DETAILING FOR ACOUSTICS

Peter Lord and Duncan Templeton
with graphics by Aidan Potter

Second edition

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Richard Cowell, Dr Judith Lang, Nils Jordan, Hadyn Bodycombe, and colleagues at BDP and University of Salford, Department of Applied Acoustics.

Material from CIRIA Report 1988, 'Sound Insulation of House Separating and External Walls (with lightweight masonry for thermal insulation)' is reproduced by permission of the Director of CIRIA.

FOREWORD

Effective acoustic design—unfortunately still a Cinderella element of our architecture—depends heavily on detail. There are many references for guidance on the principles of good acoustic design, not enough tackling the details.

Here is a book which emphasizes details, and the authors set out to make it useful. Details, whether for sound separation, absorbent linings or impact isolation need to take due account of non-acoustic influences, and favourite solutions differ widely. Whether taken from product technical literature or prised from private collections these details represent a useful reference for all those involved with building.

I expect to refer to them often and hope they will help stimulate debate and development in a field where they are badly needed.

Richard Cowell
Arup Acoustics

1 OBJECTIVES

There is paucity of practical material relating to architectural acoustics, compared with academic material dealing with the mathematics and physics of sound. This book is composed largely of guidance details intended for reference by architects, students, structural and services engineers and interior designers. Some knowledge of the theory of sound is assumed. Exhaustive coverage is not claimed, nor does the content replace the need for specialist aid. Component assembly and choice of materials are 'moving targets' and sheets could be added ad infinitum to this selection of standard and built examples.

Sources
Wherever possible laboratory test results have been obtained for the standard assemblies of materials: often the basic 'favourites' could be traced to a number of sources, with minor variations on a theme. Inevitably, for light partitions and ceilings in particular, manufacturers' information has been an important source of data. Such data should be treated with some caution as results may be given in the best light. The material presented has been checked as far as possible. Exact trade name specifications and references are given only where critical, as some products are subject to frequent change and development.

Format
The material comprises details of standard elements of building construction, assemblies of elements from projects and diagrams for assessing basics. Standard elements consider both sound insulation and sound absorption aspects. In the case of the former, a single value is normally given; for sound reduction, values are in the range 100 – 3150 Hz (with values listed for octaves, ie 125, 250, 500, 1000, 2000, and 4000 Hz). The scale of details as originally drawn is generally 1:5 unless noted otherwise, but all drawings are reproduced at reduced scale—use the drawn scale on each sheet for reference. Details of specialist components—eg suspended discs—illustrate specific usage and are not for copying on another project: we want to encourage dialogue with acoustic consultants, not replace it.

Content
The stated performance of the sound insulation of component assemblies is not intended to assign each a definite value. A particular assembly does not have a 'magic number' because its performance will depend on the context of use. Taking a partition type as an example, the sound insulation performance depends not only on its sectional constituents but on its size, degree of restraint at all sides, flanking effects and receiving room absorption. The values stated are only an average and two elements with the same average may have widely varying sound transmission at a particular frequency. For this reason, some important examples have their performance illustrated throughout the frequency range.

The single-figure values are to be used to provide a choice of comparable elements of construction, consistent in acoustical terms. A 'kit of parts' of elements can be put together where no part of the whole assembly is significantly weaker than the rest in performance. Doors and windows are problematic in that they are inherently lighter and gap-prone, but all is not lost when doors and windows are not up to the performance of the surrounding walls, floors and ceiling, and composite performance of assemblies can be assessed. A philosophy that the whole is only as good as the weakest link is analogous to components in a sound-reproduction system. Care in detailing junctions is particularly important where discontinuous construction details are used to achieve good sound isolation. Cost-cutting exercises through the design stage should not allow part of the 'kit' to be downrated to meet budget.

In the case of sound-absorption values, the figures should be used together with the tabulated values to sum the total effect of absorption in a particular space. In a large-area space, for example, an open-plan office, the characteristics of the ceiling and floor will be of particular concern.

Information can only reflect the current 'state of the art'. There are exciting developments in materials technology, for instance in the development of thin but very effective isolating membranes. In a future of lighter buildings and higher external noise levels, such materials could be a valuable asset to the designer.

Notes on 2nd edition

The second edition of this collection of details gives us the opportunity to add, update, or correct material. In particular the new UK Building Regulations made our guidance on the old Part G obsolete and mark a change in emphasis. The old Regulations needed diagrams just to explain the meaning of the many subparagraphs and were a confusing mixture of deemed-to-satisfy provisions, not necessarily meeting the performance figures also meant to apply. The new Regulations are commendably practical and clearly set out.

We have, therefore, included test results of walls and floors illustrating some of the favoured permutations of materials. As a matter of common sense, it may be observed that not all combinations are advisable, for example, certain substantial floors should not be used with certain lightweight walls.

The new Regulations endorse the use of built-up layers of plasterboard within partitions, floor deck linings, and ceilings. The authors can vouch for the excellent performance possible from wide-spaced double or triple plasterboard layers with a bit of absorption in the cavity. The practical advantages of plasterboard are its density (750 kg/m^3), fire resistance, ready availability, low cost, ease of fixing, and its sealability by skimming, overlap of successive panel layers, and caulk.

Design process

For basic knowledge, use a primer text: eg the classic 'Acoustics Noise and Buildings', 4th Edition, Parkin, Humphreys and Cowell. The details we give here are intended to help at the practical rather than the crucial concept end of the acoustical design process. Stages of acoustical design input are summarized to show the total picture through a project. Acoustic consultants should be approached where a close check of characteristics is required.

1 Briefing

The client may state required standards in the finished building or, more likely, the functions stated dictate the fabric performance. Target criteria should be set at this stage.

2 Site selection

If a choice of sites is available noise sources may be included with other environmental criteria in a scoring matrix to determine the most suitable.

3 Noise survey

Background noise levels may be taken to assist brief-making studies or to determine the best position of a building on site. Quantification of adjacent noise sources may influence the design of the external envelope, in order to avoid noise intrusion.

4 Outline design

The form of the building may allow 'buffer' screening of sensitive spaces, and the arrangement of rooms may allow those requiring quiet conditions to be remote from noisy rooms, with fenestration limited and not facing any external noise source.

5 Detail design

In order that rooms can be sized to suit function and good aural reception, proportion, volume/occupant, reverberation time and surface geometry may be considered and adjusted. The quantity, shape and specification of finishes may be made optimal to required sound reflection, diffusion or absorption properties. The required separation between rooms or to outside noise is designed-in by each element having adequate sound insulating properties. Noise-control standards for services should be compatible with fabric-design standards: air-conditioning systems, plumbing, lighting, generators and switchgear plant are frequent noise culprits in large buildings. Design of specialist sound systems to suit the acoustics of the spaces is finalized at this stage.

6 Supervision

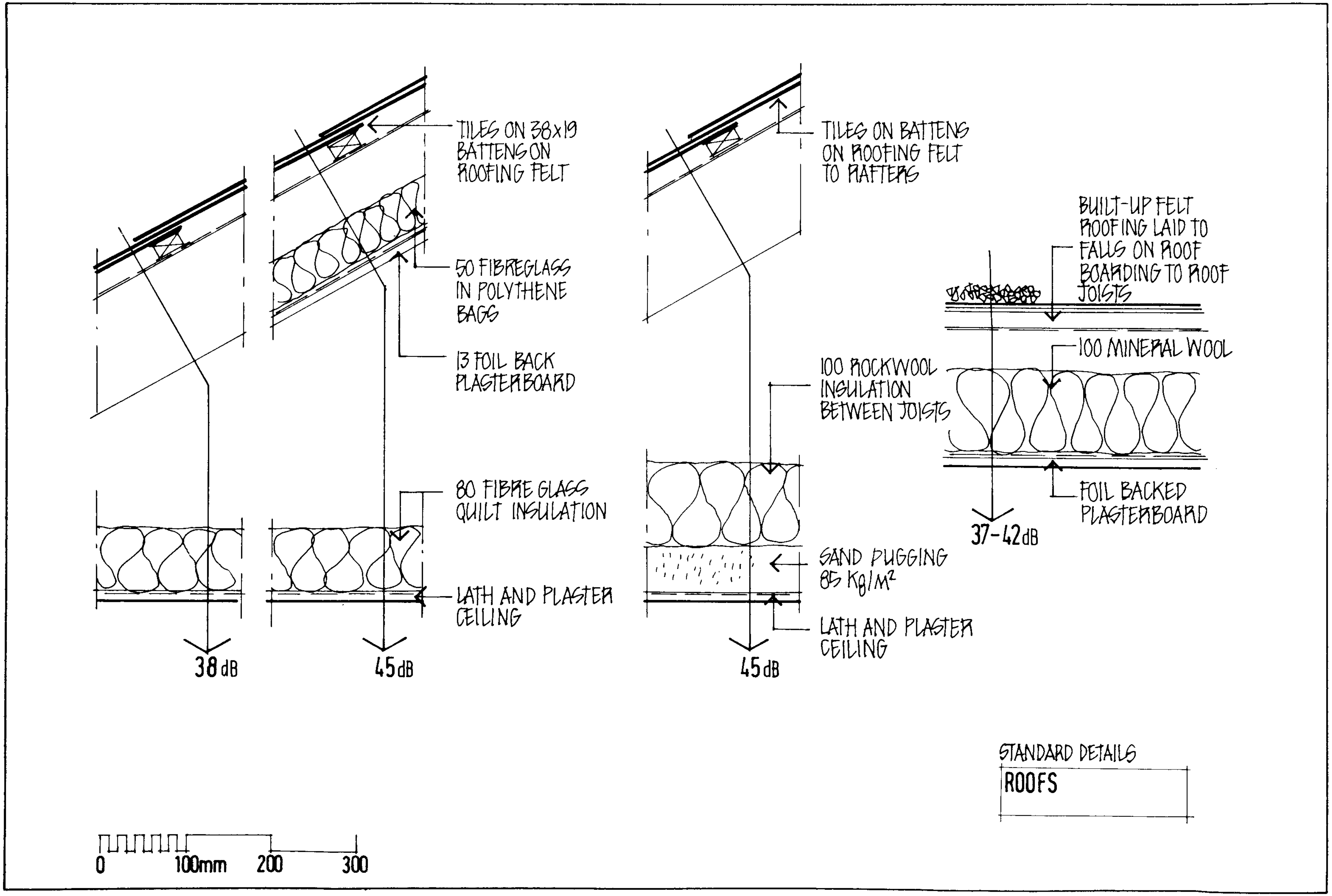
Care must be taken in getting many of the assemblies shown built properly, as some principles go against the grain of normal building practice—discontinuous construction at junctions and cavity walls with no ties will tempt the average contractor used to tying the whole lot together for stability.

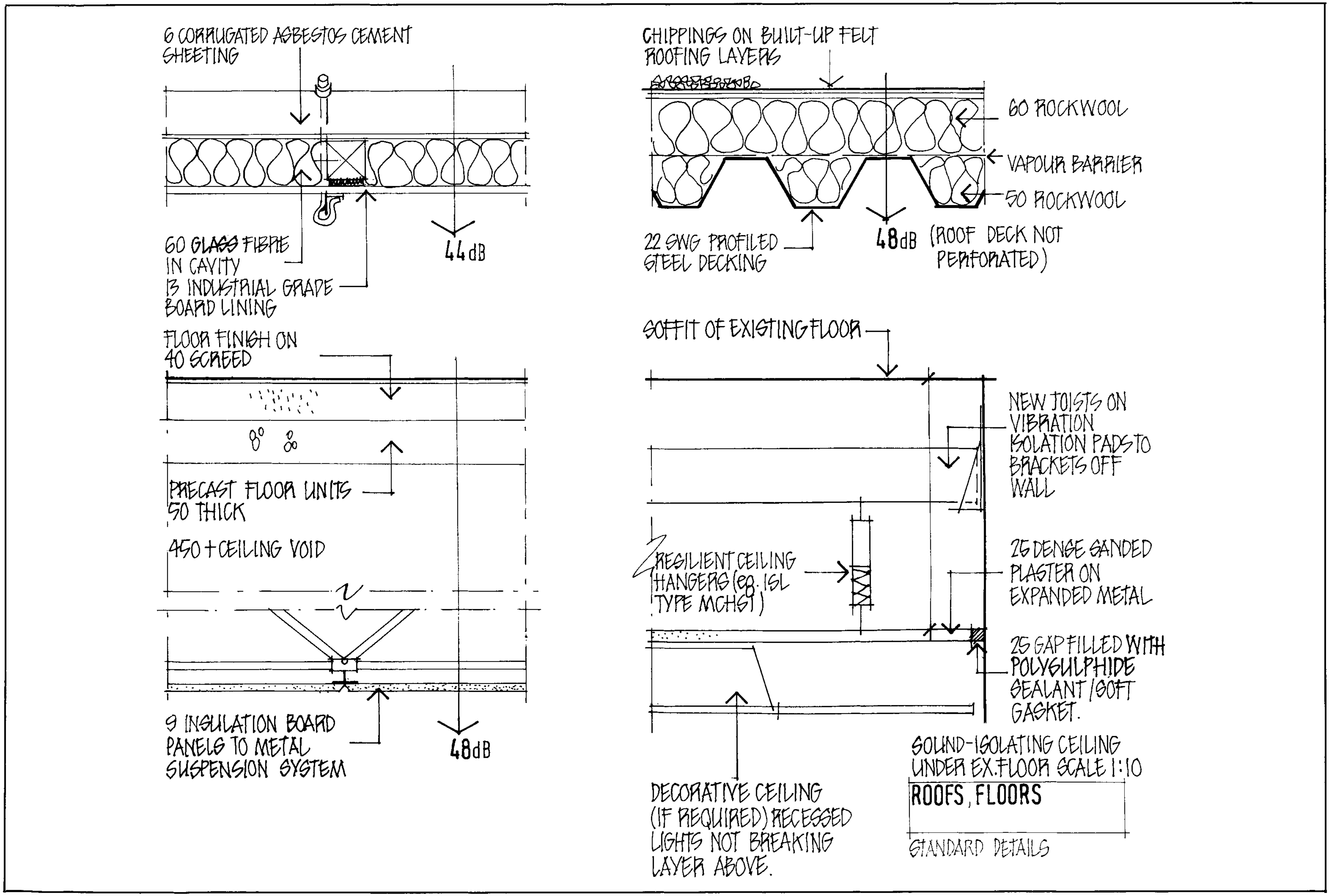
7 Commissioning

Testing and tuning of services systems and sound systems and checking that sound insulation standards are provided in practice are advisable as the logical follow-up to care in detailing.

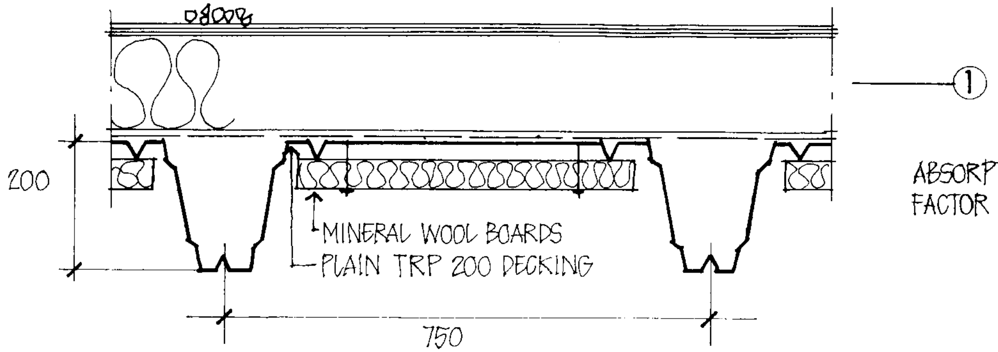
2 DETAILS

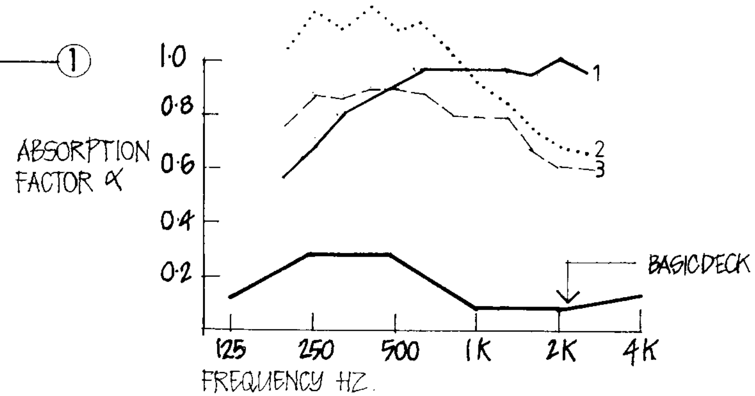
ROOFS

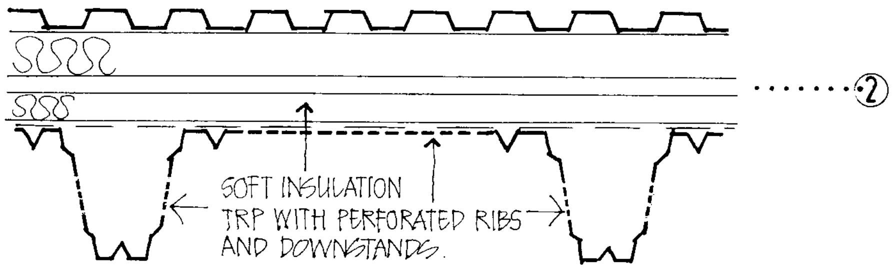

TILES ON 38x19 BATTENS ON ROOFING FELT
50 FIBREGLASS IN POLYTHENE BAGS
13 FOIL BACK PLASTERBOARD
80 FIBRE GLASS QUILT INSULATION
LATH AND PLASTER CEILING
38 dB
45 dB
TILES ON BATTENS ON ROOFING FELT TO RAFTERS
100 ROCKWOOL INSULATION BETWEEN JOISTS
SAND PUGGING 85 Kg/M²
LATH AND PLASTER CEILING
45 dB
BUILT-UP FELT ROOFING LAID TO FALLS ON ROOF BOARDING TO ROOF JOISTS
100 MINERAL WOOL
FOIL BACKED PLASTERBOARD
37-42 dB
0
100mm
200
300
STANDARD DETAILS
ROOFS



6 CORRUGATED ASBESTOS CEMENT SHEETING
60 GLASS FIBRE IN CAVITY
13 INDUSTRIAL GRADE BOARD LINING
44dB
CHIPPINGS ON BUILT-UP FELT ROOFING LAYERS
60 ROCKWOOL
VAPOUR BARRIER
50 ROCKWOOL
22 SWG PROFILED STEEL DECKING
48dB
(ROOF DECK NOT PERFORATED)
FLOOR FINISH ON 40 SCREED
PRECAST FLOOR UNITS 50 THICK
450 + CEILING VOID
9 INSULATION BOARD PANELS TO METAL SUSPENSION SYSTEM
48dB
SOFFIT OF EXISTING FLOOR
NEW JOISTS ON VIBRATION ISOLATION PADS TO BRACKETS OFF WALL
RESILIENT CEILING HANGERS (eg. ISL TYPE MCHS1)
25 DENSE SANDED PLASTER ON EXPANDED METAL
25 GAP FILLED WITH POLYSULPHIDE SEALANT / SOFT GASKET.
DECORATIVE CEILING (IF REQUIRED) RECESSED LIGHTS NOT BREAKING LAYER ABOVE.
SOUND-ISOLATING CEILING UNDER EX. FLOOR SCALE 1:10
ROOFS, FLOORS
STANDARD DETAILS





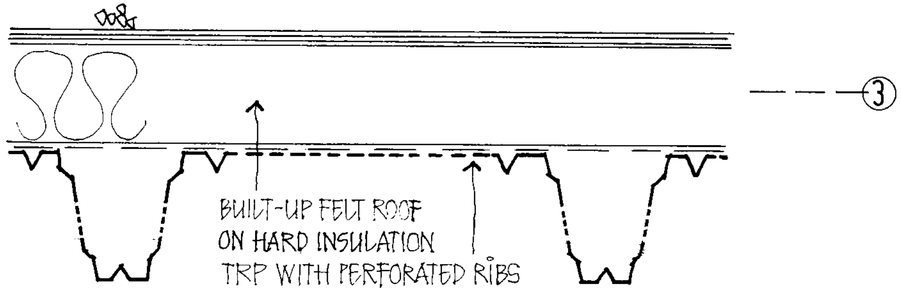


STEEL DECKING CAN BE PROBLEMATIC WHEN EXPOSED INTERNALLY IN INDUSTRIAL OR EVEN OFFICE BUILDINGS. THIS FORM OF ROOFING HAS DEEP RIBS WHICH DIFFUSE REFLECTED SOUND AT THE HIGHER [SPEECH] FREQUENCIES, AND A GOOD PROPORTION OF PERFORATIONS LOCATED ON PART OF THE DECKING NOT CRITICAL FOR STRENGTH.

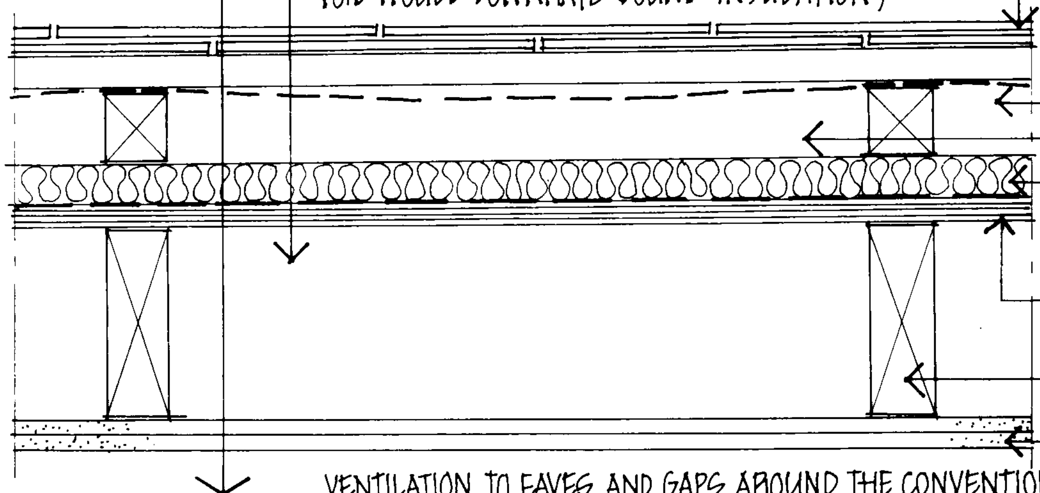
IN ASSESSING PERFORATED STEEL DECK ROOFS, CHECK GAUGE OF STEEL AND THICKNESS OF MEMBRANE IMMEDIATELY ABOVE THE PERFORATIONS ~ BOTH CAN AFFECT α.

HEAVY LINE IS AVERAGE VALUE OF STEEL 'PLANNJA' DECK WITH NO PERFORATIONS OR ABSORPTION.

17% OF THE CURRENT PLANNJA DECK IS OPEN.



ROOFS
SOURCE: PLANNJA

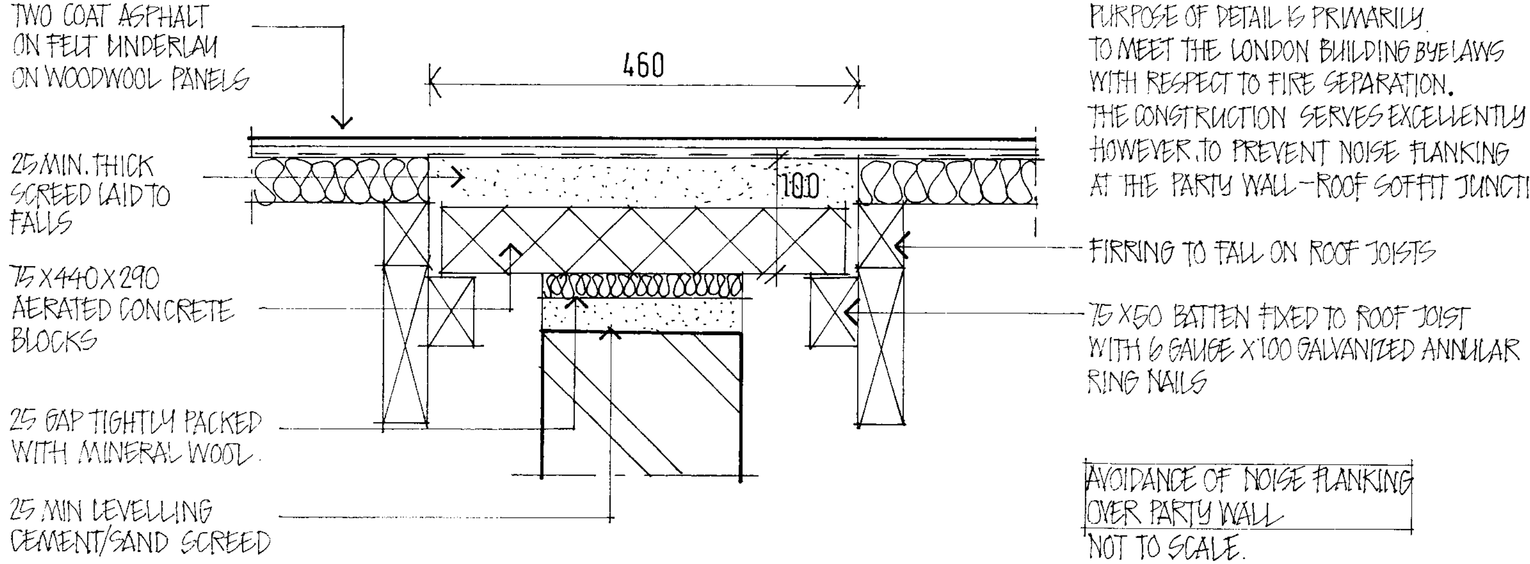


VENTILATION TO EAVES AND GAPS AROUND THE CONVENTIONAL ROOF FINISH OF SLATES OR TILES / BATTENS / ROOFING FELT / JOISTS SEVERELY LIMIT ITS SOUND INSULATION PROPERTIES. IN THIS EXAMPLE, A TRADITIONAL SLATED ROOF FINISH WAS REQUIRED FOR THE REBUILDING OF A CONCERT HALL. LONG SPANS AND EXISTING SUPPORT MASONRY PREVENTED USE OF A 'HEAVY ROOF,' BUT A REASONABLE PERFORMANCE WAS REQUIRED TO MEET NR=20 WITHIN THE HALL.

OLDER BUILDINGS HAVE INHERENTLY MORE MASSIVE CONSTRUCTION AND THE MOST SHOULD BE MADE OF THIS. IN A CONVERSION SCHEME TO PUT TV/FILM STUDIOS IN A LISTED WAREHOUSE BUILDING, THE EXISTING HEAVY ROOF BOARDING WAS RETAINED AND INSULATION BOARD / VAPOUR BARRIER, COUNTER BATTENS, ROOF FELT & SLATES ADDED TO GIVE A BUILD UP OF LAYERS VERY SIMILAR TO THIS DETAIL. INTERLOCKING CONCRETE ROOF TILES ARE HEAVIER AND MORE CLOSELY FITTING THAN NATURAL OR ASBESTOS CEMENT SLATES, AND SO WOULD GIVE MARGINALLY BETTER SOUND INSULATION.

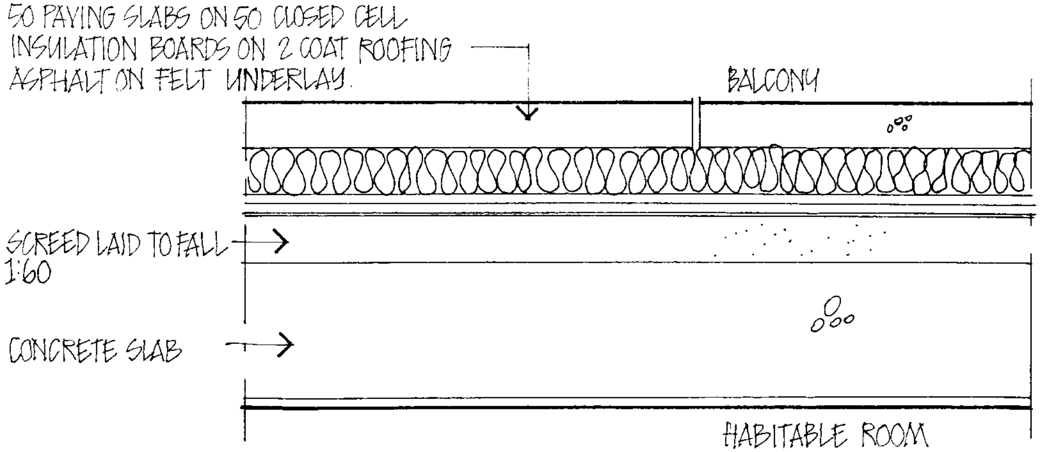
ROOFS
SOURCE: BDP.

0 100mm 200 300



PURPOSE OF DETAIL IS PRIMARILY TO MEET THE LONDON BUILDING BYELAWS WITH RESPECT TO FIRE SEPARATION. THE CONSTRUCTION SERVES EXCELLENTLY, HOWEVER, TO PREVENT NOISE FLANKING AT THE PARTY WALL–ROOF SOFFIT JUNCTION.

AVOIDANCE OF NOISE FLANKING OVER PARTY WALL
NOT TO SCALE.



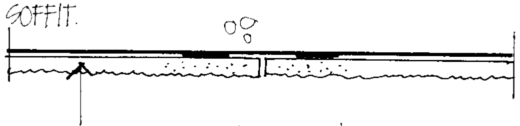
THE INCORPORATION OF THERMAL INSULATION TO MEET RECENT STANDARDS TOO GIVES THE OPPORTUNITY TO ISOLATE STRUCTURE FROM IMPACT SOUND. SIMILARLY ROOF PARKING CAN HAVE IMPACT CAR NOISE ISOLATED BY WEARING DECK SEPARATED FROM STRUCTURAL SLAB BY WATERPROOF MEMBRANE AND RIGID INSULATION BOARDS – THE 'UPSIDE DOWN' ROOF PRINCIPLE.

ISOLATION FROM IMPACT SOUND.
NOT TO SCALE

ROOFS
SOURCE: GLC

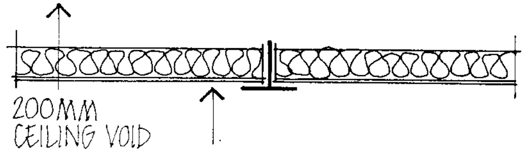
CEILINGS

SOLID SOFFIT.



15 HEAVILY FISSURED 'KOMFORT' CEILING TILES GLUED DIRECT TO SOFFIT

0·09 0·30 0·82 0·95 0·76 0·61



200MM CEILING VOID

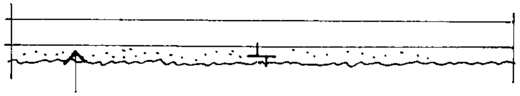
25 LIGHTWEIGHT LAY-IN GLASSFIBRE SUSPENDED CEILING TILES, MATT WHITE COAT FINISH TO UNDERSIDE (TYPE: ROCLAINE DIAPAISON 'P')

0.33 0.84 0.64 0.88 0.89 0.92

40 FIBREGLASS TILES OVER 400 VOID

0.70 0.75 0.65 0.75 0.60 0.35

300 VOID



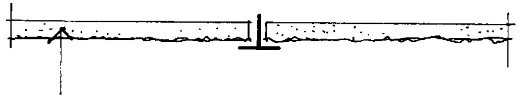
15 HEAVILY FISSURED CONCEALED GRID PLASTER 'GYPTONE' CEILING TILES. METAL SUSPENSION SYSTEM

0.30 0.35 0.40 0.55 0.80 0.70

ABSORPTION FIGURES RELATE TO FREQUENCIES.

125HZ. 250 500 1K 2K 4K

300 CEILING VOID



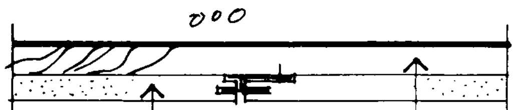
15 FISSURED-FINISH ARMSTRONG 'CERAMGUARD' KILN-FIRED MINERAL FIBRE TILES (FOR USE IN CORROSIVE OR HUMID SITUATION EG. SWIMMING POOLS)

0.25 0.25 0.45 0.70 0.80 1.10

STANDARD DETAILS

CEILINGS

SOUND ABSORPTION

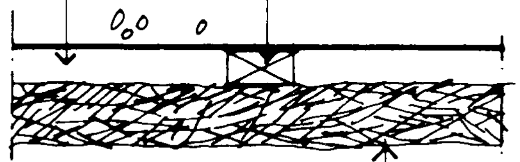


FABRIC COVER TO PROPRIETARY PANELS 600 WIDE. PANELS 19 PERFORATED MINERAL FIBREBOARD BY ARMSTRONG. 50×25 BATTENS ON MASONRY

0.22 0.58 0.56 0.72 0.76 0.81

50×25 BATTENS

25 AIR GAP

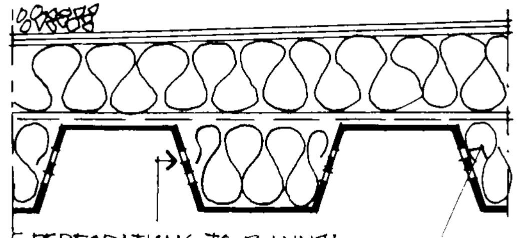


50 WOODWOOL / CEMENT BUILDING SLABS (PRESCREEDED WOODCEMAIRE)

0.30 0.40 0.50 0.85 0.50 0.65

0.15 0.20 0.55 0.75 0.65 0.85 (NO AIR GAP)

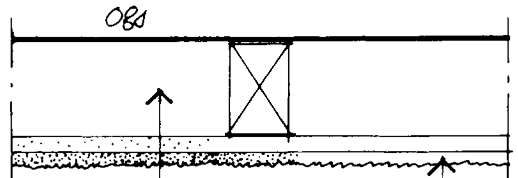
ABSORPTION FIGURES RELATE TO FREQUENCIES
125 250 500 1K 2K 4K.



5 PERFORATIONS TO PLANNJA PROFILED DECKING EXPOSED TO UNDERSIDE

MINERAL WOOL PADS
NOTE: PERFORATIONS MEAN THAT ROOF HAS POOR SOUND INSULATION PROPERTIES

0.20 0.50 0.80 0.85 0.60 0.50



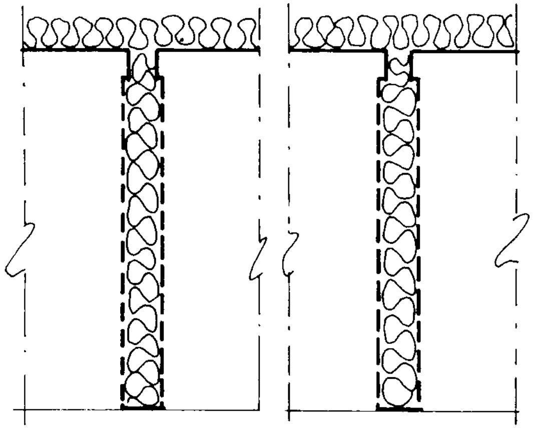
75 AIR GAP
13 ACOUSTIC PLASTER (SPRAY APPLIED EG. 'AUDEX') ON 13 PLASTERBOARD BACKING

0.30 0.35 0.55 0.70 0.85 0.95

STANDARD DETAILS.

CEILINGS / WALL FINISHES
SOUND ABSORPTION

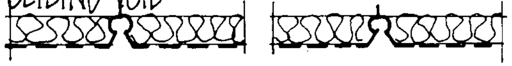
CEILING VOID 370



PROPRIETARY 'DAMPA' BAFFLES OF PERFORATED ALUMINIUM ON 600 X 600 MODULE PACKED WITH 25 MINERAL WOOL PACKED IN POLYTHENE FOIL. 22% PERFORATIONS.

0·22 0·27 0·61 0·71 0·71 0·80

CEILING VOID

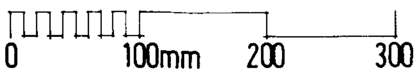


PERFORATED 'DAMPA' TRAYS WITH 25 MINERAL WOOL PADS ON POLYTHENE FOIL. 600 X 600 MODULE IN ALUMINIUM OR STEEL

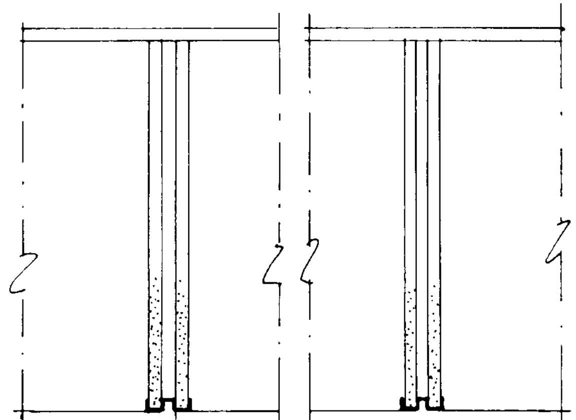
0·68 0·66 0·57 0·58 0·52 0·62

ABSORPTION FIGURES RELATE TO FREQUENCIES:

125Hz 250 500 1K 2K 4K



CEILING VOID 125



ARMSTRONG FISSURED 15 THICK TWIN PANELS OF MINERAL WOOL

0·10 0·30 0·55 1·35 1·15 0·90

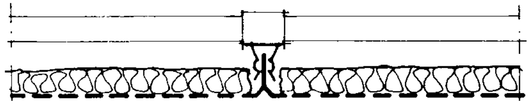
CEILING VOID.

'ROCLAINE' METAL PANELS 5% PERFORATED WITH 20 GLASS FIBRE FACED IN BLACK FIBRE FELT.

0·13 0·27 0·55 0·79 0·90 1·00

STANDARD DETAILS

CEILINGS
SOUND ABSORPTION.

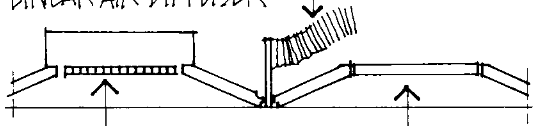


PERFORATED METAL TILES CLIPPED TO SUPPORT FRAMING, 25 PROPRIETARY PADS - DENSITY 64 KG/M2.

SOUND ABSORPTION:
0·20 0·55 0·80 0·80 0·80 0·75

SOUND ATTENUATION (BS 2750 ROOM TO ROOM)
32 dB (40 dB FOR SOLID FACE TILE)

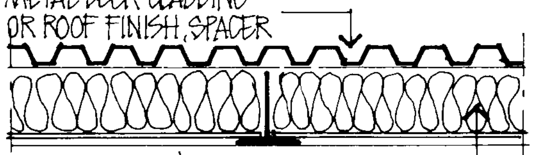
LINEAR AIR DIFFUSER



LIGHT FITTINGS IN 900 MODULAR COFFERED CEILING PANELS

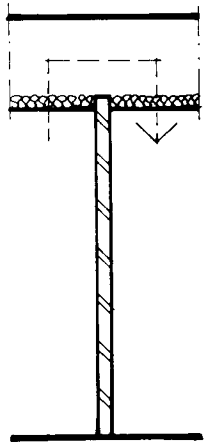
PERFORATED METAL SKIN WITH MINERAL WOOL BACKING
NOT TO SCALE
0·45 0·50 0·75 0·90 0·90 0·90

METAL DECK CLADDING OR ROOF FINISH, SPACER

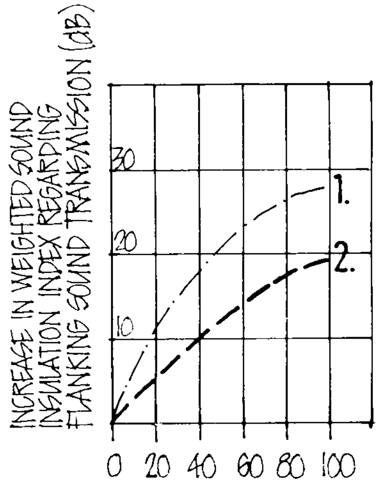


FACTORY LINER' FIBREGLASS LTD. PANELS 50 THICK, IN METAL TEE-SECTION FRAMING TO PURLINS
0·45 1·00 0·90 0·70 0·50 0·35
STANDARD DETAILS.

VARYING THICKNESSES OF MINERAL WOOL ON LIGHTWEIGHT CEILING

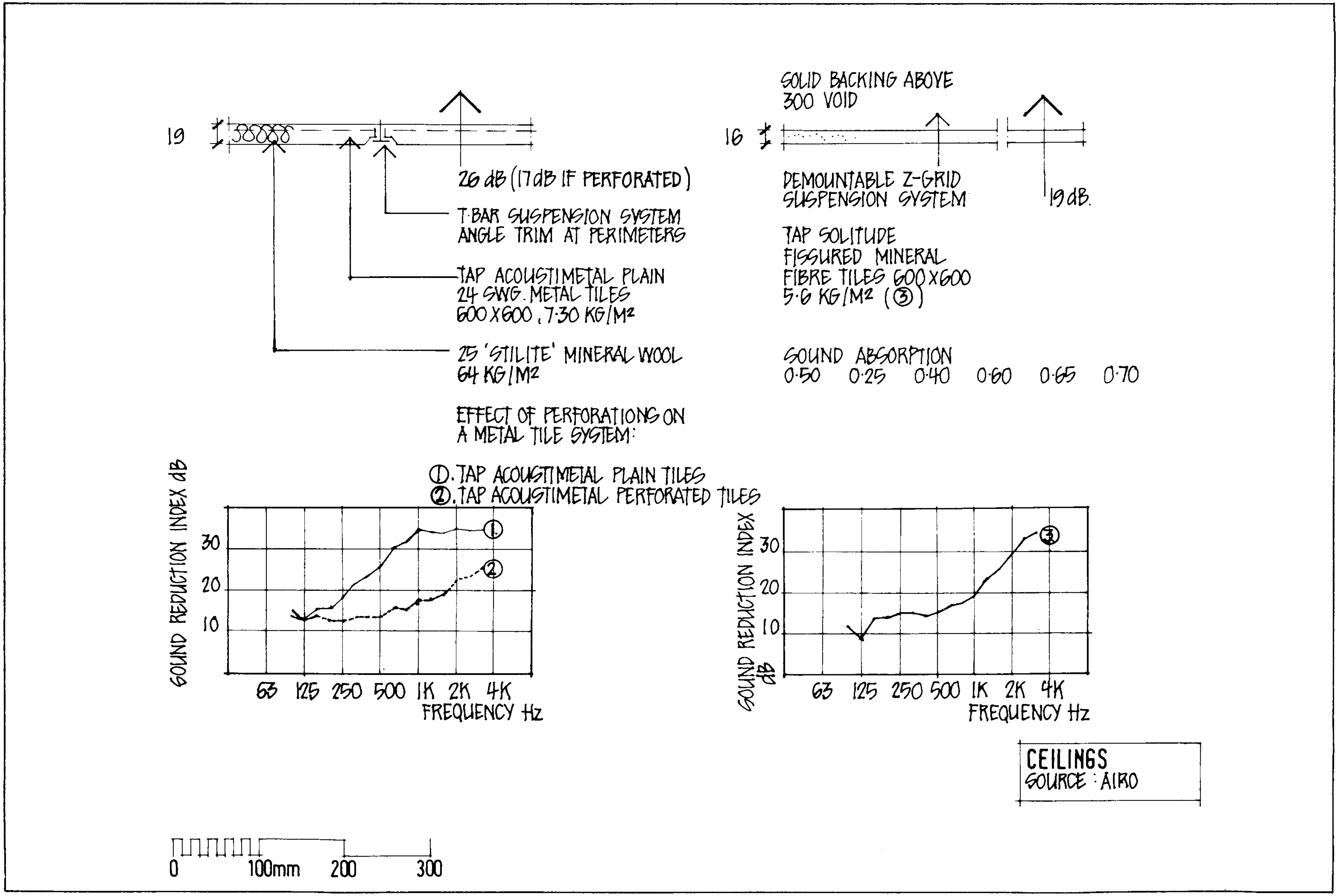


SECTION. NTS

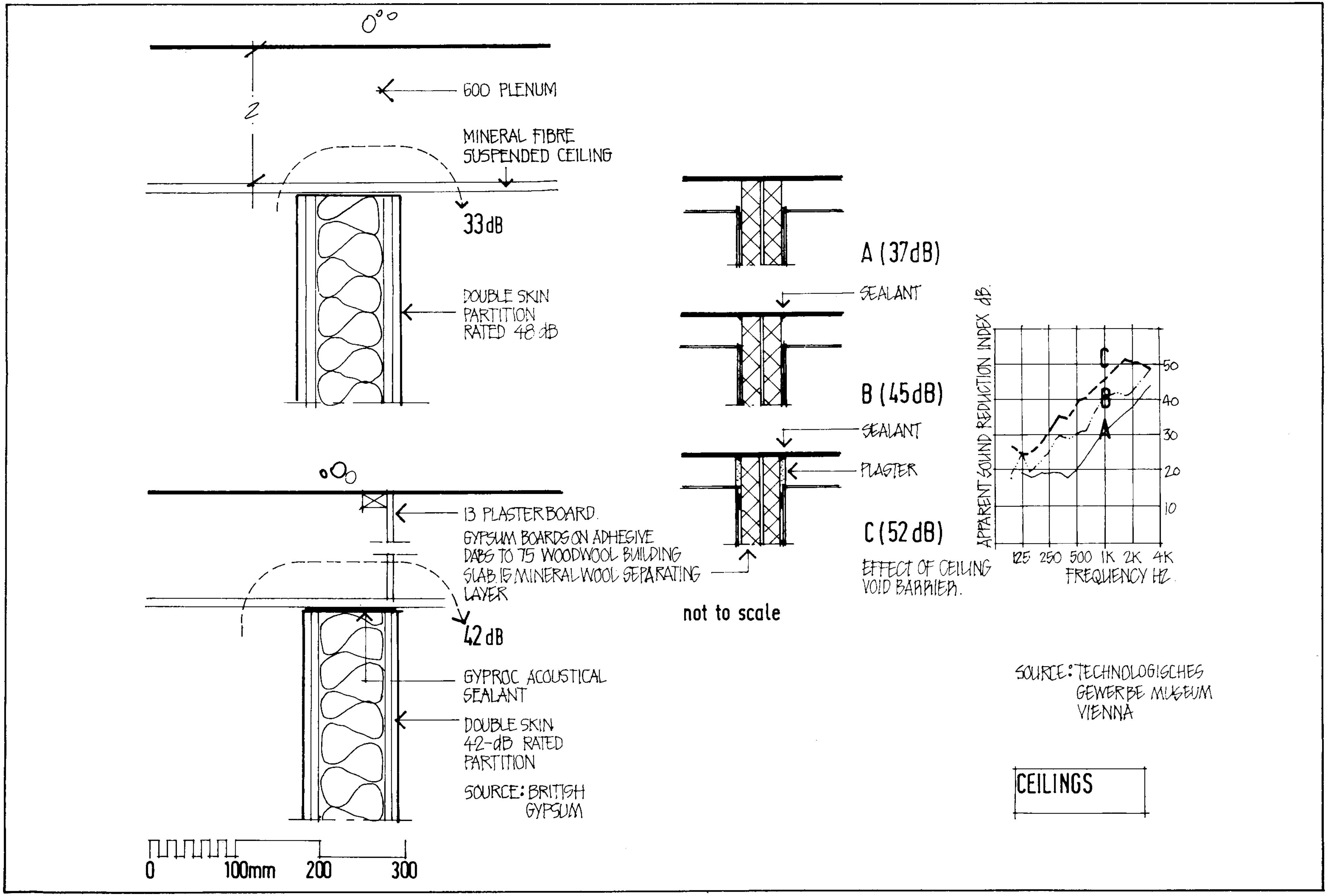


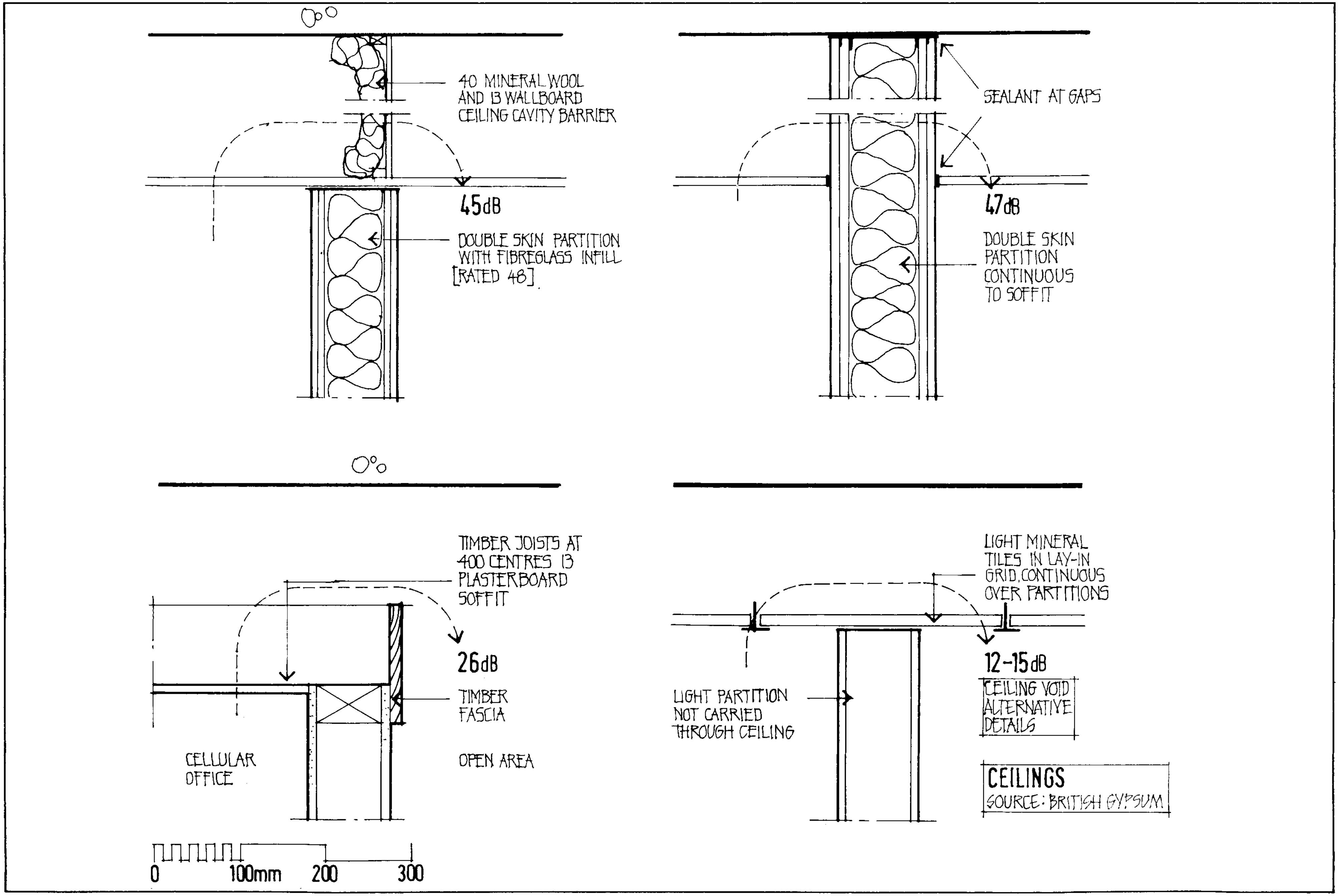
THICKNESS OF MINERAL WOOL
1. AIRTIGHT CEILINGS
2. SUSPENDED PROPRIETARY CEILINGS - NO AIRTIGHT JOINTS
SOURCE: DR. LANG. TECHNOLOGISCHES GEWERBE MUSEUM VIENNA.

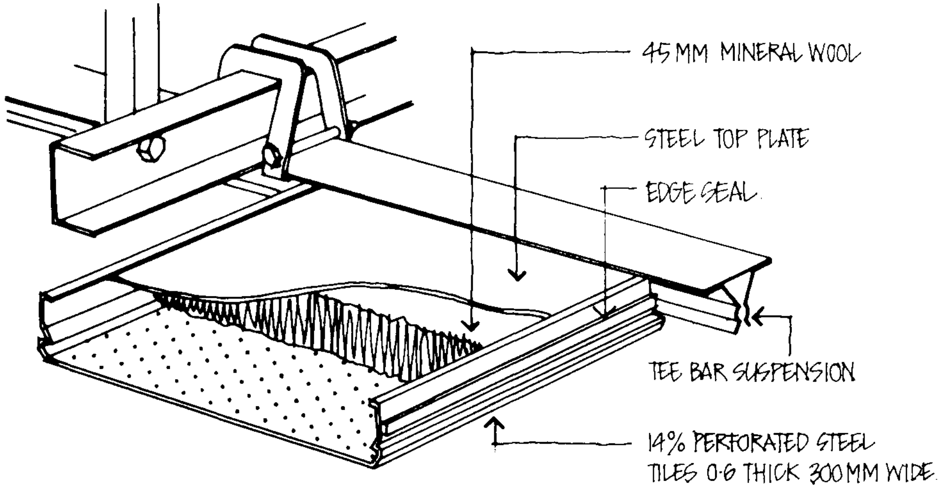
CEILINGS

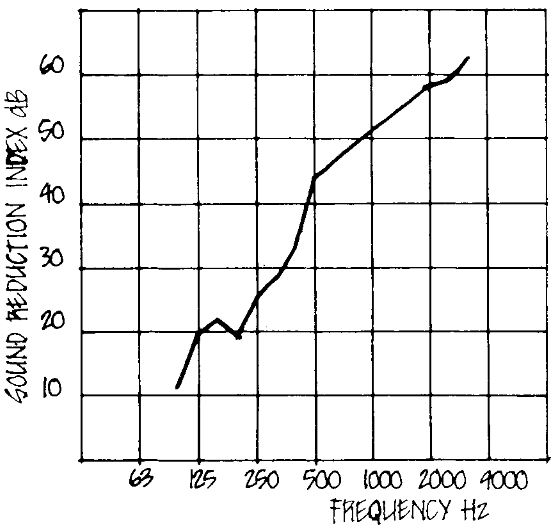


19
26 dB (17 dB IF PERFORATED)
T-BAR SUSPENSION SYSTEM
ANGLE TRIM AT PERIMETERS
TAP ACOUSTIMETAL PLAIN
24 SWG. METAL TILES
600 X 600, 7·30 KG/M²
25 'STILITE' MINERAL WOOL
64 KG/M²
EFFECT OF PERFORATIONS ON
A METAL TILE SYSTEM:
①. TAP ACOUSTIMETAL PLAIN TILES
②. TAP ACOUSTIMETAL PERFORATED TILES
SOUND REDUCTION INDEX dB
30
20
10
63 125 250 500 1K 2K 4K
FREQUENCY Hz
SOLID BACKING ABOVE
300 VOID
16
DEMOUNTABLE Z-GRID
SUSPENSION SYSTEM
19 dB.
TAP SOLITUDE
FISSURED MINERAL
FIBRE TILES 600 X 600
5·6 KG/M² (③)
SOUND ABSORPTION
0·50 0·25 0·40 0·60 0·65 0·70
SOUND REDUCTION INDEX dB
30
20
10
63 125 250 500 1K 2K 4K
FREQUENCY Hz
CEILINGS
SOURCE : AIRO
0 100mm 200 300


600 PLENUM
MINERAL FIBRE SUSPENDED CEILING
33dB
DOUBLE SKIN PARTITION RATED 48 dB
13 PLASTERBOARD.
GYPSUM BOARDS ON ADHESIVE DABS TO 75 WOODWOOL BUILDING SLAB. 15 MINERAL WOOL SEPARATING LAYER
42 dB
GYPROC ACOUSTICAL SEALANT
DOUBLE SKIN 42-dB RATED PARTITION
SOURCE: BRITISH GYPSUM
0
100mm
200
300
A (37dB)
SEALANT
B (45dB)
SEALANT
PLASTER
C (52dB)
not to scale
EFFECT OF CEILING VOID BARRIER.
APPARENT SOUND REDUCTION INDEX dB.
10
20
30
40
50
C
B
A
125 250 500 1K 2K 4K
FREQUENCY HZ.
SOURCE: TECHNOLOGISCHES GEWERBE MUSEUM VIENNA
CEILINGS

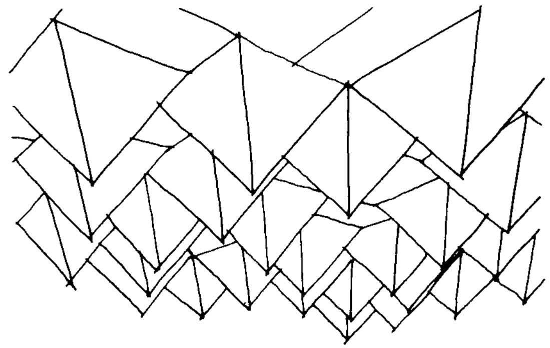

40 MINERAL WOOL
AND 13 WALLBOARD
CEILING CAVITY BARRIER
45dB
DOUBLE SKIN PARTITION
WITH FIBREGLASS INFILL
[RATED 48]
SEALANT AT GAPS
47dB
DOUBLE SKIN
PARTITION
CONTINUOUS
TO SOFFIT
TIMBER JOISTS AT
400 CENTRES 13
PLASTERBOARD
SOFFIT
26dB
TIMBER
FASCIA
CELLULAR
OFFICE
OPEN AREA
LIGHT MINERAL
TILES IN LAY-IN
GRID, CONTINUOUS
OVER PARTITIONS
12-15dB
CEILING VOID
ALTERNATIVE
DETAILS
LIGHT PARTITION
NOT CARRIED
THROUGH CEILING
CEILINGS
SOURCE: BRITISH GYPSUM
0
100mm
200
300





SOUND ABSORPTION
0.50 0.70 0.80 1·00 1·00 1·00

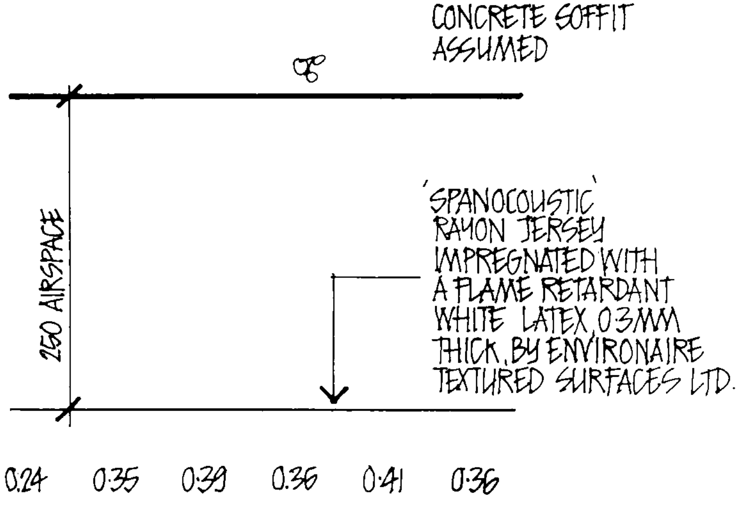
PROPRIETARY CEILING TILE FOR SOUND INSULATION AND SOUND ABSORBTION

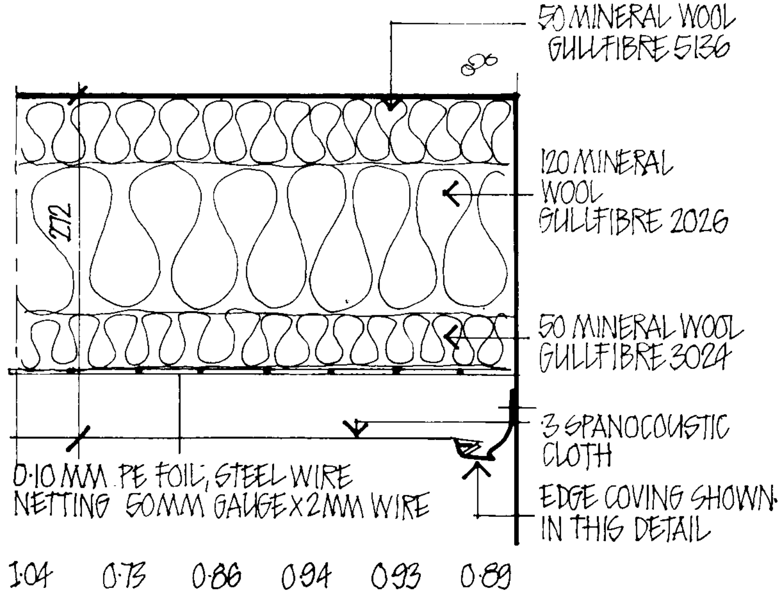


SPECIAL METAL CEILING UNITS 600 X 600 X 0·6 THICK PYRAMIDS FORMING A SOUND DIFFUSING CEILING

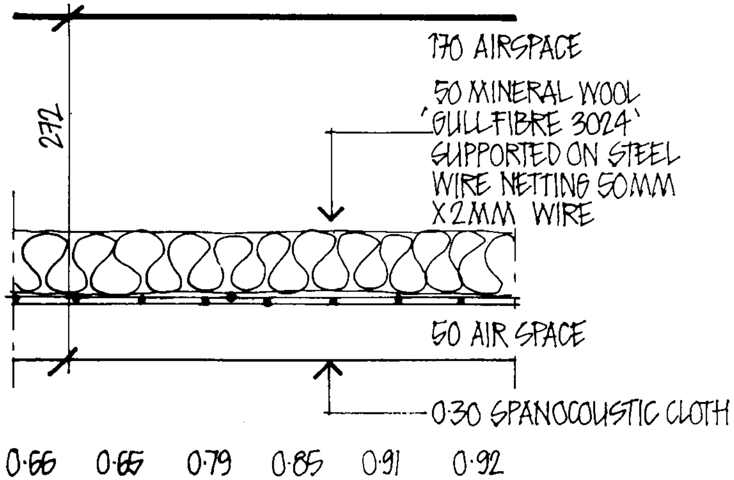
UNPERFORATED METAL TILES CAN GIVE ROOM-TO-ROOM (BS 2750) AVERAGE NORMALIZED S.L. DIFFERENCE 41 dB.

CEILINGS
SOURCE: BURGESS ARCHITECTURAL PROD LTD.

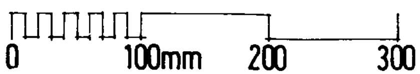




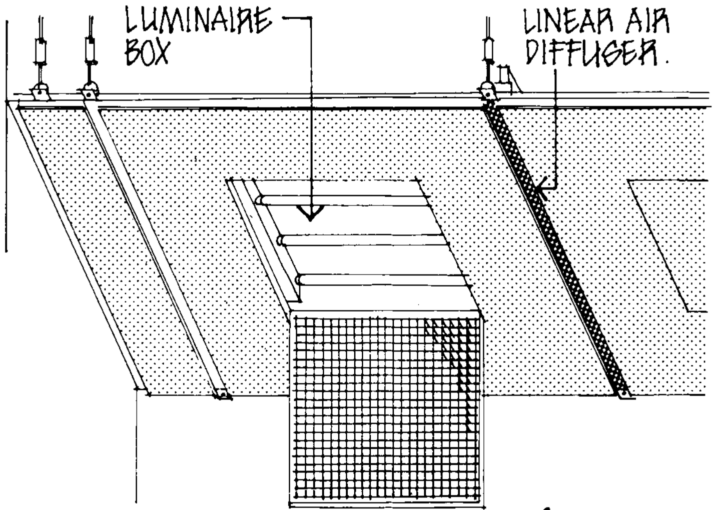
THIS IS A RECENT INNOVATION TO THE U.K.: MOIST TEXTILE MATERIAL IS STRETCHED TO EDGE BATTENS AND A ONE-OFF EVAPORATION RESULTS IN A TAUT CEILING MEMBRANE UNAFFECTED BY SUBSEQUENT CHANGES IN HUMIDITY AND TEMPERATURE. CLAIMED LIFE EXPECTANCY IS 20 YRS. NO FIRE PROTECTION GIVEN BY THIS CEILING, WHICH IS TESTED TO BS 476: PART 7: CLASS 1. A LIGHT CEILING OF THIS FORM MAY BE CONSIDERED IN REFURBISHMENT WHERE WEIGHT OF SUSPENDED CEILING WOULD BE PROBLEMATIC.

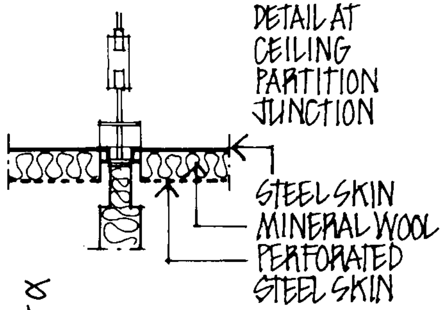


(TEST STANDARD: ISO/R354, SIMILAR TO BS 3638/1963)

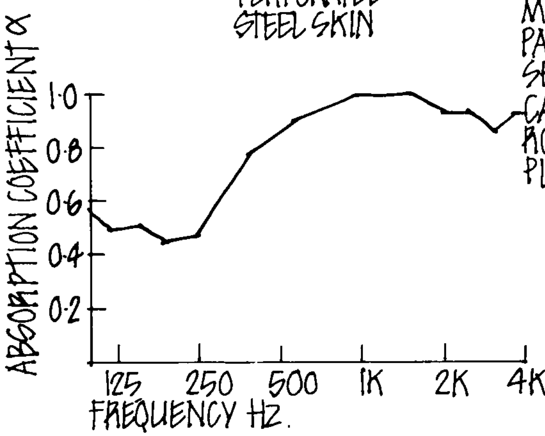


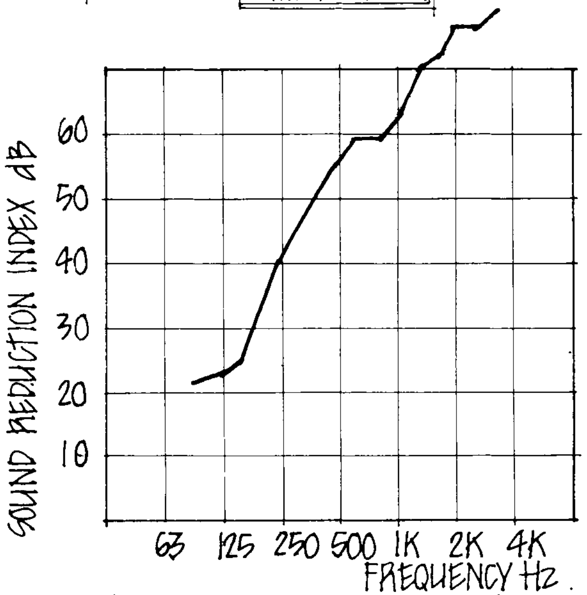
CEILINGS
SOURCE: UNIVERSITY OF TECHNOLOGY, LUND SWEDEN



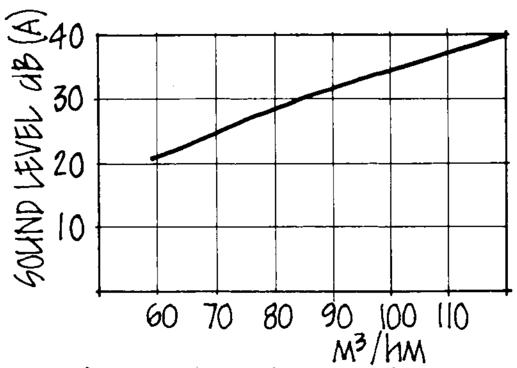


WHEN SOUND REDUCTION AS WELL AS ABSORPTION IS REQUIRED OF A CEILING, CARE SHOULD BE TAKEN THAT CEILING FITTINGS DO NOT DE-RATE. IN THIS EXAMPLE, LIGHT BOXES ARE FULLY ENCLOSED TO MAINTAIN SEPARATION, PARTITION JUNCTIONS ARE SEALED, AND AIR DIFFUSERS CAN BE LINEAR, SQUARE OR ROUND, ALL WITH SEALED PLENUM BOXES BEHIND.





