
| 5                | —                      | —  | 74 | 57 |
| 5 1/2            | —                      | —  | 60 | 47 |
| 6                | 77                     | 65 | 51 | 40 |
| 6 1/2            | 66                     | 55 | 43 | 34 |
| 7                | 57                     | 48 | 37 | 29 |
| 7 1/2            | 49                     | 41 | 33 | 25 |
| 8                | 43                     | 36 | 29 | 22 |
| 8 1/2            | 39                     | 32 | 25 | 20 |
| 9                | 34                     | 29 | 23 | 18 |
| 9 1/2            | 31                     | 26 | —  | —  |
| 10               | 27                     | 22 | —  | —  |
| 10 1/2           | 23                     | 19 | —  | —  |

Type C  
5 in pitch  
1 1/2 in  
2 in Valley

Type A & B  
5 & 5 1/8 in

## TILES

### CONCRETE ROOFING TILES

| Size of Tile            | Plain or Cross Camber |      |      | Single Lap Interlocking |                            |                                  |                          | Bold Roll             | Cladding                  |                       |
|-------------------------|-----------------------|------|------|-------------------------|----------------------------|----------------------------------|--------------------------|-----------------------|---------------------------|-----------------------|
|                         | 10½" × 6½"            |      |      | Standard 49<br>15" × 9" | Double Roman<br>16½" × 13" | Grovebury Prantley<br>16½" × 11" | Inter-Slate<br>17" × 15" | Regent<br>15½" × 10½" | Orna-mental<br>10½" × 6½" | Brick-bond<br>9" × 3" |
| Lap in Inches           | 3½                    | 3    | 2½   | 3                       | 3                          | 3                                | 3                        | 3                     | 1½                        | —                     |
| Batten gauge inches     | 3½                    | 3½   | 4    | 12                      | 13½                        | 13½                              | 14                       | 12½                   | 4½                        | —                     |
| No. of tiles per square | 635                   | 590  | 550  | 150                     | 90                         | 110                              | 77                       | 127                   | 492                       | 534                   |
| Weight per square in lb | 1700                  | 1580 | 1480 | 820                     | 896                        | 930                              | 1052                     | 1052                  | 1366                      | 1533                  |
| Minimum Pitch (eaves)   | 30°                   |      |      | 35°                     | 30°                        | 30°                              | 22½°                     | 30°                   | —                         | —                     |
| Usual rafter centres    | 16in                  |      |      | 18in                    | 18in                       | 18in                             | 18in                     | 18in                  | —                         | —                     |
| Batten size in inches   | 1 × ½                 |      |      | 1½ × ½                  | 1½ × ½                     | 1½ × ½                           | 1½ × ½                   | 1½ × ½                | 1½ × ½                    | 1½ × ½                |
| Nails                   | 1½in × 12G            |      |      | 1½" Alum Alloy          | 1½" Alum Alloy             | 1½" Alum Alloy                   | —                        | 1½" Alum Alloy        | 1½" Alum Alloy            | 1½" × 12G             |

### CONCRETE ROOFING TILES: METRIC SIZES

| Size of Tile                                 | Single lap interlocking                 |  |  |   |                                      |   | Bold Roll                            | Cladding                                |           |
|--|---|--|--|---|--------------------------------------|---|--------------------------------------|---|-----------|
|  | Plain Tile<br>10½" × 6½"<br>265 × 165mm | Delta Stone-wold<br>17" × 15"<br>430 × 380mm | Standard 49<br>15" × 9"<br>380 × 230mm | Double Roman<br>16½" × 13"<br>420 × 330mm | Renown<br>16½" × 13½"<br>420 × 332mm | Grovebury Pantley<br>16½" × 13½"<br>420 × 332mm | Regent<br>16½" × 13½"<br>420 × 332mm | Ornamental<br>10½" × 6½"<br>265 × 165mm |           |
| Headlap                                      | 2½"/65mm                                | 3"/75mm                                      | 3"/75mm                                | 3"/75mm                                   | 3"/75mm                              | 3"/75mm   | 22½" B over<br>4"/100mm              | 1½"/38mm                                |           |
| Gauge (max)                                  | 4"/100mm                                | 14"/355mm                                    | 12"/305mm                              | 13½"/345mm                                | 13½"/345mm                           | 13½"/345mm                                      | 12"/320mm                            | 4½"/114mm                               |           |
| No. of Tiles yd <sup>2</sup> /m <sup>2</sup> | 50/60                                   | 6-9/8-2                                      | 137/16-5                               | 2-8/9-5                                   | 8/9-5                                | 8-2/9-7   | 8-2/9-7                              | 8-8/10-4                                | 45/53     |
| Weight per 1,000 tiles tonnes/tons           | 1-290/1-3                               | 7-060/9-95<br>Stone-wold<br>6-270/6-2        | 2-800/2-76                             | 4-500/4-4                                 | 4-430/4-3                            | 5-100/5<br>Mk. I Mk. II                         | Mk. I<br>4-500/4-48<br>Mk. I         | Mk. II<br>5-080/5<br>Mk. II             | 1-290/1-3 |
| Min. Pitch                                   | 35°                                     | 17½°   | 30°                                    | 30°                                       | 30°                                  | 30° 22½°  | 30°                                  | 17½°                                    |           |
| Nails  | Alum Alloy<br>1½"/38mm                  | —  | 1½"/45mm                               | 2½"/65mm                                  | 1½"/45mm                             | 2½"/ —<br>70mm                                  | 2½"/70mm                             | 1½"/38mm                                | 1½"/38mm  |

**Fittings:** All customary fittings are made to match the tiles; eaves, gables, bonnets, valleys, internal angle, mansards, half and third round ridge, Pascall roll and others for plain tiles, and half-tiles mansards, valleys and half third round ridge tiles for interlocking tiles.

**BATTEN SIZES**

For rafters not exceeding 457mm/18" c/c  
 = 610mm/24" c/c  
 = 914mm/36" c/c

**Single Lap**

38 × 19mm/1½" × ¾"  
 38 × 25mm/1½" × 1"  
 38 × 38mm/1½" × 1½"

**Plain Tiles**

25 × 19mm/1" × ¾"  
 32 × 25mm/1½" × 1"

**CLIPS.** Purpose made clips available for extra securement where necessary.

(Data by courtesy of Redland Tiles Ltd.)

### MINIMUM PITCHES

| Eaves Pitch, in Degrees | Type of Material for Roofing                |
|-------------------------|---|
| 45                      | Slates, 6 in wide (150 mm)                  |
| 40                      | Plain tiles, slates 7 in wide (175 mm)      |
| 35                      | Single-lap tiles; slates 8 in wide (200 mm) |

|         |  |
|---------|--|
| 30      | Fully interlocking tiles (on sides and ends); Slates 9 in and 10 in wide (225–350 mm)  |
| 25      | Slates 12 in and 14 in wide; optimum pitch for corrugated roofing materials with one corrugation of side lap (300 and 350 mm). |
| 17      | Roman tiles; certain types of fully-interlocking tiles, imported from France.  |
| 15      | Lowest limit for corrugated roofing materials, unsealed laps.  |
| 9       | Corrugated roofing materials, end and side laps sealed.  |
| Under 9 | Flat roofs of concrete, asphalt or bitumen-felt, or lead, zinc or aluminium*.  |

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The minimum slope for sheet metal roofs is 1 in in to 6ft with a fall of 2 in in 6ft.

#### RELATIONSHIP OF PITCH TO LAP, FOR SLATES AND PLAIN TILES

| Eaves Pitch in Degrees | Lap              |
|------------------------|------------------|
| 35 and less            | 3 1/2 in (88 mm) |
| 35–45                  | 3 in (75 mm)     |
| Over 45                | 2 1/2 in (63 mm) |

*Note* Allowance should also be made for exposure of site: a very 1 exposed site may justify a greater lap.

*Note* Lap for plain tiles should not be less than 2 1/2 in. In 2: exposed sites 3 in/75 mm is recommended. Lap of plain tiles should never exceed one-third the length of the tile.

# 14. THE DRAINLAYER

## CODES OF PRACTICE

**CP 3: Chapter VII: 1950:** Engineering and utility services.

Parts dealing with sanitation, sewage and rainwater disposal, etc.

**CP 301:1971:** Building drainage.

Recommendations for design, layout and construction of foul-sewage, surface-water and ground-water drains.

**CP 302:1972:** Small sewage treatment works.

Methods, equipment and installation for treatment of domestic sewage (small groups of houses etc.) for up to 300 persons.

**CP 302:200:1949:** Cesspools.

Guidance on the provision of cesspools.

**CP 2005:1968:** Sewerage.

Design and construction of the whole system of sewers, manholes, storm overflows, siphons, pumping stations and mains, etc.

**B.S. 5572:1978:** Code of practice for sanitary pipework (formerly CP 304).

Design, installation, testing and maintenance of above ground non-pressure pipework.

## BRITISH STANDARDS

**B.S. 65 and B.S. 540:** Clay drain and sewer pipes including surface water pipes and fittings.

**Part 1:1971:** pipes and fittings, dimensions and tolerances.

**TABLE 1. DIMENSIONS OF BARRELS**

| 1            | 2                           |            | 3                              |            | 4   |
|--------------|-----------------------------|------------|--------------------------------|------------|---|
| Nominal bore | Limits of Internal diameter |            |                                |            | Permissible variation In thickness (See 5.1.2)... |
|              | British Standard            |            | British Standard Surface Water |            |   |
|              | Min. dia.                   | Max. dia.  | Min.dia.                       | Max. dia.  |   |
| mm           | mm                          | mm         | mm                             | mm         | mm  |
| <b>75</b>    | <b>73</b>                   | <b>80</b>  | <b>71</b>                      | <b>81</b>  | <b>2</b>  |
| <b>100</b>   | <b>98</b>                   | <b>105</b> | <b>96</b>                      | <b>107</b> | <b>2</b>  |
| *125         | 122                         | 132        | 119                            | 135        | 2   |

|            |            |            |            |            |          |
|------------|------------|------------|------------|------------|----------|
| <b>150</b> | <b>147</b> | <b>158</b> | <b>145</b> | <b>160</b> | <b>2</b> |
| *175       | 173        | 183        | 170        | 185        | 2        |
| *200       | 196        | 210        | 193        | 213        | 2        |
| <b>225</b> | <b>222</b> | <b>235</b> | <b>219</b> | <b>239</b> | <b>2</b> |
| *250       | 246        | 262        | 242        | 266        | 2        |
| <b>300</b> | <b>296</b> | <b>313</b> | <b>292</b> | <b>317</b> | <b>2</b> |
| <b>375</b> | <b>371</b> | <b>391</b> | <b>366</b> | <b>396</b> | <b>3</b> |
| <b>450</b> | <b>447</b> | <b>467</b> | <b>442</b> | <b>472</b> | <b>3</b> |
| <b>525</b> | <b>520</b> | <b>547</b> | <b>514</b> | <b>553</b> | <b>3</b> |
| <b>600</b> | <b>596</b> | <b>623</b> | <b>590</b> | <b>629</b> | <b>3</b> |
| <b>675</b> | <b>666</b> | <b>705</b> | <b>657</b> | <b>715</b> | <b>3</b> |
| <b>750</b> | <b>736</b> | <b>788</b> | <b>736</b> | <b>801</b> | <b>3</b> |
| <b>825</b> | <b>812</b> | <b>864</b> | <b>801</b> | <b>876</b> | <b>3</b> |
| <b>900</b> | <b>889</b> | <b>940</b> | <b>876</b> | <b>953</b> | <b>3</b> |

\* These are non-preferred sizes.

**TABLE 2. DIMENSIONS OF SOCKETS (TYPE 2)**

| <b>1</b>            | <b>2</b>                                | <b>3</b>                                   |
|---------------------|---|--|
| <b>Nominal bore</b> | <b>Minimum Internal depth of socket</b> | <b>Minimum excess shoulder measurement</b> |
|                     | <i>(B)</i>                              | <i>(C-A)</i>                               |
| mm                  | mm                                      | mm   |
| <b>75</b>           | <b>50</b>                               | <b>8</b>                                   |
| <b>100</b>          | <b>50</b>                               | <b>10</b>                                  |
| *125                | 55                                      | 10   |
| <b>150</b>          | <b>55</b>                               | <b>10</b>                                  |
| *175                | 55                                      | 10   |
| *200                | 65                                      | 13   |
| <b>225</b>          | <b>65</b>                               | <b>13</b>                                  |
| *250                | 70                                      | 15   |
| <b>300</b>          | <b>70</b>                               | <b>15</b>                                  |
| <b>375</b>          | <b>75</b>                               | <b>15</b>                                  |
| <b>450</b>          | <b>75</b>                               | <b>15</b>                                  |
| <b>525</b>          | <b>80</b>                               | <b>20</b>                                  |
| <b>600</b>          | <b>90</b>                               | <b>20</b>                                  |
| <b>675</b>          | <b>90</b>                               | <b>20</b>                                  |
| <b>750</b>          | <b>90</b>                               | <b>20</b>                                  |
| <b>825</b>          | <b>90</b>                               | <b>25</b>                                  |
| <b>900</b>          | <b>90</b>                               | <b>25</b>                                  |

\* These are non-preferred sizes.

**Part 2:1972:** flexible mechanical joints, tests for deflection, straight draw, line

displacement, shear loading and water tightness.

B.S. 437: Cast iron spigot and socket drain pipes and fittings.

Part 1:1970: pipes, bends, branches and access fittings.

**TABLE 1. DIMENSIONS OF DRAIN PIPES (M)**

|                                   |                             | Nominal bore (mm) |      |      |      |       |       |
|-----------------------------------|-----------------------------|-------------------|------|------|------|-------|-------|
|                                   |                             | 50                | 75   | 100  | 150  | 225   |       |
| Pipe                              |                             |                   | mm   | mm   | mm   | mm    | mm    |
|                                   | Minimum bore                | A                 | 48   | 74   | 99   | 150   | 226   |
|                                   | External diameter (max.)    | B                 | 65   | 92   | 119  | 173   | 256   |
| ....                              |                             |                   |      |      |      |       |       |
| Socket                            | Minimum bore                | F                 | 81   | 108  | 136  | 190   | 276   |
|                                   | External diameter (nominal) | G                 | 117  | 150  | 185  | 239   | 337   |
|                                   | Internal depth (min.)       | J                 | 76   | 76   | 76   | 89    | 114   |
| ....                              |                             |                   |      |      |      |       |       |
|                                   | Caulking clearance (min.)   |                   | 8    | 8    | 9    | 9     | 10    |
| Nominal weight of pipe            |                             |                   | kg   | kg   | kg   | kg    | kg    |
| per 1.83 m length (single socket) |                             |                   | 17.7 | 28.6 | 40.8 | 71.2  | 143.8 |
| per 1.83 m length (double socket) |                             |                   | —    | 33.1 | 46.7 | 80.3  | 162.8 |
| per 2.74 m length (single socket) |                             |                   | —    | 40.8 | 58.5 | 102.1 | 206.4 |
| per 3.66m length (single socket)  |                             |                   | —    | 52.6 | 76.2 | 132.9 | 268.5 |

NOTE 1. For other sizes of pipe refer to BS 1211 (Centrifugally cut (spun) iron pressure pipes for water, gas and sewage). Class B.

NOTE 2. Length for 50 mm size 1.83 m effective

Length for 75, 100, 150, 225 mm size 1.83, 2.74 and 3.66 m effective

Length for 75, 100, 150, 225 mm size With double socket 1.83 m effective

NOTE 3. 3 in, 4 in, 6 in and 9 in centrifugally cast (spun) iron pressure pipes to BS 1211. Class B shall be deemed to comply with ... this British Standard.

B.S. 497: Specification for manhole covers, road gully gratings and frames for drainage purposes.

Part 1:1976: cast iron and cast steel.

B.S. 539:1971: Dimensions of fittings for use with clay drain and sewer pipes.

Design and dimensions of branch heads, channels, interceptors, gullies, traps and raising pieces, hoppers, yard or street gullies.

B.S. 556: Concrete cylindrical pipes and fittings including manholes, inspection chambers, and street gullies.

Part 1:1966: imperial units.

Part 2:1972: metric units.

**TABLE 1. DIMENSIONS AND TOLERANCES FOR CONCRETE PIPES AND FITTINGS**

| 1                 | 2   | 3  | 4   | 5                             |
|-------------------|---|--|---|-------------------------------|
| Nominal bore .... | Permissible deviation (plus or minus) from mean bore .... | Permissible variation of wall thickness (plus or minus) .... | Minimum clearance between spigot and socket* .... | Minimum depth of socket* .... |
| <i>A</i>          |   |  | <i>B</i>  | <i>C</i>                      |
| mm                | mm  | mm   | mm  | mm                            |
| 150               | 3   | 3  | 10  | 56                            |
| 225               | 3   | 3  | 10  | 56                            |
| 300               | 3   | 3  | 15  | 56                            |
| 375               | 5   | 3  | 15  | 62                            |
| 450               | 5   | 3  | 15  | 70                            |
| 525               | 6   | 3  | 15  | 70                            |
| 600               | 6   | 3  | 20  | 70                            |
| 675               | 6   | 3  | 20  | 76                            |
| 750               | 6   | 3  | 20  | 82                            |
| 825, 900          | 6   | 3  | 20  | 88                            |
| 975, 1050         | 6   | 5  | 20  | 95                            |
| 1125              | 6   | 5  | 20  | 100                           |
| 1200              | 10  | 5  | 20  | 100                           |
| 1350              | 10  | 5  | 20  | 100                           |
| 1500              | 10  | 5  | 20  | 100                           |
| 1650              | 10  | 5  | 20  | 100                           |
| 1800              | 10  | 5  | 20  | 100                           |

\* The minimum dimensions given in Columns 4 and 5 apply only to ordinary spigot and socket joints...

**B.S. 1143:1974:** Vitrified clay pipes and fittings with extra chemically resistant properties.

Pipes and fittings up to 900mm nominal bore for use under conditions of severe acidity.

**B.S. 1194:1969:** Concrete porous pipes for under-drainage.

Cement and aggregate, composition and preparation. Form, dimensions and tolerances.

**B.S. 1196:1971:** Clayware field drain pipes.

Quality, workmanship, dimensions 65mm to 400mm pipes.

**B.S. 1247:1975:** Manhole step irons.

Tests and requirements, appendices.

**B.S. 2494:1976:** Materials for elastomeric jointings for pipework and pipelines.

Suitable elastomers for jointing pipes.

**B.S. 2760:1973:** Pitch-impregnated fibre pipes and fittings for below and above ground drainage.

Dimensions and requirements. Specifies materials and tests.

**TABLE 1. NOMINAL BORES**

| Nominal bore, mm            | 50 | 75 | 100 | 125 | 150 | 200 | 225 |
|-----------------------------|----|----|-----|-----|-----|-----|-----|
| Limits of internal diameter | mm | mm | mm  | mm  | mm  | mm  | mm  |
| min.                        | 51 | 76 | 102 | 127 | 152 | 203 | 229 |
| max.                        | 54 | 80 | 106 | 133 | 160 | 213 | 239 |

**B.S. 3656:1973:** Asbestos-cement pipes, joints and fittings for sewerage and drainage.  
Nominal bore range 100mm to 1050mm.

**TABLE 1. CLASSIFICATION OF PIPES**

| Nominal bore | Minimum ultimate crushing load |              |              |
|--------------|--------------------------------|--------------|--------------|
|              | Class L (AC)                   | Class M (AC) | Class H (AC) |
| mm           | kg/m                           | kg/m         | kg/m         |
| 100          | —                              | —            | 3870         |
| 125          | —                              | —            | 3870         |
| 150          | —                              | —            | 3870         |
| 175          | —                              | —            | 3870         |
| 200          | —                              | —            | 3870         |
| 225          | —                              | —            | 3870         |
| 250          | —                              | —            | 3870         |
| 300          | —                              | 3570         | 4760         |
| 375          | —                              | 3940         | 5360         |
| 450          | 3570                           | 4460         | 5950         |
| 525          | 3870                           | 4840         | 6700         |
| 600          | 4300                           | 5800         | 7900         |
| 675          | 4900                           | 6550         | 8780         |
| 750          | 5200                           | 7000         | 9370         |
| 825          | 5650                           | 7600         | 10270        |
| 900          | 5950                           | 8930         | 11000        |
| 975          | 6400                           | 9670         | 11900        |
| 1050         | 6700                           | 10120        | 12650        |

NOTE 1. In specifying the above crushing loads in kg/m it is assumed that the measurements will be made in conditions of standard gravity.

NOTE 2. The choice or class of pipe is determined by the pipeline design engineer who alone is qualified to judge the conditions of installation, laying and operation of the pipes. However, it is recommended that a class be selected such that, taking into account all the loads and the bedding adopted, the pipes in use give a factor of safety at crushing of at least 1.25.

NOTE 3. Occasional internal pressures are admissible provided that an adequate



factor of safety be maintained in relation to the hydrostatic test pressure given in 2.4.2.1 and 4.4.2.

**B.S. 3868:1973:** Prefabricated drainage stack units, galvanised steel.

For use above ground in plumbing systems for soil waste and rainwater.

**TABLE 1. DIMENSIONS AND WEIGHTS**

|                                | Nominal bore (mm) |       |       |       |       |       |        |        |
|--------------------------------|-------------------|-------|-------|-------|-------|-------|--------|--------|
|                                | 32                | 40    | 50    | 65    | 80    | 100   | 125    | 150    |
| Class                          | Light             | Light | Light | Light | Light | Light | Medium | Medium |
| Max. diameter (o.d.) mm        | 42.5              | 48.4  | 60.2  | 76.0  | 88.7  | 113.9 | 140.6  | 166.1  |
| Thickness mm                   | 2.65              | 2.90  | 2.90  | 3.25  | 3.25  | 3.65  | 4.85   | 4.85   |
| Weight (ungalvanized) kg/m run | 2.58              | 3.25  | 4.11  | 5.80  | 6.81  | 9.89  | 16.20  | 19.20  |

**B.S. 4101:1967:** Concrete unreinforced tubes and fittings with ogee joints for surface water drainage.

Definitions, materials, testing, etc.

**B.S. 4118:1967:** Glossary of sanitation terms.

Covers above and below ground drainage, including connection to a local authority's sewerage system.

**B.S. 4514:1969:** Unplasticised PVC soil and ventilating pipe, fittings and accessories.

For use in above ground drainage systems.

**TABLE 1. DIMENSIONS OF PIPES AND FITTINGS**

| Nominal size | Mean outside diameter* |         | Tolerance on mean outside diameter* |           | Minimum wall thickness |         |          |         |
|--------------|------------------------|---------|-------------------------------------|-----------|------------------------|---------|----------|---------|
|              |                        |         |                                     |           | pipe                   |         | fittings |         |
|              | mm                     | (in)    | mm                                  | (in)      | mm                     | (in)    | mm       | (in)    |
| 3            | 82.6                   | (3.250) | ±0.2                                | (± 0.008) | 3.2                    | (0.125) | 3.2      | (0.125) |
| 4            | 110.2                  | (4.339) | ±0.2                                | (± 0.008) | 3.2                    | (0.125) | 3.2      | (0.125) |
| 6            | 160.3                  | (6.312) | ±0.3                                | (± 0.012) | 3.3                    | (0.130) | 3.5      | (0.138) |

\* The mean outside diameters and tolerances thereon apply to pipe, and to spigots of fitting for ring seal and solvent cement joints. 'Mean outside diameter' of a pipe is defined as the arithmetic mean of any two perpendicularly opposed diameters.

**B.S. 4660:1973:** Unplasticised PVC underground drain pipe and fittings. Nominal sizes 110mm and 160mm.

**TABLE 1. DIMENSIONS OF PIPE AND FITTINGS**

| Nominal size | Mean outside diameter |       | Extreme Individual outside diameter |       | Minimum wall thickness |                               |           |
|--------------|-----------------------|-------|-------------------------------------|-------|------------------------|-------------------------------|-----------|
|              | min.                  | max.  | min.                                | max.  | Pipe                   | Fittings other than junctions | Junctions |
| mm           | mm                    | mm    | mm                                  | mm    | mm                     | mm                            | mm        |
| 110          | 110.0                 | 110.4 | 108.0                               | 112.4 | 3.4                    | 3.4                           | 3.8       |
| 160          | 160.0                 | 160.6 | 157.1                               | 163.5 | 4.1                    | 4.1                           | 4.1       |

NOTE 1. 110 mm and 160 mm pipes have previously been known as 4 inch and 6 inch nominal drain pipes respectively.

NOTE 2. The minimum wall thickness of the socket, where it is supported by the pipe, may be reduced by up to 10 % of the specified value.

NOTE 3. Mean outside diameter applies to pipe and to spigots of fittings for ring seal and solvent cement joints. Mean outside diameter is defined as the arithmetic mean of any two diameters at right angles to each other.

**B.S. 4962:1973:** Performance requirements for plastics pipe for use as light duty sub-soil drains.

Materials, construction and tests, etc.

**B.S. 5178:1975:** Prestressed concrete pipes for drainage and sewage.

Pipes and fittings for use at atmospheric pressure. Nominal bores from 450 to 3000mm. Materials, design, tests, etc.

**B.S. 5481:1977:** Specification for unplasticised PVC pipe and fittings for gravity sewers.

Nominal diameters 200 to 630mm. Materials, dimensions, construction, tests, etc.

## RECENT DEVELOPMENTS

### FLEXIBLE PIPELINES

Recent research carried out at the Building Research Station has established principles that will revolutionize the traditional methods of drain-laying. It has been found that ground movement, especially in shrinkable clay and some other soils, causes fractures in the usual type of drain—that is, pipes of ceramic or similar brittle material, laid with rigid joints of cement on a continuous bed of concrete. If, however, the rigid concrete bed is omitted, and in addition, flexible pipelines of pitch-fibre, steel or plastics are used instead of the usual stone-ware drainpipes, fractures are virtually eliminated. If brittle pipes are used, such as the ordinary stoneware drain pipes or cast-iron pipes, they can be jointed with flexible joints, using rubber jointing rings or flexible bitumen joints. They will then be as free from fracture as pitch-fibre or steel or plastics pipes. Rings for ceramic, concrete, asbestos-cement and spun iron pipes can now be bought.

This does not mean that the pipes may be laid direct on a trench bottom: this bottom should be of uniform hardness, and well consolidated. Nevertheless, these new materials and methods enable considerable savings to be made, notably by the omission of concrete beds, the speed of forming joints, the possibility of testing as soon as the line is laid and the advantage of being able to cover in as soon as testing is complete. Further details are given in Building Research Station Digests, Nos. 124, 125, 134 and (New Series) No. 6 (obtainable from H.M.S.O.).

### PITCH-FIBRE PIPES

Pitch-fibre pipes, made from a cellulose material impregnated with bitumen, and long used in Germany, Canada and the U.S.A., are now manufactured in this country to B.S. 2760, and are accepted by most local authorities for drainage underground. They can be used to carry hot liquids, up to 120–130°F without fear of deterioration. The great advantage of using them is fast laying—up to 400ft run of 4in pipes per hour—due to long lengths, light weight and simple jointing. In addition, because of their flexibility, no concrete bedding or haunching is required. Long lengths can be made up, and lowered into the trenches as required. Pipes should be to B.S. 2760.

Pipes are obtainable in internal diameters of 2, 3, 4, 5, 6 and 8in, and in lengths of 5, 6, 8 and 10ft, with ends tooled to meet couplings. Couplings are available (straight and 5° angled) in all diameters. Junctions, male or female taper, in 90°, 95°, 112°, 120° and 130°, all sizes on all pipes, and long tailed septic tank junctions (90°) are available from stock, as are long-radius bends (22 1/2°, 45° and 90°, radius from 1ft 4in to 3ft 6in are general, but a larger range is stocked) and tapers, adaptors and other fittings. Joints are coned, and jointing consists merely in hammering the pipes together, using a wood block to prevent deformation of the cone joint.

The pipe can be cut to length by a carpenter's saw, and tapers can be made on the cut ends by simple jointing tools that can be hired from the suppliers. Details of laying procedure are given in Building Research Digests 97, 124 and 125, and in publications of the Pitch Fibre Pipe Association. Intending users should verify, with their local authority, whether the use of these pipes is permitted, and under what conditions, before embarking on their use. The Association will gladly supply names and addresses of manufacturers. Pitch-fibre and plastics pipes are liable to flattening or other distortion if subjected to heavy loads.

Although these new methods and materials dispense, in the ordinary way, with concrete drain-beds, there are conditions where possible damage to the pipeline demands either a concrete bed or a concrete surround that may also be reinforced, or a concrete cover. Further design information is given in *The structural design of the cross-section of vitrified clay pipelines buried in trenches* by J.H.Walton, F.I.P.H.E., from the Clay Pipe Development Association. The MOHLG Working Party second report (see above) gives design methods for the rational structural design of pipelines and design tables, for use with these methods (by C.E.G.Bland, M.I.P.H.E.) are published, by the Clay Pipe Development Association, in a collection of papers on drainage.

### DOMESTIC DRAINAGE MEMORANDA

Waste water allowances in gallons per person per day discharged in 12 hours are:

|   |    |   |
|---|----|---|
| Domestic  | 35 |   |
| Hospitals   | 50 |   |
| Schools   | 10 |   |
| Barracks  | 15 |   |
| <i>Example.</i> For one house of 5 persons,<br>the discharge is |    | $\frac{35 \times 5}{12 \times 60} = \cdot 24 \text{ gal/min}$ |

Stormwater allowances should be made for  $\frac{1}{2}$ " to 1", say  $\frac{3}{4}$ " of rainfall per hour for impermeable areas, and  $\frac{1}{8}$ , say  $\frac{1}{4}$ , from permeable areas.

*Example.* For one house at a density of 12 to the acre with about  $\frac{1}{4}$  impermeable area (roofs, paths and roads), the requirement in gallons per minute would be as follows:—

|  |   |                         |   |                         |   |               |
|--|---|-------------------------|---|-------------------------|---|---------------|
| Impermeable 1210 sq. ft                              | × | $\frac{3}{4 \times 12}$ | × | $\frac{6 \cdot 25}{60}$ | = | 7·88 gal/min  |
| Permeable 2420 sq. ft                                | × | $\frac{1}{8 \times 12}$ | × | $\frac{6 \cdot 25}{60}$ | = | 2·63 gal/min  |
| Stormwater for $\frac{1}{12}$ th acre or 3630 sq. ft |   |                         |   |                         | = | 10·51 gal/min |
| Add Domestic soil and waste (see above)              |   |                         |   |                         |   | ·24 gal/min   |
| Total per house... ..                                |   |                         |   |                         |   | 10·75 gal/min |
| Total per acre ... ..                                |   |                         |   |                         |   | 129 gal/min   |

*Note:* 1 litre equals 0·22 galls  
 1 gallon equals 4·54 litres  
 1 acre equals 0·40 hectares  
 1 hectare equals 2·47 acres

### DRAIN AND SEWER FALLS

Drains, to be self-cleansing, should not be larger than necessary and should have a minimum velocity of 3 ft per second. Maguire's rule of a fall of 1 in 10d (d equals internal diameter of pipe) gives the following familiar falls: for a 4in pipe, 1 in 40ft; for a 6in pipe, 1 in 60ft; and for a 9in pipe, 1 in 90ft. These are today considered excessive and the following table (from Escritt's *Building Sanitation*, p. 91) should be used:

| Internal Diameter | inches | Fall:  |
|-------------------|--------|--------|
| millimetres       |        | one in |
| 101·6             | 4      | 90     |

|       |    |     |
|-------|----|-----|
| 152.4 | 6  | 150 |
| 177.8 | 7  | 190 |
| 228.6 | 9  | 265 |
| 304.8 | 12 | 385 |
| 381.0 | 15 | 520 |

**DISCHARGE AND VELOCITY IN VITRIFIED CLAY PIPES**

| Diam of Drain | Area (full) sq. in | Fall  | Velocity Ft per sec | Discharge Gal per min |           |
|---------------|--------------------|-------|---------------------|-----------------------|-----------|
|               |                    |       |                     | Full                  | Half full |
| 4"            | 12.57              | 1:60  | 3.02                | 99                    | 49        |
|               |                    | 1:40  | 3.70                | 121                   | 61        |
|               |                    | 1:30  | 4.28                | 140                   | 70        |
| 6"            | 28.27              | 1:100 | 3.07                | 226                   | 113       |
|               |                    | 1:80  | 3.44                | 253                   | 126       |
|               |                    | 1:60  | 3.97                | 291                   | 146       |
|               |                    | 1:40  | 4.86                | 357                   | 179       |
| 9"            | 63.62              | 180   | 3.01                | 497                   | 249       |
|               |                    | 1:120 | 3.68                | 609                   | 305       |
|               |                    | 1:90  | 4.25                | 702                   | 351       |
|               |                    | 1:60  | 5.21                | 860                   | 430       |
| 12"           | 113.10             | 1:260 | 3.03                | 892                   | 446       |
|               |                    | 1:120 | 4.46                | 1311                  | 655       |

The velocity in the foregoing table is calculated from Manning's formula:

$B=C.R.^{.67}S^5$ , where C=128-83 for stoneware drains, R is the Hydraulic Mean Depth in feet(=sectional area of flow÷wetted perimeter), and S is the sine of the slope.

The discharge (G) in gallons per minute is found from the formula  $G= 2.6 aV$ , where aV=the sectional area of flow in inches.

**LEAD AND YARN**

**APPROXIMATE AMOUNTS REQUIRED FOR JOINTS IN CAST IRON SOIL AND WATER PIPES**

| Size of Pipe | Caulking Space in Joint | Depth of Lead in Joint | Weight of Lead | Weight of Yarn |    |    |
|--------------|-------------------------|------------------------|----------------|----------------|----|----|
| in           | in                      | in                     | lb             | lb             | oz |    |
| 2            | }                       | 1½                     | 2¾             | 0              | 2  |    |
| 2½           |                         | 1½                     | 3              | 0              | 2½ |    |
| 3            |                         | 1¾                     | 4              | 0              | 3  |    |
| 4            |                         | 1¾                     | 4¾             | 0              | 4  |    |
| 5            |                         | 1¾                     | 5¾             | 0              | 7  |    |
| 6            |                         | 1¾                     | 6¾             | 0              | 8  |    |
| 7            |                         | }                      | 1¾             | 8              | 0  | 9  |
| 8            |                         |                        | 2              | 10             | 0  | 11 |
| 9            |                         |                        | 2              | 11¼            | 0  | 13 |
| 10           |                         |                        | 2              | 12½            | 0  | 14 |
| 12           |                         |                        | 2              | 14½            | 1  | 1  |
| 14           |                         |                        | 2¼             | 18½            | 1  | 6  |
| 15           |                         |                        | 2¼             | 20             | 1  | 7  |
| 16           |                         |                        | 2¼             | 21½            | 1  | 9  |
| 18           | 2¼                      |                        | 28             | 2              | 0  |    |
| 20           | }                       |                        | 2¼             | 31             | 2  | 3  |
| 22           |                         | 2½                     | 37             | 2              | 9  |    |
| 24           |                         | 2½                     | 40             | 2              | 13 |    |
| 26           |                         | 2½                     | 43½            | 3              | 1  |    |
| 27           |                         | 2½                     | 45             | 3              | 2  |    |
| 28           |                         | 2½                     | 47             | 3              | 4  |    |
| 30           |                         | 2½                     | 50             | 3              | 7  |    |
| 32           |                         | 2½                     | 53             | 3              | 11 |    |
| 33           |                         | }                      | 2½             | 55             | 3  | 13 |
| 36           |                         |                        | 2½             | 59½            | 4  | 3  |
| 38           |                         |                        | 2½             | 68             | 4  | 5  |
| 39           |                         |                        | 2¾             | 71             | 4  | 1  |
| 40           |                         |                        | 2¾             | 73             | 4  | 3  |
| 42           |                         |                        | 2¾             | 76             | 4  | 5  |
| 44           | 2¾                      |                        | 79             | 4              | 7  |    |
| 45           | 2¾                      |                        | 81½            | 4              | 9  |    |
| 46           | 2¾                      |                        | 82½            | 4              | 11 |    |
| 48           | 2¾                      |                        | 86½            | 4              | 14 |    |

### MANHOLE COVERS

Manhole covers, to B.S. 497, are manufactured in three grades—Grade A, heavy duty (HD) taking wheel loads up to 11 1/4 tons (11.43 tonnes): Grade B, medium duty (MD) for use where heavy commercial vehicles would be exceptional and Grade C, light duty (LD) not suitable for wheeled vehicular traffic.

## TYPES AND SIZES

| Grade | Description          | British Standard<br>reference | Clear opening |             |
|-------|----------------------|-------------------------------|---------------|-------------|
|       |                      |                               | inches        | millimetres |
| HD    | Double triangle      | A1                            | 20            | 508         |
| HD    | Double triangle      | A1                            | 22            | 558         |
| HD    | Single triangle      | A2                            | 19 1/2        | 495         |
| HD    | Double triangle      | A3                            | 27            | 608         |
| MD    | Circular             | B4                            | 20 & 25       | 508 & 559   |
| MD    | Rectangular*         | B5                            | 24×18         | 610×475     |
| LD    | Single seal          | C6                            |               |             |
| LD    | Double seal          | C7                            | 18×18         | 457×457     |
| LD    | Single seal recessed | C8                            | 24×18         | 610×457     |
| LD    | Double seal recessed | C9                            | 24×24         | 610×610     |

\*Recessed top type also available. When ordering any of the above range, specify by the B.S. reference, to avoid confusion. A large range of manhole covers and access covers, not covered by a British Standard, are commonly used in the trade.

# 15. THE PLUMBER

## CODES OF PRACTICE

**CP 3: Chapter VII: 1950:** Engineering utility services.

Information concerning services for most types of buildings. Parts dealing with cold and hot water supply—tables covering consumption, rates of flow and sanitary provision.

**CP 308:1974:** Drainage of roofs and paved areas.

Covers surface water from roofs and paved areas. Design and installation of gutters and rainwater pipes.

**CP 310:1965:** Water supply.

Deals with the supply of water to houses and most other buildings. Appendix for pipe sizing.

**B.S. 5572:1978:** Code of practice for sanitary pipework (formerly CP 304).

Design, installation, testing and maintenance of above ground non-pressure pipework.