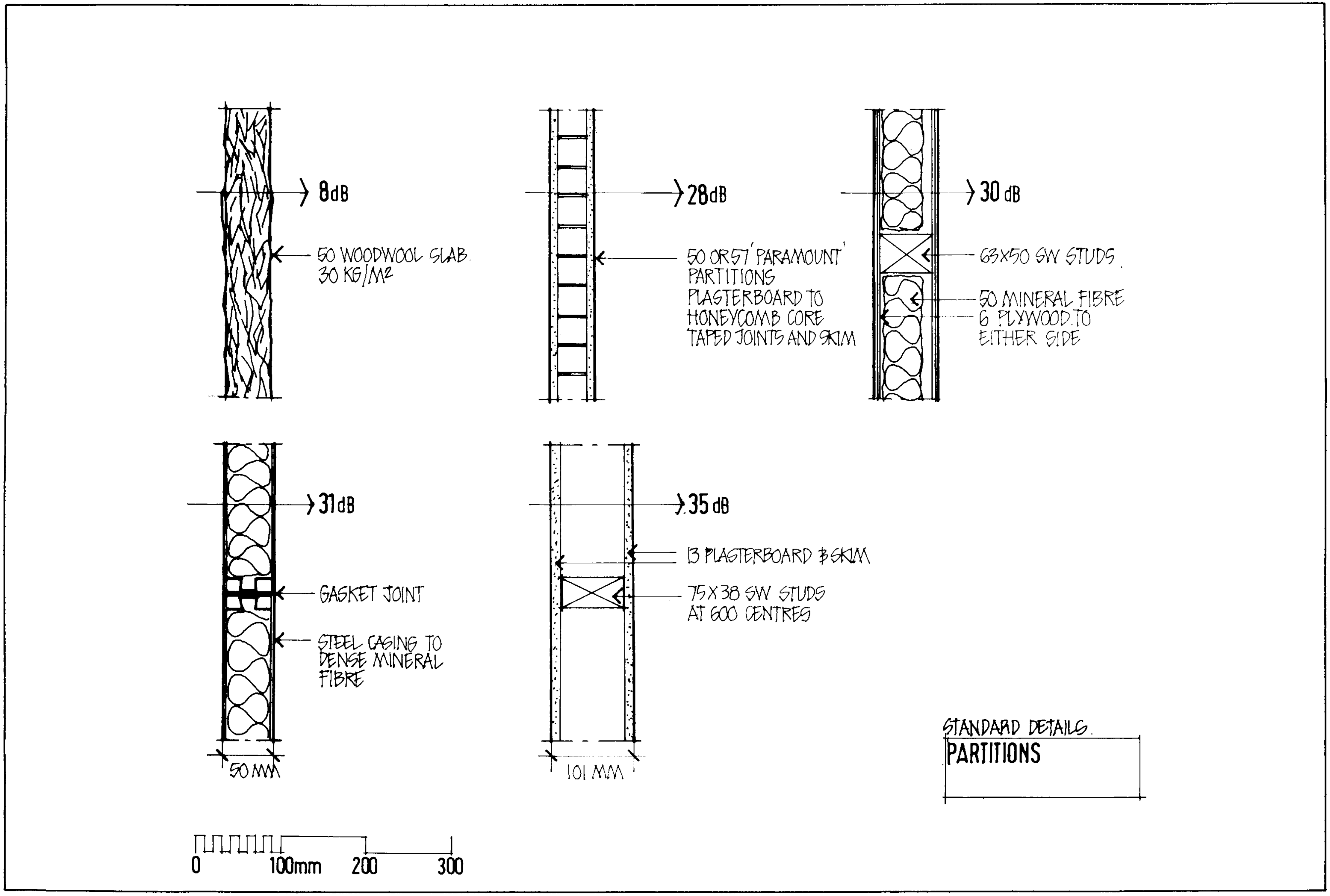
SOUND REDUCTION FOR REINFORCED PANEL OPTION (TYPE 'COMPAC REGULAR')

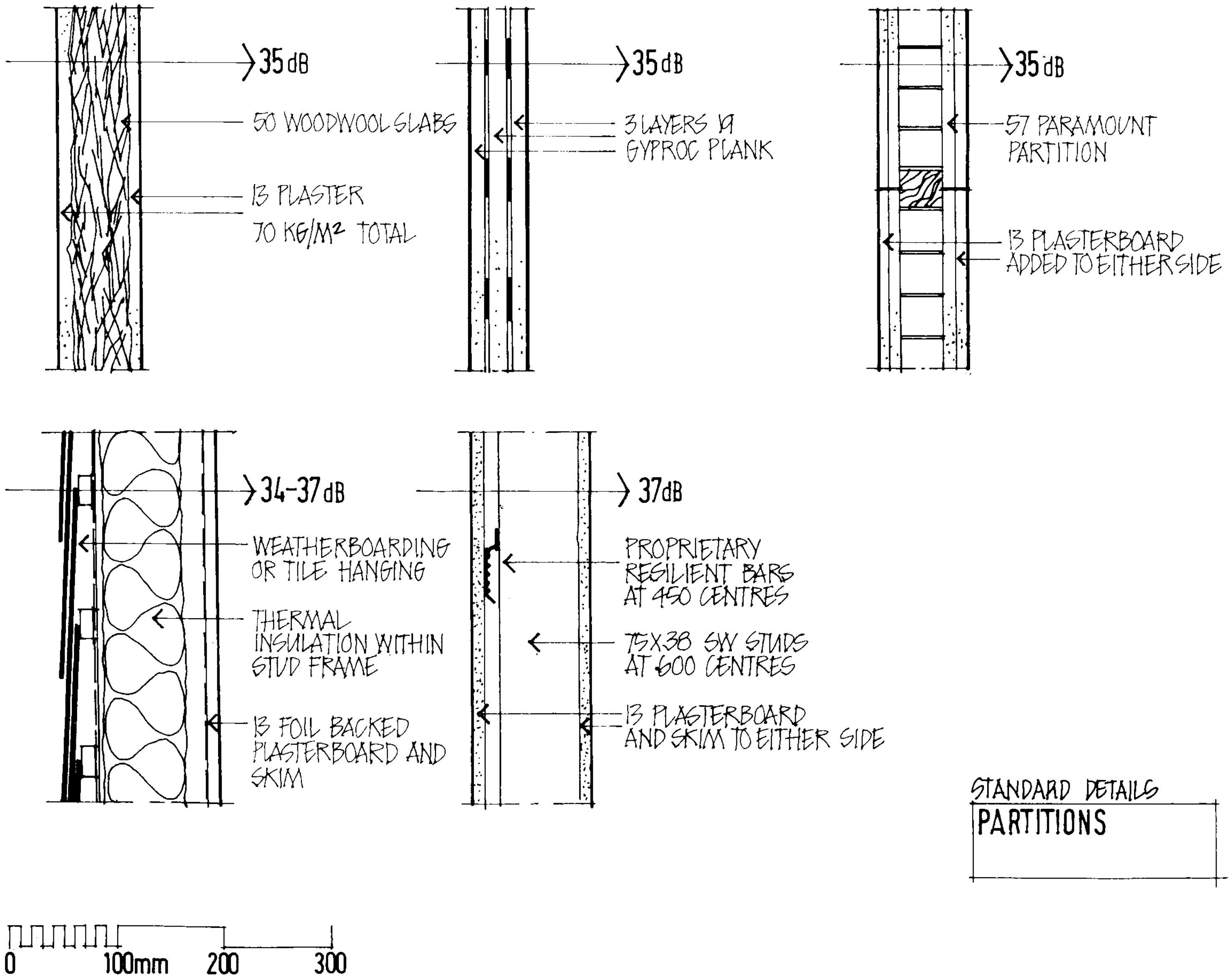


SOUND LEVELS THROUGH LINEAR 3-DIRECTIONS DIFFUSER
(INDICATION ONLY : DEPENDS ON ROOM CONDITIONS)

CEILINGS
SOURCE:
HAUSERMAN LTD

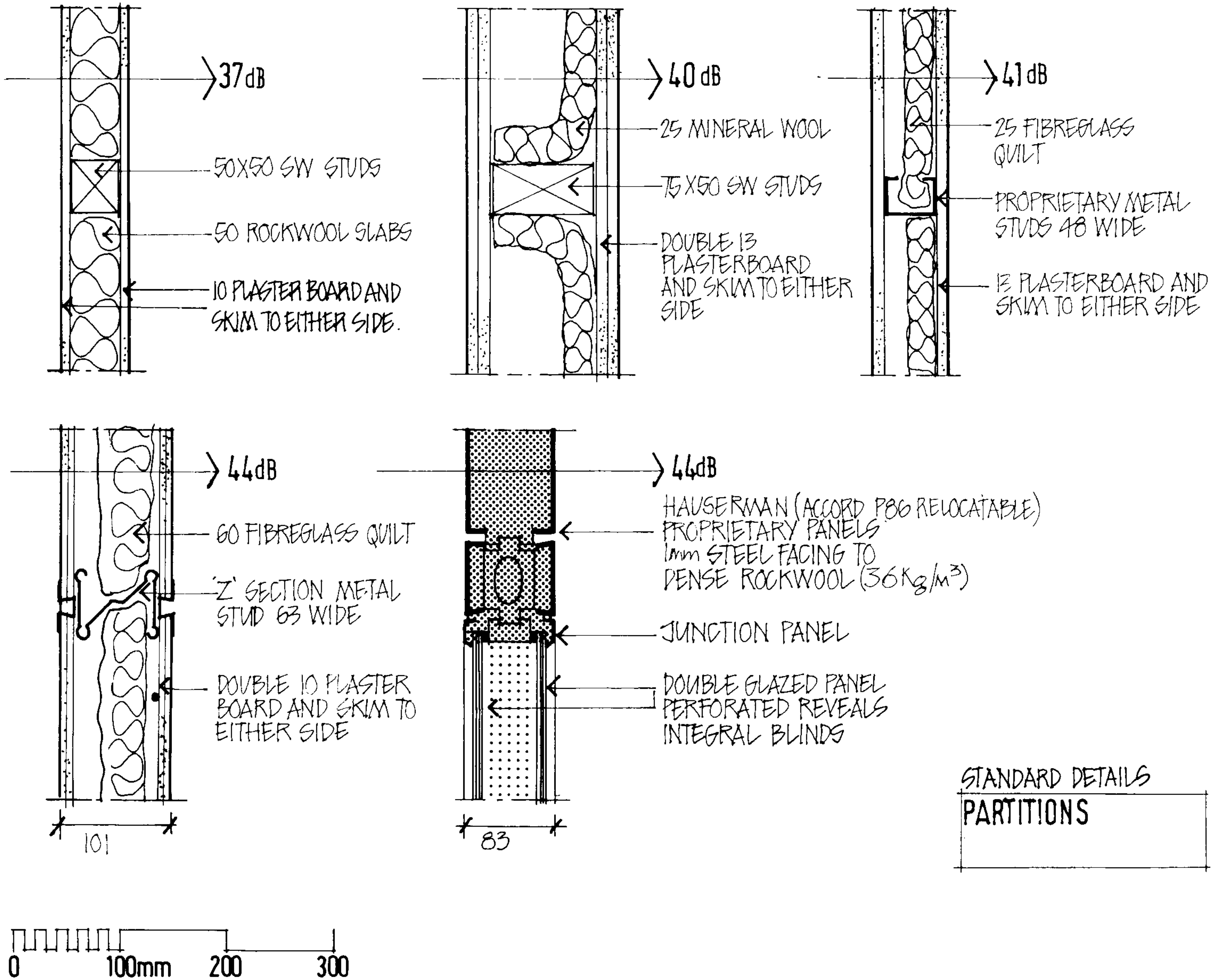
PARTITIONS

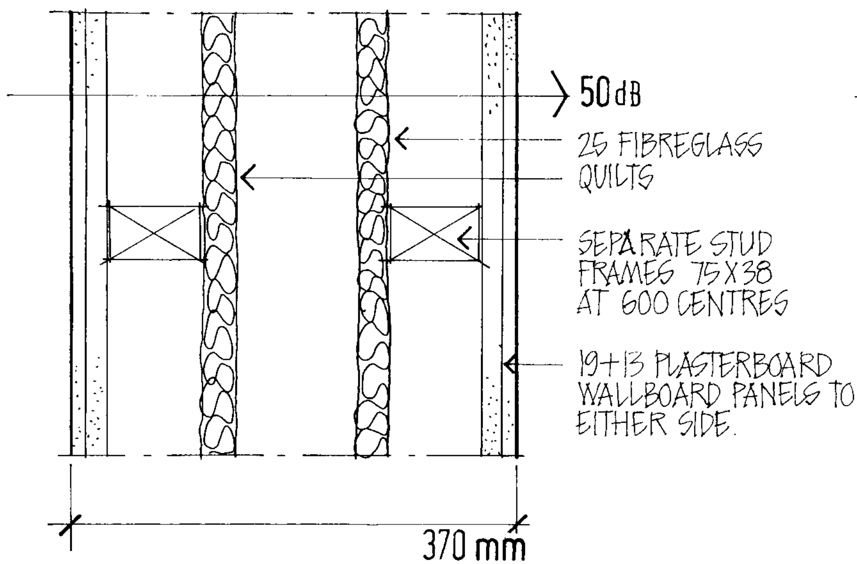

8dB
50 WOODWOOL SLAB.
30 KG/M2
28dB
50 OR 57 'PARAMOUNT'
PARTITIONS
PLASTERBOARD TO
HONEYCOMB CORE
TAPED JOINTS AND SKIM
30 dB
63x50 SW STUDS.
50 MINERAL FIBRE
6 PLYWOOD TO
EITHER SIDE
31dB
GASKET JOINT
STEEL CASING TO
DENSE MINERAL
FIBRE
50 MM
35 dB
13 PLASTERBOARD & SKIM
75 X 38 SW STUDS
AT 600 CENTRES
101 MM
0
100mm
200
300
STANDARD DETAILS.
PARTITIONS

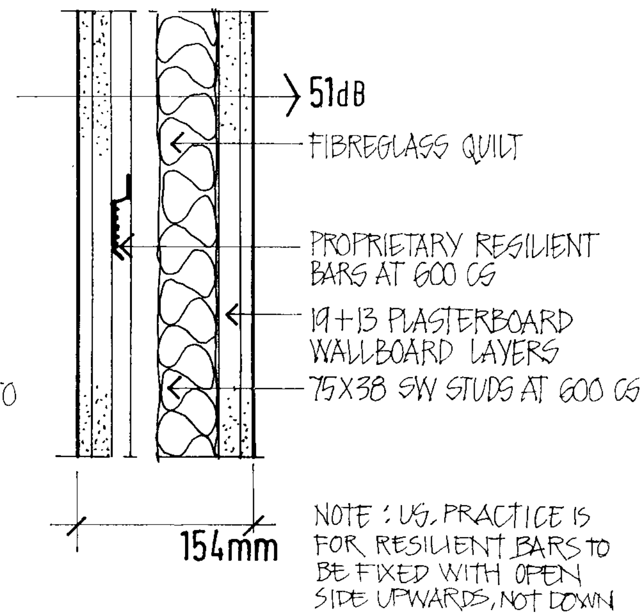


STANDARD DETAILS

PARTITIONS

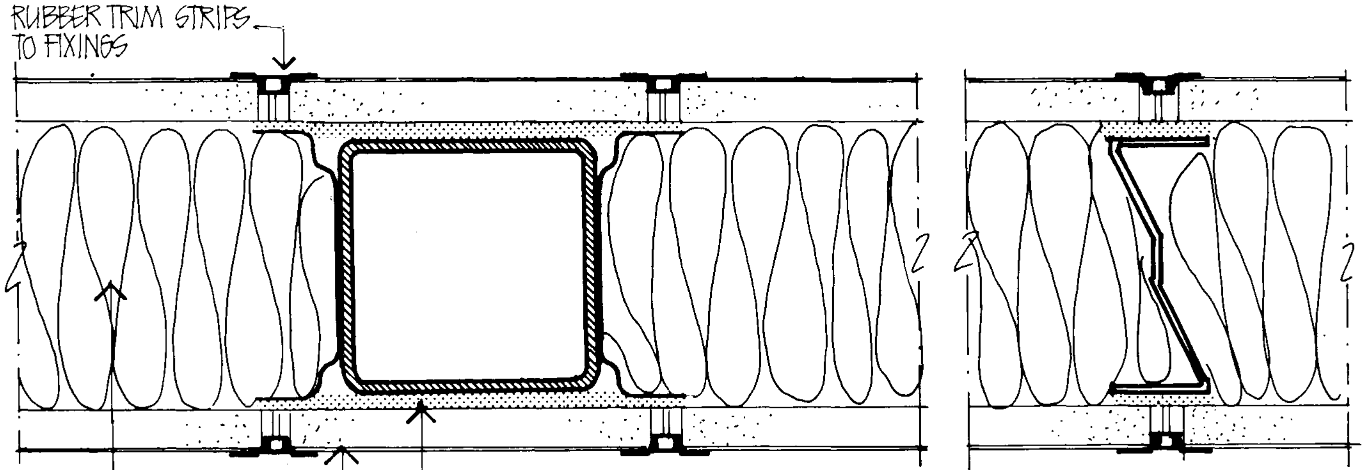

37dB
50X50 SW STUDS
50 ROCKWOOL SLABS
10 PLASTER BOARD AND SKIM TO EITHER SIDE.
40 dB
25 MINERAL WOOL
75X50 SW STUDS
DOUBLE 13 PLASTERBOARD AND SKIM TO EITHER SIDE
41 dB
25 FIBREGLASS QUILT
PROPRIETARY METAL STUDS 48 WIDE
13 PLASTERBOARD AND SKIM TO EITHER SIDE
44dB
60 FIBREGLASS QUILT
'Z' SECTION METAL STUD 63 WIDE
DOUBLE 10 PLASTER BOARD AND SKIM TO EITHER SIDE
101
44dB
HAUSERMAN (ACCORD P86 RELOCATABLE) PROPRIETARY PANELS 1mm STEEL FACING TO DENSE ROCKWOOL (36Kg/m³)
JUNCTION PANEL
DOUBLE GLAZED PANEL PERFORATED REVEALS INTEGRAL BLINDS
83
STANDARD DETAILS
PARTITIONS
0
100mm
200
300





STANDARD DETAILS.

PARTITIONS



HORIZONTAL SECTIONS

73 MINERAL WOOL

13 GYPSUM BOARD WITH PLASTIC FACINGS

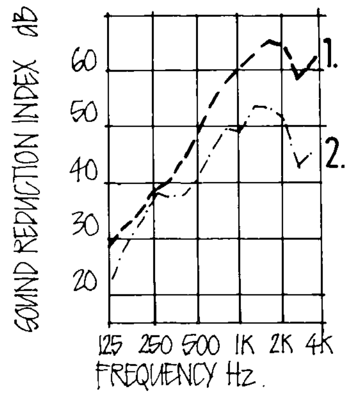
INTERMEDIATE LAYER OF FOAMED PLASTIC STRIPS

STEEL SUPPORTS AND STUDDING

1. FASTENING OF GYPSUM PANELS AS DETAILED (R=47 dB)

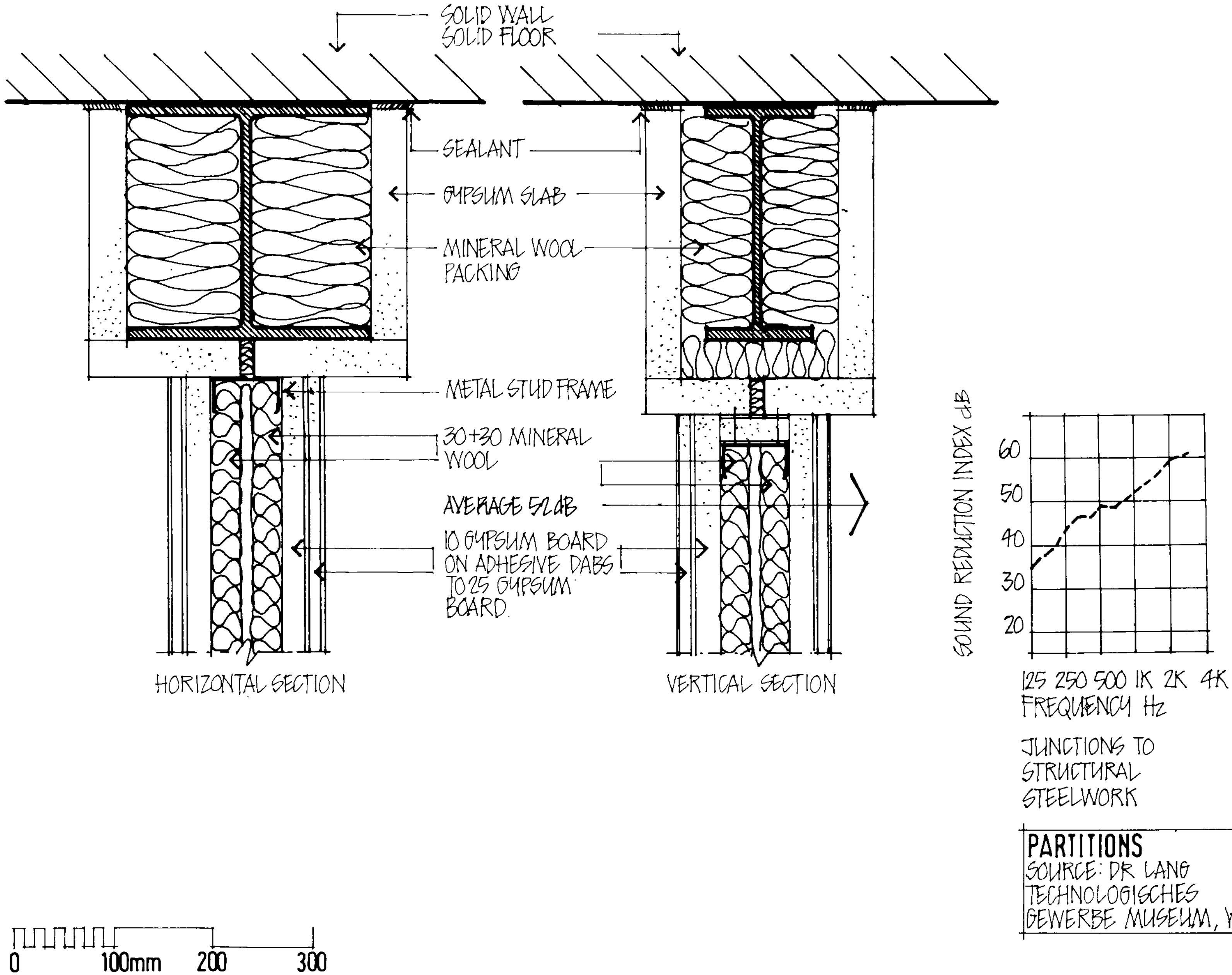
2. GYPSUM PANELS FIXED DIRECTLY TO STEEL SUPPORTS (R=45 dB)

RESILIENT MOUNTING TO FRAMING GIVES LIGHTWEIGHT PARTITIONS GOOD PERFORMANCE AT HIGH FREQUENCIES. BENEFIT FOR SPEECH PRIVACY (GOOD PERFORMANCE IN 1-2K RANGE) BUT SMALL IMPROVEMENT FOR LOW FREQUENCY PERFORMANCE: MASS REQUIRED.



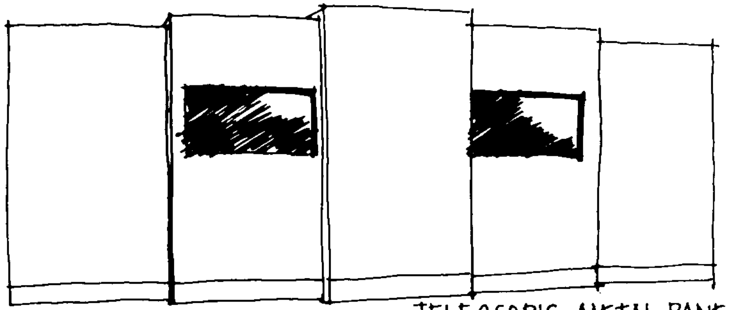
PARTITIONS
SOURCE: DR LANG
TECHNOLOGISCHES
GEWERBE MUSEUM VIENNA

0 50mm

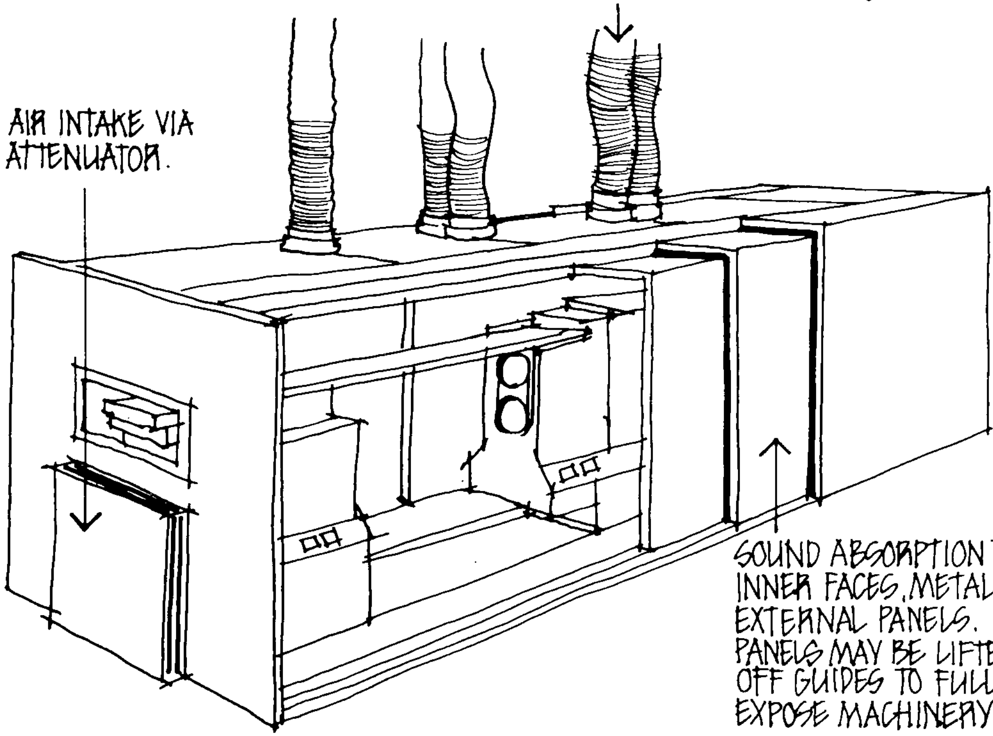


JUNCTIONS TO STRUCTURAL STEELWORK

PARTITIONS
SOURCE: DR LANG TECHNOLOGISCHES GEWERBE MUSEUM, VIENNA

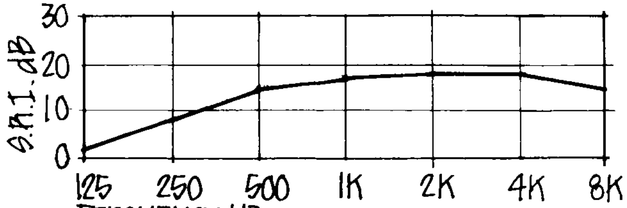


TELESCOPIC METAL PANEL ENCLOSURE.
OWN VENTILATION EXTRACT.

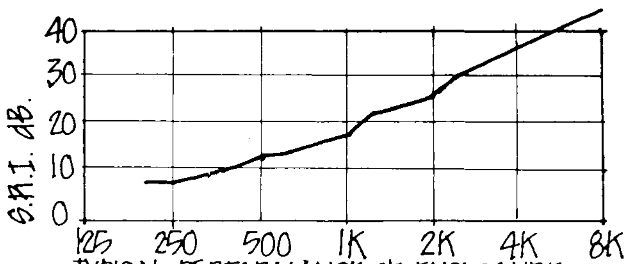


AIR INTAKE VIA ATTENUATOR.

SOUND ABSORPTION TO INNER FACES, METAL EXTERNAL PANELS.
PANELS MAY BE LIFTED OFF GUIDES TO FULLY EXPOSE MACHINERY



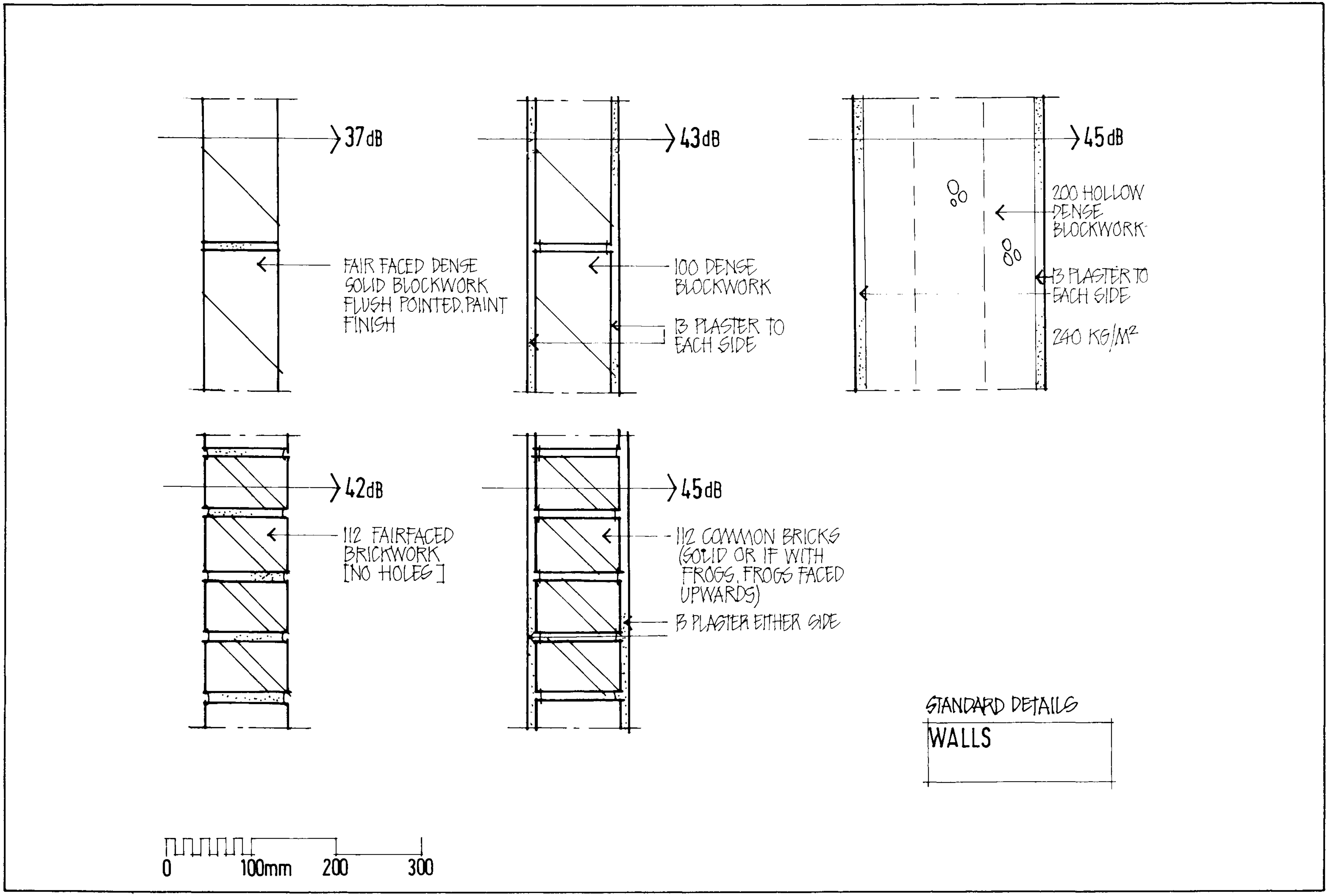
TYPICAL PERFORMANCE OF METAL PANEL ENCLOSURE.
(OVERALL: 15-20dBA)
SOURCE: THE NOISE CONTROL CENTRE LTD.

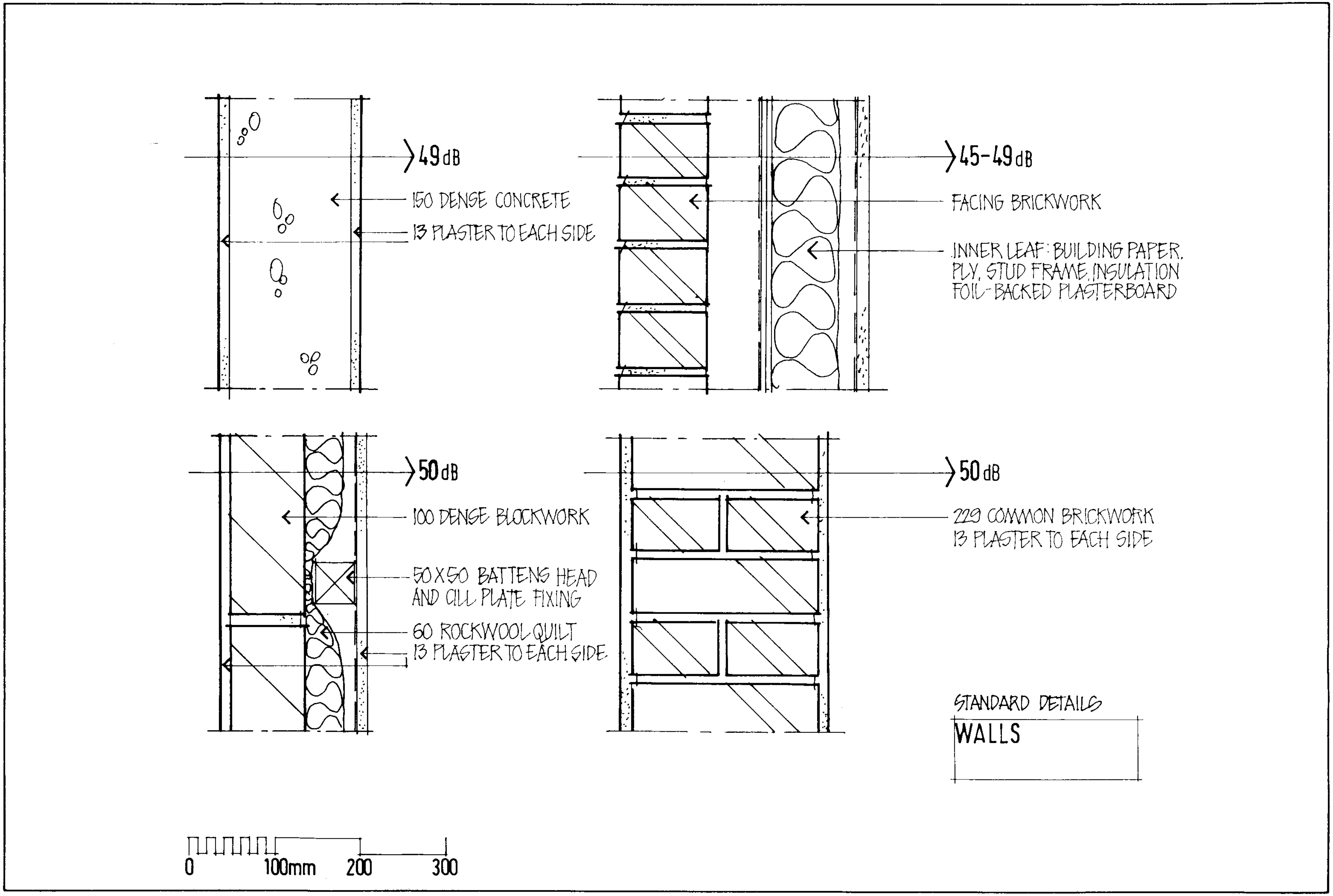


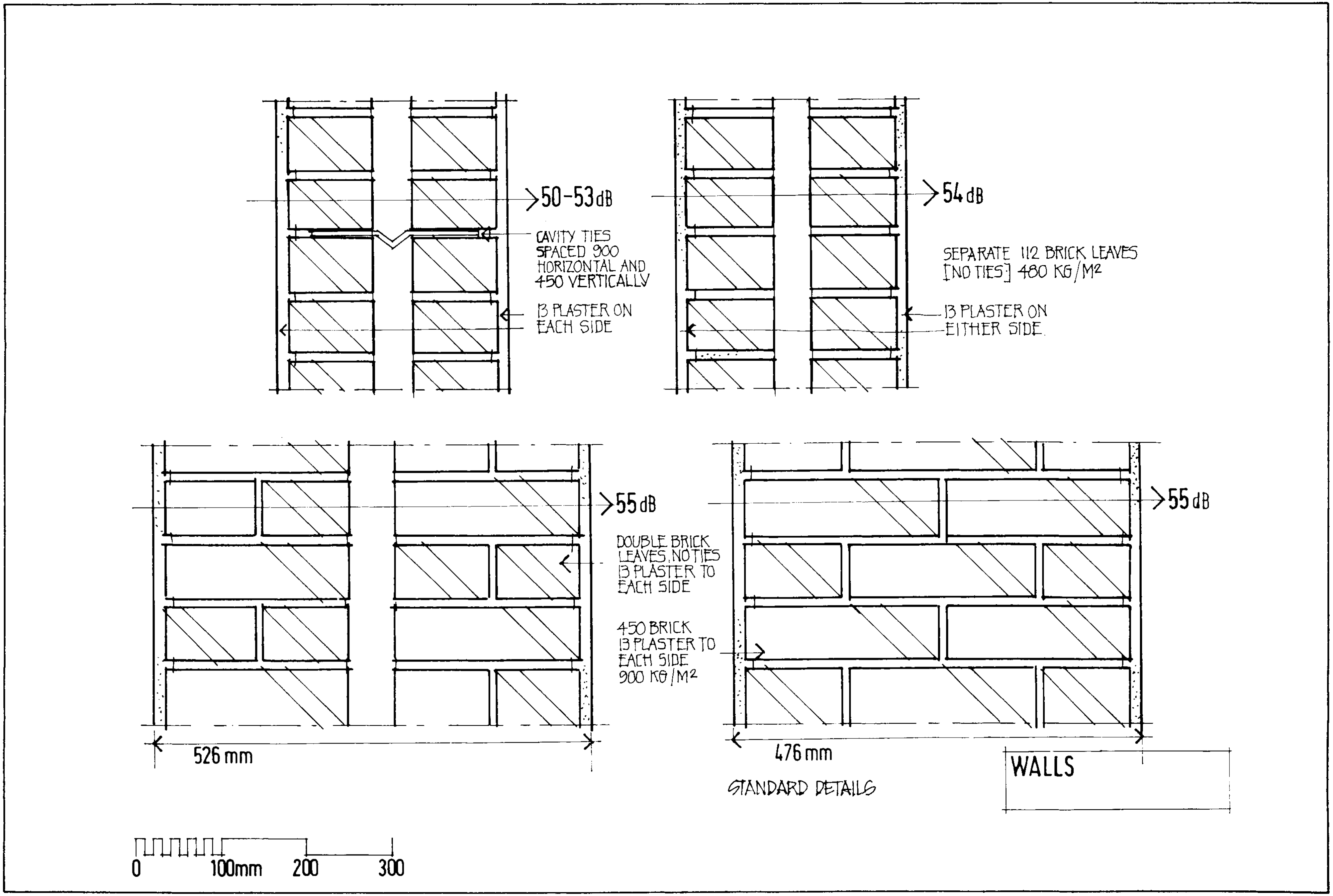
TYPICAL PERFORMANCE OF ENCLOSURE BY PROPRIETARY LIMP LOW-STIFFNESS ACOUSTIC CURTAINS
SOURCE: BESTOBELL ACOUSTICS.
SUCH SYSTEMS SHOULD BE CONSIDERED TO SCREEN PRESSES, MACHINE TOOLS, PUMPS, COMPRESSORS ETC, MOUNTED WITHIN WORKING AREAS. NEITHER SYSTEM EFFECTIVE TO SCREEN LOW FREQUENCY NOISE, BUT USEFUL IMPROVEMENT IN SPEECH FREQUENCIES.

MACHINERY ENCLOSURES

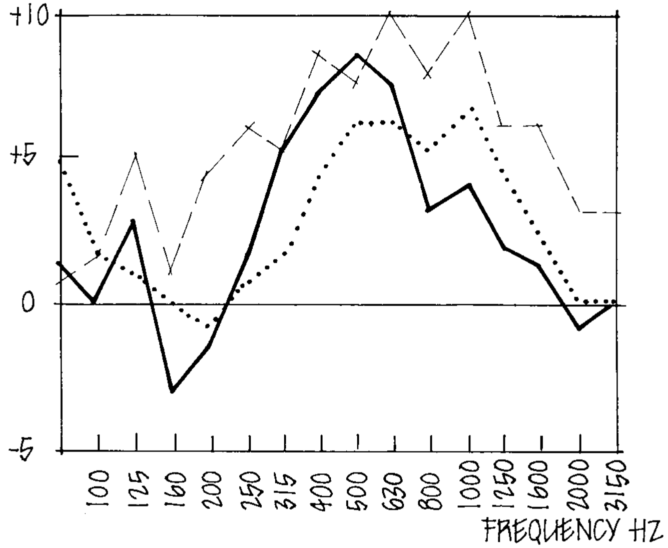
WALLS

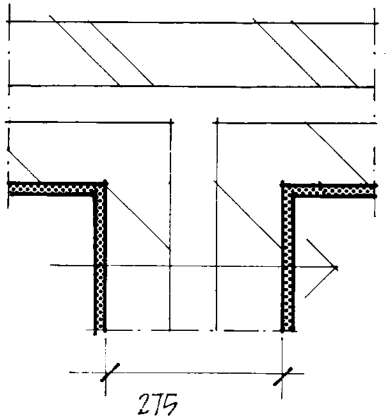

37dB
FAIR FACED DENSE SOLID BLOCKWORK FLUSH POINTED.PAINT FINISH
43dB
100 DENSE BLOCKWORK
13 PLASTER TO EACH SIDE
45dB
200 HOLLOW DENSE BLOCKWORK
13 PLASTER TO EACH SIDE
240 KG/M²
42dB
112 FAIRFACED BRICKWORK [NO HOLES]
45dB
112 COMMON BRICKS (SOLID OR IF WITH FROGS, FROGS FACED UPWARDS)
13 PLASTER EITHER SIDE
STANDARD DETAILS
WALLS
0
100mm
200
300


49 dB
150 DENSE CONCRETE
13 PLASTER TO EACH SIDE
45-49 dB
FACING BRICKWORK
INNER LEAF: BUILDING PAPER,
PLY, STUD FRAME, INSULATION
FOIL-BACKED PLASTERBOARD
50 dB
100 DENSE BLOCKWORK
50 X 50 BATTENS HEAD
AND CILL PLATE FIXING
60 ROCKWOOL QUILT
13 PLASTER TO EACH SIDE
50 dB
229 COMMON BRICKWORK
13 PLASTER TO EACH SIDE
STANDARD DETAILS
WALLS
0
100mm
200
300



50-53dB
CAVITY TIES
SPACED 900
HORIZONTAL AND
450 VERTICALLY
13 PLASTER ON
EACH SIDE
54dB
SEPARATE 112 BRICK LEAVES
[NO TIES] 480 KG/M2
13 PLASTER ON
EITHER SIDE
55dB
DOUBLE BRICK
LEAVES, NO TIES
13 PLASTER TO
EACH SIDE
450 BRICK
13 PLASTER TO
EACH SIDE
900 KG/M2
55dB
526 mm
476 mm
STANDARD DETAILS
WALLS
0
100mm
200
300





EXTERNAL AND SEPARATING WALL LINING EITHER:

- ——— 1 LAYER 9·5 PLASTERBOARD
- – – – 2 LAYER 9·5 PLASTERBOARD (1 LAYER TO EXTERNAL WALL)
- ······· 12·5 LIGHTWEIGHT PLASTER.

SOURCE: CIRIA REPORT 1988

PARTY WALLS.

AS WELL AS THE MASS OF SEPARATING AND EXTERNAL WALLS THE FOLLOWING ASPECTS AFFECT THE SOUND INSULATION THROUGH THE OPERATING WALLS

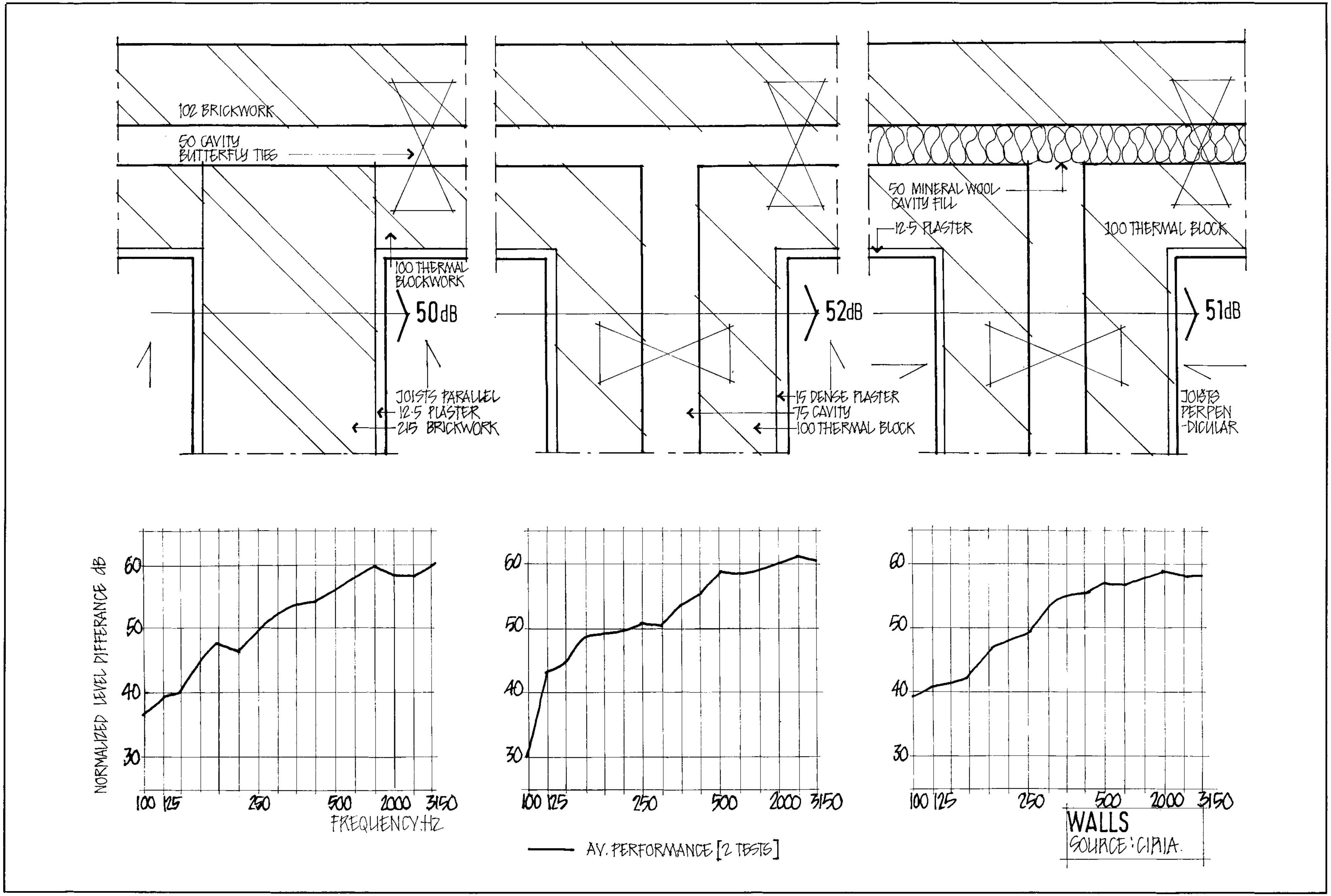
1. TIES. ABSENCE OF TIES CONSIDERABLY IMPROVES THE SOUND INSULATION. BUTTERFLY TIES PREFERABLE TO STRIP TIES.

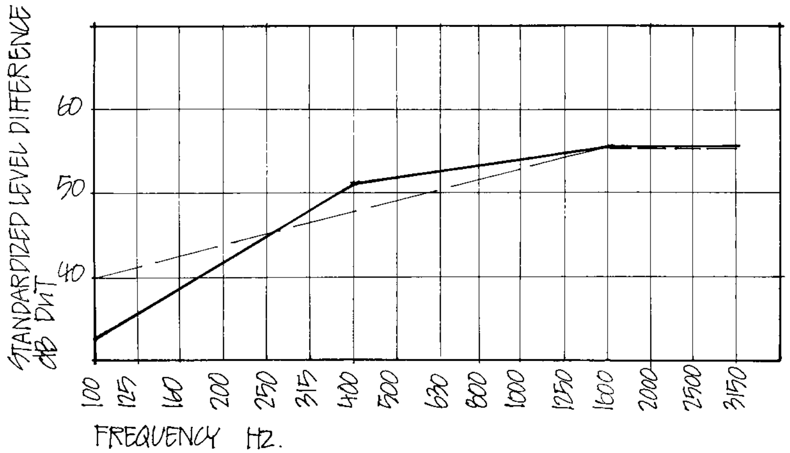
2. CAVITY INSULATION. 60–70 KG./M³ MINERAL WOOL LINING TO SEPARATING WALL CAVITY IMPROVES SOUND INSULATION BY IMPEDING SOUND TRACKING ACROSS THE CAVITY. (MUST BE LOOSELY PLACED IN CAVITY.)

3. JOIST DIRECTION. JOISTS PARALLEL TO SEPARATING WALLS HAVE IN TESTS GIVEN CONSISTENTLY HIGHER SOUND INSULATION THAN JOISTS PERPENDICULAR TO SEPARATING WALL

4. JOIST TIGHTNESS. RATHER THAN 'LOOSE' POCKETS AT JOIST ENDS, CONSIDER USE OF JOIST HANGERS TO ALLOW THE WALL INTEGRITY TO BE MAINTAINED.

5. DRY LINING. THE EFFECT OF WALL FINISHES IS SHOWN AT LHS. 2 LAYERS TO SEPARATING WALL ARE NECESSARY TO IMPROVE ON PLASTER. 1 LAYER CAN ACTUALLY REDUCE SOUND INSULATION AT SOME FREQUENCIES BECAUSE OF RESONANCE.


102 BRICKWORK
50 CAVITY
BUTTERFLY TIES
100 THERMAL BLOCKWORK
50dB
JOISTS PARALLEL
12·5 PLASTER
215 BRICKWORK
52dB
15 DENSE PLASTER
75 CAVITY
100 THERMAL BLOCK
50 MINERAL WOOL CAVITY FILL
12·5 PLASTER
100 THERMAL BLOCK
51dB
JOISTS PERPEN-DICULAR
NORMALIZED LEVEL DIFFERANCE dB
60
50
40
30
100 125 250 500 2000 3150
FREQUENCY Hz
AV. PERFORMANCE [2 TESTS]
WALLS
SOURCE: CIRIA.



—— 1985 BUILDING REGULATIONS. (DnTw)
- - - 1976 BUILDING REGULATIONS MAX AAD 23dB.

- PARTY WALLS
(BS 5821 / 1981 / ISO 717 : 1982)

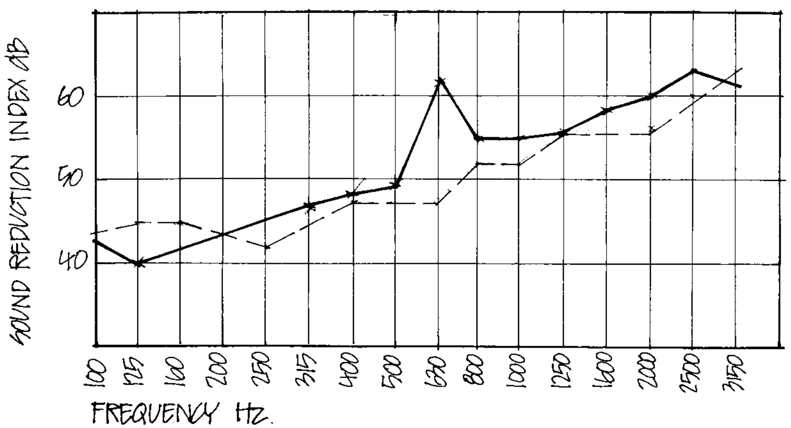
SINGLE VALUE TAKEN FROM REFERENCE CURVE AT 500 Hz

REQUIREMENT IN dB.

INDIVIDUAL	MEAN
49	< 4 PAIRS OF TESTS 53 ≥ 4 PAIRS OF TESTS 52

UNFAVOURABLE DEVIATION IF MORE THAN 8 dB AT ANY ONE 1/3 OCTAVE FREQUENCY BAND.

THE NEW STANDARDS IN THE UK MEAN THAT FOR AIRBORNE SOUND INSULATION, FRANCE, DENMARK, SWEDEN AND THE NETHERLANDS NOW HAVE MORE STRINGENT CRITERIA TO BE MET IN HOUSING.



—— SOLID 190 MM THICK BLOCKWORK
- - - SOLID 175 MM THICK BLOCKWORK

SRI dB	THICKNESS	DENSITY	TYPE OF FORTICRETE DCM.
41	90 100	150	SOLID HOLLOW
43	90 140	180	NO VOID SOLID HOLLOW
46	190	240	HOLLOW
48	140	240	SOLID
50	190	340	SOLID

SOUND ABSORPTION:

0.2 0.2 0.2 0.15 0.2 0.25

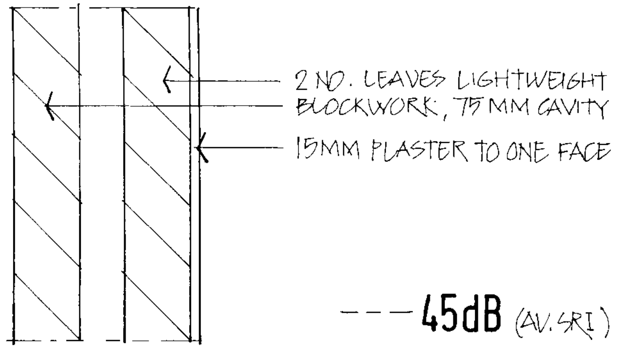
(UNPAINTED BLOCKWORK)

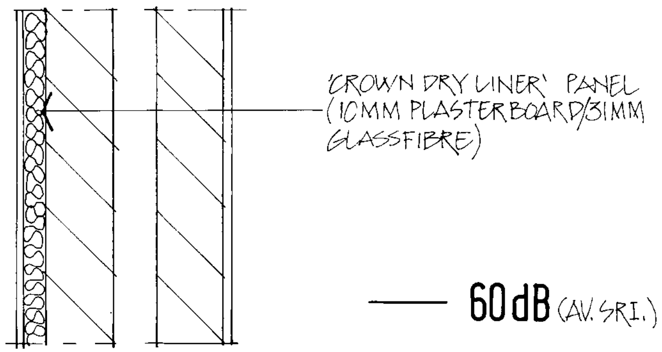
- BLOCKWORK

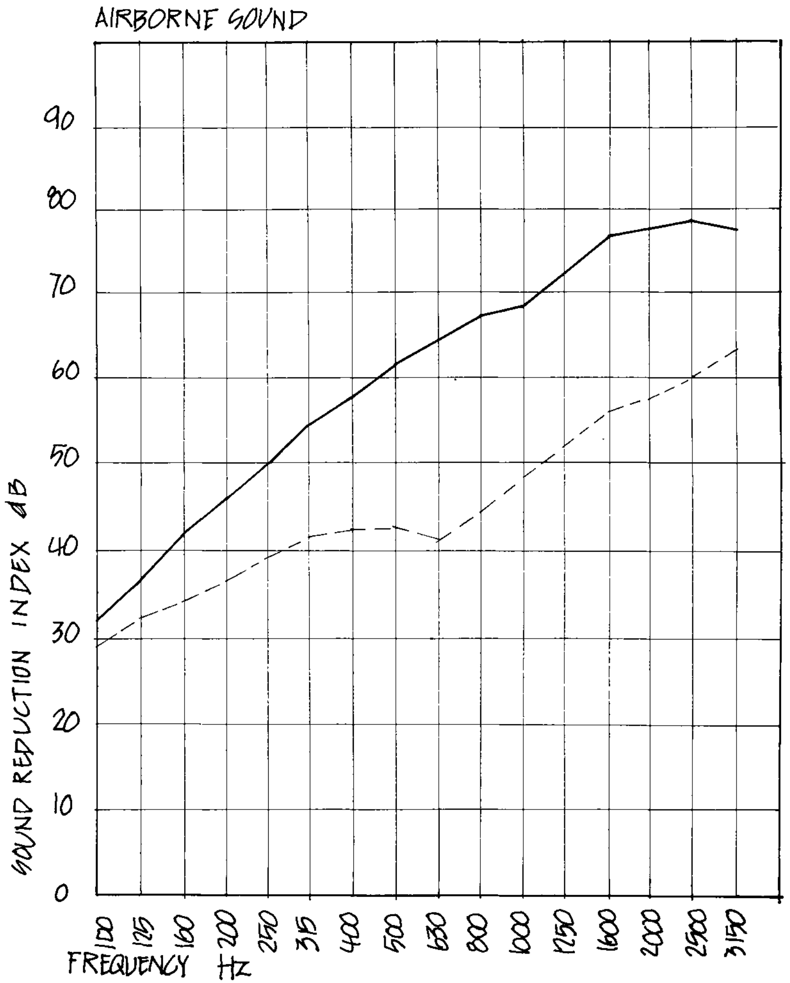
(FORTICRETE DCM)

FOR SOUND INSULATION BLOCKWORK IS BEST PLASTERED AS THIS CLOSES FISSURES, USING NON VOID SOLID DCM BLOCKS. BEWARE SHRINKAGE CRACKS PARTICULARLY AT BEAM OR COLUMN JUNCTIONS.
TEST FINDINGS ARE FOR BLOCKWORK LAID IN 1:1:6 CEMENT : LIME : SAND MORTAR AND PAINTED 2 COATS. (UNPAINTED PERFORMANCE 1-2dB LESS THROUGHOUT FREQUENCY RANGE).

PARTY WALLS





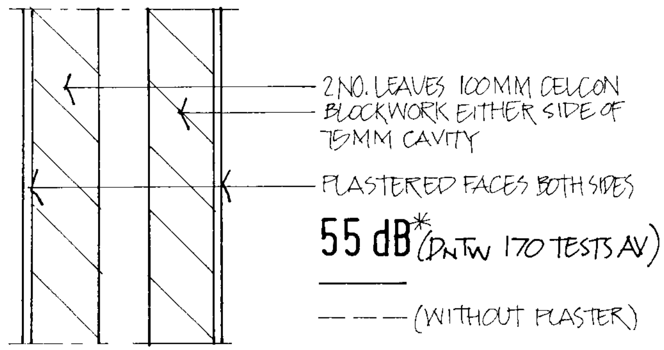


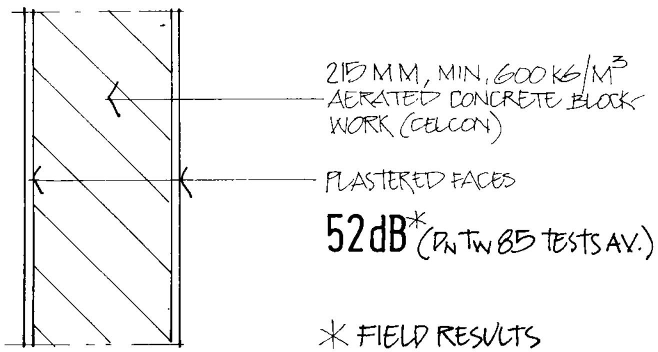
RESULTS FROM A TEST PROGRAMME ON THIS FORM OF LINING TO UPGRADE MASONRY WALLS INDICATES ;

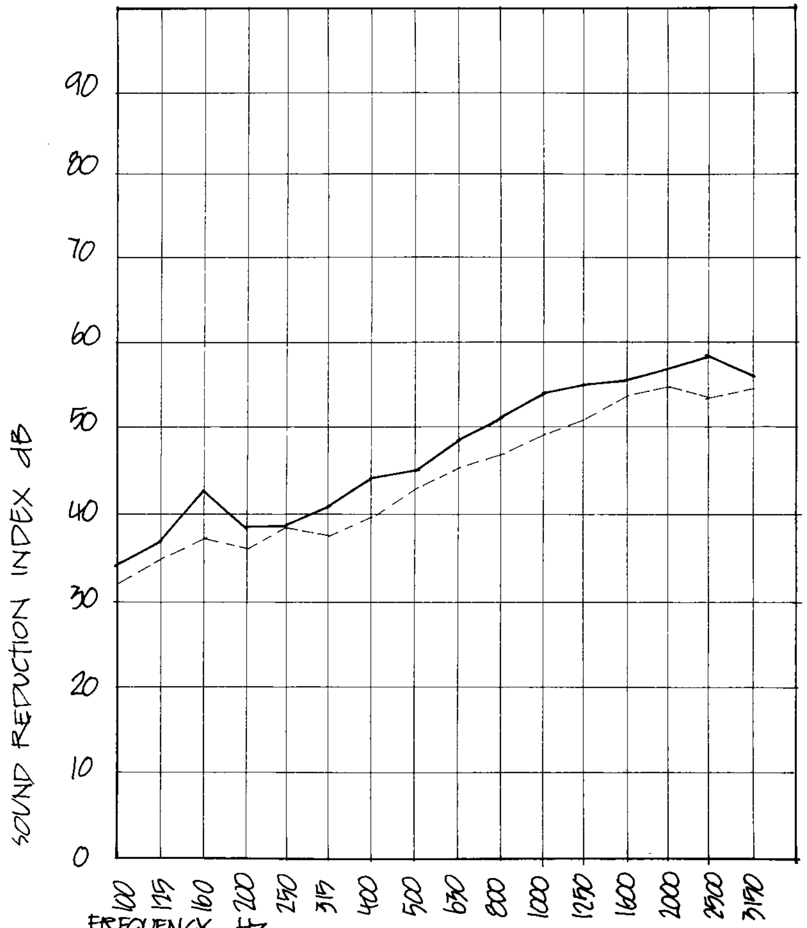
1. GOOD IMPROVEMENT BY LINING ONE SIDE ONLY (TO LINE BOTH SIDES IS OF LITTLE ADDITIONAL BENEFIT)
2. ADHESIVE NOT MECHANICAL FIXING OF PANELS HAS TO BE USED.

PARTY WALLS

SOURCE: PILKINGTON FIBREGLASS/
UNIVERSITY OF SALFORD
DEPT. OF APPLIED ACOUSTICS







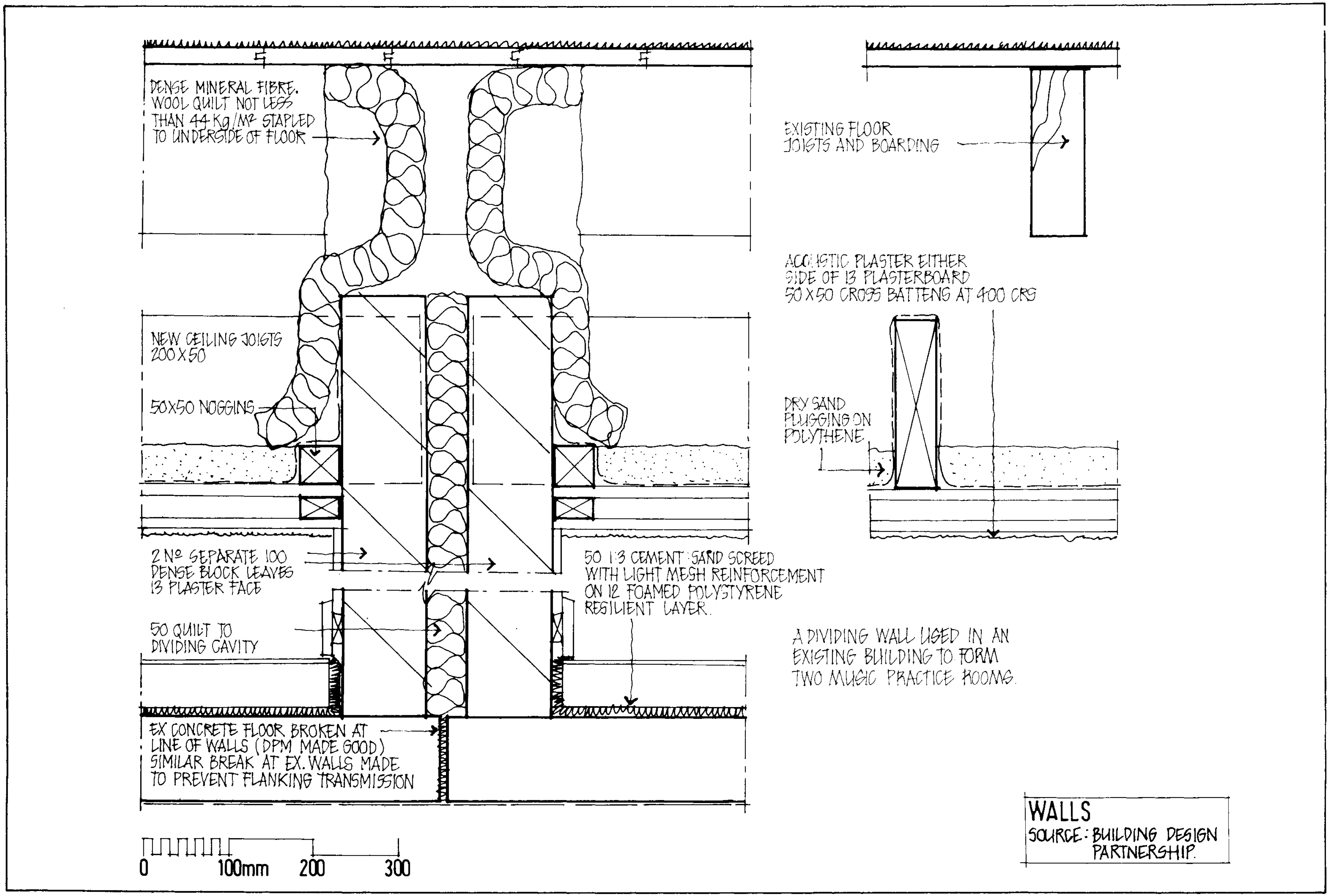
TYPICAL LABORATORY TEST RESULTS

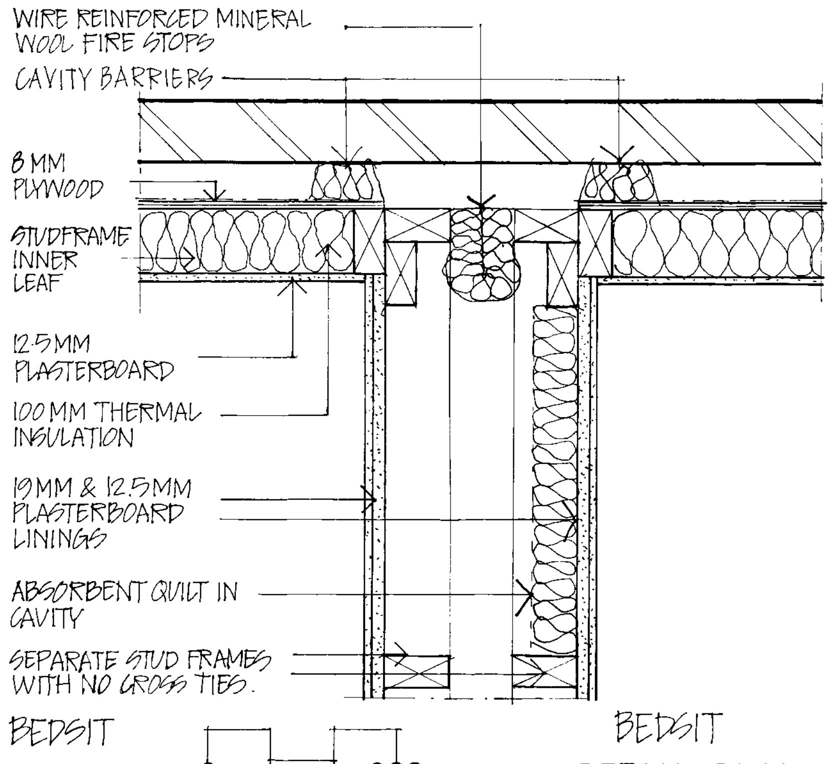
RESULTS COMPARE FAVOURABLY WITH TABLE 1/SECTION 3/APPROVED DOCUMENT 'E', BUILDING REGULATIONS 1985, ALTHOUGH THESE ARE NOT CONSTRUCTIONS SPECIFICALLY LISTED IN THE APPROVED DOCUMENT.

AIRO HAVE FOUND THAT A 'CORRECTION FACTOR' OF 3dB. APPLIES FOR FIELD RESULTS COMPARED WITH LABORATORY.

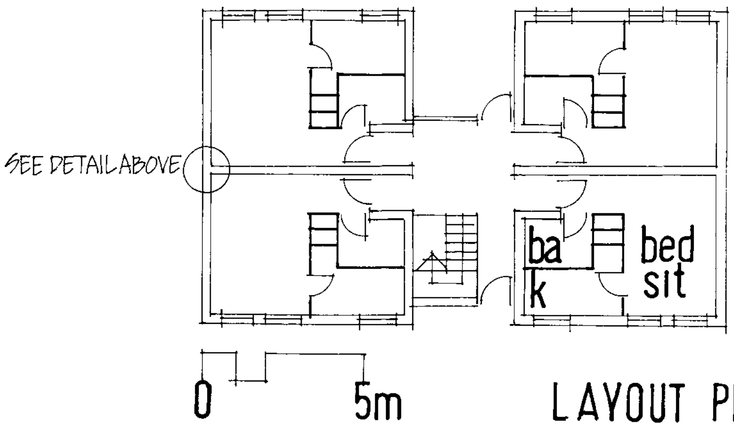
PARTY WALLS

SOURCE: CELCON LTD./AIRO.

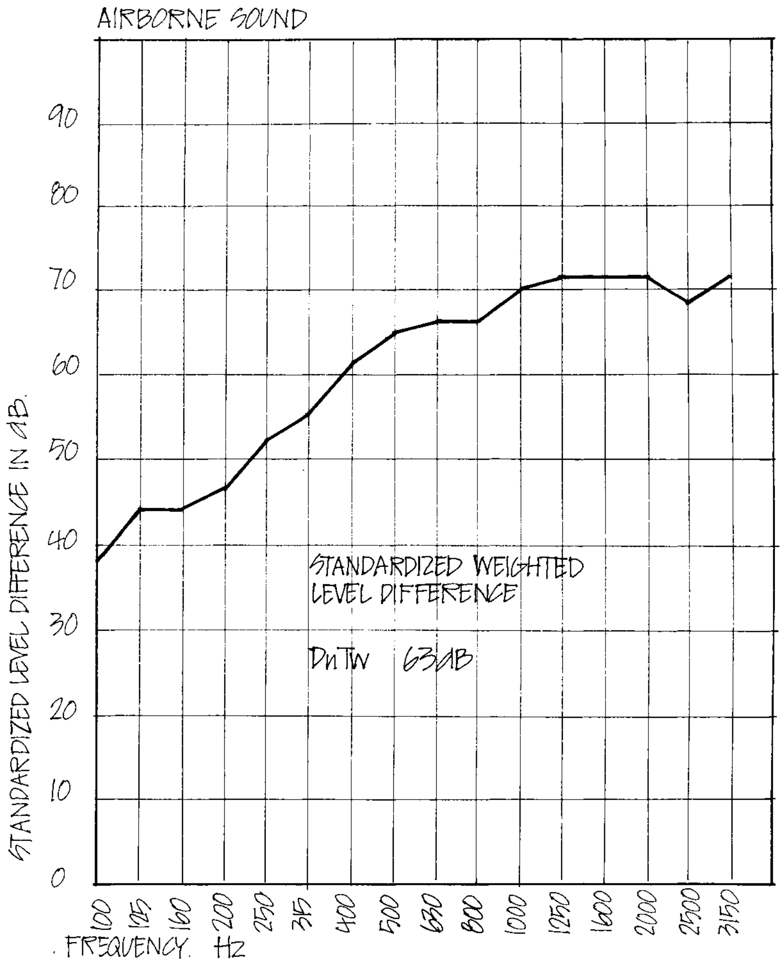

DENSE MINERAL FIBRE. WOOL QUILT NOT LESS THAN 44 Kg/M² STAPLED TO UNDERSIDE OF FLOOR
NEW CEILING JOISTS 200X50
50X50 NOGGINS
2 Nº SEPARATE 100 DENSE BLOCK LEAVES 13 PLASTER FACE
50 QUILT TO DIVIDING CAVITY
EX CONCRETE FLOOR BROKEN AT LINE OF WALLS (DPM MADE GOOD) SIMILAR BREAK AT EX. WALLS MADE TO PREVENT FLANKING TRANSMISSION
50 1:3 CEMENT:SAND SCREED WITH LIGHT MESH REINFORCEMENT ON 12 FOAMED POLYSTYRENE RESILIENT LAYER.
EXISTING FLOOR JOISTS AND BOARDING
ACOUSTIC PLASTER EITHER SIDE OF 13 PLASTERBOARD 50 X 50 CROSS BATTENS AT 400 CRS
DRY SAND PLUGGING ON POLYTHENE
A DIVIDING WALL USED IN AN EXISTING BUILDING TO FORM TWO MUSIC PRACTICE ROOMS.
0 100mm 200 300
WALLS
SOURCE: BUILDING DESIGN PARTNERSHIP.



DETAIL PLAN



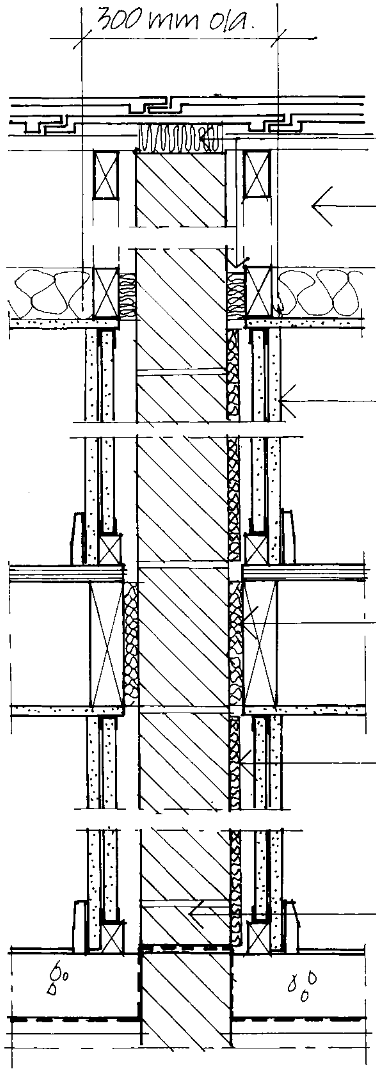
LAYOUT PLAN



GIVEN CAREFUL CONSTRUCTION LIGHTWEIGHT PARTY WALLS NEED NOT BE INFERIOR TO MASONRY, AS THESE TESTS ON COMPLETED FLATS SHOW.

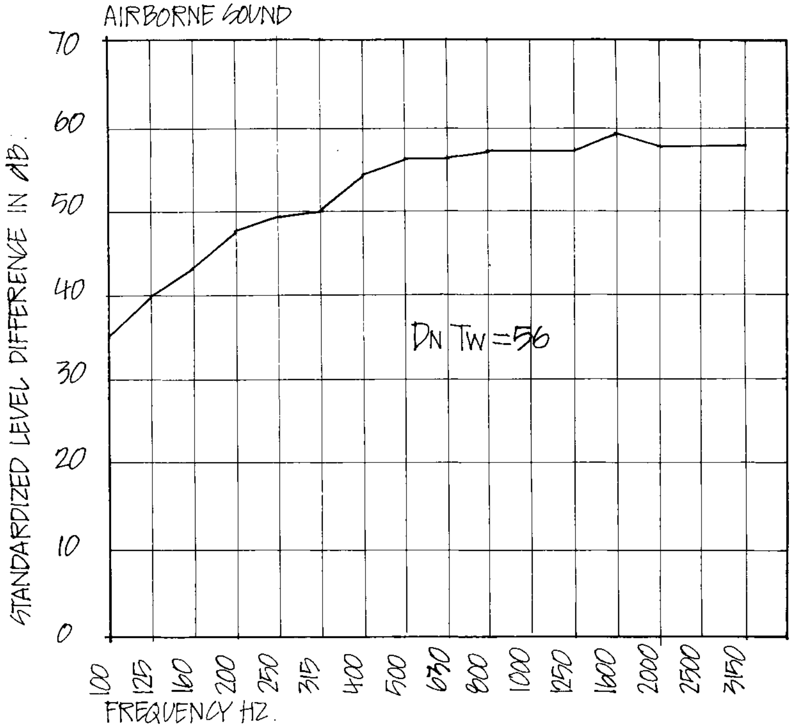
PARTY WALLS

SOURCE: WIMPEY LABORATORIES LTD.



DETAIL SECTION

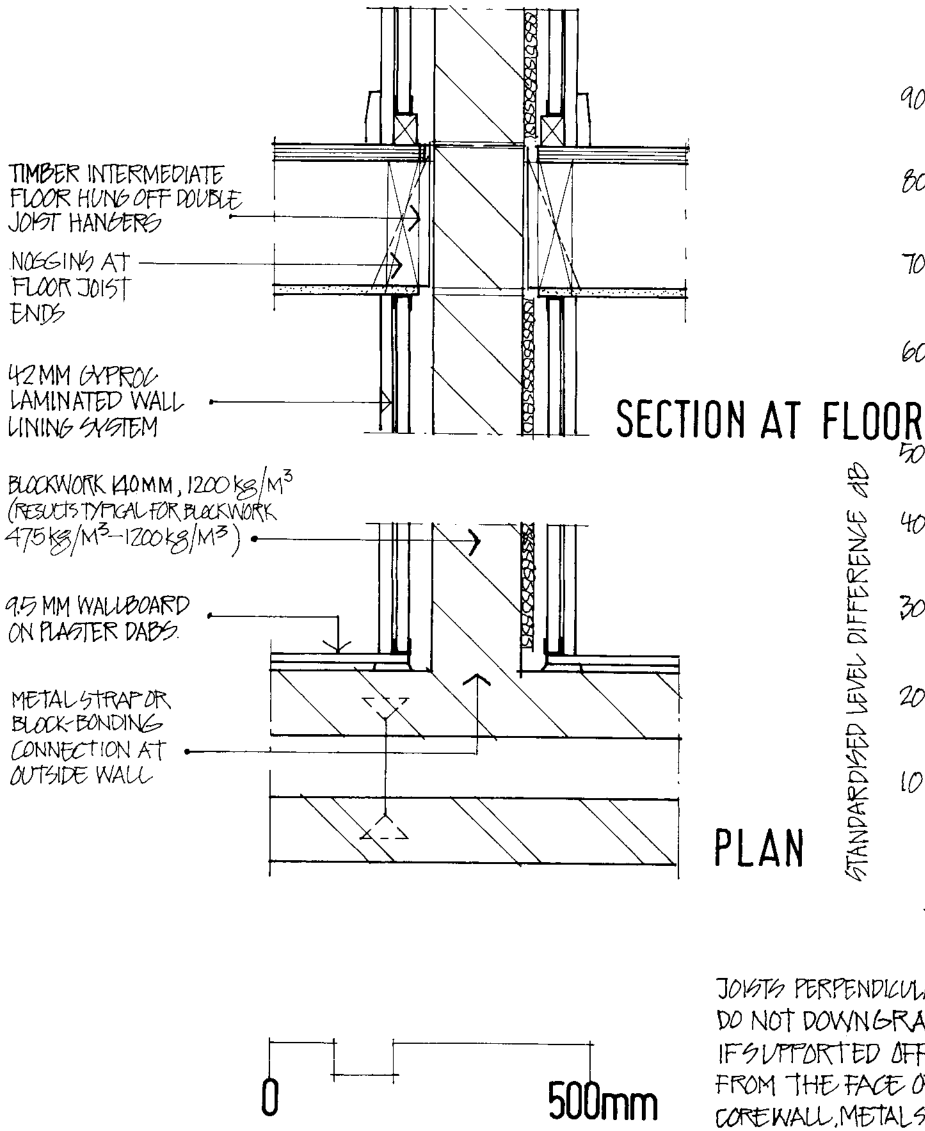
ISOLATION TO THE MASONRY CORE IS MAINTAINED AT OUTSIDE WALL BY PLASTERBOARD DRY LINING TO THE CAVITY WALL INNER LEAF. AVOIDANCE OF BUILT-IN FLOOR JOISTS MAINTAINS THE INTEGRITY AND ISOLATION OF THE CORE WALLS. THIS TYPE OF PARTY WALL TO BE USED ONLY WITH CONCRETE GROUND FLOOR.

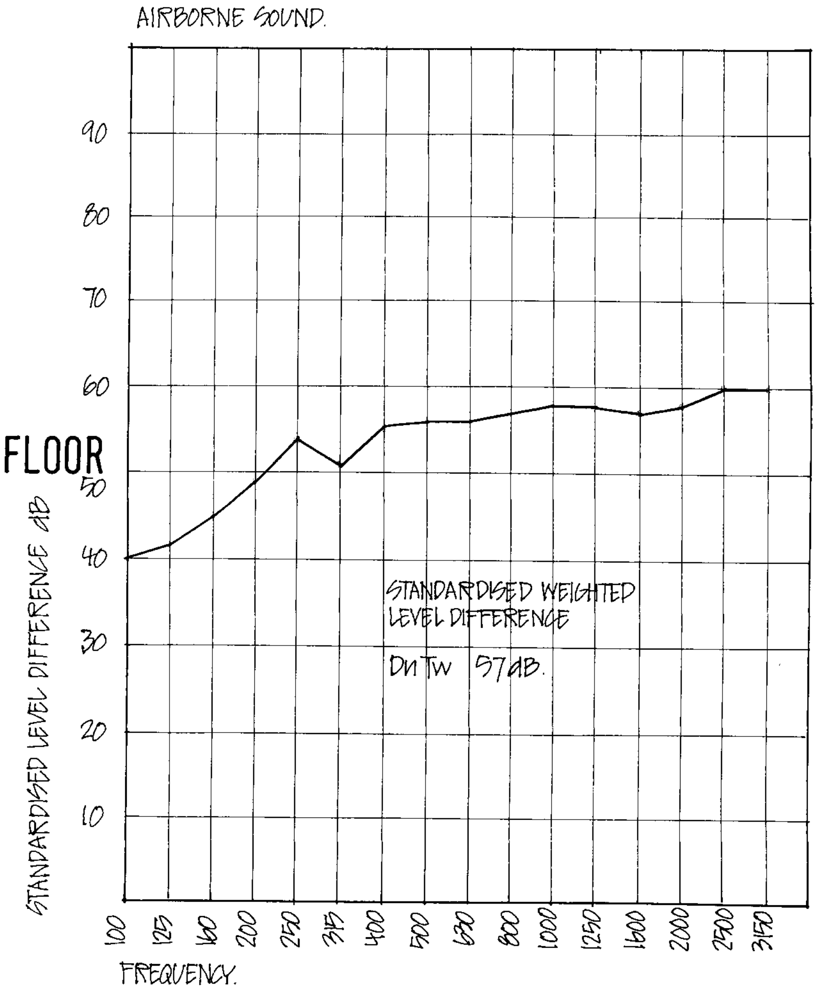


PARTY WALL PERFORMANCE AT CONTROL CHAMBER PROTOTYPE CONSTRUCTION

PARTY WALLS

SOURCE: THE CEMENT AND CONCRETE ASSOCIATION / WIMPEY LABORATORIES LTD.

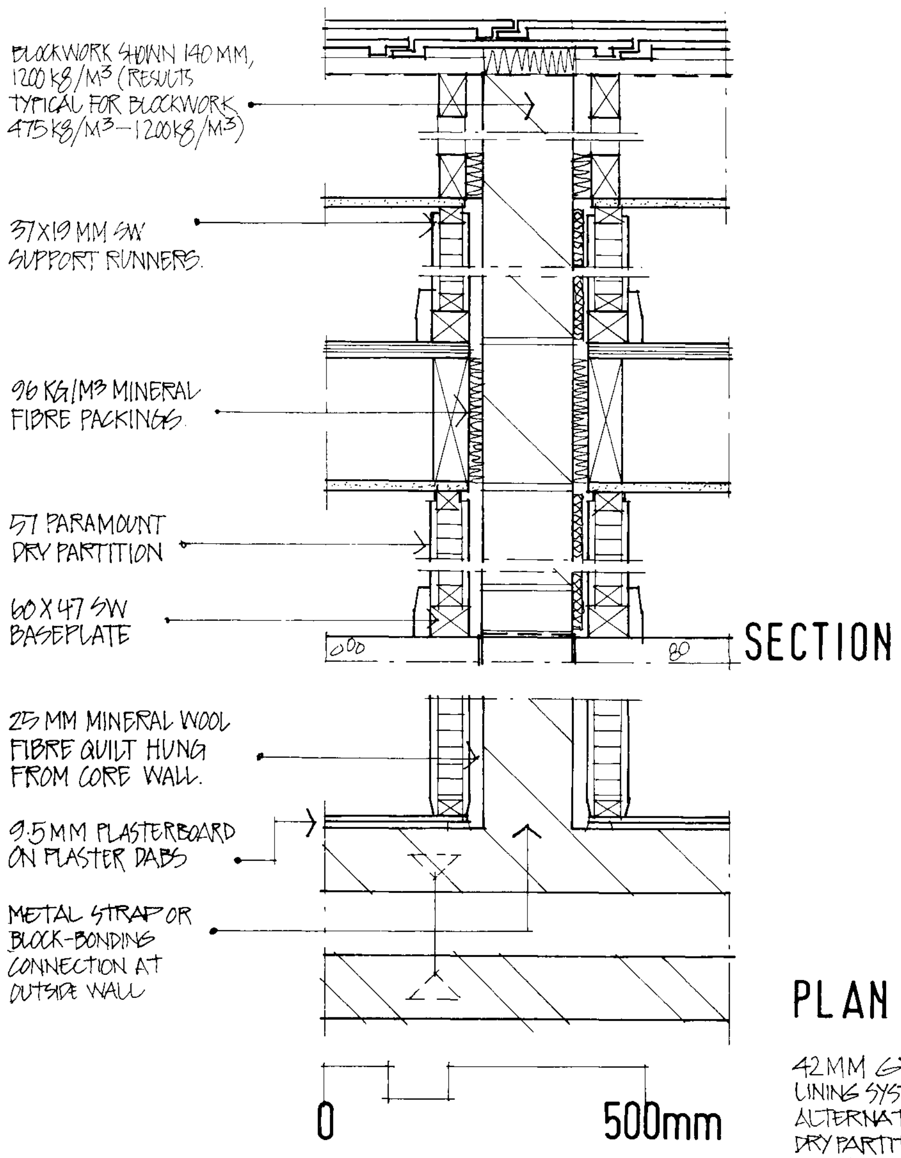


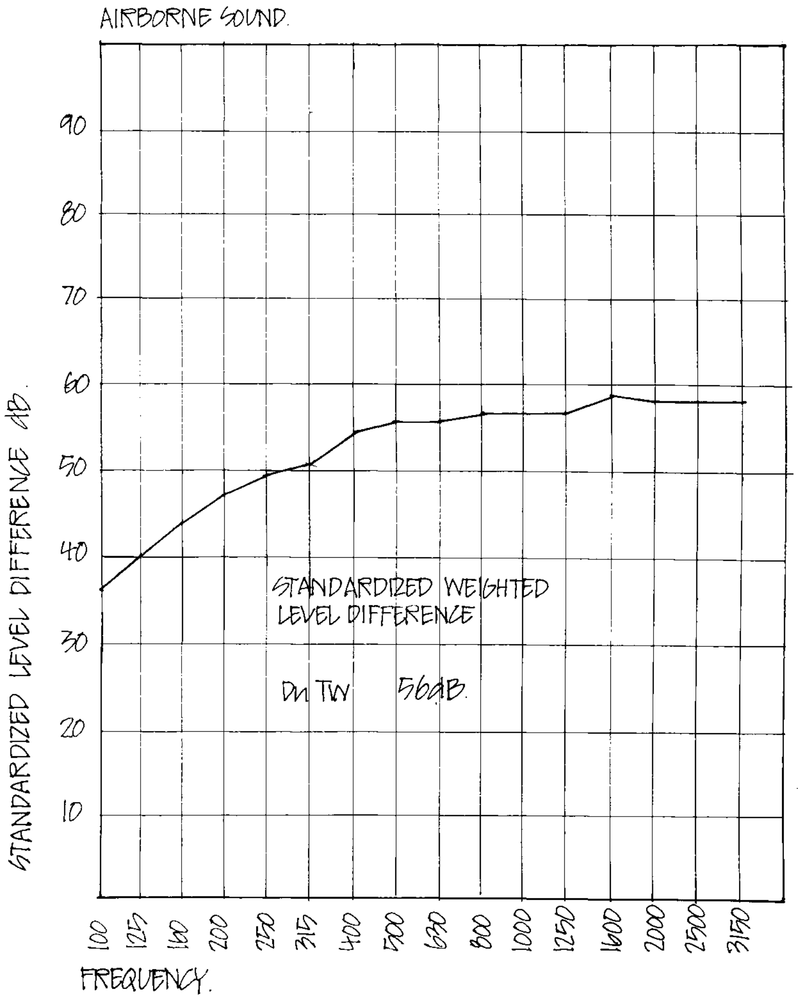


JOISTS PERPENDICULAR TO PARTY WALL DO NOT DOWNGRADE PERFORMANCE IF SUPPORTED OFF JOIST HANGERS FROM THE FACE OF THE MASONRY CORE WALL. METAL STRAPS CAN ALSO BE USED TO PROVIDE STRUCTURAL LATERAL RESTRAINT OF THE INTERMEDIATE FLOOR ACROSS THE PARTY WALL CONSTRUCTION.

PARTY WALLS

SOURCE: CEMENT AND CONCRETE ASSOCIATION.



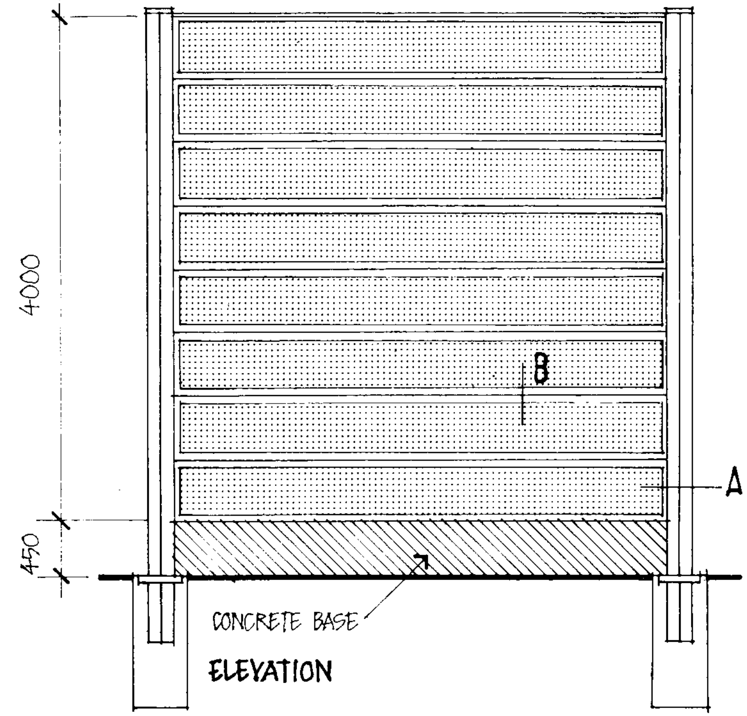


42 MM GYPROC LAMINATED WALL LINING SYSTEM CAN BE USED AS AN ALTERNATIVE TO 57 MM PARAMOUNT DRY PARTITION AND THERE IS LITTLE TO CHOOSE IN PERFORMANCE TERMS BETWEEN THESE TWO FINISHING METHODS

PARTY WALLS

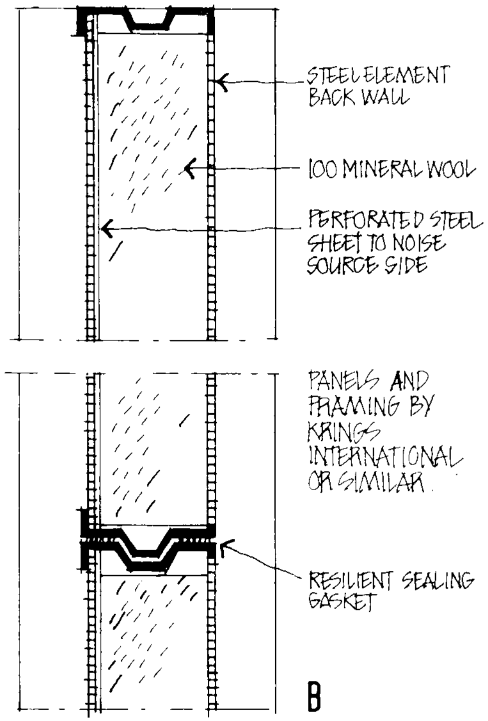
SOURCE: CEMENT AND CONCRETE ASSOCIATION.

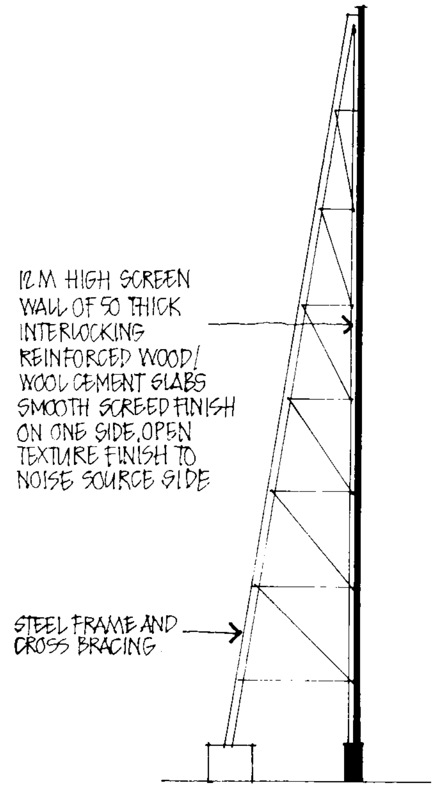
NOISE BARRIERS

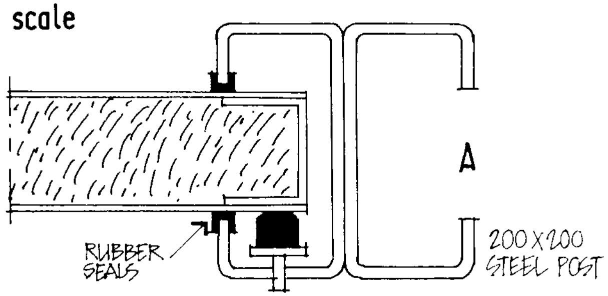


ELEVATION

not to scale







DETAIL OF RESILIENT MOUNTING OF PANELS

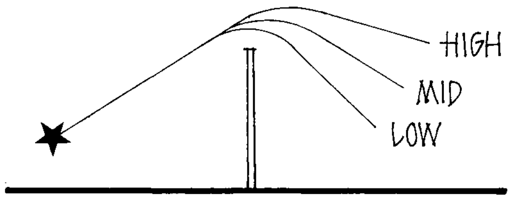
PROPRIETARY SOUND ABSORBING SCREEN PANELS. SECTION 1:5

USED ALONG SIDE OF ROADS TO PROJECT ADJACENT HOUSING. RESILIENT MOUNTING ALLOWS 'LIMP' ACTION OF PANEL TO ABSORB NOISE.
DAMPING EFFECT (DIN 52210) AVERAGE 27 dB.

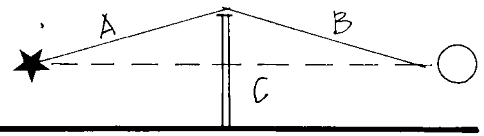
BAFFLE WALL TO INDUSTRIAL PLANT. NTS

HIGH SCREENS AROUND PLANT NECESSARY WHERE A LARGE AREA OF PROCESS PLANT HAS TO BE SCREENED.

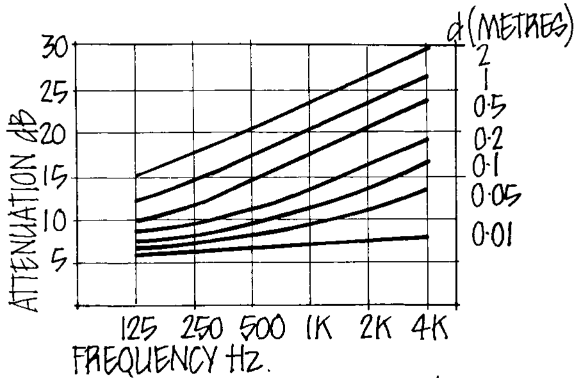
BARRIERS AND SCREENS



VARYING DIFFRACTION OVER A BARRIER AT DIFFERENT FREQUENCIES

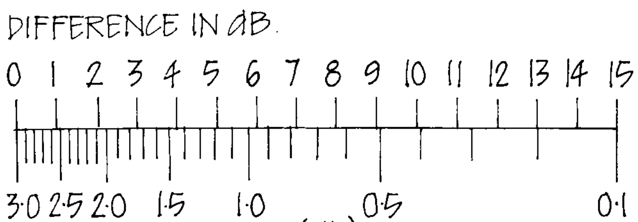


DIFFERENCE IN SOUND PATHS, $d = A + B - C$

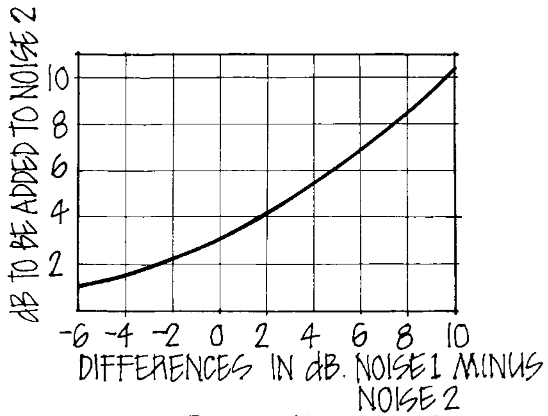


SOURCE: PARKIN HUMPREYS & COWELL

ATTENUATION DUE TO SCREENS IN OPEN AIR IS RELATED TO HOW MUCH FURTHER THE SOUND HAS TO TRAVEL AROUND THE SCREEN. FOR ATTENUATION DUE TO A FINITE SCREEN LENGTH, CARRY OUT PATH DIFFERENCE CALCULATIONS IN PLAN AS WELL AS SECTION AND COMBINE ATTENUATIONS. WEIGHT OF SCREEN MATERIAL IS IMMATERIAL, BUT NEEDS TO BE SOLID FACED TO NOISE SIDE.

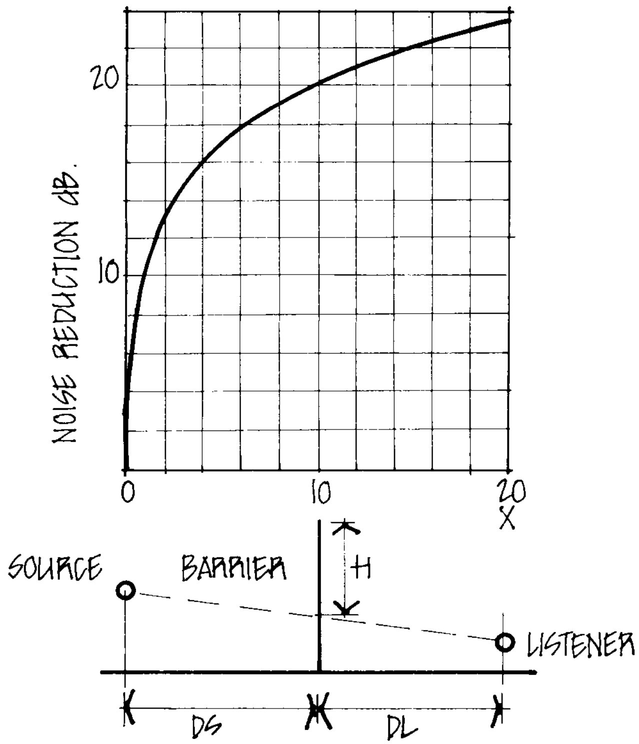


SOURCE: T.E. MOORE.



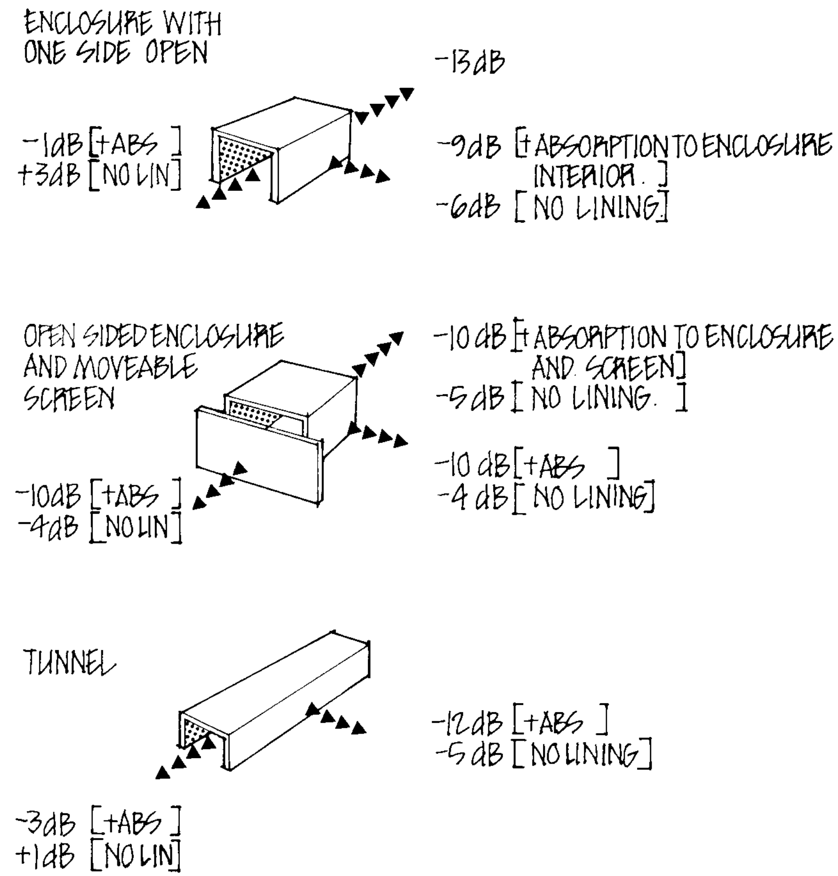
SOURCE: PARKIN HUMPREYS & COWELL

COMBINING SOUND LEVELS, FOR EXAMPLE IN PATH DIFFERENCE CALCULATIONS ABOVE, CAN BE CARRIED OUT USING EITHER OF THE FIGURES AT LHS. FOR INSTANCE, A TELEPHONE BELL 3M. AWAY AT 73dB ADDS TO THE BACKGROUND 70 dB. IN A TYPISTS POOL TO GIVE A RESULTANT SOUND OF 74·75 dB (i.e. 75)



X = H²/λDS PROVIDED DL>>DS AND DS>H

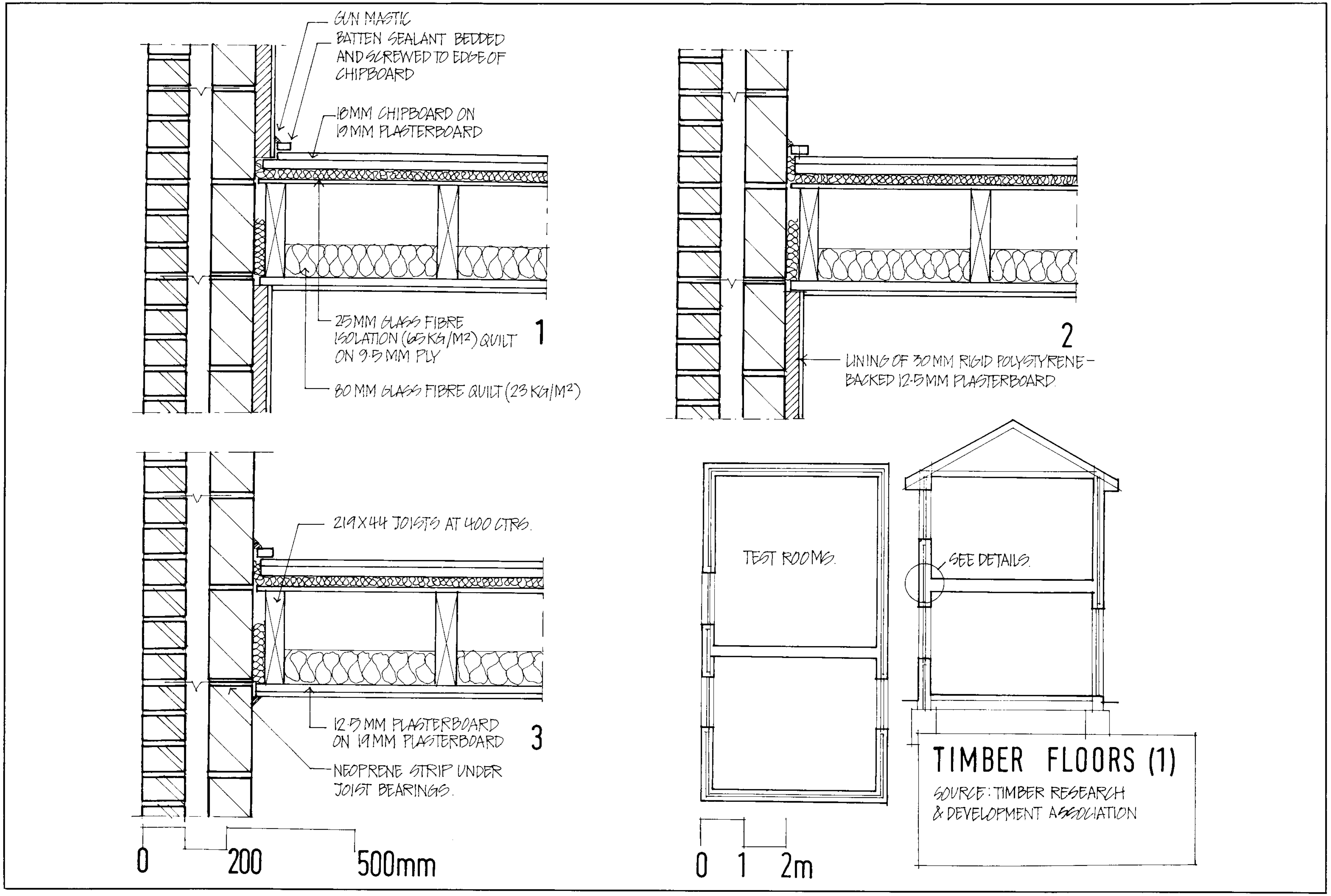
HEIGHT OF BARRIER CAN BE DETERMINED IF WAVELENGTH OF NOISE SOURCE AND DS ARE KNOWN AND REQUIRED dB. REDUCTION SPECIFIED.



EFFECT ON DIRECT SOUND PRESSURE LEVEL FREQUENCY RANGE 500-4K Hz OF SOME PARTIAL ENCLOSURES.
SOURCE: WOODS OF COLCHESTER.
(NOTE: INDICATION ONLY FOR POINTS NEAR ENCLOSURES.)

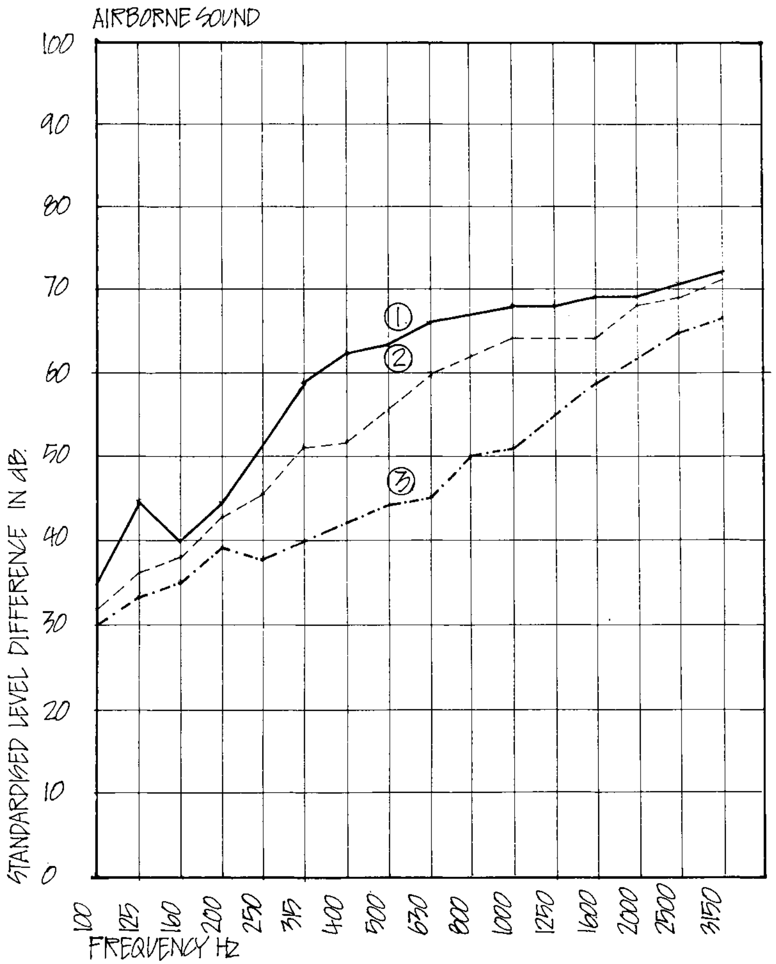
NOISE BARRIERS

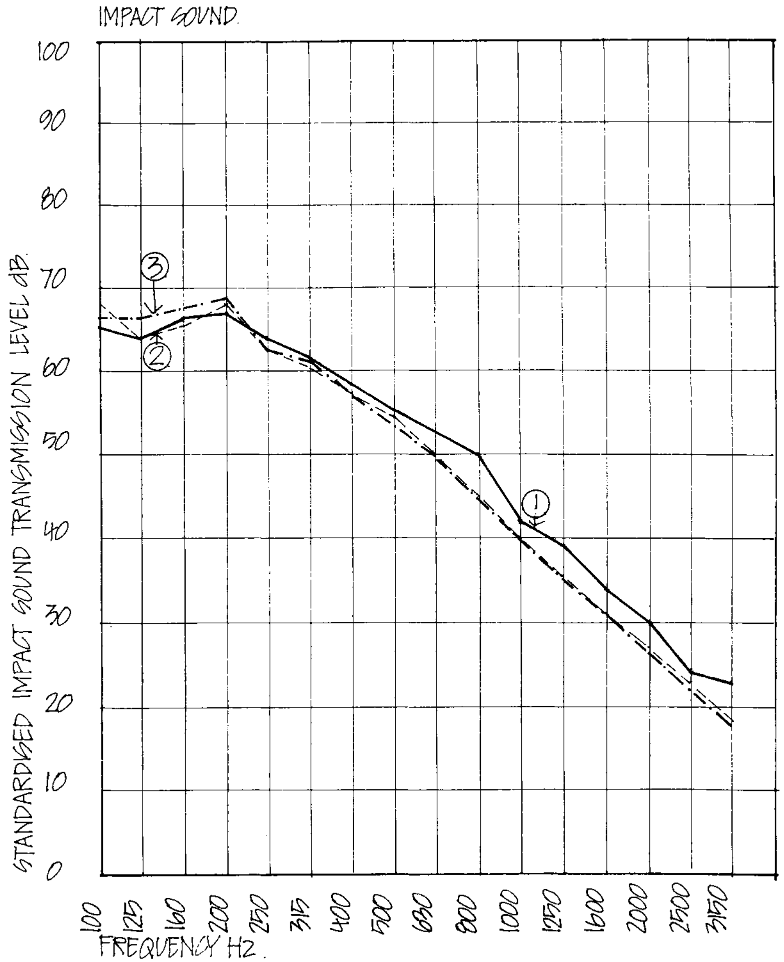
FLOORS



TIMBER FLOORS (1)

SOURCE: TIMBER RESEARCH & DEVELOPMENT ASSOCIATION





——— GND AND FIRST FLOOR WALLS LINED (SEE DETAIL SECTION 1)

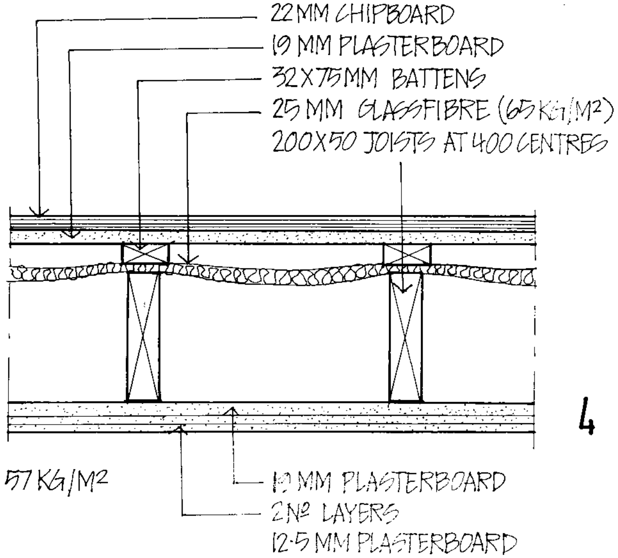
- - - - GND FLOOR WALLS ONLY LINED (2)

—·—·— WALLS UNLINED. (3)

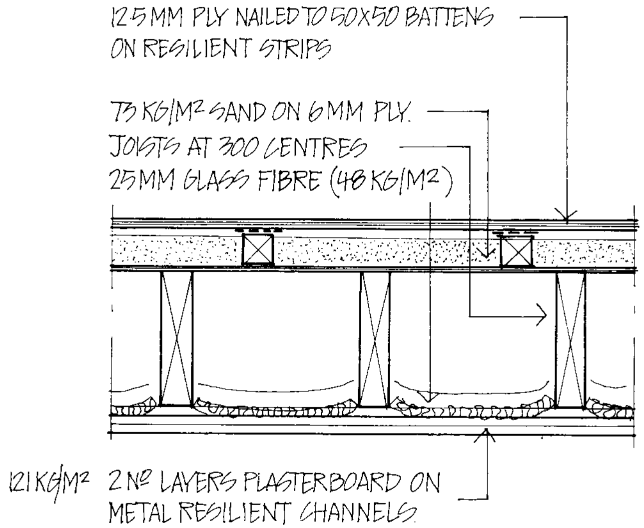
THE RESULTS SHOW THAT DRY LININGS TO BOTH GROUND AND FIRST FLOORS IMPROVED THE AIRBORNE SOUND INSULATION PERFORMANCE BY REDUCING FLANKING EFFECTS.
LABORATORY TESTS TO BS 2750 : 1980 / ISO 140 / ASTM E90-75 SHOW SIMILAR RESULTS EXCEPT FOR HIGHER H.F. VALUES

TIMBER FLOORS (2)

SOURCE: TIMBER RESEARCH AND DEVELOPMENT ASSOCIATION



4



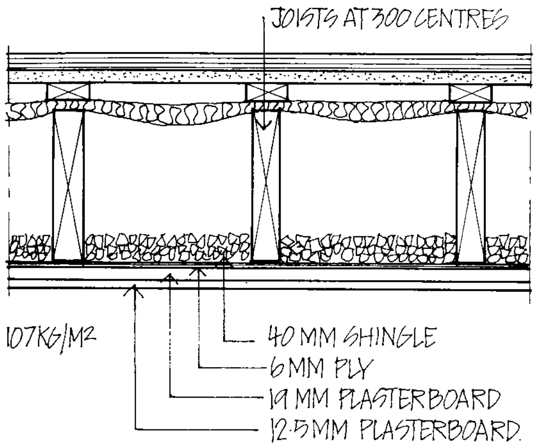
5

GOOD TIMBER FLOORS SHOULD INCLUDE AS FEATURES:

- SUBSTANTIAL ISOLATED FLOOR DECK
- STIFF SUPPORT FRAME OF JOISTS
- ABSORPTIVE QUILT IN FLOOR CAVITY
- SUBSTANTIAL CEILING

CONSTRUCTION SHOULD NOT BE OVER INTRICATE AND UNREALISTIC IN WORKMANSHIP REQUIRED.

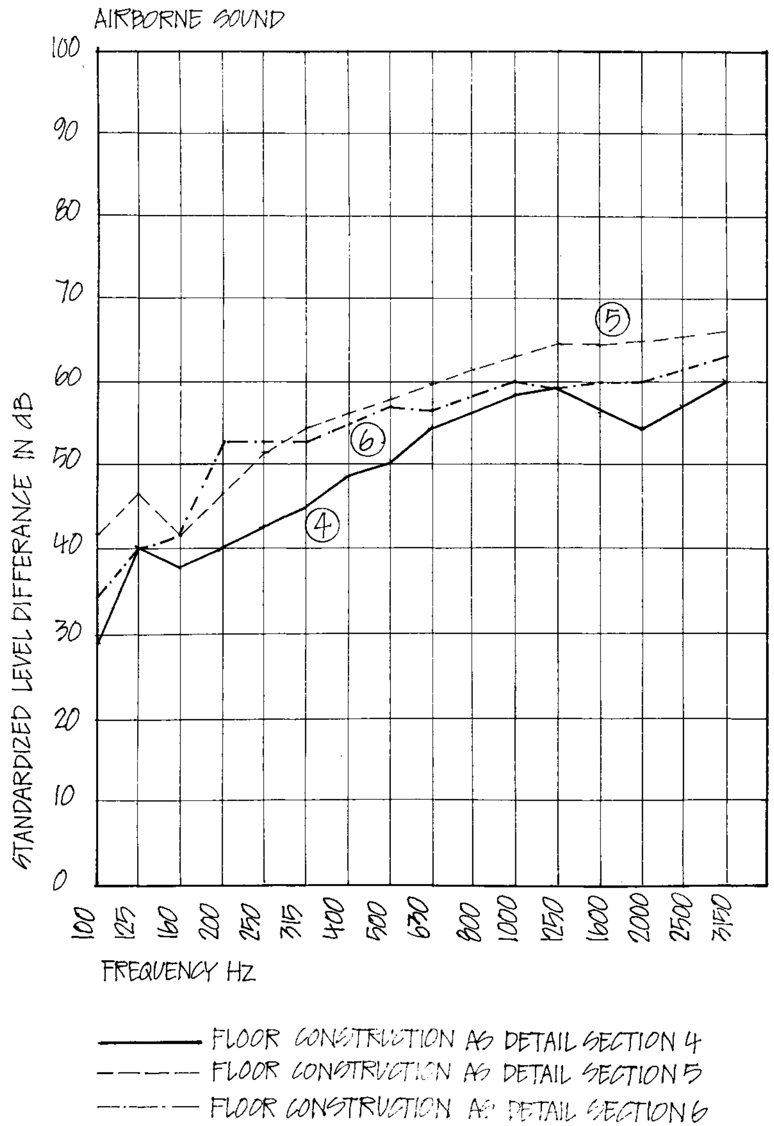
PUGGING (6) IS FAVOURED IN SCOTTISH CONSTRUCTION
ELECTRICAL CONDUITS CAN BE RUN IN THE SAND (5)

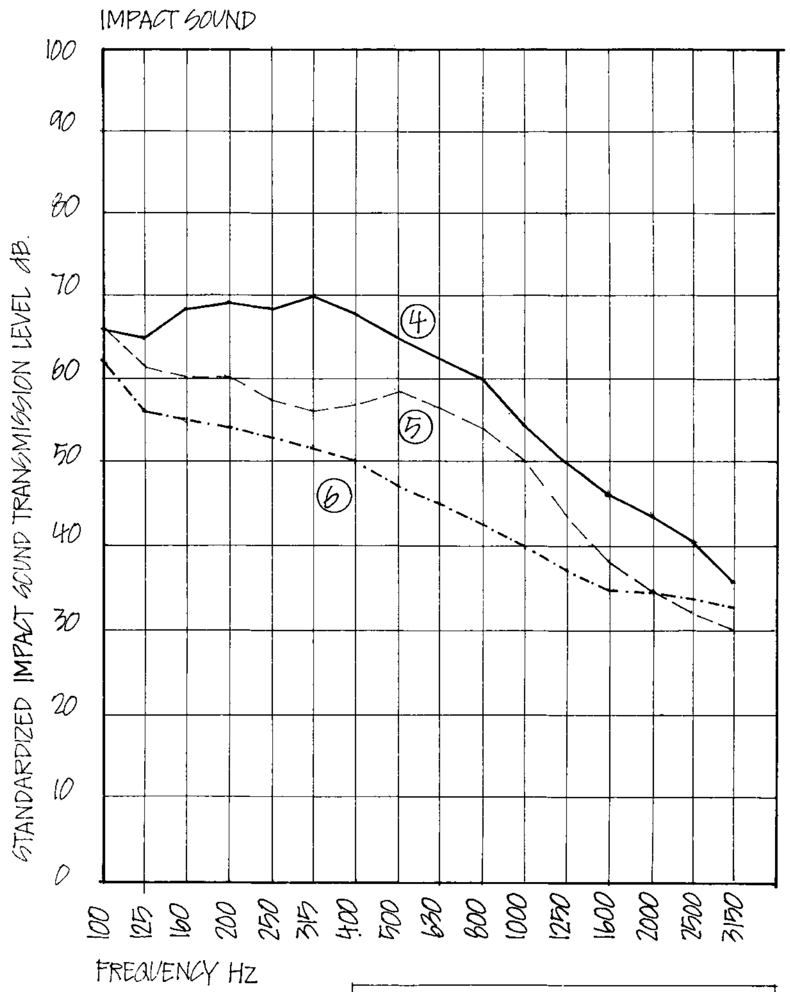


6

TIMBER FLOORS (3)

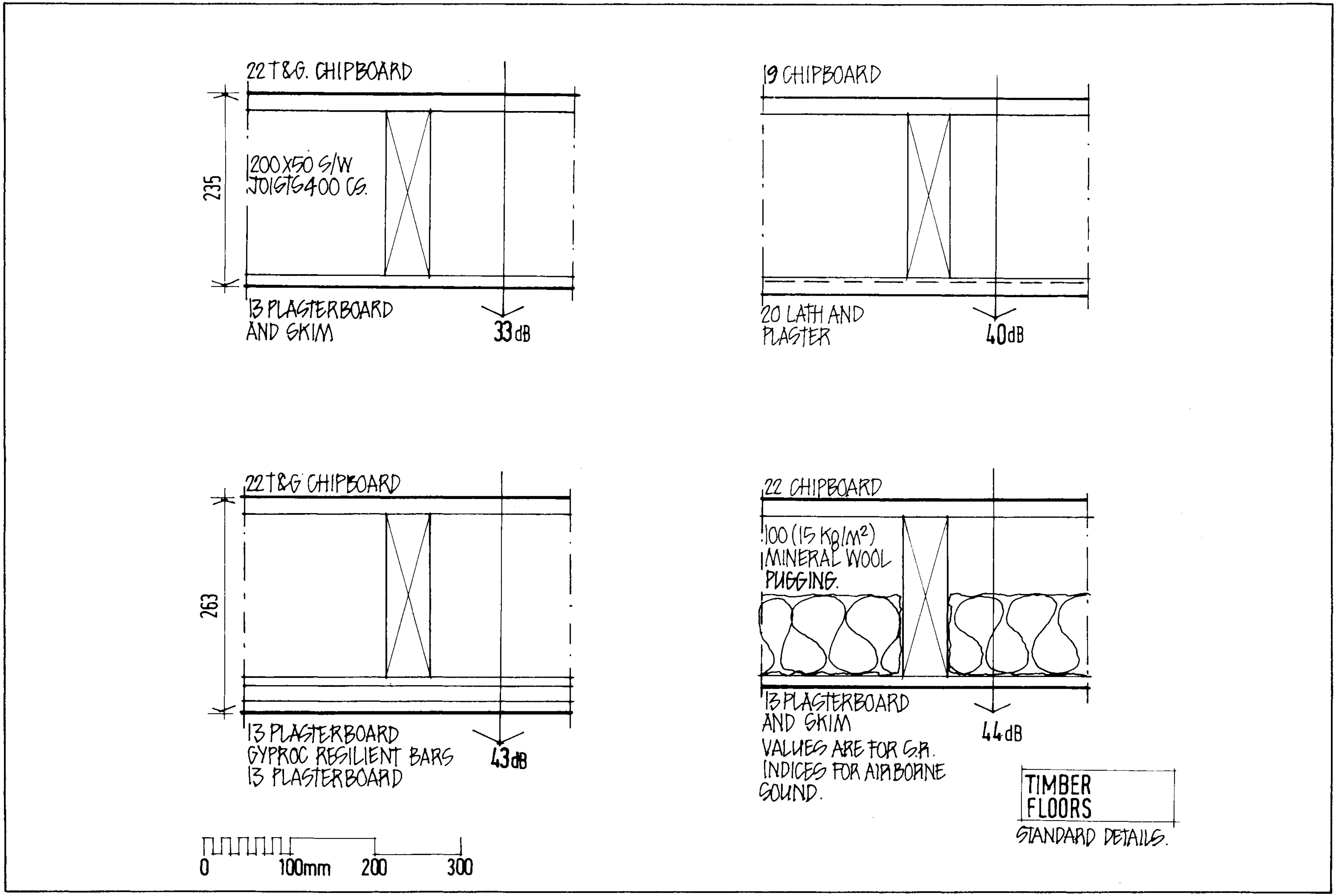
SOURCE: TIMBER RESEARCH AND DEVELOPMENT ASSOCIATION

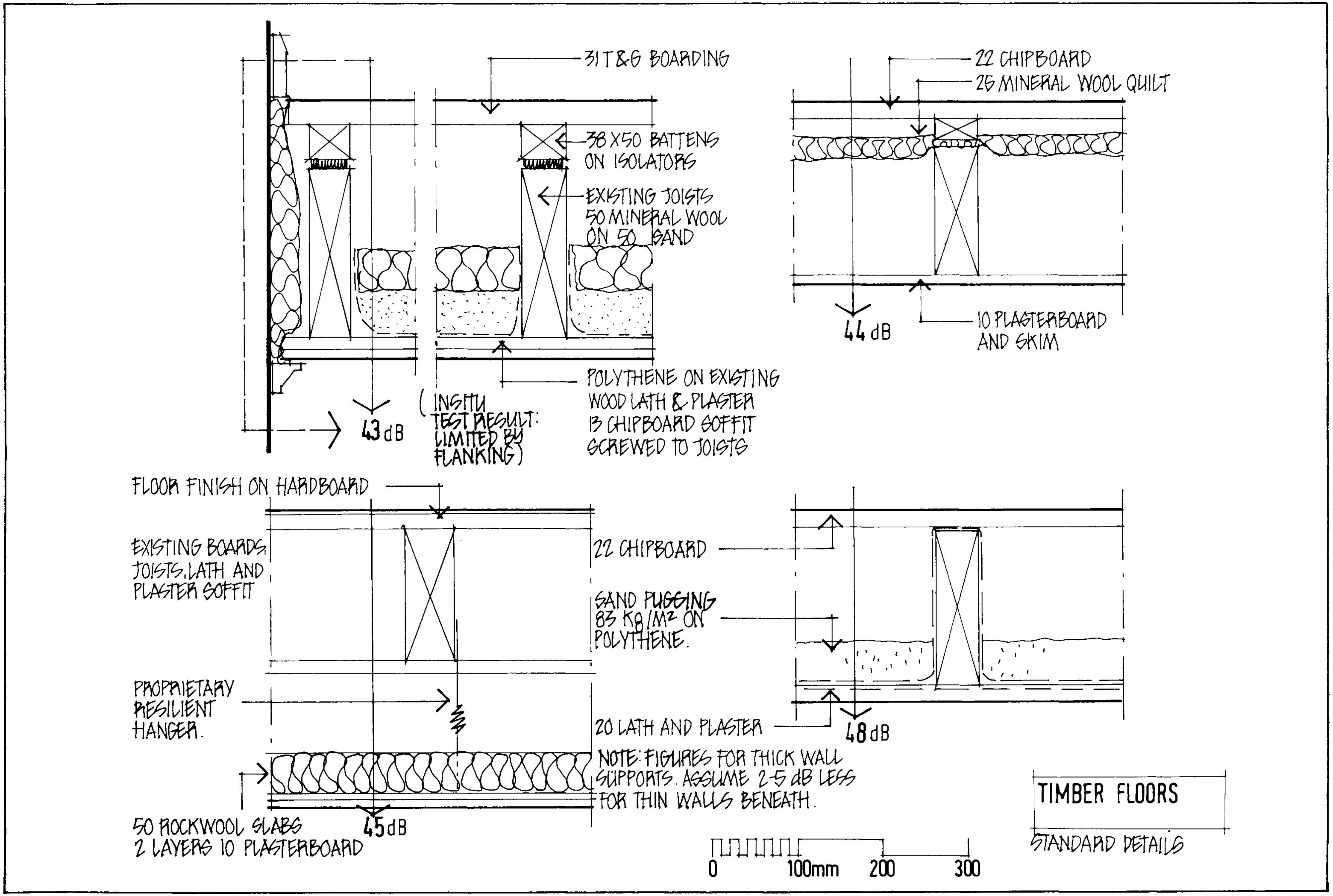


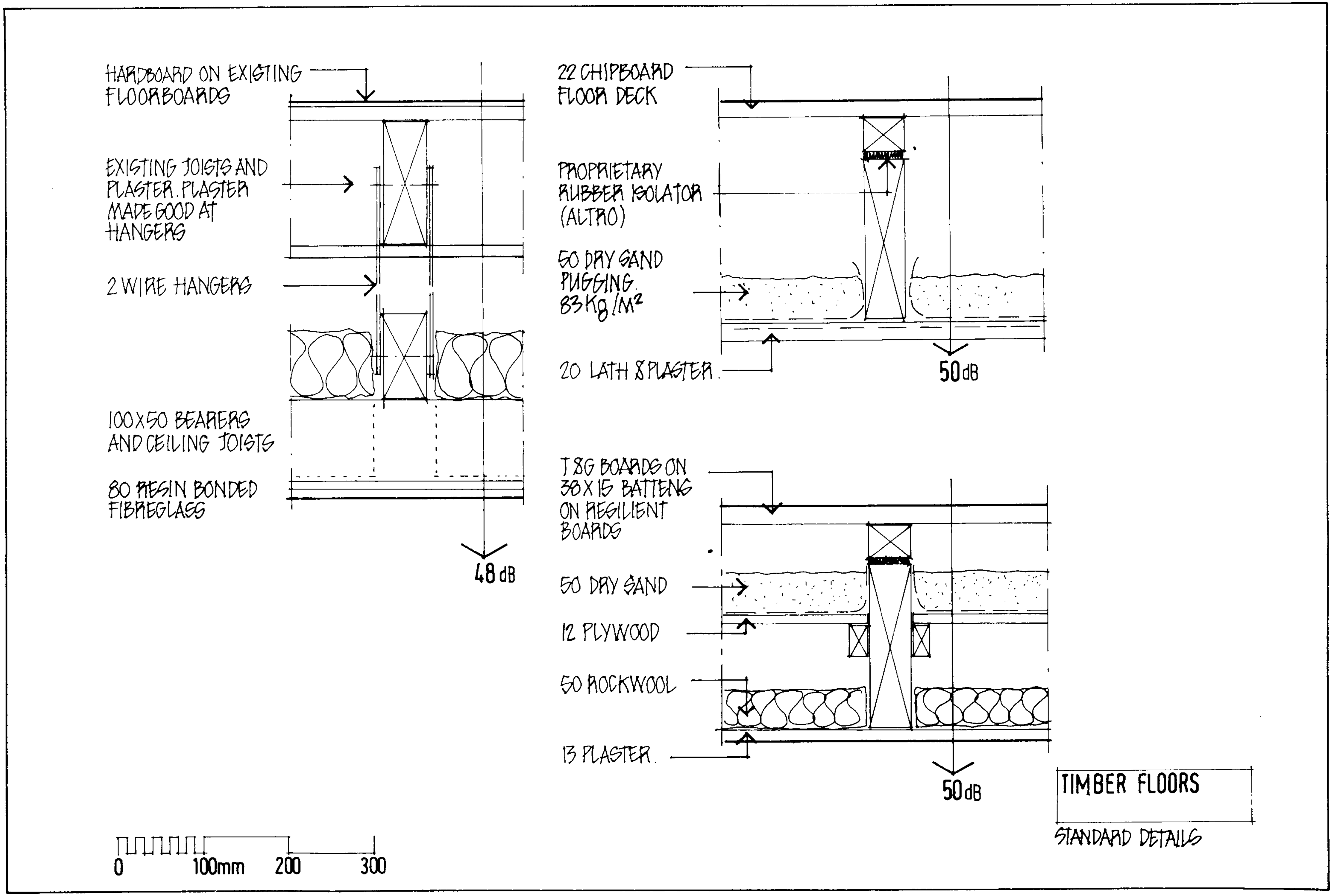


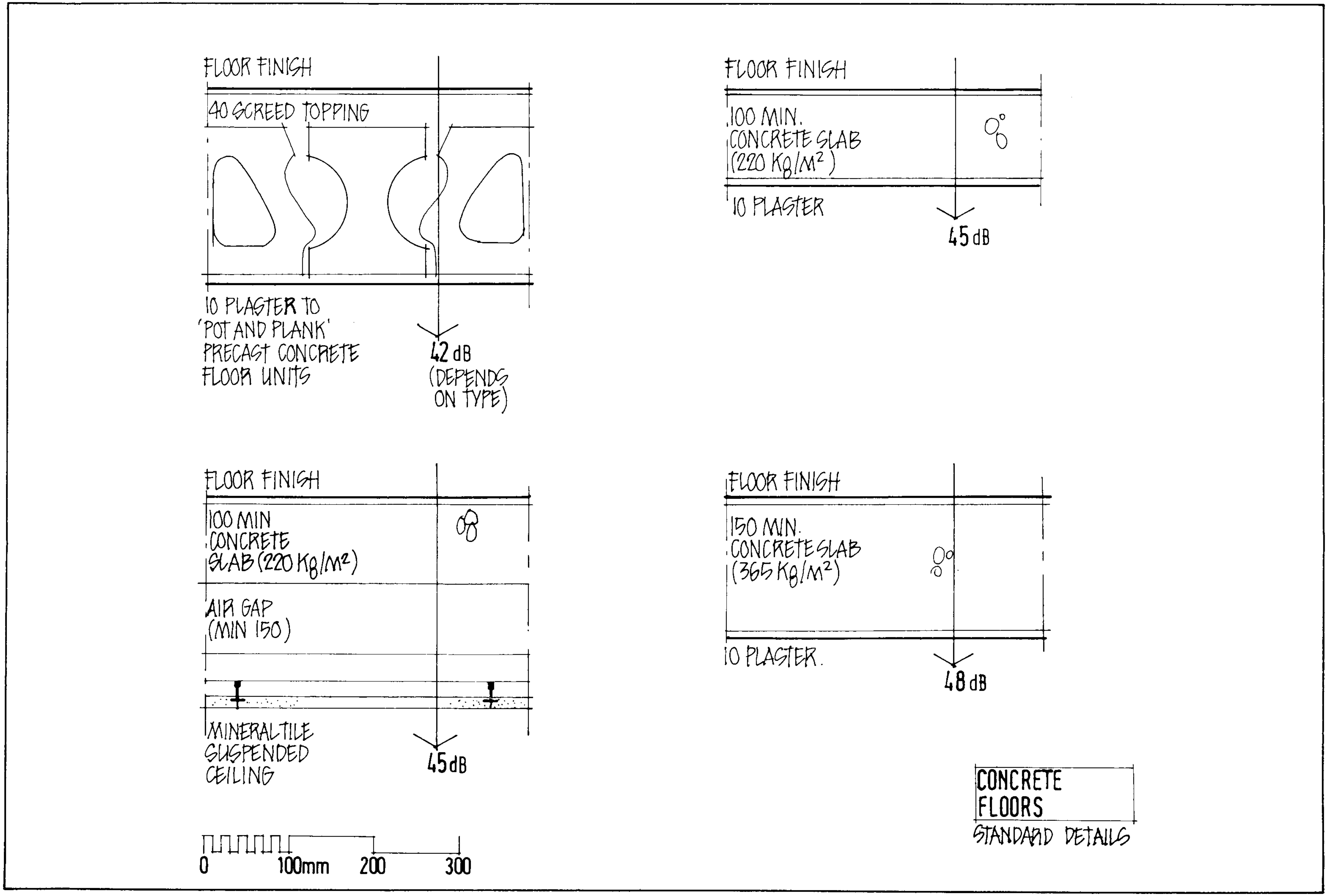
TIMBER FLOORS (4)

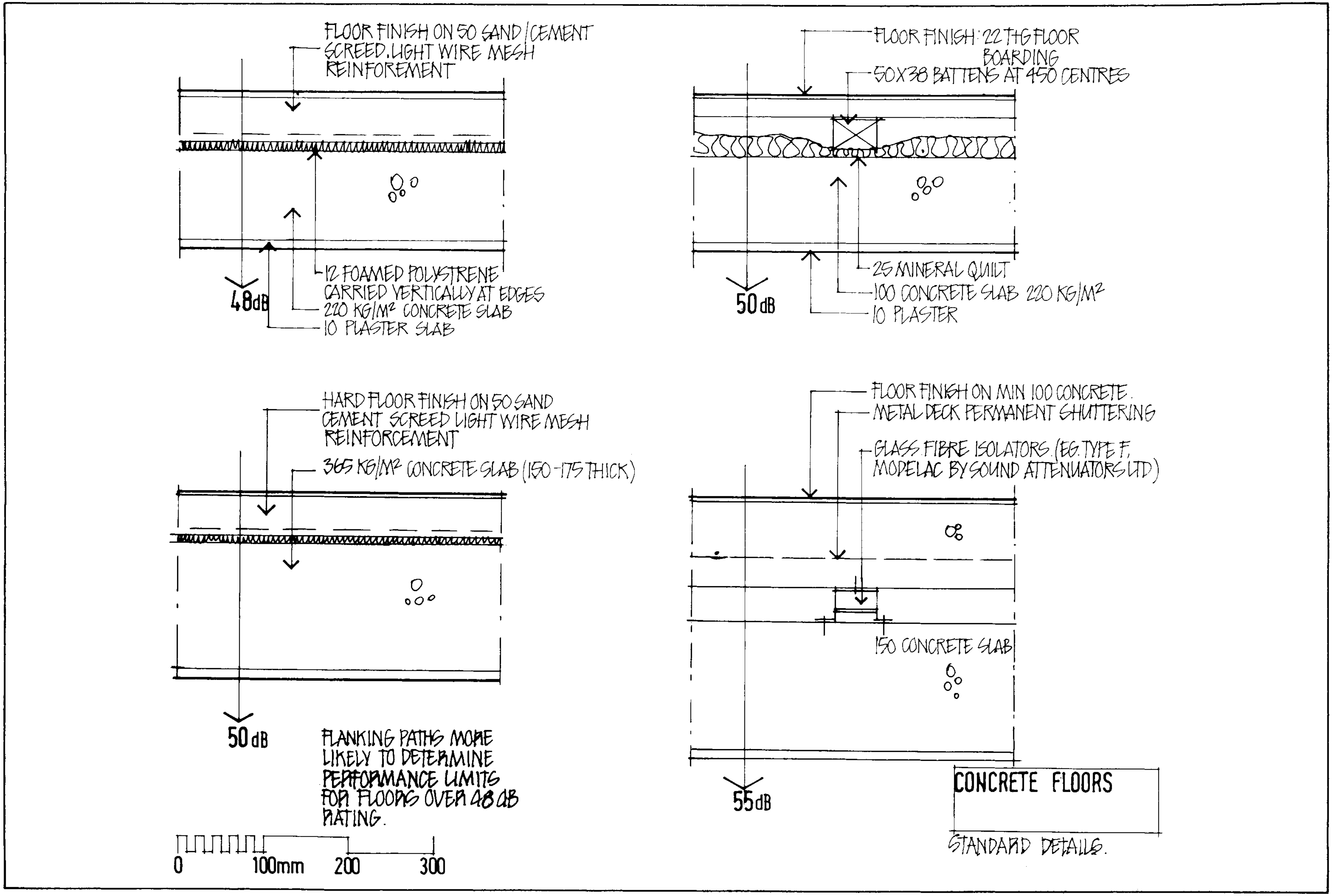
SOURCE: TIMBER RESEARCH AND DEVELOPMENT ASSOCIATION


22 T&G. CHIPBOARD
235
200 X 50 S/W JOISTS 400 CS.
13 PLASTERBOARD AND SKIM
33 dB
19 CHIPBOARD
20 LATH AND PLASTER
40 dB
22 T&G CHIPBOARD
263
13 PLASTERBOARD
GYPROC RESILIENT BARS
13 PLASTERBOARD
43 dB
22 CHIPBOARD
100 (15 Kg/M²) MINERAL WOOL PUGGING.
13 PLASTERBOARD AND SKIM
44 dB
VALUES ARE FOR S.R. INDICES FOR AIRBORNE SOUND.
0
100mm
200
300
TIMBER FLOORS
STANDARD DETAILS.