## BRITISH STANDARDS

**B.S. 417:** Galvanised mild steel cisterns and covers, tanks and cylinders.

**Part 1:1964:** imperial units.

**Part 2:1973:** metric units.

**TABLE 1. DIMENSIONS OF CISTERNS AND COVERS**

| 1                  | 2                      | 3        | 4        | 5  | 6                               | 7        | 8        | 9       | 10         |                      |
|--------------------|------------------------|----------|----------|--|---------------------------------|----------|----------|---------|------------|----------------------|
| BS type Reference* | Dimensions of cisterns |          |          | Minimum thickness of steel, before galvanizing for cisterns and covers |                                 |          | Grade A  | Grade B | Covers for | No. of pieces Length |
|                    | <i>L</i>               | <i>W</i> | <i>D</i> | Capacity to water line   | Distance of water line from top | cisterns | cisterns | for     | pieces     | Length               |
|                    | mm                     | mm       | mm       | litres   | mm                              | mm       | mm       | mm      | mm         | mm                   |
| SCM 34             | 457                    | 305      | 305      | 18   | 111                             | 1.6      | 1.2      | 1.0     | 1.0        | ...                  |
| SCM 70             | 610                    | 305      | 371      | 36   | 111                             | 1.6      | 1.2      | 1.0     | 1.0        | ...                  |
| SCM 90             | 610                    | 406      | 371      | 54   | 111                             | 1.6      | 1.2      | 1.0     | 1.0        | ...                  |
| SCM 110            | 610                    | 432      | 432      | 68   | 114                             | 1.6      | 1.2      | 1.0     | 1.0        | ...                  |
| SCM 135            | 610                    | 457      | 482      | 86   | 114                             | 1.6      | 1.2      | 1.0     | 1.0        | ...                  |



|           |      |      |      |      |     |     |     |     |
|-----------|------|------|------|------|-----|-----|-----|-----|
| SCM 180   | 686  | 508  | 508  | 114  | 114 | 1.6 | 1.2 | 1.0 |
| SCM 230   | 736  | 559  | 559  | 159  | 114 | 2.0 | 1.6 | 1.0 |
| SCM 270   | 762  | 584  | 610  | 191  | 114 | 2.0 | 1.6 | 1.0 |
| SCM 320   | 914  | 610  | 584  | 227  | 114 | 2.0 | 1.6 | 1.0 |
| SCM 360   | 914  | 660  | 610  | 264  | 114 | 2.0 | 1.6 | 1.0 |
| SCM 450/1 | 1219 | 610  | 610  | 327  | 114 | 2.0 | 1.6 | 1.0 |
| SCM 450/2 | 965  | 686  | 686  | 336  | 114 | 2.0 | 1.6 | 1.0 |
| SCM 570   | 965  | 762  | 787  | 423  | 146 | 2.5 | 2.0 | 1.2 |
| SCM 680   | 1092 | 864  | 736  | 491  | 146 | 2.5 | 2.0 | 1.2 |
| SCM 910   | 1168 | 889  | 889  | 709  | 146 | 2.5 | 2.0 | 1.2 |
| SCM 1130  | 1524 | 914  | 813  | 841  | 146 | 2.5 | 2.0 | 1.2 |
| SCM 1600  | 1524 | 1143 | 914  | 1227 | 146 | 3.2 | 2.5 | 1.6 |
| SCM 2270  | 1828 | 1219 | 1016 | 1727 | 146 | 3.2 | 2.5 | 1.6 |
| SCM 2720  | 1829 | 1219 | 1219 | 2137 | 190 | 3.2 | 2.5 | 1.6 |
| SCM 4540  | 2438 | 1524 | 1219 | 3364 | 254 | 4.8 | 3.2 | 1.6 |

\* Cisterns should be ordered by the BS type reference to avoid confusion.

For welded cisterns, the lengths may be increased by not more than 25 mm (see Fig. 1). These dimensions were determined for the depths necessary to accommodate ball valves and overflow pipes in the sizes likely to be used, and in the position, to satisfy water supply requirements. The dimensions have been used in calculating the capacities.

The dimension is for the lapping piece: the lapped piece is 5 mm less.

**B.S. 460:1964:** Cast iron rainwater goods.

Pipes from 2in to 6in, fittings and accessories (imperial units).

**B.S. 504:1961:** Drawn lead traps.

Imperial units, 'S' and 'P' lead traps.

**B.S. 569:1973:** Asbestos-cement rainwater goods.

Quality, dimensions, coating and marking for pipes, gutters and fittings.

**TABLE 1. DIMENSIONAL TOLERANCES: PIPES AND PIPE FITTINGS**

| Nominal bore of pipe and fitting | Internal diameter permissible deviation (plus or minus) from nominal bore | Thickness of pipe and fitting | Permissible deviation (plus or minus) from thickness of pipes and fittings | Outside diameter (see Note) | Permissible deviation (plus or minus) from outside diameter | Length of pipe only | Permissible deviation from length of pipes only |
|----------------------------------|---|-------------------------------|--|-----------------------------|---|---------------------|---|
| mm                               | mm  | mm                            | mm   | mm                          | mm  | mm                  | mm  |
| 50                               | } 3.0   | 6.0                           | 1.0  | 62.0                        | } 3.0   | } 1800 and 3000     | } 0 12  |
| 65                               |   | 6.0                           | 1.0  | 77.0                        |   |                     |   |
| 75                               |   | 7.5                           | 1.0  | 90.0                        |   |                     |   |
| 100                              |   | 7.5                           | 1.0  | 115.0                       |   |                     |   |
| 150                              |   | 9.0                           | 1.5  | 168.0                       |   |                     |   |

NOTE: The sum of the permissible deviations on the nominal bore and on the thickness shall not exceed the limits of the outside diameter.

**TABLE 2. DIMENSIONAL TOLERANCES: GUTTERS AND GUTTER FITTINGS**

| Type of gutter              | Work size of gutter or fitting | Thickness of gutter or fitting | Permissible deviation (plus or minus) from thickness | Permissible deviation (plus or minus) from internal dimensions | Effective length of gutter | Permissible deviation from length |
|-----------------------------|--------------------------------|--------------------------------|--|--|----------------------------|-----------------------------------|
| Half round                  | mm                             | mm                             | 1.5  | 2.0  | 1800                       | +0<br>-12                         |
|                             | 75                             | 7.5                            |  |  |                            |                                   |
|                             | 100                            | 9.0                            |  |  |                            |                                   |
|                             | 115                            | 9.0                            |  |  |                            |                                   |
|                             | 125                            | 9.0                            |  |  |                            |                                   |
| 150                         | 9.0                            |                                |  |  |                            |                                   |
| 200                         | 9.0                            |                                |  |  |                            |                                   |
| Valley No. 1 pattern        | 406 x 127 x 254                | 12.0                           |  | 5.0  |                            |                                   |
|                             | 457 x 127 x 152                | 12.0                           |  |  |                            |                                   |
|                             | 610 x 152 x 229                | 12.0                           |  |  |                            |                                   |
| North light valley          | 457 x 152 x 102                | 12.0                           | 5.0  |  |                            |                                   |
| Boundary wall No. 1 pattern | 279 x 127 x 178                | 9.0                            | 3.0<br>5.0<br>5.0                                    |  |                            |                                   |
|                             | 305 x 152 x 229                | 12.0                           |  |  |                            |                                   |
|                             | 457 x 152 x 305                | 12.0                           |  |  |                            |                                   |
| Boundary wall No. 2 pattern | 559 x 152 x 406                | 12.0                           | 5.0  |  |                            |                                   |
| Box                         | 127 x 152                      | 9.0                            | 3.0<br>5.0<br>5.0                                    |  |                            |                                   |
|                             | 305 x 203                      | 12.0                           |  |  |                            |                                   |
|                             | 381 x 127                      | 12.0                           |  |  |                            |                                   |

**B.S. 1091:1963:** Pressed steel gutters, rainwater pipes, fittings and accessories.

Light pressed, galvanised gutters, pipes etc., and heavy pressed gutters.

**B.S. 1184:1976:** Copper and copper alloy traps.

'S' and 'P' traps for use with baths, basins, sinks, etc.

**B.S. 1431:1960:** Wrought copper and wrought zinc rainwater goods.

Half-round, rectangular, ogee gutters, round and rectangular pipes and accessories.

**B.S. 1968:1953:** Floats for ballvalves (copper).

Class A, soldered joints; Class B, solderless joints; Class C, brazed, welded or silver soldered joints.

**B.S. 1972:1967:** Polythene pipe (Tyne 32) for cold water services.

Dimensions, physical and mechanical characteristics. (See table overleaf).

**B.S. 2456:1973:** Floats (plastics) for hot and cold water.

Requirements for floats 102mm, 114mm, 127mm and 152 mm diameter. Performance tests specified.

**TABLE 2. BOSSES**

| 1  | 2                                      | 3   | 4  | 5  |
|--|--|---|--|----|
| BS type reference of floats (see 1.3(2)) | Minimum length of screw thread in boss | Diameter of BS Whitworth screw thread in boss | Size of BS 1212 ballvalve which boss thread will fit |    |
|  | mm                                     | in  | in   | in |
| 102 S                                    | 13                                     | $\frac{5}{16}$                                | $\frac{1}{2}$ and $\frac{3}{4}$                      |    |
| 102 NS                                   | 13                                     | $\frac{5}{16}$                                | $\frac{1}{2}$ and $\frac{3}{4}$                      |    |
| 114 S                                    | 13                                     | $\frac{5}{16}$                                | $\frac{1}{2}$ and $\frac{3}{4}$                      |    |
| 114 NS                                   | 13                                     | $\frac{5}{16}$                                | $\frac{1}{2}$ and $\frac{3}{4}$                      |    |
| 127 S                                    | 13                                     | $\frac{5}{16}$                                | $\frac{1}{2}$ and $\frac{3}{4}$                      |    |
| 127 NS                                   | 13                                     | $\frac{5}{16}$                                | $\frac{1}{2}$ and $\frac{3}{4}$                      |    |
| 152 S                                    | 19                                     | $\frac{7}{16}$                                | 1  | —  |
| 152 NS                                   | 19                                     | $\frac{7}{16}$                                | 1  | —  |
| 152 LS                                   | —                                      | —   | —  | —  |
| 152 LNS                                  | —                                      | —   | —  | —  |

**B.S. 2997:1958:** Aluminium rainwater goods.

Range of rainwater goods in aluminium alloys. Quality of materials, dimensions, workmanship, jointing and fixing.

**B.S. 3380:** Wastes for sanitary appliances and overflows for baths.

**Part 1:1976:** wastes (excluding skeleton sink wastes) and bath overflows; for baths, basins, sinks and bidets.

**Part 2:1962:** skeleton sink wastes; three-piece brass wastes for fireclay sinks.

**TABLE 1. PIPE DIMENSIONS**

| Nominal size | Outside diameter |              | Wall thickness   |             |  |             |
|--------------|------------------|--------------|--|-------------|--|-------------|
|              |                  |              | Class B  |             | Class C  |             |
|              |                  |              | (0.60 N/mm <sup>2</sup> ∗:0.60 MPa∗: 200 ft hd: 86.7 lbf/in <sup>2</sup> ) |             | (0.89 N/mm <sup>2</sup> ∗:0.89 MPa∗: 300 ft hd:130 lbf/in <sup>2</sup> ) |             |
|              | Min.             | Max.         | Min.   | Max.        | Min.   | Max.        |
| in           | mm (in)          | mm (in)      | mm (in)  | mm (in)     | mm (in)  | mm (in)     |
| 3/8          | 17.0 (0.669)     | 17.3 (0.681) | —  | —           | 2.2 (0.087)  | 2.5 (0.098) |
| 1/2          | 21.2 (0.835)     | 21.5 (0.847) | —  | —           | 2.7 (0.106)  | 3.0 (0.118) |
| 3/4          | 26.6 (1.047)     | 26.9 (1.059) | 2.3 (0.091)  | 2.6 (0.102) | 3.4 (0.134)  | 3.7 (0.146) |
| 1            | 33.4 (1.315)     | 33.7 (1.327) | 3.0 (0.118)  | 3.3 (0.130) | 4.2 (0.165)  | 4.6 (0.181) |
| 1 1/4        | 42.1 (1.657)     | 42.5 (1.673) | 3.7 (0.146)  | 4.1 (0.161) | 5.3 (0.209)  | 5.8 (0.228) |
| 1 1/2        | 48.1 (1.894)     | 48.5 (1.910) | 4.3 (0.169)  | 4.7 (0.185) | 6.1 (0.240)  | 6.7 (0.264) |
| 2            | 60.1 (2.366)     | 60.6 (2.386) | 5.3 (0.209)  | 5.8 (0.228) | 7.6 (0.299)  | 8.4 (0.331) |

|   |              |              |             |             |             |             |
|---|--------------|--------------|-------------|-------------|-------------|-------------|
| 3 | 88.6 (3.488) | 89.3 (3.516) | 7.8 (0.307) | 8.6 (0.339) | 11.2(0.441) | 12.3(0.484) |
| 4 | 113.9(4.484) | 114.7(4.516) | 10.0(0.394) | 11.0(0.433) | —           | —           |

\* In the original standard these values are expressed in MN/m<sup>2</sup>. Numerically they

**B.S. 3943:1965:** Plastics waste traps.

Dimensions, design and construction.

**B.S. 4118:1967:** Glossary of sanitation terms.

Covers water supply, sanitary appliances and drainage.

**B.S. 4213:1975:** Cold water storage cisterns (polyolefin or olefin copolymer) and cistern covers.

Requirements, dimensions and tests.

**TABLE 1 (METRIC UNITS)**

| BS type reference | Minimum capacity to water line | Distance of water line from top | Maximum height of cistern | Minimum thickness | Minimum mass |
|-------------------|--------------------------------|---------------------------------|---------------------------|-------------------|--------------|
|                   | 1                              | mm                              | mm                        | mm                | kg           |
| PC 4              | 18                             | 111                             | 310                       | 1.4               | 1.36         |
| PC 8              | 36                             | 111                             | 380                       | 1.4               | 1.81         |
| PC 15             | 68                             | 114                             | 430                       | 2.1               | 2.95         |
| PC 20             | 91                             | 114                             | 510                       | 2.1               | 3.18         |
| PC 25*            | 114                            | 114                             | 560                       | 2.1               | 3.40         |
| PC 40             | 182                            | 114                             | 610                       | 2.1               | 6.35         |
| PC 50*            | 227                            | 114                             | 660                       | 2.1               | 7.03         |
| PC 60             | 273                            | 114                             | 660                       | 2.1               | 7.26         |
| PC 70             | 318                            | 114                             | 660                       | 2.1               | 9.07         |
| PC 100            | 455                            | 114                             | 760                       | 2.1               | 12.70        |

**B.S. 4576:** Unplasticised PVC rainwater goods.

**Part 1:1970:** half-round gutter and circular pipe; material, colour, dimensions, notes on fixing.

**TABLE 1. PIPE DIMENSIONS**

| Nominal size | Mean outside diameter |         | Tolerance on outside diameter |          | Minimum wall thickness |         | Minimum bore |         |
|--------------|-----------------------|---------|-------------------------------|----------|------------------------|---------|--------------|---------|
|              | mm                    | (in)    | mm                            | (in)     | mm                     | (in)    | mm           | (in)    |
| 63mm         | 63.1                  | (2.486) | ±0.15                         | (±0.006) | 1.8                    | (0.071) | 58.4         | (2.300) |
| 2 1/2 in     | 68.15                 | (2.696) | ±0.18                         | (±0.007) | 1.8                    | (0.071) | 63.5         | (2.500) |
| 75 mm        | 75.2                  | (2.961) | ±0.20                         | (±0.008) | 1.8                    | (0.071) | 70           | (2.756) |

NOTE. Three further sizes of pipe (3, 4 and 6 nominal) are not specified in tab standard but are included in BS 4514,

'Unplasticized PVC soil and ventilating pipe, fittings and accessories', and are suitable for sealed systems for internal or external use

**TABLE 2. DIMENSIONS OF TRUE HALF-ROUND\* GUTTERS**

| Nominal size | Minimum wall thickness |         | Minimum cross-sectional area |                    | Minimum effective sealed cross-sectional area |                    |
|--------------|------------------------|---------|------------------------------|--------------------|---|--------------------|
|              | mm                     | (in)    | mm <sup>2</sup>              | (in <sup>2</sup> ) | mm <sup>2</sup>                               | (in <sup>2</sup> ) |
| 4            | 2.2                    | (0.085) | 4000                         | (6.2)              | 3200  | (5.0)              |
| 4 1/2        | 2.2                    | (0.085) | 5100                         | (7.9)              | 4080  | (6.3)              |
| 5            | 2.3                    | (0.090) | 6300                         | (9.8)              | 5040  | (7.8)              |
| 6            | 2.5                    | (0.100) | 9100                         | (14.5)             | 7280  | (11.3)             |

**TABLE 3. DIMENSIONS OF NORMAL HALF-ROUND\* GUTTERS**

| Nominal size | Minimum wall thickness |         | Minimum cross-sectional area |                    | Minimum effective sealed cross-sectional area |                    |
|--------------|------------------------|---------|------------------------------|--------------------|---|--------------------|
|              | mm                     | (in)    | mm <sup>2</sup>              | (in <sup>2</sup> ) | mm <sup>2</sup>                               | (in <sup>2</sup> ) |
| 4            | 2.2                    | (0.085) | 3200                         | (5.0)              | 2560  | (4.0)              |
| 4 1/2        | 2.2                    | (0.085) | 4000                         | (6.2)              | 3200  | (5.0)              |
| 5            | 2.3                    | (0.090) | 4900                         | (7.6)              | 3920  | (6.1)              |
| 6            | 2.5                    | (0.100) | 7200                         | (11.1)             | 5760  | (8.9)              |

The minimum cross-sectional areas given in Tables 2 and 3 are calculated cross-sectional areas and no cutting allowance has been made.

**B.S. 5254:1976:** Polypropylene waste pipe and fittings (external diameter 34.6mm, 41.0mm and 54.1mm).

Dimensions and performances.

**B.S. 5255:1976:** Plastics waste pipe and fittings.

Dimensions and performance for pipes made from acrylonitrile butadiene styrene (ABS) modified unplasticised polyvinyl chloride (MUPVC), polypropylene (PP) and polyethylene (PE).

### WATER DATA

1 gallon of water weighs 10 lb or 4.454 kg.

1 cubic foot of water equals 6.232 gallons or 28–293 kg.

1 hundredweight of water (50 kg) equals 1.8 cu. ft.

1 litre equals 1 kg of water or 1 cubic decimetre, or 0.22 galls.

1 cubic metre equals 1,000 cubic decimetres.

Water pressure is now in a new unit—the Bar. See page 320.

**WATER CONSUMPTION FOR BUILDINGS OF VARIOUS TYPES**

per person per day

|                      | Galls | Litres |
|----------------------|-------|--------|
| Schools .. . . .     | 10    | 45.45  |
| Office Buildings ... | 15    | 60.24  |
| Dwelling Houses ...  | 25*   | 112.50 |
| Hotels .. . . .      | 30    | 136.37 |

**\*This figure is made up as follows:**

|                          |                 |               |
|--------------------------|-----------------|---------------|
| Drinking .. .. .         | $\frac{1}{2}$   | 1.17          |
| Food preparation .. .. . | $\frac{1}{2}$   | 1.17          |
| Washing-up .. .. .       | 1               | 4.54          |
| House Cleaning .. .. .   | 2               | 9.09          |
| Laundry .. .. .          | 3               | 13.60         |
| Toilet Purposes .. .. .  | 5               | 22.72         |
| Baths and WC's .. .. .   | $13\frac{1}{2}$ | 61.35         |
| <b>Total .. .. .</b>     | <b>25</b>       | <b>112.50</b> |

**RELATIVE DISCHARGING POWER OF WATER PIPES  
INTERNAL DIAMETER OF PIPES**

| Inches            | 4   | $3\frac{1}{2}$ | 3  | $2\frac{1}{2}$ | 2     | $1\frac{1}{2}$ | $1\frac{1}{2}$ | 1     | $\frac{3}{4}$ | $\frac{1}{2}$ |
|-------------------|-----|----------------|----|----------------|-------|----------------|----------------|-------|---------------|---------------|
| mm                | 102 | 89             | 76 | 74             | 51    | 38             | 31             | 26    | 19            | 13            |
| Lead Code numbers | 27  | 26             | 25 | 24             | 22-23 | 19-21          | 17-18          | 13-16 | 7-12          | 4-6           |
|                   | 1=  | 1              | 2  | 3              | 5     | 11             | 18             | 32    | 65            | 181           |
|                   |     | 1=             | 1  | 2              | 4     | 8              | 13             | 22    | 47            | 129           |
|                   |     |                | 1= | 1              | 2     | 5              | 8              | 15    | 31            | 88            |
|                   |     |                |    | 1=             | 1     | 3              | 5              | 9     | 20            | 55            |
|                   |     |                |    |                | 1=    | 2              | 3              | 5     | 11            | 32            |
|                   |     |                |    |                |       | 1=             | 1              | 2     | 5             | 19            |
|                   |     |                |    |                |       |                | 1=             | 1     | 3             | 9             |
|                   |     |                |    |                |       |                |                | 1=    | 2             | 5             |
|                   |     |                |    |                |       |                |                |       | 1=            | 2             |

**LEAD PIPES**

Lead pipe to B.S. 602:1970 and B.S. 1085:1972. These new sizes of lead pipe are now in code numbers.

**APPENDIX A STANDARD METRIC SIZES OF PIPES**

| Code No. | Nominal bore | Nominal wall thickness | Nearest arithmetical equivalent size in BS 602, 1085:1956 |
|----------|--------------|------------------------|---|
|          | mm           | mm                     |   |
| 1        | 10.0         | 5.00                   | 3/8 in x 5 lb/yd  |
| 2        | 12.0         | 2.00                   | 1/2 in x 2 lb/yd  |

|   |      |      |                |
|---|------|------|----------------|
| 3 | 12.0 | 3.60 | 1/2 in×4 lb/yd |
| 4 | 12.0 | 4.80 | 1/2 in×6 lb/yd |
| 5 | 12.0 | 5.60 | 1/2 in×7 lb/yd |
| 6 | 12.0 | 6.70 | 1/2 in×9 lb/yd |
| 7 | 16.0 | 2.30 | 5/8 in×3 lb/yd |
| 8 | 20.0 | 2.60 | 3/4 in×4 lb/yd |
| 9 | 20.0 | 3.20 | 3/4 in×5 lb/yd |

| Code No. | Nominal bore | Nominal wall thickness | Nearest arithmetical equivalent size in BS 602, 1085:1956 |
|----------|--------------|------------------------|---|
| 10       | 20.0         | 5.30                   | 3/4 in×9 lb/yd  |
| 11       | 20.0         | 6.40                   | 3/4 in×11 lb/yd   |
| 12       | 20.0         | 8.50                   | 3/4 in×15 lb/yd   |
| 13       | 25.0         | 3.00                   | 1 in×6 lb/yd  |
| 14       | 25.0         | 3.30                   | 1 in×7 lb/yd  |
| 15       | 25.0         | 8.00                   | 1 in×16 lb/yd   |
| 16       | 25.0         | 10.0                   | 1 in×21 lb/yd   |
| 17       | 32.0         | 2.80                   | 1 1/4 in×7 lb/yd  |
| 18       | 32.0         | 3.60                   | 1 1/4 in×9 lb/yd  |
| 19       | 40.0         | 2.50                   | 1 1/2 in×7 lb/yd  |
| 20       | 40.0         | 3.10                   | 1 1/2 in×9 lb/yd  |
| 21       | 40.0         | 4.00                   | 1 1/2 in×12 lb/yd   |
| 22       | 50.0         | 3.10                   | 2 in×12 lb/yd   |
| 23       | 50.0         | 4.00                   | 2 in×16 lb/yd   |
| 24       | 65.0         | 2.50                   | 2 1/2 in×12 lb/yd   |
| 25       | 75.0         | 2.70                   | 3 in×15 lb/yd   |
| 26       | 90.0         | 2.70                   | 3 1/2 in×17 lb/yd   |
| 27       | 100.0        | 2.70                   | 4 in×19 lb/yd   |
| 28       | 115.0        | 2.70                   | 4 1/2 in×22 lb/yd   |
| 29       | 125.0        | 3.20                   | 5 in×30 lb/yd   |

**COPPER TUBE**

**TABLE Z. DIMENSIONS AND WORKING PRESSURES FOR HARD DRAWN THIN WALL COPPER TUBES**

| 1            | 2                | 3       | 4                 | 5                          |
|--------------|------------------|---------|-------------------|----------------------------|
| Size of tube | Outside diameter |         | Nominal thickness | Maximum working pressures* |
|              | maximum          | minimum |                   |                            |
| mm           | mm               | mm      | mm                | bar†                       |
| 6            | 6.045            | 5.965   | 0.5               | 113                        |
| 8            | 8.045            | 7.965   | 0.5               | 98                         |

|    |        |        |     |    |
|----|--------|--------|-----|----|
| 10 | 10.045 | 9.965  | 0.5 | 78 |
| 12 | 12.045 | 11.965 | 0.5 | 64 |
| 15 | 15.045 | 14.965 | 0.5 | 50 |
| 18 | 18.045 | 17.965 | 0.6 | 50 |
| 22 | 22.055 | 21.975 | 0.6 | 41 |
| 28 | 28.055 | 27.975 | 0.6 | 32 |
| 35 | 35.07  | 34.99  | 0.7 | 30 |

| 1            | 2                |         | 3                 | 4                          | 5 |
|--------------|------------------|---------|-------------------|----------------------------|---|
| Size of tube | Outside diameter |         | Nominal thickness | Maximum working pressures* |   |
|              | maximum          | minimum |                   |                            |   |
| 42           | 42.07            | 41.99   | 0.8               | 28                         |   |
| 54           | 54.07            | 53.99   | 0.9               | 25                         |   |
| 67           | 66.75            | 66.60   | 1.0               | 20                         |   |
| 76.1         | 76.30            | 76.15   | 1.2               | 19                         |   |
| 108          | 108.25           | 108.00  | 1.2               | 17                         |   |
| 133          | 133.50           | 133.25  | 1.5               | 16                         |   |
| 159          | 159.50           | 159.25  | 1.5               | 15                         |   |

\* Based on material in H condition...at 65 °C.

† 1 bar=0.1 N/mm<sup>2</sup>=0.1 MPa.

Note: This tube must not be bent: use easy bends and pitcher tees.

**TABLE X. DIMENSIONS AND WORKING PRESSURES FOR HALF HARD, LIGHT GAUGE COPPER TUBES**

| 1            | 2                |         | 3                 | 4                          | 5 |
|--------------|------------------|---------|-------------------|----------------------------|---|
| Size of tube | Outside diameter |         | Nominal thickness | Maximum working pressures* |   |
|              | maximum          | minimum |                   |                            |   |
| mm           | mm               | mm      | mm                | bar†                       |   |
| 6            | 6.045            | 5.965   | 0.6               | 133                        |   |
| 8            | 8.045            | 7.965   | 0.6               | 97                         |   |
| 10           | 10.045           | 9.965   | 0.6               | 77                         |   |
| 12           | 12.045           | 11.965  | 0.6               | 63                         |   |
| 15           | 15.045           | 14.965  | 0.7               | 58                         |   |
| 18           | 18.045           | 17.965  | 0.8               | 56                         |   |
| 22           | 22.055           | 21.975  | 0.9               | 51                         |   |
| 28           | 28.055           | 27.975  | 0.9               | 40                         |   |
| 35           | 35.07            | 34.99   | 1.2               | 42                         |   |
| 42           | 42.07            | 41.99   | 1.2               | 35                         |   |
| 54           | 54.07            | 53.99   | 1.2               | 27                         |   |
| 67           | 66.75            | 66.60   | 1.2               | 20                         |   |
| 76.1         | 76.30            | 76.15   | 1.5               | 24                         |   |



|     |        |        |     |    |
|-----|--------|--------|-----|----|
| 108 | 108.25 | 108.00 | 1.5 | 17 |
| 133 | 133.50 | 133.25 | 1.5 | 14 |
| 159 | 159.50 | 159.25 | 2.0 | 15 |

\* Based on material in 1/2H condition...at 65 °C.

† 1 bar=0.1 N/mm<sup>2</sup>=0.1 MPa<sup>3</sup>.

**TABLE Y. DIMENSIONS AND WORKING PRESSURES FOR HALF HARD AND ANNEALED COPPER TUBES**

| 1            | 2                | 3       | 4                 | 5   | 6                                       |
|--------------|------------------|---------|-------------------|---|---|
| Size of tube | Outside diameter |         | Nominal thickness | Maximum working pressures 1/2H condition* | Maximum working pressures O condition † |
|              | maximum          | minimum |                   |   |   |
| mm           | mm               | mm      | mm                | bar ‡                                     | bar ‡                                   |
| 6            | 6.045            | 5.965   | 0.8               | 188                                       | 144                                     |
| 8            | 8.045            | 7.965   | 0.8               | 136                                       | 105                                     |
| 10           | 10.045           | 9.965   | 0.8               | 106                                       | 82                                      |
| 12           | 12.045           | 11.965  | 0.8               | 87  | 67                                      |
| 15           | 15.045           | 14.965  | 1.0               | 87  | 67                                      |
| 18           | 18.045           | 17.965  | 1.0               | 72  | 55                                      |
| 22           | 22.055           | 21.975  | 1.2               | 69  | 57                                      |
| 28           | 28.055           | 27.975  | 1.2               | 55  | 42                                      |
| 35           | 35.07            | 34.99   | 1.5               | 54  | 41                                      |
| 42           | 42.07            | 41.99   | 1.5               | 45  | 34                                      |
| 54           | 54.07            | 53.99   | 2.0               | 47  | 36                                      |
| 67           | 66.75            | 66.60   | 2.0               | 37  | 28                                      |
| 76.1         | 76.30            | 76.15   | 2.0               | 33  | 25                                      |
| 108          | 108.25           | 108.00  | 2.5               | 29  | 22                                      |

\* Based on material in 1/2H condition...at 65 °C.

† Based on material in O condition...at 65 °C.

‡ 1 bar=0.1 N/mm<sup>2</sup>=0.1 MPa.

*Note:* Since the diameters in this table differ from the former (Imperial and metric) sizes, it is imperative that new formers for bending machines (except for 1/2in and 2in, which will serve) and new bending springs be obtained. Fittings for old sized pipe cannot be used on these tubes.

**WATER PRESSURE**

**EQUIVALENTS OF THE BAR**

1 atmosphere=14.7 lb.f/sq. in=1032 grams per cm<sup>2</sup>.

10<sup>5</sup> Nm<sup>2</sup>.

29.53in or 75.01cm of mercury (lin watergauge=2.491 millibar).

1 million dynes per cm<sup>2</sup>.

*Note:* This unit must not be confused with the Acoustic bar, which is the unit of acoustic pressure in a sound-wave, and 1 dyne/cm<sup>2</sup>.

**BAR AND POUNDS FORCE PER SQUARE INCH**

| bar    |     | lb.f.sq.in. |       |
|--------|-----|-------------|-------|
| 0.0686 | 1   |             | 14.7  |
| 0.1373 | 2   |             | 29.4  |
| 0.2060 | 3   |             | 44.1  |
| 0.2756 | 4   |             | 58.8  |
| 0.3430 | 5   |             | 73.5  |
| 0.4120 | 6   |             | 88.2  |
| 0.4806 | 7   |             | 102.9 |
| 0.5512 | 8   |             | 117.6 |
| 0.6180 | 9   |             | 132.3 |
| 0.6860 | 10  |             | 147.0 |
| 1.030  | 15  |             | 220.5 |
| 1.373  | 20  |             | 294   |
| 2.060  | 30  |             | 441   |
| 2.756  | 40  |             | 588   |
| 3.450  | 50  |             | 735   |
| 6.890  | 100 |             | 1470  |

**EXTERNAL DIAMETERS OF PIPES**

| Nominal internal diameters |      | Galvanised carbon steel, for central heating | Stainless steel for central heating | Polythene, for cold water supply |
|----------------------------|------|--|-------------------------------------|----------------------------------|
| in                         | mm   | mm   | mm                                  | mm                               |
| 3/8                        | 9.5  | 11.96  | 11.96                               | 17.3                             |
| 1/2                        | 12.7 | 15.14  | 15.14                               | 21.5                             |
| 3/4                        | 19.0 | 21.49  | 21.49                               | 26.9                             |
| 1                          | 25.4 | 28.24  | 28.24                               | 33.7                             |

|       |      |       |   |      |
|-------|------|-------|---|------|
| 1 1/4 | 31.7 | 34.59 | — | 42.5 |
| 1 1/2 | 38.1 | 40.94 | — | 48.5 |

*Notes:* Coated carbon steel pipes (B.S. 4182) are coming into use because they are considerably cheaper than copper.

Soldered or compression joints can be used.

These tubes should not be used with copper cylinders, calorifiers or tanks, nor with copper or brass fittings.

Stainless steel tubes (B.S. 864) should be used with stainless steel compression fittings and with stainless steel cylinders (which are cheaper than copper) and should be used in those districts where the water supply attacks copper.

The range of polythene pipes extends to 2in, 4in and 6in pipes. These are three grades—B, C and D. Taper pipe threads can be cut on grades C and D.

Care should be taken not to cut too long a thread.

### COMPOSITION GAS PIPE

| Internal Diameter |       | Weight              |                    | Length of coil |        |
|-------------------|-------|---------------------|--------------------|----------------|--------|
| inches            | mm    | per yard<br>lbs/ozs | per metre<br>grams | yards          | metres |
| 1/2               | 6.35  | 15oz                | 466.5              | 73             | 66.7   |
| 3/8               | 7.94  | 18oz                | 559.8              | 67             | 61.2   |
| 3/8               | 9.53  | 22oz                | 684.2              | 53             | 48.4   |
| 1/2               | 11.11 | 23oz                | 785.3              | 43             | 39.3   |
| 1/2               | 12.70 | 1lb 11oz            | 795.2              | 32             | 29.3   |
| 3/4               | 14.29 | 2lb 1oz             | 937.0              | 29             | 26.4   |
| 3/4               | 15.88 | 2lb 4oz             | 1 030.4            | 29             | 26.4   |
| 1                 | 19.05 | 2lb 10oz            | 1 217.0            | 25             | 22.8   |
| 1                 | 22.22 | 2lb 4 1/2 oz        | 1 045.0            | 20             | 18.2   |
| 1                 | 25.40 | 3lb 2oz             | 1 289.0            | 15             | 13.7   |

**SOLDER AND PETROL REQUIREMENTS**

**LEAD JOINTS TO PIPES ETC**

| Lead pipe<br>Code No.                        | Solder |                | Petrol                   |     |
|--|--------|----------------|--------------------------|-----|
|  | g      | lb             | lt                       | pt  |
| 4-6 .. .. .                                  | 227    | $\frac{1}{2}$  | 0.056                    | 0.1 |
| 7-12 .. .. .                                 | 340    | $\frac{3}{4}$  | 0.11                     | 0.2 |
| 13-16 .. .. .                                | 450    | 1              | 0.13                     | 0.2 |
| 17-18 .. .. .                                | 568    | $1\frac{1}{2}$ | 0.17                     | 0.3 |
| 19-21 .. .. .                                | 680    | $1\frac{3}{4}$ | 0.23                     | 0.4 |
| 24 .. .. .                                   | 1 133  | 2              | 0.28                     | 0.4 |
| 25 .. .. .                                   | 1 359  | $2\frac{1}{2}$ | 0.29                     | 0.5 |
| 26 .. .. .                                   | 1 586  | 3              | 0.34                     | 0.6 |
| 27 .. .. .                                   | 1 613  | 4              | 0.56                     | 0.6 |
| Cesspools (each) .. .. .                     | 1 613  | 4              | 0.56                     | 0.2 |
| Soldered dots (each) .. .. .                 | 450    | 1              | 0.11                     | 0.2 |
| Soldered seams & angles<br>metre run .. .. . | 46     | 0.1            | 0.11                     | 0.1 |
| Stop ends to pipes:                          |        |                |                          |     |
| 4-12 .. .. .                                 | 153    | 0.33           | } As for wiped<br>joints |     |
| 13-21 .. .. .                                | 227    | 0.50           |                          |     |
| 24 .. .. .                                   | 340    | 0.75           |                          |     |

**Note:** For Imperial Diameters and Imperial (old) sizes see page 000.

**RAINWATER PIPES AND GUTTERS**

To deal adequately with a storm rainfall, which is taken to be at the rate of 3in (75mm) per hour, 1in (6.45cm) square of the sectional area of the bore of a rainwater pipe is required for every square of roofing (measured on plan) in the area drained. The crucial item is, therefore, not the type or size of gutter but the size of the outlet or (if the gutter drains into a hopper-head) the size of the rainwater pipe. It is very rare, however, that a gutter drains directly into a hopper-head. In the vast majority of instances, the size of gutter to be employed, and the size of rainwater pipe will depend on the bore of the outlet. Calculate the number of squares of roofing to be drained, and select the nearest figure in the table below. On the line above will be read the size of gutter to employ and on the line beneath the size of rainwater pipe, swan-necks, bends, offsets, etc.

|                                   |                |                |                |                |                |                           |
|-----------------------------------|----------------|----------------|----------------|----------------|----------------|---------------------------|
| Gutter size half round or<br>ogee | 3<br>76        | 4<br>102       | 4 1/2<br>113   | 5<br>127       | 6<br>152       | inches<br>mm              |
| Area of roof to be drained        | 1 7/8<br>17.42 | 2 5/8<br>24.38 | 2 5/8<br>24.38 | 2 7/8<br>26.71 | 2 7/8<br>26.71 | squares<br>m <sup>2</sup> |
| size of outlet                    | 2<br>51        | 2 1/2<br>63    | 2 1/2<br>63    | 3<br>76        | 4<br>102       | inches<br>mm              |

**Notes:** The length of gutter should not exceed 20ft (6m) on each side of an outlet.

These figures are in accord with CP 142 (1951) and therefore are deemed to satisfy the Building Regulations.

### THE SINGLE STACK SYSTEM

This system has largely taken the place of the two-pipe system, and is now developed for up to 25-storey buildings. Soil and waste are accommodated in one stack, without venting the traps. To prevent syphonage all fittings are grouped together. 3in deep seal traps should be used. The slope of the waste pipes should be as flat as possible. Branches should not exceed 5ft for basin and bath, and up to 9ft for sink, in length. Connections to stack are made by plumbers' unions. "Specials", 3ft long, with inlet for W.C. waste and threaded bosses for unions, in various positions on the pipe, are now obtainable from all manufacturers of cast-iron drainpipes, and are included in B.S. 416.

### LEAD SHEET

#### WEIGHTS AND EQUIVALENT THICKNESSES

| Metric number | Wt in lb per sq. ft | Thickness (inches) |          | Metric equivalent in millimetres | Nearest S.W.G. |
|---------------|---------------------|--------------------|----------|----------------------------------|----------------|
|               |                     | Fractions          | Decimals |                                  |                |
| 3             | 3                   | 3/64 plus          | 0.050    | 1.270                            | 18             |
| 4             | 4                   | 1/16 plus          | 0.068    | 1.702                            | 16             |
| 5             | 5                   | 5/64 plus          | 0.084    | 2.130                            | 14             |
| 6             | 6                   | 7/64               | 1.101    | 2.560                            | 12             |
|               |                     | minus              |          |                                  |                |
| 7             | 7                   | 1/8 minus          | 0.118    | 2.990                            | 11             |
| 8             | 8                   | 9/64               | 0.135    | 3.420                            | 10             |

#### WEIGHTS OF LEAD SHEETS FOR VARIOUS POSITIONS

| Position                                       | Metric Code Numbers |
|--|---------------------|
| Main Gutters (Box or Parapet) . . . . .        | 5 or 6              |
| Flats, Roofs, small Gutters . . . . .          | 4 or 5              |
| Hips, Valleys and Ridges . . . . .             | 4 or 5              |
| Flashings and Aprons . . . . .                 | 4 or 5              |
| Soakers . . . . .                              | 3 or 4              |
| Flat Roof, small, no traffic . . . . .         | 4 or 5              |
| Flat Roof, large, with traffic . . . . .       | 5, 6 or 7           |
| Swept and pitched Roofs . . . . .              | 4, 5 or 6           |
| Dormer Cheeks . . . . .                        | 4 or 5              |
| Cloaks in Cavity Walls . . . . .               | 3                   |
| Linings:                                       |                     |
| Water Tanks, Up to 30 galls Capacity . . . . . | 4 or 5              |

|   |        |
|---|--------|
| Safes to Baths and Tanks . . . . .          | 4      |
| Water Tanks over 30 galls Capacity. . . . . | 5 or 6 |
| Flower boxes . . . . .                      | 6      |

**LEAD SOAKERS**

**LENGTHS OF LEAD SOAKERS TO SUIT DIFFERENT SIZES OF SLATES**

| Length of Slate | Length of Soaker |        |        |                |        |        |
|-----------------|------------------|--------|--------|----------------|--------|--------|
|                 | Head nailing     |        |        | Centre nailing |        |        |
|                 | 2" lap           | 3" lap | 4" lap | 2" lap         | 3" lap | 4" lap |
| 24              | 13 1/2           | 14     | 14 1/2 | 14             | 14 1/2 | 15     |
| 22              | 12 1/2           | 13     | 13 1/2 | 13             | 13 1/2 | 14     |
| 20              | 11 1/2           | 12     | 12 1/2 | 12             | 12 1/2 | 13     |
| 18              | 10 1/2           | 11     | 11 1/2 | 11             | 11 1/2 | 12     |
| 16              | 9 1/2            | 10     | 10 1/2 | 10             | 10 1/2 | 11     |
| 14              | 8 1/2            | 9      | 9 1/2  | 9              | 9 1/2  | 10     |
| 13              | 8                | 8 1/2  | 9      | 8 1/2          | 9      | 9 1/2  |
| 12              | 7 1/2            | 8      | 8 1/2  | 8              | 8 1/2  | 9      |
| 11              | 7                | 7 1/2  | 8      | 7 1/2          | 8      | 8 1/2  |
| 10              | 6 1/2            | 7      | 7 1/2  | 7              | 7 1/2  | 8      |
| 9               | 6                | 6 1/2  | 7      | 6 1/2          | 7      | 7 1/2  |
| 8               | 5 1/2            | 6      | 6 1/2  | 6              | 6 1/2  | 7      |

*Note:* Soakers vary in width from 7in to 9in.

# 16.

## THE HEATING ENGINEER

### CODES OF PRACTICE

**CP 3: Chapter VIII: 1949:** Heating and thermal insulation.

Conditions affecting temperature in dwellings. Recommends standards of warmth for rooms.

**CP 324 and CP 202; 1951:** Provision of domestic electric water-heating installations.

Design and installation of domestic water-heating systems.

**CP 332:** Selection and installation of town gas space heating.

**Part 1:1961:** independent domestic appliances, selection and installation of radiant or convector fires.

**Part 3:1970:** boilers of more than 150,000 Btu/h (44kw) and up to 2,000,000 Btu/h (586kw) output.

**Part 4:1966:** ducted warm air systems.

**CP 333:** Selection and installation of town gas hot water supplies.

**Part 1:1964:** domestic premises.

**CP 341 and CP 300–307:1966:** Central heating by low pressure hot water.

Head-code and seven sub-codes covering boilers and calorifiers; storage vessels; pipework, fittings, valves, taps and cocks; appliances; unit heaters, circulating pumps, and thermal insulation.

**CP 342:1950:** Centralised domestic hot water supply.

Installation of boilers, calorifiers, storage vessels, pipework and electrically driven circulators in central systems of domestic hot water supply.

**CP 403:1974:** Installation of domestic heating and cooking appliances.

Installation of room heaters, independent boilers and fanned warm air heater units.

**CP 403:101:1952:** Small boiler systems using solid fuel.

Combined heating and hot water supply systems using solid fuel.

**CP 1018:1971:** Electric floor-warming systems for use with off-peak and similar supplies of electricity.

Guidance on electric floor-warming systems in concrete and similar floors.

**B.S. 5410:** Code of practice for oil-firing.

**Part 2:1977:** installations up to 44kW output capacity for space heating, hot water and steam supply.

**B.S. 5449:** Code of practice for central heating for domestic premises.

**Part 1:1957:** forced circulation hot water systems.

### BRITISH STANDARDS

**B.S. 699:1972:** Copper cylinders for domestic purposes.

Cylinders for heating and storage of hot water. (See table opposite).

**B.S. 779:1976:** Cast iron boilers for central heating and indirect hot water supply.

Performance requirements, materials, mountings and fittings, wiring, etc.

**TABLE 1. DIMENSIONS AND DETAILS OF COPPER INDIRECT CYLINDERS**

| 1                                | 2                 | 3                           | 4                | 5               | 6   | 7      | 8              | 9            | 10     |  |  |
|----------------------------------|-------------------|-----------------------------|------------------|-----------------|---|--------|----------------|--------------|--------|--|--|
| British Standard type reference* | External diameter | External height (over dome) | Storage capacity | Heating surface | Minimum thickness of copper forming             |        |                |              |        |  |  |
|                                  |                   |                             |                  |                 | Grade 2   |        |                | Grade 1      |        |  |  |
|                                  |                   |                             |                  |                 | Test pressure: 0.220 N/mm <sup>2</sup> ¶ (MPa)¶ |        |                |              |        | Test pressure: 0.220 N/mm <sup>2</sup> ¶ |  |
|                                  |                   |                             |                  |                 | Maximum working head: IS m†                     |        |                |              |        | Maximum working head: IS m†              |  |
|                                  |                   |                             |                  |                 | Body and top                                    | Bottom | Primary heater | Body and top | Bottom |  |  |
| A                                | B                 | min.                        | min.             | mm              | mm  | mm     | mm             | mm           |        |  |  |
| 1                                | 350               | 900                         | 72               | 0.40            | 0.9   | 1.4    | 0.9            | 0.7          | 1      |  |  |
| 2                                | 400               | 900                         | 96               | 0.52            | 0.9   | 1.6    | 0.9            | 0.7          | 1      |  |  |
| 3                                | 400               | 1050                        | 114              | 0.63            | 0.9   | 1.6    | 0.9            | 0.7          | 1      |  |  |
| 4                                | 450               | 675                         | 84               | 0.46            | 1.0   | 1.6    | 1.0            | 0.7          | 1      |  |  |
| 5                                | 450               | 750                         | 95               | 0.52            | 1.0   | 1.6    | 1.0            | 0.7          | 1      |  |  |
| 6                                | 450               | 825                         | 106              | 0.60            | 1.0   | 1.6    | 1.0            | 0.7          | 1      |  |  |
| 7                                | 450               | 900                         | 117              | 0.66            | 1.0   | 1.6    | 1.0            | 0.7          | 1      |  |  |
| 8                                | 450               | 1050                        | 140              | 0.78            | 1.0   | 1.6    | 1.0            | 0.7          | 1      |  |  |
| 9                                | 450               | 1200                        | 162              | 0.91            | 1.0   | 1.6    | 1.0            | 0.7          | 1      |  |  |
| 10                               | 500               | 1200                        | 190              | 1.13            | 1.2   | 1.8    | 1.2            | 0.9          | 1      |  |  |
| 11                               | 500               | 1500                        | 245              | 1.30            | 1.2   | 1.8    | 1.2            | 0.9          | 1      |  |  |
| 12                               | 600               | 1200                        | 280              | 1.60            | 1.4   | 2.5    | 1.4            | 1.2          | 2      |  |  |
| 13                               | 600               | 1500                        | 360              | 2.10            | 1.4   | 2.5    | 1.4            | 1.2          | 2      |  |  |
| 14                               | 600               | 1800                        | 440              | 2.50            | 1.4   | 2.5    | 1.4            | 1.2          | 2      |  |  |

\* Cylinders should be ordered by the BS type references.

† The working head shall be the vertical distance from the bottom of the cylinder to the top of the cylinder.

‡ N/mm<sup>3</sup>¶).

§ Fitted to sizes 1-9 only when specified.

|| BSP.F external threads may be supplied when so ordered.

¶ Preferred sizes for new installations in dwellings.

¶ In the original standard these values are expressed in kN/m<sup>2</sup>.

**B.S. 843:1976:** Specification for thermal-storage electric water heaters (constructional



and water requirements).

Requirements for stationary non-instantaneous electric water heaters.

**B.S. 853:** Calorifiers for central heating and hot water supply.

**Part 1:1960:** mild steel and cast iron.

**MINIMUM REQUIREMENTS FOR INSPECTION OPENINGS**

(All dimensions are inside i.e. ‘clear hole’)

| Internal diameter of Calorifier      | SIZES OF OPENINGS  |  |
|--------------------------------------|--|--|
|                                      | Storage Calorifiers  | Non-storage Calorifiers  |
| Below 18 in                          | Optional   | Optional   |
| 18 in up to and including 24 in      | Two oval openings each 4 1/4 in x 2 3/4 in or one circular opening 8 in diameter                                   | Two 3 in diameter screwed bosses fitted with plugs or one circular opening 8 in diameter |
| Over 24 in up to and including 30 in | Two oval openings each 5 in x 3 1/2 in or one circular opening 10 in   | Two circular openings each 8 in diameter or one circular opening 10 in                   |
| Over 30 in up to and including 36 in | Two oval openings each 8 in x 4 in or one circular opening 12 in diameter or one oval opening 14 in x 11 in        | Two circular openings each 6 in diameter or one circular opening 12 in diameter          |
| Over 36 in up to and including 42 in | Two circular openings each 9 in diameter or one circular opening 15 in diameter or one oval opening 15 in x 11 in  | Two circular openings 9 in diameter or one circular opening 15 in diameter               |
| Over 42 in                           | Two circular openings each 10 in diameter or one circular opening 18 in diameter or one oval opening 16 in x 12 in | Two circular openings each 10 in diameter or one circular opening 18 in diameter         |

Oval openings shall be filled with internal doors. Circular openings, other than screwed bosses, shall be fitted with external covers secured by setscrew

**Part 2:1960:** Copper.

**MINIMUM REQUIREMENTS FOR INSPECTION OPENINGS**

| Internal diameter of Calorifier | SIZES OF OPENINGS  |   |
|---------------------------------|--|---|
|                                 | Storage Calorifiers  | Non-storage Calorifiers   |
| Below 18 in                     | Optional   | Optional  |
| 18 in up to and including 24 in | Two oval openings each 4 1/4 in x 2 3/4 in or one circular opening 8 in diameter | Two 3 in dia. screwed bosses fitted with plugs or one circular opening 8 in |

|                                      |   |  |
|--------------------------------------|---|--|
| Over 24 in up to and including 30 in | Two oval openings each 5 in×3 1/2 in or one circular opening 10 in  | diameter<br>Two circular openings each 5 in diameter or one circular opening 10 in |
| Over 30 in up to and including 36 in | Two oval openings each 8 in×4 in or one circular opening 12 in diameter or one oval opening 14 in×11 in           | Two circular openings each 6 in diameter or one circular opening 12 in diameter    |
| Over 36 in up to and including 42 in | Two circular openings each 9 in diameter or one circular opening 15 in diameter or one oval opening 15 in× 11 in  | Two circular openings 9 in diameter or one circular opening 15 in diameter         |
| Over 42 in                           | Two circular openings each 10 in diameter or one circular opening 18 in diameter or one oval opening 16 in× 12 in | Two circular openings each 10 in diameter or one circular opening 18 in diameter   |

Oval openings shall be fitted with internal doors. Circular openings, other than screwed bosses, shall be fitted with external covers secured by setscrew which shall comply with *the standard* as regards permissible stresses.

**B.S. 855:1976:** Specification for welded steel boilers for central heating and indirect hot water supply (rated output 44kW to 3mW).

Specifies minimum efficiencies for oil, gas and solid fuel firing.

**B.S. 1250: Part 4:1965:** Domestic appliance burning town gas.

Space heating appliances, performance, and test methods.

**B.S. 1565:** Galvanised mild steel indirect cylinders, annular or saddle-back type.

**Part 1:1949:** imperial units.

**Part 2:1973:** metric units.

**TABLE 1. DIMENSIONS AND DETAILS OF GALVANIZED MILD STEEL INDIRECT CYLINDERS**

| BS size No. | Dimensions  |                    | Approx. capacity | Min. heating surface | Heights of screwed connections |                |                       |      |      | Size of cylinder connections BSP.F internal threads |       |
|-------------|-------------|--------------------|------------------|----------------------|--------------------------------|----------------|-----------------------|------|------|---|-------|
|             | Int. dia. A | Height over dome B |                  |                      | H                              | J <sub>1</sub> | J <sub>2</sub> *<br>2 | L    | M    |   | P     |
|             | mm          | mm                 | litres           | m <sup>2</sup>       | mm                             | mm             | mm                    | mm   | mm   | mm  | in    |
| BSG.1M      | 457         | 762                | 109              | 0.74                 | 559                            | 140            | 254                   | †140 | 610  | 165   | 1     |
| BSG.2M      | 457         | 914                | 136              | 0.88                 | 686                            | 140            | 254                   | †140 | 749  | 165   | 1     |
| BSG.3M      | 457         | 1067               | 159              | 1.11                 | 813                            | 152            | 254                   | †152 | 914  | 165   | 1 1/4 |
| BSG.4M      | 508         | 1270               | 227              | 1.58                 | 991                            | 178            | 305                   | 178  | 1041 | 178   | 1 1/2 |

|        |     |      |     |      |      |     |     |      |      |     |       |
|--------|-----|------|-----|------|------|-----|-----|------|------|-----|-------|
| BSG.5M | 508 | 1473 | 273 | 1.86 | 1143 | 178 | 305 | 178  | 1194 | 178 | 1 1/2 |
| BSG.6M | 610 | 1372 | 364 | 2.51 | 1041 | 191 | 330 | 191  | 1143 | 191 | 2     |
| BSG.7M | 610 | 1753 | 455 | 3.16 | 1346 | 191 | 330 | 191  | 1524 | 191 | 2     |
| BSG.8M | 457 | 838  | 123 | 0.84 | 635  | 140 | 254 | †140 | 686  | 165 | 1     |

| BS size<br>No. | Minimum thicknesses of material  |        |               |               |   |                |               |               |    |
|----------------|--|--------|---------------|---------------|---|----------------|---------------|---------------|----|
|                | Class B. Tested 0.276 N/mm <sup>2</sup> ¶<br>(0.276 MPa)¶ Maximum<br>permissible working head §=18 m |        |               |               | Class C. Tested 0.138 N/mm <sup>2</sup> ¶<br>(0.138 MPa)¶ Maximum<br>permissible working head §=9 m |                |               |               |    |
|                | Cylinder   |        | Heater        |               | Cylinder  |                | Heater        |               |    |
|                | Body<br>and<br>dome  | Bottom | Inner<br>wall | Outer<br>wall | Body<br>and<br>dome   | Bottom<br>wall | Inner<br>wall | Outer<br>wall |    |
|                | mm   | mm     | mm            | mm            | mm  | mm             | mm            | mm            | mm |
| BSG.1M         | 3.2  | 3.2    | 3.2           | 3.2           | 2.0   | 2.5            | 2.0           | 2.0           |    |
| BSG.2M         | 3.2  | 3.2    | 3.2           | 3.2           | 2.0   | 2.5            | 2.0           | 2.0           |    |
| BSG.3M         | 3.2  | 3.2    | 3.2           | 3.2           | 2.0   | 2.5            | 2.0           | 2.0           |    |
| BSG.4M         | 4.8  | 4.8    | 4.8           | 4.8           | 3.2   | 3.2            | 3.2           | 3.2           |    |
| BSG.5M         | 4.8  | 4.8    | 4.8           | 4.8           | 3.2   | 3.2            | 3.2           | 3.2           |    |
| BSG.6M         | 4.8  | 4.8    | 4.8           | 4.8           | 3.2   | 3.2            | 3.2           | 3.2           |    |
| BSG.7M         | 4.8  | 4.8    | 4.8           | 4.8           | 3.2   | 3.2            | 3.2           | 3.2           |    |
| BSG.8M         | 3.2  | 3.2    | 3.2           | 3.2           | 2.0   | 2.5            | 2.0           | 2.0           |    |

\* This arrangement does not apply to cylinders with saddle-back heaters (see Clause 5).

† For saddle-back heaters each of these dimensions becomes 75 mm.

‡ For saddle-back heaters the heater connection nearest the externally domed end is internal.

§ The maximum permissible working head of water shall be measured from the bottom of the cylinder.

|| If the immersion heater is mounted horizontally (see Clause 13) these thicknesses shall be increased as may be necessary to secure the required strength from the altered design of primary heater.

¶ In the original standard these values are expressed in kN/m<sup>2</sup>

**B.S. 1566:** Copper indirect cylinders for domestic purposes.

**Part 1:1972:** double feed indirect cylinders. (See table overleaf).

**Part 2:1972:** single feed indirect cylinders. (See table overleaf).

**TABLE 1. DIMENSIONS AND DETAILS OF COPPER INDIRECT CYLINDERS**

|   |   |   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 1 |
|---|---|---|---|---|---|---|---|---|---|

| British Standard type reference* | External diameter | External height (over dome) | Storage capacity | Heating surface | Minimum thickness of copper forming             |        |                |  |        |
|----------------------------------|-------------------|-----------------------------|------------------|-----------------|---|--------|----------------|--|--------|
|                                  |                   |                             |                  |                 | Grade 2   |        |                | Grade 1                                  |        |
|                                  |                   |                             |                  |                 | Test pressure: 0.220 N/mm <sup>2</sup> ¶ (MPa)¶ |        |                | Test pressure: 0.220 N/mm <sup>2</sup> ¶ |        |
|                                  |                   |                             |                  |                 | Maximum working head: IS m†                     |        |                | Maximum working head: IS m†              |        |
|                                  |                   |                             |                  |                 | Body and top                                    | Bottom | Primary heater | Body and top                             | Bottom |
| A                                | B                 | min.                        | min.             | mm              | mm  | mm     | mm             | mm                                       |        |
| 1                                | 350               | 900                         | 72               | 0.40            | 0.9   | 1.4    | 0.9            | 0.7                                      | 1      |
| 2                                | 400               | 900                         | 96               | 0.52            | 0.9   | 1.6    | 0.9            | 0.7                                      | 1      |
| 3                                | 400               | 1050                        | 114              | 0.63            | 0.9   | 1.6    | 0.9            | 0.7                                      | 1      |
| 4                                | 450               | 675                         | 84               | 0.46            | 1.0   | 1.6    | 1.0            | 0.7                                      | 1      |
| 5                                | 450               | 750                         | 95               | 0.52            | 1.0   | 1.6    | 1.0            | 0.7                                      | 1      |
| 6                                | 450               | 825                         | 106              | 0.60            | 1.0   | 1.6    | 1.0            | 0.7                                      | 1      |
| 7                                | 450               | 900                         | 117              | 0.66            | 1.0   | 1.6    | 1.0            | 0.7                                      | 1      |
| 8                                | 450               | 1050                        | 140              | 0.78            | 1.0   | 1.6    | 1.0            | 0.7                                      | 1      |
| 9                                | 450               | 1200                        | 162              | 0.91            | 1.0   | 1.6    | 1.0            | 0.7                                      | 1      |
| 10                               | 500               | 1200                        | 190              | 1.13            | 1.2   | 1.8    | 1.2            | 0.9                                      | 1      |
| 11                               | 500               | 1500                        | 245              | 1.30            | 1.2   | 1.8    | 1.2            | 0.9                                      | 1      |
| 12                               | 600               | 1200                        | 280              | 1.60            | 1.4   | 2.5    | 1.4            | 1.2                                      | 2      |
| 13                               | 600               | 1500                        | 360              | 2.10            | 1.4   | 2.5    | 1.4            | 1.2                                      | 2      |
| 14                               | 600               | 1800                        | 440              | 2.50            | 1.4   | 2.5    | 1.4            | 1.2                                      | 2      |

\* Cylinders should be ordered by the BS type references.

† The working head shall be the vertical distance from the bottom of the cylinder to the top of the cylinder (N/mm<sup>2</sup>¶).

‡ Fitted to sizes 1-9 only when specified.

§ BSP.F external threads may be supplied when so ordered.

|| Preferred sizes for new installations in dwellings.

¶ In the original standard these values are expressed in kN-m<sup>2</sup>.

**TABLE 1. DIMENSIONS AND DETAILS OF SINGLE FEED COPPER INDIRECT CYLINDERS**

| 1                | 2                 | 3               | 4                | 5               | 6   | 7      | 8              | 9   | 10     |
|------------------|-------------------|-----------------|------------------|-----------------|---|--------|----------------|---|--------|
| British Standard | External diameter | External height | Storage capacity | Heating surface | Minimum thickness of copper forming           |        |                |   |        |
|                  |                   |                 |                  |                 | Grade 1                                       |        |                | Grade 2                                       |        |
|                  |                   |                 |                  |                 | Test pressure: 0.220 N/mm <sup>2</sup> (MPa)¶ |        |                | Test pressure: 0.220 N/mm <sup>2</sup> (MPa)¶ |        |
|                  |                   |                 |                  |                 | Maximum working head: IS m†                   |        |                | Maximum working head: IS m†                   |        |
|                  |                   |                 |                  |                 | Body and top                                  | Bottom | Primary heater | Body and top                                  | Bottom |
|                  |                   |                 |                  |                 | mm  | mm     | mm             | mm  | mm     |

| type reference* | diameter | (over dome) | capacity | surface        | Maximum working head: 15 m† |        |                | Maximum head |        |
|-----------------|----------|-------------|----------|----------------|-----------------------------|--------|----------------|--------------|--------|
|                 | A        | B           | min.     | min.           | Body and top                | Bottom | Primary heater | Body and top | Bottom |
|                 | mm       | mm          | litres   | m <sup>2</sup> | mm                          | mm     | mm             | mm           | m      |
| 3§              | 400      | 1050        | 104      | 0.63           | 0.9                         | 1.6    | 0.55           | 0.7          | 1      |
| 5               | 450      | 750         | 86       | 0.52           | 1.0                         | 1.6    | 0.55           | 0.7          | 1      |
| 7§              | 450      | 900         | 108      | 0.66           | 1.0                         | 1.6    | 0.55           | 0.7          | 1      |
| 8§              | 450      | 1050        | 130      | 0.78           | 1.0                         | 1.6    | 0.55           | 0.7          | 1      |
| 9§              | 450      | 1200        | 152      | 0.91           | 1.0                         | 1.6    | 0.55           | 0.7          | 1      |
| 10              | 500      | 1200        | 180      | 1.13           | 1.2                         | 1.8    | 0.55           | 0.9          | 1      |

\* Cylinders should be ordered by the BS type references.

† The working head shall be the vertical distance from the bottom of the cylinder to the water level (1 mH<sub>2</sub>O=0.01 N/mm<sup>2</sup>).

‡ BSP.F external threads may be supplied when so ordered.

§ Preferred sizes for new installations in dwellings.

|| *In the original standard these values are expressed in kN/m<sup>2</sup>.*

**B.S. 1846:** Glossary of terms relating to solid fuel burning equipment.

**Part 1:1968:** domestic appliances.

**B.S. 2767:1972:** Valves and unions for hot water radiators.

Revised to cover non-rising stem angle valves, etc.

**B.S. 2773:1965:** Domestic single-room space heating appliances for use with liquefied petroleum gases.

For use with commercial butane or propane.

**B.S. 3198:1960:** Combination hot water storage units (copper) for domestic purposes. Requirements and tests for direct and indirect storage units of 25 gallons capacity.

**B.S. 3377:1969:** Back boilers for use with domestic solid fuel appliances.

Materials and methods of construction.

**TABLE 1. MATERIALS FOR DOMESTIC BOILERS** (Recommendations for use are given in Appendix A)

| 1          | 2                 | 3     | 4    | 5           | 6                      | 7                  |
|------------|-------------------|-------|------|-------------|------------------------|--------------------|
| MATERIAL   | MINIMUM THICKNESS |       |      | At tappings | METHOD OF CONSTRUCTION | TEST PRESSURE bar* |
|            | Common name       | Tubes | Wall |             |                        |                    |
| Mild steel | ****              | 4.0   | 6.0† | 8.0         | Welding....            | 2.75               |
| Cast iron  |                   |       | 9.5‡ | 16.0        | Casting                | 2.75‡              |

|                     |  |     |      |              |      |
|---------------------|--|-----|------|--------------|------|
| Copper              |  | 4.5 | 11.0 | Welding .... | 2.10 |
| Aluminium<br>bronze |  | 2.5 | 8.0  | Welding      | 2.10 |
| Stainless<br>steel  |  | 2.5 | 8.0  | Welding....  | 2.10 |

\* 1 bar=1.0 N/mm<sup>2</sup>=14.50 lbf/in<sup>2</sup>.

† For water backed surfaces in contact with the fire or with products of primary combustion; 5.0 mm elsewhere.

‡ The thickness of the walls of cast iron boilers may be less than 9.5 mm if every boiler is tested hydraulically or pneumatically to a pressure of not less than 5.2 bar and is unaffected after a period of not less than 5 min.

**B.S. 3378:1972:** Room heaters burning solid fuel.

Construction, performance and methods of test.

**B.S. 3528:1977:** Specification for convection type space heaters operating with steam or hot water.

Determining thermal output of heating appliances, including radiators.

**B.S. 3955:** Electrical controls for domestic appliances.

**Part 1:1965:** general requirements.

**Section 2A: 1967:** manually operated appliance switches.

**Section 2B: 1966:** thermostats for electrically heated hot water supply.

**Section 2F: 1967:** room thermostats.

**Part 3:1972:** general and specific requirements.

### 6.3 Function

Classification according to the function of the controls shall be as follows:

- (1) Thermostat.
- (2) Temperature limiter.
- (3) Self-resetting thermal cut-out.
- (4) Non-self-resetting thermal cut-out.
- (5) Thermal link.
- (6) Energy regulator.
- (7) Motorized control.
- (8) Manually operated switch.
- (9) Current sensitive control.
- (10) Pressure sensing control.
- (11) Position sensing control.
- (12) Light sensing control.
- (13) Velocity sensing control.
- (14) Liquid level sensing control.
- (15) Humidity sensing control.
- (16) Solenoid operated control.

**B.S. 4256:** Oil-burning air heaters.

**Part 2:1972:** fixed, flued, fan-assisted heaters.

**Part 3:1972:** fixed, flued, convector heaters.

**B.S. 4433:** Solid smokeless fuel boilers with rated outputs up to 45kW.

**Part 1:1973:** boilers with undergrate ash removal.

**TABLE 1. MINIMUM NOMINAL BORE FOR TAPPINGS**

| Rated output | Minimum nominal pipe bore       |                                  |
|--------------|---------------------------------|----------------------------------|
|              | One flow and one return tapping | Two flow and two return tappings |
| kW           | mm                              | mm                               |
| Up to 6      | 25                              | 25                               |
| 6–13         | 32                              | 25                               |
| 13–22        | 38                              | 32                               |
| 22–35        | 50                              | 38                               |
| Over 35      | 63                              | 50                               |

If boilers are supplied with bushes or reducers in the flow tappings, these shall be of the eccentric pattern and fixed so that the reduced outlet is in the uppermost position.

The minimum depth of tappings shall be as given in Table 2.

\* BS 21, 'Pipe threads for tubes and fittings where pressure-tight joints are made on the threads'.

**Part 2:1969:** gravity feed boilers designed to burn small anthracite.

**TABLE 1. MINIMUM NOMINAL BORE FOR TAPPINGS**

| Rated output |              | Minimum nominal pipe bore        |       |                                  |       |
|--------------|--------------|----------------------------------|-------|----------------------------------|-------|
|              |              | One flow and one return tappings |       | Two flow and two return tappings |       |
| kW           | Btu/h        | mm                               | in    | mm                               | in    |
| Up to 13     | Up to 45000  | 32                               | 1 1/4 | 32                               | 1 1/4 |
| 13–22        | 45001–75000  | 38                               | 1 1/2 | 38                               | 1 1/2 |
| 22–35        | 75001–120000 | 50                               | 2     | 38                               | 1 1/2 |
| Over 35      | Over 120000  | 63                               | 2 1/2 | 50                               | 2     |

**TABLE 2. MINIMUM DEPTH OF TAPPINGS**

| Nominal pipe bore |             | Minimum depth of tappings |     |
|-------------------|-------------|---------------------------|-----|
| mm                | in          | mm                        | in  |
| Up to 38          | Up to 1 1/2 | 16                        | 5/8 |
| Over 38           | Over 1 1/2  | 19                        | 3/4 |

\* BS 21. 'Pipe threads for tubes and fittings where pressure and tight joints are made on the threads'.

**B.S. 5258:** Safety of domestic gas appliances.

**Part 1:1975:** central heating boilers and circulators.

**Part 4:1977:** fanned-circulation ducted-air heaters.

**Part 7:1977:** storage water heaters.

**B.S. 5384:1977:** Guide to the selection and use of central systems for heating, ventilating and air conditioning installations.

**CONVERSION TABLES**

**BRITISH THERMAL UNITS (BTU) AND KILOCALORIES**

| Btu   |       | k/cal |
|-------|-------|-------|
| 397   | 100   | 25    |
| 794   | 200   | 51    |
| 1191  | 300   | 76    |
| 1587  | 400   | 101   |
| 1984  | 500   | 126   |
| 3908  | 1000  | 252   |
| 7837  | 2000  | 504   |
| 11905 | 3000  | 756   |
| 15873 | 4000  | 1008  |
| 19842 | 5000  | 1260  |
| 39682 | 10000 | 2520  |
| 78306 | 20000 | 5640  |

| Btu     |        | k/cal |
|---------|--------|-------|
| 119 050 | 30000  | 7560  |
| 158 733 | 40000  | 10080 |
| 198 416 | 50000  | 12900 |
| 396 532 | 100000 | 25199 |

*Note:* The values are rounded up to the nearest whole number.

**BTU PER SQUARE FOOT PER HOUR AND WATTS PER SQUARE METRE**

| Btu/ft <sup>2</sup> /h | Wm <sup>2</sup> |
|------------------------|-----------------|
|------------------------|-----------------|



|        |       |         |
|--------|-------|---------|
| 031    | 1     | 3.15    |
| 0.63   | 2     | 6.30    |
| 0.95   | 3     | 9.46    |
| 1.26   | 4     | 12.61   |
| 1.58   | 5     | 15.71   |
| 3.1    | 10    | 31.5    |
| 6.3    | 20    | 63.0    |
| 9.5    | 30    | 94.6    |
| 12.6   | 40    | 126.1   |
| 15.8   | 50    | 157.1   |
| 31.7   | 100   | 315.4   |
| 63.4   | 200   | 630.9   |
| 95.0   | 300   | 946.3   |
| 126.7  | 400   | 1261.8  |
| 158.5  | 500   | 1557.3  |
| 316.9  | 1000  | 3154.5  |
| 633.9  | 2000  | 6309.1  |
| 950.9  | 3000  | 9563.6  |
| 1269.9 | 4000  | 12618.2 |
| 1584.9 | 5000  | 15778.0 |
| 3168.0 | 10000 | 35145.0 |
| 6339.0 | 20000 | 63091.0 |

*Note:* A rough conversion is to multiply BTU/ft<sup>2</sup>/h by 10 to obtain Wm<sup>2</sup>, and to divide Wm<sup>2</sup> by 10 to obtain BTU/ft<sup>2</sup>/h.

### RELATIVE FUEL VALUES

| Unit    | Fuel        | BTU per unit | Efficiency % | Units per 100,000 BTU |            | Av cost per unit | Relative value |
|---------|-------------|--------------|--------------|-----------------------|------------|------------------|----------------|
|         |             |              |              | at 100%               | at % shown |                  |                |
| 1 lb    | Anthracite  | 14000        | (10–50) 45   | 7.14                  | 15.87      | .64d.            | 10.2           |
| "       | Coke        | 10000        | (10–50) 45   | 10.00                 | 22.20      | .51 d.           | 11.3           |
| "       | Coal        | 13000        | (10–30) 25   | 7.69                  | 30.77      | .48d.            | 14.8           |
| "       | Oil         | 18800        | (50–60) 55   | 5.32                  | 9.68       | .88d.            | 8.5            |
| 1 therm | Gas         | 100000       | (55–65) 60   | 1.00                  | 1.67       | 1.8d.            | 30.1           |
| 1 Unit  | Electricity | 3412         | (75–95) 80   | 29.30                 | 36.63      | 1 1/4d.          | 45.8           |

*Note:* 'Efficiency' is the product of combustion, boiler, installation and circulation efficiencies (excluding power station conversion efficiency) and varies over the range shown in brackets. Fuel costs vary with locality, quality, quantity

and period. Installation, maintenance and attendance costs and relative flexibility also effect system comparisons.

## CENTRAL HEATING

Central heating is the maintenance of a fixed temperature inside a building, irrespective of the temperature outside it. There are several methods of so doing:

1. By hot air, circulated through ducts;
2. By hot water, circulated through pipes and radiators, and
3. Various electrically heated devices, such as strip heaters fixed to skirtings or heated floors or heated ceilings.

Of these, the most popular is heating by hot-water. If solid fuel, such as coke or anthracite be used, it is generally the cheapest, with oil, gas and electricity following in order of expensiveness. Hot-water heating has become extremely popular of late, since rival fuel interests have devised design and installation schemes the cost of which can be spread over ten years. All systems of hot water heating consist of:

1. The boiler that heats the water;
2. The pipe that conducts the hot water (called the "flow") from the boiler to;
3. Surfaces called radiators that give off large quantities of heat and so warm the rooms in which they are situated. The water has now done its job, and is returned by;
4. The return pipe to the boiler, to be reheated and used again.

A 'make-up tank', fitted with a ball-valve connected to a cold-water supply, provides the little additional water the system needs because of loss through evaporation or by boiling through over-heating.

This is the simplest form of hot-water heating, and is known as the gravity system. The freshly heated water ascends, and by doing so, allows the cooled water to descend and return to the boiler. There it is heated and when heated, ascends, and the cycle repeats itself over and over again. The 'small' bore system, now so popular, is a development of the simple system outlined above, and was developed by the Coal Utilization Research Station. The addition of a pump, that forces the water through the system, permits the use of very small bore piping (1/2in copper or 3/8in steel) for many of the runs. Using special wall drills, these small pipes are easily and unobtrusively installed, without spoiling decorations.

In addition to the pump, it is necessary to install a temperature-controlling device. This may be, in order of cheapness:

1. A hand-set mixing valve, which delivers water at a pre-determined temperature to the pump;
2. An automatic mixing valve, in which the temperature of the water delivered to the pump is regulated by the external temperature; or

### 3. A thermostatic radiator valve fitted to each radiator.

This last, although very expensive, is generally considered to be the best.

When designing a heating system, it is first necessary to determine how much heat in British Thermal Units (BTU) would be needed to maintain the required constant internal temperature in the worst set of external circumstances. In Britain, this greatest difference between outside and inside temperatures (generally called the temperature rise) is normally assumed to be 30 degrees F. Therefore, if the external temperature be 30 degrees F (two degrees below freezing point) the temperature inside will be a comfortable 60 degrees.

In every building there is, in winter, a constant movement of heat (called 'heat loss') through the walls of the building from the warm inside to the colder outside. In addition, the air inside the building will leak out through crevices around doors and windows. This leakage is called 'air change' and a certain amount of air change is vitally necessary to health. The combination of heat loss and air change will represent the total loss of heat from the building, expressed in BTU in one hour.

To arrive at the total heat loss, the heat loss of each room, passage and hall must be ascertained. This is done by taking each room, hall and passage separately and calculating separately the heatloss of each element of construction. (Stage 1) Take each wall separately, and all doors and windows separately, and differing types of walling separately, and the floor and ceiling separately. Take the "U" value (the thermal transmittance value) of each element of construction, as given on page 347, in the Insulation Section. These values are given in square feet and the area of each element of construction must be multiplied by its "U" value. If the ceiling is below a heated room, it may be ignored for the purposes of this calculation. (Stage 2) Total up the results of these calculations and (Stage 3) add them to the heat loss by air change. For this, take the number of air changes per hour from Table on page 339, multiply this by the cubic capacity in feet of the room and by the "U" value, usually assumed to be 0.02. Repeat this process for every room, hall and passage. The grand total of the heat loss of each room will give the total number of BTU's required each hour to keep the whole building at the predetermined degree of heat.

Radiator size can be calculated by dividing the output (in BTU) per square foot of radiating surface of the type of radiator used (see page 340) into the number of BTU's required to keep the room warm, as ascertained at the end of Stage 3 above. A separate calculation must be made for each room, to ascertain the exact size of radiator or radiators required.

The size of boiler required for the whole system is ascertained from the grand total of heat loss in the building, plus the allowance for friction in the pipes (this can be calculated, or an additional 25 per cent be made to the total heat loss) and it is usual to add a further factor of 25 per cent of total heat loss so as to be sure that the boiler is not working 'flat out'.