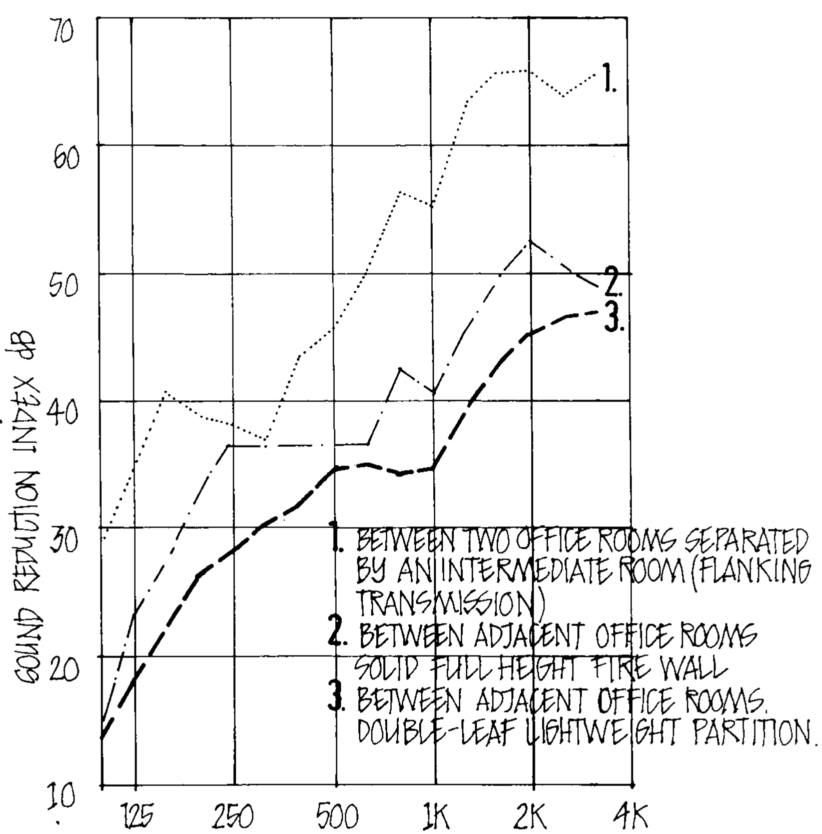

31 T&G BOARDING
38 X 50 BATTENS ON ISOLATORS
EXISTING JOISTS
50 MINERAL WOOL ON 50 SAND
POLYTHENE ON EXISTING WOOD LATH & PLASTER
13 CHIPBOARD SOFFIT SCREWED TO JOISTS
43 dB
(INSITU TEST RESULT: LIMITED BY FLANKING)
22 CHIPBOARD
25 MINERAL WOOL QUILT
44 dB
10 PLASTERBOARD AND SKIM
FLOOR FINISH ON HARDBOARD
EXISTING BOARDS, JOISTS, LATH AND PLASTER SOFFIT
PROPRIETARY RESILIENT HANGER.
50 ROCKWOOL SLABS
2 LAYERS 10 PLASTERBOARD
45 dB
22 CHIPBOARD
SAND PUGGING 83 Kg/M² ON POLYTHENE.
20 LATH AND PLASTER
48 dB
NOTE: FIGURES FOR THICK WALL SUPPORTS. ASSUME 2-5 dB LESS FOR THIN WALLS BENEATH.
0
100mm
200
300
TIMBER FLOORS
STANDARD DETAILS


HARDBOARD ON EXISTING FLOORBOARDS
EXISTING JOISTS AND PLASTER. PLASTER MADE GOOD AT HANGERS
2 WIRE HANGERS
100 X 50 BEARERS AND CEILING JOISTS
80 RESIN BONDED FIBREGLASS
48 dB
22 CHIPBOARD FLOOR DECK
PROPRIETARY RUBBER ISOLATOR (ALTRO)
50 DRY SAND PUGGING. 83 Kg/M^2
20 LATH & PLASTER.
50 dB
T&G BOARDS ON 38 X 15 BATTENS ON RESILIENT BOARDS
50 DRY SAND
12 PLYWOOD
50 ROCKWOOL
13 PLASTER.
50 dB
TIMBER FLOORS
STANDARD DETAILS
0
100mm
200
300

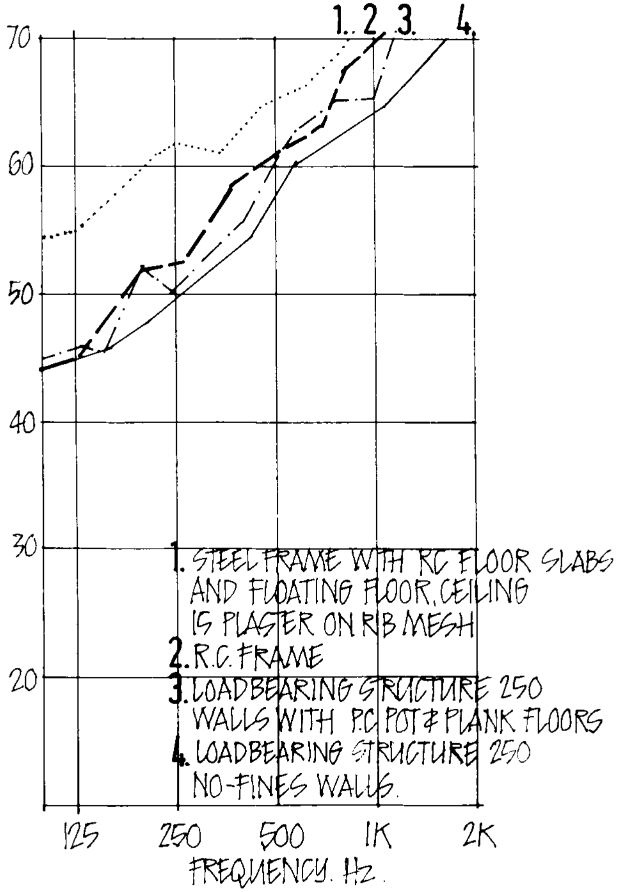

FLOOR FINISH
40 SCREED TOPPING
10 PLASTER TO 'POT AND PLANK' PRECAST CONCRETE FLOOR UNITS
42 dB (DEPENDS ON TYPE)
FLOOR FINISH
100 MIN. CONCRETE SLAB ($220\ Kg/M^2$)
10 PLASTER
45 dB
FLOOR FINISH
100 MIN CONCRETE SLAB ($220\ Kg/M^2$)
AIR GAP (MIN 150)
MINERAL TILE SUSPENDED CEILING
45 dB
FLOOR FINISH
150 MIN. CONCRETE SLAB ($365\ Kg/M^2$)
10 PLASTER.
48 dB
0
100mm
200
300
CONCRETE FLOORS
STANDARD DETAILS


FLOOR FINISH ON 50 SAND/CEMENT SCREED. LIGHT WIRE MESH REINFOREMENT
12 FOAMED POLYSTRENE CARRIED VERTICALLY AT EDGES
220 KG/M² CONCRETE SLAB
10 PLASTER SLAB
48dB
FLOOR FINISH: 22 T&G FLOOR BOARDING
50X38 BATTENS AT 450 CENTRES
25 MINERAL QUILT
100 CONCRETE SLAB 220 KG/M²
10 PLASTER
50dB
HARD FLOOR FINISH ON 50 SAND CEMENT SCREED LIGHT WIRE MESH REINFORCEMENT
365 KG/M² CONCRETE SLAB (150-175 THICK)
50dB
FLANKING PATHS MORE LIKELY TO DETERMINE PERFORMANCE LIMITS FOR FLOORS OVER 48 dB RATING.
0
100mm
200
300
FLOOR FINISH ON MIN 100 CONCRETE.
METAL DECK PERMANENT SHUTTERING
GLASS FIBRE ISOLATORS (EG. TYPE F, MODELAC BY SOUND ATTENUATORS LTD)
150 CONCRETE SLAB
55dB
CONCRETE FLOORS
STANDARD DETAILS.

AIRBORNE SOUND INSULATION IN AN OFFICE BUILDING WITH A STEEL FRAME, LIGHT-WEIGHT SOLID FLOORS AND DOUBLE-LEAF WALLS. SUSPENDED CEILINGS

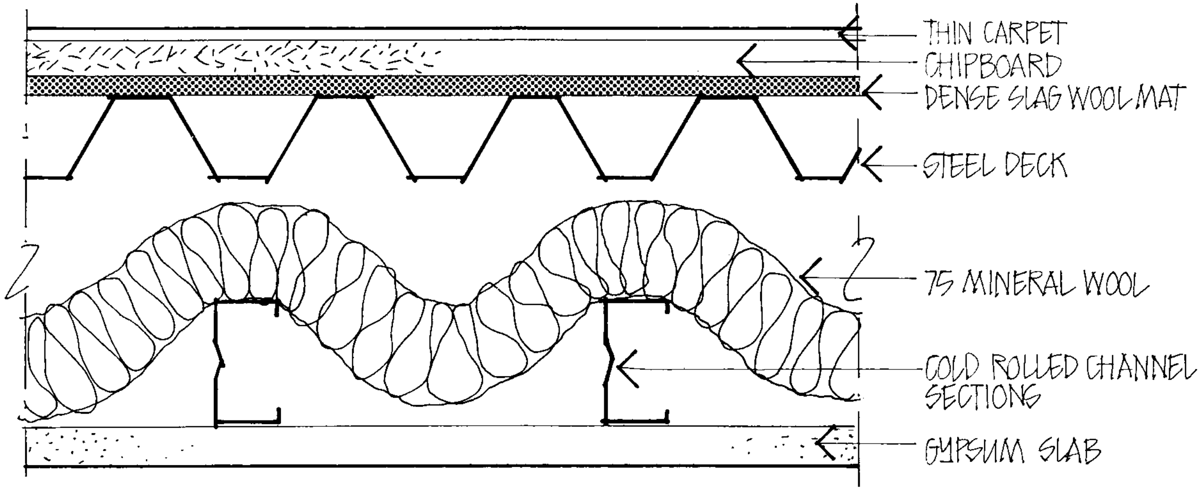


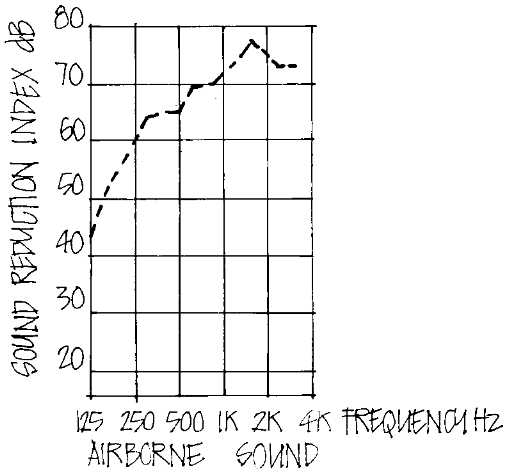
AIRBORNE SOUND INSULATION BETWEEN 2 ROOMS SEPARATED BY AN INTERMEDIATE FLOOR

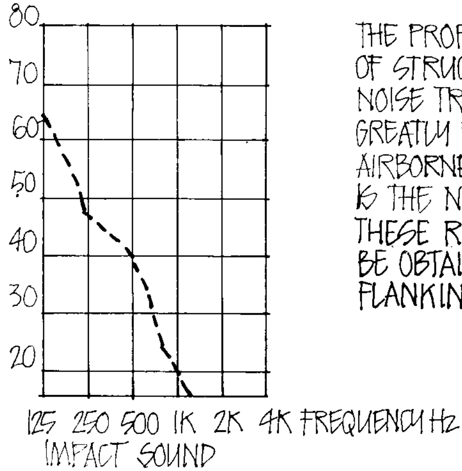


IMPROVEMENT IS ACHIEVED AT ALL FREQUENCIES IN SPITE OF FLANKING TRANSMISSION, BY INCREASING SOLIDITY OF SUBDIVISION AND SEPARATING NOISY AND NOISE-SENSITIVE ROOMS.

STRUCTURE
SOURCE: DR. LANG. TECHNOLOGISCHE GEWERBE MUSEUM. VIENNA

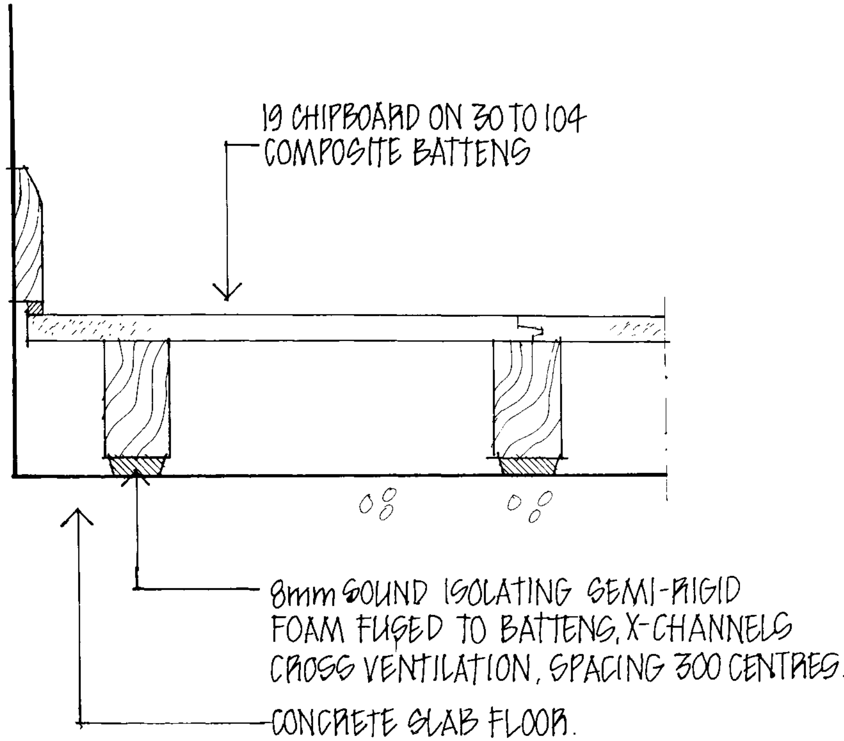


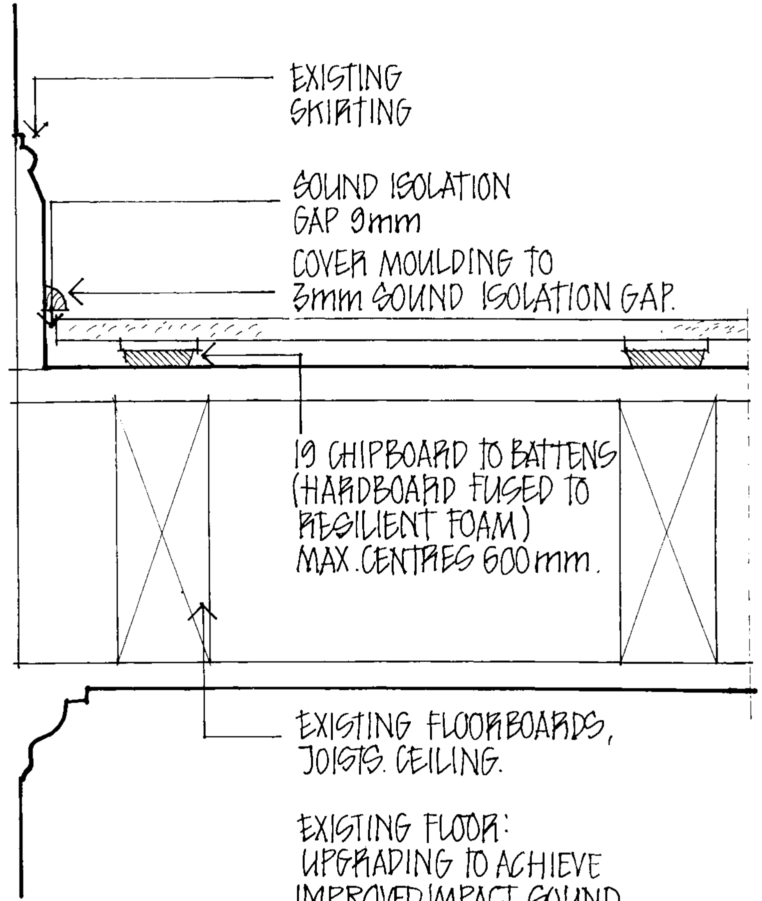


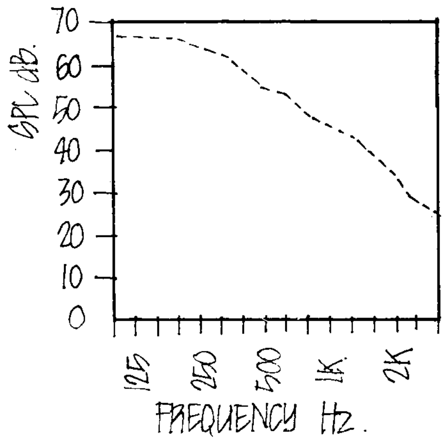


THE PROPERTY OF ELEMENTS OF STRUCTURE TO PREVENT NOISE TRANSMISSION DIFFERS GREATLY FOR WHETHER AIRBORNE OR IMPACT SOUND IS THE NOISE SOURCE. NOTE THESE RESULTS WOULD ONLY BE BE OBTAINED WITH NEGLIGIBLE FLANKING.

FLOORS
SOURCE: DR. LANG
TECHNOLOGISCHES
GEWERBE MUSEUM: VIENNA





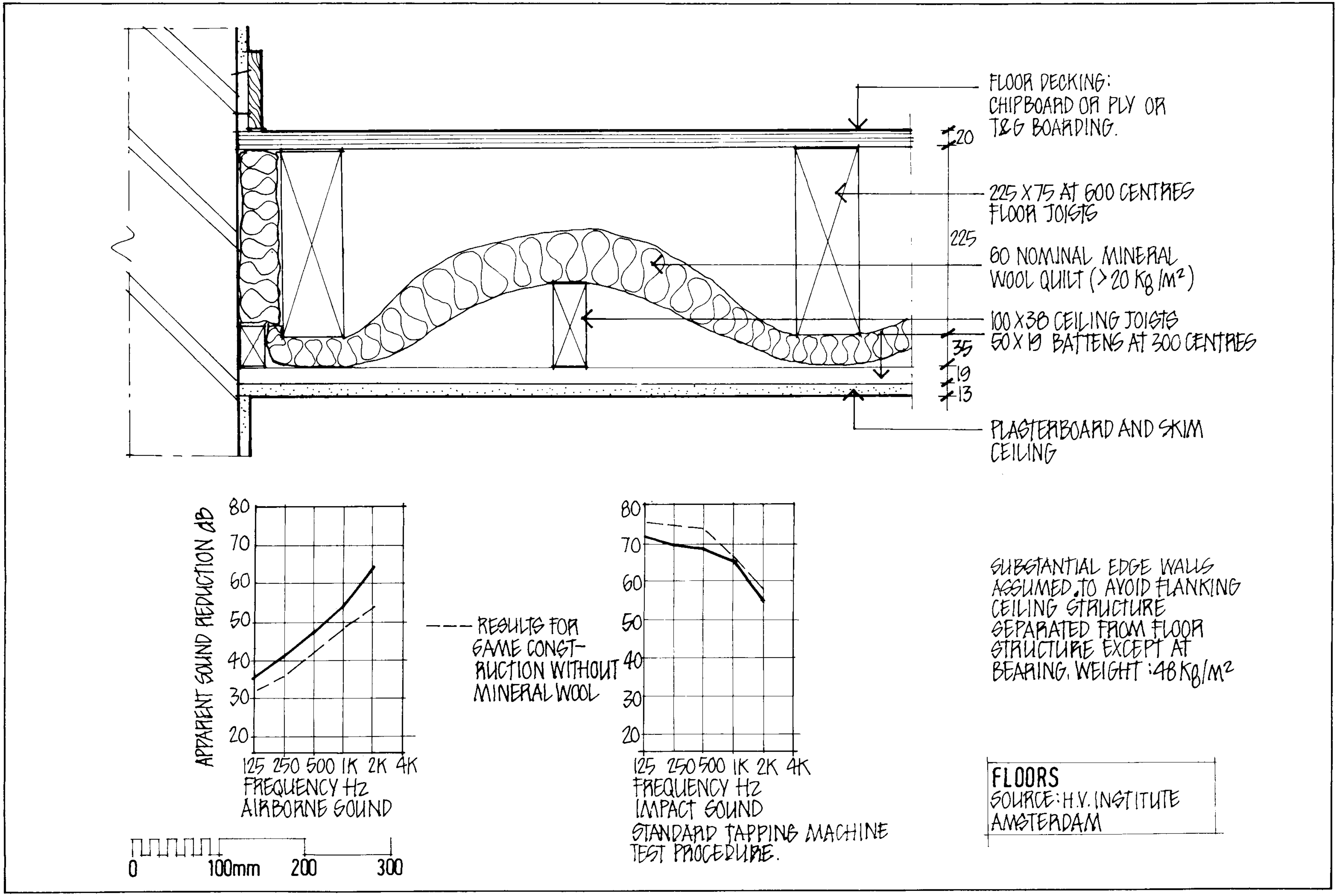


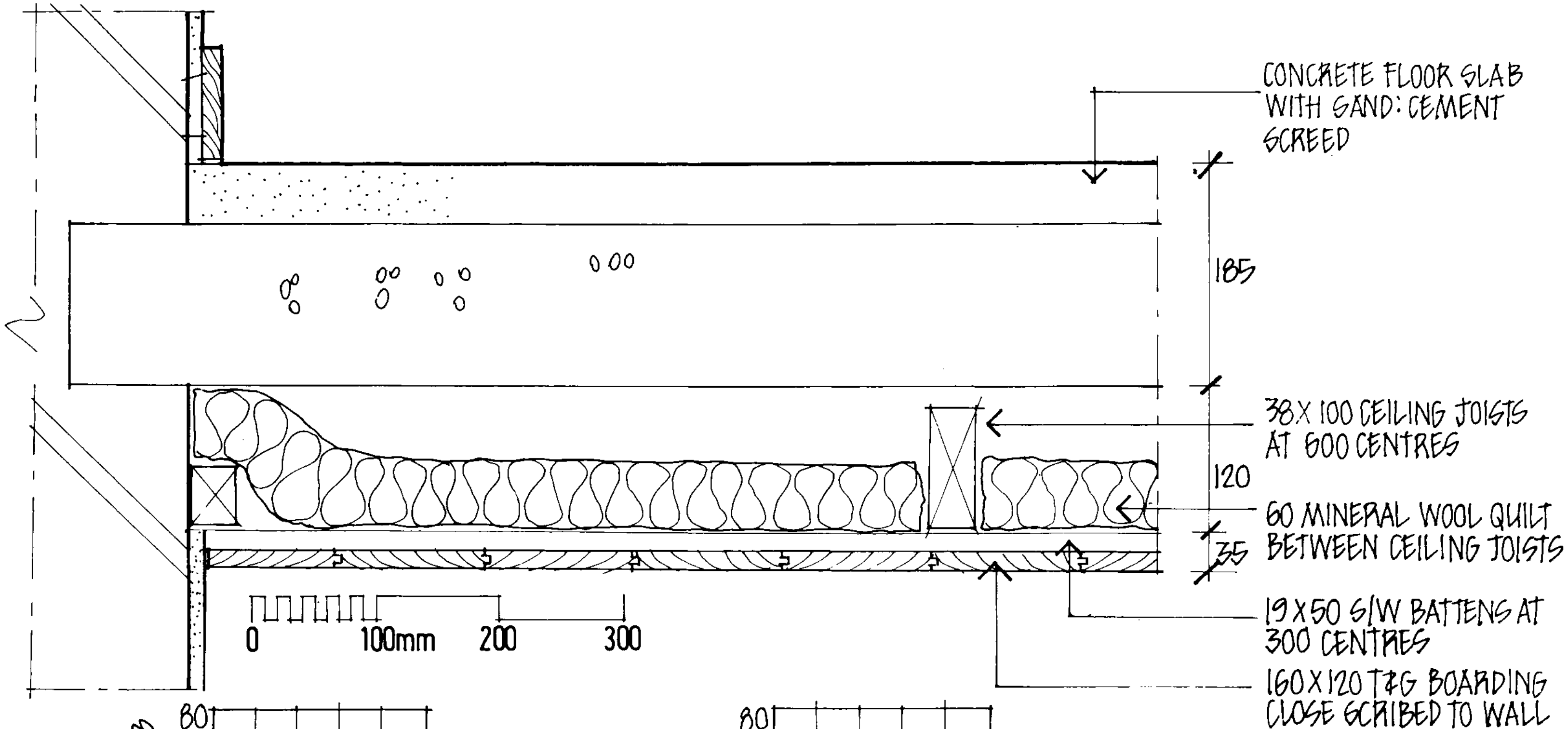
NEW CONSTRUCTION:
FLOATING FLOOR TO ACHIEVE GOOD IMPACT SOUND INSULATION BY LOMBARD FLOORING SYSTEMS.

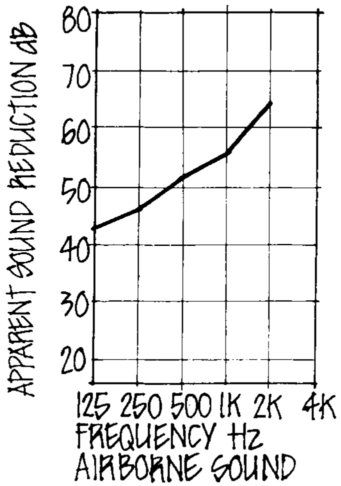
USE IN FLATS, MAISONETTES AND OPEN PLAN OFFICES.

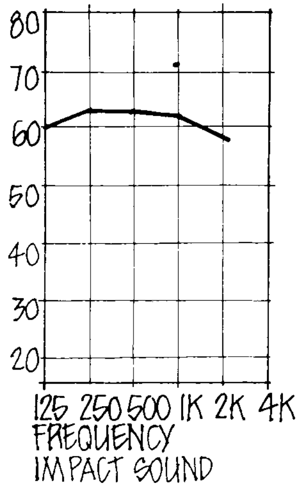
EXISTING FLOOR:
UPGRADING TO ACHIEVE IMPROVED IMPACT SOUND INSULATION BY MODIFIED WESTBOURNE SYSTEM OF FLOORING.

FLOORS
SOURCE: CONTIWOOD (DURABELLA) LTD.


FLOOR DECKING:
CHIPBOARD OR PLY OR
T&G BOARDING.
20
225 X 75 AT 600 CENTRES
FLOOR JOISTS
225
60 NOMINAL MINERAL
WOOL QUILT (>20 Kg/m²)
100 X 38 CEILING JOISTS
50 X 19 BATTENS AT 300 CENTRES
35
19
13
PLASTERBOARD AND SKIM
CEILING
APPARENT SOUND REDUCTION dB
80
70
60
50
40
30
20
125 250 500 1K 2K 4K
FREQUENCY Hz
AIRBORNE SOUND
RESULTS FOR
SAME CONST-
RUCTION WITHOUT
MINERAL WOOL
80
70
60
50
40
30
20
125 250 500 1K 2K 4K
FREQUENCY Hz
IMPACT SOUND
STANDARD TAPPING MACHINE
TEST PROCEDURE.
SUBSTANTIAL EDGE WALLS
ASSUMED TO AVOID FLANKING
CEILING STRUCTURE
SEPARATED FROM FLOOR
STRUCTURE EXCEPT AT
BEARING. WEIGHT: 48 Kg/m²
FLOORS
SOURCE: H.V. INSTITUTE
AMSTERDAM
0
100mm
200
300

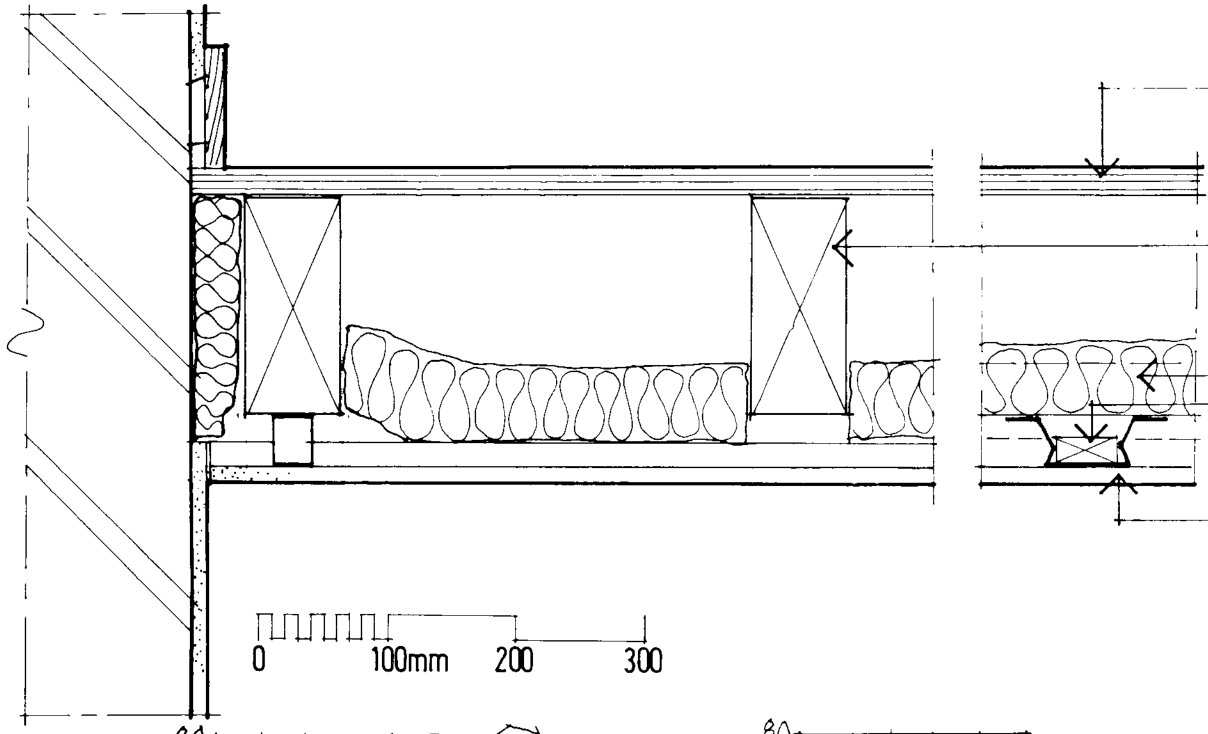






MASS COMPOSITE CONSTRUCTION AND DISCONTINUITY GIVE A GOOD OVERALL PERFORMANCE. BATTENS GIVE AIR SPACE BELOW AS WELL AS ABOVE QUILT. GOOD FOR ISOLATION OF UPPER FLOOR FROM NOISY ACTIVITIES BELOW (eg. COMMON ROOMS BELOW STUDENT BEDROOMS)
WEIGHT 420 Kg/M²

FLOORS
SOURCE: H.V. INSTITUTE AMSTERDAM

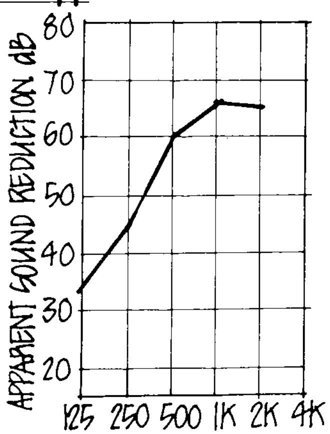


FLOOR DECKING:
CHIPBOARD OR PLY
OR T+G BOARDING

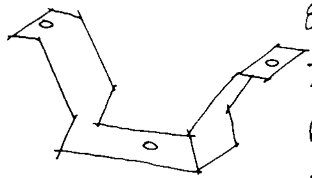
75 X 175 AT 400 CENTRES
FLOOR JOISTS

60 MINERAL WOOL QUILT
50 X 19 BATTENS AT 300 CENTRES

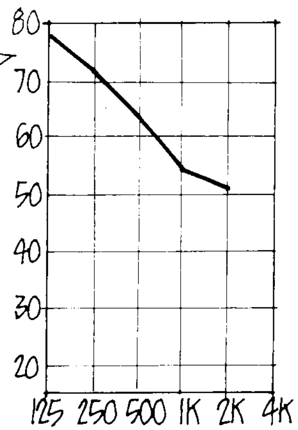
PROPRIETARY RESILIENT CEILING HANGERS TO EVERY OTHER FLOOR JOISTS, 300 CS RESILIENT PACKERS TO BATTENS
13 PLASTERBOARD & SKIM CEILING.
MUCH IMPROVED PERFORMANCE COMPARED WITH SAME CONSTRUCTION WITHOUT HANGERS (AIRBORNE +15 dB AT MID FREQUENCIES)
HANGERS ARE USEFUL FOR UPGRADING EXISTING FLOOR CONSTRUCTIONS, WHERE EXISTING FLOOR JOISTS CANNOT BEAR MUCH ADDITIONAL DEAD LOAD eg. SAND PLUGGING.



FREQUENCY Hz
AIRBORNE SOUND

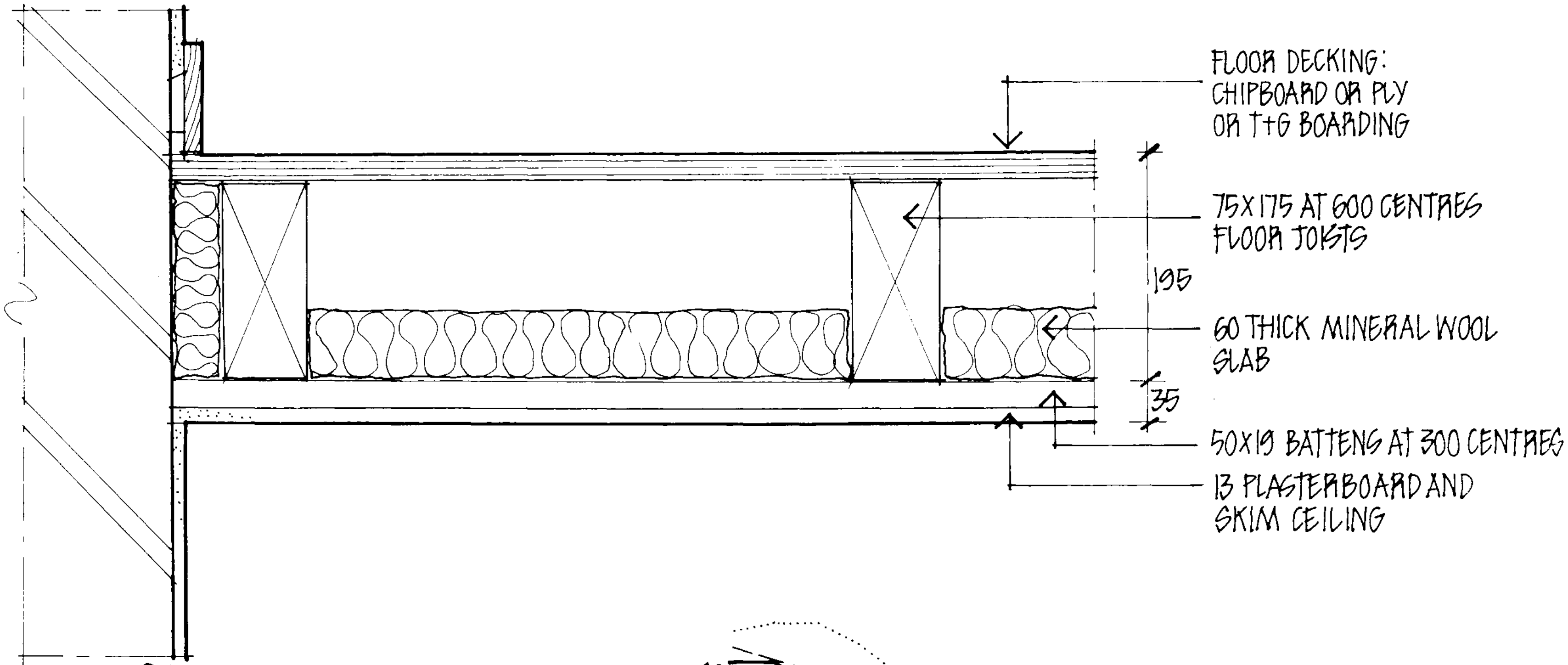


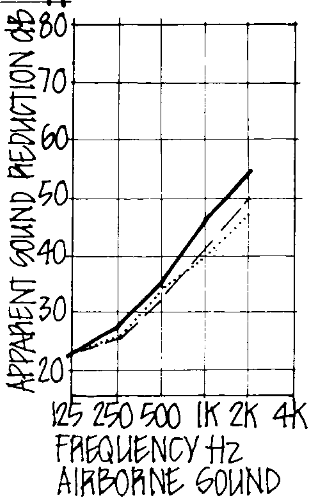
SKETCH OF HANGER.



FREQUENCY Hz
IMPACT SOUND

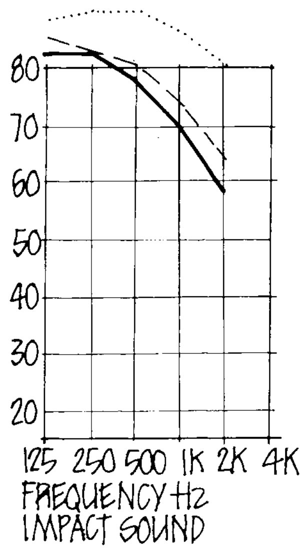
FLOORS
SOURCE: HV. INSTITUTE. AMSTERDAM.





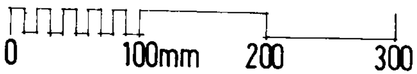
---- RESULTS FOR SAME CONSTRUCTION WITHOUT MINERAL WOOL.

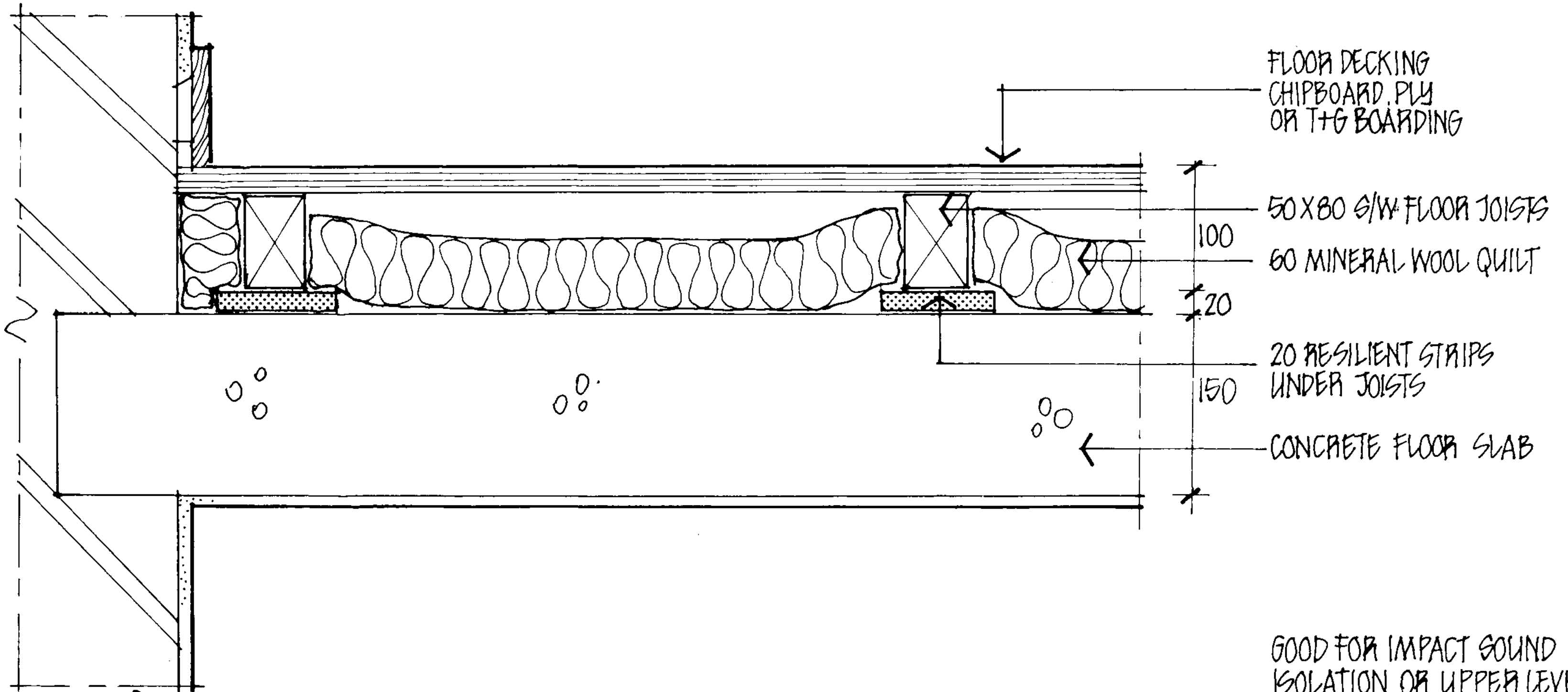
.... RESULTS FOR CONSTRUCTION WITH 9.5 PLASTERBOARD CEILING DIRECT TO JOISTS. NO MINERAL WOOL.

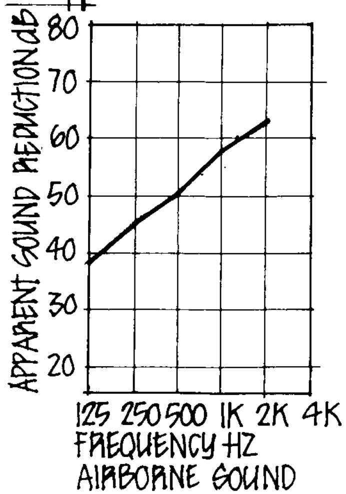


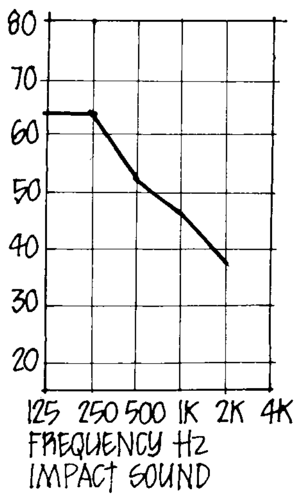
EVEN A SUBSTANTIAL TIMBER FLOOR CANNOT COMPARE IN AIRBORNE OR IMPACT SOUND PERFORMANCE WITH 'SPLIT' FLOOR AND CEILING CONSTRUCTION. ABSORPTIVE MATERIAL IN FLOOR VOID HELPS IN DAMPING THE TRACKING OF SOUND ACROSS. WEIGHT 39 Kg/M²

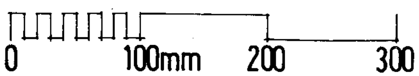
FLOORS
SOURCE: H.V. INSTITUTE
AMSTERDAM.





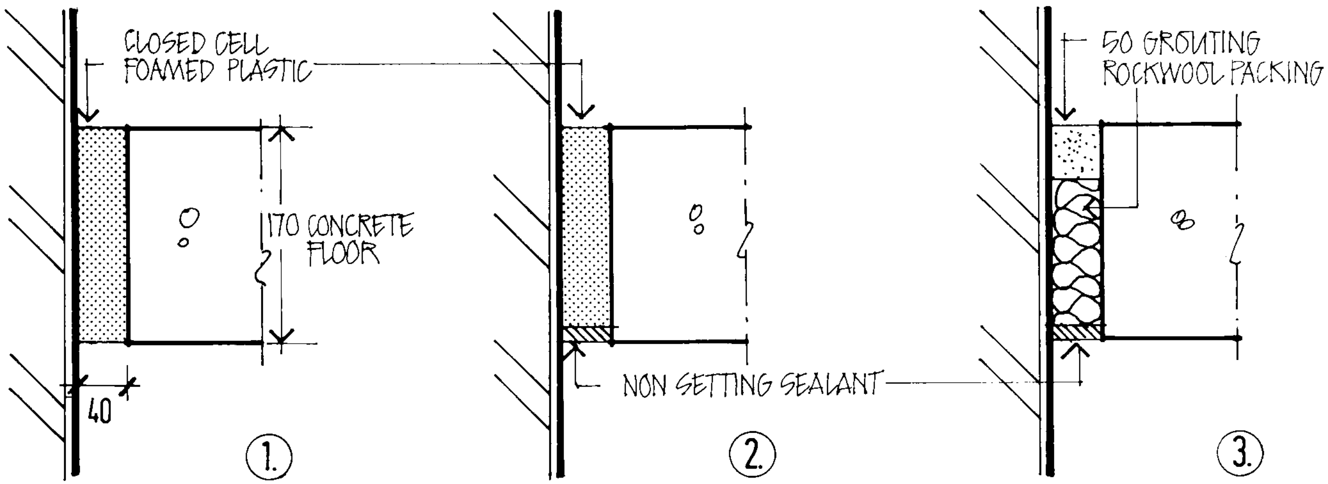






GOOD FOR IMPACT SOUND ISOLATION OR UPPER LEVEL NOISE SOURCE. BECAUSE OF FLANKING, IT IS NOT WORTH GOING TO THE TROUBLE OF TRIPLE FLOOR CONSTRUCTION (ie. FLOATING FLOOR/STRUCT-URAL SLAB/SEPARATE CEILING SUSPENSION) UNLESS ISOLATING WALLS TO SUCH ELEMENTS ARE ALSO USED. WEIGHT 350 Kg/m²

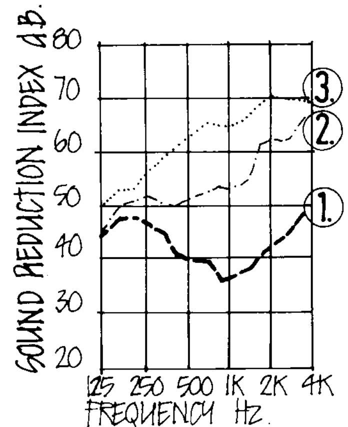
FLOORS
SOURCE: H.V. INSTITUTE AMSTERDAM



VERTICAL SECTIONS

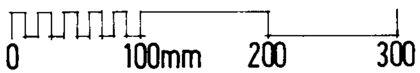
SOUND LEVEL DIFFERENCE BETWEEN TWO ROOMS CAUSED BY A 2 METRE SLOT IN ONE SIDE OF A FLOOR (LABORATORY TEST). GOOD SEALING OF GAPS NECESSARY FOR SPEECH FREQUENCY PRIVACY, SEALING LESS CRITICAL AT LOW FREQUENCIES.

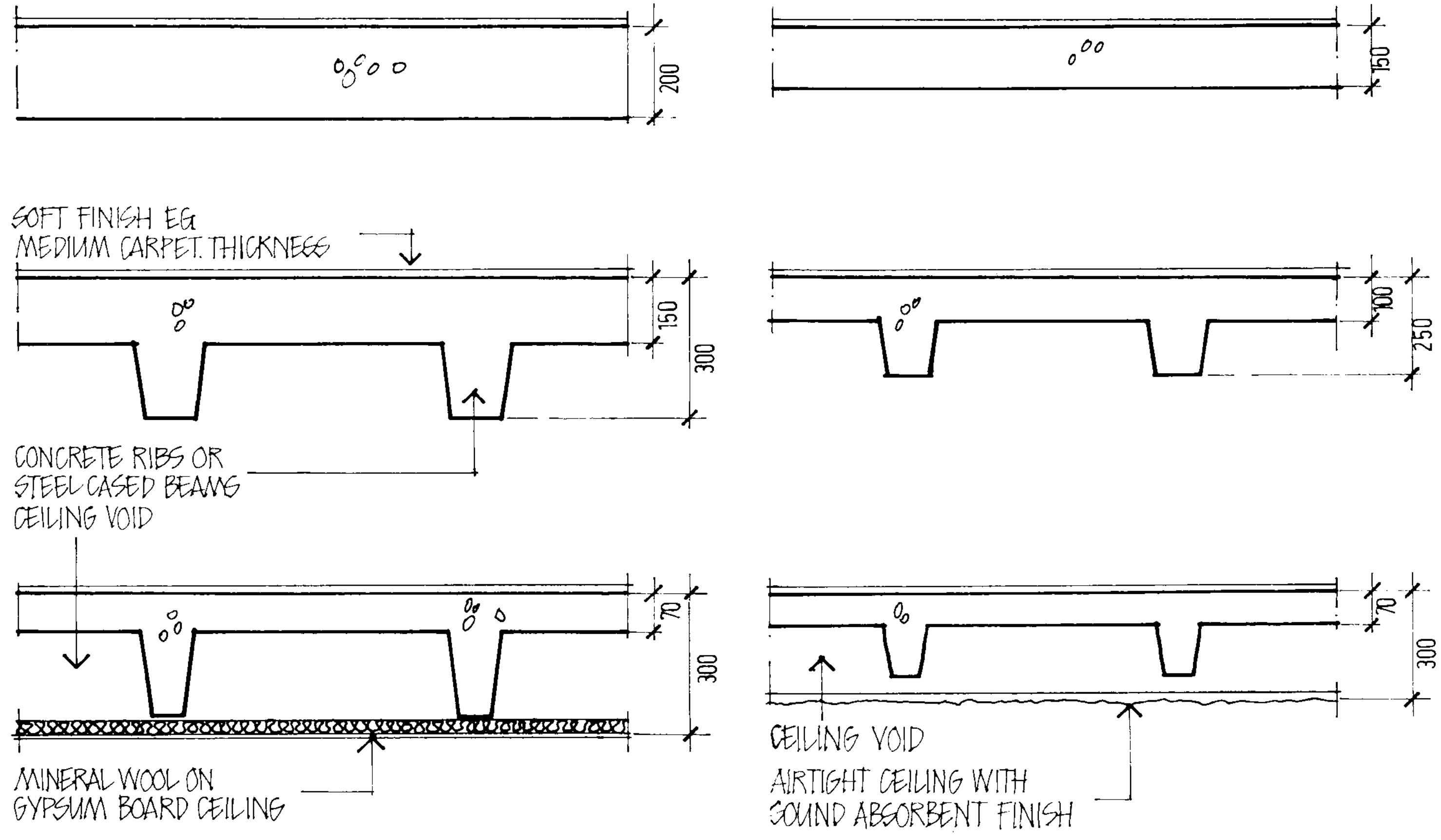
A SMALL STOREY-HEIGHT CRACK 0·2 mm WIDE IN A WALL 10 M² IN AREA WOULD RESULT IN A 7 dB LOSS IN A 50 dB-RATED WALL, BUT 1 dB ONLY REDUCTION OF INSULATION IN A 35 dB. PARTITION: LACK OF CRACKS OR GAPS IS PARTICULARLY IMPORTANT FOR SUBSTANTIAL SEPARATING ELEMENTS.



AIRBORNE SOUND

FLOORS
SOURCE: INSTITUT FÜR TECHNISCHE PHYSIK STUTTGART





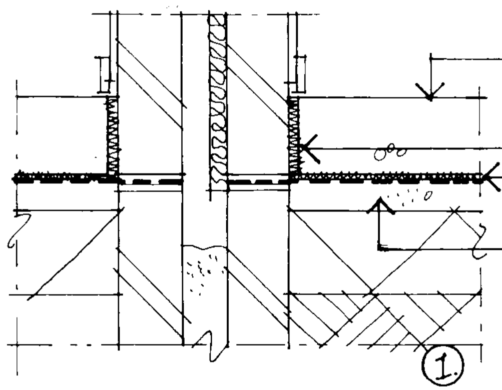
FLOOR STRUCTURES WITH
EQUAL IMPACT SOUND
INSULATION

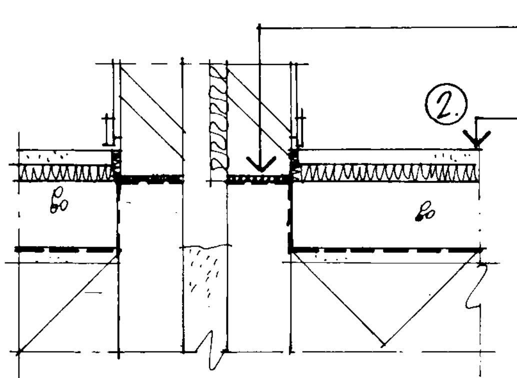
LuTw = 63dB
(LuTw IS WEIGHTED STANDARDIZED IMPACT
SOUND PRESSURE LEVEL TO BS 5281 PART 7)
MEASURED IN ACCORDANCE WITH BS 2750

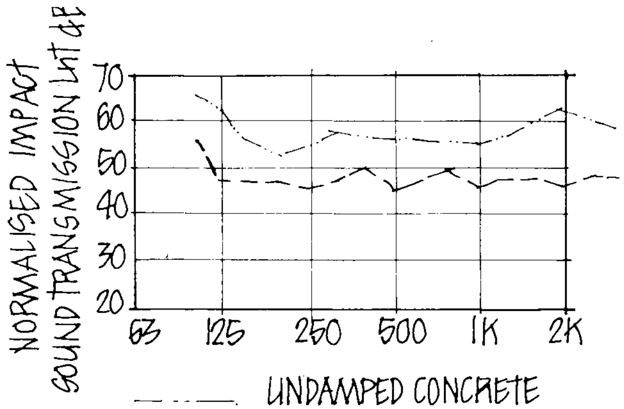
LuTw = 68 dB
SECTIONS NOT TO SCALE
FIGURES ASSUME
NEGLIBLE FLANKING

FLOORS
SOURCE: DR. LANG
TECHNOLOGISCHES
GEWERBE MUSEUM, VIENNA

not to scale







LONG FIBRE GLASS WOOL AND MINERAL WOOL QUILTS HAVE BEEN SUGGESTED AS THE MOST PROVEN MATERIALS (BRE 103). FIBREBOARD AND HAIR FELT HAVE SHOWN UNSATISFACTORY COMPACTION UNDER CONTINUOUS LOAD. MATERIAL TO BE USED TO HAVE FOLLOWING FEATURES:

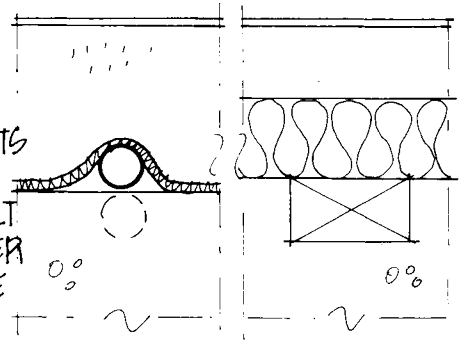
A.– DENSITY 15-25 Kg/m² MIN
B.– THICKNESS NOT LESS THAN 13mm
C.– BOARD PRECOMPRESSED TO HALF INITIAL THICKNESS WITH RAPID RECOVERY TO 9% INITIAL THICKNESS.

THIN MATERIALS ARE PROMISING IN PERFORMANCE: REDUC HAVE A MEMBRANE ONLY 1·5MM THICK. OTHER INSULATION PANELS eg. TRT PANELS CONSIST OF CHIPBOARD, HARDBOARD OR PLY EITHER SIDE OF A THIN VISCO ELASTIC LAYER WHICH HAS THE PROPERTY OF A HIGH DEGREE OF INTERNAL DAMPING.

(1) IS POOR COMPARED WITH (3): RESILIENT QUILT IS SUBJECT TO EXTRA COMPRESSION LOAD AND WATER FROM CONCRETE MIX. ABSORBENT MATERIAL IN CAVITY CUTS DOWN TRACKING OF NOISE ACROSS CAVITY.

(1)-(4) SHOW VARYING MEANS OF ISOLATING FLOOR SLABS IN ADJACENT ROOMS TO PREVENT FLANKING. (eg. IN MUSIC ROOMS, CONFERENCE ROOMS)

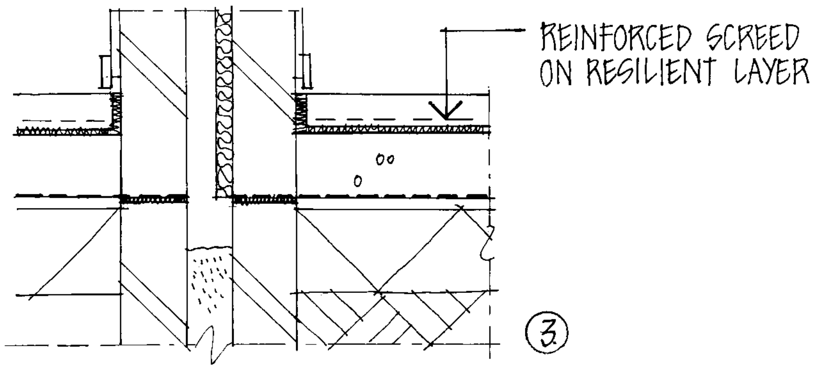
(4) IS IMPRACTICAL TO INSTALL

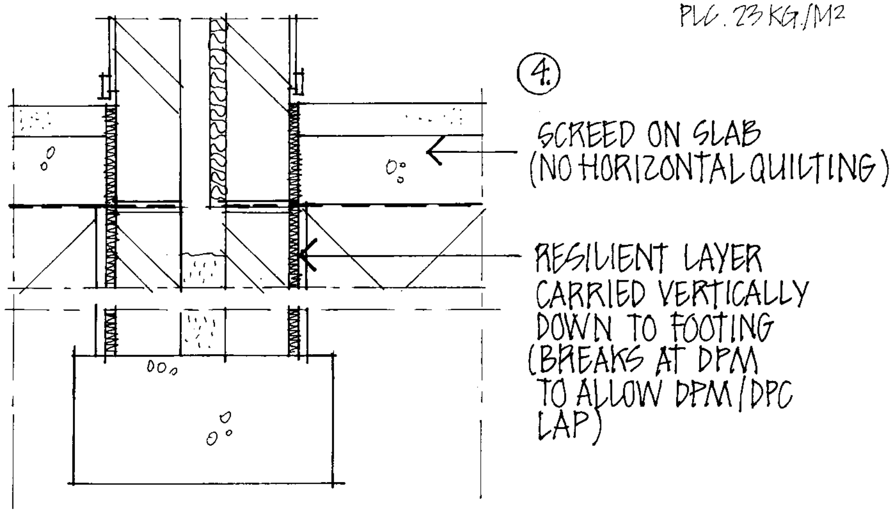


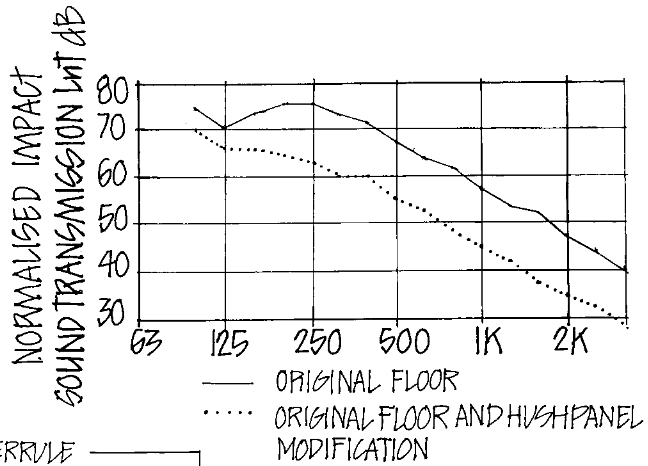
CONDUIT OR PIPE SET UNDER SCREED (NOT TO EXCEED 25 IN 50 SCREED)

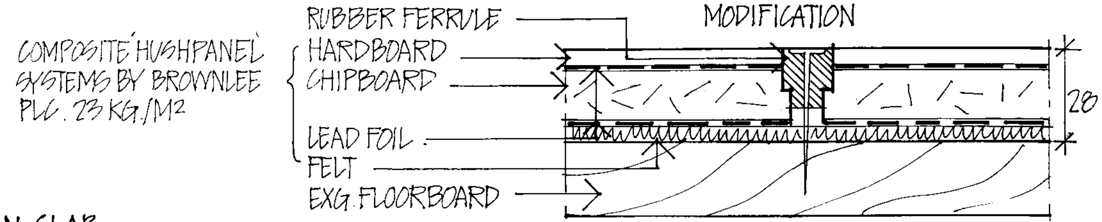
POCKETS UNDER EXPANDED POLY STYRENE NOT EXCEEDING 75 WIDTH

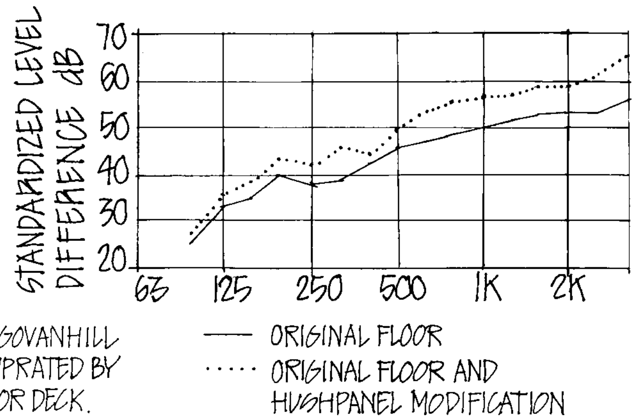
FLOORS





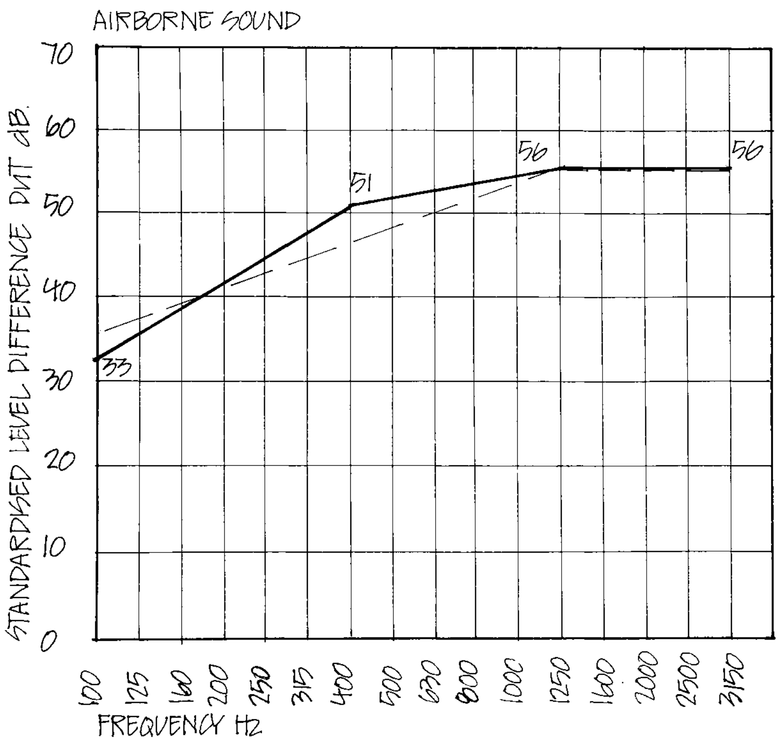






◦ FLOORS AT GOVANHILL GLASGOW UPRATED BY ADDED FLOOR DECK. SOURCE: GLASGOW COLLEGE OF BUILDING

FLOORS



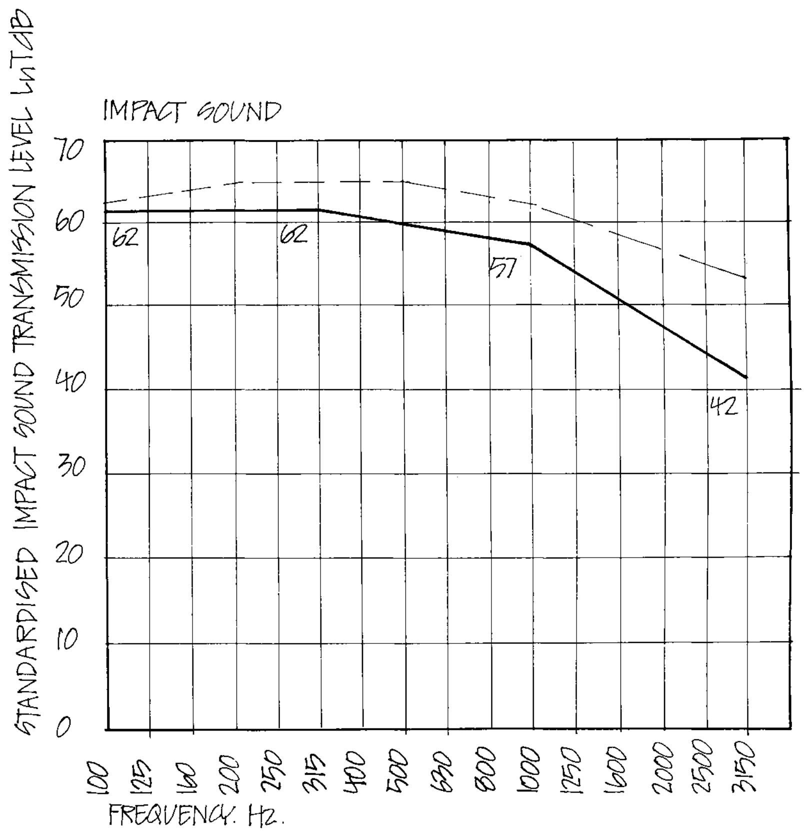
— — 1976 BUILDING REGULATIONS MAX 23dB AAD
—— 1985 BUILDING REGULATIONS (DnTw)

REQUIREMENT IN dB

INDIVIDUAL	MEAN
48	< TESTS ON 4 PAIRS OF ROOMS 52 > TESTS ON 4 PAIRS OF ROOMS 51

SINGLE VALUE TAKEN FROM REFERENCE CURVE AT 500 Hz.
TOTAL DEVIATION/16 ≯ 2dB.

UNFAVOURABLE DEVIATION IF MORE THAN 8dB AT ONE FREQUENCY.



— — 1976 BUILDING REGULATIONS MAX 23dB AAD
—— 1985 BUILDING REGULATIONS (LnTw)

REQUIREMENT IN dB.

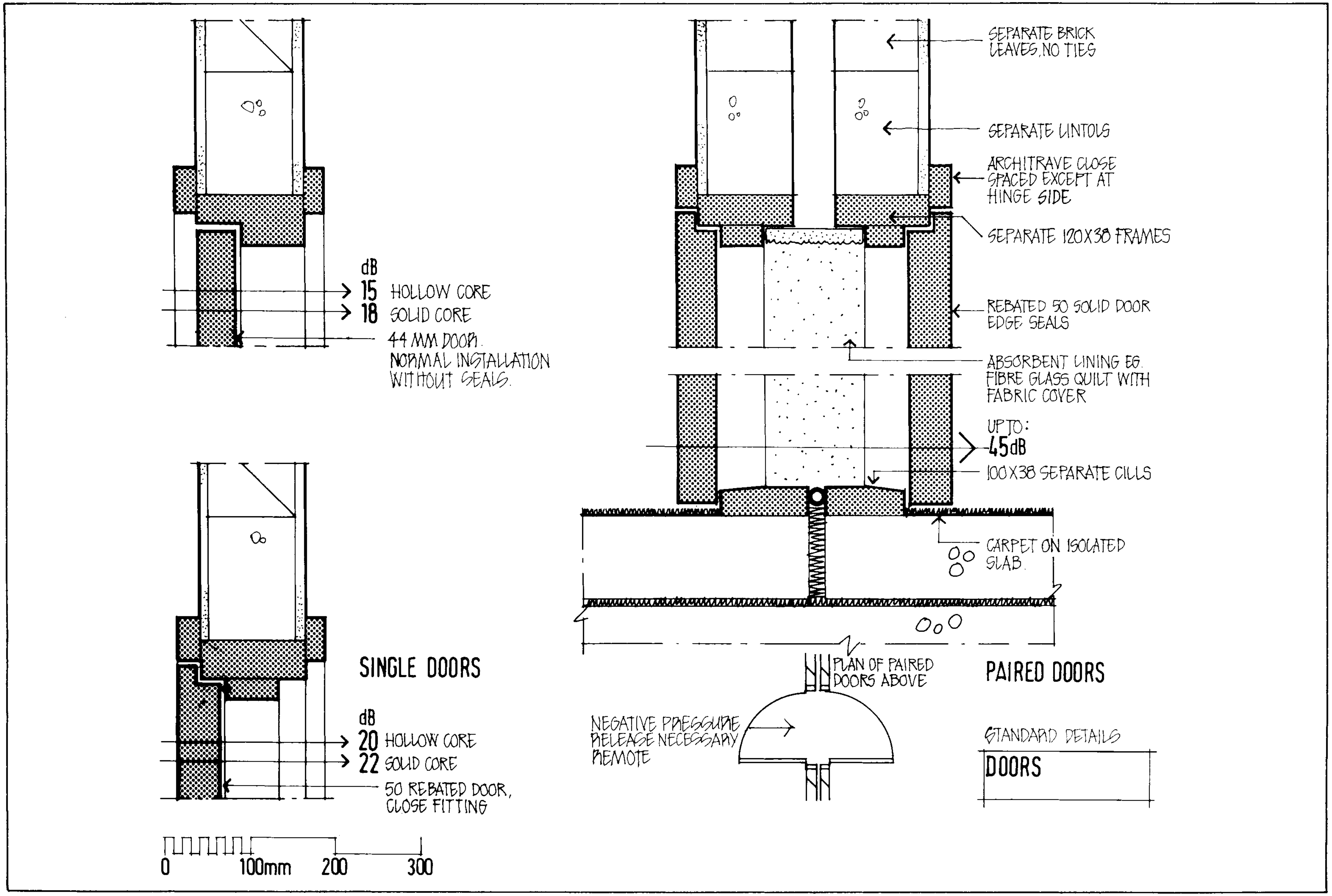
INDIVIDUAL	MEAN
65	< TESTS ON 4 PAIRS OF ROOMS 61 > TESTS ON 4 PAIRS OF ROOMS 62

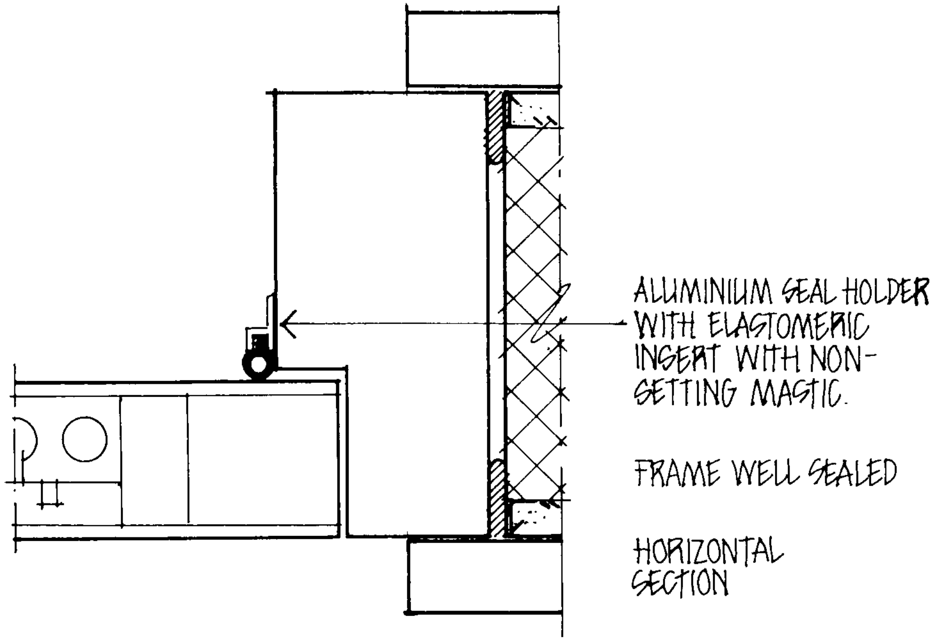
SINGLE VALUE TAKEN FROM REFERENCE CURVE AT 500 Hz.