The size of pipes for various parts of an installation can be taken from the table, and the size of the pump is determined by the circuit that offers the greatest resistance to flow, if there be more than one circuit.

The foregoing is a brief outline of the design of small-bore heating systems, and will

serve at least to check heating calculations. Before attempting to design heating systems, the readers should consult one or more of the following booklets. They explain the subject in greater detail and also contain a number of valuable tables that will take much of the toil out of the calculations. The combination of hot water heating and domestic hot water has not been treated, partly for the sake of simplicity and partly because it is better and cheaper to have a completely separate means of heating small quantities of water for domestic use.

1. *Principles of Forced Circulation in Hot-water Heating Systems*: Sigmund Pumps Ltd, Team Valley Trading Estate, Gateshead 11.
2. *Copper Tubes for Small-bore Heating Installations*; The Copper Development Association.
3. *The Design and Installation of Small-pipe Heating Systems*: Coal Utilization Council.

### HOT-AIR CENTRAL HEATING

This type of installation is cheaper to install than the usual system of radiators and pipes. It is necessary to make the calculations detailed above, to arrive at the hourly requirements of BTU. An appliance (fuelled by solid fuel, gas or oil) can be chosen from a manufacturer's range of sizes. Hot air as usually ducted to rooms by trunking, and released through gratings. The siting of the ducts and of the gratings that serve the rooms plays a vital part in the efficiency of the system and most manufacturers, if sent a plan and elevation of the building, are able to suggest the best layout for efficient working.

### MICROBORE INSTALLATIONS

Pioneered by the Wednesbury Tube Co. Ltd, this type of forced circulation system has become popular. It employs very small tubes, 6, 8, 10mm external diameter, with special fittings. Normal boilers and standard pumps with special heads are used. Since the tubes are supplied in long lengths (coils of 90 to 200 metres maximum) fewer connectors are needed. The tube can be bent by hand or, for small radii, with an external spring bender, without cutting the tube. The advantages of the system can be summarised as follows:

1. Reduced labour costs and reduced materials costs;
2. A neater installation, with less disturbance to house occupiers;
3. Reduced water content provides greater sensitivity to thermostatic control;
4. A faster heat recovery and a more flexible installation, allowing ease of extension if required.

Calculation and design procedure for microbore systems are more critical than for small-bore installations: it cannot be over-emphasised that detailed and correct calculations are essential. The Wednesbury Tube Co. Ltd. has produced the *Microbore Installation Manual*, describing design and installation in detail. This is an essential for all designers and installers of such systems and copies can be had from the Company's Publications Department, Oxford St, Bilston, Staffs WV14 7DS.

**HEAT EMISSION FROM PIPES, PER 100 PER CENT TEMPERATURE DIFFERENCE**

| Pipe size in inches | Heat emission in BTU per hour |            |
|---------------------|-------------------------------|------------|
|                     | copper pipe                   | steel pipe |
| 1/2                 | 25                            | 56         |
| 3/4                 | 36                            | 70         |
| 1                   | 43                            | 80         |
| 1 1/4               | 50                            | 98         |

**AIR CHANGES AND RECOMMENDED TEMPERATURES FOR ROOMS**

| Room                                     | Air changes per hour | Recommended temperature degrees F |
|--|----------------------|-----------------------------------|
| Halls, staircases and passages . . . . . | 2-3                  | 60                                |
| .....                                    |                      |                                   |
| Living rooms                             |                      |                                   |
| (a) fireplace sealed . . . . .           | 1 1/2                | 65                                |
| (b) with convector fire . . . . .        | 2-2 1/2              | 65                                |
| (c) with open fire . . . . .             | 3-5                  | 65                                |
| Kitchens . . . . .                       | 2-3                  | 60                                |
| Bedrooms . . . . .                       | 1 1/2                | 50                                |
| Bed-sitting rooms . . . . .              | 2                    | 65                                |
| Bathrooms and lavatories . . . . .       | 2                    | 60                                |
| .....                                    |                      |                                   |

**RADIATION FROM RADIATORS IN BTU PER HOUR PER SQUARE FOOT**

| Type of Radiator                       | Width in inches | Emission per sq. ft per hr in BTU |
|--|-----------------|-----------------------------------|
| Column radiators . . . . .             | 2 1/2-3 3/4     | 185                               |
|  | 5-5 5/8         | 170                               |
| Window radiators . . . . .             | 13-13 1/2       | 158                               |
| Cast-iron wall radiators . . . . .     | —               | 171                               |
| Pressed steel wall radiators . . . . . | —               | 192                               |
| ..                                     |                 |                                   |

**PIPES**

**PIPE SIZES**

| Emission of circuit or radiator, in BTU per hour | Size of pipe required, in inches |
|--|----------------------------------|
| Up to 15,000                                     | 1/2                              |
| 15,000 to 40,000                                 | 3/4                              |
| 40,000 to 72,000                                 | 1                                |

### PIPE THREADS

There are two systems in use in England—Whitworth Threads and British Standard Pipe Threads. Whitworth threads are almost universally used. The difference between the two systems is very slight: a matter of a few ten-thousandths at the top and bottom of the thread. Whitworth-threaded pipes fit easily into BSP threaded fittings, but BSP threaded pipes will only fit with difficulty into Whitworth-threaded fittings. BSP threads extend up to 6in, whereas Whitworth threads stop at 4in. It is very rare to go beyond that with screwed connections, The International Standards Organization has agreed, in principle, on a system of pipe threads, but these may not be introduced for many years.

# 17. INSULATION

## METRICATION OF THERMAL INSULATION

The change to metric involves the use of new units. These are as follows. For the 'K' value (thermal conductivity) the new unit is watts per square metre of surface area, with a temperature difference of 1 degree C, and is written *W/m deg C*. The reciprocal of this (1/k) is the *thermal resistivity*: if the thickness of a material is known (in metres and decimal fractions) 1/k times the thickness equals the *thermal resistance*, which is written *m<sup>2</sup> deg C/W*. The 'U' value, or *thermal transmittance* is derived as follows.

'A property of any material is its thermal conductivity (k): the reciprocal of this is resistivity (1/k). For materials of known thickness, the resistance (R) can be calculated (resistivity×thickness) and from the resistances of the various layers (of material) comprising a construction and the resistances of cavities and of inner and outer surfaces the 'U' value can be calculated'.

(From the BRS Digest No. 108, Second Series—'Standardised 'U' Values'—which is recommended as a clear and detailed account of the new system, including tables of the new, metric 'U' values.)

The calculation is, therefore, the same as used for Imperial quantities.

$$\begin{array}{ccccccc}
 \mathbf{U} & = & \mathbf{internal} & + & \mathbf{external} & + & \mathbf{resistance} \\
 & & \mathbf{surface} & & \mathbf{surface} & & \mathbf{of} \\
 & & \mathbf{resistance} & & \mathbf{resistance} & & \mathbf{cavities} \\
 & & & & & & \\
 & + & \mathbf{resistances} & \mathbf{of} & \mathbf{each} & \mathbf{material} & \mathbf{in} & \mathbf{the} & \mathbf{construction.}
 \end{array}$$

In this section, metric and Imperial values are given in all the thermal insulation tables, and a conversion table for K values is included. It should be noted that the U values given in some of the tables do not exactly correspond. This is because the new metric values (called 'standardised values') are calculated from slightly different and more accurate basic data.

### CONVERSION TABLE

| K VALUES              |           |
|-----------------------|-----------|
| IMPERIAL              | METRIC    |
| BTU in sq. ft h deg F | Wm deg. C |
| 0.1                   | 0.0144    |

|     |        |
|-----|--------|
| 0.2 | 0.0288 |
| 0.3 | 0.0432 |
| 0.4 | 0.0576 |
| 0.5 | 0.0720 |
| 0.6 | 0.0864 |
| 0.7 | 0.1000 |

K VALUES

| IMPERIAL<br>BTU in sq. ft h deg F | METRIC<br>Wm deg. C |
|-----------------------------------|---------------------|
| 0.8                               | 0.1150              |
| 0.9                               | 0.1300              |
| 1.0                               | 0.1440              |
| 2.0                               | 0.2880              |
| 3.0                               | 0.4320              |
| 4.0                               | 0.5760              |
| 5.0                               | 0.7200              |
| 6.0                               | 0.8640              |
| 7.0                               | 1.0080              |
| 8.0                               | 1.1520              |
| 9.0                               | 1.2960              |
| 10.0                              | 1.4400              |
| 20.0                              | 2.8800              |
| 30.0                              | 4.3200              |

Insulation is a form of protection against heat, cold, sound and vibration. These are, in the main, diseases of civilization: part of the price we pay for our modern amenities, and for living at a standard of comfort far beyond that ever known by any people as a whole. It has been established, however, that we need not pay anything so great a price in discomfort, or in cash. Since the war, the activities of scientific workers in building subjects has shown how our homes, offices and factories may be made warmer, quieter and more comfortable—sometimes at little or no increased cost.

**THERMAL INSULATION**

The importance of thermal insulation in modern building cannot be over-estimated. All the heat that we put into houses, factories, offices and other buildings leaks out through the various parts of these structures—through walls, windows, floors and roofs. We are constantly compelled to renew the heat thus lost. The coal consumed every year in heating houses and small industrial buildings amounts to approximately 65,000,000 tons. The cost of this enormous amount of fuel is something like equivalent to that of the 200,000 to 300,000 new houses that we build every year. Large industrial buildings cost very much more to heat.



It is plain that, if the amount of heat escaping from buildings can be reduced, savings can be made because less fuel would be needed. Alternatively, a greater degree of comfort can be obtained or a balance may be struck by having some saving of money and some degree of increased comfort. In the normal house, the effect is a relatively long-term one, because the extra cost of preventing the escape of a sufficient amount of heat—a relatively large sum—anything over £200. It would take a considerable time to regain this by the accumulation of the amount saved on the purchase of fuel. In some shed-type factory buildings, with walls and roof of very light construction, the fuel bill is so huge that the cost of installing thermal insulation is repaid in two or three years, after which there is a definite saving in fuel and therefore a lower heating cost. In new buildings of this type a smaller heating plant is required if the structure is insulated. The saving on the heating plant pays for the insulation. Here there is an immediate reduction in the cost of heating.

Thermal insulation may be defined as the adding to an existing structure, or incorporating in a new one, materials that have the property of slowing down the rate of leakage of heat from the structure. These materials are usually of low density, that is, light in weight and cellular (those having a large number of pockets of air in them). In this type of material, the air pockets act as poor conductors of heat. To a lesser extent, air-spaces, such as the cavity in a cavity wall, perform the same function. The other type of material acts by reflecting back the heat that strikes it, and is always some sort of bright metal surface. Polished aluminium foil is practically the only material of this type in use.

The unit of thermal transmittance 'U' for short) is used to denote the suitability or otherwise of a material for insulating purposes. The lower the thermal transmittance, the slower heat goes through it, the better the material is as a thermal insulator.

This 'U' value is ascertained by a somewhat roundabout process. It is based on the conductivity of a material per inch of thickness, of which the unit is 'k', and from which is derived the resistivity of the material per inch of thickness, which is the reciprocal of 'k'. For instance, the conductivity of stone is 12, and the resistivity is therefore 1/2 or 0.08.

When in practice it is desired to find the 'U' value of any particular wall, floor or roof, proceed as follows:

1. Take the external resistance of surface material.
2. Add the resistance of each element of the construction, and
3. The internal surface resistance of the material that forms the inner face.

Do not forget to include, under 2, the thermal resistance of any air-space, such as the cavity in an 11 in cavity wall.

*Example.*—What is the 'U' value of a 9in wall, in common bricks, rendered externally with 1 in of rendering and plastered internally with 5/8in of plaster?

Commence by setting out the elements of the walling, with the exterior surface resistance in front of them and the internal surface resistance after them, thus:

|                        |                     |                            |                     |                        |
|------------------------|---------------------|----------------------------|---------------------|------------------------|
| 1                      | 2                   | 3                          | 4                   | 5                      |
| External<br>resistance | 1in of<br>rendering | 9in of common<br>brickwork | 5/8in of<br>plaster | Internal<br>resistance |

Then, from the tables fill in the resistance value of each element. Do not forget that the resistances given are per inch of thickness and that, therefore, the resistance value for brickwork must be multiplied by 9 to give 3., while the plaster 4., is obtained by taking 5/8in only of the resistance for plaster per inch of thickness as given by the table. Set out the resistances thus obtained under the elements above, thus:

|      |      |      |      |      |
|------|------|------|------|------|
| 1    | 2    | 3    | 4    | 5    |
| 0.30 | 0.25 | 1.12 | 0.15 | 0.70 |

These five items, added together, make 2.52, which is the total resistance of the wall. The reciprocal of this (*i.e.* 1 over this number) is 1/252 or 100/252, or 0.39, which is the 'U' value of this type of walling.

Thermal insulation is of value in preventing some undesirable and expensive phenomena, such as 'pattern staining' on ceilings and excessive condensation in buildings. This latter, in factories containing machinery, especially knitting and similar delicate mechanisms, is a major problem that can only be avoided by adequate insulation. True, it would not occur if the heating were continuous and were thermostatically controlled, but the expense of heating a building in this manner would at least quadruple the annual fuel bill.

### RESISTIVITY AND CONDUCTIVITY OF VARIOUS BUILDING MATERIALS

| Material                                    | Thermal Conductivity (k)<br>Per in thickness | Thermal Resistance I/k<br>Per in thickness | Metric (k) |
|---|--|--|------------|
| "Asbestolux" insulating board . .           | 0.8  | 0.125                                      | 0.216      |
| ..  |  |  |            |
| Asbestos insulating board . . . . .         | 1.8  | 1.250                                      | 0.576      |
| Asbestos cement sheets, plain or corrugated | 1.9  | 0.527                                      | 0.576      |
| Asphalt . . . . .                           | 8.7  | 0.115                                      | 1.210      |
| Bricks (common) . . . . .                   | 8.0  | 0.125                                      | 1.470      |
| „ (engineering) . . . . .                   | 5.5  | 0.182                                      | 1.440      |
| Concrete (ballast 1-2-4) . . . .            | 7.0  | 0.140                                      | 0.430      |
| (clinker or breeze) . . . .                 | 2.3  | 0.440                                      | 0.051      |
| Glass . . . . .                             | 7.3  | 0.137                                      | 0.401      |
| Plaster and renderings . . . . .            | 4.0  | 0.250                                      | 1.530      |

| Material        | Thermal Conductivity (k)<br>Per in thickness | Thermal Resistance I/k<br>Per in thickness | Metric (k) |
|-----------------|--|--|------------|
| Stone . . . . . | 12.0   | 0.080                                      | 0.576      |

|                           |      |       |       |
|---------------------------|------|-------|-------|
| Slate . . . . .           | 10.4 | 0.096 | 0.853 |
| Tiles (roofing) . . . . . | 5.8  | 0.170 | 0.216 |
| Hardboard . . . . .       | 0.7  | 1.410 | 0.065 |
| Fibreboard . . . . .      | 0.3  | 2.860 | 0.158 |
| Plasterboard . . . . .    | 1.1  | 0.910 | 0.049 |
| Cork . . . . .            | 0.7  | 1.370 | 0.138 |
| Timber . . . . .          | 1.0  | 1.000 | 0.093 |
| Wood-wool . . . . .       | 0.58 | 1.720 | 0.084 |

**SURFACE RESISTANCES**

| Element of construction                   | Internal surface resistance |        | External surface resistance |        |
|---|-----------------------------|--------|-----------------------------|--------|
|   | Imperial                    | Metric | Imperial                    | Metric |
| Walls . . . . .                           | 0.70                        | 0.12   | 0.30                        | 0.053  |
| Roofs (flat or pitched) . .               | —                           | —      | 0.25                        | 0.440  |
| Ceiling (heat movement upwards) . . . . . | 0.60                        | 0.15   | —                           | —      |
| Floor (heat movement downwards) . . . . . | 0.84                        | 0.11   | —                           | —      |

**THERMAL RESISTANCES OF AIR SPACES**

| Type of air-space  | Thermal resistance |        |
|--|--------------------|--------|
|  | Imperial           | Metric |
| Corrugated and plain surfaces in close contact . . . . .   | 0.5                | 0.16   |
| Over 3/4in between materials . . . . .                     | 0.9                | 0.14   |
| Over 3/4in between materials with bright metallic foil . . | 2.2                | 0.25   |
| Hollow blocks, 4in thick . . . . .                         | 1.0                | —      |
| Bright foil, 1 in air-space each side . . . . .            | 4.0                | 0.12   |

**'U' VALUES OF DIFFERING CONSTRUCTIONAL ELEMENTS**

| Construction   | Thermal Transmittance (U) |        |
|--|---------------------------|--------|
|  | Imperial                  | Metric |
| <b>Pitched Roofs</b>   |                           |        |
| Corrugated iron . . . . .  | 1.50                      | 5.4    |
| Corrugated asbestos . . . . .  | 1.40                      | 5.3    |
| Corrugated asbestos lined with 1/4in asbestos sheet with air-space . . . . . | 0.55                      | 1.8    |
| Corrugated asbestos lined with 1/2in fibreboard with air-space . . . . .     | 0.32                      | 1.3    |
| Tiles on battens, plaster ceiling . . . . .                                  | 0.56                      | —      |

|   |      |      |
|---|------|------|
| Tiles on battens, felted, plaster ceiling . . . . .   | 0-46 | —    |
| Tiles on battens, felted! Aluminium foil or 1in glass silk quilt on joists, plaster ceiling . . . . . | 0-15 | 1-5  |
| <b>Flat Roofs</b>   |      |      |
| Asphalt on 6in concrete, plastered soffit . . . .   | 0-52 | 3-4  |
| Asphalt on 6in concrete, 2in light weight concrete screed, plastered soffit . . . . .                 | 0-34 | 1-4  |
| Asphalt on concrete, hollow tile roof with 1/2in fibreboard insulation and plaster ceiling . . . . .  | 0-20 | 0-90 |
| <b>Walls</b>  |      |      |
| 1/4in asbestos cement sheet . . . . .   | 0-89 | 5-3  |
| 9in brick . . . . .   | 0-47 | 3-3  |
| 11 in cavity brick wall (unventilated), plastered . .   | 0-30 | 1-5  |
| 11 in cavity brick with 1/2in fibreboard on battens . .   | 0-18 | 2-8  |
| Corrugated asbestos lined with 1/2in fibreboard with air-space . . . . .                              | 0-30 | 0-78 |
| <b>Floors</b>   |      |      |
| 1in tongued and grooved boarding on timber joists ventilated under covered linoleum . . . . .         | 0-35 | —    |
| 1in wood block on concrete on ground . . . .  | 0-15 | —    |
| <b>Windows</b>  |      |      |
| Single glazing . . . . .  | 1-0  | —    |
| Double glazing . . . . .  | 0-5  | —    |

**SOUND INSULATION**

Some degree of sound insulation is desirable in almost every building that is being used to its fullest extent. This desirability becomes a necessity in many modern buildings which consist of lightweight claddings suspended on a structural frame through which sound may be conducted from one part of the building to the other. Even in traditional buildings with loadbearing walls excessive noises from cisterns and other internal services may constitute a major annoyance as may traffic and other noises from a busy street. In special cases, such as doctors' consulting rooms, the intensity of the sound may not be great, but its transmittance to, say, an adjacent waiting-room must be prevented.

There are two units of sound measurement: the *phon* and the *decibel*. For all practical purposes, they can be regarded as equivalents for a large range of everyday noises. The decibel is the unit of sound intensity, while the phon is the unit of sound loudness. Put another way, the decibel is a unit of energy, measured on an instrument, while a phon is a unit of loudness as perceived by the ear and measured by comparison with other known sounds.

**RECOMMENDED STANDARDS OF QUIET**

| Activity | Loudness in phons |
|----------|-------------------|
|----------|-------------------|

|   |    |
|---|----|
| Study or sleeping . . . . .                 | 15 |
| Reading or writing . . . . .                | 20 |
| Boardroom . . . . .                         | 30 |
| Sedentary office, or quiet conversation . . | 35 |
| Average office, telephone work, restaurant  | 40 |
| Noisy office . . . . .                      | 60 |

Average airborne noises should be reduced to these levels of loudness, or as near to them as possible, within, say, 5 decibels or phons. The following notes show how this may be done.

WINDOWS

The sound reduction of an ordinary single pane of 24oz glass reduces external noise by 28 decibels, and so cuts down noise made by a noisy sports car or a pneumatic drill to the level of average music or loud public speaking. If, however, the room is used for any of the activities given in this table, the noise penetrating the room through the window will still be too much, and the following table gives the insulation value of various types of double-glazing.

SOUND REDUCTIONS OF GLAZING

| Type of glazing  | Sound reduction in decibels |
|--|-----------------------------|
| Double glazing at following spacing:   |                             |
| 1 in . . . . .   | 42                          |
| 2in . . . . .  | 46                          |
| 5in . . . . .  | 49                          |
| 1/4in plate, 5 3/4in apart . . . . .   | 58                          |
| As above, but interspace lined 1in felt or glass wool, or cork, or other absorbent . . . . . | 63                          |

It will therefore be seen that a noise equivalent to a pneumatic drill constantly at work can be cut down, by the last method shown, to little more than quiet conversation, and providing an atmosphere where sedentary office work can be carried on in comfort.

WALLS

Here, again, the following table gives the amount of airborne sound reduction for typical constructions.

SOUND REDUCTIONS OF TYPICAL CONSTRUCTIONS

| Material or construction   | Average sound reduction in decibels |
|----------------------------|-------------------------------------|
| 1/2in fibreboard . . . . . | 20                                  |

|   |       |
|---|-------|
| 3/8in plasterboard . . . . .  | 25    |
| 1/4in plate glass . . . . .   | 30    |
| 3/4in plasterboard plastered 3/8in both sides . . . . .   | 35    |
| 3in clinker concrete block plastered . .  | 44    |
| 4 1/2in brickwork or concrete plastered   | 43    |
| 9in brick work plastered . . . .  | 48    |
| 3in woodwool slab 3/4in plastered both sides . . . . .  | 48    |
| Timber stud partition with metal lath and plaster both sides . .                                      | 35    |
| Cupboards used as partitions  | 25-35 |
| Double partition of 3in hollow clay blocks. 2in cavity plastered externally. Strip metal ties . .     | 40-43 |
| Double partition of 3in breeze block. 2in cavity plastered.   | 50    |
| No wall ties  |       |
| Two leaves of 2 1/2in breeze blocks plastered and separated by a 2in air-space with suspended ceiling | 50-60 |
| As above, with 4 1/2in brick walls . .  | 60-70 |

**SOUND REDUCTIONS OF TIMBER FLOORS**

| Construction  | Average sound reduction (phons) |
|---|---------------------------------|
| Boarding on timber joints with plasterboard ceiling and plaster skim coat . . . . . | 30-35                           |
| As 1, but with metal lath and plaster ceiling . . . . .                             | 35-40                           |
| As 1, but with solid pugging 20lb per sq. ft . . . . .                              | 40-55                           |
| As 2, but with floating floor of boarding on battens on resilient quilt . .         | 55                              |

**FLOORS**

Impact noises on floors are difficult to reduce, except by:

1. Carpet on underlay of rubber or felt.
2. Pugging between joists.
3. Suspended ceiling, each of which gives approximately 10 phons reduction.

Noises transmitted through a frame can be prevented by insulating the floor of each room from the building itself. This always means a 'floating' floor, resting on felt or rubber pads.

Absorption of sound, by lightweight cellular materials such as those used in thermal insulation, can do much to prevent reflection of sound, which causes echoes, but such absorbents are of little value in reducing airborne sound and even less in reducing impact sound.

## VIBRATION INSULATION

In industrial and commercial buildings, vibration can present definite and urgent problems, sometimes of considerable magnitude. For instance, a drying machine running in a cleaner's shop has been known to cause bottles on the shelves in the adjacent shop to vibrate and chatter together. Vibration of machinery can cause a whole building to tremble unpleasantly and can seriously interfere with precision work being done on other machines, such as jig-borers, and with other delicate operations. On a large scale, as when immense forging-hammers are in operation, impact vibrations can cause something like minor earthquakes, which bring down plaster ceilings for 400 yards around, and literally shake adjacent buildings to pieces.

The whole subject of vibration engineering is too complex to summarize here, but, for the relatively simple problems that come within normal building practice, the following notes will indicate possible solutions.

### GROUND VIBRATIONS

The transmission of vibrations from the ground, caused by external causes not under the control of the owner of the site can only be prevented from being transmitted through the structural frame of a building by insulating the frame itself. Special foundations will be required, incorporating rubber pads or springs, or lead pads, or a combination of these between the frame itself and the foundation.

### HEAVY MACHINERY

Ground vibrations are often due to heavy machinery and here the remedy is to construct foundations for such machines that are isolated from both the structure and the ground. Normally, this is done by forming a pit, lined with sheeting of rubber or cork, into which the foundation concrete for the machine is poured. It is most important that the floor and sides of the pit be lined. Vibrations caused by very heavy impacts may need further 'damping', by providing systems of springs, as well as rubber and other pads, between the machine foundation block and the pit in which it is constructed.

Much can be done to overcome this trouble of vibration by using machinery driven by electricity, in preference to internal combustion engines. Each machine should be independently motorized, not powered from shafting and belts actuated by one central source of power. Shafting and belts are one of the principal causes of vibration in the old-fashioned workshops where the centralized power system is still used. Another source of vibration is old machinery, badly maintained, and yet another is failure to anchor adequately the machinery to the floor, while the siting of machinery on floors not specially constructed for the purpose gives rise to much vibration trouble. In these latter instances, the strengthening and stiffening of the floor often remedies the evil.

## LIGHT MACHINERY

It is often sufficient to mount light machines on special rubber pads: There is a range of proprietary rubber machine pads that can, and should be, used when installing every machine, whether vibration be anticipated or not. Where vibration still persists, the machine should be installed on an isolated concrete foundation as described above.

## OTHER VIBRATION SOURCES

Pipelines that transmit vibrations may be rendered silent by inserting a short length (up to 2ft or 3ft at most) of special rubber tube in the pipe-line. Overhead travelling cranes and hoists may have their tracks isolated from the structure by pads or springs.

Very delicate instruments, such as chemical balances and optical measuring devices, can be successfully insulated from the small amounts of vibration that impair their efficiency by mounting them on specially designed rubber pads. It will often be found more economical, when only one or two precision machines suffer from relatively small vibration interference, to provide insulated foundation blocks for these machines in preference to installing every other machine in the engineering or other workshop on insulated foundations.

It is not generally realized that noises are caused at times by vibration, as when a WC pan is mounted on an ordinary wooden floor in a small house. Considerable lessening in the transmission of noise, and its propagation by the floor, which acts as a sounding-board, can be obtained by mounting the WC pan on a rubber pad, mounting the supply tank (the WWP) in a similar manner, and insulating the supply and overflow pipes by rubber or felt sleeveings at the points where they pass through walls.

The insulation of vibrating machinery should on no account be undertaken without the advice of an expert. It is possible to produce a resilient support that at certain frequencies of the machine will become resonant and may well double or even treble the amount of vibration imparted to the structure.



# 18.

## THE ELECTRICIAN

Normally, this trade is sublet to electrical contractors, and in a sense is not a building, but an engineering trade. However it is as well that everyone in a responsible position in building should have read the Wiring Rules issued by the Institution of Electrical Engineers and be acquainted with their provisions. Local Electricity Boards accept only work executed in accordance with these Wiring Rules as being fit to receive supplies of current.

### CODES OF PRACTICE

**CP 3: Chapter 1:** Lighting.

**Part 2:1973:** artificial lighting, aims and processes of design.

**Chapter VIII: 1949:** heating and thermal insulation.

**CP 324:202:1951:** Provision of domestic electric water heating installations.

Design and installation.

**CP 1013:1965:** Earthing.

Methods for earthing electrical systems.

**CP 1014:1963:** The protection of electrical power equipment against climatic conditions.

Classifies climates into three classes; 'slight', 'medium' and 'extreme',

**CP 1017:1969:** Distribution of electricity on construction and building sites.

Recommendations for supplies operating at voltages up to 650V.

Includes 110V systems for portable and hand-held tools and lamps.

**CP 1018:1971:** Electric floor-warming systems, for use with off-peak and similar supplies of electricity.

Design of systems and electrical requirements.

**CP 1019:1972:** Installation and servicing of electrical fire alarms.

Covers electrical fire alarms in buildings.

### BRITISH STANDARDS

**B.S. 31:1940:** Steel conduit and fittings for electrical wiring.

Class A; plain conduit; Class B; screwed conduit, corresponding fittings, couplings, boxes, elbows, etc.

**B.S. 37:** Electricity meters.

**Part 1:1952:** general clauses.

**Part 2:1969:** watt hour meters.

**Part 3:1970:** prepayment watt hour meters.

**B.S. 546:1950:** Two-pole and earthing pin plugs, socket-outlet adaptors for circuits up to 250V.

As used in domestic premises, offices, etc.

B.S. 731 Flexible steel conduit and adaptors for the protection of electric cable

**Part 1 1952:** flexible steel conduit and adaptors.

**Part 2:1958:** flexible steel tubing to enclose flexible drives for power driven tools for general purposes.

**B.S. 816:1952:** Requirements for electrical accessories.

Electrical devices not covered by British Standards for single phase a.c. or d.c. circuits, etc.

**B.S. 889:1965:** Flameproof electric light fittings.

Three temperature range classes.

**B.S. 1361:1971:** Cartridge fuses for a.c. circuits in domestic and similar premises.

Requirements, ratings and tests for fuse links, fuse bases and carriers.

**B.S. 1362:1973:** General purpose fuse links for domestic and similar purposes (primarily for use in plugs).

Performance, dimensions, markings and tests, etc.

**B.S. 1363:1967:** 13A plugs, switched and unswitched socket-outlets and boxes.

**Part 1:** requirements for multiple flush and surface-mounted sockets.

**Part 2:** boxes and enclosures.

**B.S. 1454:1969:** Consumers' electricity control units. Fuse and miniature circuit breakers types principally for use in domestic premises.

Rating 100A Control of different types of domestic load.

**B.S. 1778:1951:** 15A three pin plugs, socket outlets and connectors (theatre type).

Round pin type, dimensionally interchangeable with those in B.S. 546.

**B.S. 3052:1958:** Electric shaver units.

Fixed supply units for flush or surface mounting.

**B.S. 3456:** Specification for safety of household electrical appliances.

Specification used by the British Electrotechnical Board for Household Equipment.

**Part 1:1969:** and **Part 101:1976:** general requirements.

**Section A1:1966:** general requirements for all household heating and cooking appliances.

**Section A4:1971:** electrically heated blankets.

**Part C: 1967:** electrical refrigerators and food freezers.

**Part 2:** particular requirements.

**Section 2.1:1972:** cooking ranges, cooking tables and similar appliances.

**Section 2.2:1971:** electrical vacuum cleaners and water suction cleaning appliances.

**Section 2.3:1970:** appliances for heating liquids.

**Section 2.4:1970:** electric irons, ironers and pressing machines.

**Section 2.5:1970:** shavers, hair clippers and similar appliances.

**Section 2.6:1970:** frying pans, grills, plate warmers, and other dry cooking appliances.

**Section 2.7:1970:** stationary non-instantaneous water heaters.

**Section 2.8:1970:** portable immersion heaters.

**Section 2.9:1970:** clothes drying cabinets and towel rails.

**Section 2.10:1972:** room heating and similar appliances.

**Section 2.11:1970:** electric clothes-washing machines.

**Section 2.12:1970:** spin extractors.

**Section 2.13:1970:** tumbler dryers.

**Section 2.14:1971:** electric soldering irons.

**Section 2.15:1970:** electric heaters for baby feeding bottles.

**Section 2.16:1971:** clocks.

**Section 2.17:1970:** electric sewing machines.

**Section 2.18:1970:** massage appliances.

**Section 2.19:1970:** electric firelighters.

**Section 2.20:1971:** electric floor polishers.

**Section 2.21:1972:** electric immersion heaters.

**Section 2.22:1972:** electricaire heaters.

**Section 2.23:1971:** cooking ventilating hoods.

**Section 2.26:1973:** thermal storage electrical room heaters.

**Section 2.27:1973:** dish-washing machines.

**Section 2.28:1973:** food preparation machines including mixers, coffee grinders and coffee mills.

**Section 2.29:1971:** ventilating fans.

**Section 2.30:1971:** food waste disposal units.

**Section 2.31:1973:** appliances for skin or hair treatment.

**Section 2.32:1974:** mains operated electric lawn-movers.

**Section 2.33:1976:** specification for microwave ovens.

**Section 2.34:1976:** room air-conditioners.

**Section 2.35:1975:** electrical pumps.

**Section 2.36:1973:** battery chargers.

**Section 2.37:** sauna baths (in course of preparation).

**Section 2.38:1974:** still projectors and viewers.

**Section 2.39:1973:** room humidifiers.

**Section 2.40:1977:** room heating and similar appliances for use in children's nurseries and similar situations.

**Section 2.42:1977:** battery-operated lawn mowers.

**B.S. 3676:1963:** Switches for domestic and similar purposes (for fixed or portable mounting).

Domestic in wall or ceiling mounting, and in cords and landholders, and certain appliances.

**B.S. 3999:** Methods of measuring the performance of household electrical appliances.

In thirteen parts; (1) electric kettles, (2) thermal-storage electric water heaters, (3) food preparation machines, (4) electric clothes drying cabinets and racks, (5) electric cookers, (6) electrically heated blankets, (7) electric irons, (8) electric coffee percolators and similar appliances, (9) electric toasters, (10) food freezers, (11) dishwashing machines, (12) vacuum cleaners, (13) frozen food storage compartments in refrigerators and frozen food storage cabinets.

**B.S. 4363:1968:** Distribution units for electricity supplies for construction and building

sites.

Requirements for six types of distribution units to give a system of control and distribution on site.

**B.S. 4491:1969:** Appliance couplers for household and similar general purposes.

Requirements and dimensions for connectors and appliance inlets for portable electrical appliances.

**B.S. 4568:** Steel conduit and fittings with metric threads of ISO form for electrical installation.

**Part 1:1970:** steel conduit, bends and couplers.

**Part 2:1970:** fittings and components.

**B.S. 4573:1970:** Two-pin reversible plugs and shaver socket-outlets.

Requirements for rewirable or integrally moulded plugs and shuttered socket-outlets of 200mA.

**B.S. 4607:** Non-metallic conduits and fittings of electrical installations.

**Part 1:1970:** metric units, rigid PVC conduits and conduit fittings.

**Part 2:1970:** imperial units, rigid PVC conduits and conduit fittings.

**Part 3:1971:** pliable corrugated, plain and reinforced conduits of self-extinguishing plastics material.

**Part 5:1973:** rigid PVC conduit, fittings and components.

**B.S. 4662:1970:** Boxes for the enclosure of electrical accessories. Recessed or surface mounting.

## ELECTRICAL REGULATIONS

*The Electricity Supply Regulations.*

Deal mainly with the duties of the suppliers of current, that is, the various Area Boards of the Central Electricity Board. Regulations 26 to 35 are concerned with the suppliers duty to customers. Suppliers must ensure:

1. That the insulation of the wiring is sufficiently good as to prevent more than 1/10,000 of the maximum current leaking through it.
2. That the switches and other equipment are adequate in type and in installation to prevent danger.
3. That single-pole switches are connected to the live leads.
4. That all metal parts, other than the conductors, are earthed.
5. That the voltage supplied must be maintained to plus or minus 6 per cent, and frequency to plus or minus 1 per cent.

*I.E.E. Wiring Rules* (properly called the Wiring Regulations of the Institution of Electrical Engineers).

Are generally accepted by supply undertakings as an adequate standard of workmanship. They are very detailed, and cover all aspects of electrical installation.

Requirements of the Electrical Supply Regulations do not apply to factories and building sites. Instead these are governed by the Electricity Regulations of the Factory Act.

For further details, consult: *The Electricity Supply Regulations*, and *The Electricity (Factory Acts) Special Regulations*, from H.M.S.O.

## CABLES

CP 321.101 lays down that cables should be protected from excessive heat, dampness and mechanical injury, that external wiring should be weatherproof, and that adequate fuses be provided. The older method of fusing both the 'live' or 'phase' wire and the 'neutral' or 'earthed' wire has now been replaced by the custom of fusing the live or phase wire (this is usually brown-covered) only. It is imperative that switches and plug sockets be so connected that the circuit is 'dead' when the plug is withdrawn or the switch is in the 'off' position. The switch must always be in the 'live' or brown lead, not in the blue or 'neutral' one. It is advisable to control plug-sockets by switches, and to see that the type of plug-socket used incorporates some form of safety-shutter.

## METRICATION

House wiring cables and flexible cords are now in metric dimensions. Various modifications in manufacture now give single wires instead of the three or five smaller wires in the old type of cable, which is no longer manufactured. Sizes of accessories have not changed, but dimensions are now expressed in metric units. Conduit remains unaltered in size, so that existing pipe dies may be used.

CABLE SIZES: NEW (METRIC) AND OLD

| Metric<br>(mm <sup>2</sup> ) | Old   | Rating in<br>amps | Type of Circuit                                       |
|------------------------------|-------|-------------------|---|
| —                            | 1/044 | 5                 | Lighting  |
| —                            | 3/044 | 10                |   |
| 1.0                          | —     | 11                | Lighting : small heaters                              |
| 1.5                          | —     | 13                |   |
| —                            | 7/029 | 15                | Ring circuits, water-heaters, 3 kw heaters            |
| 2.5                          | —     | 18                |   |
| 4.0                          | —     | 24                | Radial circuits                                       |
| —                            | 7/036 | 30                |   |
| 6.0                          | —     | 31                | Cooker circuits                                       |
| 10.0                         | —     | 42                | Large cookers   |
| —                            | 7/064 | 50                | internal mains from meter to consumers' control unit. |

It is usual to fit a SPN 60 amp switch-fuse near to the incoming main and the company's meter is connected to this by 16mm<sup>2</sup> cable. From the switch-fuse, 16mm<sup>2</sup> cable is taken to the consumer's control unit, which is an assembly containing a main switch and as many fuses as is considered necessary. The sizes of fuses should be as follows: 5 amp for

lighting circuits, 10 amp for a lighting circuit incorporating a small heater (as in a bathroom), 15 amp for a single plug-point, or 3 kw water heater (either in a storage tank or in a washing machine) and 30 amp for a cooker. One extra fuse should always be installed, to allow for the addition of an extra circuit. Each ring-main (or, more properly, ring circuit) requires a 30 amp fuse.

|      |    |
|------|----|
| 0.50 | 3  |
| 0.75 | 6  |
| 1.00 | 10 |
| 1.5  | 15 |
| 2.5  | 20 |

**COLOUR CODE FOR 3-CORE FLEXIBLES**

| Old   | New                    | Wire    |
|-------|------------------------|---------|
| Red   | Brown                  | Live    |
| Black | Blue                   | Neutral |
| Green | Green & Yellow stripes | Earth   |

**RING AND RADIAL CIRCUITS**

Modern practice favours the complete separation of wall and ceiling fixed lighting from circuits containing socket outlets. 3 amp and 5 amp socket outlets, often forming part of lighting circuits, are now obsolete. Instead, all socket outlets are grouped in separate circuits and serve for movable lighting fittings and all other appliances. This is made possible by employing ring circuits or radial subcircuits.

**RING CIRCUITS**

A ring circuit consists of a loop of cable, both ends of the wires in which are connected to their same terminals at the fuse or miniature circuit breaker in the customer's control box. In all ring circuits, there are three loops; one for line, one for neutral and one for earth.

Connection of socket-outlets is by looping-in line wire to line terminal, neutral wire to neutral terminal and earth wire to earth terminal. Each socket is of the 3 pin type, taking the rectangular pins of the plug. Each plug is fitted with a cartridge fuse on the line wire; these fuses are of 3 amp rating for standard or table lamps or 13 amp rating for other movable appliances, such as heaters or fans. This ensures that only the lamp or other appliance is disconnected by its fuse 'blowing'—not the rest of the appliances in circuit. A socket-outlet controlled by a switch gives added safety at very little extra cost: it cuts off the current to the appliance before the plug is removed.

When the total floor area of a dwelling is less than 100m<sup>2</sup>, an unlimited number of socket-outlets can be looped into a ring circuit. In larger premises, a ring circuit for each 100m<sup>2</sup> is necessary. Appliances such as fixed wall heaters, fan heaters when fixed and sink-disposal units should be connected to the ring circuit by a fused spur-connector with

switch either by direct looping-in or through a junction-box. For clocks, shavers and electric gas-lighters, special spur-connectors with 1 amp fuses should be used. For heaters that switch on and off automatically, such as water-heaters, a separate ring circuit, serving the appliance only, is recommended.

A single 3-core cable, called an unfused spur, can be taken by junction-box or direct looping-in, from a ring-circuit to serve one fixed appliance or two 13 amp socket outlets. Only one spur is allowed on each ring circuit. It should be remembered that the total loading on a ring circuit in 2.5 mm<sup>2</sup> wire should not exceed 7.2 kw.

### RADIAL SUB-CIRCUITS

In some situations, where the load is particularly high, it is often advantageous to use a radial final subcircuit, as listed in table A3 of the I.E.E. Wiring Rules.

These circuits consist of single 3-core cables and typical such circuits are:

1. 4 mm<sup>2</sup> cable with a 30 amp fuse at the consumer's control box, serving five socket outlets and one fixed appliance.
2. A 2.5 mm<sup>2</sup> cable, with a 20 amp fuse, supplying two socket-outlets.
3. In a room not exceeding 30m<sup>2</sup> in floor area, six socket outlets supplied by a 2.5 mm<sup>2</sup> cable, with a 20 amp fuse at the consumer's control box.

### CABLE SUPPORTS

Tough rubber or PVC sheathed cable, either twin or three core, is often used without conduit for house-wiring, although it is advisable to provide some form of protection to all 'drops'. Cable so installed is likely to sag and so cause accidents, if the fixing clips are not spaced at the correct intervals. The following table gives the correct vertical and horizontal spacing of clips.

| Cable  | Maximum spacing of fixings |    |            |    |
|--|----------------------------|----|------------|----|
|  | Vertical                   |    | Horizontal |    |
|  | mm                         | in | mm         | in |
| 1/044, 3/044, 7/029:1.0 & 1.5mm <sup>2</sup> . . . . . | 224                        | 9  | 381        | 15 |
| 7/036:2.5 & 4.0 mm <sup>2</sup> . .                    | 305                        | 12 | 381        | 15 |
| 7/064:10.0 & 16.0 mm <sup>2</sup> . .                  | 381                        | 15 | 457        | 18 |

### SOCKET OUTLETS FOR DOMESTIC PREMISES

| Room                 | Number of outlets | Remarks  |
|----------------------|-------------------|--|
| Separate living room | 3 }<br>2 }        | Distributed so as conveniently to serve appliances in all parts of the rooms |
| Separate dining room |                   |  |

|                       |        |  |
|-----------------------|--------|--|
| 'Through' living room | 3 or 4 |  |
| Kitchen               | 3      | Excluding one socket outlet on cooker control unit             |
| Double bedroom        | 2      | Placed with due consideration of likely furniture arrangements |
| Single bedroom        | 1      |  |
| Hall or landing       | 1      | General service outlet for cleaning stairs, etc.               |
| Store or workshop     | 1      | For tools such as drills, soldering irons etc.                 |

*(From Building Research Station Digest No. 22, 2nd series).*

### EARTHING—A WARNING

It was formerly standard practice to earth electrical circuits and appliances to cold-water pipes. Plastic pipes, which are insulators, are often used nowadays in new work, and existing metal cold-water installations may be extended or repaired in plastics pipe. In instances where plastics piping is used, the householder should be warned that this does not provide an earth unless a metal insert has been provided for earthing purposes. The electricity supply undertaking should be requested, if necessary, to provide an earthing terminal. If this cannot be provided, an earth-leakage circuit breaker should be fitted.

Preferably, if expense permits, miniature circuit-breakers (one for each fuse in the consumer's control box) should be installed.

Metal water and gas pipes should still be bonded, as required by regulations D 10 and D 14 of the *I.E.E. Wiring Rules*.

### NUMBERS AND SIZES OF 'COILED COIL' TUNGSTEN FILAMENT LAMPS FOR VARIOUS SITUATIONS

|   |   |
|---|---|
| Living room, 150–175 ft/14–16 m <sup>2</sup> super floor area . . . . . | 1/150 watt or 2/75 watt, plus reading lamps.            |
| Bathroom . . . . .  | 1/60 watt, illuminating mirror over washbasin.          |
| Bedroom—up to 120ft/11 m <sup>2</sup> super floor area                  | 60 watt direct lighting, or 100 watt indirect lighting. |
| Bedroom—over 120ft/11 m <sup>2</sup> super floor area                   | 100 watt direct or 150 watt indirect lighting.          |
| (For bedrooms, allow two plug points in addition).                      |   |
| W.C. . . . .  | 1/40 watt.  |
| Stairs . . . . .  | 1/40 watt at head of stairs.                            |
| Halls and passages . . . . .  | 1/40 watt lamp every 20ft of passage length             |
| Kitchens (general lighting only):—                                      |   |



Up to 80 ft. super floor area                    7.4m<sup>2</sup>Lamps up to 100 watts  
 Up to 120 ft super floor area                11.0m<sup>2</sup>Lamps up to 115 watts  
 Over 120ft super floor area                11.8m<sup>2</sup>Lamps not less than 140 watts  
 For further details see CP 324.101 .

The Electrical Development Association issues a series of data sheets and also publishes a number of technical notes, including one on typical specifications for house wiring and another on the design of simple heaters for domestic hot water. The Association is always ready to assist with technical advice without charge.

**SIZES OF ELECTRIC HEATERS REQUIRED FOR ROOM HEATING**

**Radiant Fires**

| m <sup>2</sup> | Floor area of room 8 ft ceiling |  | Loading of fire |         |
|----------------|---------------------------------|--|-----------------|---------|
|                | sq. ft                          |  | A               | B       |
| 9.2            | 100                             |  | 1.5kW           | 1.5kW   |
| 13.3           | 140                             |  | 2.0 kW          | 1.5kW   |
| 15.8           | 170                             |  | 2.25 kW         | 1.75 kW |
| 19.8           | 210                             |  | 2.75 kW         | 2.0 kW  |
| 22.3           | 240                             |  | 3.0 kW          | 2.25 kW |

Column A: 11 in cavity brick wall plastered, suspended floor, and plaster ceiling.

Column B: More efficient construction giving average 'U' value of 0.20.

**Convectors**

| m <sup>2</sup> | Capacity of room cu ft |       | Halls, landings, living rooms, loadings in kW |             | Bedrooms loadings in kW |          |      |
|----------------|------------------------|-------|---|-------------|-------------------------|----------|------|
|                | 10/ 12.8C              | 15.6C | 18.3C   | 12.8 C*     | 10/ 12.8C               | 18.3 C   |      |
|                | 50/55° F 60° F         |       |   | 65° F 60 F° | 50/55° F                | 60/65° F |      |
| 17             | 600                    | 0.80  |   | 0.90        | —                       | 0.80     | 1.10 |
| 20             | 700                    | 0.90  |   | 1.00        | —                       | 0.80     | 1.20 |
| 23             | 800                    | 1.00  |   | 1.10        | —                       | 1.00     | 1.30 |
| 25             | 900                    | 1.10  |   | 1.20        | 0.75                    | 1.10     | 1.50 |
| 28             | 1,000                  | 1.20  |   | 1.30        | 0.90                    | 1.20     | 1.60 |
| 31             | 1,100                  | 1.30  |   | 1.40        | 1.00                    | 1.30     | 1.70 |
| 34             | 1,200                  | 1.45  |   | 1.60        | 1.00                    | 1.45     | 1.90 |
| 38             | 1,300                  | 1.60  |   | 1.70        | 1.00                    | 1.60     | 2.00 |
| 41             | 1,400                  | 1.70  |   | 1.80        | 1.20                    | 1.70     | 2.20 |
| 43             | 1,500                  | 1.80  |   | 1.90        | 1.30                    | 1.80     | 2.30 |
| 46             | 1,600                  | 1.90  |   | 2.00        | 1.40                    | 1.90     | 2.40 |

|    |       |      |      |      |      |      |
|----|-------|------|------|------|------|------|
| 49 | 1,700 | 2·00 | 2·20 | 1·40 | 2·00 | 2·60 |
| 52 | 1,800 | 2·20 | 2·30 | 1·50 | 2·20 | 2·80 |
| 55 | 1,900 | 2·30 | 2·50 | 1·60 | 2·30 | 3·00 |
| 58 | 2,000 | 2·40 | 2·60 | 1·70 | 2·40 | 3·20 |

For intermediate sizes, take average of the two nearest sizes above and below. For rooms with outside walls facing north or east, add 10 per cent. The cubic capacity of halls must include staircase and top landing. Column headed \* is for living rooms where the heating is auxiliary to a coal fire in constant use. Where electric fires are used as well as heaters, the latter should be sized for 50/55°F.

This table is only applicable to buildings of sound construction with an average 'U' value of 0.4 or better.

# 19.

## THE PAVIOR AND TILER

### CODES OF PRACTICE

**CP 201:1951:** Timber flooring.

**Part 1:1967:** Wood flooring (board, strip, block and mosaic).

**Part 2:1972:** metric units.

**CP 202:1972:** Tile flooring and slab flooring.

**CP 203:1969:** Sheet and tile flooring (cork, linoleum, plastics and rubber).

**Part 2:1972:** metric units.

**CP 204:** In-situ floor finishes.

**Part 1:1965:** imperial units.

**Part 2:1970:** metric units.

**CP 209:** Care and maintenance of floor surfaces.

**Part 1:1963:** wooden flooring.

These Codes of Practice cover very diverse materials and equally diverse methods of laying, involving a large number of specialist trades. The provisions for work on site are so numerous as to be impossible to summarize here. Some points, however, need emphasis:

1. Make sure that the material is suitable for the situation in which it will be laid: e.g. magnesium oxychloride flooring, with sawdust as filler, is unsuitable for kitchens, as are corks tiles, Grease-resistant tiles are necessary in kitchens.
2. The screed on which linoleum, vinyl, rubber and other sheet or thin tile materials are laid must be
  - a. solid with the base,
  - b. free from dust and contamination by plaster, oil, etc.
3. All flooring materials of this type (and some others, such as magnesium oxychloride) are liable to fail if laid on solid ground floor slabs unless the slabs have a damp-proof membrane incorporated. If a floor, where a failure has occurred, has no damp-proof membrane, the recommended remedy is to lay a 3/4 in (19 mm) layer of asphalt, to which the flooring is glued.
4. If laid at the same time as the mass concrete of the slab screeds may be 3/4 in (19 mm) thick; otherwise a minimum of 1 1/2 in (38 mm) is recommended.

### BRITISH STANDARDS

**B.S. 776:** Materials for magnesium oxychloride (magnesite) flooring.

**Part 1:1963:** imperial units.

**Part 2:1972:** metric units.

**B.S. 810:1966:** Sheet linoleum (calendered types), cork carpet and linoleum tiles.

**B.S. 882:** and **B.S. 1201:** Aggregates from natural sources for concrete (including granolithic).

**Part 1:1965:** imperial units.

**Part 2:1973:** metric units.

Note: **B.S. 1201** covers aggregates for granolithic concrete floor finishes, also '10 per cent fines' value of coarse aggregate.

**B.S. 988, 1076, 1097,** and **1451:1973:** Mastic asphalt for building.

Covers flooring, coloured flooring and grades are given to flooring according to usage.

**B.S. 1162, 1418** and **1410:1973:** Mastic asphalt for building (natural rock asphalt aggregate).

Three types, flooring type may be used as an underlay to other floor coverings as a protection against rising damp.

**B.S. 1187:1959:** Wood blocks for floors.

**B.S. 1197:** Concrete flooring tiles and fittings.

**Part 1:1955:** imperial units.

**Part 2:1973:** metric units.

**B.S. 1286:1974:** Clay tiles for flooring.

**B.S. 1297:1970:** Grading and sizing of softwood flooring.

**B.S. 1450:1963:** Black pitch mastic flooring.

**B.S. 1711:1975:** Solid rubber flooring.

**B.S. 1863:1952:** Felt backed linoleum.

**B.S. 2592:1973:** Thermoplastic flooring tiles.

**B.S. 2604:** Resin-bonded wood chipboard.

**Part 1:1963:** imperial units (withdrawn).

**Part 2:1970:** metric units.

**B.S. 3187:1978:** Specification for electrically conducting rubber flooring.

**B.S. 3260:1969:** PVC (vinyl) asbestos floor tiles.

**B.S. 3261:** Unbacked flexible PVC flooring.

**Part 1:1973:** Homogeneous flooring (continuous lengths or tile form).

**B.S. 3672:1963:** Coloured pitch mastic flooring.

**B.S. 4050:** Specification for mosaic parquet panels.

**Part 1:1977:** general characteristics.

**Part 2:1966:** classification and quality requirements.

**B.S. 4131:1973:** Terrazzo tiles.

## EXTERIOR PAVING

**B.S. 435:1975:** Dressed natural stone kerbs, channels, quadrants and setts.

There are three standard 'dressings' or finishes:

A: fine picked.

B: fair picked, single axed or nridged.

C: rough punched.

| Single dressed edge kerb <sup>1</sup> |       |        |    | Straight dressed flat kerb <sup>2</sup> |       |        |    |   |
|---------------------------------------|-------|--------|----|---|-------|--------|----|---|
| Width<br>(inches)                     | Depth | Length |    | Width<br>(inches)                       | Depth | Length |    |   |
|                                       |       | ft     | in |   |       | ft     | in |   |
| 8                                     |       | 12     | 2  | 6                                       | 12    | 8      | 2  | 6 |
| 6                                     |       | 12     | 2  | 6                                       | 12    | 6      | 2  | 6 |
| 6                                     |       | 10     | 2  | 0                                       | 10    | 6      | 2  | 0 |
| 6                                     |       | 9      | 1  | 9                                       | 9     | 6      | 1  | 9 |
| 6                                     |       | 8      | 1  | 9                                       | 8     | 6      | 1  | 9 |
| 5                                     |       | 10     | 2  | 0                                       |       |        |    |   |
| 4                                     |       | 10     | 2  | 0                                       |       |        |    |   |

| Straight dressed channel <sup>1</sup> |       |        |    | Straight rough-punched kerb <sup>2</sup> |       |        |    |
|---------------------------------------|-------|--------|----|--|-------|--------|----|
| Width<br>(inches)                     | Depth | Length |    | Width<br>(inches)                        | Depth | Length |    |
|                                       |       | ft     | in |  |       | ft     | in |
| 12                                    | 6     | 2      | 0  | 6  | 12    | 2      | 6  |
| 10                                    | 6     | 2      | 0  | 5  | 10    | 2      | 6  |
|                                       |       |        |    | 4  | 9     | 1      | 3  |

| Setts <sup>3</sup> |   |             |
|--------------------|---|-------------|
| Section (in)       |   | Length (in) |
| 4×4                |   | 4           |
| 3×5                | } | 5–10        |
| 3×6                |   |             |
| 4×4                | } | 6–10        |
| 4×5                |   |             |
| 4×6                | } | 6–10        |
| 5×4                |   |             |
| 5×6                |   |             |

*Note* Top and front face to depth of 5in to be A or B dressing,  
1: with 1in chisel-drafted margins to top surface and to top edge.

*Note* Standard dressing, with ends hammer dressed or punched.  
2:

*Note* Setts are to be square, hammer-dressed.  
3:

Stone kerbs, setts etc. and occasionally, flagstones may be re-dressed and re-used two or three times. In addition, many new products in non-standard sizes are produced and are in fairly general use.

**B.S. 340:1963:** Precast concrete kerbs, channels edgings, and quadrants.

This Standard had not, at the time of going to press, been metricated. It provides dimensioned sections of all the following.

*Straight kerbs:* 3ft long-12in by 6in; 10in by 5in; 10in by 4in; and 5in by 6in with 5/8in or 3/4in radius on one top edge.

*Radius kerbs and channels;* length, between 2ft and 3ft.

*External radii;* 3, 6, 8, 10, 15, 20, 25, 30, 35 and 40ft.

*Internal radii;* as above, except 15,25 and 35ft.

*Straight channels;* 3ft long by 12in by 6in; 10in by 5in and 10in by 4in.

*Edging:* 3ft long by 2in by 6, 8, and 10in, with plain, radiused or half-round top edges.

*Quadrants:* 12in and 18in radii, by 6, 8, and 10in deep, to match kerbs.

**B.S. 368:1971:** Precast concrete flags.

**TABLE 1. FLAG DIMENSIONS**

| Flag type | Co-ordinating size | Work size | Maximum limit of manufacturing size | Minimum limit of manufacturing size |
|-----------|--------------------|-----------|-------------------------------------|-------------------------------------|
|           | mm                 | mm        | mm                                  | mm                                  |
| A         | 600×450            | 598×448   | 600×450                             | 596×446                             |
| B         | 600×600            | 598×598   | 600×600                             | 596×596                             |
| C         | 600×750            | 598×748   | 600×750                             | 596×746                             |
| D         | 600×900            | 598×898   | 600×900                             | 596×896                             |

NOTE. When ordering, it will be necessary only to specify the type followed by the thickness, e.g. 'A 50'.

**B.S. 802:1967:** Tarmacadam with crushed rock or slag aggregate.

See table opposite.

APPROXIMATE COVERING CAPACITY OF TARMACADAM

The table on page 370 shows the approximate ranges of cover of various compacted thicknesses of tarmacadam. The tolerances given take into account the fact that the covering capacity is influenced by such factors as specific gravity of aggregate, grading of aggregates, weather conditions, length of haul, whether the material is laid in one or more courses, method of laying, weight of roller, etc.

**TABLE 8. TARMACADAM FOR VARIOUS TYPES OF CONSTRUCTION**

The lower limits of thickness given below apply only where the accuracy of finish of the surface on which the tarmacadam is to be laid is within the limits specified in *the standard*.

| Number | Range of total | Average thickness of | Nominal size and type |
|--------|----------------|----------------------|-----------------------|
|--------|----------------|----------------------|-----------------------|

| of courses            | compacted thickness            | compacted course or courses should be between the limits specified below (see A.3)   | of tarmacadam  |
|-----------------------|--------------------------------|--|--|
| One                   | 3/4 in (19 mm) to 3 in (76 mm) | 2 1/4 in (57 mm) to 3 in (76 mm)<br>1 1/4 in (32 mm) to 1 1/2 in (38 mm)<br>3/4 in (19 mm) to 1 in (25 mm)<br>3/4 in (19 mm)                                     | 1 1/2 in (38 mm) single course<br>3/4 in (19 mm) open or medium texture<br>1/2 in (13 mm) open or medium texture<br>3/8 in (10 mm) open or medium texture                                    |
| Two                   | 3 in (76 mm) to 5 in (127 mm)  | Basecourse<br>2 1/4 in (57 mm) to 3 in (76 mm)<br><br>Wearing course<br>1 1/4 in (32 mm) to 1 1/2 in (38 mm)<br>3/4 in (19 mm) to 1 in (25 mm)<br>3/4 in (19 mm) | 1 1/2 in (38 mm) basecourse or 1 1/2 in (38 mm) single course<br><br>3/4 in (19 mm) open or medium texture<br>1/2 in (13 mm) open or medium texture<br>3/8 in (10 mm) open or medium texture |
| Multi (more than two) | Greater than 5 in (127 mm)     | Upper course or courses as above Lower courses not greater than 3 1/2 in (89 mm) each  | Upper course or courses as above 1 1/2 in (38 mm) single course (hot-laid)   |

| Thickness of course |    | Nominal size of material (see Tables 1a to 4)                                  | Approximate covering capacity |                       |
|---------------------|----|--|-------------------------------|-----------------------|
| in                  | mm |  | yd <sup>2</sup> /ton          | m <sup>2</sup> /tonne |
| 3/4                 | 19 | 3/8 in (10 mm) open texture<br>1/2 in (13 mm) or 3/8 in (10 mm) medium texture | 25–30                         | 20–25                 |
| 1                   | 25 | 1/2 in (13 mm) open texture<br>1/2 in (13 mm) medium texture                   | 20–24                         | 17–20                 |
| 1 1/4               | 32 | 3/4 in (19 mm) open texture<br>3/4 in (19 mm) medium texture                   | 17–20                         | 14–17                 |
| 1 1/2               | 38 | 3/4 in (19 mm) open texture<br>3/4 in (19 mm) medium texture                   | 15–18                         | 13–15                 |
| 2                   | 51 | 3/4 in (19 mm) open texture  | 11–14                         | 9–12                  |
| 2 1/4               | 57 | 1 1/2 in (38 mm) basecourse  | 10–13                         | 8–11                  |

|       |    |   |      |      |
|-------|----|---|------|------|
|       |    | 1 1/2 in (38 mm) single course                                |      |      |
| 2 1/2 | 64 | 1 1/2 in (38 mm) basecourse<br>1 1/2 in (38 mm) single course | 9-12 | 8-10 |
| 3     | 76 | 1 1/2 in (38 mm) basecourse<br>1 1/2 in (38 mm) single course | 8-10 | 7-8  |

These coverages apply to materials to be laid on a foundation, the profile of which complies with the requirements of this specification. For more irregular foundations, lower coverages must be expected. The table is given without implying obligation on any of the parties concerned.

B.S. 802 also provides standards of workmanship in laying, and composition of tarmacadam mixes.

### CLAY FLOORING TILES

**B.S. 1286:1974** Clay tiles for flooring.

Quality, shape, range of ceramic floor tiles and clay floor quarries, sills and associated fittings. Full range of fittings illustrated for each type. Sampling methods, tests for warpage, curvature and water absorption are covered.

Preferred sizes for modular ceramic floor tiles 100 by 100 by 9.5mm, and 200 by 200 by 9.5 mm, and for modular clay floor quarries 200 by 100 by 19 mm, and 100 by 100 by 19 mm. Predominant range in non-modular clay floor quarries from 229 by 229 by 32 mm, to 150 by 150 by 15 mm.

### CONCRETE FLOORING TILES

**B.S. 1197:** Concrete flooring tiles and fittings.

**Part 2:1973:** metric units.

**TABLE 1. SIZES OF SQUARE TILES**

| Length of each side          | Thickness                  |
|------------------------------|----------------------------|
| Work size                    | Work size                  |
| mm                           | mm                         |
| 150                          | 15                         |
| 200                          | 20                         |
| 225                          | 20                         |
| 300                          | 30                         |
| 400                          | 35                         |
| 500                          | 40                         |
| Permissible deviation ± 1 mm | Permissible deviation ±3mm |

When laid, diagonal and rectangular half-tiles shall conform to the above sizes.



**TABLE 2. SIZES OF SKIRTINGS AND FITTINGS**

| Dimension (see Figs. 1, 2 and 3)   | Work size | Permissible deviation |    |
|------------------------------------|-----------|-----------------------|----|
|                                    |           | mm                    | mm |
| Length of skirting<br>( <i>l</i> ) | 150       | ±1                    |    |
|                                    | 200       | ±1                    |    |
|                                    | 225       | ±1                    |    |
|                                    | 300       | ±1                    |    |
|                                    | 400       | ±1                    |    |
|                                    | 450       | ±1                    |    |
|                                    | 500       | ±1                    |    |
|                                    | 600       | ±1                    |    |
|                                    | 675       | ±1                    |    |
|                                    | 750       | ±1                    |    |
|                                    | 800       | ±1                    |    |
| 900                                | ±1        |                       |    |
| Base width<br>( <i>w</i> )         | 40        | ±1                    |    |
| Height<br>( <i>h</i> )             | 100       | ±1                    |    |
|                                    | 150       | ±1                    |    |
| Thickness<br>( <i>t</i> )          | 12        | ±3                    |    |
| Radius of cove                     | 25        | ±3                    |    |
| Radius of bull-nose (if made)      | 8         | ±4                    |    |

**TABLE 3. DIMENSIONALLY CO-ORDINATED SIZES FOR TILES**

*These sizes may be supplied by agreement between the purchaser and the supplier.*

| Length of tile-side co-ordinating size                | mm     | mm     | mm     |
|---|--------|--------|--------|
|   | 300    | 400    | 500    |
| Joint clearance                                       | 3      | 3      | 3      |
| Work size   | 297    | 397    | 497    |
| Permissible deviation on work size                    | ±      | ±      | ±      |
| Maximum limit of manufacturing size                   | 298    | 398    | 498    |
| Minimum limit of manufacturing size                   | 296    | 396    | 496    |
| Thickness, work size (not dimensionally co-ordinated) | 30 ± 3 | 35 ± 3 | 40 ± 3 |

### CERAMIC INTERNAL WALL TILES

**B.S. 1281:1974:** Glazed ceramic tiles and tile fittings for internal walls.

Provides specification for quality, shape, range of sizes, physical and chemical requirements. Sampling methods, tests for warpage, curvature, wedging, water absorption, crazing, resistance to chemicals and impact.

Preferred sizes for modular tiles 100 by 100 by 5mm, and 200 by 100 by 6.5mm. Predominant range in non-modular tiles from 152 by 152 by 9.5mm to 108 by 108 by 4mm.

Round edge, attached angle and angle bead tile fittings, cushion edges, and spacer lugs. B.S. 1281 contains illustrations for application of tiles and tile fittings.

**Warning: These tiles are not suitable for external work.**

**NUMBER OF TILES OF VARIOUS SIZES PER SQUARE METER**

| Size of tiles |        | No. of tiles per m <sup>2</sup> |  |
|---------------|--------|---------------------------------|--|
| in            | Exact  | To nearest whole tile           |  |
| 12×12         | 10.764 | 11                              |  |
| 12×10         | 12.644 | 13                              |  |
| 12×9          | 13.445 | 14                              |  |
| 10×10         | 14.054 | 15                              |  |

| Size of tiles |         | No. of tiles per m <sup>2</sup> |  |
|---------------|---------|---------------------------------|--|
| in            | Exact   | To nearest whole tile           |  |
| 9×9           | 17.963  | 18                              |  |
| 8×8           | 24.219  | 25                              |  |
| 6×6           | 42.856  | 43                              |  |
| 4×4           | 96.876  | 97                              |  |
| 3×3           | 161.424 | 162                             |  |
| 6×3           | 85.712  | 86                              |  |
| mm            |         |                                 |  |
| *200×200      | 25.000  | 25                              |  |
| *250×250      | 16.000  | 16                              |  |

\*These are the two principal sizes of Continental concrete tiles. Small quantities have been imported for some time.

The above table makes no allowance for mortar joints, nor for waste. Only rectangular tiles are included: a few hexagonal or rhomboidal tiles are occasionally used. Allow an extra 33 per cent over the nearest rectangular tiles.

## 20. THE PLASTERER

### CODES OF PRACTICE

**B.S. 5492:1977:** Code of practice for internal plastering.

Covers plastering on all common forms of background. Supersedes CP 211.

### BRITISH STANDARDS

**B.S. 890:1972:** Building limes.

In four parts; general; hydrated lime (powder); quicklime; lime putty.

**B.S. 1191:** Gypsum building plaster.

**Part 1:1973:** excluding premixed lightweight plaster.

**Part 2:1973:** premixed lightweight plaster.

**B.S. 1230:1970:** Gypsum plasterboard.

Quality and dimensions (with appendices).

**TABLE 1. SIZES\***

|                  | Length | Permissible deviation | Width | Permissible deviation | Thickness     | Permissible deviation    |
|------------------|--------|-----------------------|-------|-----------------------|---------------|--------------------------|
|                  | m      | mm                    | mm    | mm                    | mm            | mm                       |
| Gypsum wallboard | 1800   | } $\pm 0$<br>-6       | 600   | } - 0<br>-5           | } 9.5<br>12.7 | $\pm 0.50$<br>$\pm 0.60$ |
|                  | 2350   |                       |       |                       |               |                          |
|                  | 2400   |                       |       |                       |               |                          |
|                  | 2700   |                       |       |                       |               |                          |
|                  | 3000   |                       |       |                       |               |                          |
| Gypsum plank     | 2350   | } $+ 0$<br>-6         | 600   | } $+ 0$<br>-5         | 19.0          | $\pm 0.75$               |
|                  | 2400   |                       |       |                       |               |                          |
|                  | 2700   |                       |       |                       |               |                          |
|                  | 3000   |                       |       |                       |               |                          |
|                  |        |                       |       |                       |               |                          |
| Gypsum lath      | 1200   | } $\pm 0$<br>-6       | 406   | } $\pm 3$             | } 9.5<br>12.7 | $\pm 0.50$<br>$\pm 0.60$ |
|                  |        |                       |       |                       |               |                          |
| Gypsum baseboard | 1200   | } $+ 0$<br>-6         | 914   | } $\pm 3$             | 9.5           | $\pm 0.50$               |

**TABLE 2. WEIGHT\***

| Thickness | Gypsum plasterboard   |                       |
|-----------|-----------------------|-----------------------|
|           | Min                   | Max                   |
| mm        | kg/100 m <sup>2</sup> | kg/100 m <sup>2</sup> |
| 9.5       | 650                   | 1000                  |
| 12.7      | 950                   | 1450                  |
| 19.0      | 1400                  | 2050                  |

**B.S. 1369:1947:** Metal lathing (steel) for plastering. Five types of mild steel lathing.

**B.S. 4049:1966:** Glossary of terms applicable to internal plastering, external rendering and floor screeding.

Defines terms in current use.

### PLASTERING DATA

1 ton equals 1 metric tonne (approx).

1 bushel equals 8 gallons, or 36 litres, or 1.28 cubic feet, or 0.036 cubic metres.

21 bushels equal 1 cubic yard: 30 bushels equal 1 cubic metre.

1 ton or tonne of lime equals 42 bushels or 1 10/11 cubic yards, or 51 cubic feet or 1.444 cubic metres.

1 cubic foot (0.282 cu. metres) of lime weighs 44lb (19.950 kg).

1 cubic foot of sand weighs 100 lb (approx) or 45.35 kg.

A convenient bushel measure is a box with internal measurements of 13 1/4in × 13 1/4in × 13 1/4in (346.5mm × 346.5mm × 346.5mm).

1 cubic yard is very approximately three-quarters of 1 cubic metre.

### MODERN PLASTERING MATERIALS

Gypsum plasters have almost wholly replaced the old plastering system based on lime. Hydrated lime in bags is universally used for 'compo' mixes and for lime putty. Hydraulic limes, such as blue lias, are nowadays very difficult to obtain, because backing coats of lime and sand alone are no longer used. Nor is lime putty alone used as a finishing coat. Lime plastering is confined today to repair and restoration work. Plasterboard or expanded metal lathing have replaced wooden laths, which today are difficult to obtain and, when obtainable, very expensive.

### LIGHTWEIGHT PLASTERS AND RENDERINGS

In recent years, a number of firms have introduced ready-gauged plaster, consisting of lightweight aggregates such as vermiculite or perlite, combined with gypsum plaster. Others sell these lightweight aggregates, and give directions for compounding mixes for

various uses and situations. For many years, a patented process of applying, by spray-gun, mixtures of asbestos, or mixtures of vermiculite or perlite with Portland cement (the 'Pyrok' system) has met with considerable success for exterior renderings, for condensation control in factories and for fire-resisting coatings on all manner of building materials. These lightweight plasters, when used in domestic work, give increased thermal insulation. Local authorities accept them as internal plastering on 9in solid brickwork (used internally) to bring it up to the thermal insulation requirements of the Building Regulations. They are, however, more expensive than normal plastering.

### PLASTERING MACHINES

These machines require special mixes, some of which are based on Portland cement. The machine manufacturers supply recommended mixes, as does the Gypsum Products Development Association.

### BONDING LIQUIDS

These materials are:

1. Bitumen solutions that, while tacky, are dashed with concreting sand to provide a key, or.
2. A type of adhesive.

They eliminate all hacking of the background and allow any surface, such as glazed tiles, to be plastered upon. When applied to old, cracked surfaces, they eliminate hacking-off. They also allow surfaces such as concrete to be plastered without using special grades of plaster. While it is now general to use a Portland cement backing coat, with a gypsum plaster skim coat in these instances, a lightweight plaster should be used if possible, because it puts less weight, and therefore less strain, on the adhesive.

### 'DRY LINING SYSTEMS'

These consist of plasterboard, stuck to the brickwork or other backing with 'dabs' or lines of plaster. The joints are filled with a special filler, with sometimes a scrim tape incorporated. Alternatively, after filling, a tapered paper strip is used to mask the joints. These methods have not become popular, except with prefabricated systems of construction, despite the elimination of wet plastering and its attendant mess. Cost and a slightly substandard finish have been the deciding factors.

### SUSPENDED CEILING SYSTEMS

These consist of plasterboard panels set in a light metal grillage of 'T' section aluminium or steel. They are largely used in factory work, for thermal insulation. The work is not plastered.

### GYPSUM BUILDING PLASTERS

Internal plastering employing gypsum plasters is described in B.S. 5492 and additional practical information is given in the Department of the Environment Advisory Leaflet No. 2 'Gypsum Plasters Used in Building', obtainable from H.M.S.O. These documents describe the range of plasters, including plaster of paris, retarded hemihydrate gypsum plaster, anhydrous gypsum plaster, Keenes and premixed lightweight plaster types, with a full list of trade names and the purposes for which they may be employed and the mixes to use.

The following is an outline of the uses of the types of gypsum plasters now available.

#### GYPSUM BUILDING PLASTERS MANUFACTURED TO B.S. 1191 : PART 1. EXCLUDING PREMIXED LIGHTWEIGHT PLASTERS.

| Type                 | Variety  | Uses  |
|----------------------|--|---|
| Class A              |  |   |
| Plaster of paris     | One type only: coarse pink, grey or white generally used in building work  | For gauging lime finishing coats, use up to 1/4 plaster to 1 of lime. For repair work and for fibrous plaster, use neat without lime.   |
| Class B              |  |   |
| Retarded hemihydrate | (i) Undercoat type for all materials, including boards<br><br>(ii) Final coat type may be 'finish' or 'board finish' | Use 1 part of plaster to from 1 to 3 parts of sand. Use lower sand proportions on low-suction backgrounds, such as plasterboard and concrete.<br><br>For finishing coats in 2 or 3 coat work, use neat or with lime. For single coat work on plasterboard, fibreboard or other boards, use neat.<br><br>Do not retemper Class B plasters. |
| Class C              |  |   |
| Anhydrous            | Final coat type only   | May show a double set and first set can be 'killed' if desired.<br>Use neat or with lime up to 1/4 of plaster by volume. Use from 1/4 to 1 part of plaster to 1 of lime with fine sand if desired for gauged lime finishing coats.<br>Not recommended for direct application to boards.<br>Do not retemper after 1/2 hour from mixing.    |
| Class D              |  |   |
| Keenes               | Final coat type only   | Use neat for finishing coats and external angles. Not suitable for use outside. Not   |

recommended for direct application to boards.

Do not retemper after 1 hour from mixing.

## GYPSUM BUILDING PLASTERS MANUFACTURED TO B.S. 1191 : PART 2. PREMIXED LIGHTWEIGHT PLASTERS.

| Type                                | Variety   | Uses   |
|-------------------------------------|---|--|
| Premixed lightweight gypsum plaster | Undercoat type  | Requires the addition of clean water only  |
| Browning plaster                    | (i) containing expanded perlite aggregate                               | Use on normal suction backgrounds such as brick, clinker and most proprietary partition blocks. Do not use on plasterboard or in situ concrete   |
| Bonding plaster                     | (ii) containing exfoliated vermiculite aggregate                        | Use on plasterboard and in situ concrete and other low suction backgrounds.  |
| Metal lathing plaster               | (iii) containing expanded perlite and exfoliated vermiculite aggregates | Use on expanded metal lathing and other backgrounds where there may be a risk of rusting. Also on expanded polystyrene and wood wool slabs. Requires the addition of clean water only. |
| Finish plaster                      | Final coat type containing exfoliated vermiculite aggregate             | Use as a finishing coat for 2 or 3 coat work to any lightweight undercoat plaster.   |

## GYPSUM BUILDING PLASTERS WITH SPECIAL APPLICATIONS

| Type                          | Variety                                       | Use  |
|-------------------------------|---|--|
| Acoustic plaster              | Final coat type                               | Requires the addition of clean water only. Use in two coats on suitably prepared gypsum plaster undercoats. To obtain maximum sound absorption, follow manufacturer's instructions.                            |
| Premixed Gypsum X-Ray Plaster | Undercoat type containing barytes aggregate   | Requires the addition of clean water only. Use in two or three coats depending upon thickness specified and type of background. Thickness can only be specified by the National Radiological Protection Board. |
| Finish plaster                | Final coat type containing barytes aggregate. | Requires the addition of clean water only. Use as a finishing coat on barytite premixed gypsum X-ray plaster undercoats.   |
| Thin coat finish plaster      | Final coat type                               | Requires the addition of clean water only. Use on suitably smooth and straight backgrounds,  |

regardless of suction in one coat to a minimum thickness of 1/16 in.