PARTY FLOORS

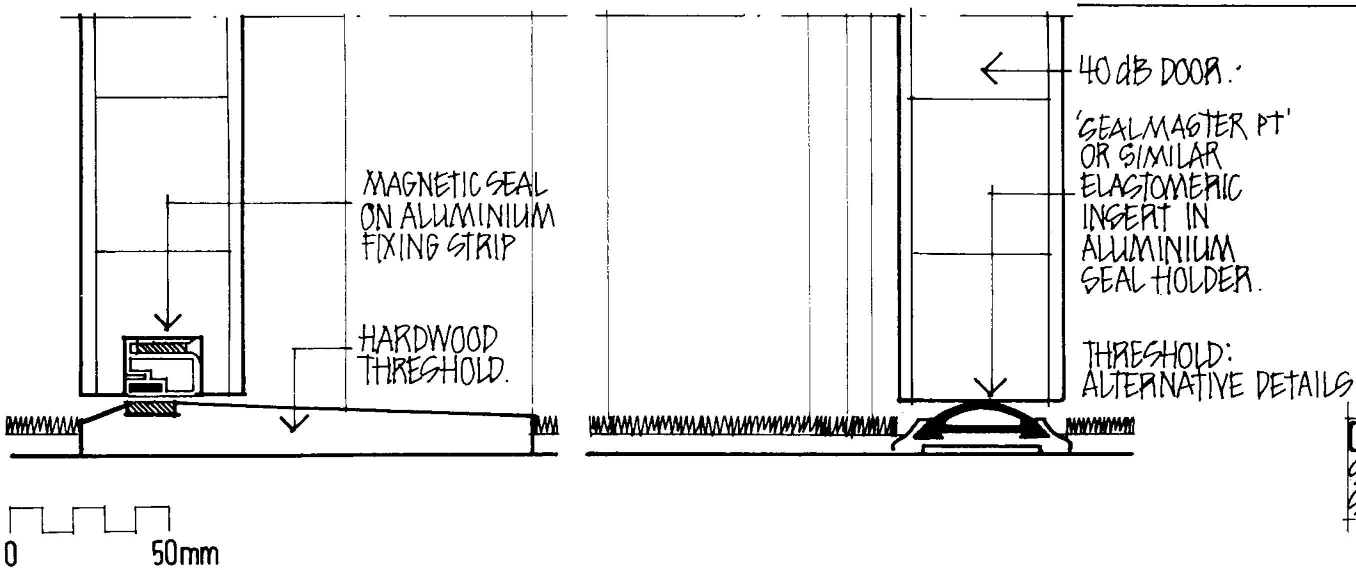
SOURCES:
BS 5821 : PART 1&2 1984
ISO 717 : 1982

DOORS

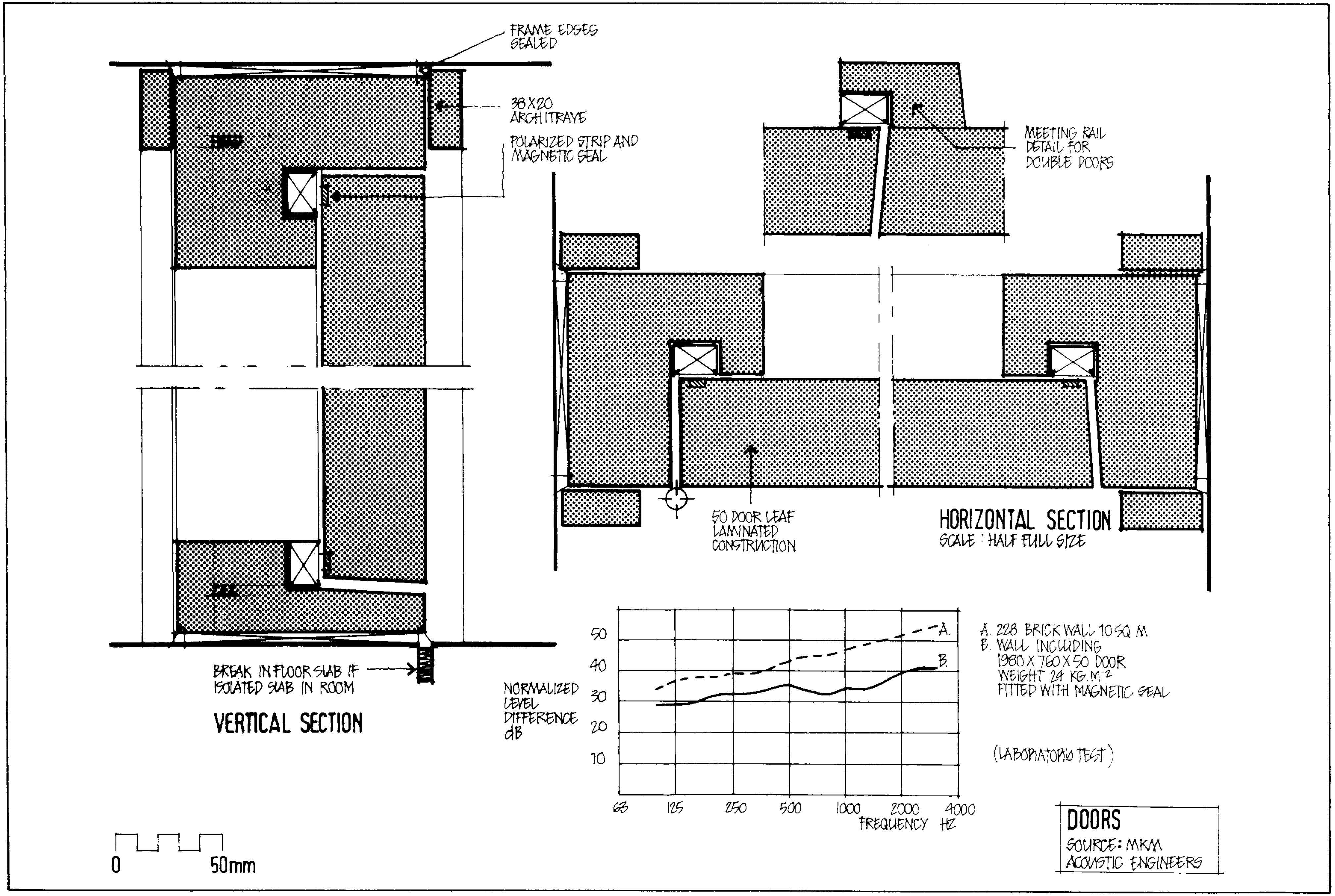

dB
15 HOLLOW CORE
18 SOLID CORE
44 MM DOOR.
NORMAL INSTALLATION
WITHOUT SEALS.
dB
20 HOLLOW CORE
22 SOLID CORE
50 REBATED DOOR,
CLOSE FITTING
SINGLE DOORS
0 100mm 200 300
SEPARATE BRICK
LEAVES, NO TIES
SEPARATE LINTOLS
ARCHITRAVE CLOSE
SPACED EXCEPT AT
HINGE SIDE
SEPARATE 120X38 FRAMES
REBATED 50 SOLID DOOR
EDGE SEALS
ABSORBENT LINING EG.
FIBRE GLASS QUILT WITH
FABRIC COVER
UP TO:
45dB
100X38 SEPARATE CILLS
CARPET ON ISOLATED
SLAB.
PLAN OF PAIRED
DOORS ABOVE
NEGATIVE PRESSURE
RELEASE NECESSARY
REMOTE
PAIRED DOORS
STANDARD DETAILS
DOORS

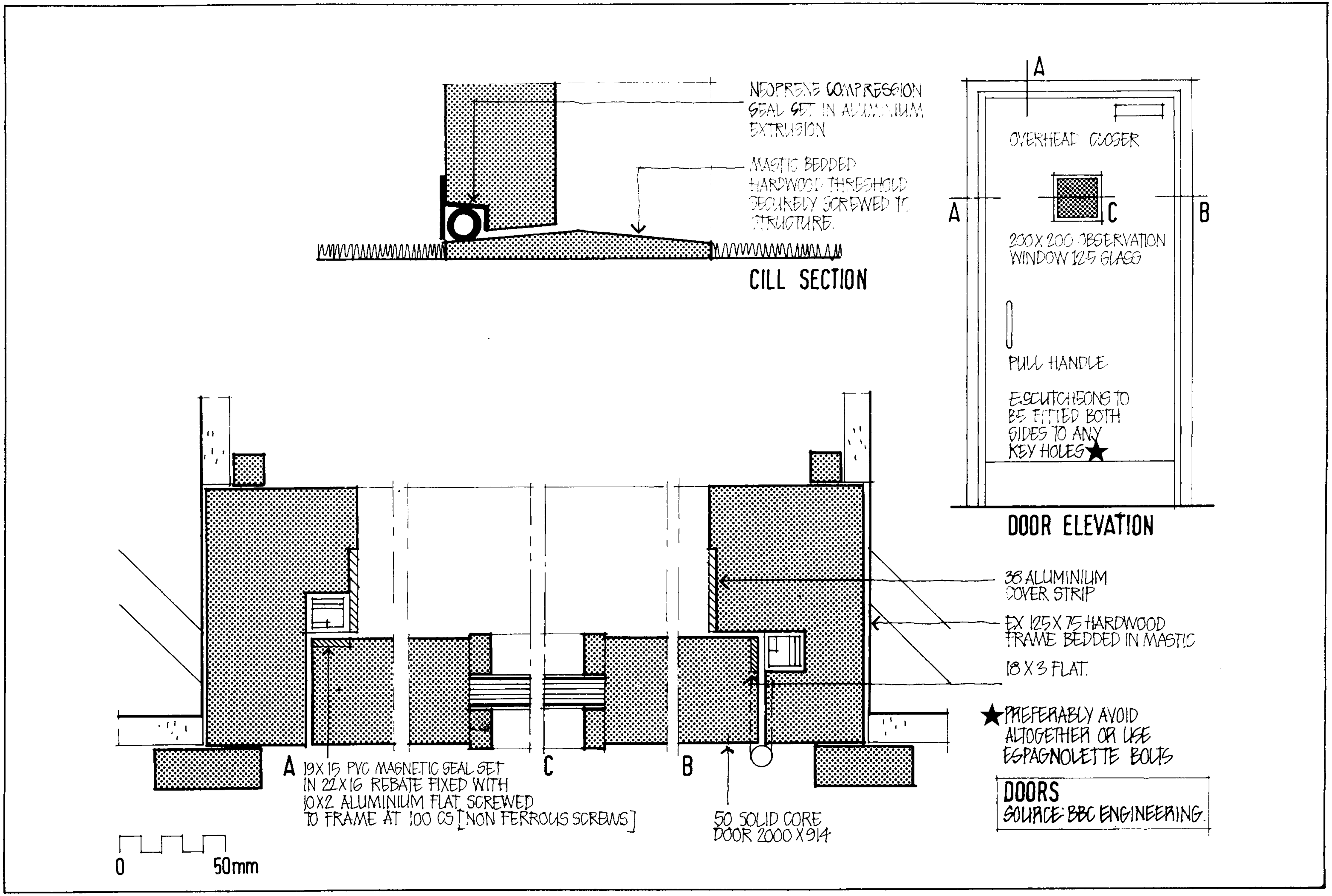


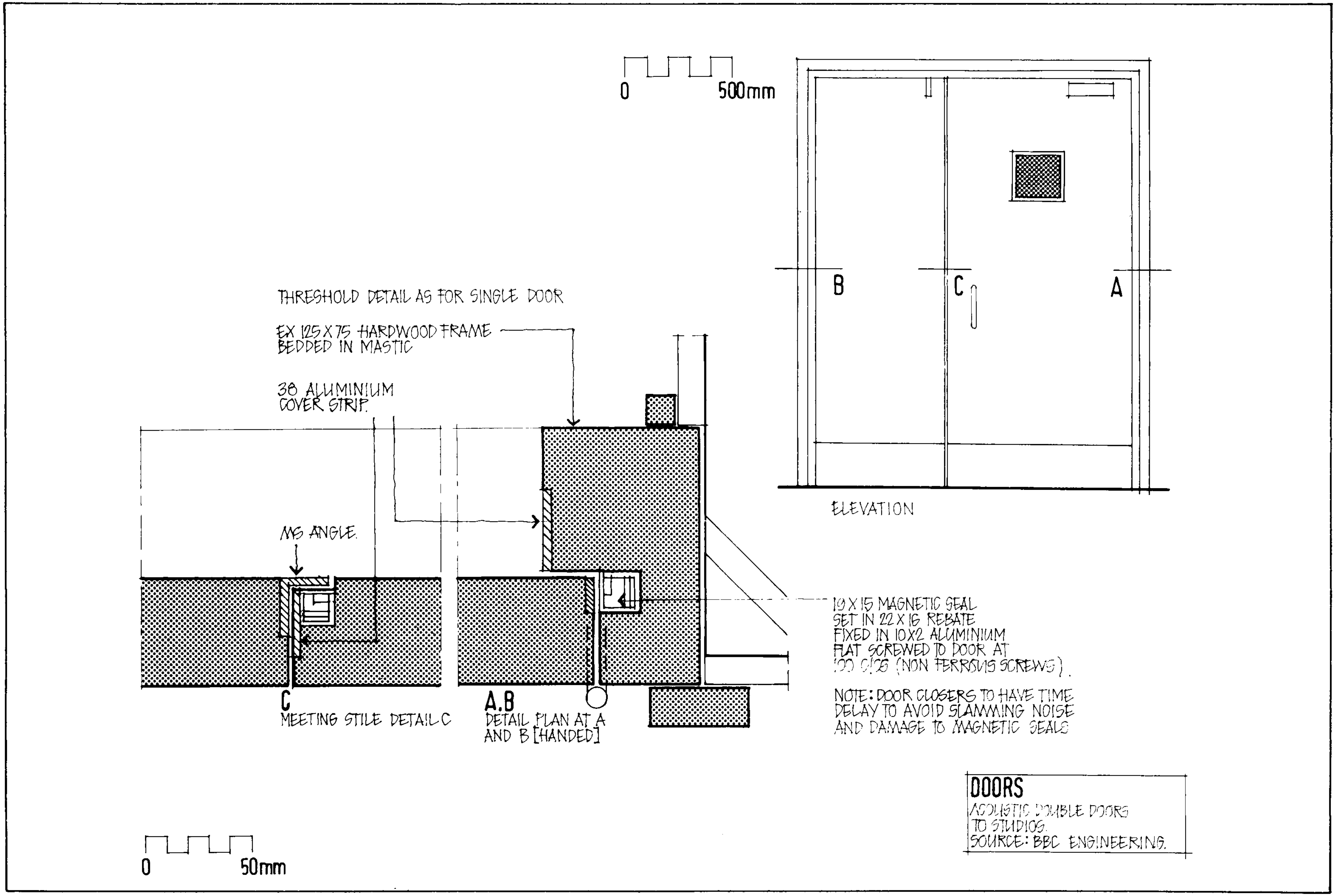
CLASS dB	33	40	42
THICKNESS	40	45	50
WEIGHT KG/M	23	26	32
DOOR FRAMING:			
TOP RAIL	40	40	60
BOTTOM RAIL	2x40	2x40	60
STILE	40+18	40+18	60+40
FACING: VENEERED HARDBOARD TO EITHER SIDE	2·10	3·20	3·20



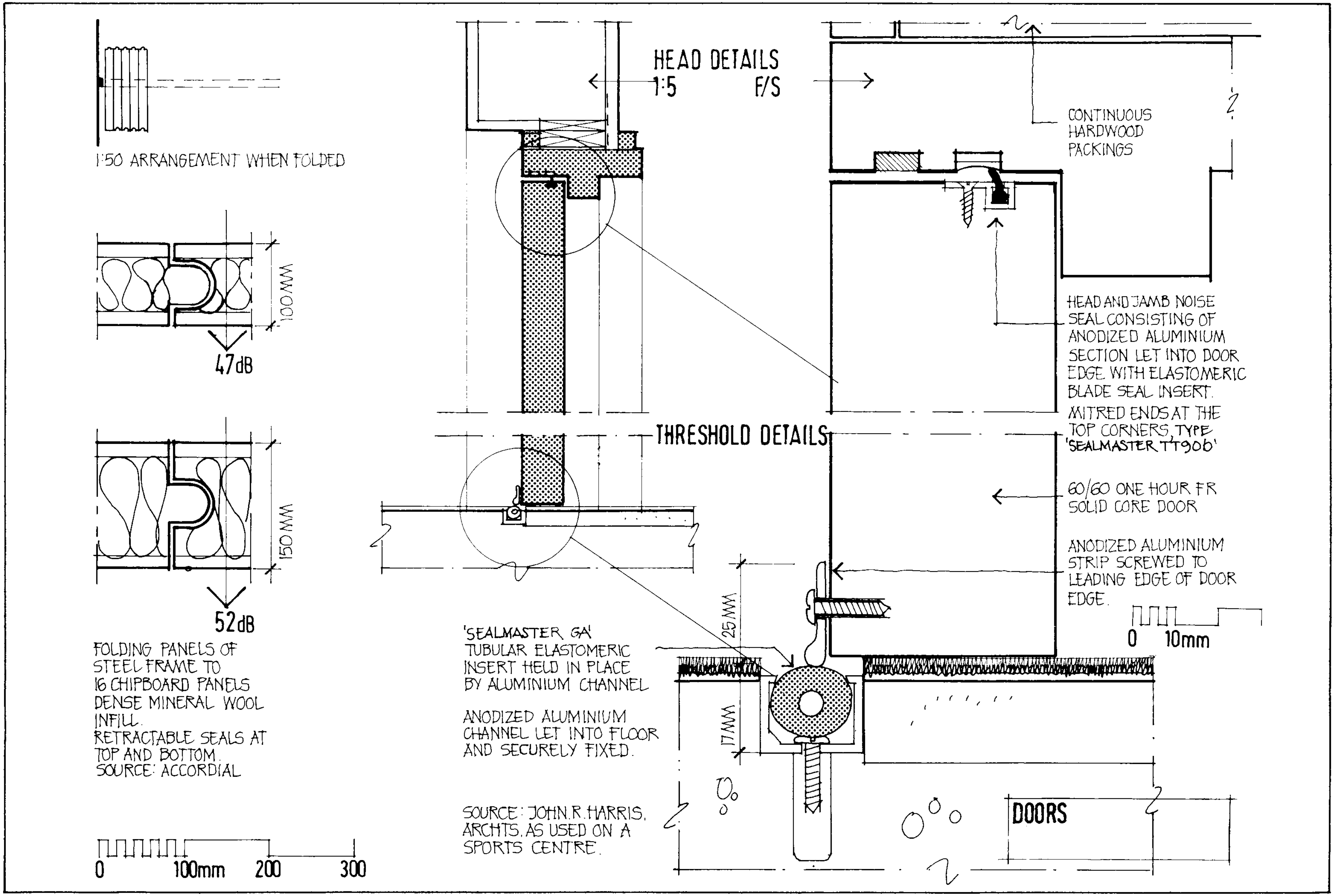
DOORS
SOURCE:
SOUND ACOUSTICS LTD

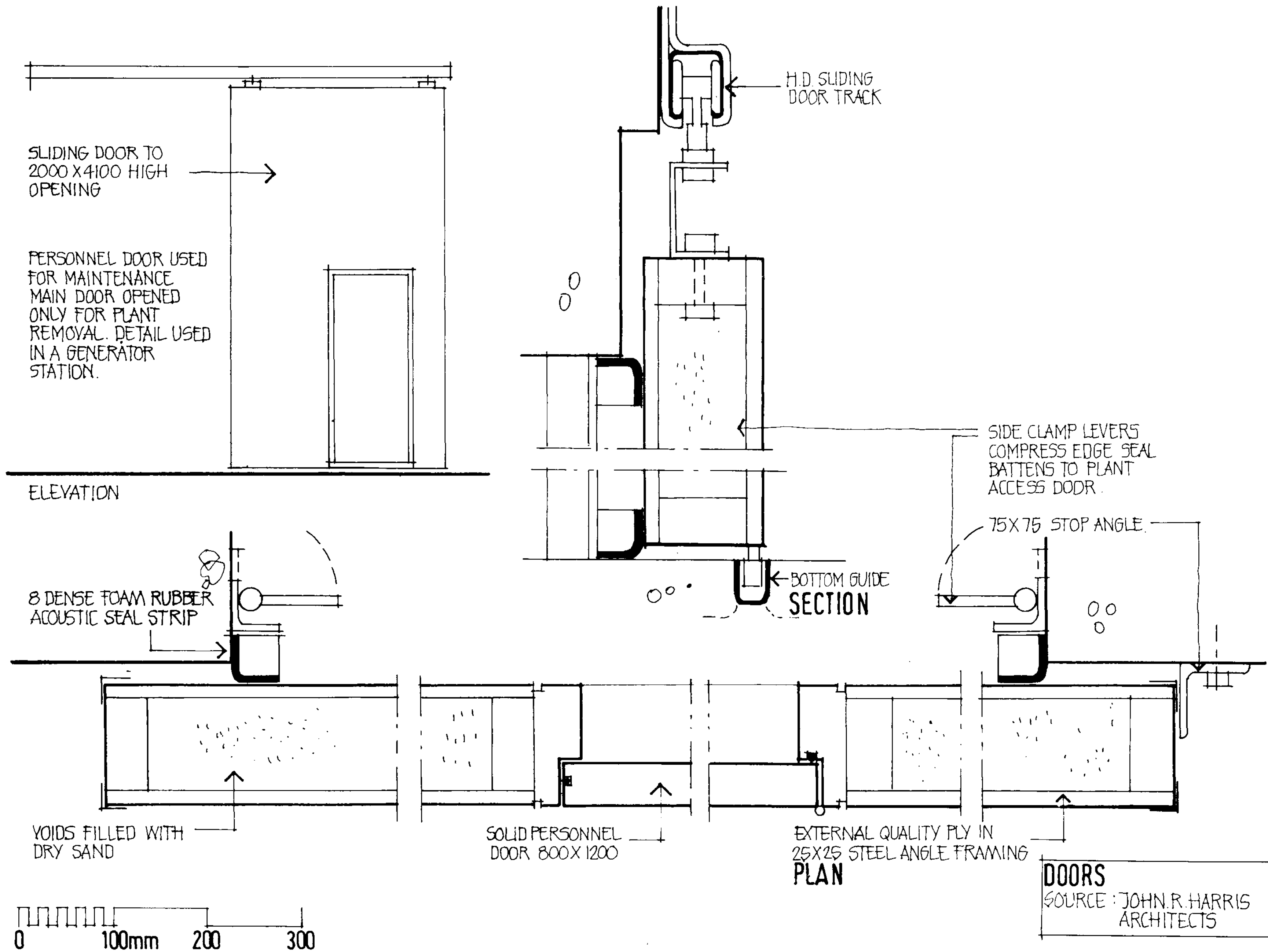

FRAME EDGES SEALED
38 X 20 ARCHITRAVE
POLARIZED STRIP AND MAGNETIC SEAL
BREAK IN FLOOR SLAB IF ISOLATED SLAB IN ROOM
VERTICAL SECTION
MEETING RAIL DETAIL FOR DOUBLE DOORS
50 DOOR LEAF LAMINATED CONSTRUCTION
HORIZONTAL SECTION
SCALE : HALF FULL SIZE
NORMALIZED LEVEL DIFFERENCE dB
10
20
30
40
50
63
125
250
500
1000
2000
4000
FREQUENCY HZ
A.
B.
A. 228 BRICK WALL 10 SQ M
B. WALL INCLUDING 1980 X 760 X 50 DOOR WEIGHT 24 KG.M-2 FITTED WITH MAGNETIC SEAL
(LABORATORY TEST)
0
50mm
DOORS
SOURCE: MKM ACOUSTIC ENGINEERS


NEOPRENE COMPRESSION SEAL SET IN ALUMINIUM EXTRUSION
MASTIC BEDDED HARDWOOD THRESHOLD SECURELY SCREWED TO STRUCTURE.
CILL SECTION
A
A
C
B
OVERHEAD CLOSER
200 X 200 OBSERVATION WINDOW 12.5 GLASS
PULL HANDLE
ESCUTCHEONS TO BE FITTED BOTH SIDES TO ANY KEY HOLES ★
DOOR ELEVATION
38 ALUMINIUM COVER STRIP
EX 125 X 75 HARDWOOD FRAME BEDDED IN MASTIC
18 X 3 FLAT
★ PREFERABLY AVOID ALTOGETHER OR USE ESPAGNOLETTE BOLTS
A
19 X 15 PVC MAGNETIC SEAL SET IN 22 X 16 REBATE FIXED WITH 10 X 2 ALUMINIUM FLAT SCREWED TO FRAME AT 100 CS [NON FERROUS SCREWS]
C
B
50 SOLID CORE DOOR 2000 X 914
0
50mm
DOORS
SOURCE: BBC ENGINEERING.

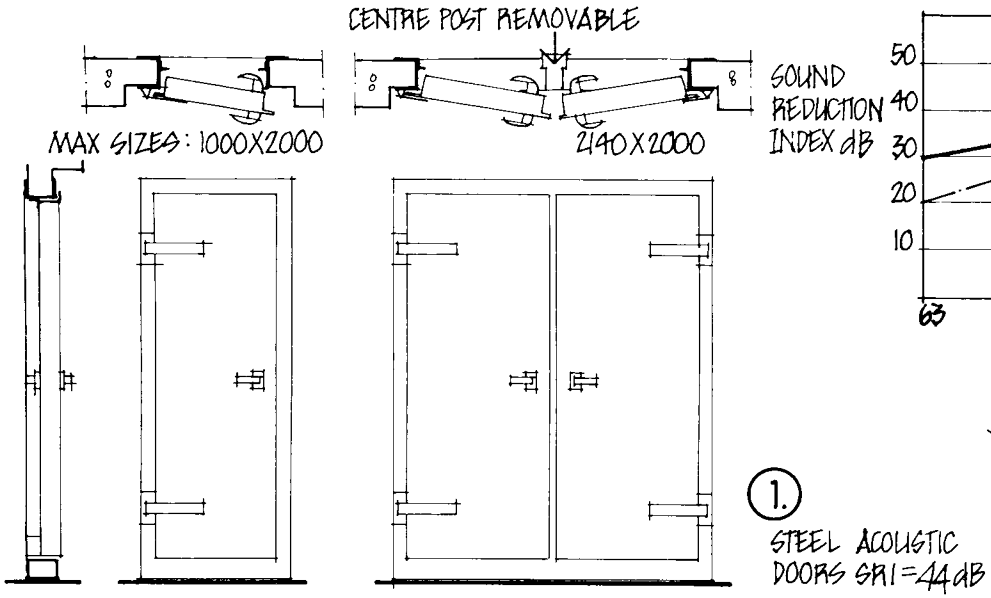


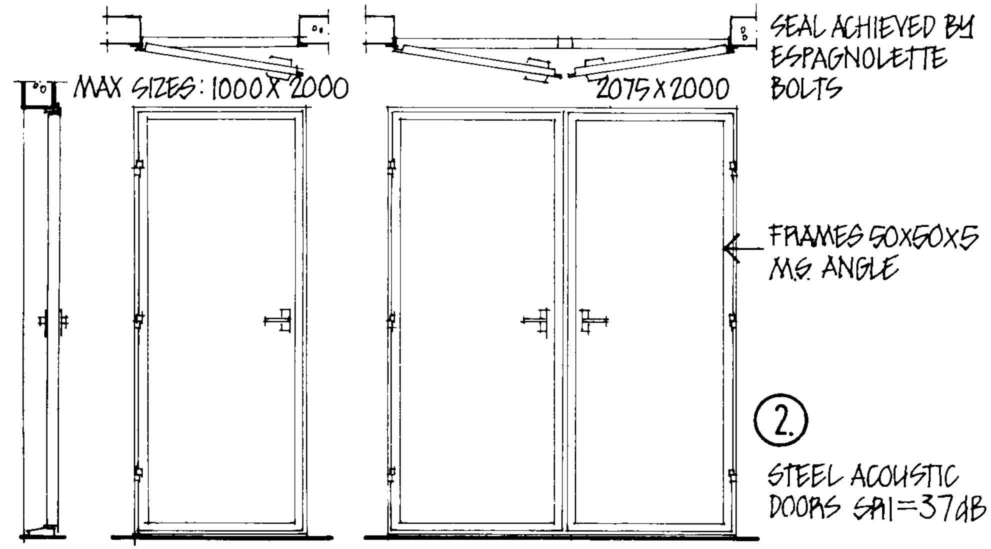
0 500mm
B
C
A
ELEVATION
THRESHOLD DETAIL AS FOR SINGLE DOOR
EX 125 X 75 HARDWOOD FRAME BEDDED IN MASTIC
38 ALUMINIUM COVER STRIP
MS ANGLE
10 X 15 MAGNETIC SEAL SET IN 22 X 16 REBATE FIXED IN 10X2 ALUMINIUM FLAT SCREWED TO DOOR AT 100 C/CS (NON FERROUS SCREWS).
NOTE: DOOR CLOSERS TO HAVE TIME DELAY TO AVOID SLAMMING NOISE AND DAMAGE TO MAGNETIC SEALS
C
MEETING STILE DETAIL C
A.B
DETAIL PLAN AT A AND B [HANDED]
0 50mm
DOORS
ACOUSTIC DOUBLE DOORS TO STUDIOS.
SOURCE: BBC ENGINEERING.

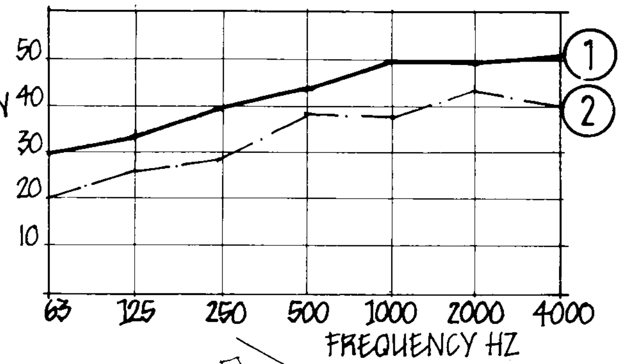

1:50 ARRANGEMENT WHEN FOLDED
100 MM
47dB
150 MM
52dB
FOLDING PANELS OF STEEL FRAME TO 16 CHIPBOARD PANELS DENSE MINERAL WOOL INFILL.
RETRACTABLE SEALS AT TOP AND BOTTOM.
SOURCE: ACCORDIAL
0
100mm
200
300
HEAD DETAILS
1:5
F/S
THRESHOLD DETAILS
CONTINUOUS HARDWOOD PACKINGS
HEAD AND JAMB NOISE SEAL CONSISTING OF ANODIZED ALUMINIUM SECTION LET INTO DOOR EDGE WITH ELASTOMERIC BLADE SEAL INSERT.
MITRED ENDS AT THE TOP CORNERS, TYPE 'SEALMASTER TT906'
60/60 ONE HOUR FR SOLID CORE DOOR
ANODIZED ALUMINIUM STRIP SCREWED TO LEADING EDGE OF DOOR EDGE.
0
10mm
25 MM
17 MM
'SEALMASTER GA' TUBULAR ELASTOMERIC INSERT HELD IN PLACE BY ALUMINIUM CHANNEL
ANODIZED ALUMINIUM CHANNEL LET INTO FLOOR AND SECURELY FIXED.
SOURCE: JOHN.R.HARRIS. ARCHTS. AS USED ON A SPORTS CENTRE.
DOORS

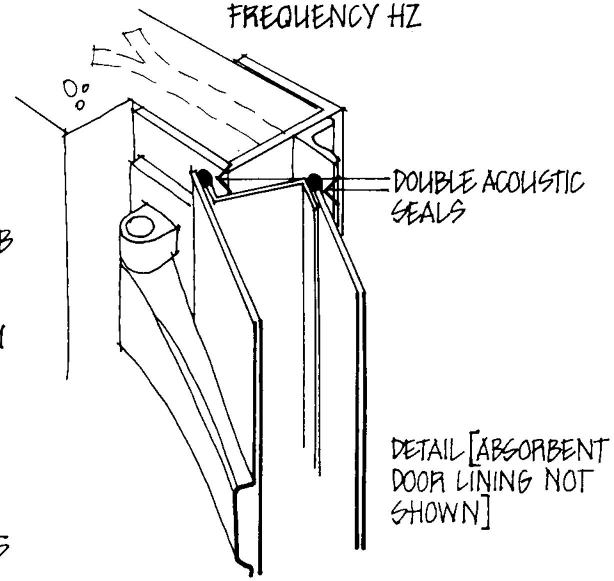


DOORS
SOURCE : JOHN.R.HARRIS ARCHITECTS



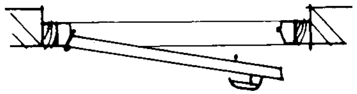




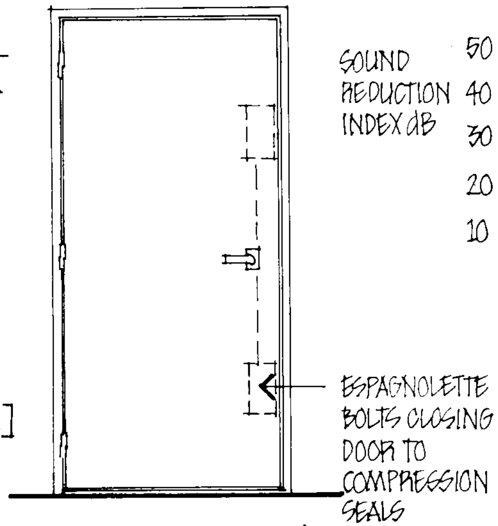


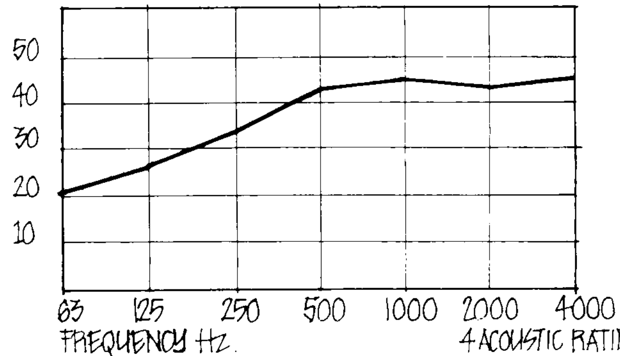
not to scale

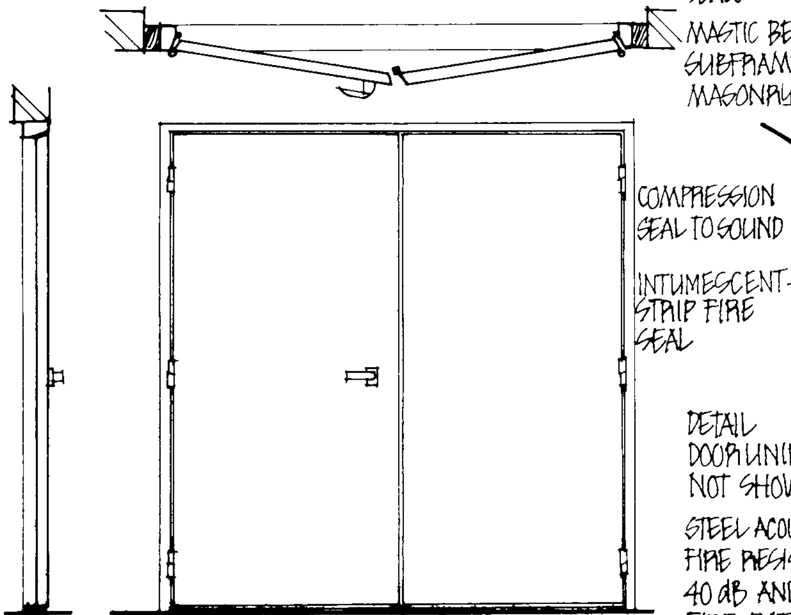
DOORS
SOURCE:
SOUND ATTENUATORS LTD

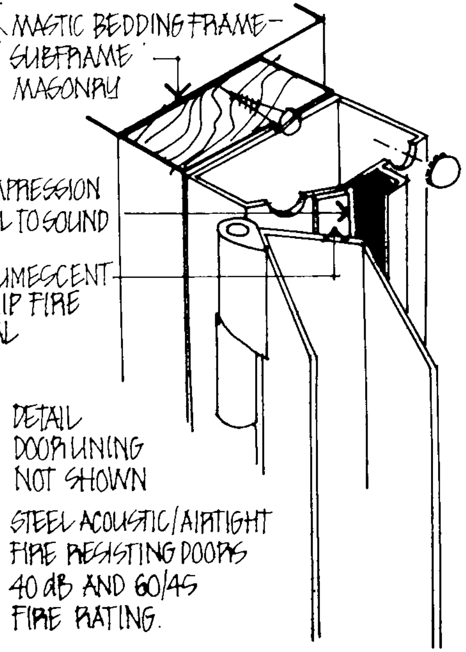


RATINGS:
1. SRI [100-3150 HZ] = 40 dB
2. AS II = 44 dB
3. SRI [100-10000 HZ] = 40 dB
4. STC = 44 dB
SEE DEFINITIONS AT RHS.
FIGURES IN THIS BOOK GENERALLY SRI [100-3150 HZ]









STEEL ACOUSTIC/AIRTIGHT FIRE RESISTING DOORS 40 dB AND 60/45 FIRE RATING.

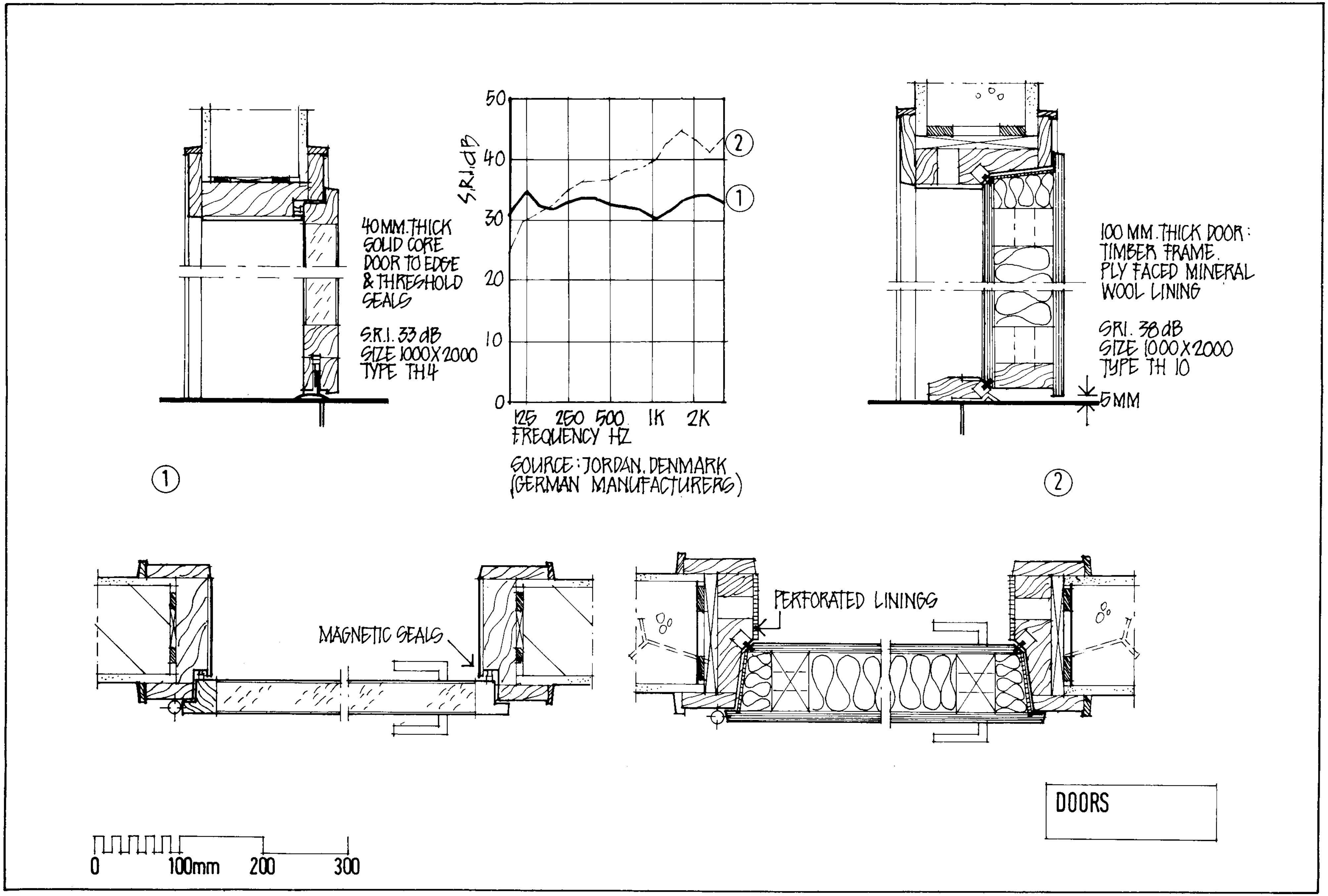
4 ACOUSTIC RATINGS ARE IN COMMON USE:

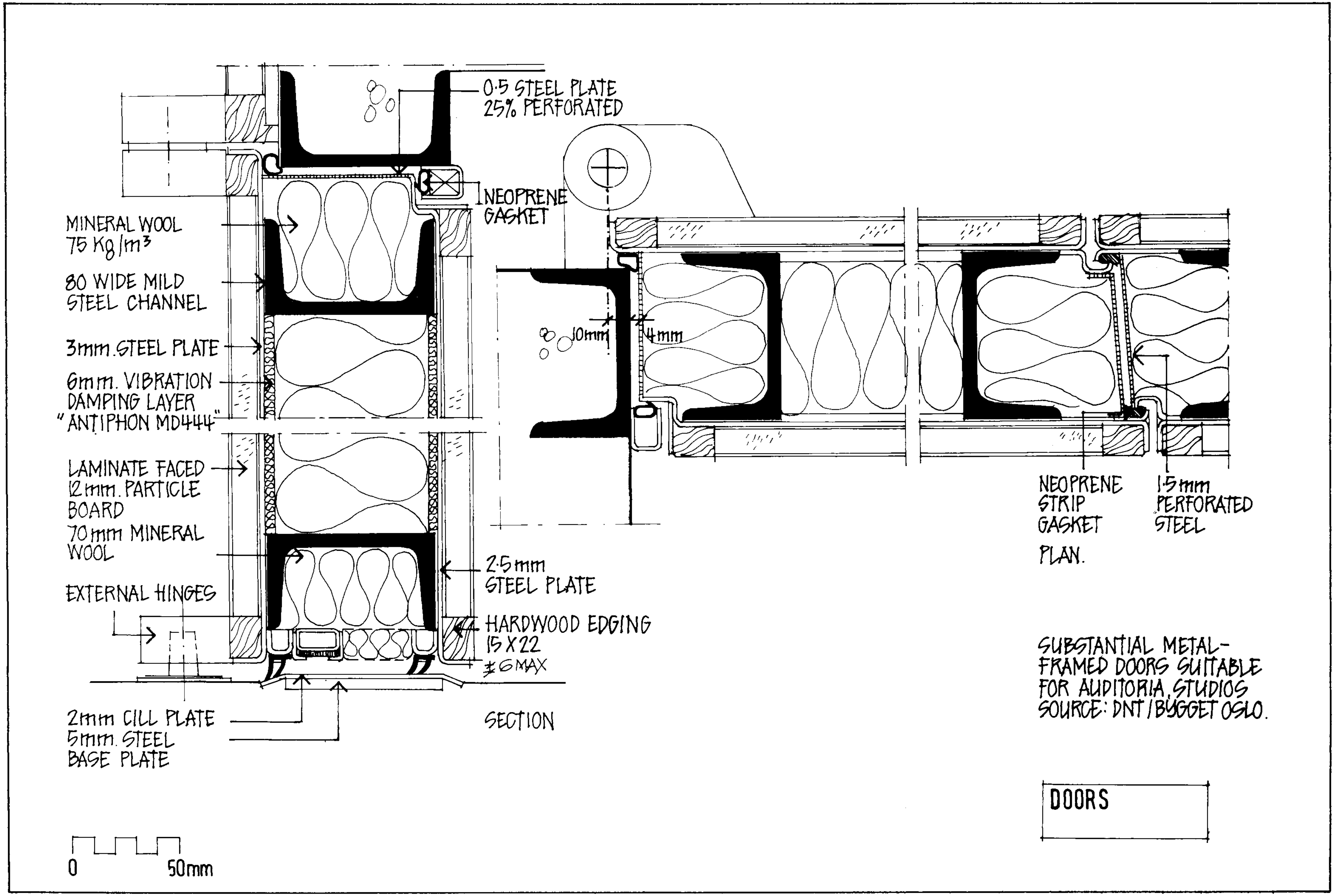
1. SOUND REDUCTION INDEX (100-3150 Hz). AVERAGE OF SOUND REDUCTION INDICES IN 16 1/3 OCTAVE BANDS FROM 100 TO 3150 Hz.
2. AIRBORNE SOUND INSULATION INDEX (AS(I)) MEASURED SOUND REDUCTION INDICES IN 16 1/3 OCTAVE BANDS FROM 100-3150 Hz COMPARED WITH REFERENCE VALUES FOR AIRBORNE SOUND INSULATION, AS SPECIFIED IN BS5821: 1980
3. SRI (100-10000 Hz) AS IN 1. EXCEPT AVERAGE OVER 21 1/3 OCTAVE BANDS 100-10 000 Hz.
4. SOUND TRANSMISSION CLASS (STC): SR INDICES IN 16 1/3 OCTAVE BANDS COMPARED WITH REFERENCE CONTOURS AS SPECIFIED IN ASTM 3413-70T

DOORS

SOURCE: SOUND ATTENUATORS LTD

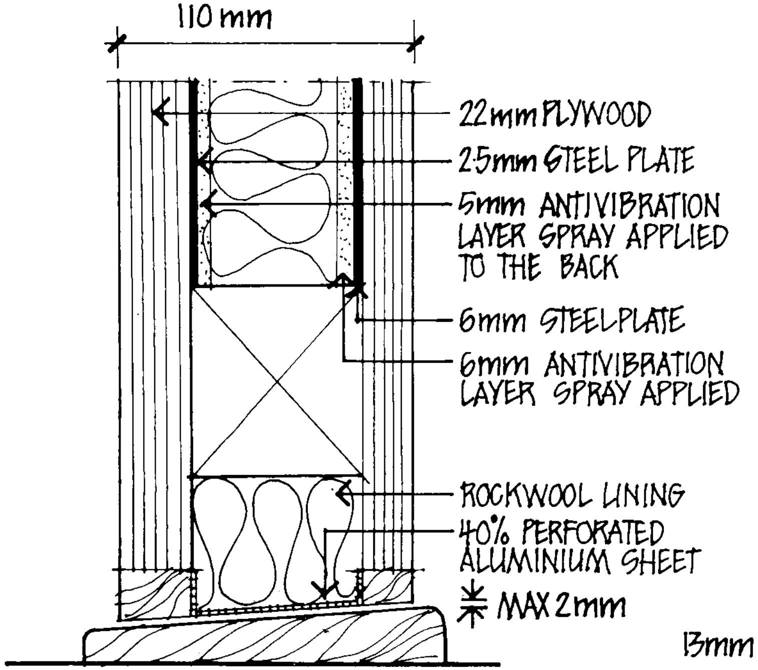
not to scale


40 MM. THICK SOLID CORE DOOR TO EDGE & THRESHOLD SEALS
S.R.I. 33 dB
SIZE 1000 X 2000
TYPE TH 4
S.R.I. dB
50
40
30
20
10
0
125 250 500 1K 2K
FREQUENCY HZ
SOURCE: JORDAN. DENMARK (GERMAN MANUFACTURERS)
1
2
100 MM. THICK DOOR: TIMBER FRAME. PLY FACED MINERAL WOOL LINING
S.R.I. 38 dB
SIZE 1000 X 2000
TYPE TH 10
5 MM
MAGNETIC SEALS
PERFORATED LININGS
0
100mm
200
300
DOORS



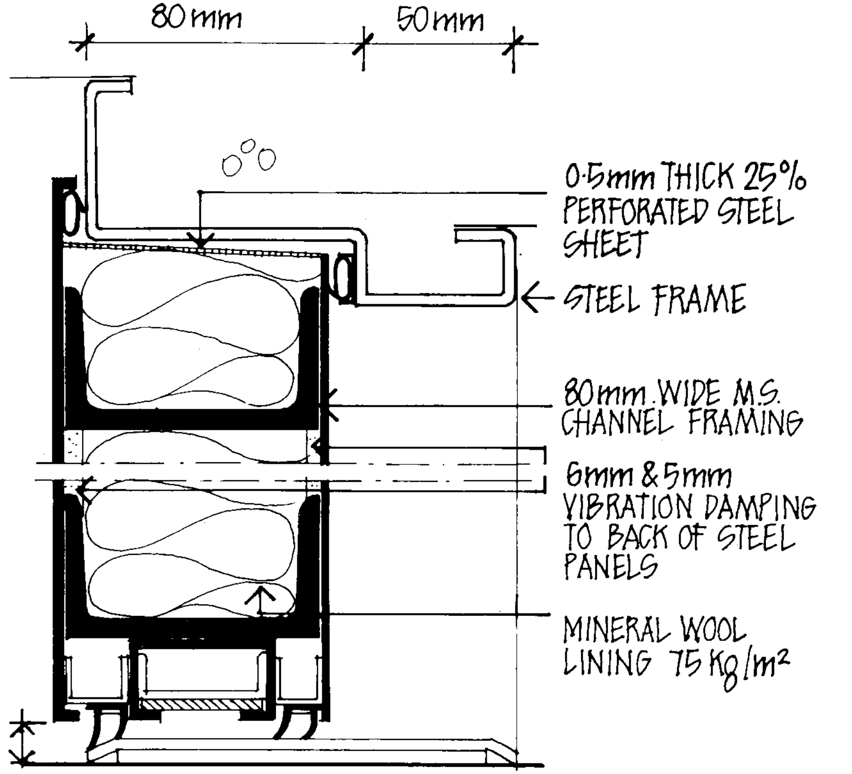
SUBSTANTIAL METAL-FRAMED DOORS SUITABLE FOR AUDITORIA, STUDIOS
SOURCE: DNT / BYGGET OSLO.

DOORS



SUBSTANTIAL TIMBER FRAMED DOOR, TEST RATED AT 45dB

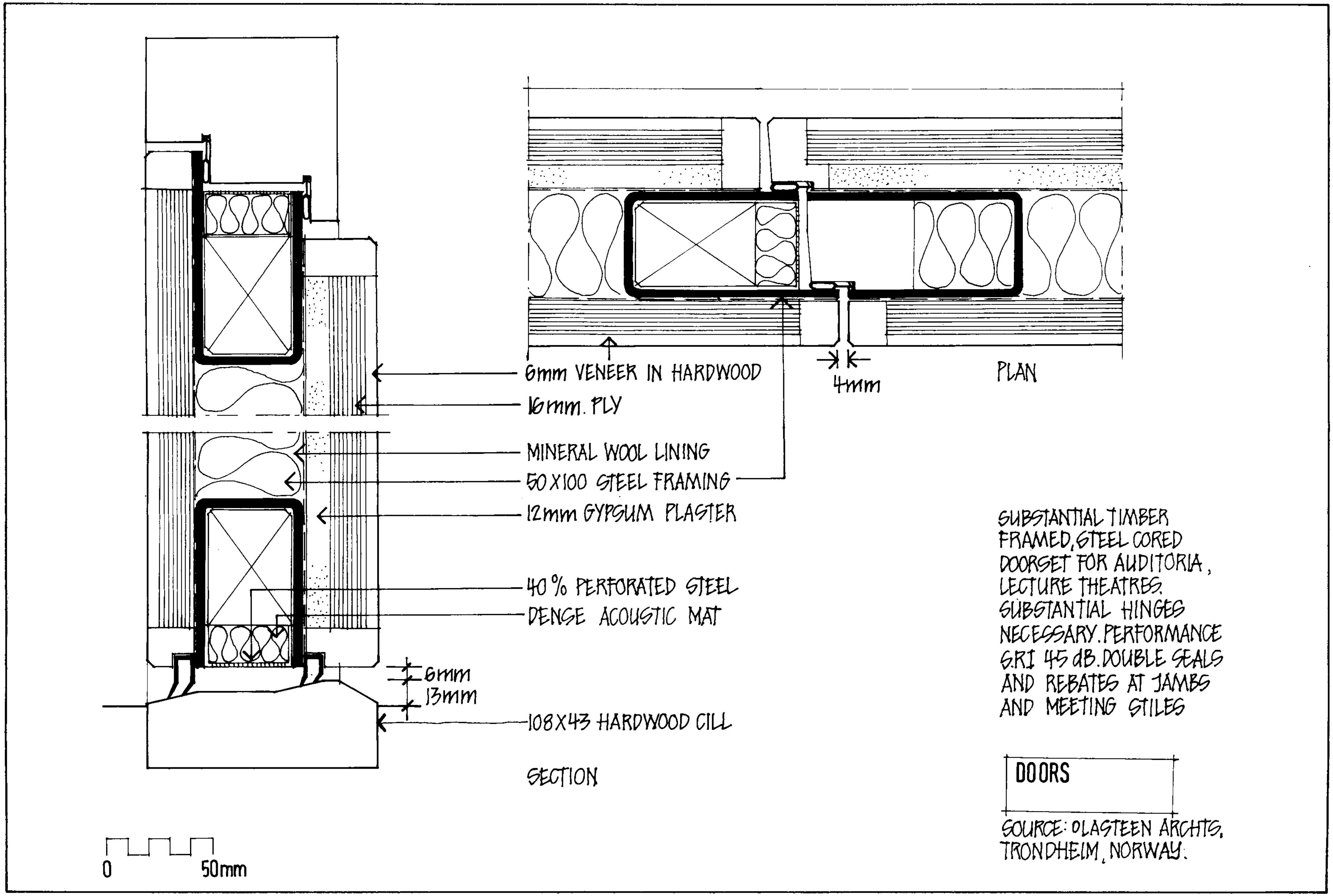
SOURCE : JORDAN DENMARK

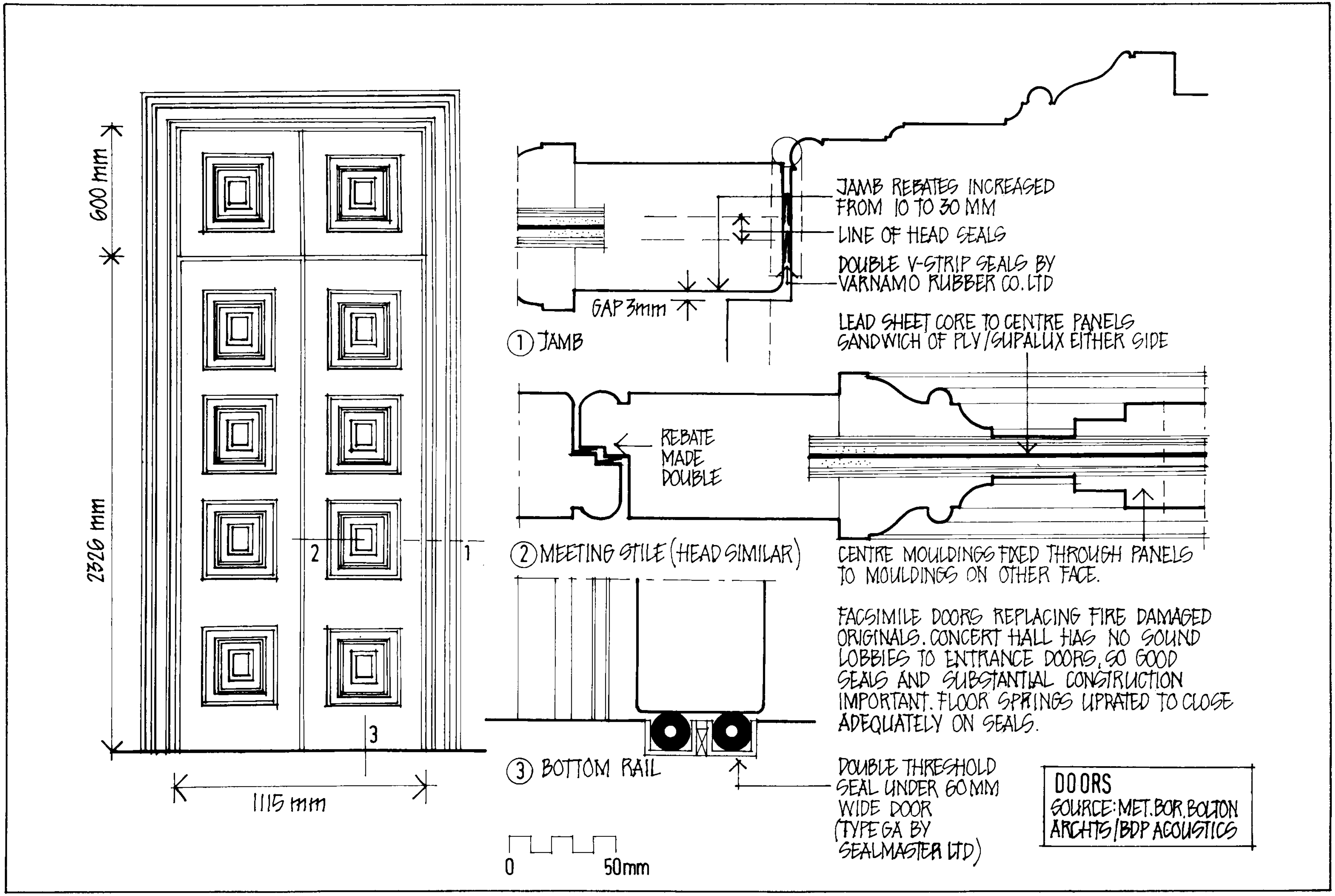


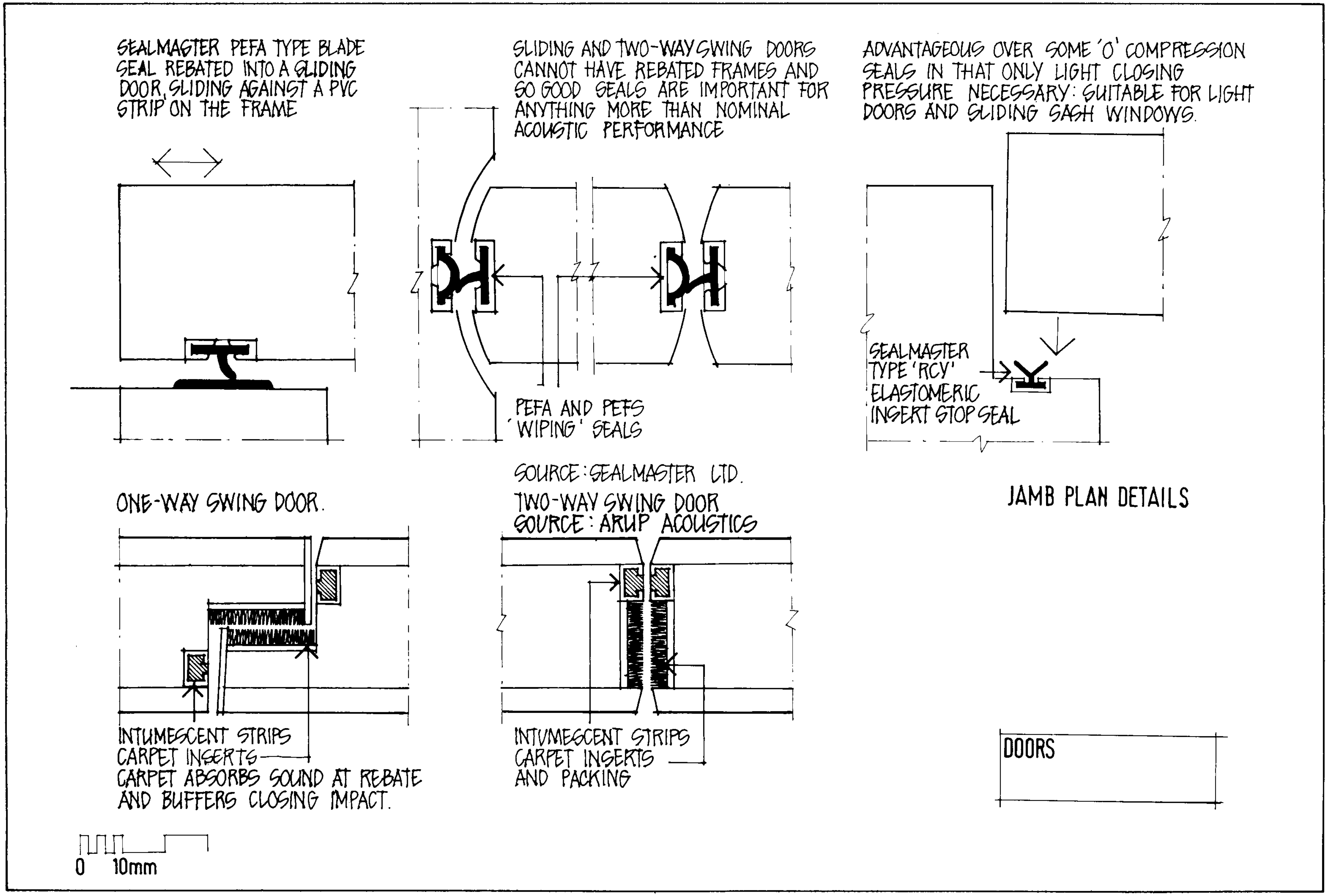
STEEL FACED & FRAMED DOOR WITH DOUBLE SEAL REBATES
SOURCE: DNT- BYGGET OSLO

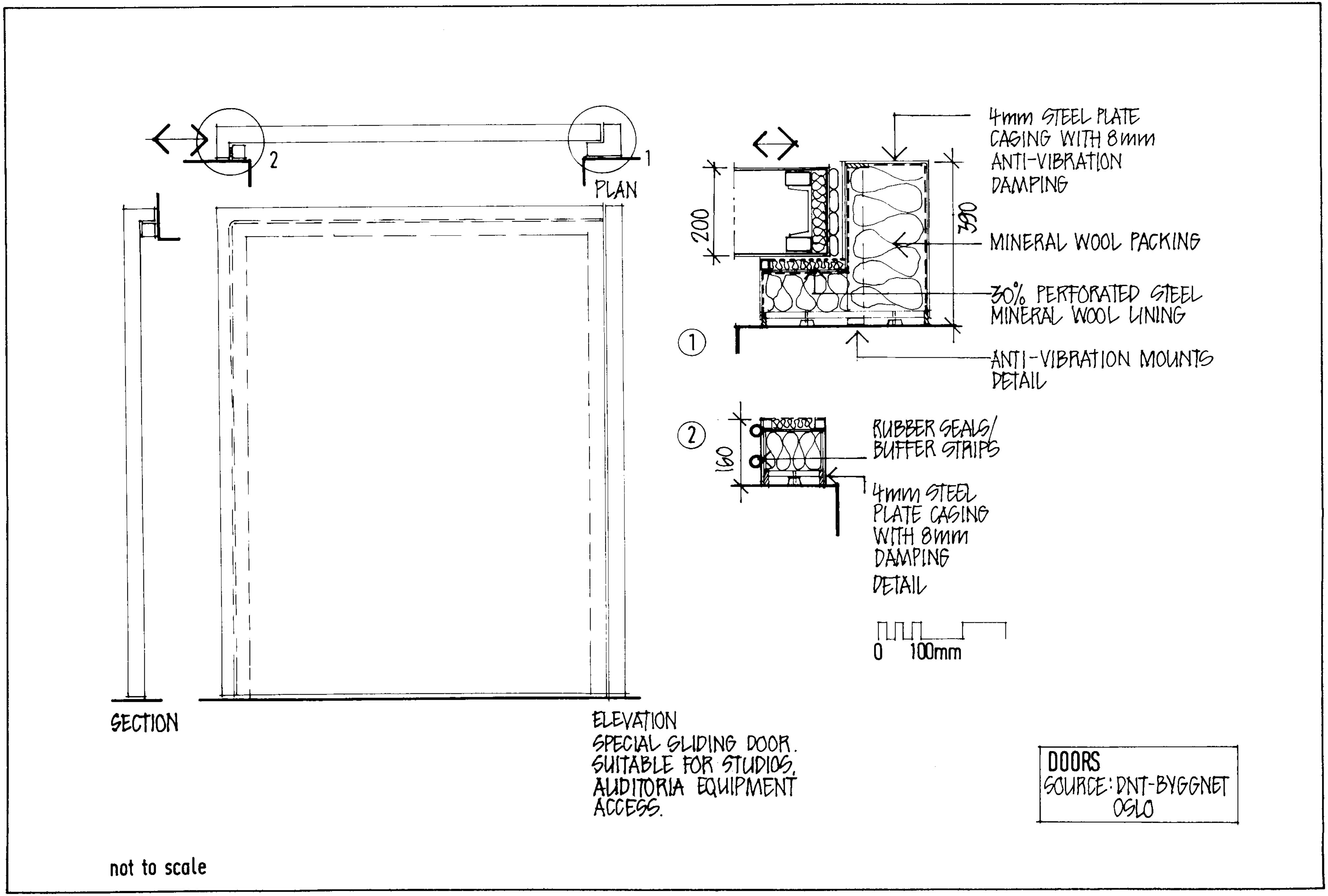
DOORS

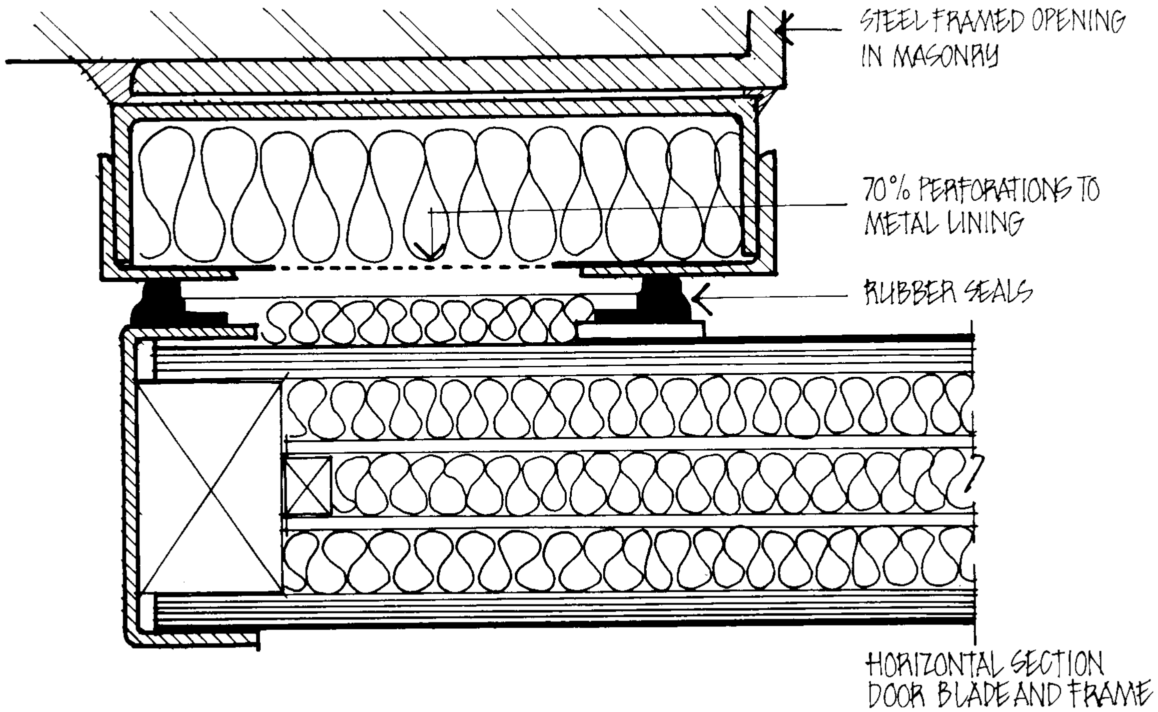
0 50mm


6mm VENEER IN HARDWOOD
16mm. PLY
MINERAL WOOL LINING
50 X 100 STEEL FRAMING
12mm GYPSUM PLASTER
40 % PERFORATED STEEL
DENSE ACOUSTIC MAT
6mm
13mm
108 X 43 HARDWOOD CILL
SECTION
4mm
PLAN
SUBSTANTIAL TIMBER FRAMED, STEEL CORED DOORSET FOR AUDITORIA, LECTURE THEATRES. SUBSTANTIAL HINGES NECESSARY. PERFORMANCE SRI 45 dB. DOUBLE SEALS AND REBATES AT JAMBS AND MEETING STILES
DOORS
SOURCE: OLASTEEN ARCHTS. TRONDHEIM, NORWAY.
0
50mm


600 mm
2326 mm
1115 mm
1
2
3
JAMB REBATES INCREASED FROM 10 TO 30 MM
LINE OF HEAD SEALS
DOUBLE V-STRIP SEALS BY VARNAMO RUBBER CO. LTD
GAP 3mm
① JAMB
LEAD SHEET CORE TO CENTRE PANELS SANDWICH OF PLY/SUPALUX EITHER SIDE
REBATE MADE DOUBLE
② MEETING STILE (HEAD SIMILAR)
CENTRE MOULDINGS FIXED THROUGH PANELS TO MOULDINGS ON OTHER FACE.
FACSIMILE DOORS REPLACING FIRE DAMAGED ORIGINALS. CONCERT HALL HAS NO SOUND LOBBIES TO ENTRANCE DOORS, SO GOOD SEALS AND SUBSTANTIAL CONSTRUCTION IMPORTANT. FLOOR SPRINGS UPRATED TO CLOSE ADEQUATELY ON SEALS.
③ BOTTOM RAIL
DOUBLE THRESHOLD SEAL UNDER 60 MM WIDE DOOR (TYPE 6A BY SEALMASTER LTD)
0
50mm
DOORS
SOURCE: MET. BOR. BOLTON ARCHTS/BDP ACOUSTICS

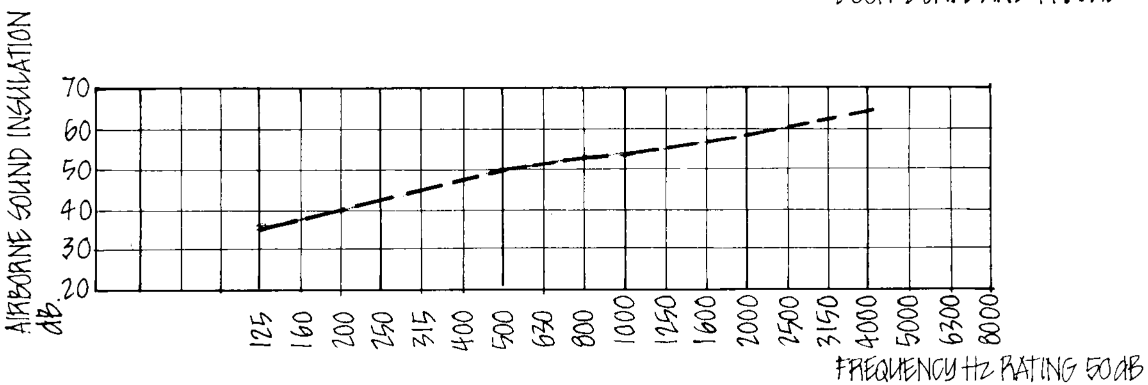

SEALMASTER PEFA TYPE BLADE SEAL REBATED INTO A SLIDING DOOR, SLIDING AGAINST A PVC STRIP ON THE FRAME
SLIDING AND TWO-WAY SWING DOORS CANNOT HAVE REBATED FRAMES AND SO GOOD SEALS ARE IMPORTANT FOR ANYTHING MORE THAN NOMINAL ACOUSTIC PERFORMANCE
ADVANTAGEOUS OVER SOME 'O' COMPRESSION SEALS IN THAT ONLY LIGHT CLOSING PRESSURE NECESSARY: SUITABLE FOR LIGHT DOORS AND SLIDING SASH WINDOWS.
PEFA AND PEFS 'WIPING' SEALS
SEALMASTER TYPE 'RCY' ELASTOMERIC INSERT STOP SEAL
SOURCE: SEALMASTER LTD.
ONE-WAY SWING DOOR.
TWO-WAY SWING DOOR
SOURCE: ARUP ACOUSTICS
JAMB PLAN DETAILS
INTUMESCENT STRIPS
CARPET INSERTS
CARPET ABSORBS SOUND AT REBATE AND BUFFERS CLOSING IMPACT.
INTUMESCENT STRIPS
CARPET INSERTS AND PACKING
DOORS
0 10mm


PLAN
1
2
SECTION
ELEVATION
SPECIAL SLIDING DOOR.
SUITABLE FOR STUDIOS,
AUDITORIA EQUIPMENT
ACCESS.
4mm STEEL PLATE
CASING WITH 8mm
ANTI-VIBRATION
DAMPING
200
390
MINERAL WOOL PACKING
30% PERFORATED STEEL
MINERAL WOOL LINING
ANTI-VIBRATION MOUNTS
DETAIL
1
2
160
RUBBER SEALS/
BUFFER STRIPS
4mm STEEL
PLATE CASING
WITH 8mm
DAMPING
DETAIL
0 100mm
DOORS
SOURCE: DNT-BYGGNET
OSLO
not to scale

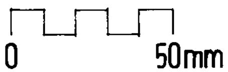


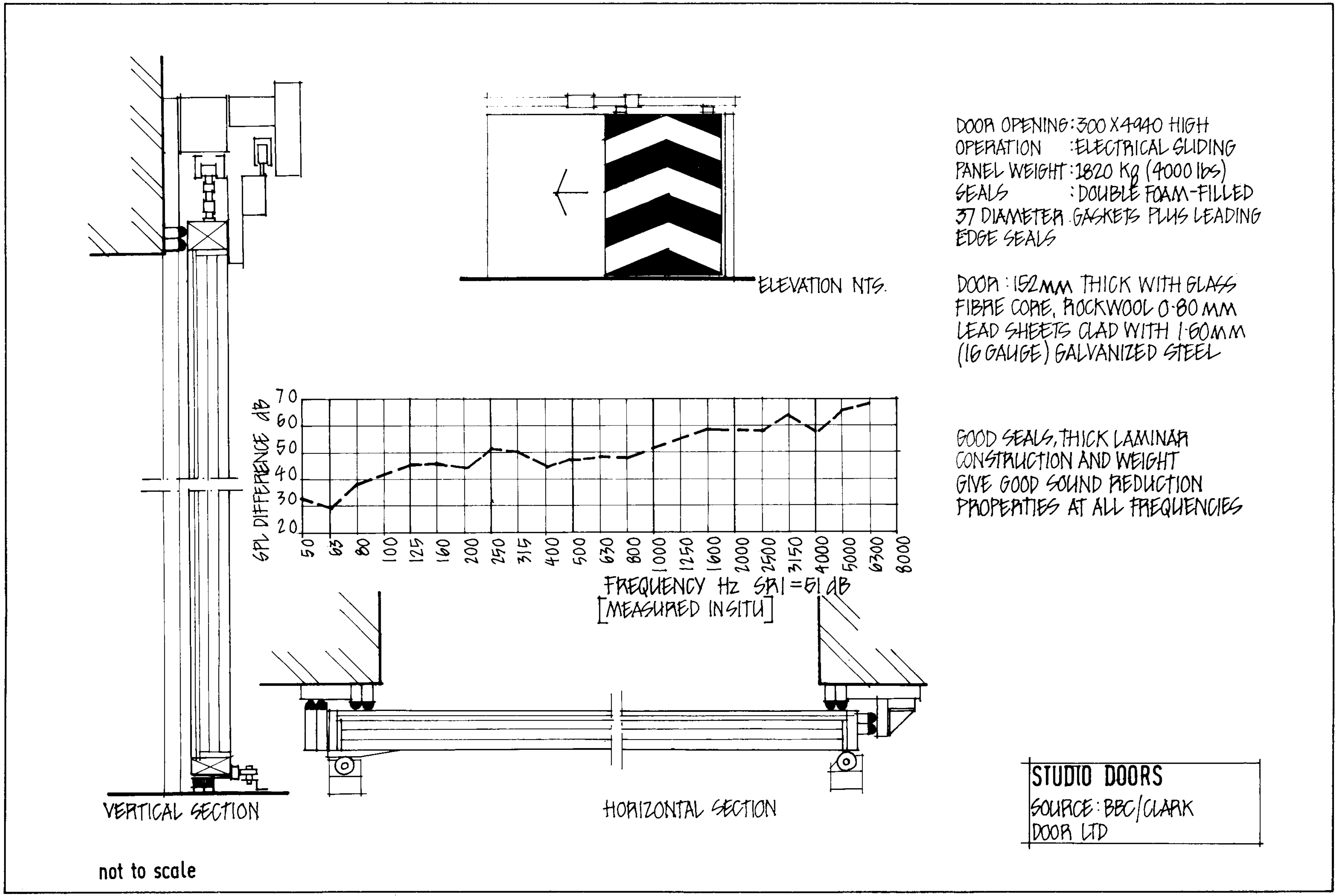
DOOR OPENING : 1340 X 2090 HIGH
OPERATION : ELECTRICAL- AS DOOR CLOSES, DROPS AND MOVES 45° TOWARDS FRAME TO SEAL AT SILL AND FRAME
SEALS : RUBBER GASKETS
DOOR : 90MM THICK. 18MM ROCKWOOL CORE. 10MM PLYWOOD AND 2MM STEEL SHEET EITHER SIDE

GOOD PERFORMANCE THROUGH THE FREQUENCY RANGE, ALTHOUGH LOW FREQUENCY PERFORMANCE LESS THAN FOR THE 152 STUDIO DOOR ILLUSTRATED.