MIX PROPORTIONS AND FINISHED THICKNESSES OF GYPSUM PLASTER UNDERCOATS

| Background   | Grade of plaster | Proportions by volume |       | Total thickness of finished plasterwork |    |               |   |       |     |    |
|--|------------------|-----------------------|-------|---|----|---------------|---|-------|-----|----|
|  |                  | plaster               | sand  | in                                      | mm |               |   |       |     |    |
| Clay brick, tiles, etc. Partitions                               | Browning         | 1                     | 3     | 1/2                                     | 13 |               |   |       |     |    |
| Concrete bricks<br>Clinker blocks<br>Lightweight concrete blocks | Browning         | 1                     | 2     | 1/2                                     | 13 |               |   |       |     |    |
| Wood wool slabs  |                  |                       |       |   |    | Metal lathing | 1 | 2     | 1/2 | 13 |
| Metal lathing (render)   |                  |                       |       |   |    | Metal lathing | 1 | 1 1/2 | 1/2 | 13 |
| Metal lathing (float)  | Metal lathing    | 1                     | 2     | (from face of lath)                     |    |               |   |       |     |    |
| Plasterboard and Plaster lath                                    | Haired           | 1                     | 1 1/2 | 3/8                                     | 9  |               |   |       |     |    |

Note: Cement-sand screeds are very often used instead of browning and metal lathing plasters. The sand should be to B.S. 1191, type 1.

(By courtesy of British Gypsum Ltd.)

AVERAGE COVERING CAPACITY OF GYPSUM PLASTERS. PER TONNE AND TON

| Background   | Coating                                | sq. yds |     |
|--|--|---------|-----|
| <b>1. Class B (retarded hemi-hydrate plasters)</b>                               |  |         |     |
| Clay brick, tiles, etc.  | Floating coat (1-3)                    | 280     | 234 |
| Concrete blocks, clinker blocks, lightweight concrete blocks and wood-wool slabs | Floating coat (1-2)                    | 217     | 181 |
| Plasterboards  | Floating coat (1-1 1/2)                | 246     | 206 |
| Metal lath   | Rendering and floating (1-1 1/2 & 1-2) | 138     | 115 |
| Neat finish (walls or ceilings)  |  | 467     | 390 |
| Neat finish (plasterboards—one coat)   |  | 197     | 165 |
| <b>2. Class D (Keenes)</b>   |  |         |     |
| setting coat only.   |  | 276     | 231 |



| Background   | Coating   | sq. yds |         |
|--|---|---------|---------|
| <b>3. Special plasters supplied in bags, pre-mixed with aggregate.</b> |   |         |         |
| <b>(a) X-ray (barium-gypsum)</b>                                       |   |         |         |
|  | Floating coat, ( $\frac{7}{8}$ "-22mm)              | 26      | 21      |
|  | Floating coat on metal lath ( $\frac{7}{8}$ "-22mm) | 21      | 17      |
|  | Setting coat ( $\frac{1}{4}$ "-3mm)                 | 180     | 151     |
| <b>(b) Lightweight plasters</b>  |   |         |         |
| Bricks, blocks, etc.   | Floating coat<br>( $\frac{7}{8}$ "-11mm)            | 157-177 | 131-148 |
| Metal lath   | Floating coat                                       | 79      | 661     |
| Wood wool slabs  | Floating coat<br>( $\frac{7}{8}$ "-11mm)            | 143     | 120     |
| Concrete and plasterboards   | Floating coat<br>( $\frac{5}{8}$ "-8mm)             | 177-200 | 148-167 |
| Finish   |   | 492-591 | 411-494 |

*Note:* Portland cement screeds are very often used instead of plaster for rendering and floating coats in section 1 above.

Neat finish on walls etc. can contain up to 25 per cent lime putty. For one-coat on plasterboards, no lime should be used.

## FILLERS

A material under such trade names as 'Polyfilla' or 'Fleetfilla', originally produced for amateur use, has been adopted by the trade. It is gypsum based and contains a water-soluble adhesive. Its cost precludes its use as a skim coat, for which it is suitable despite some difficulty in application. For patches, especially damaged external angles, it should be applied so as to stand a little 'proud' of the surface and, when set and dry, be glasspapered level. Cracks should be cut out and left undercut, as for plaster and again the filler should be left 'proud' and be glasspapered level.

The material adheres well, even to dry surfaces, but being water-soluble, it should not be applied to permanently damp surfaces. It can be used as a hardener and binder in lime putty and also as a retarder for class A gypsum plaster ('plaster of paris') although fairly large quantities are required for this purpose. The material is tenacious and resists vibration: it will take nails and screws but only for light loads. An external quality is also available, based on Portland cement.

## MORTAR MIXES IN TONS OR TONNES

| Ratios | Cement mortar  |                | Lime mortar          |                        |                |
|--------|----------------|----------------|----------------------|------------------------|----------------|
|        | Cement<br>tons | Sand<br>tonnes | Lime putty<br>cu. yd | Sand<br>m <sup>3</sup> | Sand<br>tonnes |
| 1-1    | 0.80           | 0.875          | 4/5                  | 0.607                  | 0.875          |
| 1-2    | 0.55           | 1.200          | 1/2                  | 0.382                  | 1.200          |

Cement mortar

Lime mortar

| Ratios | Cement tons | Sand tonnes | Lime putty |                | Sand tonnes |
|--------|-------------|-------------|------------|----------------|-------------|
|        |             |             | cu. yd     | m <sup>3</sup> |             |
| 1-3    | 0.40        | 1.350       | 2/5        | 0.303          | 1.350       |
| 1-4    | 0.30        | 1.350       | 3/10       | 0.218          | 1.350       |
| 1-5    | 0.28        | 1.350       | 1/4        | 0.191          | 1.350       |

**PORTLAND CEMENT SCREEDS COVERING CAPACITY PER BUSHEL**

| Cement | Sand | in 1/2          | mm 13          | in 3/4          | mm 19          | in 7/8          | mm 23          | in 1            | mm 25          |
|--------|------|-----------------|----------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|
| neat   | —    | 2.8             | 2.4            | 2.1             | 1.5            | 1.7             | 1.2            | 1.4             | 1.0            |
| 1      | 1    | 4.6             | 3.5            | 3.6             | 2.7            | 2.8             | 2.1            | 2.3             | 1.7            |
| 1      | 2    | 6.7             | 5.1            | 5.0             | 3.8            | 4.2             | 3.2            | 3.4             | 2.5            |
| 1      | 3    | 9.0             | 6.8            | 6.7             | 5.1            | 5.6             | 4.2            | 4.5             | 3.4            |
|        |      | yd <sup>2</sup> | m <sup>2</sup> | yd <sup>2</sup> | m <sup>2</sup> | yd <sup>2</sup> | m <sup>2</sup> | yd <sup>2</sup> | m <sup>2</sup> |

**LIME MORTAR COVERING CAPACITY PER BUSHEL**

| Surface and No. of Coats | Total Thickness |       | Coverage |                |          |                |       |                |      |
|--------------------------|-----------------|-------|----------|----------------|----------|----------------|-------|----------------|------|
|                          | in              | mm    | 1st Coat | 2nd Coat       | 3rd Coat |                |       |                |      |
|                          |                 |       | cu. yd   | m <sup>2</sup> | cu.yd    | m <sup>2</sup> | cu.yd | m <sup>2</sup> |      |
| Brick or Similar         | {               | 2 5/8 | 15.8     | 3.42           | 2.85     | 6.85           | 5.72  | —              | —    |
|                          |                 | 3 7/8 | 22.2     | 3.42           | 2.85     | 4.57           | 3.82  | 13.71          | 11.3 |
|                          |                 | 2     | 15.8     | 4.76           | 3.97     | 6.85           | 5.72  | —              | —    |
| Rubble                   | {               | 3 7/8 | 22.2     | 4.76           | 3.97     | 4.47           | 3.82  | 13.71          | 11.3 |

For covering capacities per cu. yd, multiply by 21; for m<sup>3</sup> multiply by 30.

**COMPOSITION OF LIME PLASTERS**

**USING NON-HYDRAULIC AND SEMI-HYDRAULIC LIMES**

*Coarse stuff:* One part of lime putty to three parts of sand.

*Undercoats of lime plaster gauged with cement:* One part of cement, one part of hydrated lime, six parts of sand.

*Undercoats of lime plaster gauged with gypsum plaster:* One part of lime putty to 2-4 parts sand. Immediately before use, add retarded hemi-hydrate plaster equal to 1/3 by volume of the lime putty, with the additional water required to mix. This should not be rettempered once it has stiffened.

*Floating Coat:* This is used for the intermediate coat in 'three coat work', and has the same composition as the undercoats described above.

*Setting Coat:* One volume of lime putty, up to one volume of fine sand, and 1/4 volume of retarded hemi-hydrate plaster added just before use.

Or, one volume of lime putty gauged with 1/4 to 1 volume of retarded hemi-hydrate plaster.

USING HYDRAULIC LIME

*Coarse stuff:* One part of lime to 2–3 parts sand.

*Haired coarse stuff:* 9lb hair to every cubic yard of coarse stuff.

**EXTERNAL RENDERINGS**

The following data have been extracted from: **CP 221:1960**. The code covers workmanship, definitions and much other matter: it should be read by every builder and craftsman.

Table 1. Recommended mixes for external renderings in relation to background material, exposure conditions and finish desired. (See page 384.)

Mix: 1 part Portland cement: 0 to 1/4 part lime: 3 parts sand

Type 1. by volume.

Type 2. 1 part Portland cement: 1/2 part lime: 4 to 4 1/2 parts sand by volume.

Type 3. 1 part Portland cement: 1 part lime: 5 to 6 parts sand by volume.

Type 4. 1 part Portland cement: 2 parts lime: 8 to 9 parts sand by volume.

(For mixes consisting of masonry cement and sand, or hydraulic lime and sand, see Clauses 313d and e. For mixes for machine-applied finishes, see Clause 313g.) Type of mix recommended for the given exposure conditions (see Clause 313a).

| Background material (see Clause 303) | Type of Finish (see Clause 302) | First and subsequent undercoats |           |           | Final Coat      |           |           |
|--------------------------------------|---------------------------------|---------------------------------|-----------|-----------|-----------------|-----------|-----------|
|                                      |                                 | severe                          | moderate  | sheltered | severe          | moderate  | sheltered |
| (A)Dense, strong and smooth          | Wood-float                      | 1, 2 or 3                       | 1, 3 or 4 | 1, 3 or 4 | 1 or 3          | 1, 3 or 4 | 1, 3 or 4 |
|                                      | Scraped or textured             | 3                               | 3 or 4    | 3 or 4    | 3               | 3 or 4    | 3 or 4    |
| (B)Moderately strong and porous      | Roughcast                       | 1, 2 or 3                       | 1, 2 or 3 | 1, 2 or 3 | As undercoats   |           |           |
|                                      | Dry-dash                        | 1 or 2                          | 1 or 2    | 1 or 2    | 2               | 2         | 2         |
| (C)Moderately weak and porous        | Wood-float                      | } 3                             | 3 or 4    | 3 or 4    | } As undercoats |           |           |
|                                      | Scraped or textured             |                                 |           |           |                 |           |           |
|                                      | Roughcast                       |                                 |           |           |                 |           |           |
|                                      | Dry-dash                        | 2 or 3                          | 2 or 3    | 2 or 3    |                 |           |           |

|  |                        |           |              |              |           |           |           |
|--|------------------------|-----------|--------------|--------------|-----------|-----------|-----------|
| (D)No-fines<br>concretes<br>(see Clause<br>303b(iv)) | Wood-<br>float         | 1, 2 or 3 | 1, 2, 3 or 4 | 1, 2, 3 or 4 | 1, 2 or 3 | 1, 3 or 4 | 1, 3 or 4 |
|  | Scraped or<br>textured | 1, 2 or 3 | 2, 3 or 4    | 2, 3 or 4    | 3         | 3 or 4    | 3 or 4    |
|  | Roughcast              | 1, 2 or 3 | 1, 2 or 3    | 1, 2 or 3    | 1, 2 or 3 | 1, 2 or 3 | 1, 2 or 3 |
|  | Dry-dash               | 1 or 2    | 1 or 2       | 1 or 2       | 2         | 2         | 2         |
| (E)Metal<br>lathing or<br>expanded<br>metal          | Wood-<br>float         | 1, 2 or 3 | 1, 2 or 3    | 1, 2 or 3    | 1 or 3    | 1 or 3    | 1 or 3    |
|  | Scraped or<br>textured | 1, 2 or 3 | 1, 2 or 3    | 1, 2 or 3    | 3         | 3         | 3         |
|  | Roughcast              | 1, 2 or 3 | 1, 2 or 3    | 1, 2 or 3    | 3         | 3         | 3         |
|  | Dry-dash               | 1 or 2    | 1 or 2       | 1 or 2       | 2         | 2         | 2         |

**FOR BRICKWORK HIGHLY CONTAMINATED BY SOLUBLE SALTS (GENERALLY SULPHATES)** In place of type 1 mixes (in above table) use 1 high alumina cement: 1 sand (by volume.) In place of type 2 mixes, use 1 high alumina cement: 1/2-3/4 ground chalk: 4-4 1/2 sand. In place of type 3, use 1 high alumina cement: 1-1 1/2 ground chalk. 5-6 sand. For spatterdash: 1 high alumina cement: 1 1/2-2 parts sand.

# 21.

## THE PAINTER

### CODES OF PRACTICE

**CP 231:1966:** Painting of buildings.

Covers design, organisation, supervision, paint systems, substrates, materials, surfaces, preparation and maintenance for a wide range of materials and surfaces.

### BRITISH STANDARDS

**B.S. 217:1961:** Red lead for paints and jointing compounds.

Red lead, non-setting for paints and ordinary for paint mixed on the site.

**B.S. 239, 254, 296, 338 and 637:1967:** White pigments for paints.

White lead (239); zinc oxide (254); lithopones (296); antimony oxide (338); and basic lead sulphate (637).

**B.S. 242, 243, 259 and 632:1969:** Linseed oil.

Raw, refined and boiled linseed oil.

**B.S. 244 and 290:1962:** Turpentine for paints.

Gum spirits, wood and sulphate.

**B.S. 245:1976:** Specification for mineral solvents (white spirit and related hydrocarbon solvents) for paint and other purposes.

Types A and B solvents based on two ranges of aromatic content.

**B.S. 283:1965:** Prussian blues for paints.

Sampling, composition, colour, staining power etc.

**B.S. 284-6:1952:** Black (carbon) pigments for paints.

Carbon black (284); bone black (285); and lamp (or vegetable) black (286).

**B.S. 303:1978:** Specification for lead chrome green pigments for paints.

Definition, required characteristics, etc.

**B.S. 311:1936:** Gold size for paints.

Quality, drying times, etc.

**B.S. 314:1968:** Ultramarine pigments.

Requirements and methods of test for three types, etc.

**B.S. 318:1968:** Chromic oxide pigments.

Requirements for two types, etc.

**B.S. 332:1956:** Liquid dryers for oil paints.

Colours, mixing properties, etc.

**B.S. 388:1972:** Aluminium pigments.

Powder, paste, leafing and non-leafing, etc.

**B.S. 391:1962:** Tung oil.

Two types of oil derived from *Aleurites Fordii* and *A. Montana*.

**B.S. 1070:1973:** Black paint (tar-based).

Requirements, etc.

**B.S. 1215:1945:** Oil stains.

Mainly for builders' joinery.

**B.S. 1336:1971:** Knotting.

Solid content, appearance, drying time, resistance to white spirit, etc.

**B.S. 1795:1976:** Specification for extenders for paints.

Grades and descriptions of various types, etc.

**B.S. 1851:1978:** Titanium pigments for paints.

Description, classification, requirements, etc.

**B.S. 2015:1965:** Glossary of paint terms.

Definitions of over 500 terms used in the paint industry.

**B.S. 2521 and 2523:1966:** Lead-based priming paints.

Composition, samples, consistency, drying times, etc.

**B.S. 2524:1966:** Red oxide-linseed oil priming paint.

Scope, composition, drying times, properties, etc.

**B.S. 3357:1961:** Glue size for decorators' use.

Animal glue, in granular or powder form, for use in sizing walls, ceilings and similar surfaces.

**B.S. 3416:1975:** Black bitumen coating solutions for cold application.

Bitumen coating solutions.

**B.S. 3634:1963:** Black bitumen oil varnish.

Coating for the protection of iron and steel.

**B.S. 3698:1964:** Calcium plumbate priming paints.

Requirements for two types.

**B.S. 3699:1964:** Calcium plumbate for paints.

Requirements for use in paints.

**B.S. 3722:1964:** Machine-made shellac.

Specifies four main types.

**B.S. 3761:1970:** Non-flammable solvent-based paint remover.

Description and requirements, etc.

**B.S. 3981:1976:** Iron oxide pigments for paints.

Requirements for five colour groups.

**B.S. 3982:1966:** Zinc dust pigment.

Requirements, methods of test, etc.

**B.S. 4232:1967:** Surface finish of blast-cleaned steel for painting.

First, second and third qualities of surface finish (cleanliness and roughness).

**B.S. 4310:1968:** Permissible limit of lead in low-lead paints and similar materials.

Gives an upper limit and method for detection.

**B.S. 4313:1968:** Strontium chromate for paints.

Requirements, etc.

**B.S. 4652:1971:** Metallic zinc-rich priming paint (organic media).

Three types and requirements, etc.

**B.S. 4725:1971:** Linseed stand oils.

Requirements and methods of test, etc.

**B.S. 4756:1971:** Ready mixed aluminium priming paints for woodwork.

Two types, properties and finish, etc.

**B.S. 4764:1971:** Powder cement paints.

Requirements, qualities, recommendations for use, etc.

**B.S. 4800:1972:** Paint colours for building purposes.

Illustrates 86 colours on 8 cards and refers to black and white. Supersedes B.S. 2660.

**B.S. 5082:1974:** Water-thinned priming paints for wood.

Specifies materials suitable for site application and for application to factory-primed joinery.

**B.S. 5358:1976:** Specification for low-lead solvent-thinned priming paint for woodwork.

Methods for outdoor exposure and recoatability after outdoor exposure, etc.

### CONVERSION TABLES

| SQUARE YARDS AND SQUARE METRES |                | GALLONS AND LITRES |      |        |      |
|--------------------------------|----------------|--------------------|------|--------|------|
| sq. yd                         | m <sup>2</sup> | gallons            |      | Litres |      |
| 36                             | 30             | 25                 | 0.22 | 1      | 4.5  |
| 42                             | 35             | 30                 | 0.44 | 2      | 9.0  |
| 48                             | 40             | 34                 | 0.65 | 3      | 13.6 |
| 54                             | 45             | 38                 | 0.88 | 4      | 18.2 |
| 60                             | 50             | 42                 | 1.09 | 5      | 22.7 |
| 66                             | 55             | 46                 | 1.31 | 6      | 27.2 |
| 72                             | 60             | 50                 | 1.53 | 7      | 31.8 |
| 84                             | 70             | 59                 | 1.75 | 8      | 36.3 |
| 96                             | 80             | 67                 | 1.97 | 9      | 41.0 |
| 108                            | 90             | 76                 | 2.19 | 10     | 45.0 |
| 120                            | 100            | 84                 |      |        |      |
| 239                            | 200            | 168                |      |        |      |
| 479                            | 400            | 335                |      |        |      |

(Rounded up to nearest whole numbers)

### CHOICE OF PAINT

Formulae for mixing paint to-day have nothing more than academic interest. Paint is now bought ready-mixed and, since the war, has been made from materials other than the natural oils and resins and thinners and the traditional lead and zinc bases. There is no indication, except by chance, of the contents of the can of paint, distemper or varnish: all that a painter can do, to achieve a good job, is to follow slavishly the directions printed on the can and in the advertising literature concerning the material. It is not always enough to adhere to these except in very straightforward jobs. For a manufacturer to

accept full responsibility, in new work, the whole painting system, from primer to finish coat, must be of his material, and of a good grade of that material. On old work, where repainting is undertaken every care should be given to adequate cleansing and filling; otherwise any defect in the finish will be put down to poor preparation.

The first essential is to choose a good paint manufacturer, and to use the better class paints and other materials that he manufactures. In anything but run-of-the mill jobs, consult his technical department, and request them to suggest a suitable painting system. Never forget that there are now primers other than red-lead priming, and special primers for non-ferrous metals, new cement and plaster, that sealers and primer-sealers are frequently used on stonework or concrete and that phosphating treatments have revolutionized the treatment of ironwork. Emulsion paints have brought with them their own problems, and the newer ranges of bituminous paints are very different from the crude materials of some few years ago.

Doubtless we all deplore the passing of the skilled painter and the coming of those who merely apply something of which they know nothing to surfaces of which they know less. It is, however, a regrettable fact that must be taken into account when undertaking painting work.

It is possible, for the large user of paint, such as a railway undertaking or a very large firm that employs paint in great quantities, to have paint compounded to a specification. The writing of such specifications is, however, no easy matter, since a knowledge of paint chemistry is a necessity. There are, however, signs that some knowledge of paint chemistry is reaching the skilled decorator, and firms are being forced to give, if not the composition, at least the type of paint they offer for sale. This classification appears to be by the type of synthetic resin or binder used in these preparations, although the presence of such expensive pigments (or bases) as titanium dioxide is often mentioned.

## MIXING PAINTS

Although this procedure is not recommended by paint manufacturers, most painting materials of the same type can be mixed together without ill effects ensuing. Emulsion paints, of the three most usual types, can be mixed together, even if made by different manufacturers. This can be done either to alter the colour or to use up small batches of material. Emulsion paints of any type, or mixtures thereof, can be tinted with colour in oil or colour in water, taking care to work the colour to a consistency of cream with some of the emulsion paint before adding it to the bulk of the paint to be tinted. Colour in lumps or in powder form should never be added: these are most difficult to incorporate thoroughly and often cause streaks of strong unmixed colour to appear on the finished work.

The majority of high-gloss or hard-gloss paints are based on a synthetic gum known as alkyd resin. Such paints, of differing colours and by different manufacturers, can readily be mixed together without mishap; indeed, the product is often a better paint. They may be tinted with colours in oil: for small quantities, artists' colours in small tubes (students' quality will serve) are excellent. Generally it is not necessary to add driers, such as terebene, but thinning with white spirit is always permissible. For indoor use, high gloss



can be mixed with undercoat to produce any degree of matt or semi-matt finish desired. High-gloss paints should not be mixed with chlorinated rubber paint, nor with two-to-four hour 'enamels' or one-hour 'finishes', because livering almost always results.

**PAINTING DATA**

One gallon of ready mixed paint weighs approximately 27 lbs or 12.5 kg, or 4.5 litres.

One book gold leaf contains 25 leaves size 3 1/2in×3 3/4 and covers approximately one superficial foot, or 0.09 sq. m.

The percentage of increase in area of corrugated sheets when painted is 12 1/2 per cent (Divide Ft Sup. by 8 for Yd Sup.).

**COVERAGE OF VARIOUS MATERIALS**

**WARNING:** All tables giving coverage of paints, varnishes and distempers should be used with caution. Exhaustive tests under scientific control, carried out in the U.S.A. have shown that the coverage of paints varies from painter to painter and that every craftsman gives his own personal coverage, which is different from every other painter's. The variations are very large and range from 516 to 896 ft super per gallon for primings (approx. 50 per cent variation) from 732 to 1,286 ft super per gallon for undercoating (a variation of 70 per cent) and from 705 to 1,335 ft super per gallon for finishing coats (a variation of almost 90 per cent).

**COVERING CAPACITIES OF VARIOUS MATERIALS, FOR FIRST COAT  
PER 100 YDS SUPER AND PER 84 m<sup>2</sup>**

| Material      | Surface      | gal    | lt   |
|---------------|--------------|--------|------|
| Creosote      | Wood (rough) | 5      | 23   |
| Creosote      | Wood (wrot)  | 2      | 9    |
| French Polish | "            | 3/4    | 3.5  |
| Oil           | "            | 4      | 19   |
| Stain         | "            | 1/2    | 2.25 |
| Tar           | Wood (rough) | 10     | 45   |
| Tar           | Wood (wrot)  | 5      | 23   |
| Knotting      | "            | 1/8    | 0.6  |
|               |              | pounds | kg   |
| Size          | Plaster      | 3      | 1.36 |

24 sheets of glasspaper or 3lb (1.36kg) of pumice are needed to rub down 100 yds super (84m).

SCHEDULE OF AVERAGE COVERAGE (IN YARDS SUPER) OF PAINTS AND DISTEMPERS (THIS SCHEDULE CANCELS THAT ISSUED IN NOVEMBER 1951)

| SURFACE COATINGS                                   | Surfaces          |              |                        |            |                             |                 |           |                |         |                 |                      |            |
|--|-------------------|--------------|------------------------|------------|-----------------------------|-----------------|-----------|----------------|---------|-----------------|----------------------|------------|
|  | Hand Wall Plaster | Lime Plaster | Brickwork (Fair Faced) | Hard Board | Soft Fibre Insulating Board | Asbestos Sheets | Steelwork | Metal Sheeting | Joinery | Primed Surfaced | Undercoated Surfaces |            |
| Wood primer  | —                 | —            | —                      | —          | —                           | —               | —         | —              | 65      | —               | —                    | per gallon |
| Metal primer                                       | —                 | —            | —                      | —          | —                           | —               | 55        | 70             | —       | —               | —                    | .. ..      |
| Plaster primer                                     | 60                | 50           | 35                     | —          | —                           | 50              | —         | —              | —       | —               | —                    | .. ..      |
| Building board primer                              | —                 | —            | —                      | 60         | 35                          | 50              | —         | —              | —       | —               | —                    | .. ..      |
| Undercoat  | —                 | —            | 40                     | —          | 40                          | —               | —         | —              | —       | 65              | 70                   | .. ..      |
| Gloss finish                                       | —                 | —            | 55                     | —          | 55                          | —               | —         | —              | —       | —               | 70                   | .. ..      |
| Eggshell finish                                    | —                 | —            | 55                     | —          | 55                          | —               | —         | —              | —       | 65              | 70                   | .. ..      |
| Emulsion paint                                     | 75                | 70           | 50                     | 75         | 40                          | 65              | —         | —              | —       | 75              | —                    | .. ..      |
| First grade water paint                            | 500               | 450          | 350                    | 500        | 300                         | 400             | —         | —              | —       | 600             | —                    | per cwt    |
| Oil bound water paint (B.S. 1053—Type A)           | 400               | 350          | 250                    | 350        | 200                         | 300             | —         | —              | —       | 400             | —                    | .. ..      |
| Distemper non-washable oil free (B.S. 1053-Type C) | 250               | 225          | 175                    | 250        | 150                         | 225             | —         | —              | —       | 250             | —                    | .. ..      |

METRIC

| SURFACE COATINGS      | Surfaces          |              |                        |           |            |                    |           |                |         |                 |                       |                        |
|-----------------------|-------------------|--------------|------------------------|-----------|------------|--------------------|-----------|----------------|---------|-----------------|-----------------------|------------------------|
|                       | Hand Wall Plaster | Lime Plaster | Brickwork (Fair Faced) | Hardboard | Fibreboard | Asbestos Cmt Board | Steelwork | Metal Sheeting | Joinery | Primed Surfaced | Unclassified Surfaces |                        |
| Wood primer           | —                 | —            | —                      | —         | —          | —                  | —         | —              | 59      | —               | —                     | Square metre           |
| Metal Primer          | —                 | —            | —                      | —         | —          | —                  | 50        | 65             | —       | —               | —                     | per 5 litres           |
| Plaster primer        | 35                | 46           | 33                     | —         | —          | 46                 | —         | —              | —       | —               | —                     | ..                     |
| Board primer          | —                 | —            | —                      | 55        | 33         | —                  | —         | —              | —       | —               | —                     | ..                     |
| Undercoat             | —                 | —            | 37                     | —         | 37         | —                  | —         | —              | —       | 59              | 65                    | ..                     |
| Gloss finish          | —                 | —            | 50                     | —         | 50         | —                  | —         | —              | —       | —               | 65                    | ..                     |
| Eggshell finish       | —                 | —            | 50                     | —         | 50         | —                  | —         | —              | —       | 59              | 65                    | ..                     |
| Emulsion paint        | 69                | 65           | 46                     | 69        | 37         | 59                 | —         | —              | —       | 69              | —                     | ..                     |
| First grade distemper | 419               | 359          | 275                    | 419       | 251        | 333                | —         | —              | —       | 503             | —                     | ..                     |
| Oil bound distemper   | 333               | 275          | 210                    | 275       | 168        | 211                | —         | —              | —       | 335             | —                     | square metres per 50kg |
| Distemper             | 510               | 184          | 148                    | 210       | 126        | 184                | —         | —              | —       | 275             | —                     | ..                     |

*Note* Differing conditions, such as absorbency, temperature of storage and at time of application, unevenness of surface, choice of colour, etc., can vary the figures on pages 391 and 392 by approximately 15 per cent either way.

*Note* Thixotropic Paints. Whilst it is agreed that if well “brushed out”, their spreading capacity is comparable with that of ordinary paints, their characteristics enable a thicker coating to be applied, when their coverage would be from 10–15 per

cent lower.

(Issued by the Paint and Painting Industries' Liaison Committee representing the leading associations in the paint manufacturing and in the decorating industries, by whose courtesy this table is here reproduced.)

## **PRIMING PAINTS FOR METAL**

### **IRON AND STEEL**

- 1 Red oxide and zinc chromatic;
2. Red lead;
3. Calcium plumbate;
4. Zinc ('galvanizing') paint;
5. Metallic lead primer.

**ZINC** (including sheradized-zinc-sprayed and hot-dipped steel): Any primer recommended for iron and steel. For hot-dipped galvanizing; and zinc sheet, use an etching primer or a mordant solution first.

### **ALUMINIUM**

Castings may be primed direct with a zinc chromatic or other leadless primer. Extended sections should be de-greased with turps-substitute or solvent naphtha before priming. Use an etching primer on polished aluminium.

### **LEAD AND COPPER**

Any type of primer may be used, subject to the general rule that for non-ferrous metals, primers containing lead or graphite should not be used.

## **PRIMING PAINTS FOR SOFTWOOD**

Tests by the Timber Research and Development Association have shown that an aluminium primer affords the best protection, and moreover, obviates one process, i.e. knotting. This does not, however, protect nails, screws and ironwork from rusting. If an aluminium primer is used externally or in bathrooms and kitchens, galvanized or sheradized nails and screws (or non-ferrous metal nails and screws) should be used. The next best is a properly compounded red lead primer, containing not less than 5 per cent of red lead. This type of primer should always be used if plain ferrous metal nails and screws are employed.

## PRIMING PAINTS FOR PLASTER AND CEMENT

Gypsum plaster, if it is certain that it contains no free-lime, may be painted, preferably with a 'sharp' undercoat as primer.

Plaster containing lime, or mixtures of lime and Portland cement, or Portland cement concrete, must be treated with an alkali-resisting primer before painting. In an emergency, a coat of emulsion paint will serve. It should be remembered, however, that plaster and concrete must be allowed to dry out before priming; otherwise soluble salts may force off the primer.

## THE CAUSES OF PAINT FAILURES

| <i>Cause</i>  | <i>Resulting Defects</i>  |
|---|---|
| 1. Insufficient or unskilled preparation of surface   | Defective adhesion, delayed or imperfect drying; leading to peeling, blistering, discoloration.   |
| 2. Unskilled treatment of knots in wood.  | Blistering, exudations, discoloration.  |
| 3. Unsuitable composition or unskilled application of priming coat.   | Failure to exclude moisture, and consequent deterioration of surface painted. Defective adhesion of subsequent coats.   |
| 4. Unsuitable composition or unskilled application of undercoats and finishing coat.                        | Defective adhesion between coats; delayed drying; insufficient opacity; blistering, brush marks, cracking, loss of gloss in finishing coat. "Sheariness" or "flashing" (i.e. glossy patches on paint intended to dry flat). |
| 5. Insufficient drying between coats.   | Delayed or imperfect drying; cracking or peeling; loss of gloss.  |
| 6. Unsuitable treatment of absorbent surfaces.  |   |
| (a) Insufficient treatment.   | Disintegration of paint or distemper; paint absorbed unequally, causing non-uniform finish.   |
| (b) Excessive treatment.  | Defective adhesion, resulting in peeling.   |
| 7. Redistemper over old distemper without either complete removal or application of effective sealing coat, | Flaking.  |
| 8. Unsuitable or insufficient preparation of ironwork.  | Corrosion, leading to cracking and lifting of the paint film.   |
| 9. Improper use of alkaline materials for:  | Softening and loss of gloss. Defective drying and adhesion of the fresh paint.  |
| (a) cleaning paint,   |   |

- (b) removal of paint.
- |   |   |
|---|---|
| 10. Painting over creosote, bitumen or colours soluble in oil, without applying sealing coat. | Discoloration and defective drying due to 'bleeding' (i.e. substances on the under surfaces dissolve in and penetrate through the paint). |
| 11. Exposure of newly-painted surfaces to frost, fog or moisture.                             | Delayed or defective drying: "blooming" (i.e. permanent or temporary dulling of the gloss of finishing coat).                             |
| 12. Unsuitable or insufficient sterilization of mildewed surfaces.                            | Continued growth of moulds, causing disruption of paint film.   |
| 13. Exposure of new paint to excessive heat.  | Blistering and cracking.  |
| 14. Premature painting on new cement and plasters.  | Blistering or peeling of the paint due to pressure of escaping moisture.  |
| 15. Neglect to use alkali-resisting primer for oil paints on new cement and plasters.         | Destruction of the paint by "saponification" (i.e. alkali in the surface converts oil of the paint medium into soap).                     |
| 16. Allowing Keene's cement and similar plasters to dry too quickly in the early stages.      | Powdering of the plaster surface, causing the paint to lose adhesion.   |
| 17. Painting old cement or plasters while damp.   | Peeling due to defective adhesion, saponification or efflorescence due to alkaline salts brought to surface by escaping moisture.         |
| 18. Internal treatment of dampness arising from external causes.                              | Increases trouble by driving moisture elsewhere.  |
| 19. Painting on unseasoned new wood, or on old wood whilst damp.                              | Cracking, due to shrinkage of wood, blistering and peeling, due to defective adhesion. Possibly moulds, growths and decay of woodwork.    |

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(From 'Post-War Building Study No. 5')

### RECENT DEVELOPMENTS

These include 'wet-on-wet' paints, of which the second coat can be applied while the first is still wet, and paints that can be applied with a 6 in to 8 in brush, without laying off. White and light-coloured paints, with very high obliterating power, that will literally cover black in one coat, are now available. The success of polyurethane varnish has led to the introduction of polyurethane gloss paints that are as heat resistant as the varnish. Emulsion paints incorporating a vinyl resin are now on the market: they wash as well as oil paint and have a slight sheen. For some time, emulsion paint has been used as an undercoat on cheap commercial work. The introduction of a water-thinned gloss paint

now completes the tendency for distempers to form a complete painting system, containing no oil and requiring only water as thinners.

### COVERAGE OF WALLPAPERS

Although the Standard Method of Measurement now stipulates that wallpapering be measured by the square metre, wallpaper is sold by the piece.

Estimators who calculate from the total of square metres only are liable to make costly mistakes. The following table supplies data on most types of wallpaper obtainable in this country. When ordering foreign wallpapers, check the contents of the roll with the suppliers.

| Type of Paper               | Size of piece |         | Feet super | Average Coverage in sq.     |
|-----------------------------|---------------|---------|------------|-----------------------------|
|                             | Width         | Length  | per piece  | metres per piece inc. waste |
|                             | (inches)      | (yards) |            |                             |
| English. . . . .            | 21*           | 11      | 58         | 5.0                         |
| English<br>(lining) . . . . | 22 1/2        | 12      | 67         | 6.2                         |
| French . . . . .            | 18            | 9       | 40 1/2     | 3.7                         |
| American . . . . .          | 18            | 8       | 36         | 3.3                         |
| Continental (i) .           | 28            | 11 2/3  | 81         | 7.5                         |
| Continental<br>(ii) . . . . | 22            | 11 2/3  | 62 1/2     | 5.75                        |

\*Ready trimmed, 20 3/4 inches

Some authorities reckon waste as 15 per cent of area to be covered, but this and the approximations given in the above table must vary with the size of the pattern, the type of match and the situation: staircases give rise to more waste than rooms.

The first table opposite is based on the number of lengths that can be cut from one piece or roll of paper. An addition of half-a-metre (1 ft 8 in) has been made to every length, to allow for waste in matching. Deductions can be made from the perimeter for doors and windows that extend from floor to ceiling. The room heights are divided into groups, according to the number of lengths that can be cut from a piece. In the shorter room-heights of each group, there will be greater waste than in the taller room-heights, and in these shorter heights further deduction from the perimeter can be made (up to 20 per cent) for doors and windows, since the waste will be enough to infill over doors and over and below windows.

It is necessary to hang ceiling papers across the room, working from the window, backwards, so as to avoid shadows that make the seams very prominent. The seams should be rolled down, and be butted. Take the width of the wall containing the window, and then find the other dimension under the length of the room. Where the two lines of figures coincide is the number of pieces required. For example, if a room is 14 ft long and

16 ft wide, 5 pieces will be required for the ceiling. See the second table opposite.

**PAPERHANGING: ESTIMATING PAPER (PIECES) FOR WALLS**

| Height from skirting to cornice<br>feet metres               | Lengths in one piece | NUMBER OF PIECES REQUIRED |     |     |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |     |    |     |
|--|----------------------|---------------------------|-----|-----|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|-------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|-----|----|-----|
|  |                      | 2                         | 4   | 5   | 5    | 6    | 6    | 7    | 8    | 8    | 9    | 10   | 11   | 12   | 13   | 13   | 14   | 14   | 15   | 16   | 17   | 17   | 18   | 19   | 20   | 20   | 21   | 22   | 23   | 25   | 26   | 27   | 28   | 29   | 30   | 31   | 32   | 33   | 34   | 35   | 36   | 37   | 38   | 39   | 40   | 41   | 42   | 43   | 44   | 45   | 46   | 47   | 48   | 49   | 50   | 51   | 52   | 53   | 54   | 55   | 56   | 57   | 58   | 59   | 60   | 61   | 62   | 63   | 64   | 65   | 66   | 67   | 68   | 69   | 70   | 71   | 72    | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |     |    |     |
| up to 6 1/2  | 4                    | 2                         | 4   | 5   | 5    | 6    | 6    | 7    | 8    | 8    | 9    | 10   | 11   | 12   | 13   | 13   | 14   | 14   | 15   | 16   | 17   | 17   | 18   | 19   | 20   | 20   | 21   | 22   | 23   | 25   | 26   | 27   | 28   | 29   | 30   | 31   | 32   | 33   | 34   | 35   | 36   | 37   | 38   | 39   | 40   | 41   | 42   | 43   | 44   | 45   | 46   | 47   | 48   | 49   | 50   | 51   | 52   | 53   | 54   | 55   | 56   | 57   | 58   | 59   | 60   | 61   | 62   | 63   | 64   | 65   | 66   | 67   | 68   | 69   | 70   | 71   | 72    | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |     |    |     |
| over 6 1/2 to 10   | 3                    | 2                         | 3   | 4   | 4    | 5    | 5    | 6    | 6    | 7    | 8    | 8    | 9    | 10   | 11   | 12   | 13   | 13   | 14   | 15   | 16   | 17   | 17   | 18   | 19   | 20   | 21   | 22   | 23   | 25   | 26   | 27   | 28   | 29   | 30   | 31   | 32   | 33   | 34   | 35   | 36   | 37   | 38   | 39   | 40   | 41   | 42   | 43   | 44   | 45   | 46   | 47   | 48   | 49   | 50   | 51   | 52   | 53   | 54   | 55   | 56   | 57   | 58   | 59   | 60   | 61   | 62   | 63   | 64   | 65   | 66   | 67   | 68   | 69   | 70   | 71   | 72    | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |     |    |     |
| 10-16  | 2                    | 2                         | 3   | 3   | 4    | 4    | 5    | 5    | 6    | 6    | 7    | 8    | 8    | 9    | 10   | 11   | 12   | 13   | 13   | 14   | 15   | 16   | 17   | 17   | 18   | 19   | 20   | 21   | 22   | 23   | 25   | 26   | 27   | 28   | 29   | 30   | 31   | 32   | 33   | 34   | 35   | 36   | 37   | 38   | 39   | 40   | 41   | 42   | 43   | 44   | 45   | 46   | 47   | 48   | 49   | 50   | 51   | 52   | 53   | 54   | 55   | 56   | 57   | 58   | 59   | 60   | 61   | 62   | 63   | 64   | 65   | 66   | 67   | 68   | 69   | 70   | 71    | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99  | 100 |    |     |
| 16-20  | 1                    | 1                         | 2   | 2   | 3    | 3    | 4    | 4    | 5    | 5    | 6    | 6    | 7    | 8    | 8    | 9    | 10   | 11   | 12   | 13   | 13   | 14   | 15   | 16   | 17   | 17   | 18   | 19   | 20   | 21   | 22   | 23   | 25   | 26   | 27   | 28   | 29   | 30   | 31   | 32   | 33   | 34   | 35   | 36   | 37   | 38   | 39   | 40   | 41   | 42   | 43   | 44   | 45   | 46   | 47   | 48   | 49   | 50   | 51   | 52   | 53   | 54   | 55   | 56   | 57   | 58   | 59   | 60   | 61   | 62   | 63   | 64   | 65   | 66   | 67   | 68   | 69    | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97  | 98  | 99 | 100 |
| Distance around walls, including doors & windows -PERI-METER | feet                 | 28                        | 32  | 36  | 40   | 44   | 48   | 52   | 56   | 60   | 64   | 68   | 72   | 76   | 80   | 84   | 88   | 92   | 96   | 100  | 104  | 108  | 112  | 116  | 120  | 124  | 128  | 132  | 136  | 140  | 144  | 148  | 152  | 156  | 160  | 164  | 168  | 172  | 176  | 180  | 184  | 188  | 192  | 196  | 200  | 204  | 208  | 212  | 216  | 220  | 224  | 228  | 232  | 236  | 240  | 244  | 248  | 252  | 256  | 260  | 264  | 268  | 272  | 276  | 280  | 284  | 288  | 292  | 296  | 300  |      |      |      |      |      |      |       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |     |    |     |
|  |                      | metres                    | 8.5 | 9.7 | 11.1 | 12.1 | 13.5 | 14.5 | 15.5 | 17.1 | 18.1 | 19.5 | 20.5 | 22.1 | 23.1 | 24.5 | 25.5 | 27.1 | 28.1 | 29.5 | 30.5 | 32.1 | 33.1 | 34.5 | 35.5 | 37.1 | 38.1 | 39.5 | 40.5 | 42.1 | 43.1 | 44.5 | 45.5 | 47.1 | 48.1 | 49.5 | 50.5 | 52.1 | 53.1 | 54.5 | 55.5 | 57.1 | 58.1 | 59.5 | 60.5 | 62.1 | 63.1 | 64.5 | 65.5 | 67.1 | 68.1 | 69.5 | 70.5 | 72.1 | 73.1 | 74.5 | 75.5 | 77.1 | 78.1 | 79.5 | 80.5 | 82.1 | 83.1 | 84.5 | 85.5 | 87.1 | 88.1 | 89.5 | 90.5 | 92.1 | 93.1 | 94.5 | 95.5 | 97.1 | 98.1 | 99.5 | 100.5 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |     |    |     |

**ESTIMATING PAPER FOR CEILINGS**

| Width across wall containing window | Metres | Number of lengths per piece | Number of pieces required |     |      |      |     |    |    |
|-------------------------------------|--------|-----------------------------|---------------------------|-----|------|------|-----|----|----|
|                                     |        |                             | 10                        | 12  | 14   | 16   | 18  | 20 |    |
| up to 6 1/2                         | 2      |                             | 4                         | 2   | 2    | 3    | 3   | 3  | 3  |
| over 6 1/2 to 10                    | 2.5-3  |                             | 3                         | 2   | 3    | 3    | 4   | 4  | 4  |
| 10 to 16                            | 3.5-5  |                             | 2                         | 3   | 4    | 5    | 5   | 6  | 6  |
| 16 to 20                            | 6      |                             | 1                         | 6   | 7    | 9    | 10  | 11 | 12 |
| Length of room                      |        | Feet                        | 10                        | 12  | 14   | 16   | 18  | 20 |    |
|                                     |        | Metres                      | 3                         | 3.6 | 4.25 | 4.75 | 5.5 | 6  |    |

## 22. THE GLAZIER

### CODES OF PRACTICE

**CP 122: Part 1:1966:** Hollow glass blocks. Hollow glass blocks forming walls and partitions, including fixing, etc.

**CP 152:1972:** Glazing and fixing of glass for buildings.

Numerical values in SI units. Number of glass factor tables reduced to two.

**B.S. 5516:1977:** Code of practice for patent glazing (formerly CP 145, Part 1).

Single and double patent glazing. Systems using four-edge support.

### BRITISH STANDARDS

**B.S. 952:1964:** Classification of glass for glazing and terminology for work on glass.

Types of glass available for building in four classes; transparent, translucent, opal and special.

**Part 1:1978:** classification for building purposes in three groups; annealed flat glass, including float or polished plate, sheet, cast and wired glass; processed flat glass including toughened and laminated glass, and insulating units; miscellaneous glasses.

**B.S. 1207:1961:** Hollow glass blocks.

Dimensions, finish, etc.

**B.S. 3447:1962:** Glossary of terms used in the glass industry.

Classifies and defines a comprehensive list of terms.

THICKNESS AND WEIGHTS OF SHEET, HEAVY DRAWN AND FLOAT GLASS



| Fractions                              | Inches | Decimals      | Ounces                            | Millimetres |
|--|--------|---------------|-----------------------------------|-------------|
| $\frac{1}{28}$                         |        | 0.0357-0.0385 | $7\frac{1}{2}$ -8                 | 0.9-1.0     |
| $\frac{1}{24}$ - $\frac{1}{26}$        |        | 0.0385-0.0417 | 8- $8\frac{1}{2}$                 | 0.95-1.05   |
| $\frac{1}{22}$ - $\frac{1}{24}$        |        | 0.0417-0.0455 | $8\frac{1}{2}$ - $9\frac{1}{2}$   | 1.05-1.15   |
| $\frac{1}{20}$ - $\frac{1}{22}$        |        | 0.0455-0.05   | $9\frac{1}{2}$ - $10\frac{1}{2}$  | 1.15-1.25   |
| $\frac{1}{18}$ - $\frac{1}{20}$        |        | 0.05-0.0556   | $10\frac{1}{2}$ - $11\frac{1}{2}$ | 1.25-1.4    |
| $\frac{1}{15}$ - $\frac{1}{17}$        |        | 0.0588-0.0667 | 12-14                             | 1.5-1.7     |
| $\frac{1}{13}$ - $\frac{1}{15}$        |        | 0.0667-0.0769 | 14-16                             | 1.7-1.9     |
| $\frac{1}{12}$                         |        | about 0.08    | 17-18                             | about 2.0   |
| $\frac{1}{8}$                          |        | " 0.125       | 24-26                             | " 3.0       |
| $\frac{1}{4}$                          |        | " 0.16        | 32-34                             | " 4.0       |
| $\frac{1}{2}$                          |        | " 0.19        | 38-42                             | 4.5-5.0     |
| $\frac{1}{2}$ ( $\frac{1}{2}$ in bare) |        | " 0.22        | 44-50                             | 5.0-6.0     |
| $\frac{1}{2}$                          |        | " 0.25        | 50-58                             | 6.0-7.0     |
| $\frac{1}{2}$                          |        | " 0.32        | 60-70                             | about 8.0   |
| $\frac{1}{2}$                          |        | " 0.375       | 75-85                             | " 10.0      |
| $\frac{1}{2}$                          |        | " 0.5         | 100-110                           | " 12.5      |

GLASS DIMENSIONS AND WEIGHTS

| Type of glass          | Thickness                                     | Wt. per ft sup | Maximum sizes      |
|------------------------|---|----------------|--------------------|
|                        | ins   | oz             | ins                |
| Sheet glass            | $\frac{1}{12}$                                | $18 \pm 1$     | $62 \times 42$     |
|                        | $\frac{1}{10}$                                | $24 \pm 1$     | $66 \times 42$     |
|                        | $\frac{1}{8}$                                 | $26 \pm 2$     | $66 \times 42$     |
|                        | $\frac{1}{32}$                                | $32 \pm 2$     | $66 \times 42$     |
| Rolled and cast        | $\frac{1}{8}$                                 | 26             | $144 \times 44$    |
|                        | $\frac{1}{4}$                                 | 40             | $144 \times 44$    |
|                        | $\frac{1}{2}$                                 | 54             | $144 \times 44$    |
| Wired, rolled and cast | $\frac{1}{2}$                                 |                | $120 \times 40$    |
| Georgian wired cast    | $\frac{1}{2}$                                 |                | $120 \times 40$    |
| Figured and cathedral  | $\frac{1}{8}$ , $\frac{1}{4}$ , $\frac{1}{2}$ |                | $120 \times 42$    |
| Wired arctic           | $\frac{1}{2}$                                 |                | $120 \times 24$    |
|                        |   |                | Or $100 \times 42$ |

Weight per Square Foot for each 1/16 in of thickness is about 13 oz, or about 8.2 oz for each millimetre of thickness.

Sheet Glass Qualities: O.Q. = Ordinary Glazing Quality.

S.Q. = Selected Glazing Quality.

S.S.Q. = Special Selected Quality.

*Note:* 18 oz sheet is not suitable for windows. 24 oz is generally satisfactory for sizes up to 4ft×2ft.

**PLAIN GLASS**

| Nominal thickness (mm) sheet | Nominal maximum size                   | Approx weight kg per m <sup>2</sup> |
|------------------------------|--|-------------------------------------|
| 3                            | 2030×1220mm                            | 7.25                                |
| 4                            | 2030×1220mm                            | 10.00                               |
| 5                            | 4.65m <sup>2</sup> ×9.03m <sup>2</sup> | 12.25                               |
| 6                            | 4.65m <sup>2</sup> ×9.03m <sup>2</sup> | 15.00                               |
| Float                        |  |                                     |
| 3                            | 1270×1270 and<br>1620×1010mm           | 7.50                                |
| 5                            | 2540×2280mm                            | 12.50                               |
| 6                            | 4560×3170mm                            | 15.00                               |
| 10                           | 7100×3300mm                            | 25.00                               |
| 12                           | 7100×3300mm                            | 30.00                               |
| 15, 19 and 25                | 4320×2800mm                            | 37.5, 47.5 and 63.5                 |
| 32                           | 27400×2280mm                           | 79.25                               |
| 38                           | 2740×2280mm                            | 95.25                               |

**OTHER GLASS**

| Type                    | Nominal thickness        | Max. size in mm         |
|-------------------------|--------------------------|-------------------------|
| Patterned; all patterns | 3mm                      | 2140×1280               |
|                         | 5mm                      | 2140×1320               |
| Roughcast               | 5, 6 and 10mm            | 3710×1270               |
|                         | 12mm                     | 4420×2490               |
| 'Insulite'              | 6+12+6mm (12mm airspace) | 2400×2400 and 1930×3500 |

**PUTTY FOR GLAZING SHEET GLASS**

| Type         | Per ft super of pane sizes shown |       |       |       |         |            |
|--------------|----------------------------------|-------|-------|-------|---------|------------|
|              | Not exc. 1ft                     | 1-2ft | 2-4ft | 4-6ft | Exc 6ft | Per ft run |
|              | lb                               | lb    | lb    | lb    | lb      | lb         |
| Wood sashes  | .6                               | .4    | .3    | .25   | .2      | .125       |
| Metal sashes | .8                               | .6    | .4    | .33   | .3      | .156       |

**MEASURING**

Allow 3/32 in/2.4 mm all round (i.e., 'tight size' less 3/16 in/5 mm). For coloured glass,

or painted surfaces (*not* stained glass, but glass as used in curtain walling) allow 1/8in/3 mm all round if the longer dimension does not exceed 30 in/770 mm. For pieces of glass with one or both dimensions above 30 in/ 770 mm, allow 3/16 in/5 mm all round. The edge cover for coloured glass should not exceed 3/8 in/ 9.5mm.

**GLAZING WITHOUT BEADS MAXIMUM SIZES**

| Exposure grading | Maximum size (length and breadth) |
|------------------|-----------------------------------|
| A&B              | 84 in–2·13m                       |
| C                | 72 in–1·82m                       |
| D                | 60 in–1·52m                       |

*Note:*For E, F, G and all other more severe conditions of exposure, beads should always be used.

**MINIMUM THICKNESS OF GLASS (FOR ALL APERTURES IN VARIOUS SITUATIONS)**

The following must be taken into account when calculating the least thickness of glass for any opening: type of glass, size of opening to be glazed, height above ground, and exposure conditions. The following method, condensed from CP 1152, makes allowance for all these factors.

1. Read off from table A the exposure gradient (the Capital Letter) given (a) for the height above ground and (b) the exposure conditions: i.e. the type of site.
2. Ascertain the ‘Glass Factor’ by dividing the area of the opening by twice the length plus the breadth. Take the answer to two places of decimals.
3. Read down on Table B, under the exposure gradient found in 1. above, until reaching the first ‘Glass Factor’ larger than that obtained in 2. above.
4. On the same line, under ‘Minimum Thickness of Glass’ will be found the least thickness suitable for the opening.

**Example:** A pane of glass, 5 ft 0in (1.52 m) long by 5 ft 6 in (1.70 m) broad is required for a window on the first floor of a house in an exposed position in town. What thickness of (a) float, or (b) sheet of glass would be required?

1. For an exposed urban site, less than 40 ft (12 m) from the ground, table A shows the exposure gradient to be C.
2.
  - (a) The area of glass is 1.52 m×1.70 m=5.16 m<sup>2</sup>.
  - (b) Twice the length plus the breadth=4.74.
  - (c) Dividing (a) by (b) the result is 1.10 (approx.).
3. The nearest glass factor greater than this in column C of Table B is, for Float glass, 1.12. Therefore 4.5 mm (3/16 in) glass is required.  
For sheet glass, the nearest glass factor in column C is 1.49, and therefore 4.5 mm

(3/16 in) glass is required. The same result will be obtained if the calculations are in Imperial units.

**EXPOSURE GRADINGS**

| Type of Site                         | Mean wind velocity<br>in m.p.h. | GRADIENTS: by Height of Glass<br>above ground |       |           |
|--------------------------------------|---------------------------------|---|-------|-----------|
|                                      |                                 | 0-40  | 40-80 | 80-120 ft |
|                                      |                                 | 0-12  | 12-24 | 24-36 m   |
| Sheltered urban                      | 45                              | A   | B     | C         |
| Normal urban and sheltered elsewhere | 54                              | B   | C     | D         |
| Exposed urban and open country       | 63                              | C   | E     | E         |
| All others except extremes*          | 72                              | D   | F     | F         |

\* Extreme conditions seldom arise in the United Kingdom. If suspected consult the Meteorological Office.

**GLASS FACTORS: FLOAT**

| Exposure gradients |      |      |      |      |      | Minimum thickness of glass |       |
|--------------------|------|------|------|------|------|----------------------------|-------|
| A                  | B    | C    | D    | E    | F    | in                         | mm    |
| 1.56               | 1.30 | 1.12 | 0.98 | 0.87 | 0.78 | 3/16                       | 4.5-5 |
| 2.18               | 1.82 | 1.56 | 1.37 | 1.21 | 1.09 | 1/4                        | 6-7   |
| 3.12               | 2.60 | 2.23 | 2.00 | 1.73 | 1.59 | 5/16-3/8                   | 8-9.5 |
| 3.59               | 2.99 | 2.56 | 2.24 | 1.99 | 1.80 | 3/8                        | 9.5   |

**GLASS FACTORS: SHEET**

| Exposure gradients |      |      |      |      |      | Minimum thickness of glass |       |
|--------------------|------|------|------|------|------|----------------------------|-------|
| 0.76               | 0.71 | 0.66 | 0.62 | 0.58 | 0.54 | 24oz                       | 3mm   |
| 0.95               | 0.88 | 0.81 | 0.75 | 0.69 | 0.64 | 26 oz                      | 3mm   |
| 1.27               | 1.16 | 1.06 | 0.97 | 0.89 | 0.83 | 32 oz                      | 4mm   |
| 2.08               | 1.73 | 1.49 | 1.30 | 1.16 | 1.04 | 3/16 in                    | 4.5mm |

**MULTIPLE GLAZING**

In recent years, double glazing has steadily come into fashion in Britain. Until recently it has laboured under the disadvantage of being uneconomical. To burn a little more fuel has been less costly than incurring the capital cost of double glazing. However, with the recent staggering increases in fuel costs, double glazing is now an economical proposition.

## HOW DOUBLE GLAZING WORKS

It is almost true to say that the temperature on both sides of a pane of sheet glass is the same. All that the glass does is to protect one from the cooling effects of the wind; but a single sheet of glass is a cold spot in a room, and sometimes causes an unwanted circulation of air in the room, which one feels as a draught. This is why, in winter, it is uncomfortable to sit within 3 ft (0.9 m) of a single-glazed window, and why radiators are situated under windows. Double glazing for thermal insulation consists essentially of two panes of glass with an air-space between them. The size of the air-space is critical, because the thermal insulation is provided not by the glass panes but by the air imprisoned between them. This air must be still, without air-currents being set up in it and a spacing of 3/4 in (20 mm) between the glasses has been found to be the optimum distance without air currents being created.

### THERMAL TRANSMITTANCE DATA

|  |                            |
|--|----------------------------|
| Single glass in vertical frame         | 5.6 W/m <sup>2</sup> deg C |
| Double glass, with 20 mm air-space     | 2.94 „ „                   |
| ‘Insulite’ units, with 12 mm air-space | 3.01 „ „                   |
| ‘Insulite’ units, with 6 mm air-space  | 3.43 „ „                   |
| 9 in brickwork (215 mm) unplastered    | 2.76 „ „                   |

The greater the thermal transmittance, the greater the heat loss.

### DOUBLE GLAZING SYSTEMS

In practice, double-glazing can be effected in three ways:

1. By double sashes or casements, opening independently;
2. By sub-frames or plastics or metal, screwed to the existing lights; and
3. Factory-produced, sealed units consisting of two panes spaced 6 or 12 mm apart.  
Some variations have an inert gas or a vacuum instead of air between the panes.

Method 1 is the oldest system, but can suffer from the liability of condensation between the panes, thus obstructing the view. The inner lights, if made to open inwards, are unpopular because they interfere with window curtains. Condensation can be avoided by controlled ventilation and moisture absorbents, such as silica gel. Double casements can be made to open outwards, as one unit and the inner leaves need only be opened for cleaning.

Method 2, the most modern and least expensive relies on perfect installation and is best installed by a specialist subcontractor. The possibility of condensation in the air-space cannot be ruled out.

Method 3 is the only certain way of obtaining a sealed, condensation-free air-space. The units are purpose-made to required sizes, in the factory: they require extra-deep rebates in the lights. It is difficult to adapt existing lights to take these units.

The table above shows the gain in heat-retention in a room by various types of double glazing. It is interesting to see that the best type of double-glazing gives almost as much insulation as a 9 in (215 mm) brick wall.

In double-glazing, it is vital to see that the lights are as good a fit as possible. New windows should be weatherstripped and old, warped ones will need new or supplementary stops and beads, as well as weatherstripping. A poorly-fitting light can destroy much of the advantage of double-glazing.

### TRIPLE GLAZING

In the Scandinavian countries and northern Russia, double-glazing does not provide enough thermal insulation, and triple glazing is general. Thermal insulation is thus greatly increased, to something like twice that provided by a 9 in (215 mm) wall. Triple glazing is an expensive business and presents some interesting problems in window design. It is not a practical proposition for much of England, but in exposed situations of northern England and Scotland could be worth consideration. For a large picture window in such situations, double-glazing might not be sufficient to prevent discomfort in winter, which triple glazing would remedy.

### ADVANTAGES

The principal advantage of multiple glazing is that there are no unusable parts of the room. Heating is more even over the whole of the living space and there are no eddies to cause draughts. There will be some fuel saving: radiators can be sited where most advantageous and less heating surface will be required.

### PLASTICS IN BUILDING

Plastics may be briefly described as organic substances, mostly derived from by-products of coal-gas manufacture and of the refining of mineral oil, that can be moulded into stable shapes. The substances are manipulated or combined with others, by modern chemistry, to form 'long chain' molecules, on which the plasticity of the material and final rigidity of the objects made from it depend. Indeed, the chemistry of these substances is so far advanced that it is virtually true to say that even their basic molecular structure-patterns are man-made, in order to produce substances with predetermined properties. Space does not allow further consideration of the chemical constituents in the method of manufacture: for further information on this subject, see *Plastics in the Service of Man* by Couzens and Yarsley (Penguin Books).

Plastics range from soft, pliable rubber-like substances to intensely hard and brittle ones. They are divisible into two main groups—thermoplastic and thermosetting plastics. Articles made from thermoplastic plastics can be bent under applied heat, and 'welded' under heat, usually in an atmosphere of inert gas, to prevent oxidization. An example is Polyvinyl Chloride (PVC). Thermosetting plastics cannot be altered in shape nor joined by the application of heat after they have once become moulded into shape. In general,

plastics cannot be successfully glued. Thermoplastic plastics tend to be pliable, while thermosetting plastics are brittle.

### **THERMOPLASTIC PLASTIC**

1. POLYETHELINE ('Alkathene', 'Cryntholene', 'Polythene', 'Visqueen') Very tough, obtainable in transparent or delicately tinted forms. Used in tubular form for water supply (usually confined to cold water) and jointed by compression joints or welded joints. It can be moulded into baths, basins, etc. Also used in sheet form, as vapour barriers, underlay for concrete, and (plain or reinforced with nylon or cotton) as covers for buildings in course of erection and as damp-courses.

#### **2. POLYVINYL CHLORIDE**

Used as flooring sheets and tiles ('Marley-film', 'Vinyltiles') as a coating on washable wallpapers; as hessian or felt-backed floor-coverings ('Cresylene', 'Hardura'). Also used as coatings on steel and other metals, as cold-water tank linings, and in high-density forms such as ball-valve floats and rainwater goods.

#### **3. POLYVINYL ACETATE**

Its principal use in building is in an aqueous suspension, as 'emulsion paint'. Some rainwater goods are made from this plastic.

#### **4. POLYSTYRENE**

Used, in emulsion form, in emulsion paint; and in foamed form as an insulating material ('Jablite').

#### **5. METHYL METHACRYLATE ('Perspex', 'Diakon')**

Used for transparent corrugated sheeting on a flat sheet.

#### **6. POLYAMIDES**

Represented by 'Nylon', now used for washers and for parts of ball-valves and for ropes.

#### **7. SILICONE-BASED PLASTICS**

Used in various sealing compounds.

### **THERMOSETTING PLASTICS**

#### **1. PHENOL-FORMALDEHYDE PLASTICS ('Bakelite').**

Are those employed in the production of electrical switch-gear and fittings, door furniture, rigid sheets, hollow partitions, ventilators, tubes and many other fittings: these are among the oldest plastic materials employed in building. They are dark in colour.

## 2. UREA FORMALDEHYDE PLASTICS

Have similar uses, but in their natural state are transparent. They are used for the production of fittings in light colours.

## 3. MELAMINE

Is similar to urea-formaldehyde, and is largely used in the production of paper-based laminates ('Formica', 'Wearite').

## 4. POLYESTER PLASTICS

Are used in conjunction with glass-fibre reinforcement, to produce translucent corrugated and plain sheets ('Filon', 'Cascalite').

Combinations of plastics, such as phenol-formaldehyde, and common resin, polyesters and natural oils—such as chinawood oil (called alkyd resins) and epoxy resins—form a large range of synthetic gums that have largely replaced the natural gums, such as copal, in paints, varnishes and enamels.

Similarly, in the field of adhesives, synthetic glues such as urea-formaldehyde (mildly water-resistant), melamine (water-resistant) and resorcinol (water-resistant) plastics have been employed, with acids to harden them, as adhesives that set more quickly in the cold state, or with the aid of heat. They have virtually replaced the older animal glue in factory and workshop production, and have given to the building industry glues that will withstand permanent exposure to the severest weather conditions.



# **Employers' and Trade Unions Organisations**

## **Amalgamated Union of Asphalt Workers**

Jenkin House, 173A Queens Road, Peckham, London SE15 2NF  
(01-639 1669)

## **Amalgamated Union of Engineering Workers, Constructional Section**

Construction House, 190 Cedars Road, Clapham, London SW4 0PP  
(01-6224451)

## **Amalgamated Union of Engineering Workers, Technical and Supervisory Section**

Onslow Hall, Little Green, Richmond, Surrey TW9 1QN  
(01-9482271)

## **Architects' Benevolent Society**

66 Portland Place, London W1N 4AD  
(01-5802823)

## **Association of Painting and Decorating Employers Ltd**

1 Sheffield Road, Wylde Green, Sutton Coldfield B75 5HA  
(021-3505209)

## **Builders' Merchants Federation**

15 Soho Square, London W1V 5FB  
(01-439 1753)

## **Building Employers Confederation**

82 New Cavendish Street, London W1M 8AD  
(01-5805588)

## **Committee of Associations of Specialist Engineering Contractors**

34 Palace Court, Bayswater, London W2  
(01-2292488)

## **Confederation of British Industry**

Centre Point, 103 New Oxford Street, London WC1  
(01-3797400)

## **Electrical Contractors Association**

ESCA House, 34 Palace Court, Bayswater, London W2  
(01-229 1266)

**Electrical, Electronic Telecommunication and Plumbing Union**

Hayes Court, West Common Road, Bromley, Kent BR2 7AU  
(01-4627755)

**Federation of Associations of Specialists and Subcontractors**

Maxwelton House, Boltro Road, Haywards Heath, West Sussex RH16 1BJ  
(0444451836)

**Federation of Building and Civil Engineering Contractors (NI) Ltd**

143 Malone Road, Belfast BT9 6SU  
(0232661711)

**Federation of Building Sub-Contractors**

82 New Cavendish Street, London W1M 8AD  
(01-5805588)

**Federation of Civil Engineering Contractors**

Cowdray House, Portugal Street, London WC2A 2HH  
(01-4044020)

**Federation of Master Builders**

33 John Street, Holborn, London WC1N 2BB  
(01-2427583)

**Furniture, Timber and Allied Trades Union**

Fairfields, Roe Green, Kingsbury, London NW9 0PT  
(01-2040273)

**General Municipal Boiler Makers and Allied Trade Unions**

Thorne House, Ruxley Ridge, Claygate, Esher, Surrey KT10 0TL  
(7862081)

**Heating and Ventilation Contractors Association**

ESCA House, 34 Palace Court, Bayswater, London W2 4JG  
(01-2292488)

**House Builders Federation**

82 New Cavendish Street, London W1M 8AD  
(01-5804041)

**Iron and Steel Trades Confederation**

Swinton House, 324 Grays Inn Road, London WC1X 8DD  
(01-837 6691)

**Joint Industry Board for the Electrical Contracting Industry**

Kingswood House, 47/51 Sidcup Hill, Sidcup, Kent DA14 6HJ  
(01-3020031)

**Metal Roofing Contractors Association**

The Secretary, Hill Crest, Hockering Road, Woking, Surrey GU22 7HP  
(0486270324)

**National Association of Formwork Contractors**

82 New Cavenfish Street, London W1M 8AD  
(01-5805588)

**National Association of Plumbing, Heating and Mechanical Services Contractors**

6 Gate Street, London WC2A 3HX  
(01-405 2678)

**National Association of Scaffolding Contractors**

82 New Cavendish Street, London W1M 8AD  
(01-5805588)

**National Federation of Building Trades Employers (Now BEC)**

82 New Cavendish Street, London W1M 8AD  
(01-5805588)

**National Federation of Demolition Contractors**

6 Portugal Street, London WC2A 2HH  
(01-4044020)

**National Federation of Glass Reinforced Plastics Cladding Contractors**

82 New Cavendish Street, London W1M 8AD  
(01-5805588)

**National Federation of Painting and Decorating Contractors**

82 New Cavendish Street, London W1M 8AD  
(01-5805588)

**National Federation of Plastering Contractors**

82 New Cavendish Street, London W1M 8AD  
(01-5805588)

**National Federation of Roofing Contractors**

15 Soho Square, London W1V 5FB  
(01-439 1753)

**National Graphical Association**

63–67 Bromham Road, Bedford, Bedfordshire  
(023451521)

**National Joint Council for the Building Industry**

18 Mansfield Street, London W1M 9FG  
(01–5801740)

**National Joint Council for Felt Roofing Contracting Industry**

Maxwelton House, Boltro Road, Haywards Heath, West Sussex RH16 1BJ  
(0444451835)

**National and Local Government Officers Association (NALGO)**

1 Mabledon Place, London WC1  
(01–3882366)

**National Union of Public Employees**

Civic House, 20 Grand Depot Road, Woolwich, London SE18 6SF  
(01–8542244)

**Scottish Building Contractors Association**

13 Woodside Crescent, Glasgow G3 7UP  
(041–332 7144)

**Scottish Building Employers Federation**

13 Woodside Crescent, Glasgow G3 7UP  
(041–332 7144)

**Scottish Decorators Federation**

c/o 249 West George Street, Glasgow G2 4RG  
(041–221 7090)

**Scottish and Northern Ireland Plumbing Employers Federation**

2 Walker Street, Edinburgh EH3 7LB  
(031–225 2255)

**STAMP (Supervisory, Technical, Administrative, Managerial and Professional Section of UCATT)**

UCATT House, 177 Abbeville Road, London SW4 9RL  
(01–662 2442)

**Transport and General Workers Union, Building Crafts Section**

Transport House, Smith Square, London SW1P 3JA  
(01–828 7788)

**Union of Construction, Allied Trades and Technicians**

UCATT House, 177 Abbeville Road, London SW4 9RL

(01-662 2442)

# GOVERNMENT AND PUBLIC ORGANISATIONS

## **Association of County Councils**

66a Eaton Square, London SW1W 9BH  
(01-235 1200)

## **Association of District Councils**

9 Buckingham Gate, London SW1 6LE  
(01-828 7931)

## **Association of Metropolitan Authorities**

36 Old Queen Street, London SW1H 9HZ  
(01-222 8100)

## **British Gas Corporation**

59 Bryanston Street, London W1A 2AZ  
(01-723 7030)

## **British Overseas Trade Board**

1 Victoria Street, London SW1H 0ET  
(01-215 7877)

## **British Steel Corporation**

9 Albert Embankment, London SE1 RSM  
(01-735 7654)

## **Building Economic Development Committee**

National Economic Development Office, Millbank Tower, Millbank, London SW1P  
4QX  
(01-211 3555)

## **Central Electricity Generating Board**

Sudbury House, 15 Newgate Street, London EC1A 7AU  
(01-248 1202)

## **Central Office of Information**

Hercules Road, London SE1 7DU  
(01-928 2345)

**Civic Trust**

17 Carlton House Terrace, London SW1Y 5AW  
(01-930 0914)

**Civil Engineering Economic Development Committee**

National Economic Development Office, Millbank Tower, Millbank, London SW1P  
4QX  
(01-211 3555)

**Commission for the New Towns**

Glen House, Stag Place, London SW1E 5AS  
(01-828 7722)

**Construction Industry Training Board**

Radnor House, 1272 London Road, Norbury, London SW16 4EL  
(01-764 5060)

**Council for Environmental Conservation**

Zoological Gardens, Regent's Park, London NW1 4RY  
(01-722 7111)

**Council for Small Industries in Rural Areas**

141 Castle Street, Salisbury, Wiltshire SP1 3TP  
(0722 6255)

**Countryside Commission**

John Dower House, Crescent Place, Cheltenham, Gloucestershire GL50 3RA  
(0242 21381)

**Department of Energy**

Thames House South, Millbank, London SW1P 4QJ  
(01-211 3000)

**Department of the Environment**

2 Marsham Street, London SW1P 3EB  
(01-212 3434)

**Department of Housing, Local Government (NI)**

Stormont, Belfast BT4 3SS  
(0232 63210)

**Department of Planning (NI)**

Commonwealth House, Castle Street, City Centre, Belfast  
(0232 21212)

**Department of Industry**

Ashdown House, 213 Victoria Street, London SW1E 6RB  
(01-212 3395)

**Department of Trade**

1-19 Victoria Street, London SW1H 0ET  
(01-215 7877)

**Development Commission**

11 Cowley Street, London SW1P 3NA  
(01-222) 9134

**Electricity Council**

30 Millbank, London SW1P 4RD  
(01-834 2333)

**Historic Buildings Council for England**

25 Savile Row, London W1X 2BT  
(01-734 6010)

**Housing Centre Trust**

33 Alfred Place, London WC1E 7JU  
(01-637 4202)

**Housing Corporation**

149 Tottenham Court Road, London W1P 0BN  
(01-387 9466)

**Housing Project Control, Costs and Contracts**

c/o Department of the Environment, 2 Marsham Street, London SW1  
(01-212 3434)

**Land Registry**

32 Lincoln's Inn Fields, London WC2A 3PH  
(01-405 3488)

**Local Authorities Management Services and Computer Committee (LAMSAC)**

Vincent House, Vincent Square, London SW1P 2NB  
(01-828 2333)

**London Boroughs Association**

Room 215, Camden Town Hall, Euston Road, London NW1 2RU  
(01-278 4444)



**National Association of Local Councils**

108 Great Russell Street, London WC1B 3LD  
(01-637 1865)

**National Coal Board**

Hobart House, Grosvenor Place, London SW1X 7AE  
(01-235 2020)

**National Housing and Town Planning Council**

Norvin House, 45/55 Commercial Street, London E1 6BA  
(01-247 5732/3)

**National Investments and Loan Office**

Royex House, Aldermanbury Square, London EC2V 7LT  
(01-606 7321)

**New Towns Association**

Metro House, 57/58 St James Street, London SW1A 1LD  
(01-409 2635)

**Ordnance Survey**

Romsey Road, Maybush, Southampton SO9 4DH  
(0703 775555)

**Property Services Agency**

Lambeth Bridge House, Albert Embankment, London SE1 7SB  
(01-212 3434)

**Scottish Civic Trust**

24 George Square, Glasgow G2 1EF  
(041-221 1466)

**Scottish Council (Development and Industry)**

23 Chester Street, Edinburgh EH3 7ET  
(031-225 7911)

**Scottish Development Agency**

120 Bothwell Street, Glasgow G2 7JP  
(041-248 2700)

**Scottish Office**

New St Andrews House, St James's Centre, Edinburgh EH1 3SX  
(031-556 8400)

**Wales Investment Location**

8th Floor, Pearl Assurance House, Greyfriars Road, Cardiff CF1 3AG  
(0222 371641)

**Water Authorities Association (WAA)**

1 Queen Anne's Gate, London SW1H 9BT  
(01-222 8111)

**Welsh Development Agency**

Treforest Industrial Estate, Pontypridd, Glamorgan CS37 5UT  
(044-385 2666)

**Welsh Office**

Cathays Park, Cardiff CF1 3NQ  
(0222 825111)

# **INFORMATION, RESEARCH, TESTING, STANDARDS AND APPROVALS ORGANISATIONS AND ACADEMIC INSTITUTIONS**

## **Air Conditioning Advisory Bureau**

30 Millbank, London SW1  
(01-834 8827)

## **Asbestos Information Centre Ltd**

Sackville House, 40 Piccadilly, London W1V 9PA  
(01-439 9231)

## **Aslib (Association of Special Libraries and Information Bureaux)**

3 Belgrave Square, London SW1X 8PL  
(01-235 5050)

## **Birmingham Engineering and Building Centre Ltd**

16 Highfield Road, Edgbaston, Birmingham B15 3DU  
(021-454 9137)

## **BNF Metals Technology Centre**

Grove Laboratories, Denchworth Road, Wantage, Oxfordshire OX12 9BJ  
(023 57 2992)

## **Brick Development Association**

Woodside House, Winkfield, Windsor, Berkshire SL4 2DP  
(0344 885651)

## **British Board of Agrément**

PO Box 195, Bucknall's Lane, Garston, Watford, Herts WD2 7NG  
(09273 70844)

## **British Ceramic Research Association**

Queens Road, Penkhull, Stoke-on-Trent ST4 7LQ  
(0782 45431)

## **British Coal Utilisation Research Association**

Randalls Raod, Leatherhead, Surrey

(Leatherhead 379222)