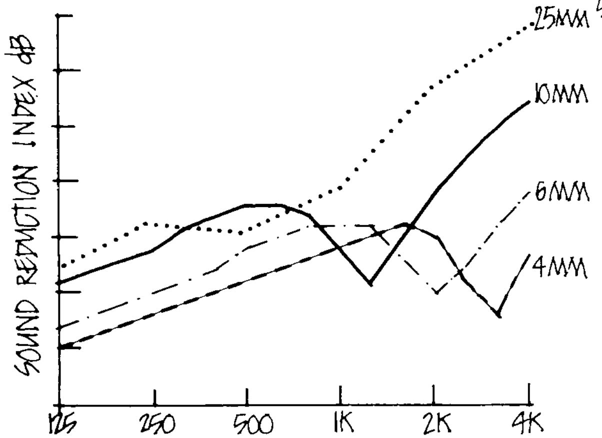


STUDIO DOORS
SOURE: RESEARCH INSTITUTE FOR ENVIRONMENTAL HYGIENE, DELFT / MARKNS

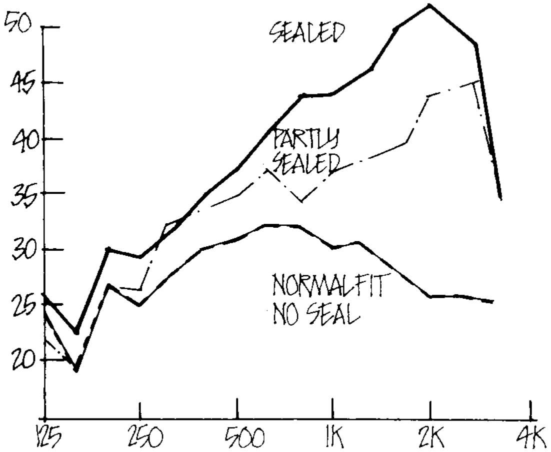



DOOR OPENING: 300 X 4940 HIGH
OPERATION : ELECTRICAL SLIDING
PANEL WEIGHT: 1820 Kg (4000 lbs)
SEALS : DOUBLE FOAM-FILLED
37 DIAMETER GASKETS PLUS LEADING
EDGE SEALS
ELEVATION NTS.
DOOR: 152MM THICK WITH GLASS FIBRE CORE, ROCKWOOL 0·80 MM LEAD SHEETS CLAD WITH 1·60MM (16 GAUGE) GALVANIZED STEEL
SPL DIFFERENCE dB
70
60
50
40
30
20
50
63
80
100
125
160
200
250
315
400
500
630
800
1000
1250
1600
2000
2500
3150
4000
5000
6300
8000
FREQUENCY Hz SRI = 51 dB
[MEASURED INSITU]
GOOD SEALS, THICK LAMINAR CONSTRUCTION AND WEIGHT GIVE GOOD SOUND REDUCTION PROPERTIES AT ALL FREQUENCIES
VERTICAL SECTION
HORIZONTAL SECTION
STUDIO DOORS
SOURCE: BBC/CLARK DOOR LTD
not to scale

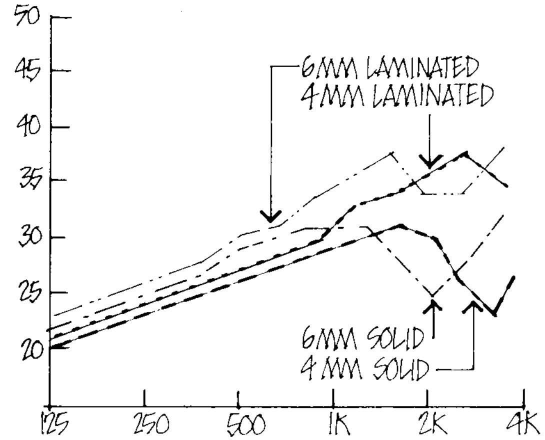
WINDOWS



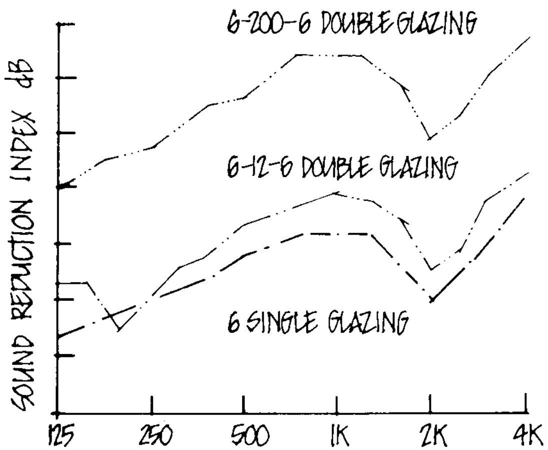
FREQUENCY HZ.
SINGLE GLAZING



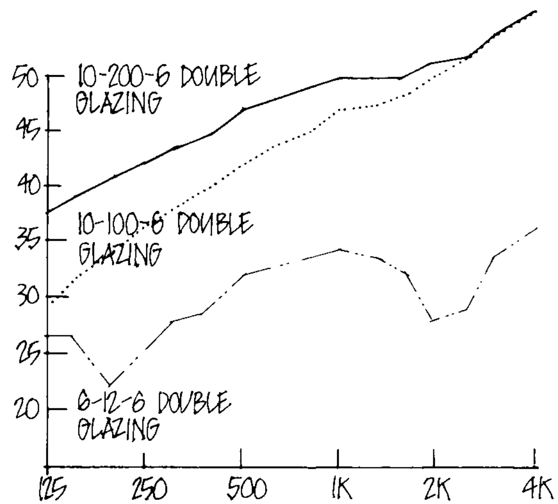
FREQUENCY HZ.
EFFECTS OF SEALING DOUBLE WINDOWS



FREQUENCY HZ.
EFFECT OF LAMINATION



EFFECT OF AIRSPACE WIDTH ON DOUBLE GLAZING

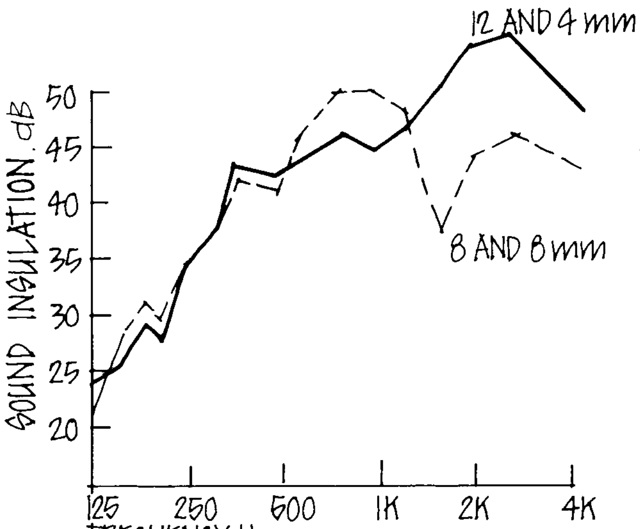


EFFECT OF GLASS THICKNESS AND AIR SPACE ON DOUBLE GLAZING

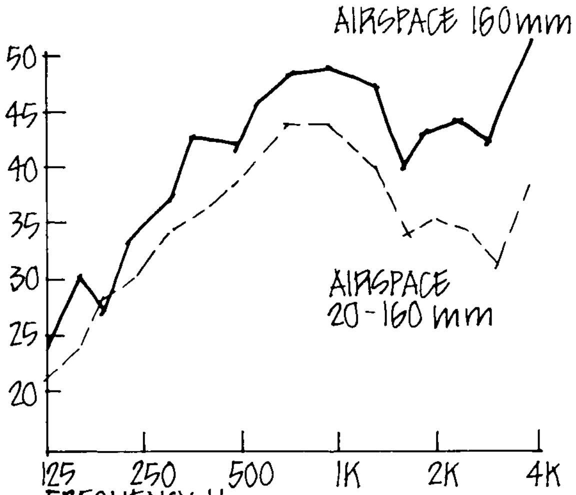
SOUND INSULATION OF WINDOWS

		SOUND REDUCTION AV. 100 – 3150 HZ
1.	OPEN WINDOW	UP TO 10 dB
2.	OPENABLE WINDOW CLOSED BUT NOT WEATHER-STRIPPED.	UP TO 20 dB
3.	SINGLE FIXED OR SEALED OPENABLE WINDOW 6MM GLASS	UP TO 25 dB
4.	FIXED WINDOW. 12 GLASS	UP TO 30 dB
5.	FIXED WINDOW 24 GLASS	UP TO 35 dB
6.	DOUBLE GLAZED WINDOW. 150-200 SPACE OPENABLE BUT WEATHER STRIPPED	UP TO 40 dB
7.	DOUBLE WINDOWS SPACED 300-400 MM ONE FRAME FIXED. ABSORPTION IN REVEALS	UP TO 45 dB.

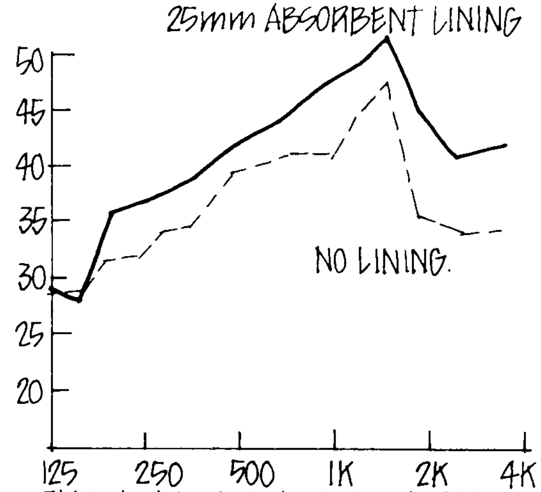
WINDOWS
SOURCE:
PILKINGTON FLAT GLASS LTD/
BRG DIGEST 128



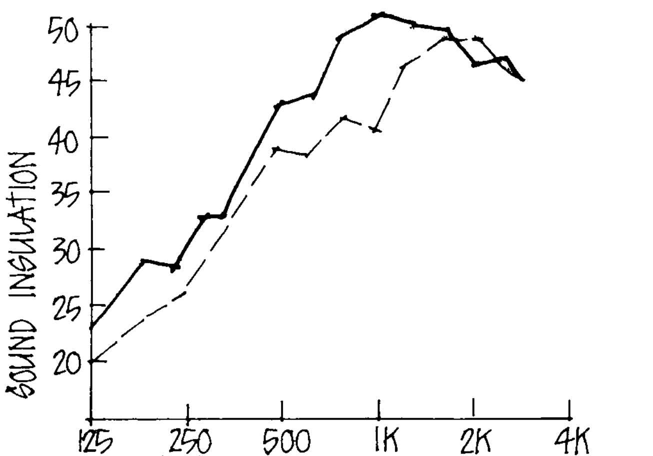
EFFECT OF VARYING PANELS THICKNESS (BOTH TO DOUBLE GLAZING WITH PANE SEPARATION 100 mm)



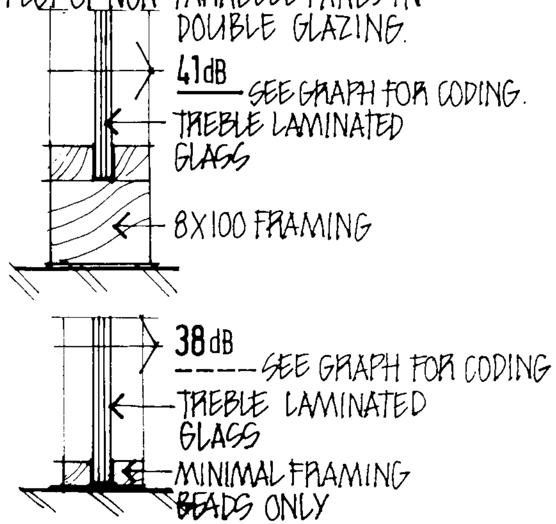
EFFECT OF NON-PARALLEL PANES IN DOUBLE GLAZING.



EFFECT OF LINING AIRSPACE EDGES OF DOUBLE WINDOW. 26mm PANES SEPARATION 100mm
SOURCE: PILKINGTONS ADVISORY SERVICE.

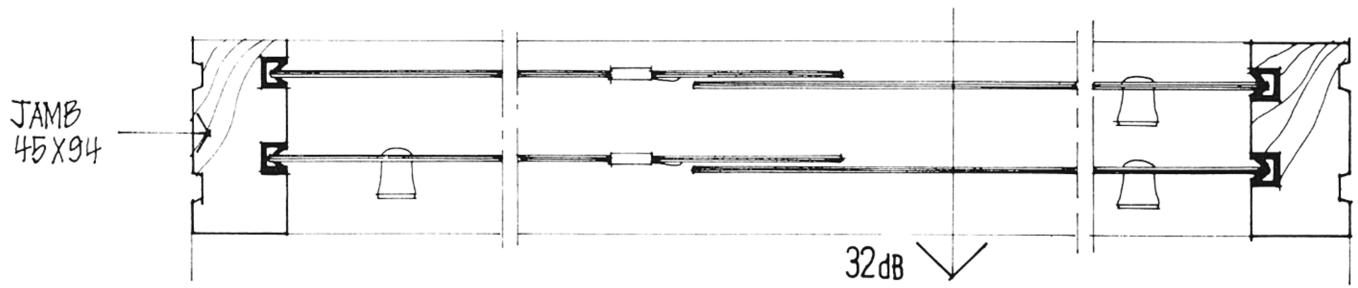


EFFECT OF FRAME SIZE

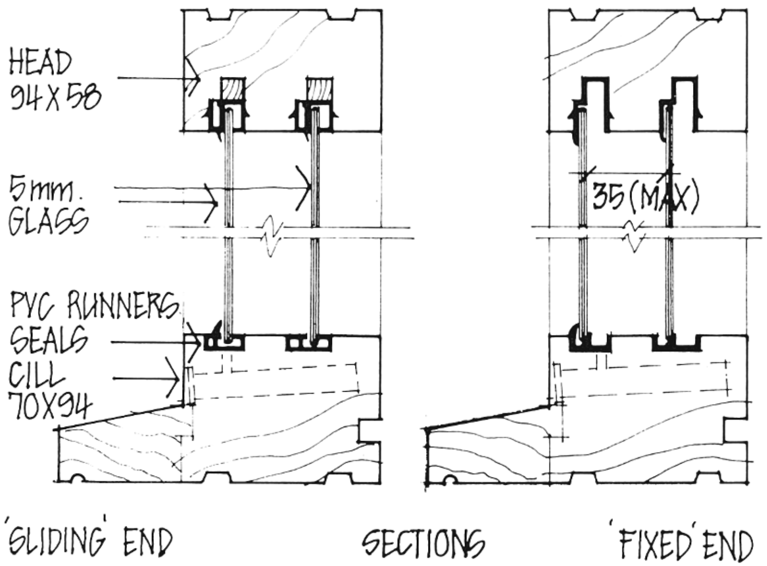


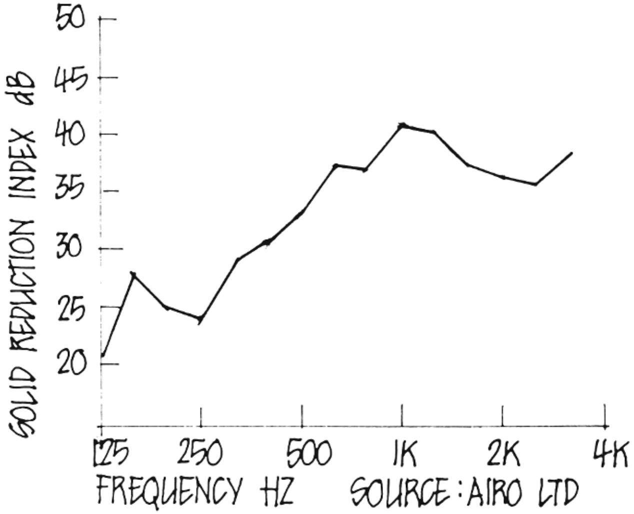
SOURCE: DR. RUCKWARD BAM. BERLIN.

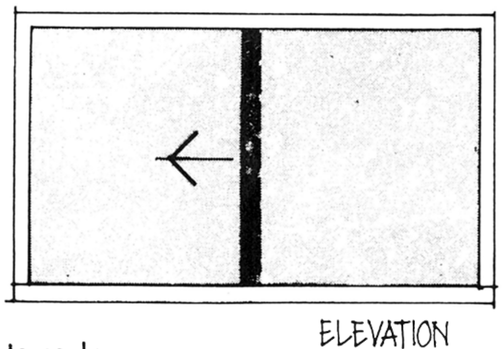
WINDOWS



QUEBEC 35 MK III. TYPE WINDOW BY
SASHLESS WINDOW CO. LTD.





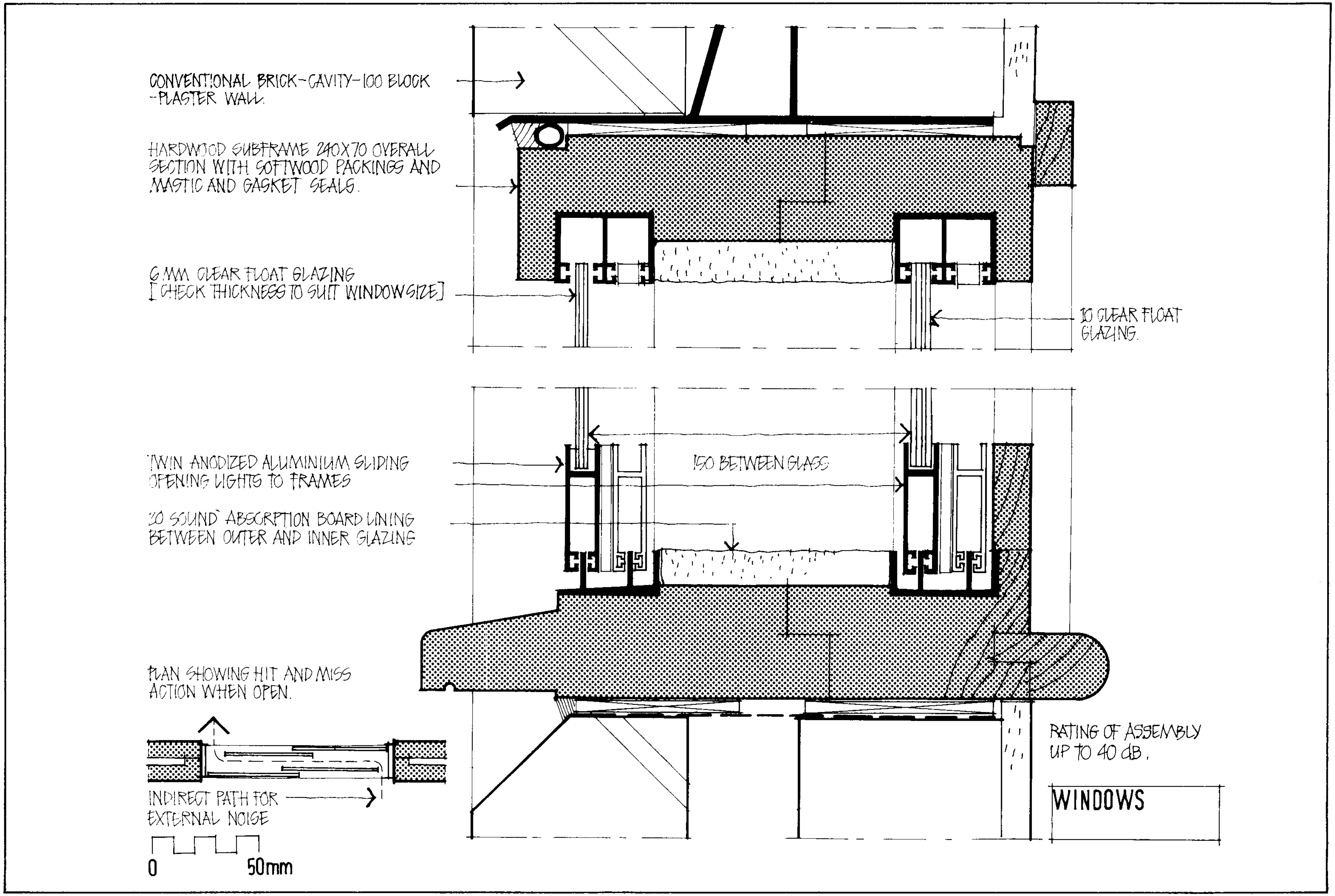


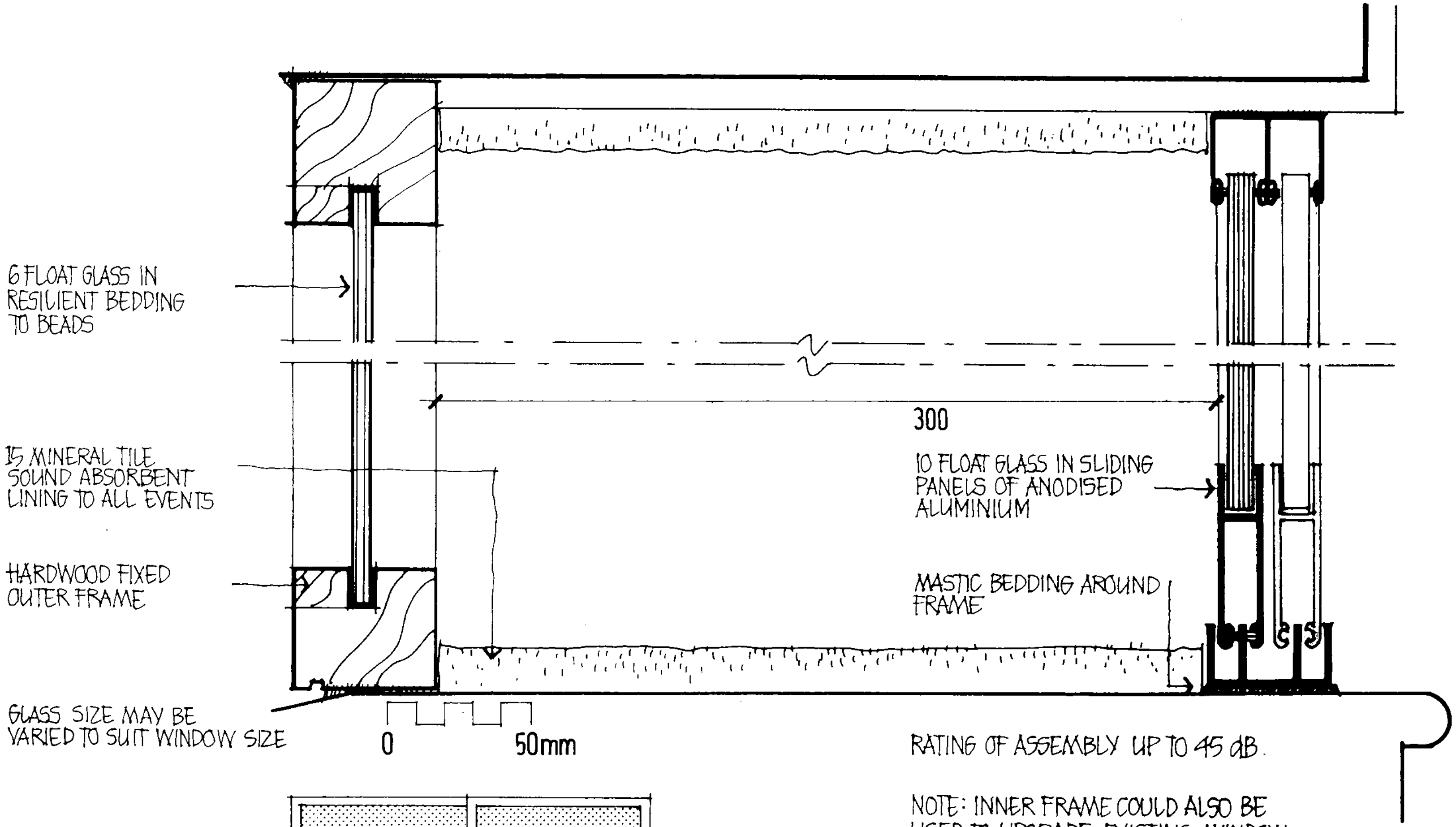
TEST CONDITION: 900X1500 WINDOW IN 250 BRICKWORK.
WHERE NATURAL LIGHT IS NOT ESSENTIAL IN A
SINGLE GLAZED WINDOW PANEL, PILKINGTONS
'ARMOURCLAD' COMPOSITE GLASS / INSULATION PANELS
MAY BE CONSIDERED:

6mm. GLASS /	25 INSULATION	32 dB. RATING
6	65	37
10	25	34
10	65	38

not to scale

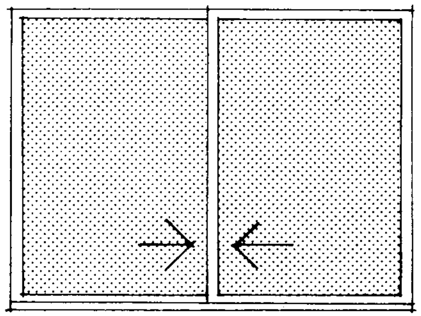
WINDOWS


CONVENTIONAL BRICK-CAVITY-100 BLOCK -PLASTER WALL.
HARDWOOD SUBFRAME 240X70 OVERALL SECTION WITH SOFTWOOD PACKINGS AND MASTIC AND GASKET SEALS.
6 MM CLEAR FLOAT GLAZING [CHECK THICKNESS TO SUIT WINDOW SIZE]
10 CLEAR FLOAT GLAZING.
TWIN ANODIZED ALUMINIUM SLIDING OPENING LIGHTS TO FRAMES
150 BETWEEN GLASS
30 SOUND ABSORPTION BOARD LINING BETWEEN OUTER AND INNER GLAZING
PLAN SHOWING HIT AND MISS ACTION WHEN OPEN.
INDIRECT PATH FOR EXTERNAL NOISE
0
50mm
RATING OF ASSEMBLY UP TO 40 dB.
WINDOWS



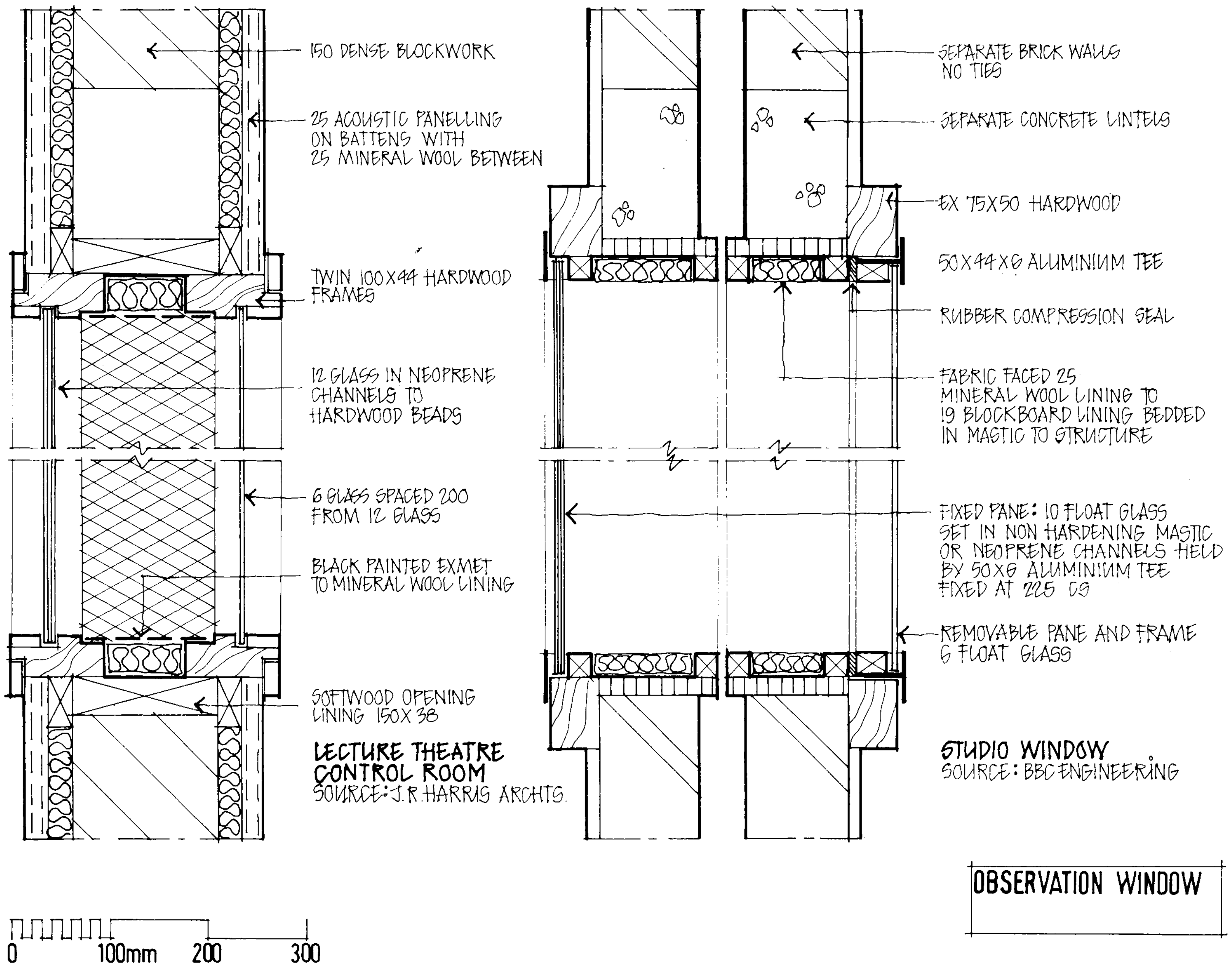
RATING OF ASSEMBLY UP TO 45 dB.

NOTE: INNER FRAME COULD ALSO BE USED TO UPGRADE EXISTING WINDOW OPENINGS. AN ORIEL MAY HAVE TO BE FORMED BECAUSE THE 300 AIR GAP MEANS THE WINDOW ASSEMBLY IS WIDER THAN THE CAVITY WALL AROUND.

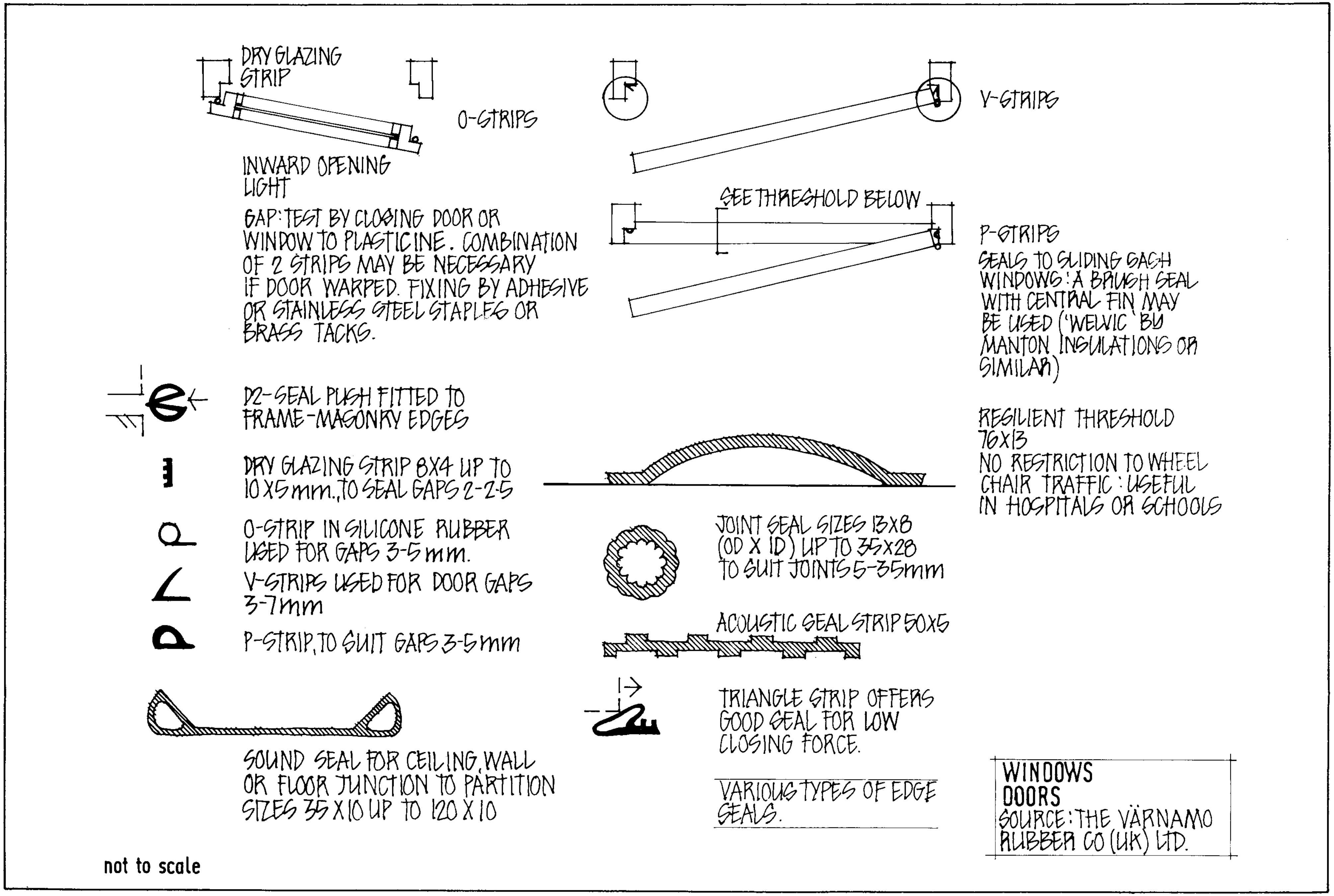


ELEVATION

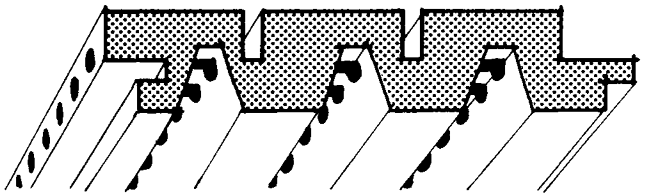
WINDOWS

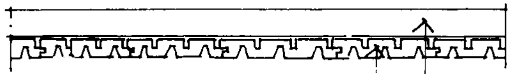


OBSERVATION WINDOW


DRY GLAZING STRIP
O-STRIPS
INWARD OPENING LIGHT
GAP: TEST BY CLOSING DOOR OR WINDOW TO PLASTICINE. COMBINATION OF 2 STRIPS MAY BE NECESSARY IF DOOR WARPED. FIXING BY ADHESIVE OR STAINLESS STEEL STAPLES OR BRASS TACKS.
V-STRIPS
SEE THRESHOLD BELOW
P-STRIPS
SEALS TO SLIDING SASH WINDOWS: A BRUSH SEAL WITH CENTRAL FIN MAY BE USED ('WELVIC' BY MANTON INSULATIONS OR SIMILAR)
D2-SEAL PUSH FITTED TO FRAME-MASONRY EDGES
DRY GLAZING STRIP 8X4 UP TO 10X5mm., TO SEAL GAPS 2-2.5
O-STRIP IN SILICONE RUBBER USED FOR GAPS 3-5mm.
V-STRIPS USED FOR DOOR GAPS 3-7mm
P-STRIP, TO SUIT GAPS 3-5mm
RESILIENT THRESHOLD 76X13
NO RESTRICTION TO WHEEL CHAIR TRAFFIC: USEFUL IN HOSPITALS OR SCHOOLS
JOINT SEAL SIZES 13X8 (OD X ID) UP TO 35X28 TO SUIT JOINTS 5-35mm
ACOUSTIC SEAL STRIP 50X5
TRIANGLE STRIP OFFERS GOOD SEAL FOR LOW CLOSING FORCE.
SOUND SEAL FOR CEILING, WALL OR FLOOR JUNCTION TO PARTITION SIZES 35 X 10 UP TO 120 X 10
VARIOUS TYPES OF EDGE SEALS.
WINDOWS
DOORS
SOURCE: THE VÄRNAMO RUBBER CO (UK) LTD.
not to scale

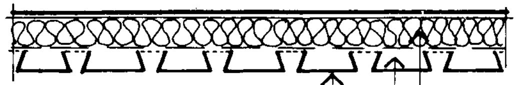
LININGS



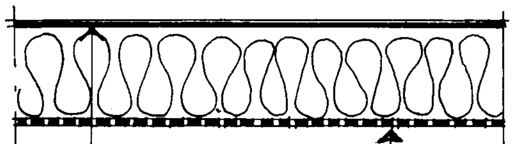


APPLIED ACOUSTICS VENABLES
PROFILED PROPRIETARY
HARDWOOD PANELS
PATTERN PERFORATED
AS SKETCH

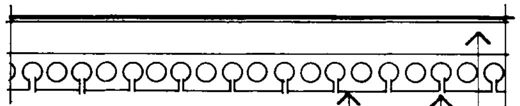
50 X 50 BATTENS TO CEILING (OR WALL)
0·1 0·35 0·80 0·40 0·25 0·35



PROPRIETARY VINYL
COVERED STEEL SLATS.
(A.A-V. STEELTONE)
GLASS FIBRE MEMBRANE
25 MINERAL WOOL QUILT
– 0·34 0·88 0·70 0·50 0·57



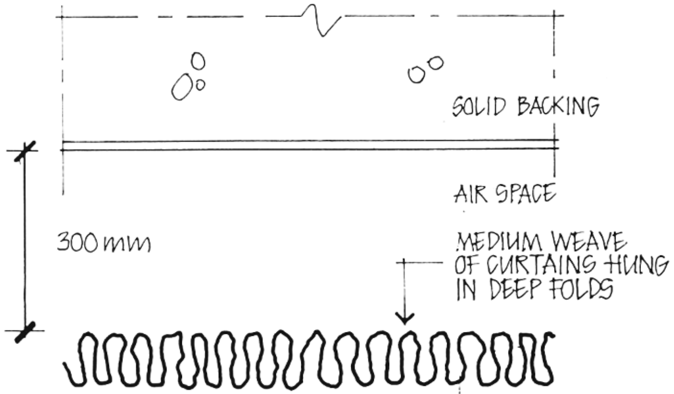
ONE SIDE NOT
PERFORATED
PROPRIETARY (HAUSERMAN)
PARTITION WITH OPTIONAL ONE
FACE PERFORATED
(NOTE : PERFORATIONS REDUCE
SOUND INSULATION VALUE
OF PARTITION TO 35 dB OR LESS)
0·46 (100–3150 Hz) 0·91 (400–1250 Hz) 0·84 (1600–5000 Hz)



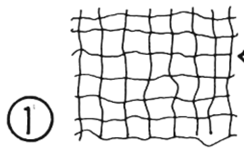
26 EXTRUDED CHIPBOARD
PANELS WITH DECORATIVE VENEER
3 CONTINUOUS SLOTS
38X25 SOFTWOOD BATTENS WITH
GLASSFIBRE INSULATION BETWEEN
0·15 0·35 0·40 0·60 0·85 0·55

STANDARD DETAILS.

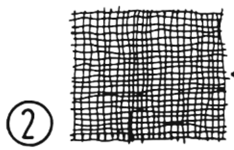
WALL FINISHES / PARTITIONS
SOUND ABSORPTION.



PLAN

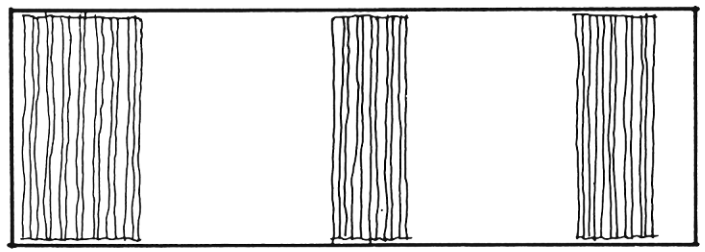


TOO LOOSE A WEAVE DENSITY AND MATERIAL IS ACOUSTICALLY TRANSPARENT



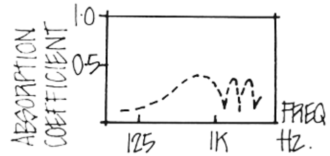
MEDIUM WEAVE GIVES MUCH BETTER ABSORPTION THAN 1. OR 2. TEST BY TRYING TO BLOW THROUGH MATERIAL. IT SHOULD BE POSSIBLE TO BLOW THROUGH THE FABRIC BUT WITH SOME RESISTANCE: FABRIC HAS OPTIMUM FLOW RESISTANCE TO SOUND

TOO TIGHT A WEAVE AND THE MATERIAL IS ONLY SLIGHTLY SOUND ABSORPTIVE.



ROOM ELEVATION

AREAS OF CURTAINS DISTRIBUTED AROUND ARE MORE EFFECTIVE IN TERMS OF SOUND ABSORPTION AND GIVE MORE EVEN SOUND QUALITY THAN IF CONCENTRATED IN ONE AREA

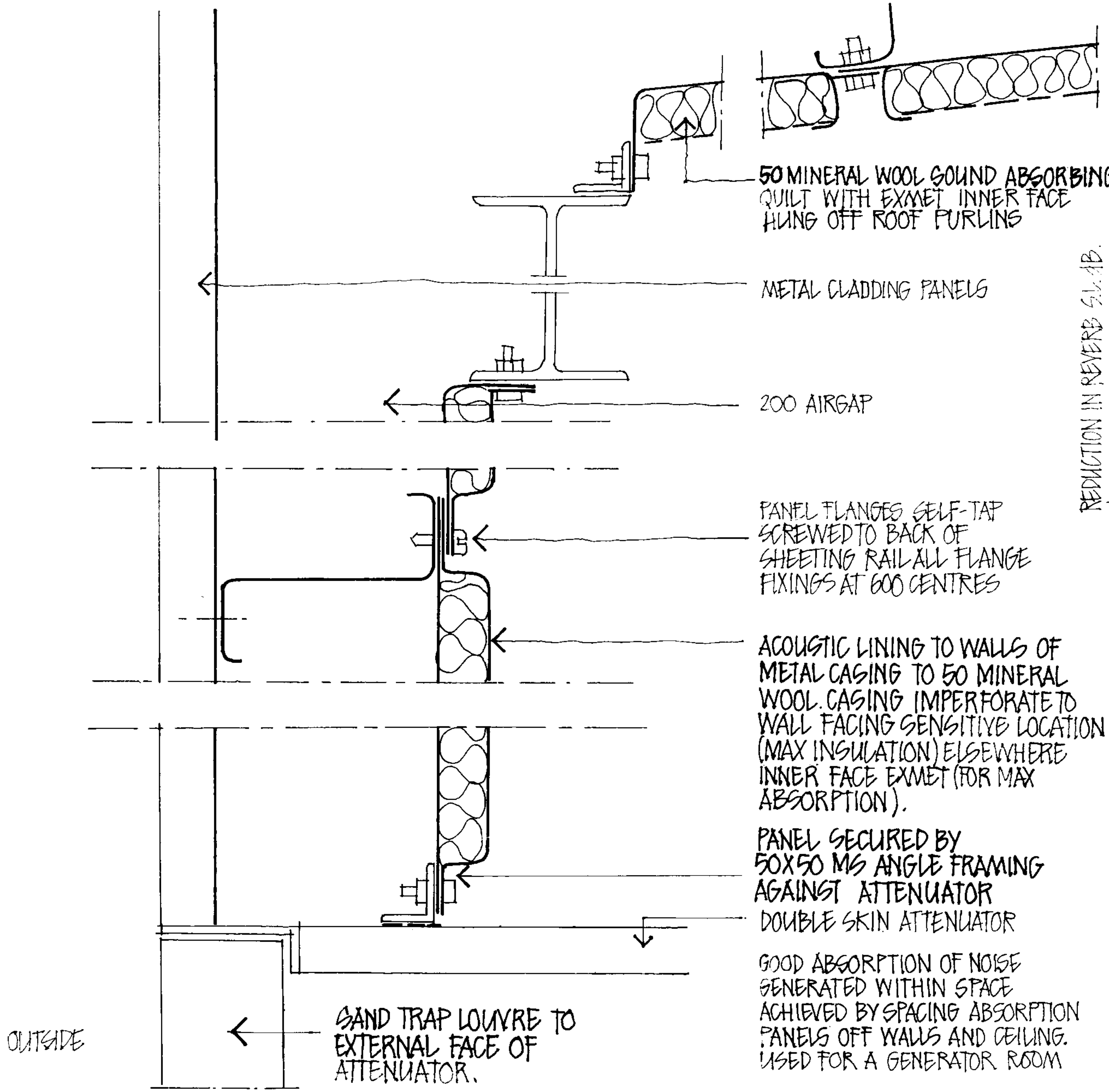


ABSORPTION CHARACTERISTIC OF THIN CURTAIN NOT HUNG IN FOLDS SPACED OFF WALL

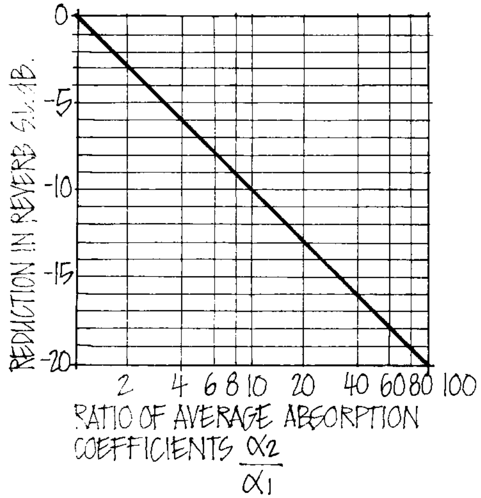
BEST USE OF CURTAIN IS AS IN PLAN, WITH MEDIUM WEAVE. FREE STANDING DIVIDER CURTAINS ARE LESS EFFECTIVE. CURTAINS ARE A SIMPLE METHOD OF PROVIDING AN ADAPTABLE AMOUNT OF ABSORPTION EG. IN MUSIC PRACTICE ROOMS. CURTAIN LINING ALSO IMPROVES SOUND ABSORPTION.

CURTAINS

not to scale



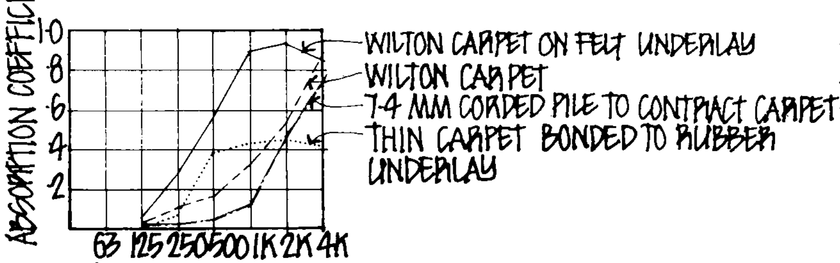
GOOD ABSORPTION OF NOISE GENERATED WITHIN SPACE ACHIEVED BY SPACING ABSORPTION PANELS OFF WALLS AND CEILING. USED FOR A GENERATOR ROOM



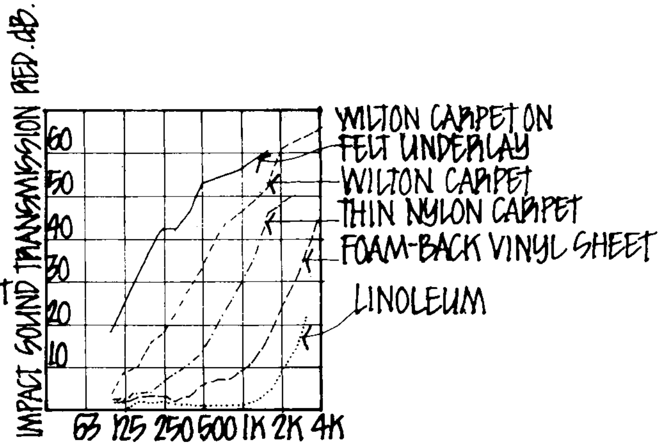
REVERBERANT SOUND, FOR EXAMPLE IN PLANT ROOMS OR OTHER SPACES WITH ALL HARD FINISHES CAN BE SIGNIFICANTLY REDUCED BY INTRODUCING SOME ABSORPTION. THE LAW OF DIMINISHING RETURNS APPLIES, HOWEVER, AS THE QUANTITY OF ABSORPTION INCREASES.

ACOUSTIC LINING

SOURCE: JOHN R HARRIS ARCHITECTS



FREQUENCY HZ
SOURCE: SRL/TRETFORD CARPETS



FREQUENCY HZ
SOURCE: SRL

CARPET

CARPET IS USEFUL FOR BOTH IMPACT SOUND REDUCTION [FOOTFALL AND TO FLOOR BELOW] AND FOR SOUND ABSORPTION. VALUES ARE SHOWN IN APPENDIX BUT FOR THIN CARPET ON SOLID BACKING [TYPICAL OFFICE FOR LEASE] VALUES ARE LOW FOR LOW AND MID FREQUENCIES. CARPET IS SOMETIMES USED AS A HARDWEARING WALL FINISH, FOR EXAMPLE IN CINEMAS. CARPETS ON THIN WALL PANELS [SEE DETAIL ASSEMBLY ④] GIVE A BROADER FREQUENCY PERFORMANCE.

CUSHIONED VINYL SHEET

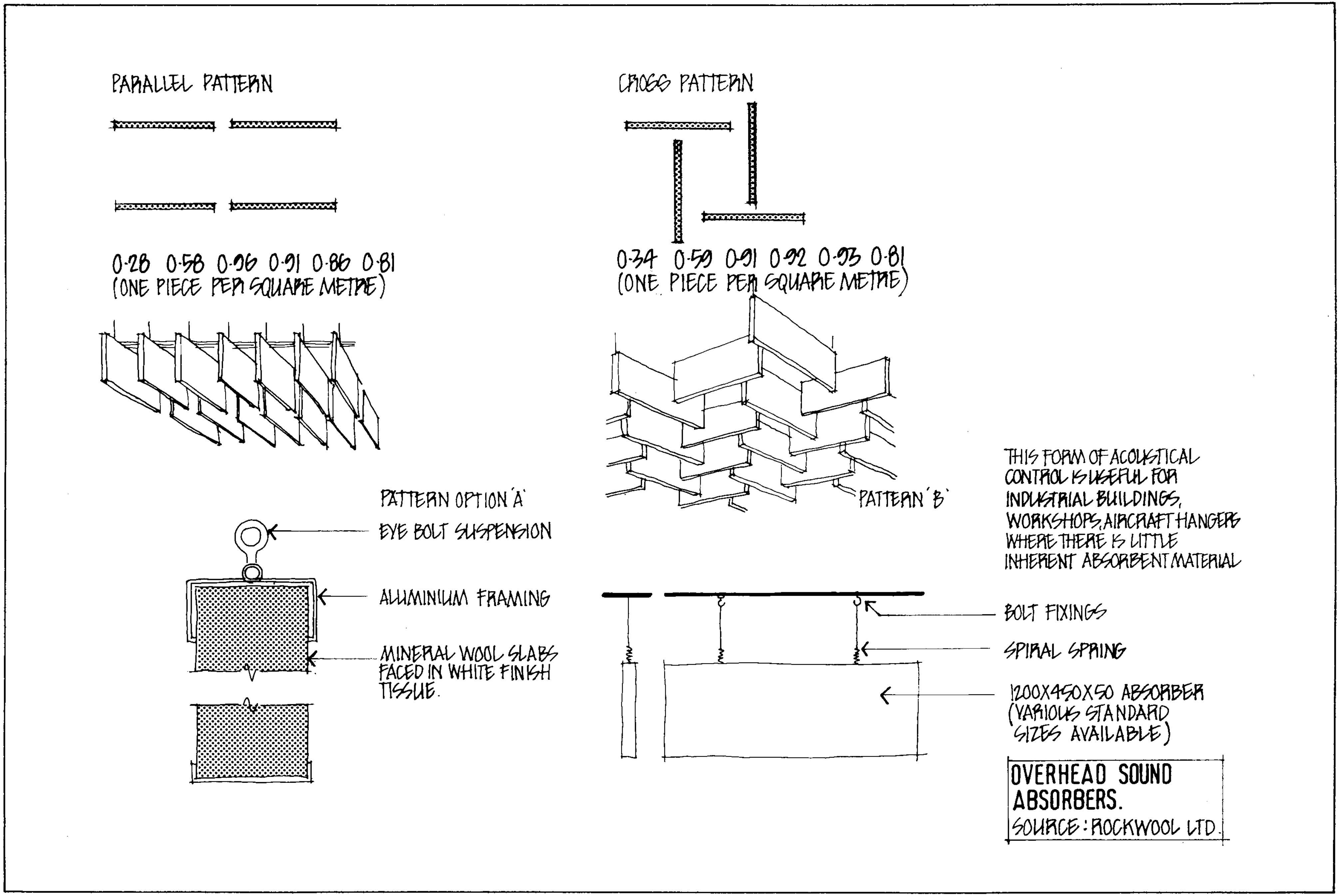
CUSHIONED VINYL SHEET ONLY 3MM THICK ('POLYTREAD' OR SIM.) ON A CONCRETE SLAB CAN GIVE IMPACT SOUND TRANSMISSION PERFORMANCE, EXCEEDING GRADE I BUILDING REGS. THIS IS A USEFUL MATERIAL FOR HOSPITALS, SCHOOLS AND OLD PEOPLES HOMES WHERE CARPET CANNOT BE USED

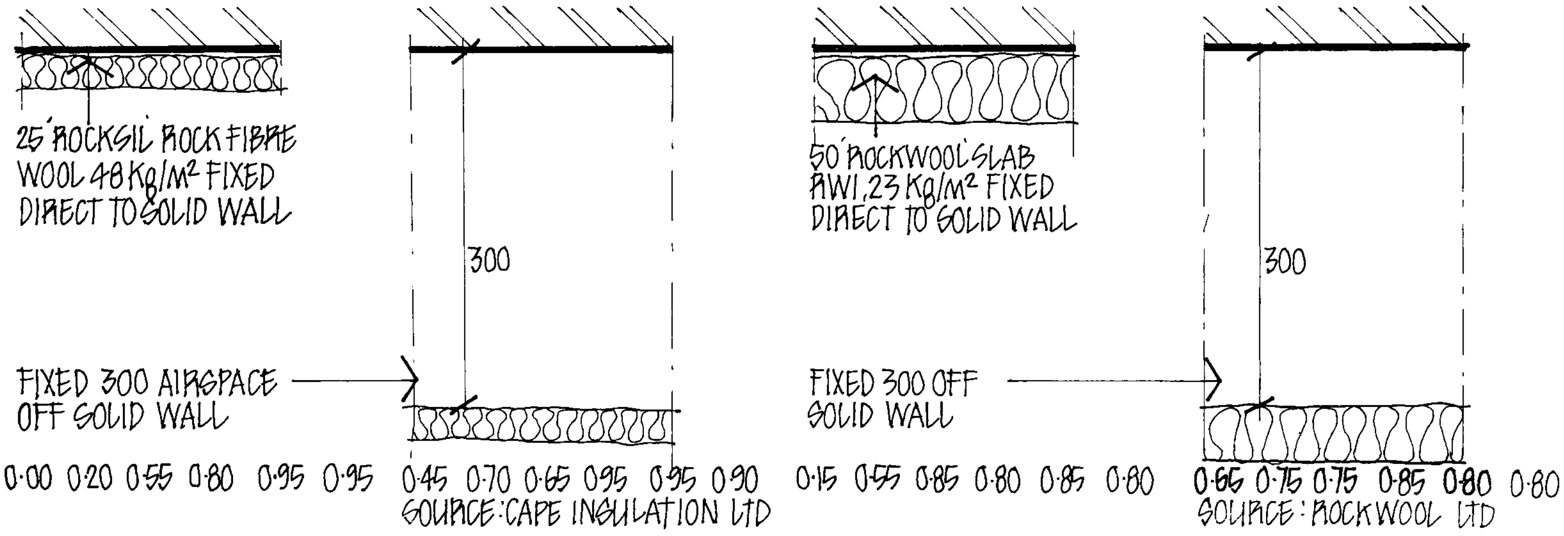
FINISHES [BRS 103 DEFINITION]

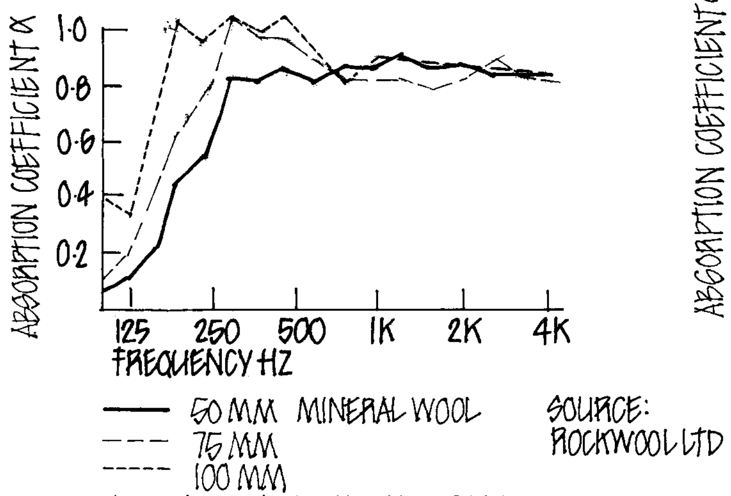
SOFT: CUSHIONED VINYL SHEET THIN CARPET WITH UNDERLAY. THICK CARPET WITH OR WITHOUT UNDERLAY, CORK TILES OVER 8MM TILES.

HARD: CONCRETE, TERRAZZO, PVC TILES, WOOD BLOCK, MASTIC ASPHALT.

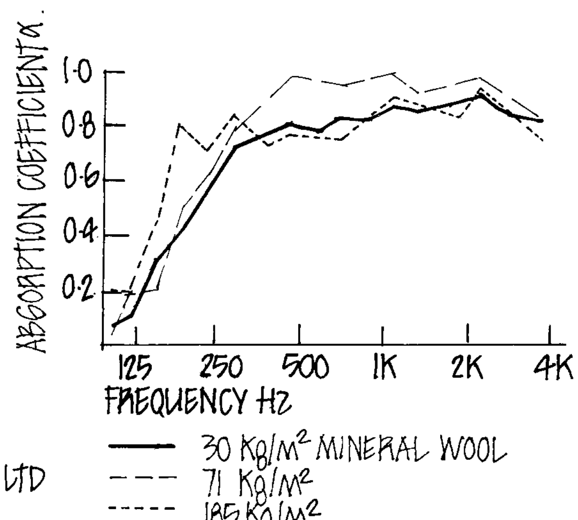
FINISHES


PARALLEL PATTERN
0·28 0·58 0·96 0·91 0·86 0·81
(ONE PIECE PER SQUARE METRE)
CROSS PATTERN
0·34 0·59 0·91 0·92 0·93 0·81
(ONE PIECE PER SQUARE METRE)
PATTERN OPTION 'A'
PATTERN 'B'
THIS FORM OF ACOUSTICAL CONTROL IS USEFUL FOR INDUSTRIAL BUILDINGS, WORKSHOPS, AIRCRAFT HANGERS WHERE THERE IS LITTLE INHERENT ABSORBENT MATERIAL
EYE BOLT SUSPENSION
ALUMINIUM FRAMING
MINERAL WOOL SLABS FACED IN WHITE FINISH TISSUE.
BOLT FIXINGS
SPIRAL SPRING
1200X450X50 ABSORBER (VARIOUS STANDARD SIZES AVAILABLE)
OVERHEAD SOUND ABSORBERS.
SOURCE: ROCKWOOL LTD.





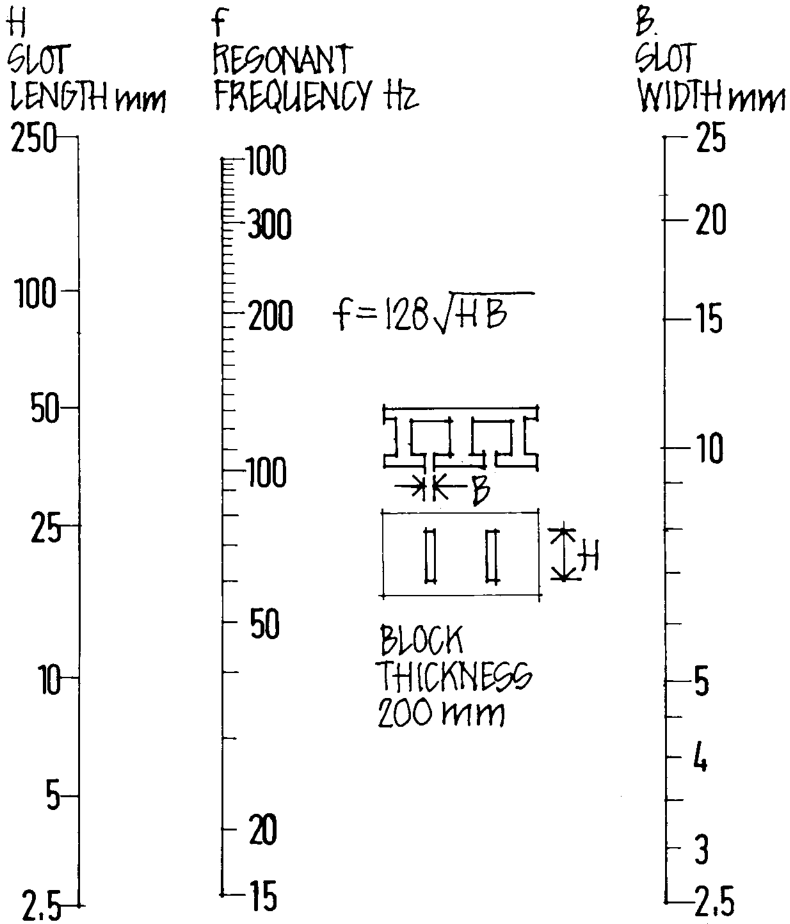
VARIATION OF α WITH THICKNESS



VARIATION OF α WITH DENSITY

ALTHOUGH SOUND ABSORPTION RANGES FROM α=0 TO α=1·0 (FULL REFLECTION TO COMPLETE SOUND ABSORPTION) FIGURES IN EXCESS OF 1·0 CAN OCCUR. THIS APPARENT ANOMALY IS DUE TO THE METHOD OF MEASUREMENT.