**British Electrotechnical Approvals Board**

Mark House, The Green, 9–11 Queens Road, Hersham, Walton-on-Thames, Surrey  
KT12 5NA

(Walton-on-Thames 44401)

**British Glass Industry Research Association**

Northumberland Road, Sheffield S10 2UA

(0742 686201)

**British Standards Institution**

2 Park Street, London W1A 2BS

(01–629 9000)

**BSI Centre**

Maylands Avenue, Hemel Hempstead, Hertfordshire HP2 4SQ

(0442 3111)

**British Standards Society**

2 Park Street, London W1A 2BS

(01–629 9000)

**Build Electric Bureau**

The Building Centre, 26 Store Street, London WC1E 7BT

(01–580 4986)

**Building Advisory Management Services**

18 Mansfield Street, London W1M 9EG

(01–636 2862)

**Building Centre**

26 Store Street, London WC1E 7BT

(01–637 1022/8361 Information: 0344 884999)

**Building Centre, Bristol**

Stonebridge House, Colston Avenue, The Centre, Bristol BS1 4TW

(0272 277022)

**Building Centre, Cambridge**

15–16 Trumpington Street, Cambridge CB2 1QD

(0223 359625)

**Building Centre, Manchester**

113–115 Portland Street, Manchester M1 6FB

(061–236 9802/6933)

**Building Centre, Scotland**

3 Claremont Terrace, Glasgow G3 7PF

(041–332 7399)

**Building Centre, Southampton**

Grosvenor House, 18–20 Cumberland Place, Southampton SO1 2BD

(0703 27350)

**Building Centre Trust**

26 Store Street, London WC1E 7BT

(01–637 1022)

**Building Conservation Trust**

Apartment 39, Hampton Court Palace, East Moseley, Surrey KT8 9BS

(01–943 2277)

**Building Cost Information Service**

85–87 Clarence Street, Kingston-upon-Thames, Surrey KT1 1RB

(01–546 7554)

**Building Regulations Division**

c/o Department of the Environment, 2 Marsham Street, London SW1

(01–212 3434)

**Building Research Advisory Service**

Building Research Establishment, Bucknall's Lane, Garston, Watford WD2 7JR

(Garston 76612)

**Building Research Establishment**

(Department of the Environment), Bucknall's Lane, Garston, Watford WD2 7JR

(Garston 74040)

**Building Research Establishment Scottish Laboratory**

Kelvin Road, East Kilbride, Glasgow G75 0RZ

(035 52 33941)

**Building Services Research and Information Association**

Old Bracknell Lane, Bracknell, Berkshire RG12 4AH

(0344 26511)

**Cement and Concrete Association**

Terminal House, 52 Grosvenor Gardens, London SW1W 0AQ

(01–235 6661)

**Central Statistical Office**

Cabinet Office, Great George Street, London SW1P 3AQ  
(01-233 3000)

**Centre for Advanced Land Use Studies**

College of Estate Management, Whiteknights Park, Reading RG6 2AW  
(0734 861101)

**Centre for Urban Studies**

55 Gordon Square, London WC1H 0NT  
(01-636 2537)

**Concrete Society**

Terminal House, 52 Grosvenor Gardens, London SW1W 0AJ  
(01-730 8252)

**CONSTRADO (Constructional Steel Research and Development Organisation)**

NLA Tower, 12 Addiscombe Road, Croydon CR9 3JH  
(01-688 2688/01-686 0366)

**Construction Industry Information Group**

26 Store Street, London WC1E 7BT

**Construction Industry Research and Information Association**

6 Storey's Gate, London SW1P 3AU  
(01-222 8891)

**Copper Development Association**

Orchard House, Mutton Lane, Potters Bar, Hertfordshire EN6 3AP  
(77 50711)

**Coventry Building Information Centre**

Department of Architecture and Planning, Council House, Earl Street, Coventry CV1  
5RT  
(0203 25555)

**Department of Architecture, University of Sheffield**

Arts Tower, Sheffield S10 2TN  
(0742 78555)

**Department of Architecture and Building Science, University of Strathclyde**

131 Rottenrow, Glasgow G4 0NG  
(041-552 4400)

**Department of Building, Polytechnic of Central London**

35 Marylebone Road, London NW1  
(01-486 5811)

**Department of Building, University of Manchester**

Institute of Science and Technology, Sackville Street, Manchester M60 1QD  
(061-236 3311)

**Department of Building Science, University of Newcastle-upon-Tyne**

Newcastle-upon-Tyne NE1 7RU  
(0632 328511)

**Department of Building Science, University of Sheffield**

Western Bank, Sheffield S10 2TN  
(0742 78555 Ext 4708)

**Design Council**

Design Centre, 28 Haymarket, London SW1Y 4SU  
(01-839 8000)

**Edinburgh Computer Aided Architectural Design Studies, University of  
Edinburgh**

Department of Architecture, 20 Chambers Street, Edinburgh EH1 1JZ  
(031-667 1011 Ext 4598)

**Electrical Research Association Ltd**

Cleeve Road, Leatherhead, Surrey KT22 7SA  
(0372) 374151

**Felt Roofing Contractors Advisory Board**

Maxwelton House, 41-43 Boltro Road, Haywards Heath, Sussex RH16 1BJ  
(0444 451835)

**Fire Prevention Information and Publication Service**

Aldermary House, 10-15 Queen Street, London EC4N 1TJ  
(01-248 4477)

**Fire Protection Association**

Aldermary House, 10-15 Queen Street, London EC4N 1TJ  
(01-248 4477)

**Fire Research Station**

Building Research Establishment, Melrose Avenue, Borehamwood, Herts WD6 2BL  
(01-953 6177)

**Glass Advisory Council**

6 Mount Row, London W1Y 6DY  
(01-629 8334)

**Gypsum Products Development Association**

Westfield, 360 Singlewell Road, Gravesend, Kent DA11 7RZ  
(0474 534251)

**Housing Research Foundation**

58 Portland Place, London WIN 4BU  
(01-637 1248)

**Housing Research Foundation**

58 Portland Place, London WIN 4BU  
(01-637 1248)

**Hydraulics Research Station Ltd**

Department of the Environment, Wallingford, Oxon OX10 8BA  
(0491 35381)

**Institute of Advanced Architectural Studies, University of York**

King's Manor, York YO1 2EP  
(0904 59861)

**Institute of Asphalt Technology**

Staines Road, Chertsey, Surrey KT16 8PP  
(09328 60172)

**Institute of Clay Technology**

c/o Butterley Building Materials Ltd, Wellington Street, Ripley, Derby DE5 3DZ  
(0773 43661)

**Institute of Wood Science**

Premier House, 150 Southampton Row, London WC1B 5AL  
(01-837 8219)

**Institution of Corrosion Science and Technology**

Exeter House, 48 Holloway Head, Birmingham B1 1NQ  
(021-622 1912)

**Lead Development Association**

34 Berkeley Square, London W1X 6AJ  
(01-499 8422)



**National Association of Building Centres**

26 Store Street, London WC1E 7BT  
(01-637 8361)

**National Building Specification**

Mansion House Chambers, The Close, Newcastle-upon-Tyne NE1 3OE  
(0632) 329594)

**National Computing Centre Ltd**

Oxford Road, Manchester M1 7ED  
(061-228 6333)

**National Engineering Laboratory**

East Kilbride, Glasgow G75 0QU  
(035 52 202222)

**National GRP Cladding Association**

82 New Cavendish Street, London W1M 8AD  
(01-580 5588)

**National House Building Council**

58 Portland Place, London WIN 4BU  
(01-637 1248)

**National Housing and Town Planning Council**

Norvin House, 45/55 Commercial Street, London E1 6BA  
(01-247 5732/3)

**National Inspection Council for Electrical Installation Contracting**

237 Kennington Lane, London SE11 5QJ  
(01-582 7746)

**National Materials Handling Centre, Cranfield Institute of Technology**

Cranfield, Bedfordshire MK43 0AL  
(0234 750323)

**National Physical Laboratory**

Queens Road, Teddington, Middlesex TW11 0LW  
(01-977 3222)

**National Research Development Corporation**

101 Newington Causeway, London SE1 6BU  
(01-403 6666)

**Natural Environment Research Council**

Polaris House, Northstar Avenue, Swindon, Wiltshire SN2 1EU  
(0793 40101)

**Paint Research Association**

Waldegrave Road, Teddington, Middlesex TW11 8LD  
(01-977 4427)

**Plastics and Rubber Institute**

11 Hobart Place, London SW1W 0HL  
(01-245 9555)

**Princes Risborough Laboratory**

Building Research Establishment, Princes Risborough, Aylesbury, Bucks HP17 9PX  
(08444 3101)

**RIBA Services Ltd**

66 Portland Place, London WIN 4AD  
(01-580 5533)

**Rubber and Plastics Research Association of GB**

Shawbury, Shrewsbury, Shropshire SY4 4NA  
(0939 250383)

**Scottish Association for Building Education and Training**

c/o Clydebank Technical College, Kilbowie Road, Clydebank, Dunbartonshire G81 2A  
(041-952 7771)

**Scottish Design Centre**

72 St Vincent Street, Glasgow G2 5TN  
(041-221 6121)

**Solar Trade Association Ltd**

26 Store Street, London WC1E 7BT  
(01-636 4717)

**Solid Fuel Advisory Service**

Hobart House, Grosvenor Place, London SW1X 7AE  
(01-235 2020)

**Timber Research and Development Association**

Stocking Lane, Hughenden Valley, High Wycombe HP14 4ND  
(02424 3091)

**Town and Country Planning Association**

17 Carlton House Terrace, London SW1Y 5AS  
(01-930 8903/5)

**Transport and Road Research Laboratory**

Departments of the Environment and Transport, Old Wokingham Road, Crowthorne,  
Berkshire RG1 6AU  
(0344 773131)

**Welsh School of Architecture, University of Wales**

Institute of Science and Technology, Colum Drive, Cardiff CF1 3EU  
(0222 42588)

**Zinc Development Association**

34 Berkeley Square, London W1X 6AJ  
(01-499 6636)

# **PROFESSIONAL ORGANISATIONS AND SEMI-PROFESSIONAL ORGANISATIONS**

## **Architects Registration Council of the United Kingdom**

73 Hallam Street, London W1N 6EE  
(01-580 5861)

## **Architectural Association (Inc)**

34-36 Bedford Square, London WC1B 3ES  
(01-636 0974)

## **Associated Master Plumbers and Domestic Engineers**

Barnard Close, 107-113 Powis Street, Woolwich, London SE18 6JB  
(01-855 1844)

## **Association of Consultant Architects**

The Secretary, c/o 7 King Street, Bristol BS1 4EQ  
(0272 293372)

## **Association of Consulting Engineers**

Alliance House, 12 Caxton Street, London SW1H 1QL  
(01-222 6557)

## **Association of Local Authorities Chief Architects**

30 Kings Road, Brighton, BN1 1PF  
(0273 29801 Ext 249)

## **Association of Local Authority Valuers and Estate Surveyors**

City Estates Surveyor, Leicester City Council, Welford Place, New Walk Centre,  
Leicester LE1 6ZG  
(0533 549922)

## **Association of London Borough Architects**

Technical Services Group, 22/24 Uxbridge Road, Ealing W5  
(01-579 2424 Ext 2520)

## **Association of Official Architects**

17 Claverton Road, Salford, Bristol BS18 3DW

## **Association of Public Service Professional Engineers**

7 Elm Grove, Wimbledon, London SW19  
(01-946 3777)

**British Computer Society**

13 Mansfield Street, London WIN 0BP  
(01-637 0471)

**British Decorators Association**

6 Haywra Street, Harrogate, N. Yorkshire HG1 5BL  
(0423 67292)

**British Institute of Interior Design**

Lenton Lodge, Wollaton Hall Drive, Nottingham NG8 1AF  
(0602 701205)

**British Property Federation**

35 Catherine Place, London SW1E 6DY  
(01-828 0111)

**Building Societies Institute**

Fanhams Hall, Ware, Herts SG12 7PZ  
(0920 5051)

**Chartered Institute of Arbitrators**

75 Cannon Street, London EC4N 5BH  
(01-236 8761)

**Chartered Institute of Building**

Englemere, King's Ride, Ascot, Berkshire SL5 8BJ  
(0990 23355)

**Chartered Institute of Building Services**

Delta House, 222 Balham High Road, London SW1 9BS  
(01-675 5211)

**City and Guilds of London Institute**

76 Portland Place, London WIN 4AA  
(01-580 3050)

**Construction Surveyors Institute**

203 Lordship Lane, East Dulwich, London SE22 8HA  
(01-693 0219/0210)

**Contractors Mechanical Plant Engineers**

The Secretary, 20 Knave wood Road, Kemsing, Sevenoaks, Kent TN15 6RH

(Otford 2628)

**County Planning Officers Society**

County Hall, Glenfield, Leicester LE3 8RH  
(0533 871313)

**County Surveyors Society**

Northampton House, Northampton NN1 2HZ  
(0604 34833)

**Design and Industries Association**

17 Lawn Crescent, Kew Gardens, Surrey TW9 3NR  
(01-940 4925)

**District Surveyors' Association**

1 Myron Place, London SE13 5AT  
(01-852 3253)

**Engineering Council**

Canberra House, 10-16 Maltravers Street, London WC2R 3ER  
(01-240 7891)

**Faculty of Architects and Surveyors**

15 St Mary Street, Chippenham, Wiltshire  
(0249 655398)

**Faculty of Building**

10 Manor Way, Borehamwood, Hertfordshire WD6 1QQ  
(01-9537053)

**Faculty of Royal Designers for Industry**

6-8 John Adam Street, London WC2N 6EZ  
(01-839 2366)

**Guild of Architectural Ironmongers**

8 Stepney Green, London E1  
(01-790 3431/6)

**Guild of Bricklayers**

1 Tamhouse, Orton Malborne, Peterborough, Cambridgeshire PE2 0NA  
(0733 231594)

**Guild of Surveyors**

The Lodge, Eastbury Farm, 33 Batch worth Lane, Northwood, Middlesex H A6 3EQ  
(6527755)

**Incorporated Association of Architects and Surveyors**

Jubilee House, Billing Brook Road, Weston Favell, Northampton  
(0604404121)

**Incorporated Society of Valuers and Auctioneers**

3 Cadogan Gate, London SW1X 0AS  
(01-235 2282)

**Institute of Builders' Merchants**

Parnall House, 5 Parnall Road, Staple Tye, Harlow, Essex CM18 7NG  
(0279419650)

**Institute of Carpenters**

45 Sheen Lane, London SW14 8AB  
(01-8764415)

**Institute of Clerks of Works**

41 The Mall, London W5  
(01-5792917)

**Institute of Housing**

12 Upper Belgrave Street, London SW1X 8BL  
(01-245 9933)

**Institute of Plumbing**

Scottish Mutual House, North Street, Hornchurch, Essex RM11 1RU  
(0402451236)  
(moving to 64 Station Lane, Hornchurch, Essex end 1983)

**Institute of Professional Designers**

1-5 Rosslyn Mews, Rosslyn Hill, London NW3  
(01-7943233)

**Institute of Mechanical Engineers**

1 Birdcage Walk, London SW1H 9JJ  
(01-2227899)

**Institute of Quarrying**

7 Regent Street, Nottingham NG1 5BY  
(0602411315)

**Institute of Solid Wastes' Management**

3 Albion Place, Northampton NN1 1UD  
(060420426/7/8)

**Institute of Water Pollution Control**

Ledson House, 53 London Road, Maidstone, Kent ME16 8JH  
(062262034)

**Institution of Building Control Officers**

The White House, 41 Carshalton Road, Sutton, Surrey SM1 4TA  
(01-6611360)

**Institution of Civil Engineers**

1-7 Great George Street, London SW1P 3AA  
(01-222 7722)

**Institution of Electrical Engineers**

2 Savoy Place, London WC2R 0BL  
(01-2401871)

**Institution of Engineering Designers**

Courtleigh, Westbury Leigh, Westbury, Wiltshire BA13 3TA  
(0373 822801)

**Institution of Fire Engineers**

148 New Walk, Leicester LE1 7QB  
(0533553654)

**Institution of Gas Engineers**

17 Grosvenor Crescent, London SW1X 7ES  
(01-2459811)

**Institution of Mining Engineers**

Hobart House, Grosvenor Place, London SW1  
(01-235 3691)

**Institution of Municipal Engineers**

13 Grosvenor Place, London SW1X 7EN  
(01-245 9778)

**Institution of Occupational Safety and Health**

222 Uppingham Road, Leicester LE5 0RG  
(0533768424)

**Institution of Public Health Engineers**

32 Eccleston Square, London SW1V 1PB  
(01-834 3017)



**Institution of Structural Engineers**

11 Upper Belgrave Street, London SW1X 8BH  
(01-235 4535/6841)

**Institution of Works and Highways Technicians Engineers**

Room 21, 4th Floor, 125 High Holborn, London WC1V 6QR  
(01-242 5733)

**The Landscape Institute**

Nash House, 12 Carlton House Terrace, London SW1Y 5AH  
(01-839 4044)

**Property Consultants Society Ltd**

5 Maple Parade, Walberton, Sussex  
(0243 551 368)

**Rating and Valuation Association**

115 Ebury Street, London SW1W 9QT  
(01-730 7258/9)

**Royal Incorporation of Architects in Scotland**

15 Rutland Square, Edinburgh EH1 2BE  
(031-229 7205/6)

**Royal Institute of British Architects**

66 Portland Place, London W1N 4AD  
(01-580 5533)

**Royal Institute of Chartered Surveyors**

12 Great George Street, London SW1P 3AD  
(01-222 7000)

**Royal Society**

6 Carlton House Terrace, London SW1Y 5AG  
(01-839 5561)

**Royal Society of Arts**

John Adam Street, Adelphi, London WC2N 6EZ  
(01-839 2366)

**Royal Society of Ulster Architects**

2 Mount Charles, Belfast BT7 1N  
(0232) 223760

**Royal Town Planning Institute**

26 Portland Place, London W1N 4BE  
(01-636 9107)

**Society of Architectural and Associated Technicians**

397 City Road, London EC1V 1NE  
(01-278 2206)

**Society of Chief Architects of Local Authorities**

County Architect, Durham County Council, Architects Department, County Hall,  
Durham  
(0385 64411)

**Society of Chief Quantity Surveyors in Local Government**

Secretary, Architects Department, Nottinghamshire County Council, County Hall,  
West Bridgford, Nottingham NG2 7QP  
(0602 823823)

**Society of Civil Engineering Technicians**

c/o Institution of Civil Engineers, 1-7 Great George Street, London SW1P 3AA  
(01-222-7722)

**Society of Engineers (Inc)**

21-23 Mossop Street, London SW3 2LW  
(01-589 6651)

**Society of Industrial Artists and Designers**

12 Carlton House Terrace, London SW1Y 5AH  
(01-930 1911)

**Society of Surveying Technicians**

Aldwych House, Aldwych, London WC2B 4EL  
(01-242 4833)

# TRADE AND INDUSTRY ORGANISATIONS

## **Aggregate Concrete Block Association**

60 Charles Street, Leicester LE1 1FB  
(0533 536161)

## **Aluminium Federation**

Broadway House, Calthorpe Road, Birmingham B15 1TN  
(021-455 0311)

## **Aluminium Windows Association**

26 Store Street, London WC1E 7EL  
(01-637 3578)

## **The Architectural Aluminium Association**

193 Forest Road, Tunbridge Wells, Kent TN2 5JA  
(0892 30630)

## **Asbestos Cement Manufacturers' Association**

16 Woodland Avenue, Lymm, Cheshire  
(092575 569 2833)

## **Association of British Manufacturers of Mineral Insulating Fibres**

St Paul's House, Edison Road, Bromley, Kent  
(01-466 6719)

## **Association of British Plywood and Veneer Manufacturers**

c/o British Plywood Manufacturers Ltd, Wharf Road, Ponders End, Enfield, Middlesex  
EN3 4TS  
(01-804 2424)

## **Association of British Roofing Felt Manufacturers**

69 Cannon Street, London EC4N 5AB  
(01-248 4444)

## **Association of British Solid Fuel Appliance Manufacturers**

Fleming House, Renfrew Street, Glasgow G3 6TG  
(041-332 0826)

## **Association of Builders' Hardware Manufacturers**

5 Greenfield Crescent, Birmingham B15 3BE

(021-454 21778/8)

**Association of Building Component Manufacturers Ltd**

26 Store Street, London WC1E 7BT

(01-580 9083)

**Association of Gunite Contractors**

45 Sheen Lane, London SW14 8AB

(01-876 4415)

**Association of Lightweight Aggregate Manufacturers**

c/o Butterley Aglite Ltd, Wellington Street, Ripley, Derbyshire DE5 3DZ

(0773 43661)

**Association of Manufacturers of Domestic Unvented Supply Systems Equipment**

c/o Maurice Thomson, Sawsley, Snail well Road, Newmarket, Suffolk CB8 9AJ

(0638 662279)

**Association of Structural Fire Protection Contractors and Manufacturers Ltd**

45 Sheen Lane, London SW14 8AB

(01-876 4415)

**Autocleaved Aerated Concrete Products Association**

c/o Celcon House, 289-293 High Holborn, London WC1V 7HV

(01-242 4803)

**Bituminous Roofing Council**

PO Box 125, Haywards Heath, West Sussex RH16 3TJ

(0444 416681)

**Boiler and Radiator Manufacturers Association Ltd**

Fleming House, Renfrew Street, Glasgow G3 6TG

(041-332 0826)

**Box Culvert Association**

60 Charles Street, Leicester LE1 1FB

(0533 536161)

**The Brick Development Association**

Woodside House, Winkfield, Windsor SL4 2DX

(03447 5651)

**British Adhesive Manufacturers Association**

2A High Street, Hythe, Southampton SO4 6YW

(0703 842765)

**British Aggregate Construction Material Industries**

25 Lower Belgrave Street, London SW1W 0LS  
(01-730 8194)

**British Bath Manufacturers Association**

Fleming House, Renfrew Street, Glasgow G3 6TG  
(041-333 0826)

**British Blind and Shutter Association**

5 Greenfield Crescent, Edgbaston, Birmingham B15 3BE  
(021-454 2177)

**British Ceramic Tile Council Ltd**

Federation House, Station Road, Stoke-on-Trent ST4 2RU  
(0782 45147)

**British Combustion Equipment Manufacturers' Association**

The Fernery, Market Place, Midhurst, Sussex GU29 9DP  
(073081 2782)

**British Constructional Steelwork Association Ltd**

92-96 Vauxhall Bridge Road, London SW1V 2RL  
(01-834 1713)

**British Electrical and Allied Manufacturers' Association Ltd**

Leicester House, 8 Leicester Street, London WC2H 7BN  
(01-437 0678)

**British Electrical Systems Association**

Granville Chambers, 2 Radford Street, Stone, Staffordshire  
(0785 814023)

**British Flue and Chimney Manufacturers' Association**

Nicholson House, High Street, Maidenhead, Berkshire SL6 1LF  
(0628 34667/8)

**British Furniture Manufacturers Federated Associations**

30 Harcourt Street, London W1H 2AA  
(01-724 0854)

**British Hardware Federation**

20 Harborne Road, Edgbaston, Birmingham B15 3AB  
(021-454 4385)

**British Hardware and Housewares Manufacturers Association (BHHMA)**

35 Billing Road, Northampton NN1 5DD  
(0604 22023)

**British Independent Steel Producers' Association**

5 Cromwell Road, London SW7 2HX  
(01-581 0231)

**British Foundry Association**

14 Pall Mall, London SW1  
(01-9307171)

**British Laminated Plastic Fabricators' Association**

5 Belgrave Square, London SW1X 8PH  
(01-2359483)

**British Lead Manufacturers' Association**

68 High Street, Weybridge, Surrey KT13 8BL  
(9756621)

**British Lock Manufacturers' Association**

91 Tettenhall Road, Wolverhampton WV3 9PE  
(090226726)

**British Non-Ferrous Metals Federation**

Crest House, 7 Highfield Road, Birmingham B15 3ED  
(021-4547766)

**British Plastics Federation**

5 Belgrave Square, London SW1X 8PH  
(01-235 9483)

**British Precast Concrete Federation Ltd**

60 Charles Street, Leicester LE1 1FB  
(053328627/9)

**British Pump Manufacturers' Association**

3 Pannels Court, Chertsey Street, Guildford, Surrey GU1 4EU  
(048337997)

**British Ready Mixed Concrete Association**

Shepperton House, Green Lane, Shepperton, Middlesex TW17 8DN  
(Walton-on-Thames 43232)

**British Refrigeration and Air Conditioning Association**

Nicholson House, High Street, Maidenhead, Berkshire SL6 1LF  
(062834667/8)

**British Reinforcement Manufacturers' Association**

15 Tooks Court, London EC4A 1CA  
(01-8317581)

**British Rubber Manufacturers' Association**

90-91 Tottenham Court Road, London W1P 0BR  
(01-5802794)

**British Timber Merchants' Association**

Blackburn House, 1 Warwick Street, Leamington Spa, Warwickshire CV325LW  
(092629905)

**British Wood Preserving Association**

Premier House, 150 Southampton Row, London WC1B 5AL  
(01-8378217)

**British Woodworking Federation**

82 New Cavendish Street, London W1M 8AD  
(01-580 5588)

**Building Materials Export Group**

33 Alfred Place, London WC1E 7EN  
(01-6365345)

**Building Societies Association**

34 Park Street, Mayfair, London W1Y 3PF  
(01-629 7233)

**Calcium Silicate Brick Association**

11 White Lion House, Town Centre, Hatfield, Hertfordshire AL10 0JL  
(30 71580)

**Cement Admixtures Association**

2A High Street, Hythe, Southampton SO4 6YW  
(0703 842765)

**Cement and Concrete Association**

Terminal House, 52 Grosvenor Gardens, London SW1W 1AQ  
(01-2356661)

**Cement Makers' Federation**

Terminal House, 52 Grosvenor Gardens, London SW1W 0AH  
(01-7302148)

**Chipboard Promotion Association**

Stocking Lane, Hughenden Valley, High Wycombe, Buckinghamshire HP14 4NU  
(0240245265)

**Clay Pipe Development Association**

Drayton House, 30 Gordon Street, London WC1E 0HN  
(01-3880025)

**Clay Roofing Tile Council**

Federation House, Station Road, Stoke-on-Trent  
(0782416256)

**Concrete Brick Manufacturers' Association**

60 Charles Street, Leicester LE1 1FB  
(0533536161)

**Concrete Block Association**

60 Charles Street, Leicester LE1 1FB  
(0533536161)

**Concrete Lintel Association**

60 Charles Street, Leicester LE1 1FB  
(0533536161)

**Concrete Pipe Association of Great Britain**

60 Charles Street, Leicester LE1 1FB  
(0533536161)

**Contract Flooring Association**

23 Chippenham Mews, London W9 2AN  
(01-286 4499)

**Contractors' Plant Association**

28 Eccleston Street, London SW1W 9PY  
(01-730 7117)

**Copper Cylinder and Boiler Manufacturers**

St James's Buildings, 89 Oxford Street, Manchester M1 4LT  
(061-236 3668/9)



**Copper Tube Fittings Manufacturers' Association**

Crest House, 7 Highfield Road, Birmingham B15 3ED  
(021-454 7766)

**Cork Industry Federation**

56 Lagham Park, South Godstone, Surrey  
(034 285 3363)

**Council of British Ceramic Sanitary ware Manufacturers**

Federation House, Station Road, Stoke-on-Trent ST4 2RT  
(0782 48675/57074)

**Decorative Lighting Association**

Bishop's Castle, Shropshire SY9 5LE  
(058 84 658)

**Decorative Paving and Walling Association**

60 Charles Street, Leicester LE1 1FB  
(0533 536161)

**District Heating Association**

Bedford House, Stafford Road, Caterham, Surrey CR3 6JA  
(0883 42323/4)

**The Door and Shutter Association**

5 Greenfield Crescent, Edgbaston, Birmingham B15 3BE  
(021-454 2177)

**Dry Lining and Partition Association**

82 New Cavendish Street, London W1M 8AD  
(01-580 5588)

**Dry Material Cavity Insulation Council**

Interpress PR, The Meusings, Church End, Walkern, Stevenage, Hertfordshire  
(0438 86347)

**Ductile Iron Pipe Association**

14 Pall Mall, London SW1Y 5LZ  
(01-930 7171)

**Environmental Protection Equipment Manufacturers' Association**

136 North Street, Brighton BN1 1RG  
(0273 26313)

**Export Group for the Construction Industries**

Kingsbury House, 15–17 Kings Street, St James, London SW1Y 7QU  
(01–930 5377)

**Federation of British Hand Tool Manufacturers**

Light Trades House, Melbourne Avenue, Sheffield S10 2QJ  
(0742 663084)

**Federation of Concrete Specialists**

60 Charles Street, Leicester LE1 1FB  
(0533 536161)

**Federation of Resin Formulators and Applicators Ltd**

2A High Street, Hythe, Southampton SO4 6YW  
(0703 842765)

**Federation of Manufacturers of Construction Equipment and Cranes**

7–15 Lansdowne Road, Croydon, Surrey CR9 2PL  
(01–688 4422)

**Federation of Piling Specialists**

15 Tooks Court, London EC4A 1LA  
(01–831 7581)

**Fibre Building Board Development Organisation Ltd**

1 Hanworth Road, Feltham, Middlesex TW13 5AF  
(01–751 6107)

**Flat Glass Manufacturers' Association**

Prescot Road, St Helens, Merseyside WA10 3TT  
(0744 28882 Ext 2585)

**GAMBICA (SIMA) Scientific Instruments Manufacturers' Association**

Leicester House, 8 Leicester Street, London WC2H 7BN  
(01–437 0678)

**Glass and Glazing Federation**

6 Mount Row, London W1Y 6DY  
(01–409 0545)

**Glass Manufacturers' Federation**

19 Portland Place, London WIN 4BH  
(01–580 6952)

**Glassfibre Reinforced Cement Association**

Farthings End, Dukes Ride, Gerrards Cross, Buckinghamshire SL9 7LD  
(0753 882606)

**Glazed and Floor Tile Home Trade Association**

Federation House, Station Road, Stoke-on-Trent ST4 2RU  
(0782 45147)

**Heat Pump Manufacturers Association**

Nicholson House, High Street, Maidenhead, Berks SL6 1LF  
(0628 34667/8)

**Heating, Ventilating and Air Conditioning Manufacturers' Association**

Nicholson House, High Street, Maidenhead, Berkshire SL6 1LF  
(062834667/8)

**Industrial Warm Air Heater Manufacturers Association Ltd**

Business Services Group, Chesterfield House, Bloomsbury Way, London WC1 2TP  
(01-2423366)

**Interlock Paving Association**

60 Charles Street, Leicester LE1 1FB  
(0533536161)

**Kitchen Furniture Manufacturers Section of the British Woodworking Federation**

82 New Cavendish Street, London W1M 8AD  
(01-5805588)

**Kitchen Specialist Association**

31 Bois Lane, Chesham Bois, Amersham, Buckinghamshire  
(0240322287)

**Lattice Girder Floor Association**

60 Charles Street, Leicester LE1 1FB  
(0533536161)

**Lighting Industry Federation**

Swan House, 207 Balham High Road, London SW17 7BQ  
(01-675 5432)

**Machine Tools Trades Association**

62 Baywater Road, London W2 3PH  
(01-4026671)

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45 Sheen Lane, London SW14 8AB  
(01-876 4415)

**Mastic Asphalt Council and Employers' Federation Ltd**

Construction House, Paddock Hall Road, Haywards Heath, West Sussex RH16 1HE  
(0444457786)

**Metal Roof Deck Association**

Maxwelton House, Boltro Road, Haywards Heath, West Sussex RH16 1BJ  
(0444451835)

**Metal Sink Manufacturer's Association**

Fleming House, Renfrew Street, Glasgow G3 6TG  
(041-3320826)

**METCON**

Fleming House, Renfrew Street, Glasgow G3 6TG  
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**Midland Federation of Brick and Tile Manufacturers**

Acorn House, 196 High Street, Erdington, Birmingham B23 6QY  
(021-373 7445)

**Mortar Producers' Association Ltd**

74 Holly Walk, Leamington Spa, Warwickshire CV32 4JL  
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8 Leicester Street, London WC2N 7BN  
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(08832 4961)

**National Brassfoundry Association**

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(021-454 2177)

**National Building and Allied Hardware Manufacturers' Federation**

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(021-454 2177)

**National Cavity Insulation Association**

PO Box 12, Haslemere, Surrey GU27 3AN  
(0428 54011)

**National Clayware Federation**

7 Castle Street, Bridgwater, Somerset TA6 3DT  
(0278 58251)

**National Council of Building Material Producers**

33 Alfred Place, London WC1E 7EN  
(01-580 3344)

**National Federation of Clay Industries**

Federation House, Station Road, Stoke-on-Trent ST4 2TJ  
(0782 416256)

**National Federation of Housing Associations**

30-32 Southampton Street, Strand, London WC2E 7HE  
(01-240 2771)

**National Federation of Terrazzo-Mosaic Specialists**

5th Floor, 3 Berners Street, London W1P 4JP  
(01-580 2903)

**National Fireplace Council**

PO Box 35, Stoke-on-Trent ST4 7NU  
(0782 44311)

**National Home Improvement Council**

26 Store Street, London WC1E 7BT  
(01-636 2562)

**National Master Tile Fixers' Association**

c/o Joliffe Cork & Co., Elvian House, 18-20 St Andrews Street, London EC4 3AE  
(01-353 3055)

**National Paving and Kerb Association**

60 Charles Street, Leicester LE1 1FB  
(0533 536161)

**Northern Ireland Builders' Merchants' Association**

2 Greenwood Avenue, Belfast BT4 6JJ  
(0232 650321)

**Paintmakers Association of Great Britain Ltd**

Alembic House, 93 Albert Embankment, London SE1 7TY  
(01-582 1185)

**Partitioning Industry Association**

1 Lansdale Avenue, Solihull, West Midlands B92 0PP  
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**Patent Glazing Conference**

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(03727 29191)

**Phenolic Foam Manufacturers Association**

45 Sheen Lane, London SW14 8AB  
(01-876 4415)

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35 New Bridge Street, London EC4V 6BH  
(01-248 5271)

**Plastic Bath Manufacturers' Association**

Fleming House, Renfrew Street, Glasgow G3 6TG  
(041-332 0826/8)

**Plastic Pipe Manufacturers' Society**

89 Cornwall Street, Birmingham B3 3BY  
(021-236 1866)

**Plastic Tanks and Cisterns Manufacturers' Association**

8 Balmain Close, Grange Road, Ealing, London W5 5BY  
(01-579 6081)

**Precast Concrete Frame Association**

60 Charles Street, Leicester LE1 1FB  
(0533 536161)

**Prefabricated Building Manufacturers' Association of Great Britain Ltd**

c/o S. Wernick & Sons Ltd., Russell Gardens, Wickford, Essex S11 8BL  
(03744 5544)

**Prestressed Concrete Association**

60 Charles Street, Leicester LE1 1FB  
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**Refined Bitumen Association**

c/o Construction House, Paddockhall Road, Haywards Heath, Sussex  
RH16 1HE

**Sand and Gravel Association Ltd**

48 Park Street, London W1Y 4HE  
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**Scottish Plant Owners' Association**

12 St. Vincent Place, Glasgow G1 2EQ  
(041-332 0021)

**Scottish Pre-Cast Concrete Manufacturers' Association**

c/o 9 Princes Street, Falkirk FK1 1LS  
(0324 22088)

**Sealant Manufacturers' Conference**

2A High Street, Hythe, Southampton SO4 6YW  
(0703 842765)

**Sectional Chamber Association**

60 Charles Street, Leicester LE1 1FB  
(0533 536161)

**Society of British Gas Industries**

36 Holly Walk, Leamington Spa, Warwickshire CV32 4LY  
(0926 34357/9)

**Solid Smokeless Fuels Federation**

York House, Empire Way, Wembley, Middlesex HA9 0PA  
(01-902 5405)

**Stainless Steel Fabricators' Association of Great Britain**

14 Knoll Road, Dorking, Surrey RH4 3EW  
(0306 884079)

**Steel Lintel Manufacturers' Association**

PO Box 10, Newport, Gwent  
(0633 272281 Ext 4198)

**Steel Window Association**

26 Store Street, London WC1E 7JR  
(01-637 3571/2)

**Stone Federation**

82 New Cavendish Street, London W1M 8AD  
(01-580 5588)

**Structural Fire Protection Contractors and Manufacturers Ltd**

45 Sheen Lane, London SW14 8AB  
(01-876 4415)

**Structural Insulation Association**

45 Sheen Lane, London SW14 8AB  
(01-876 4415)

**The Surveying Equipment Manufacturers' and Dealers' Group of DOMMDA**

6th Floor, 25/27 Oxford Street, London W1R 1RF  
(01-734 2971)

**Suspended Access Equipment Manufacturers Association**

82 New Cavendish Street, London W1M 8AD  
(01-580 5588)

**Suspended Ceilings Associations**

29 High Street, Hemel Hempstead, Hertfordshire HP1 3AA  
(0442 40313)

**Swimming Pool and Allied Trades Association**

Faraday House, 17 Essendene Road, Caterham, Surrey CR3 5PB  
(22 40110)

**Thermal Insulation Manufacturers' and Suppliers' Association**

45 Sheen Lane, London SW14 8AB  
(01-876 4415)

**Timber Research and Development Association**

Stocking Lane, Hughenden Valley, High Wycombe, Buckinghamshire HP14 4ND  
(0240 24 3091)

**Timber Trade Federation**

Clareville House, Whitcomb Street, London WC2H 7DL  
(01-839 1891)

**UK Particle Board Association**

Stocking Lane, Hughenden Valley, High Wycombe, Buckinghamshire HP14 4NT  
(0240 24 2381)



**Vitreous Enamel Development Council**

New House, High Street, Ticehurst, Wadhurst, Sussex TN5 7AL  
(0580 200152)

**Wallcovering Manufacturers' Association of Great Britain Ltd**

Alembic House, 93 Albert Embankment, London SE1 7TY  
(01-582 1185)

**Wood and Solid Fuel Association of Retailers and Manufacturers**

PO Box 35, Stoke-on-Trent ST4 7NU  
(0782 44311)

**Wood Wool Slab Manufacturers' Association**

33 Alfred Place, London WC1E 7EN  
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**Woodworking Machinery Importers' Association**

Cobbins House, 7 Broadstrood, Goldings Manor, Loughton, Essex IG10 2SE  
(01-508 9095)



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