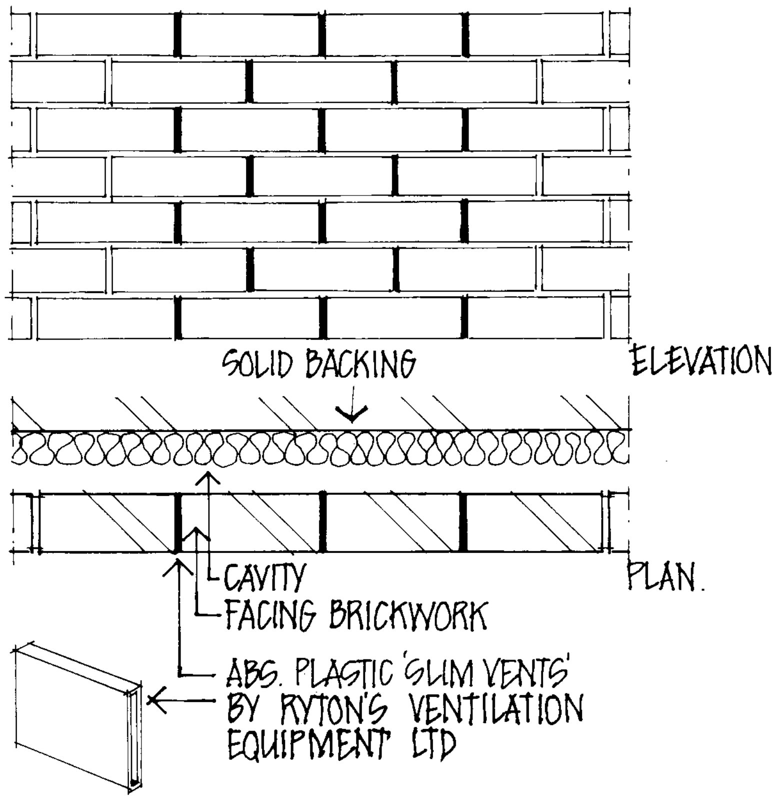
SOUND ABSORPTIVE LINING



NOMOGRAM FOR COMPUTING THE HELMHOLTZ FREQUENCY FOR SLOTTED HOLLOW CONCRETE BLOCK. (SOURCE: HERRICK LABORATORIES, PURDUE UNIVERSITY. INDIANA U.S.)
ABSORPTION COEFFICIENTS FOR SLOTTED 200 BLOCK FILLED WITH INCOMBUSTIBLE FIBROUS MATERIAL

0·72 0·55 0·42 0·34 0·35 0·34

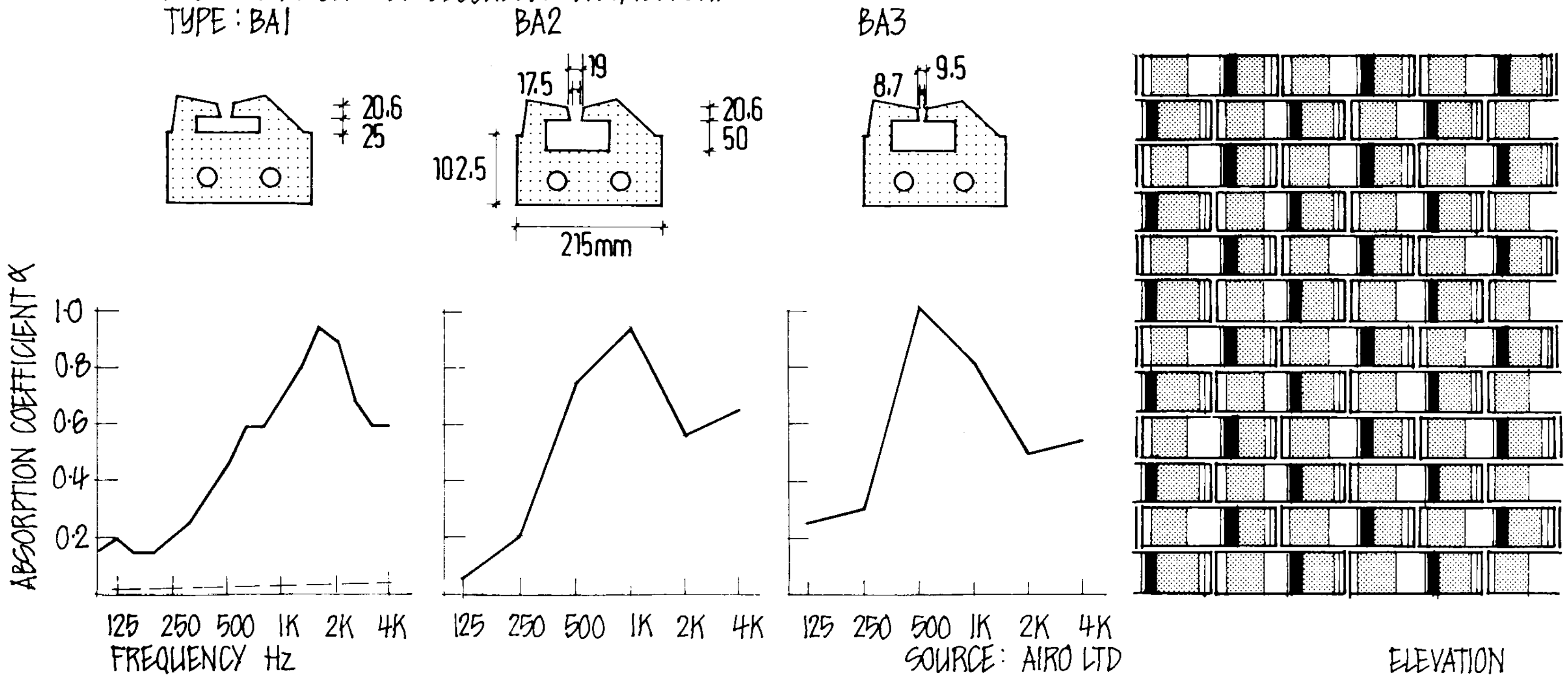
not to scale



A SIMILAR EFFECT IS OBTAINED FROM SLOTS IN BRICKWORK WITH CAVITY BEHIND (NOTE: LEAF INEFFECTIVE FOR SOUND REDUCTION BETWEEN SPACES) TO ASSESS ABSORPTION CHARACTERISTICS LABORATORY TESTS ARE REQUIRED FOR THE BRICK, SPACING AND SLOT PATTERN PROPOSED. APPLICATION: SELECTIVE ABSORPTION AT LOW FREQUENCIES.

SOUND ABSORPTIVE WALLING

'ACOUSTIC BRICKS' BY BLOCKLEYS LTD., TELFORD

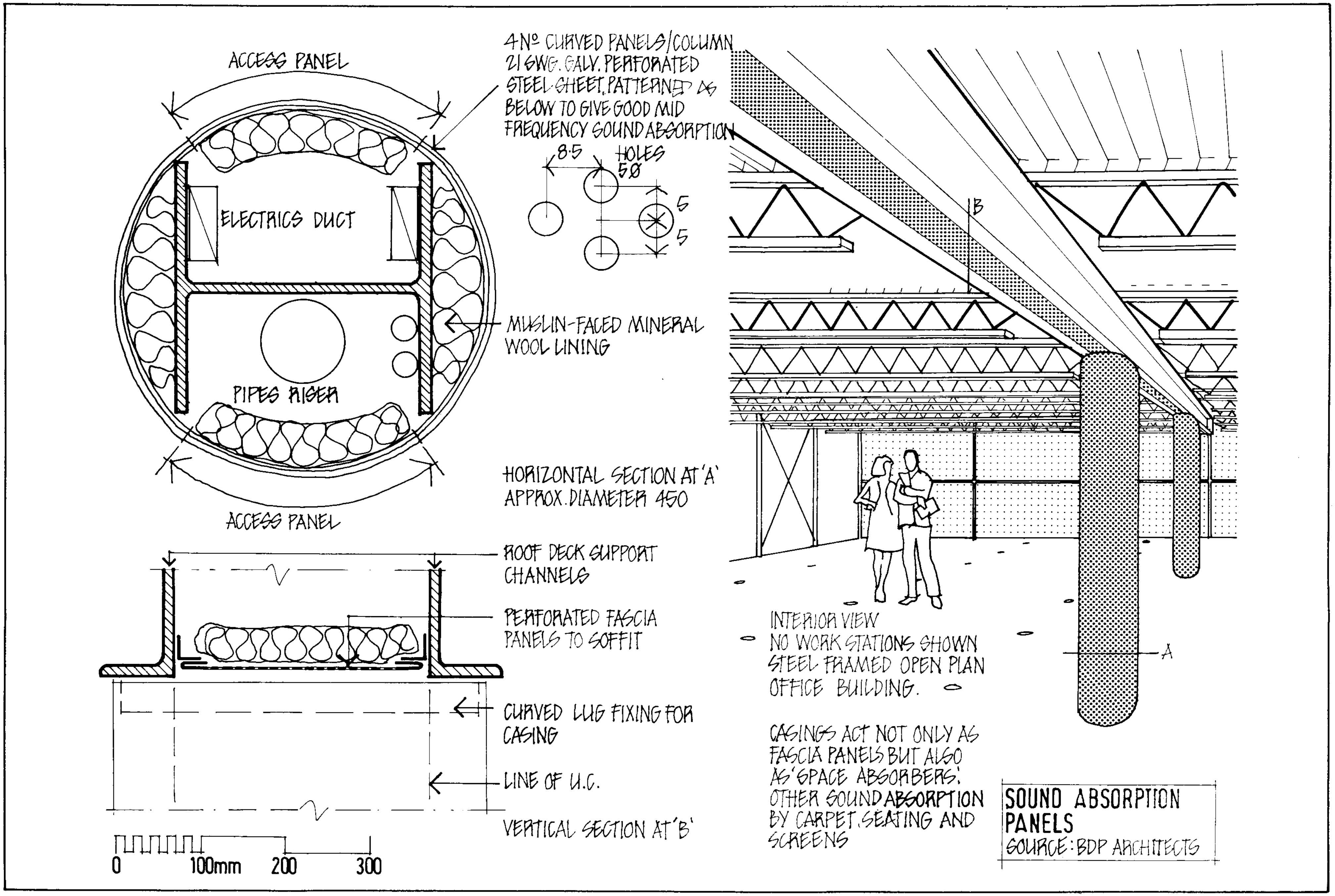


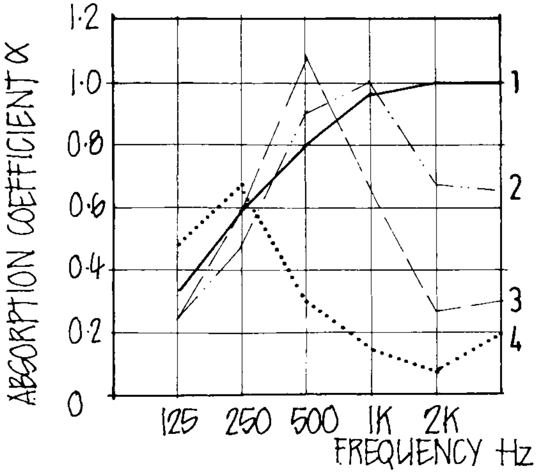
ABSORPTION COEFFICIENT OF STANDARD FAIRFACED BRICKWORK

SPECIAL DESIGN BRICKS MAY BE CONSIDERED TO 'SOFTEN' THE SOUND QUALITY OF A SPACE WHERE HARD FINISHES ARE REQUIRED. A MIX OF THE 3 TYPES WILL ACHIEVE GOOD SOUND ABSORPTION IN THE RANGE 500-2000Hz. ANGLED FACES HELP DIFFUSE INCIDENT SOUND. MORE COSTLY THAN SLOTS BETWEEN STANDARD BRICKS, BUT ADVANTAGEOUS IN THAT WALL RETAINS SOME SOUND INSULATION VALUE.

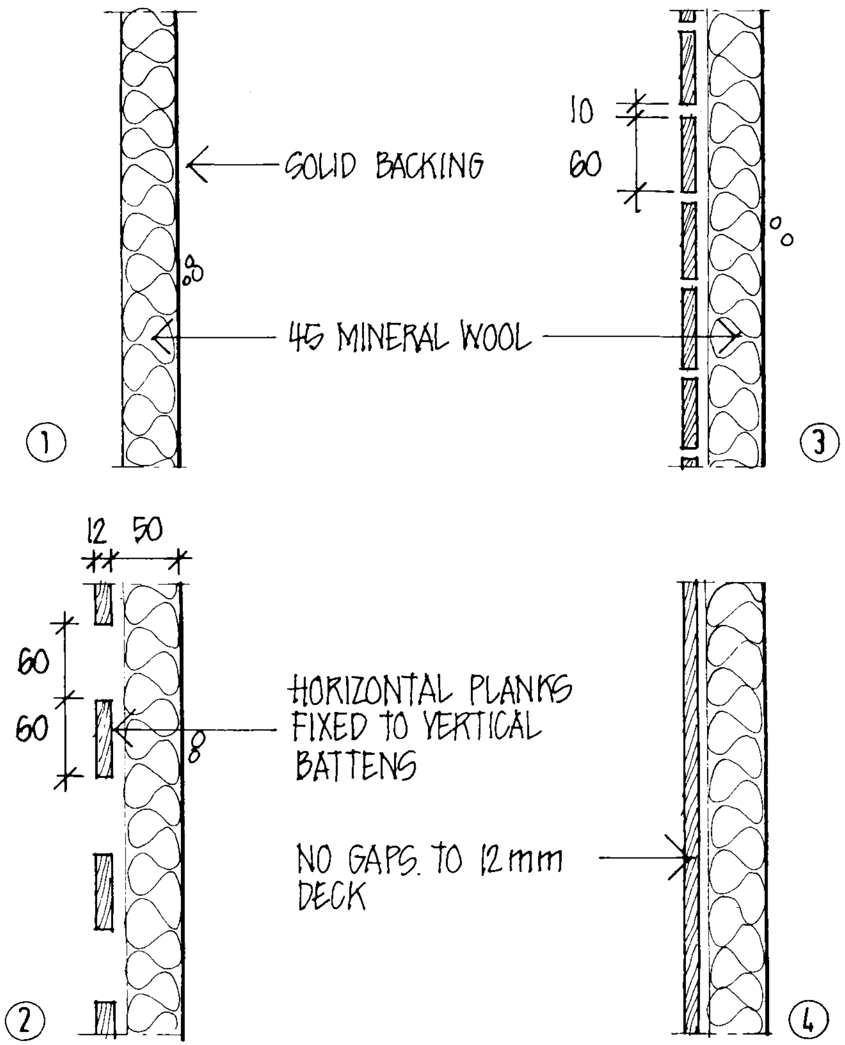
SOUND ABSORPTIVE WALLING

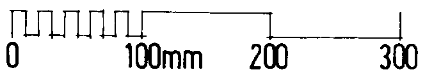
not to scale


ACCESS PANEL
4Nº CURVED PANELS/COLUMN 21 SWG. GALV. PERFORATED STEEL SHEET, PATTERNED AS BELOW TO GIVE GOOD MID FREQUENCY SOUND ABSORPTION
8·5
HOLES 5Ø
5
5
ELECTRICS DUCT
MUSLIN-FACED MINERAL WOOL LINING
PIPES RISER
HORIZONTAL SECTION AT 'A' APPROX. DIAMETER 450
ACCESS PANEL
ROOF DECK SUPPORT CHANNELS
PERFORATED FASCIA PANELS TO SOFFIT
CURVED LUG FIXING FOR CASING
LINE OF U.C.
VERTICAL SECTION AT 'B'
0
100mm
200
300
B
A
INTERIOR VIEW
NO WORK STATIONS SHOWN
STEEL FRAMED OPEN PLAN OFFICE BUILDING.
CASINGS ACT NOT ONLY AS FASCIA PANELS BUT ALSO AS 'SPACE ABSORBERS'. OTHER SOUND ABSORPTION BY CARPET, SEATING AND SCREENS
SOUND ABSORPTION PANELS
SOURCE: BDP ARCHITECTS

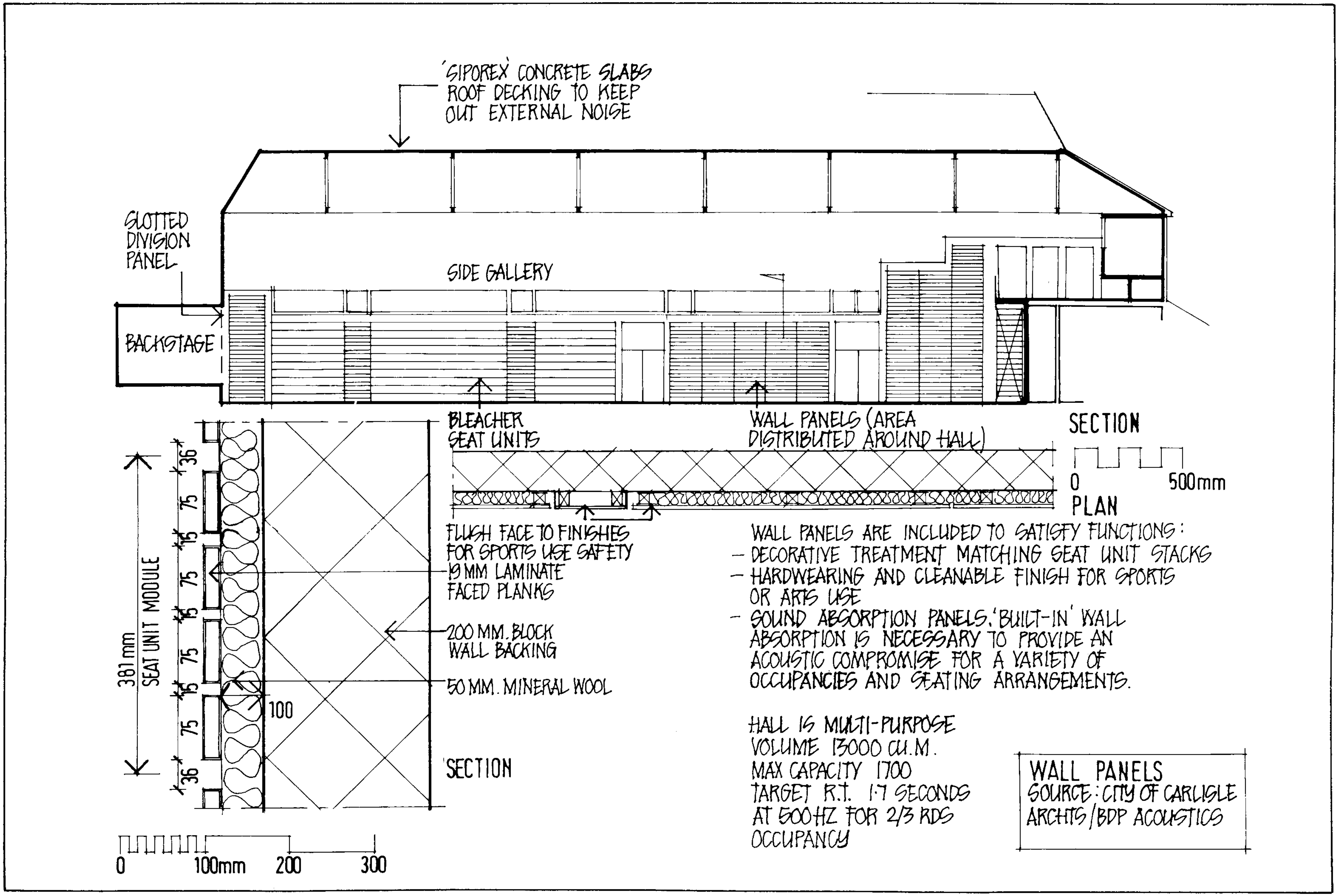


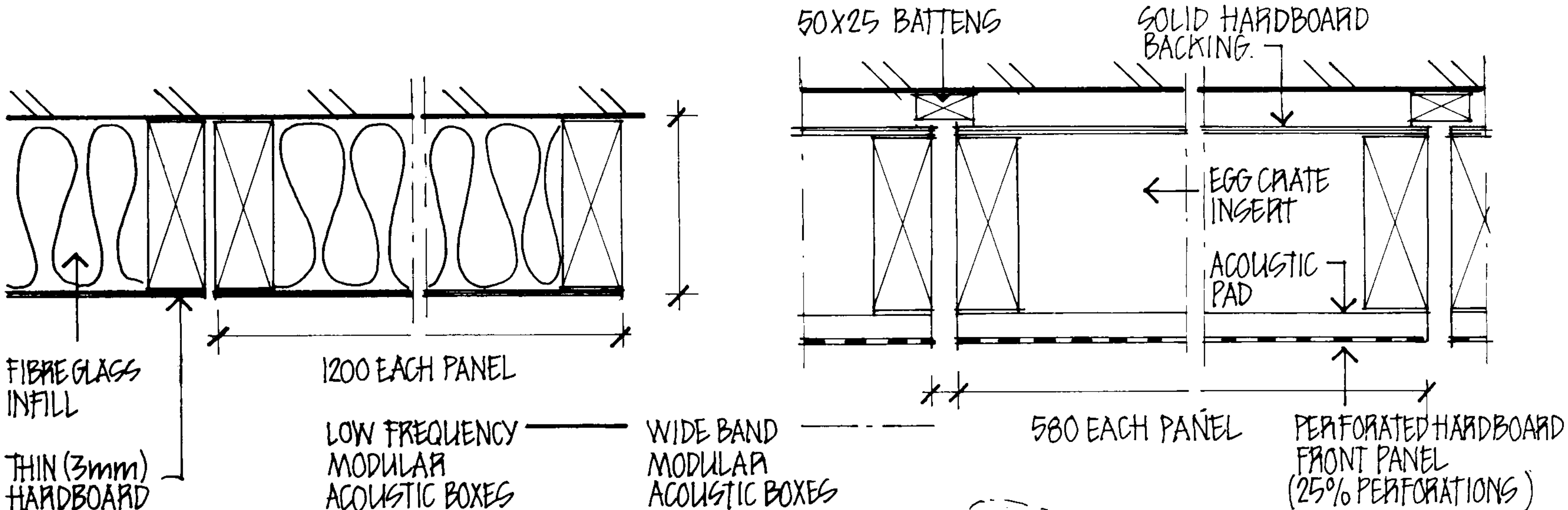
WALL PANELS CAN BE DESIGNED TO PROVIDE ABSORPTION OVER A NARROW RANGE OF FREQUENCIES BY ADJUSTING THE GAP BETWEEN PLANKS. THE PRINCIPLE OF THE SLIT RESONATOR IS THE SAME AS FOR A HELMHOLTZ RESONATOR, RESONANT FREQUENCY BEING DEPENDENT ON SLIT WIDTH DEPTH AND CROSS SECTIONAL AREA OF THE SPACE BEHIND THE SLITS FORMED BY THE PLANKS.

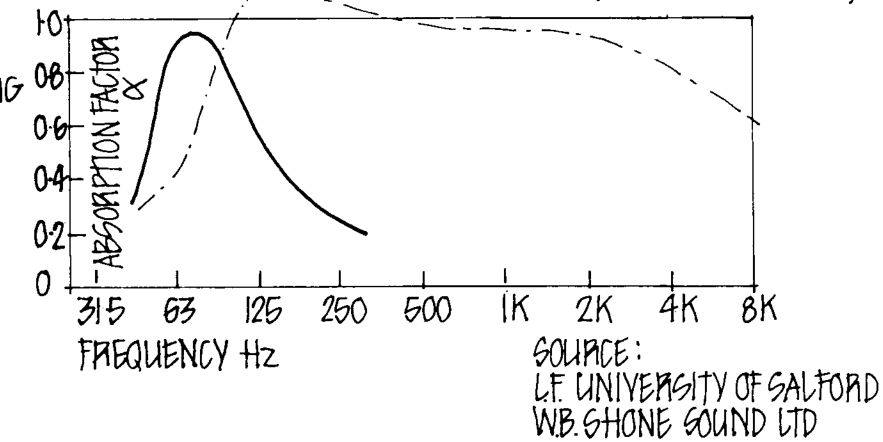




WALL PANELS
SOURCE: FURRER


'SIPOREX' CONCRETE SLABS ROOF DECKING TO KEEP OUT EXTERNAL NOISE
SLOTTED DIVISION PANEL
SIDE GALLERY
BACKSTAGE
BLEACHER SEAT UNITS
WALL PANELS (AREA DISTRIBUTED AROUND HALL)
SECTION
0
500mm
PLAN
36
75
15
75
15
75
15
75
36
381 mm SEAT UNIT MODULE
FLUSH FACE TO FINISHES FOR SPORTS USE SAFETY
19 MM LAMINATE FACED PLANKS
200 MM. BLOCK WALL BACKING
50 MM. MINERAL WOOL
100
SECTION
0
100mm
200
300
WALL PANELS ARE INCLUDED TO SATISFY FUNCTIONS:
– DECORATIVE TREATMENT MATCHING SEAT UNIT STACKS
– HARDWEARING AND CLEANABLE FINISH FOR SPORTS OR ARTS USE
– SOUND ABSORPTION PANELS. 'BUILT-IN' WALL ABSORPTION IS NECESSARY TO PROVIDE AN ACOUSTIC COMPROMISE FOR A VARIETY OF OCCUPANCIES AND SEATING ARRANGEMENTS.
HALL IS MULTI-PURPOSE
VOLUME 13000 CU.M.
MAX CAPACITY 1700
TARGET R.T. 1·7 SECONDS AT 500HZ FOR 2/3 RDS OCCUPANCY
WALL PANELS
SOURCE: CITY OF CARLISLE ARCHTS/BDP ACOUSTICS

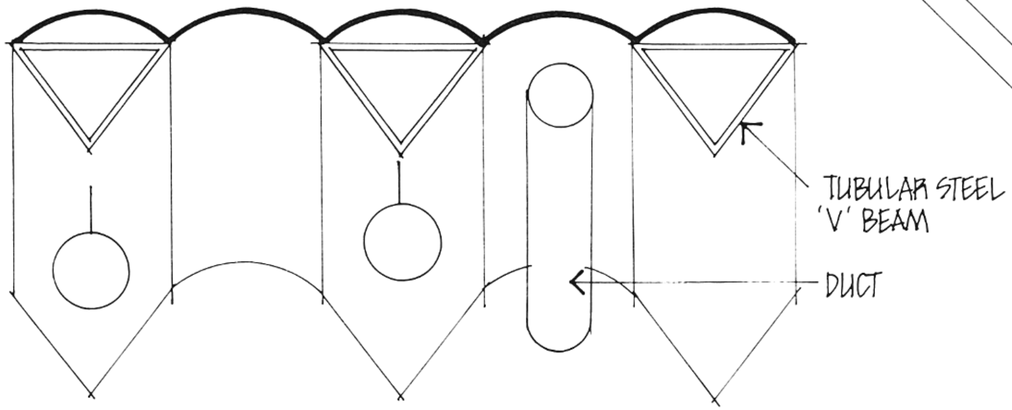


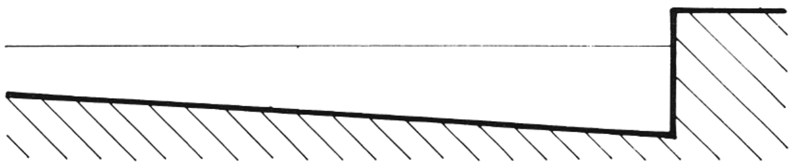


LOW FREQUENCY BOXES PROPOSED WITH WIDE BAND BOXES IN RATIO 1:2, TOTAL AREA 150 M², FOR A STUDIO REMODELLING TO ACHIEVE REVERBERATION TIME <0·5 SECONDS FOR FREQUENCIES BETWEEN 63-4K Hz. VOLUME 550 M³. FLOOR FINISH: CARPET.

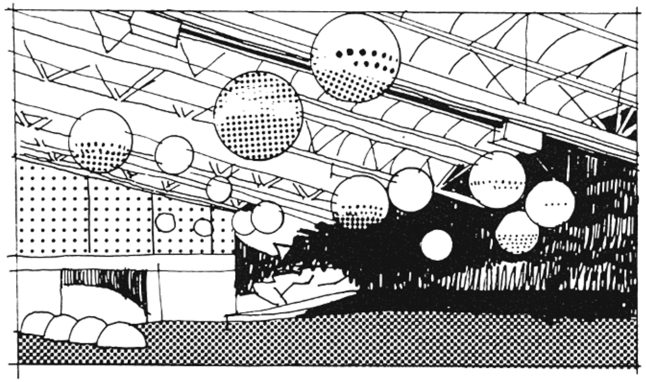
MODULAR ACOUSTIC BOXES ARE OF PARTICULAR USE IN BROADCASTING AND RADIO STUDIOS: SEEK SPECIALIST ADVICE CONCERNING USE. SOME USE OF SUCH PANELS MAY BE MADE IN eg. MUSIC ROOMS, DISCOTHEQUES. DECORATIVE OPEN WEAVE FINISH MAY BE STRETCHED OVER PANEL FRONTS. CHECK ANY REQUIREMENT FOR FIRE RESISTANCE.

MODULAR ACOUSTIC BOXES

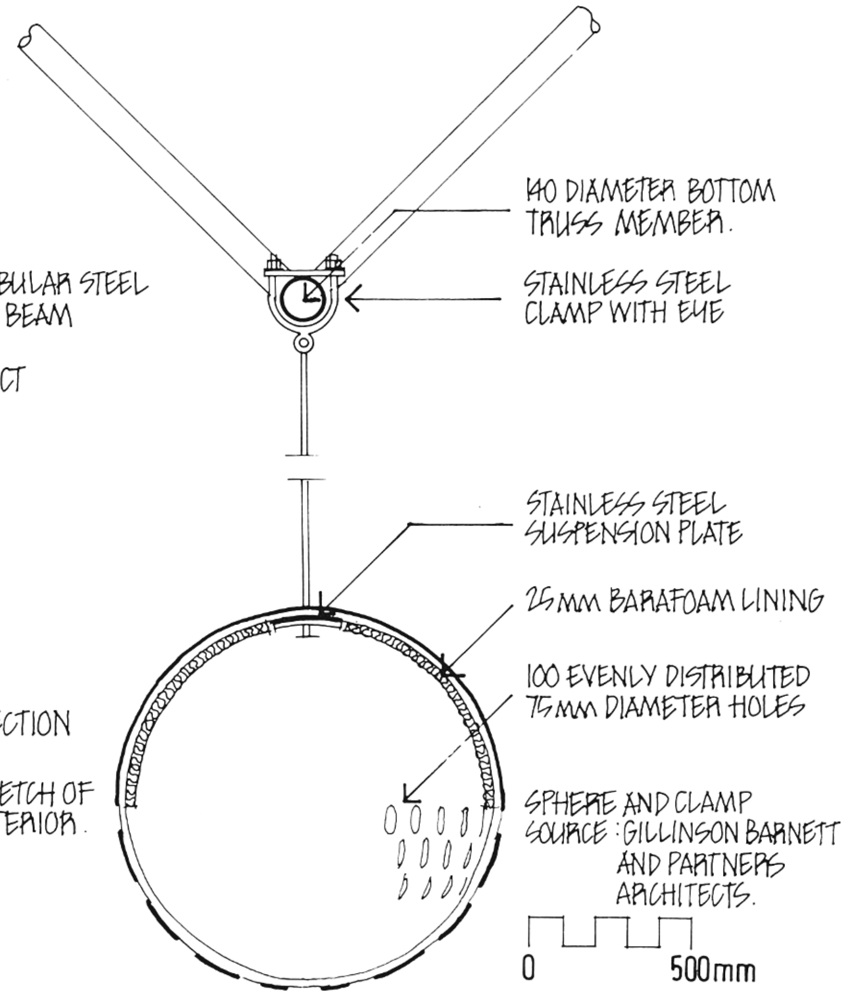




SECTION



SKETCH OF INTERIOR.



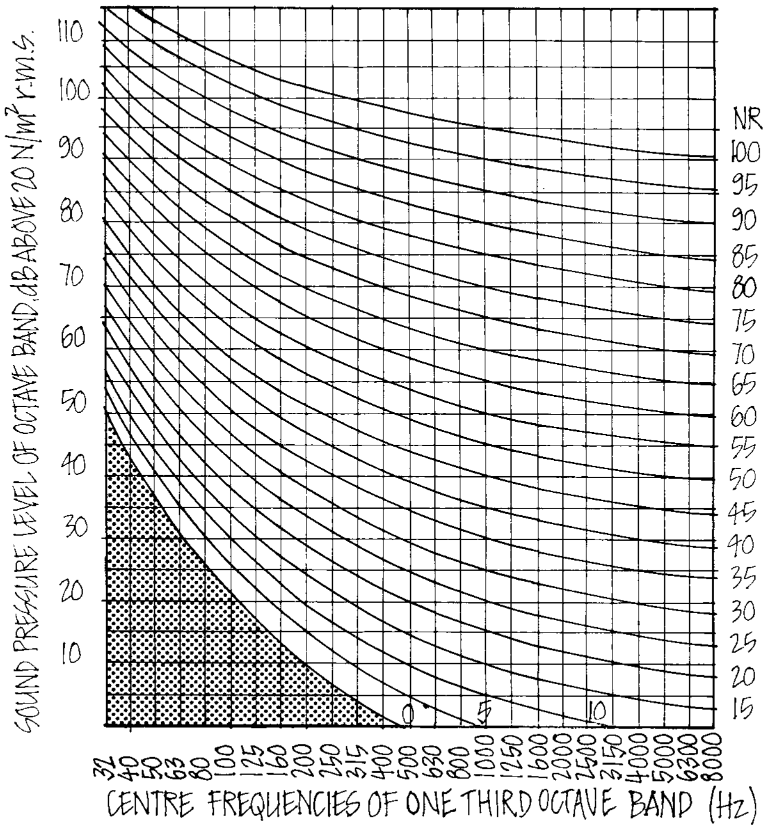
THESE GRP ORBS ARE USED IN SEVERAL SWIMMING AND LEISURE POOLS TO HELP ABSORB THE SOUND OF SHOUTS AND SPLASHES. POOL INTERIORS ARE PROBLEMATIC BECAUSE OF THE NEED FOR HARD DAMP RESISTANT MATERIALS; AVOID THE USE OF NORMAL ACOUSTIC CEILING PLASTER WHICH ABSORBS MOISTURE TO MANY TIMES ITS OWN WEIGHT AND FALLS OFF CEILING SOFFIT.

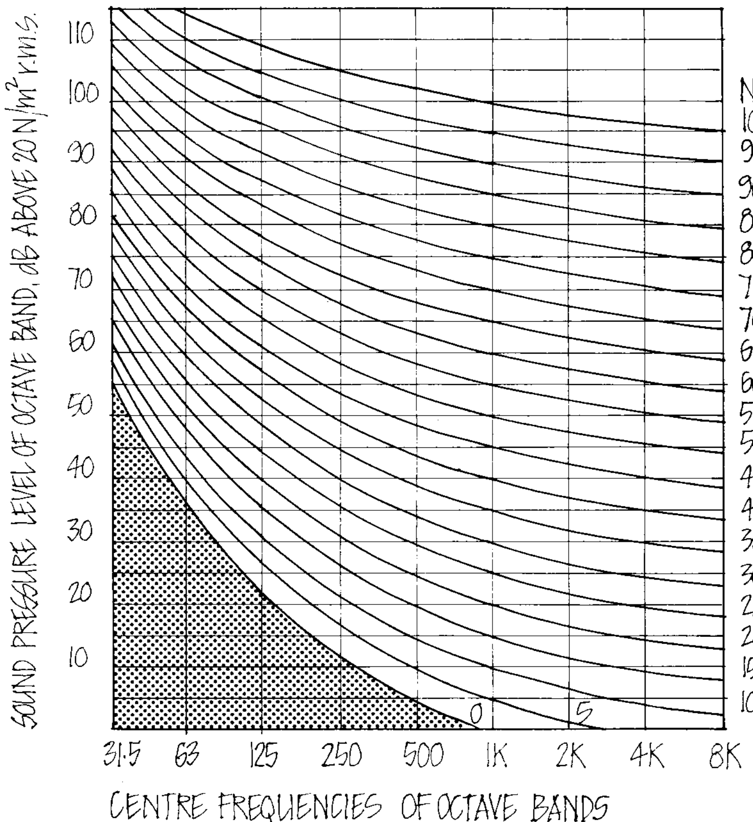
OVERHEAD SOUND ABSORBERS

not to scale

SERVICES

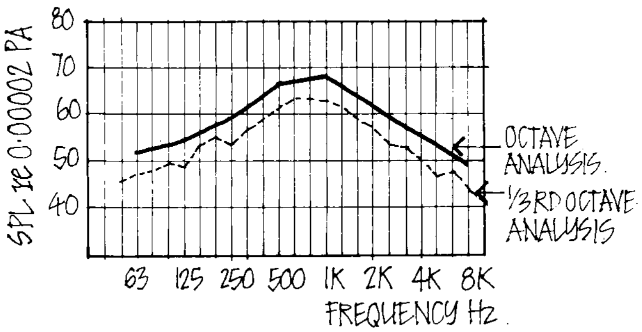
AMBIENT NOISE CONTROL (1)





NOISE RATING CURVES–OCTAVE ANALYSIS

IT IS CONVENIENT TO SPECIFY THE LEVEL OF A PARTICULAR NOISE BY EQUAL LOUDNESS CONTOURS WHICH RECOGNISE THAT THE SUBJECTIVE RESPONSE BY THE EAR IS TO FIND LOW-FREQUENCY NOISE LESS NOTICEABLE THAN HIGH FREQUENCY FOR THE SAME SOUND POWER LEVEL. THE CONTOURS ABOVE ARE NOISE RATING (NR) CURVES. ANOTHER FORM IS PNC CURVES WHICH ARE VERY SIMILAR AT MOST FREQUENCIES. CURVES CAN BE USED TO MONITOR THAT THE AMBIENT SOUND LEVEL IN A SPACE IS NOT AT AN UNSUITABLY HIGH LEVEL DUE TO EXTERNAL, VENTILATION, MACHINERY OR ADJACENT ROOM NOISES. THE MAXIMUM BAND LEVEL OF THE NOISE SPECTRAL DISTRIBUTION DETERMINES ITS NR CURVE RATING. SOUND INSULATION VALUES CAN BE USED TO CHECK SOUND PENETRATING AT EACH FREQUENCY BAND.



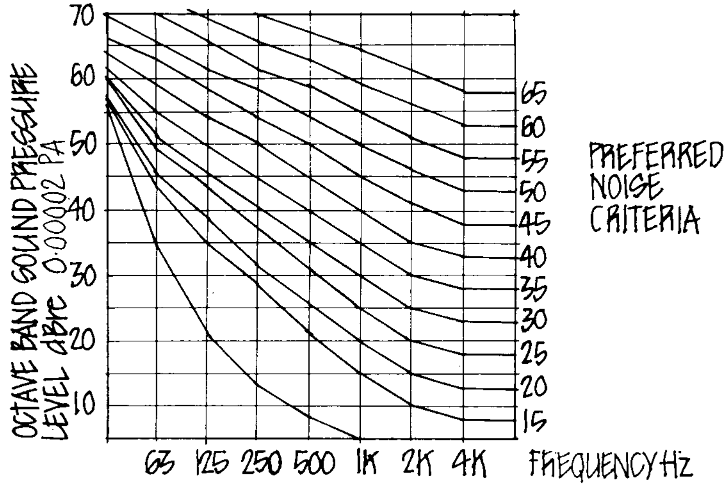
NOISE ANALYSIS IN A CANTEEN
SOURCE: PARKIN, HUMPHREYS AND COWELL.

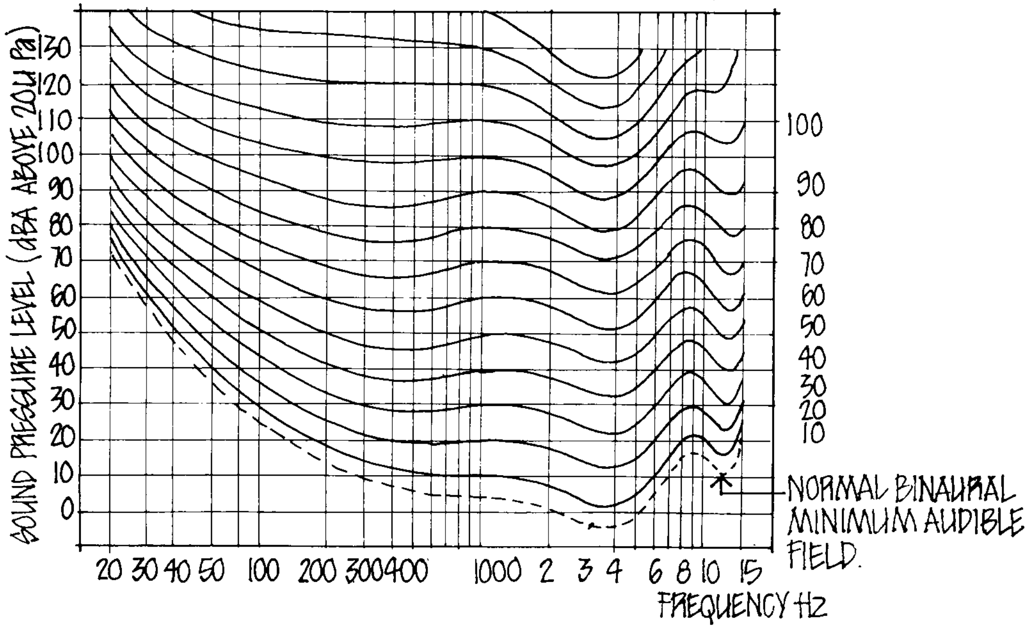
CARE SHOULD BE TAKEN THAT FIGURES USED ARE FOR OCTAVE BAND ANALYSIS AS ONE-THIRD OCTAVE BAND REQUIRES USE OF THE LHS. SET OF NR CURVES. BECAUSE OF THE REDUCED BAND-WIDTH COMPONENT INDIVIDUAL LEVELS ARE ABOUT 5dB DOWN AND THE 1/3 RD OCTAVE NR CURVES ALLOW FOR THIS. WHEN 1/3 RD OCTAVE BAND LEVELS ARE ADDED TOGETHER, A HIGHER FIGURE RESULTS AS THE LEVEL OVER THE WHOLE FREQUENCY RANGE.

RECOMMENDED NR. LEVELS FOR AMBIENT NOISE CONTROL TO SUIT USE	NR
STUDIOS SPACES FOR RECORDING OR BROADCAST	15
CONCERT HALLS	15-20
THEATRES, MULTI-PURPOSE HALLS CONFERENCE ROOMS, COURT ROOMS.	25
HOSPITAL WARDS, HOTEL BEDROOMS LIBRARIES	25-30
CLASSROOMS, MEETING ROOMS FOR SMALL GROUPS, EXECUTIVE OFFICES, HOMES.	30
RESTAURANTS, OPEN PLAN AND GENERAL OFFICES	35
CAFETERIAS, CIRCULATION	40
KITCHENS, TOILETS AND WORKSHOPS	45
CAR PARKS, SHOPPING MALLS, BUS, RAIL OR AIRPORT CONCOURSES.	50
OFFICE (TYPING, WORD PROCESS MACHINES)	55
WORKSHOPS, INDUSTRIAL PROCESS	65

DESIRABLE dB(A) CRITERIA 5-10 ABOVE RECOMMENDED NR LEVEL.

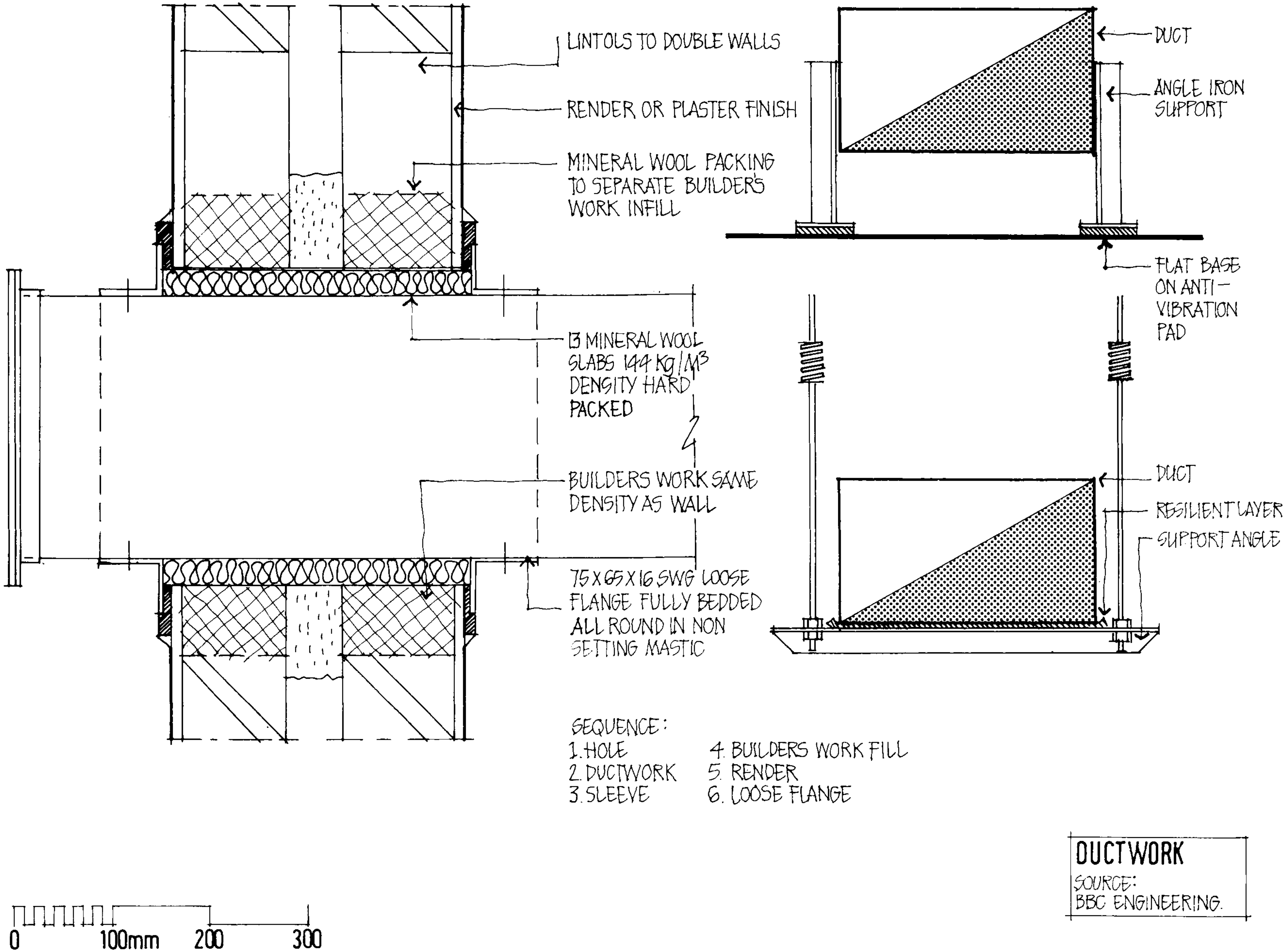
AMBIENT NOISE CONTROL (2)





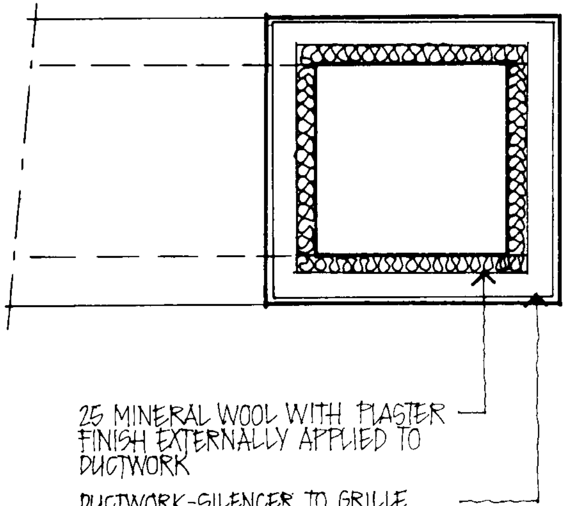
NR CURVES TEND TO BE USED IN EUROPE, WHERE AS IN THE USA THE 1971 PREFERRED NOISE CRITERIA (PNC) CURVES HAVE REPLACED THE EARLIER NOISE CRITERION (NC) CURVES. THEY HAVE, HOWEVER, NOT RECEIVED UNIVERSAL ACCEPTANCE.
COMPARISON WITH
THE EQUAL LOUDNESS CONTOURS SHOWS THE INTENTION OF EITHER SET OF CURVES TO REFLECT THE DIFFERENT SENSITIVITY OF EAR AT DIFFERENT PARTS OF THE FREQUENCY RANGE.

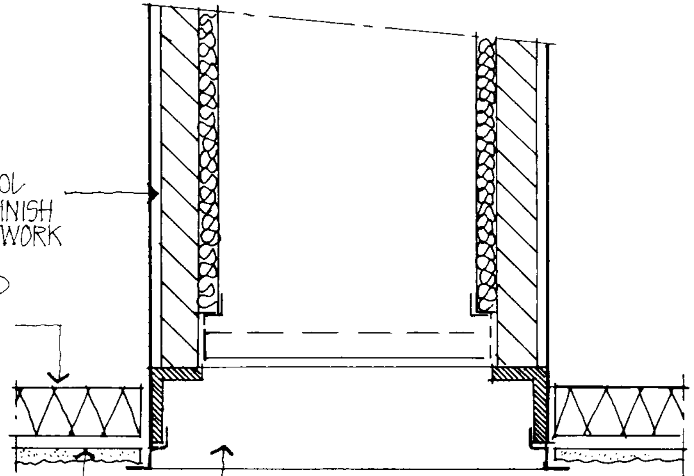
AMBIENT NOISE CONTROL (3)



DUCTWORK

SOURCE: BBC ENGINEERING.





DUCT LINING.

WHERE LARGE LOW AIR VELOCITY DUCTS ARE NECESSARY TO ACHIEVE LOW AMBIENT NOISE LEVELS, BUILDERS WORK DUCTS MAY BE AN ECONOMIC SOLUTION FOR BOTH SUPPLY AND EXTRACT.

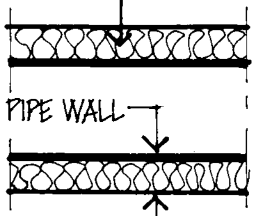
SUPPLY AIR/RETURN DIFFUSERS IN STUDIO CEILINGS.

ANALYSIS SEQUENCE FOR DUCT NOISE CONTROL:

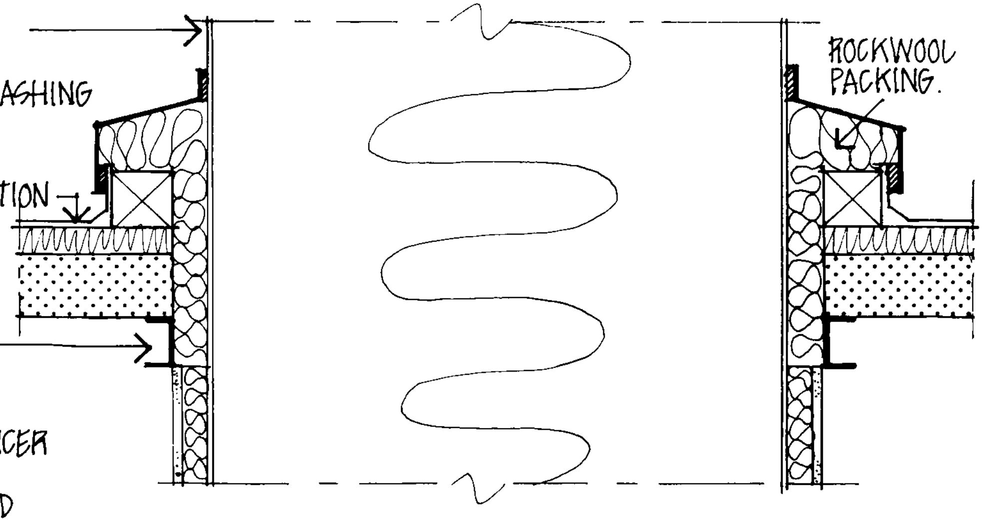
1. FAN NOISE-SUPPLY SIDE
2. FAN NOISE -EXTRACT SIDE
3. AIR THROUGH SYSTEM/ REGENERATED NOISE
4. BREAKOUT THROUGH DUCT WALLS
5. TRANSFER TO ATMOSPHERE
6. AIRBORNE TRANSMISSION OUT OF PLANT ROOMS.

DUCTWORK
SOURCE:
BBC ENGINEERING

not to scale



MASS LAGGING TO REDUCE PIPE NOISE



DUCT THROUGH ROOF

SOURCE: BDP

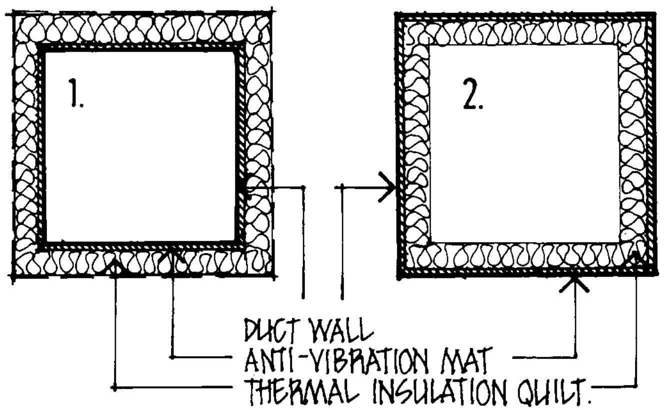
BELOW SILENCER, DUCT CASED ONLY WITH ACOUSTIC DAMPING MATERIAL. REVAC DD 2010 SA

DETAIL USED FOR A ROOF TOP H&V PLANT ON A SPORTS HALL. IT IS ADVISABLE TO AVOID OVERHEAD ROOF PLANT ON LONG SPAN AUDITORIA BECAUSE VIBRATION IS DIFFICULT TO DAMP AND IT IS DIFFICULT TO PREVENT NOISE BREAK-IN.

OPTIONS ON LAGGING

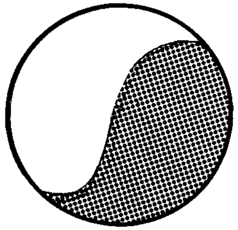
1. EXTERNAL CASING TO DUCT: EASIER TO APPLY AFTER INSTALLATION AND IF A LARGE Nº OF DUCTS ADDS SOUND ABSORPTION TO CEILING VOID OR ROOM.
2. INTERNAL - GIVES GOOD ATTENUATION TO DUCT-BORNE NOISE, BETTER APPEARANCE IF IN EXPOSED LOCATION

1 OR 2mm REDUC OR SIMILAR SOUND REDUCING MAT IS PARTICULARLY USEFUL IN LARGE DUCT SECTIONS WHERE DUCT WALLS CAN BE SET INTO EXCITATION BY AIR TURBULENCE (ESPECIALLY AT REDUCTION SECTIONS, T OR ELBOW JUNCTIONS.)

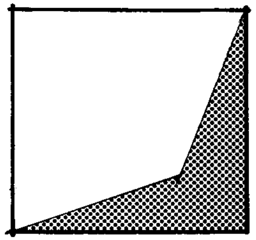


DUCTWORK

not to scale

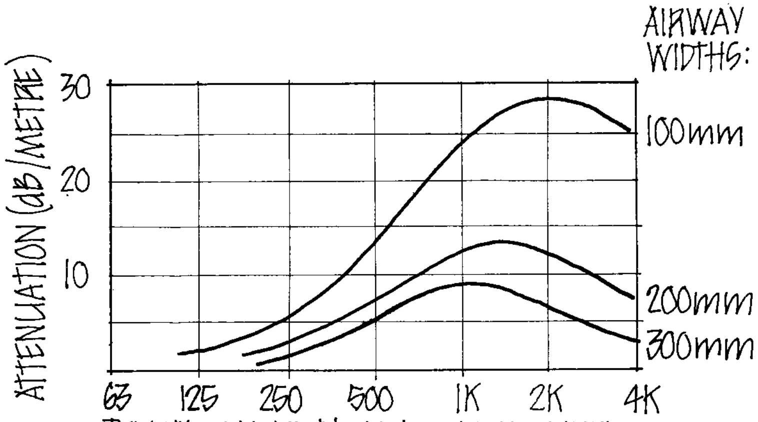


Vs.

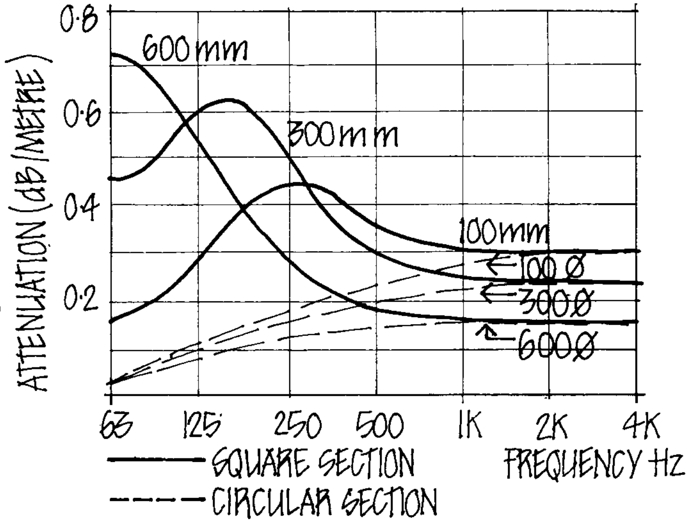


CIRCULAR DUCTS ARE INHERENTLY RIGID AND OF MINIMUM PERIMETER FOR SECTIONAL AREA: NOISE IS CONTAINED WITHIN RATHER THAN TRANSMITTED THROUGH DUCT TO SPACE. USE OF CIRCULAR DUCTWORK MAY THEREFORE BE PREFERABLE FOR EXPOSED INSTALLATIONS. CIRCULAR ATTENUATORS TEND TO BE LESS EFFICIENT: OFTEN TRANSFORMATION PIECES FROM CIRCULAR DUCTWORK TO RECTANGULAR SILENCERS ARE USED IN PRACTICE.

RECTANGULAR DUCTS HAVE LESS RIGID WALLS AND NOISE WITHIN EXCITES THE FLAT METAL SECTIONS. THIS GIVES USEFUL LOW FREQUENCY ATTENUATION ALONG DUCTS. THERE IS ALSO A LARGER INTERNAL AREA FOR LINING WITH MINERAL WOOL: USE OF SQUARE OR RECTANGULAR DUCTWORK IS BEST FOR INSTALLATIONS MOUNTED IN CEILINGS, SUPPLYING OR EXTRACTING AIR AT A LOW NOISE LEVEL, INHERENT ATTENUATION MAY ALLOW ECONOMY OF ATTENUATORS ALONG DUCTS. LINING DUCTS IS PARTICULARLY EFFECTIVE FOR SMALL DUCTS AND FOR HIGHER FREQUENCIES.

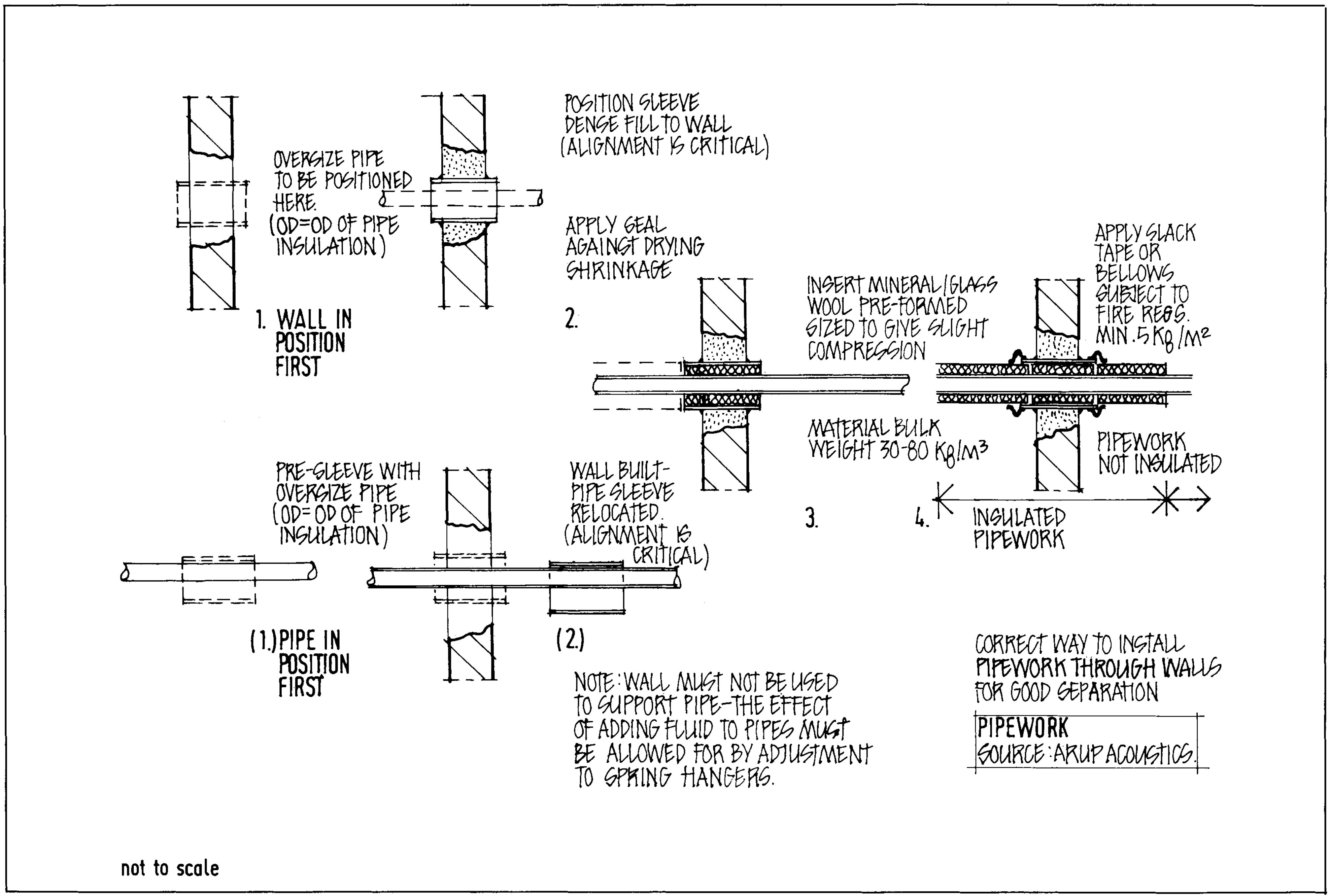


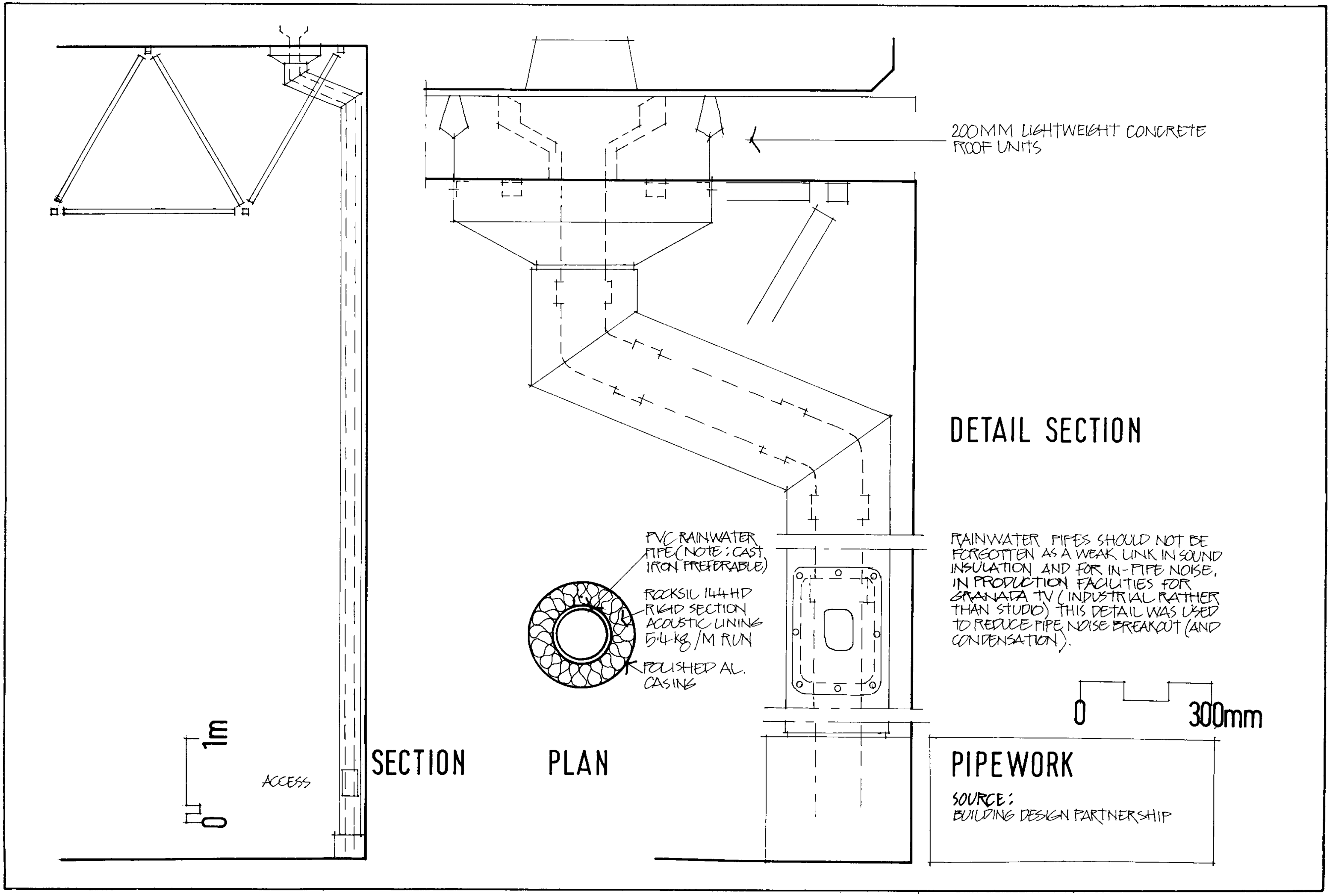
TYPICAL ATTENUATION FOR DUCTS LINED WITH 25 MINERAL WOOL

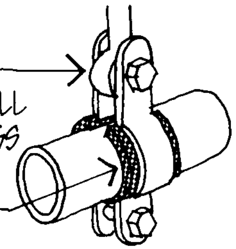


TYPICAL ATTENUATION ALONG UNLINED DUCTS.

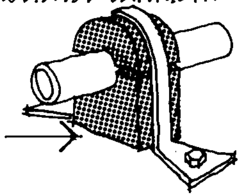
AIR HANDLING DUCTWORK
SOURCE: PARKIN HUMPHREYS & COWELL


OVERSIZE PIPE TO BE POSITIONED HERE. (OD=OD OF PIPE INSULATION)
1. WALL IN POSITION FIRST
POSITION SLEEVE DENSE FILL TO WALL (ALIGNMENT IS CRITICAL)
APPLY SEAL AGAINST DRYING SHRINKAGE
2.
INSERT MINERAL/GLASS WOOL PRE-FORMED SIZED TO GIVE SLIGHT COMPRESSION
MATERIAL BULK WEIGHT 30-80 Kg/M³
3.
APPLY SLACK TAPE OR BELLOWS SUBJECT TO FIRE REGS. MIN. 5 Kg/M²
PIPEWORK NOT INSULATED
4.
INSULATED PIPEWORK
PRE-SLEEVE WITH OVERSIZE PIPE (OD=OD OF PIPE INSULATION)
(1.) PIPE IN POSITION FIRST
WALL BUILT-PIPE SLEEVE RELOCATED. (ALIGNMENT IS CRITICAL)
(2.)
NOTE: WALL MUST NOT BE USED TO SUPPORT PIPE-THE EFFECT OF ADDING FLUID TO PIPES MUST BE ALLOWED FOR BY ADJUSTMENT TO SPRING HANGERS.
CORRECT WAY TO INSTALL PIPEWORK THROUGH WALLS FOR GOOD SEPARATION
PIPEWORK
SOURCE: ARUP ACOUSTICS
not to scale

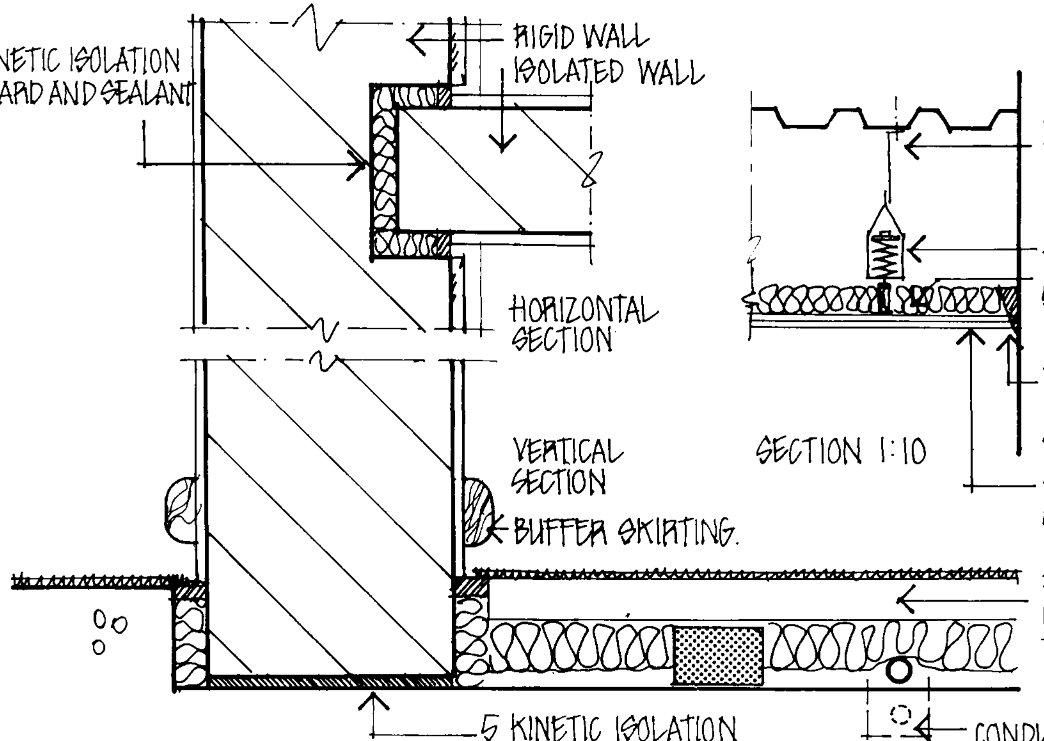

200MM LIGHTWEIGHT CONCRETE ROOF UNITS
DETAIL SECTION
PVC RAINWATER PIPE (NOTE: CAST IRON PREFERABLE)
ROCKSIL 144HD RIGID SECTION ACOUSTIC LINING 5.4 kg/M RUN
POLISHED AL. CASING
RAINWATER PIPES SHOULD NOT BE FORGOTTEN AS A WEAK LINK IN SOUND INSULATION AND FOR IN-PIPE NOISE. IN PRODUCTION FACILITIES FOR GRANADA TV (INDUSTRIAL RATHER THAN STUDIO) THIS DETAIL WAS USED TO REDUCE PIPE NOISE BREAKOUT (AND CONDENSATION).
0
300mm
1m
0
ACCESS
SECTION
PLAN
PIPEWORK
SOURCE:
BUILDING DESIGN PARTNERSHIP

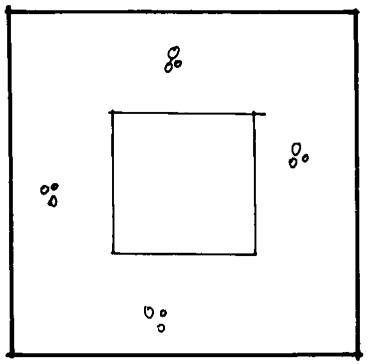


ALTERNATIVELY GROUP PIPES ON A RESILIENTLY MOUNTED CARRIER.

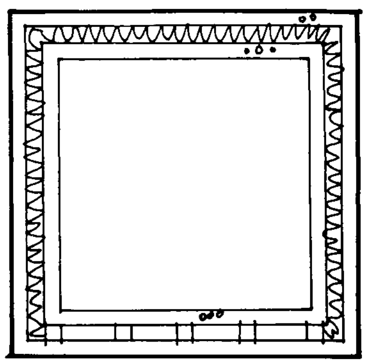


RESILIENT PIPE MOUNTINGS AVOID NOISE TRANSMITTED ALONG PIPES BEING REGENERATED VIA STRUCTURE, AND THERMAL MOVEMENT 'CLICKING' AT PIPE FIXINGS





MASS LAW



COMPOSITE CONSTRUCTION

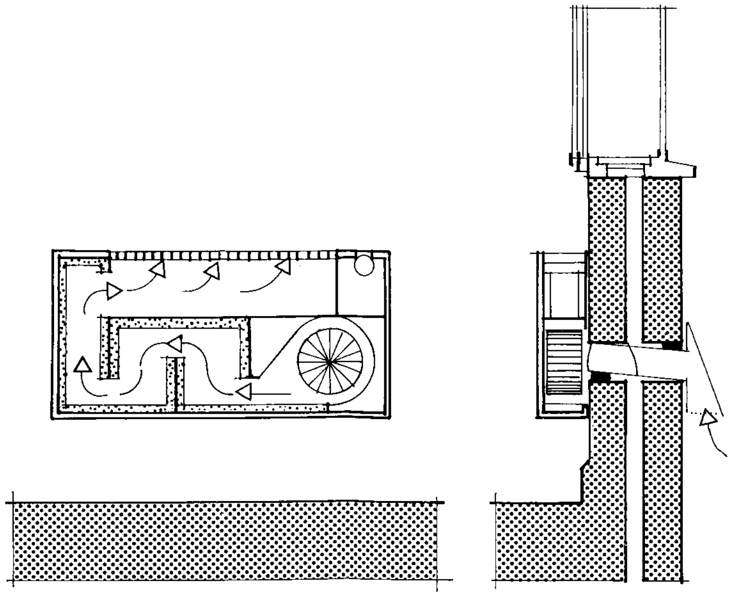
ISOLATOR SYSTEM ENABLES GREATER SOUND REDUCTION TO BE ACHIEVED THAN 3X MASS. EACH DOUBLING OF MASS ONLY ACHIEVES AN EXTRA 5 dB ON SRI. VALUE.

ENCLOSURES WITH EQUIVALENT SRI (SOUND REDUCTION INDEX dB).

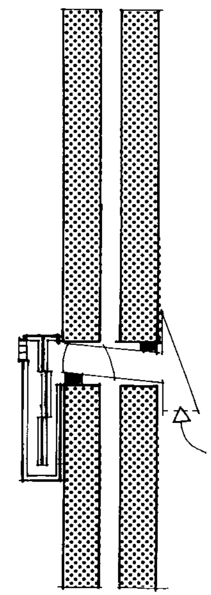
NOTE: LIGHTWEIGHT COMPOSITE CONSTRUCTION SUITABLE IN EG. OFFICES TO PREVENT TRANSMISSION OF SPEECH (HIGHER FREQUENCIES) BUT HEAVY COMPOSITE CONSTRUCTION REQUIRED TO SCREEN LOW FREQUENCIES EG. PLANT NOISE.

NOISE ISOLATION
SOURCE: SOUND ATTENUATORS LTD.

not to scale

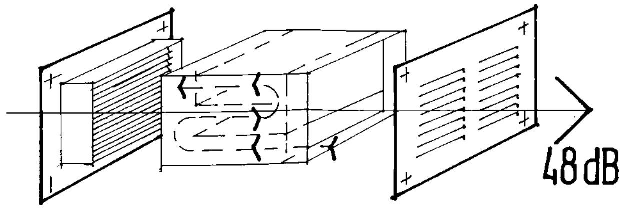


MECHANICAL VENTILATOR.



PERMANENT VENTILATOR

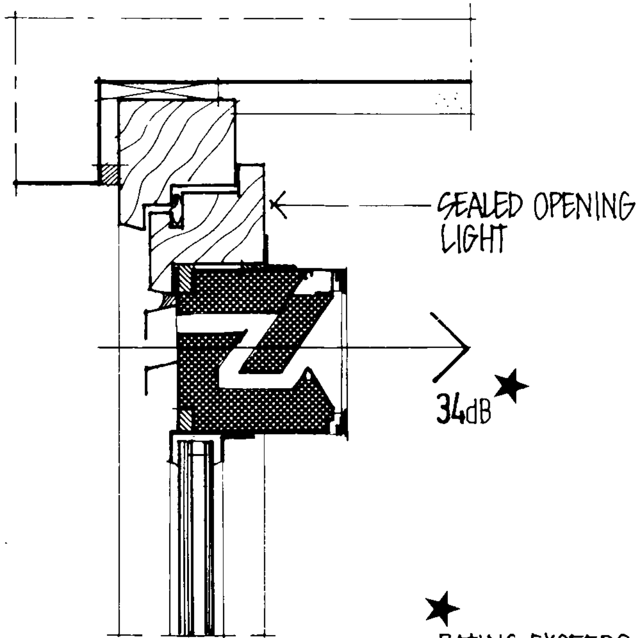
VENTILATORS WORK BY LABYRINTHE PATHS FOR AIRWAYS LINED WITH SOUND ABSORBING MATERIAL ABSORBING EXTERNAL NOISE THE FAN IN THE POWERED VERSION MUST ITSELF BE QUIET. GRANTS ALLOW USE IN LIVING ROOMS AND BEDROOMS.

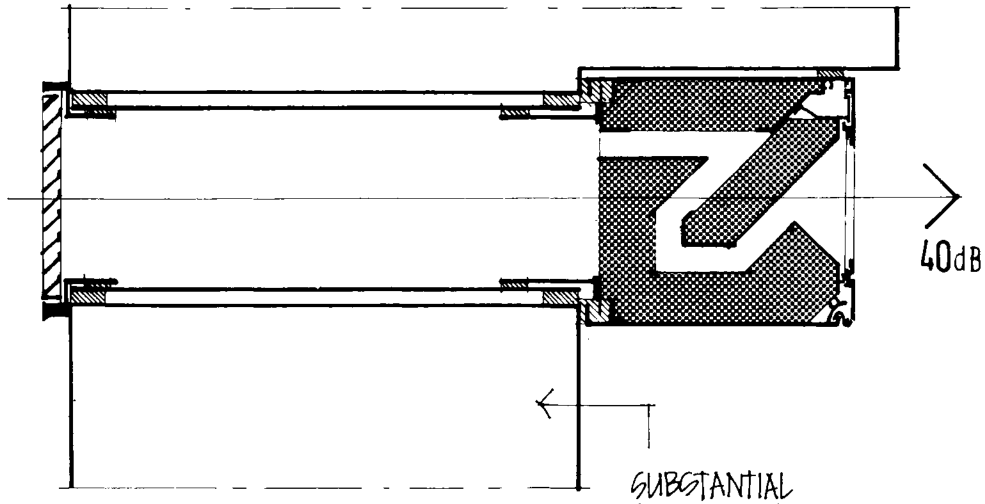


'AIRBRICK' TYPE VENTILATOR BUILT INTO WALL

WALL VENTILATORS HAVE BEEN USED WIDELY BY LOCAL AUTHORITIES. IN HOUSES NEAR NOISY MOTORWAYS, RAILWAYS OR AIRPORTS TO ALLOW NATURAL VENTILATION.

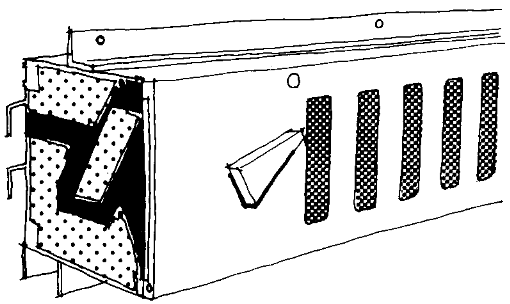
VENTILATORS





★
RATING EXCEEDS
PATH VIA GLAZING

SUBSTANTIAL
MASONRY WALL



MODEL Z100F

LINEAR SOUND-ABSORBERS VENTILATORS
ANODISED ALUMINIUM BODIES. VENTILATION
POTENTIAL UP TO 200 M^3 OF AIR/HOUR/METRE
LENGTH. SEE ALSO VENTILATOR SHOWN UNDER 'HOUSING.' USE
IN OFFICES, HOUSING.

MODEL ZR 150

SECTIONS
SECTIONAL SIZES
100 X 100, 150 X 150

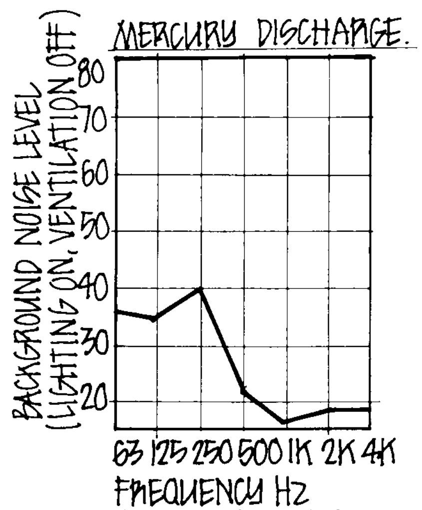
VENTILATORS
SOURCE: GH. UNITAS.

not to scale

TUNGSTEN

TUNGSTEN LAMPS GIVE OFF NEGLIGIBLE NOISE EXCEPT WHEN ABOUT TO FAIL: THE FILAMENTS THEN 'RATTLE'. TUNGSTEN LIGHTING IS THEREFORE USED FOR ANECHOIC CHAMBERS AND OTHER NOISE SENSITIVE ROOMS. DIMMER CONTROLS ON LIGHTING MAY CAUSE SOME NOISE AT LOW ILLUMINATION SETTING.

MERCURY DISCHARGE.



AIRBORNE SOUND.

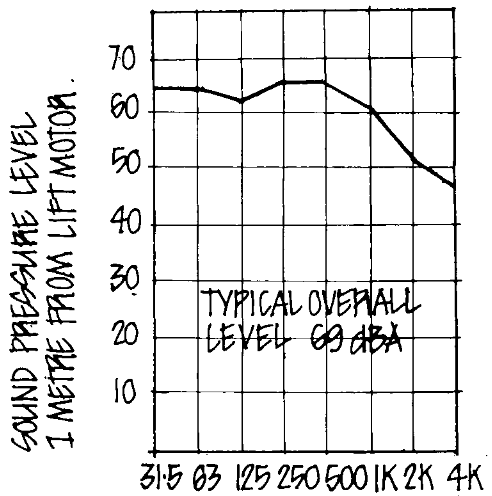
POWERFUL LIGHTING MAY CAUSE SIGNIFICANT NOISE AT SOME PARTICULAR FREQUENCY. THE DISTRIBUTION AT LHS IS A TOTAL OF 55 400W LUMINAIRES (TYPE HPI MBI SPECIAL SPORTS LIGHTS) MOUNTED UNDER HIGH LEVEL CATWALKS. IN A MULTI-PURPOSE SPORTS HALL OF 11300 CU.M. AND RT=2 SECONDS AT MID FREQUENCY. AMBIENT SOUND LEVEL FOR SPORTS LIGHTING ON, HOUSE LIGHTS AND VENTILATION OFF CORRESPONDS TO NR=30.

SOURCE: SANDY BROWN ASSOCIATES.

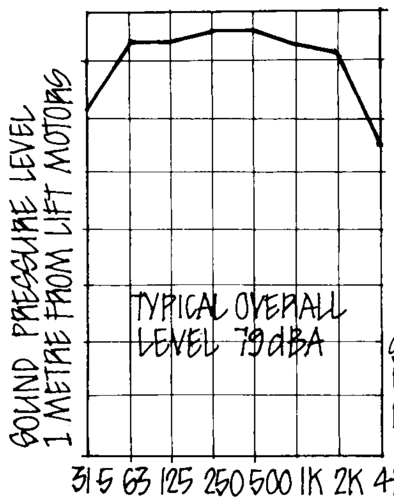
FLUORESCENT.

THERE IS A GREAT VARIATION OF NOISE FROM THE MAIN SOURCE, THE CONTROL GEAR, EVEN FOR FITTINGS OF THE SAME TYPE FROM THE SAME MANUFACTURER. THE LAMINATED IRON CORE PRODUCES NOISE DUE TO MAGNETISATION OF THE LAMINATIONS, VARYING ACCORDING TO THE TYPE OF CIRCUIT AND WATTAGE RATING. THE METHOD OF MOUNTING FITTINGS AFFECTS NOISE OUTPUT: HANGING FITTINGS ARE PREFERABLE TO SOLID FIXING. IN SENSITIVE AREAS, REMOTE CONTROL GEAR MAY HAVE TO BE CONSIDERED. INDIVIDUAL FITTINGS MAY NOT BE NOISY. FOR INSTANCE A FITTING RECENTLY TESTED HAD A WORST CASE SWL OF 23.3dB AT 630 Hz.
HOWEVER, 32 SUCH FITTINGS IN A ROOM AS A TYPICAL ARRANGEMENT WERE CALCULATED TO PRODUCE A SOUND LEVEL APPROXIMATING NR=25 AT 630 Hz
SOURCE: UNIVERSITY OF SALFORD

LIGHTING

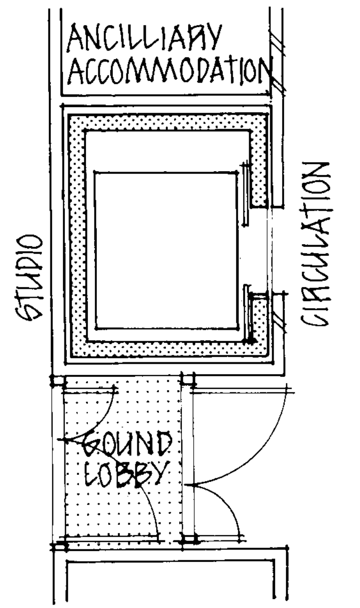


SINGLE HYDRAULIC LIFT MOTOR/ PUMP UNIT.



DOUBLE HYDRAULIC LIFT MOTOR /PUMP UNITS

SOURCE: BENNIE LIFTS LTD

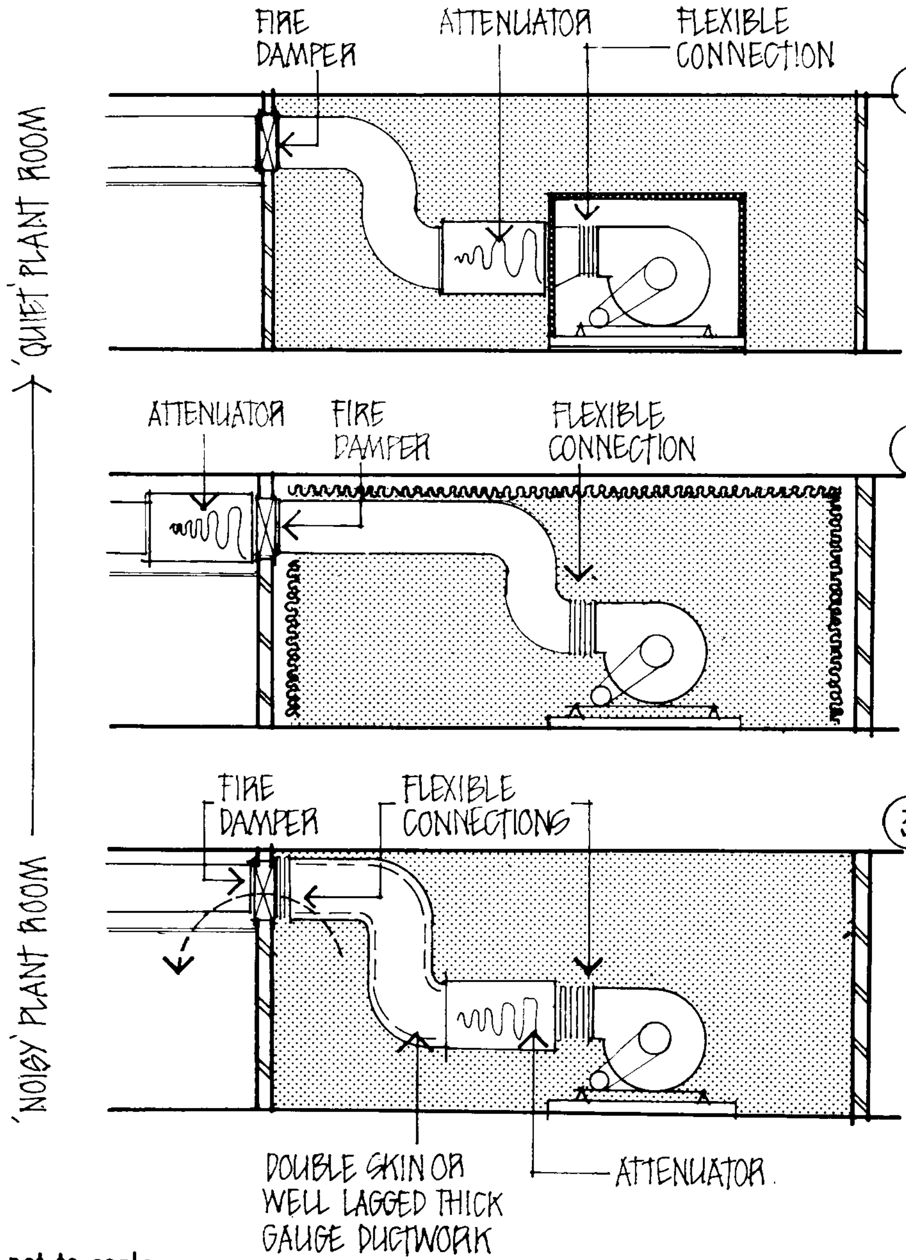


TYPICAL ISOLATED SHAFT PLAN ARRANGEMENT.

1. HYDRAULIC LIFT MOTORS ARE MORE NOISY THAN ELECTRIC MOTORS: MINIMISE BY SPECIFYING PUMP AND MOTOR TO BE SUBMERSIBLE TYPE AND TO HAVE CASINGS LINED WITH SOUND DEADENING MATERIAL.
2. SELECT LIFT DOORS FOR QUIET OPERATION
3. CHECK HIGH SPEED/HIGH RISE LIFTS FOR WIND NOISE UPSHAFT
4. ALL MACHINERY TO BE ON ANTI-VIBRATION MOUNTINGS
5. AVOID BUILDERS WORK HOLES BETWEEN LIFT SHAFTS AND OTHER AREAS.
6. CHOOSE ELECTRONIC PROXIMITY SWITCHES ETC. AS A WAY OF AVOIDING 'CLICKING' WORKING PARTS IN CONTROL GEAR
7. ENSURE GOOD MAINTENANCE OF LIFTS.
8. IN REFURBISHMENT SCHEMES, CHECK NOISE FROM EXISTING LIFT INSTALLATIONS (OLDER TYPES, ESPECIALLY OPEN SHAFT, WERE FAR NOISIER.)

LIFT NOISE IS OF PARTICULAR CONCERN IN HOTELS OR HOSPITALS WHERE THE NOISE LEVELS FROM MACHINERY MAY NOT BE HIGH, BUT THE DISCONTINUITY OF OPERATION DRAWS ATTENTION TO THE NOISE. TYPICAL SOUND LEVELS WITHIN LIFT CAR ARE 65dB FOR HYDRAULIC, 60 dB FOR ELECTRIC OPERATION.

LIFTS



1. NOISE ENCLOSED AT SOURCE

ACOUSTIC ENCLOSURES TO NOISY ITEMS OF PLANT WITHIN PLANT ROOM

A.V. MOUNTS TO ISOLATED BASE.

GOOD TO ENCLOSE NOISE AT SOURCE BUT THIS MAY NOT BE POSSIBLE IF THERE ARE MANY NOISE SOURCES, OR PLANT ITEMS REQUIRING COMPLETE ACCESS AND VENTILATION TO ALL SIDES.

2. PLANT ROOM LINED WITH SOUND ABSORBENT QUILT SPACED OFF WALLS.

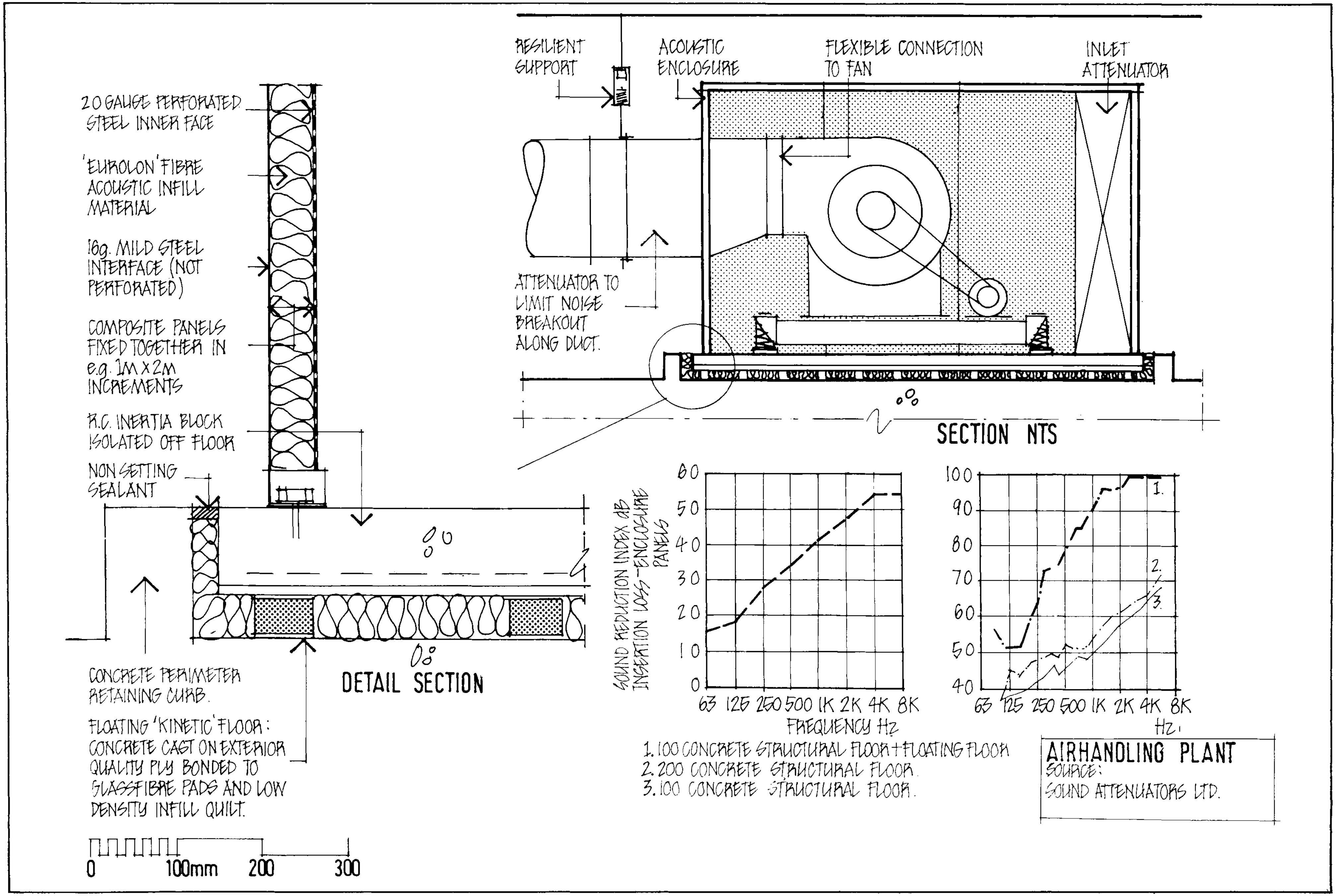
ENCLOSURE OF INDIVIDUAL ITEMS OF PLANT MAY NOT BE PRACTICAL. LINING OF PLANT ROOM MAY REDUCE REVERBERANT SOUND.

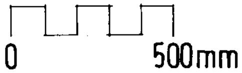
3. SUBSTANTIAL ROOM ENCLOSURE ENSURES ISOLATION. GOOD INSULATION VALUE TO WALLS, ROOF, FLOOR: SEPARATE STRUCTURE IF POSSIBLE. AIRBORNE SOUND LEVEL INSIDE PLANTROOM HIGH, PARTICULARLY WITH AMPLIFICATION FACTOR OF HARD FINISHES WHICH INCREASE NOISE LEVEL WITHIN BY UP TO 9 dB.

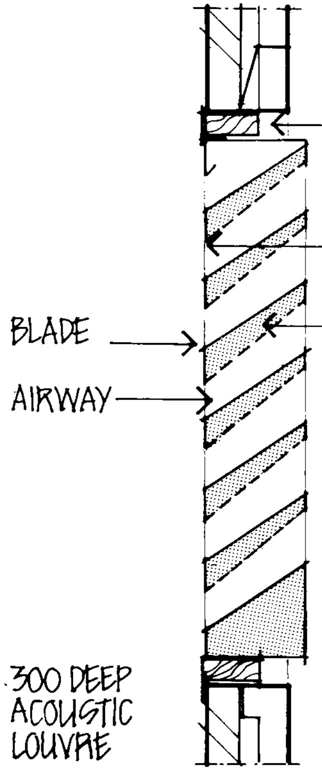
PARTICULAR CARE RE. NOISE BREAKOUT VIA DUCTWORK NECESSARY. FOR VERY NOISY PLANT AND SENSITIVE ROOMS AROUND ALL MEASURES MAY BE NECESSARY: ENCLOSURE OF PLANT, LININGS TO PLANT ROOM, SUBSTANTIAL FABRIC.

PLANTROOMS

not to scale


20 GAUGE PERFORATED STEEL INNER FACE
'EUROLON' FIBRE ACOUSTIC INFILL MATERIAL
16g. MILD STEEL INTERFACE (NOT PERFORATED)
COMPOSITE PANELS FIXED TOGETHER IN e.g. 1M X 2M INCREMENTS
R.C. INERTIA BLOCK ISOLATED OFF FLOOR
NON SETTING SEALANT
CONCRETE PERIMETER RETAINING CURB.
FLOATING 'KINETIC' FLOOR: CONCRETE CAST ON EXTERIOR QUALITY PLY BONDED TO GLASSFIBRE PADS AND LOW DENSITY INFILL QUILT.
DETAIL SECTION
0 100mm 200 300
RESILIENT SUPPORT
ACOUSTIC ENCLOSURE
FLEXIBLE CONNECTION TO FAN
INLET ATTENUATOR
ATTENUATOR TO LIMIT NOISE BREAKOUT ALONG DUCT.
SECTION NTS
SOUND REDUCTION INDEX dB INSERTION LOSS - ENCLOSURE PANELS
0 10 20 30 40 50 60
63 125 250 500 1K 2K 4K 8K
FREQUENCY Hz
40 50 60 70 80 90 100
63 125 250 500 1K 2K 4K 8K
Hz.
1.
2.
3.
1. 100 CONCRETE STRUCTURAL FLOOR + FLOATING FLOOR
2. 200 CONCRETE STRUCTURAL FLOOR.
3. 100 CONCRETE STRUCTURAL FLOOR.
AIRHANDLING PLANT
SOURCE:
SOUND ATTENUATORS LTD.

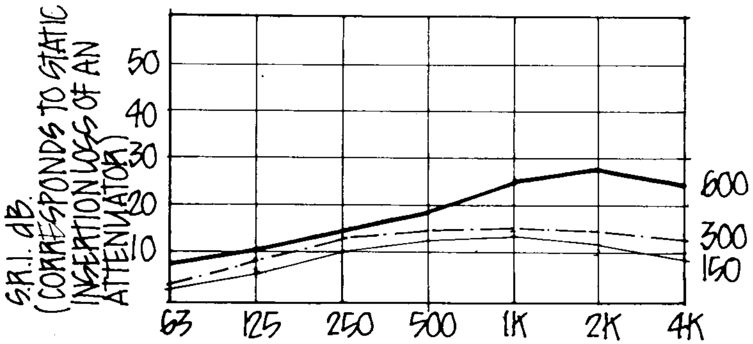




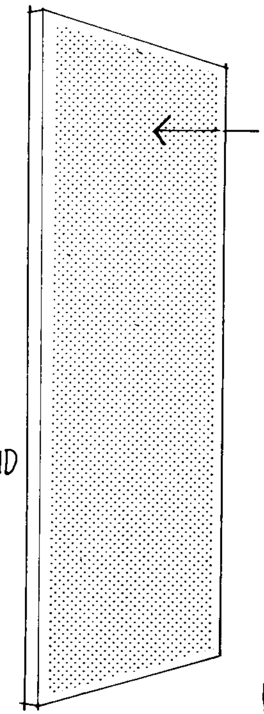
300 DEEP ACOUSTIC LOUVRE

LOUVRES CAN ALSO BE USED IN DOORS OR AS ENCLOSING PANELS

SOURCE:
BESTOBELL ACOUSTICS LTD (150 AND 300 DEEP)
SOUND SOLUTIONS LTD (600 DEEP).
PERFORMANCE DEPENDS TO A DEGREE ON PANEL SIZE AND AIR VELOCITY: OVER 4 M/SEC NOT RECOMMENDED.



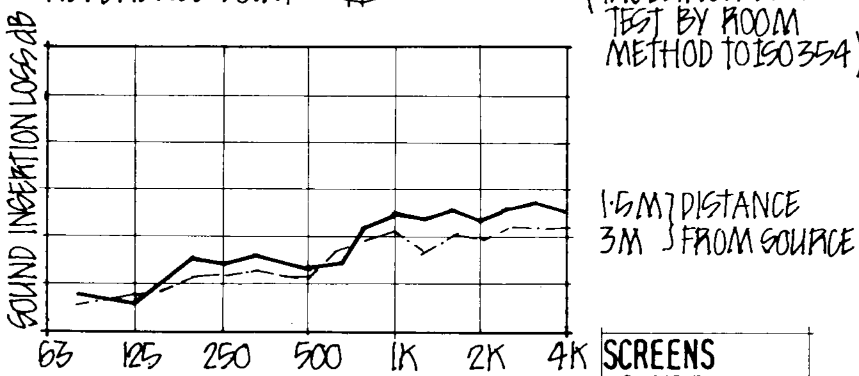
INSERTION LOSS IS DEFINED AS THE SOUND LEVEL DIFFERENCE BEFORE AND AFTER INSERTING A SOUND ABSORBER OR BARRIER BETWEEN NOISE SOURCE AND REFERENCE POINT.



·15 ·40 ·80 ·90 ·90 ·85

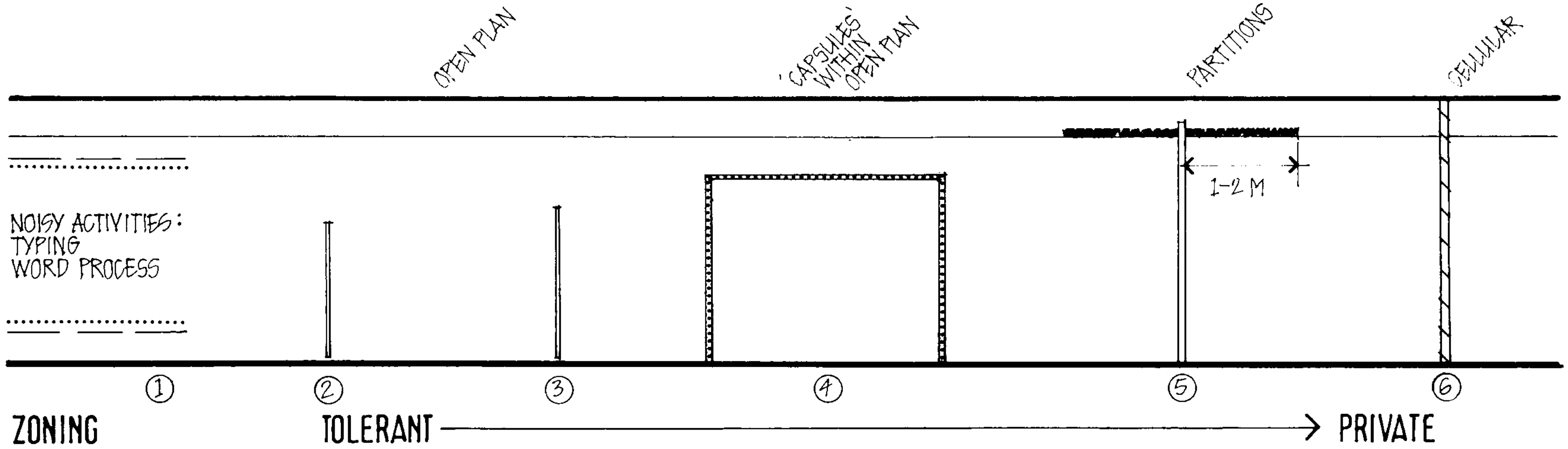
SOURCE: LUND INSTITUTE OF TECHNOLOGY

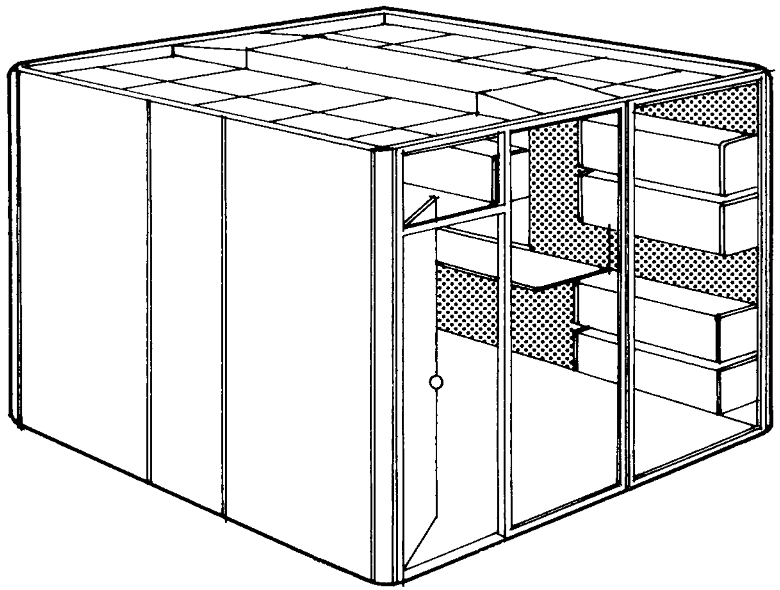
(INSERTION LOSS TEST BY ROOM METHOD TO ISO 354)



SCREENS
LOUVRES

BUILDING TYPES





HERMAN MILLER EXECUTIVE OFFICE LOCATED WITHIN AN OPEN PLAN OFFICE

OPTIONS IN SELECTING COMPONENT ASSEMBLIES

① GROUP NOISY ACTIVITIES AND ISOLATE OR SCREEN. INCLUDE LOTS OF ABSORPTION.

② SCREENS TO HEAD HEIGHT, 1800 mm.

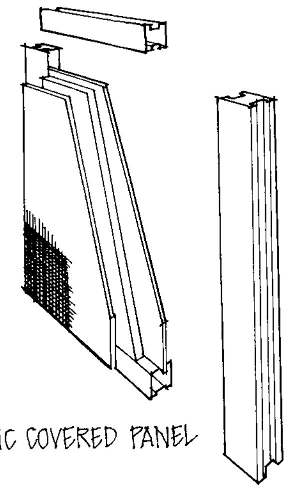
③ SCREENS TO GREATER HEIGHT, 2100 OR 2400 mm. SEPARATION BY SCREENING <20 dBA BETWEEN WORK STATIONS

④ SENIOR MANAGEMENT OR CONFIDENTIAL MEETING ROOMS WITHIN OVERALL SPACE. CAN BE MOVED. SEPARATE VENTILATION OR TRANSFER VENTILATION.

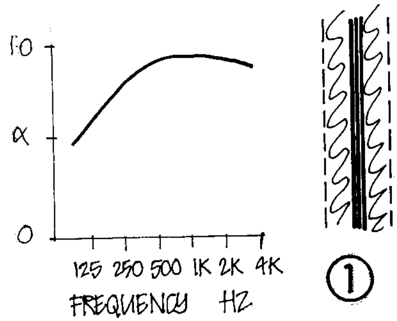
⑤ LIGHT PARTITIONS STOPPED OFF AT CEILING. DENSE QUILT OR LEAD FOIL IN CEILING BY PARTITION REDUCES CEILING VOID FLANKING.

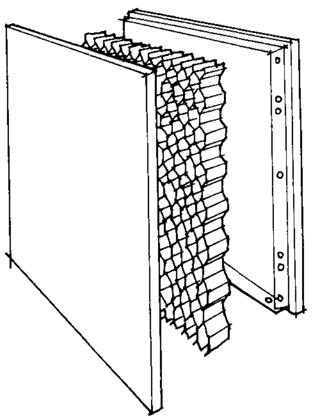
OPTIONS IN SELECTING COMPONENT ASSEMBLIES.

OFFICES

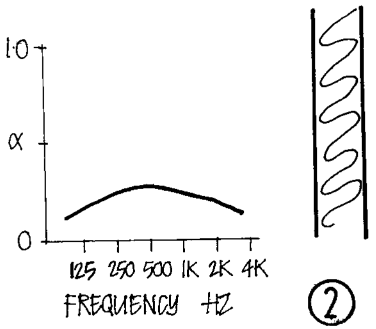


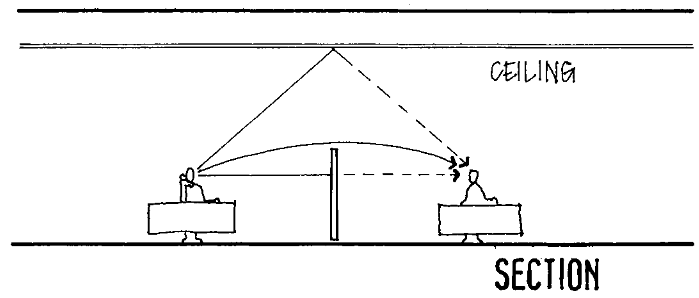
FABRIC COVERED PANEL

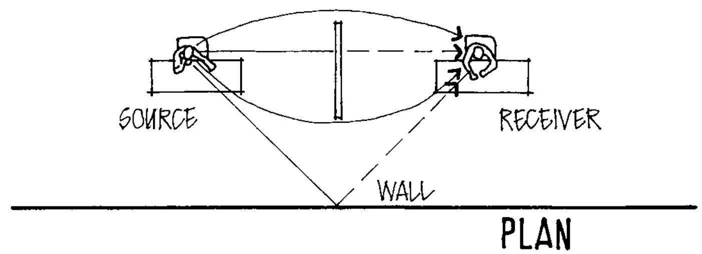




METAL PANEL



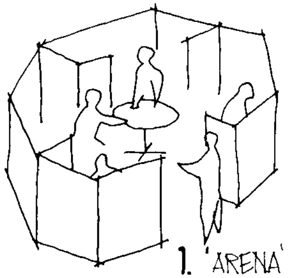




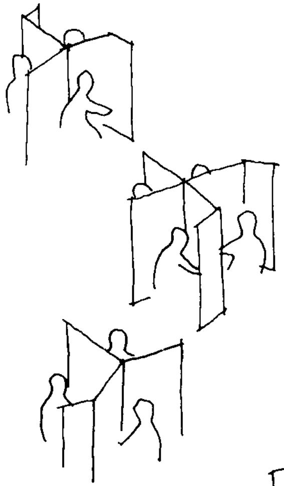
FOR A REASONABLE SPACING OF OCCUPANTS EG. 12-14 M² / PERSON SOUND ATTENUATION BETWEEN WORKPLACES ONLY 20-25 dBA MAX. EMPIRICAL FORMULA TO CHECK ADEQUATE PRIVACY: BACKGROUND NOISE (dBA) + SOUND ATTENUATION ≥ 75. BY THIS CRITERIA MANY OFFICES HAVE AN AMBIENT LEVEL TOO LOW AND MASKING SOUND MAY BE CONSIDERED.

IN CHOOSING PARTITION SYSTEMS OR DIVIDER PANELS, **LOOK FOR SANDWICH OF ABSORPTION-SOLID CORE-ABSORPTION** IF A GOOD ABSORPTION RATING (OVER 0·6) IS REQUIRED. BOTH EXAMPLE 1 AND 2 ABOVE ARE EFFECTIVE AS SCREENS. GOOD ABSORPTION AT 1-2 K IMPORTANT TO MASK SPEECH.

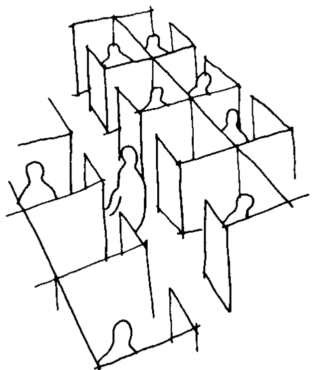
OPEN PLAN OFFICES



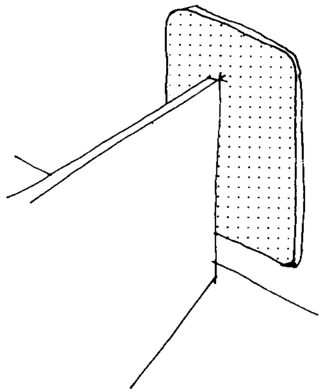
1. 'ARENA' EFFECT ALLOWS PEOPLE TO WORK ON THE PERIMETER OF A SPACE BUT TURN INWARDS FOR DISCUSSION.



2. 'SPOKE' LAYOUTS CAUSE UNCOMFORTABLE BACK EXPOSURE AND NOISE INTRUSION FROM NEAR BUT HIDDEN NEIGHBOURS



3. 'CUBICLES' GIVE HIGH DENSITY AND INVISIBILITY BUT LITTLE ACOUSTIC PRIVACY



TO AVOID REFLECTED SOUND AT PERIMETER CURTAIN WALL, TRAP SOUND BY ENCLOSING ABSORPTIVE END PANELS.

LAYOUT TYPE		STAFF ATTITUDES	
FREEFLOW	12%	NATURE OF COMMON COMPLAINTS AND REQUESTS:	
PLANNED TO WORKFLOW AND RELATIONSHIPS	60%	MORE PRIVACY	42%
		INTERNAL NOISE	42%
DIVISION BY ACOUSTIC SCREENS	44%	TEMPERATURE	42%
		VENTILATION	38%
DIVISION BY FURNITURE	32%	TOO MUCH DISTRACTION	25%
		DRAUGHTS	17%
DIVISION BY HALF HEIGHT PARTITIONS	16%	BETTER FURNITURE	12%
		BETTER LAYOUT	8%

RESULTS OF A LARGE U.K. OFFICE USE SURVEY
SOURCE: SPACE PLANNING SERVICES

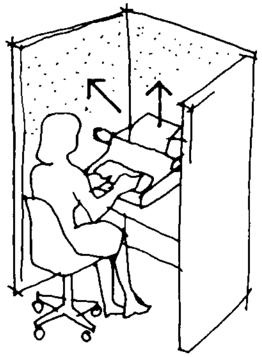
ABILITY TO CONVERSE AS A FUNCTION OF BACKGROUND NOISE

NOISE LEVEL (NR)	MAX DISTANCE FOR NORMAL CONVERSATION (M) ABSORBENT	REFLECTING	Nº PEOPLE IN CONFERENCE
30	8	50	50
35	6	25	20
40	4	10	10
50	2	2	4
55	1	1	2

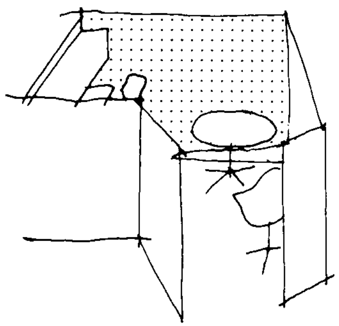
SOURCE: R.A. WALLER. APPLIED ACOUSTICS (2) 1961 PP 121-130

OPEN-PLAN OFFICES

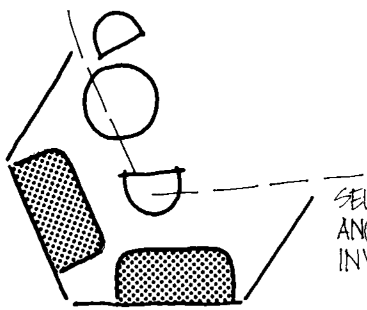
SOURCE: HERMAN MILLER RESEARCH CORPORATION.



ENCLOSE NOISY ACTIVITIES USE SCREENS EXTENDING TO FLOOR.



L-SHAPED WORKSPACES AFFORD PRIVACY

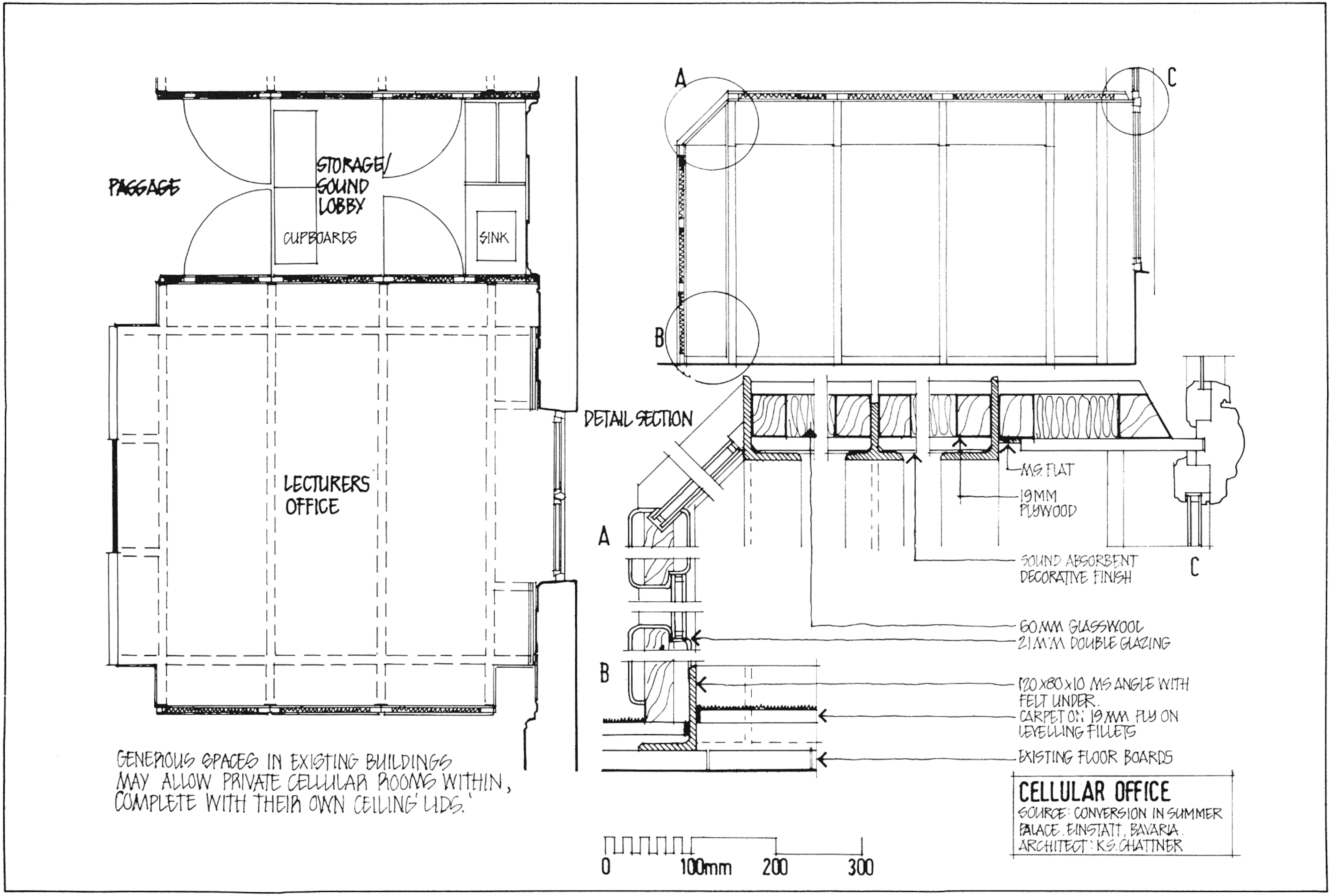


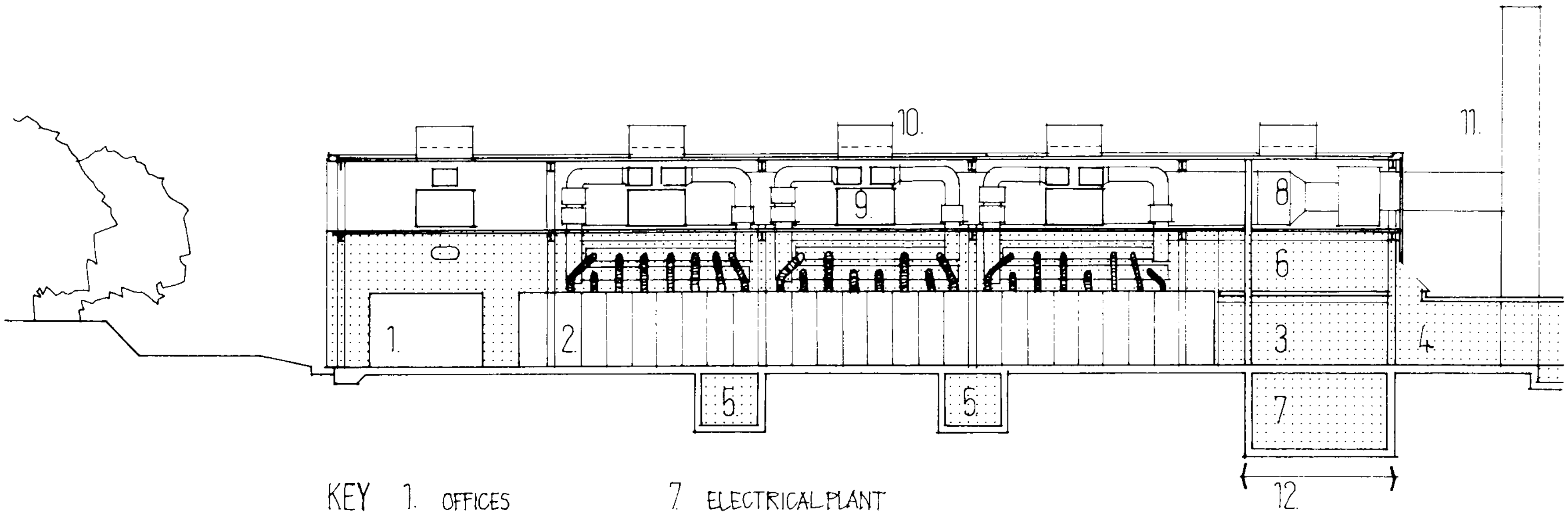
SELECTION OF WORK ANGLES ALLOWS VARIETY. INWARD FACE FOR PRIVACY.

DESIGN GUIDE

1. DESIGN IN A SPACE OVER 11 METRES WIDE.
2. PLAN 12M²/PERSON INCLUDING CIRCULATION
3. ZONE OFFICE MACHINES APART AND SCREEN.
4. DEVELOP 'ARENA' ORIENTATION LAYOUTS
5. CONTAIN BACKGROUND SOUND LEVEL WITHIN RANGE 40-50dBA
6. DEVELOP GOOD SCREEN LAYOUTS AVOID 'SPOKES' AND 'CUBICLES'.
7. LOCATE ACOUSTIC PANELS AROUND SOUND SOURCES TO BE CONTROLLED. WITHIN 1200.
8. DESIGNATE 1/3 PANELS TO BE ACOUSTIC RATHER THAN HARD SURFACE.
9. CHOOSE HIGH (2100) PANELS WHERE WORKERS STAND OR CIRCULATE
10. CHOOSE A HIGH ABSORPTION CEILING
11. CHOOSE A THICK CARPET ON A DENSE UNDERLAY.
12. CONSIDER WHETHER MASKING BACKGROUND SOUND MAY BE NECESSARY
13. MINIMISE NOISE FROM IMPULSE OR INTERMITTENT SOURCES - TELEPHONES, TYPEWRITERS, VDUS.
14. CHECK FOR SPEECH PRIVACY: GOOD IF A LISTENER 5 METRES FROM A PERSON READING AT NORMAL CONVERSATIONAL LEVEL CAN ONLY UNDERSTAND 10% OF SPEECH (STANDARD SPEECH ARTICULATION TEST). INCREASE ABSORPTIVE SCREENS IF NECESSARY.
15. CHECK RT: GENERAL OFFICE DESIRED MID FREQUENCY 0·70 SECONDS. EXECUTIVE OFFICES 0·5 SEC, OPEN PLAN 0·45.

OPEN-PLAN OFFICES
SOURCE: HERMAN MILLER RESEARCH CORPORATION.

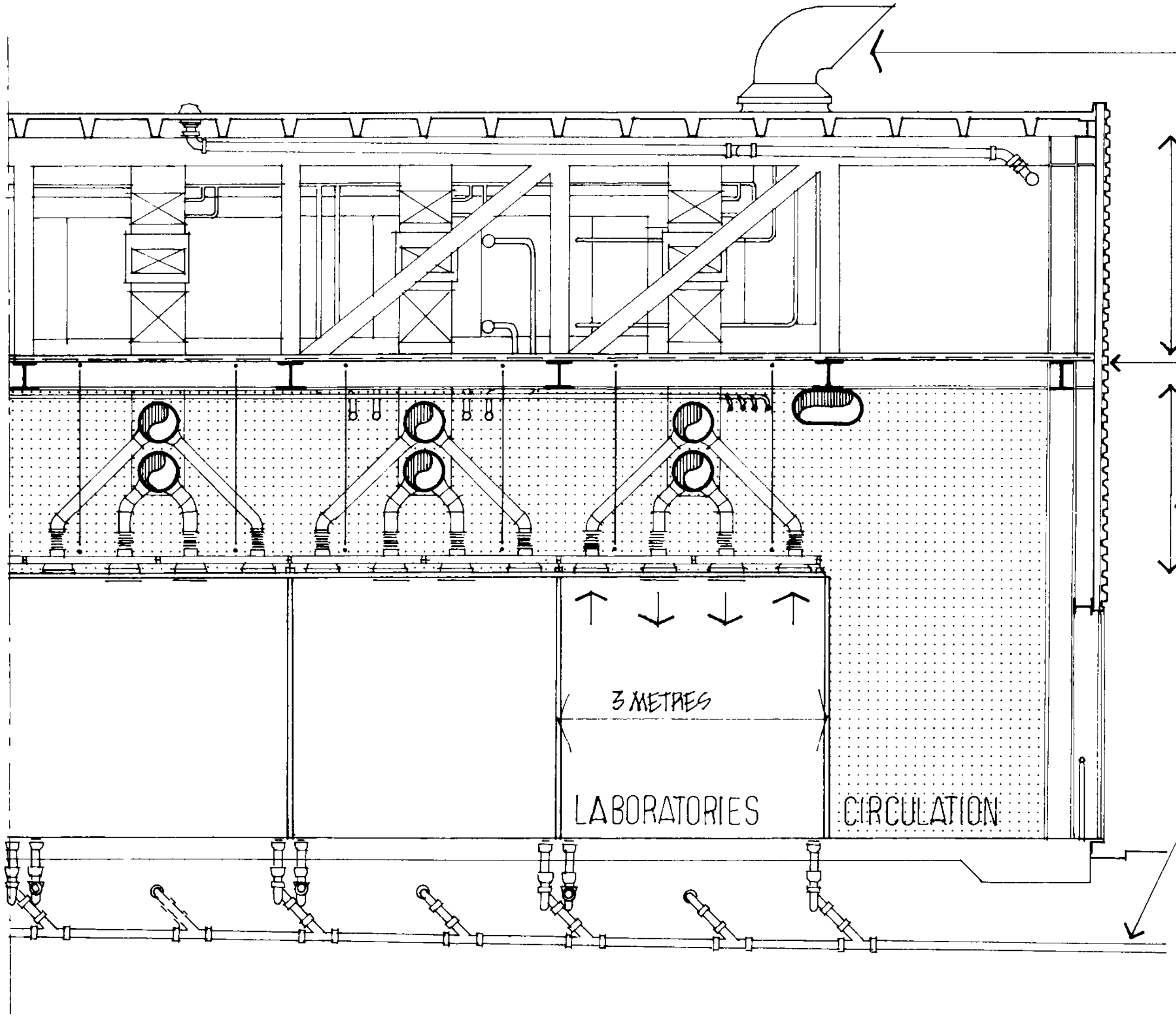

PASSAGE
STORAGE/ SOUND LOBBY
CUPBOARDS
SINK
LECTURERS OFFICE
DETAIL SECTION
A
B
C
M.S. FLAT
19MM PLYWOOD
SOUND ABSORBENT DECORATIVE FINISH
60 MM GLASSWOOL
21 M'M DOUBLE GLAZING
120 x 80 x 10 MS ANGLE WITH FELT UNDER.
CARPET ON 19 MM PLY ON LEVELLING FILLETS
EXISTING FLOOR BOARDS
0
100mm
200
300
GENEROUS SPACES IN EXISTING BUILDINGS MAY ALLOW PRIVATE CELLULAR ROOMS WITHIN, COMPLETE WITH THEIR OWN 'CEILING LIDS.'
CELLULAR OFFICE
SOURCE: CONVERSION IN SUMMER PALACE, EINSTATT, BAVARIA.
ARCHITECT: K.S. CHATTNER



KEY
1. OFFICES
2. LABORATORY BOX
3. TOILETS
4. LINK
5. DRAINAGE
6. MECHANICAL PLANT
7 ELECTRICAL PLANT
8. EXTRACT PLANT
9. SUPPLY PLANT
10. AIR INTAKES
11. EXHAUST SHAFT
12. SERVICE CORE

NOISE ZONING:
SMALLER ACTIVITIES CARRIED ON WITHIN LARGE SPACES BY ENCLOSURE WITHIN THE OVERALL SPACE.

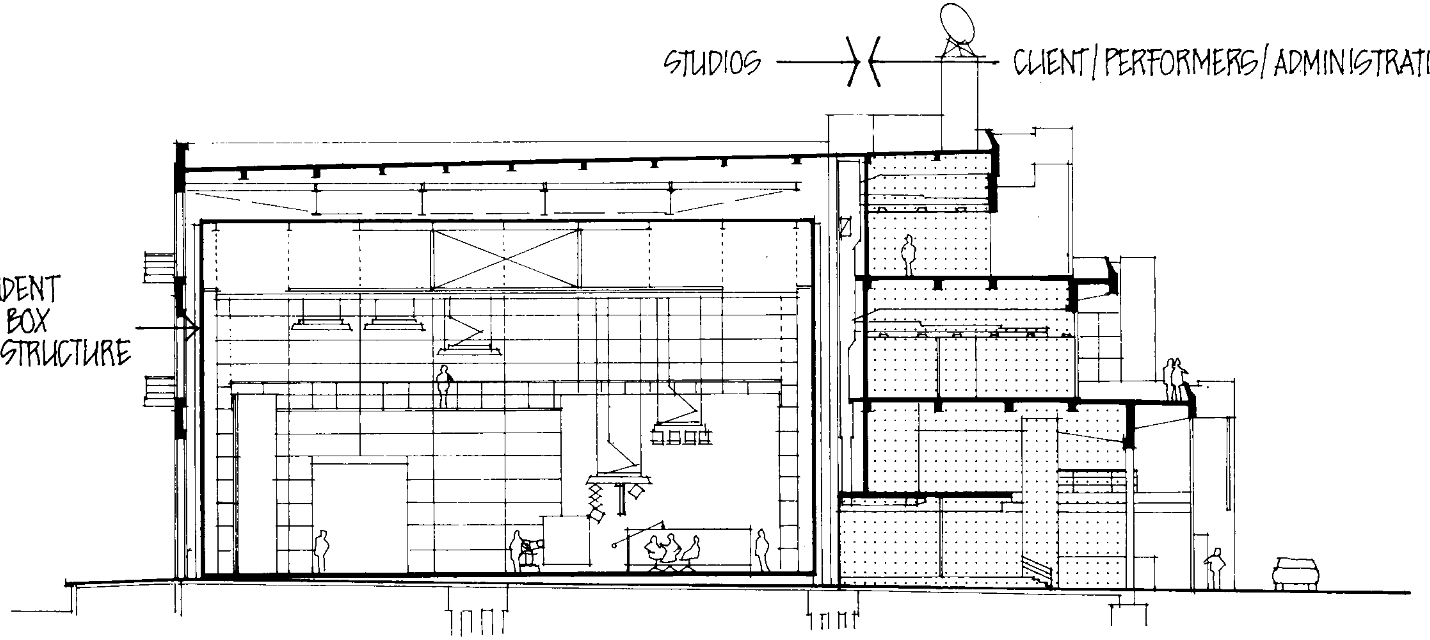
LABORATORY (1)
SOURCE: BDP.

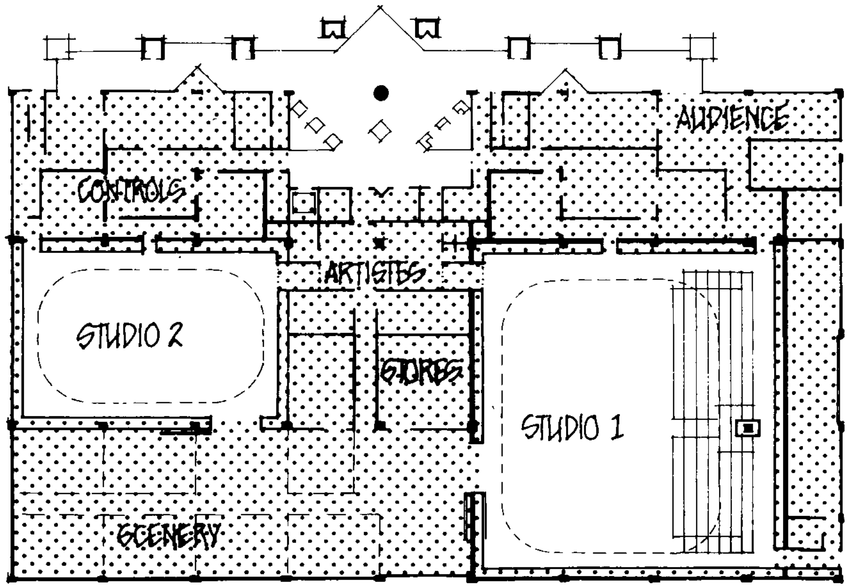


LABORATORY (2)

SOURCE: BDP

not to scale



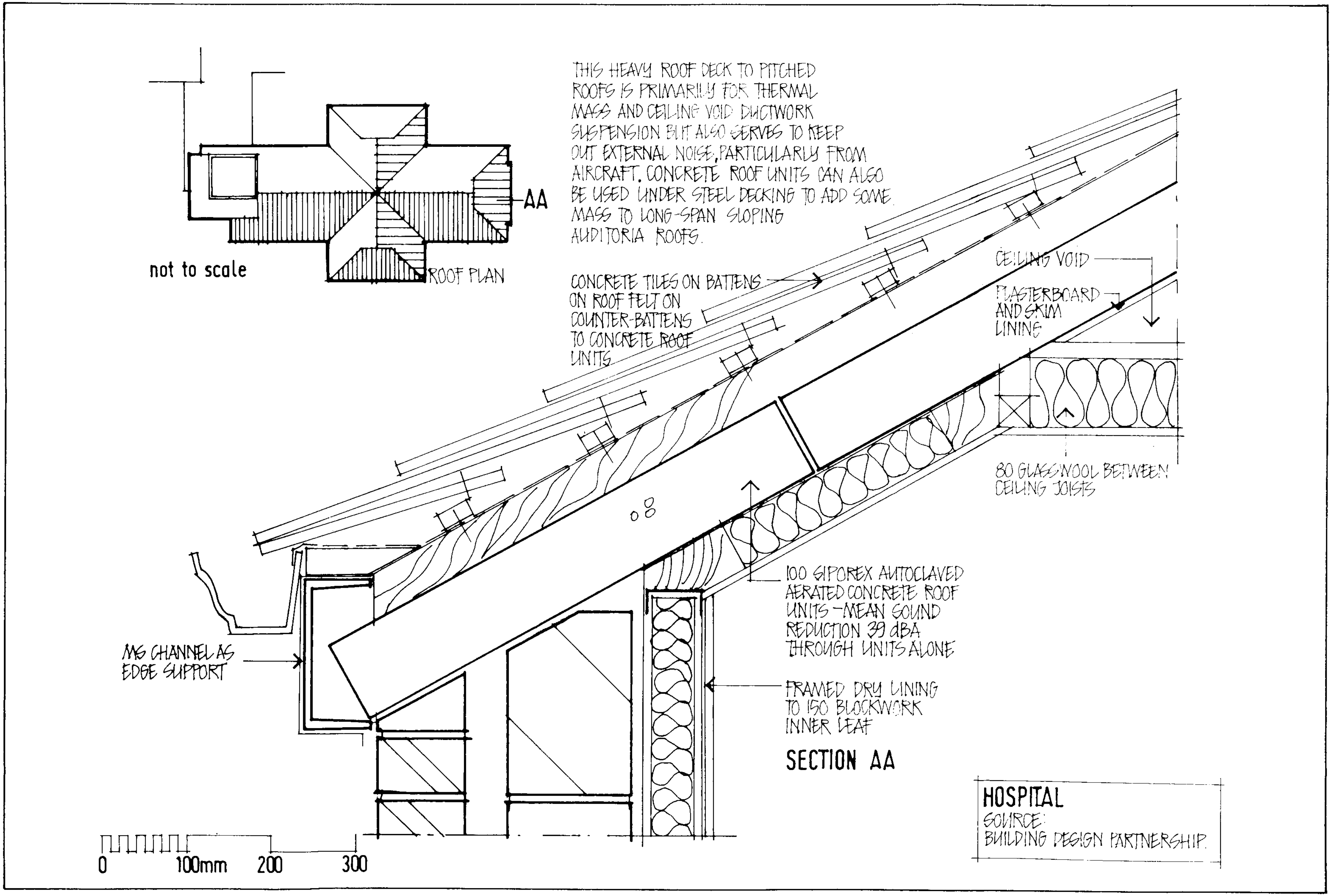


NEW STUDIOS, LONDON, INCORPORATE AN ELECTRO-ACOUSTIC SYSTEM INTEGRATED INTO THE INDEPENDENT STRUCTURE. THIS IS DESIGNED TO ADJUST REVERBERATION TIME BETWEEN 0·8 SECONDS AND 1·4 SECONDS TO SUIT PERFORMERS

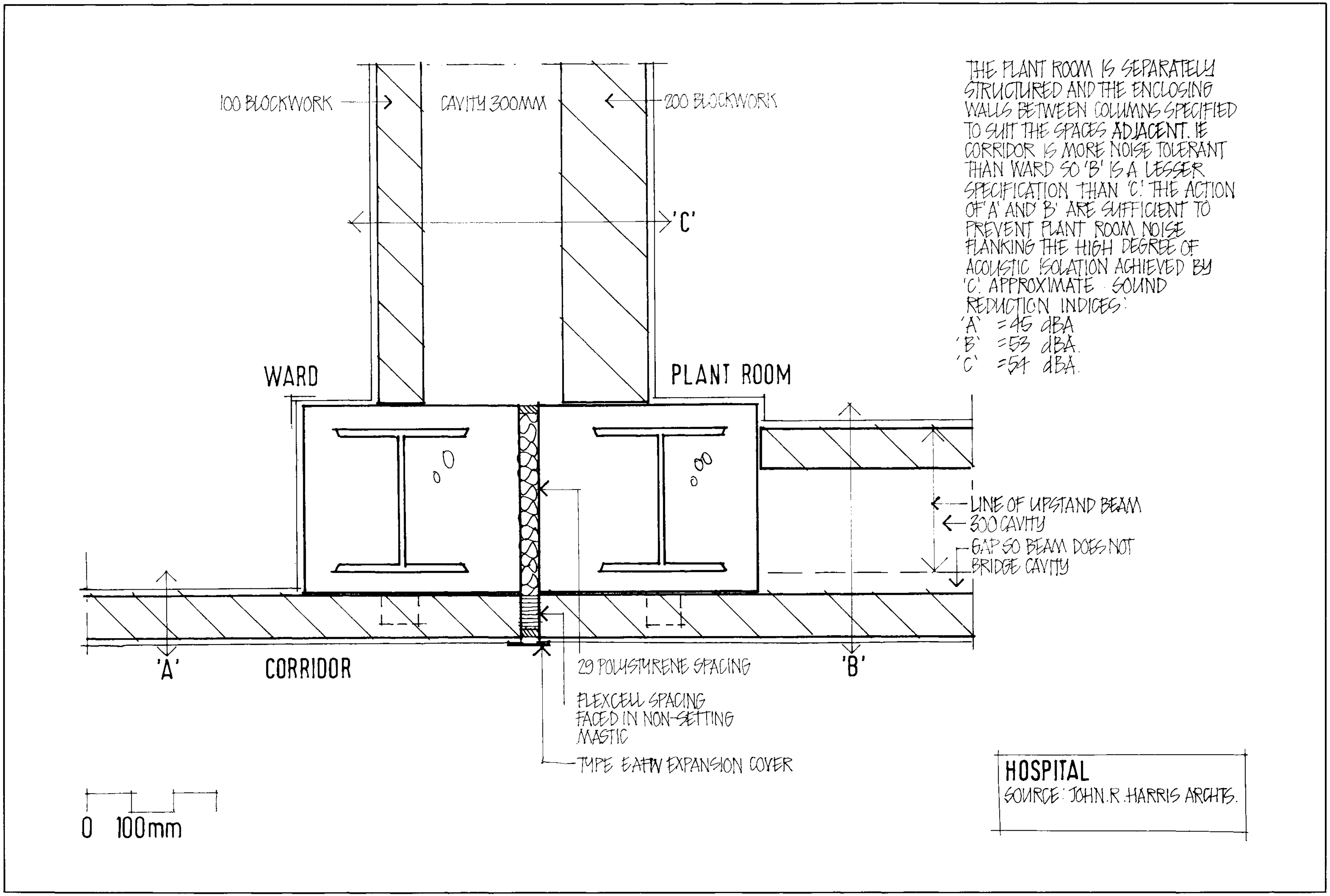
CELLULAR ACCOMMODATION BUFFERS STUDIOS FROM PUBLIC AREAS.

TV STUDIOS
SOURCE: TERRY FARRELL PARTNERSHIP ARCHITECTS., SANDY BROWN ASSOC. ACOUS.

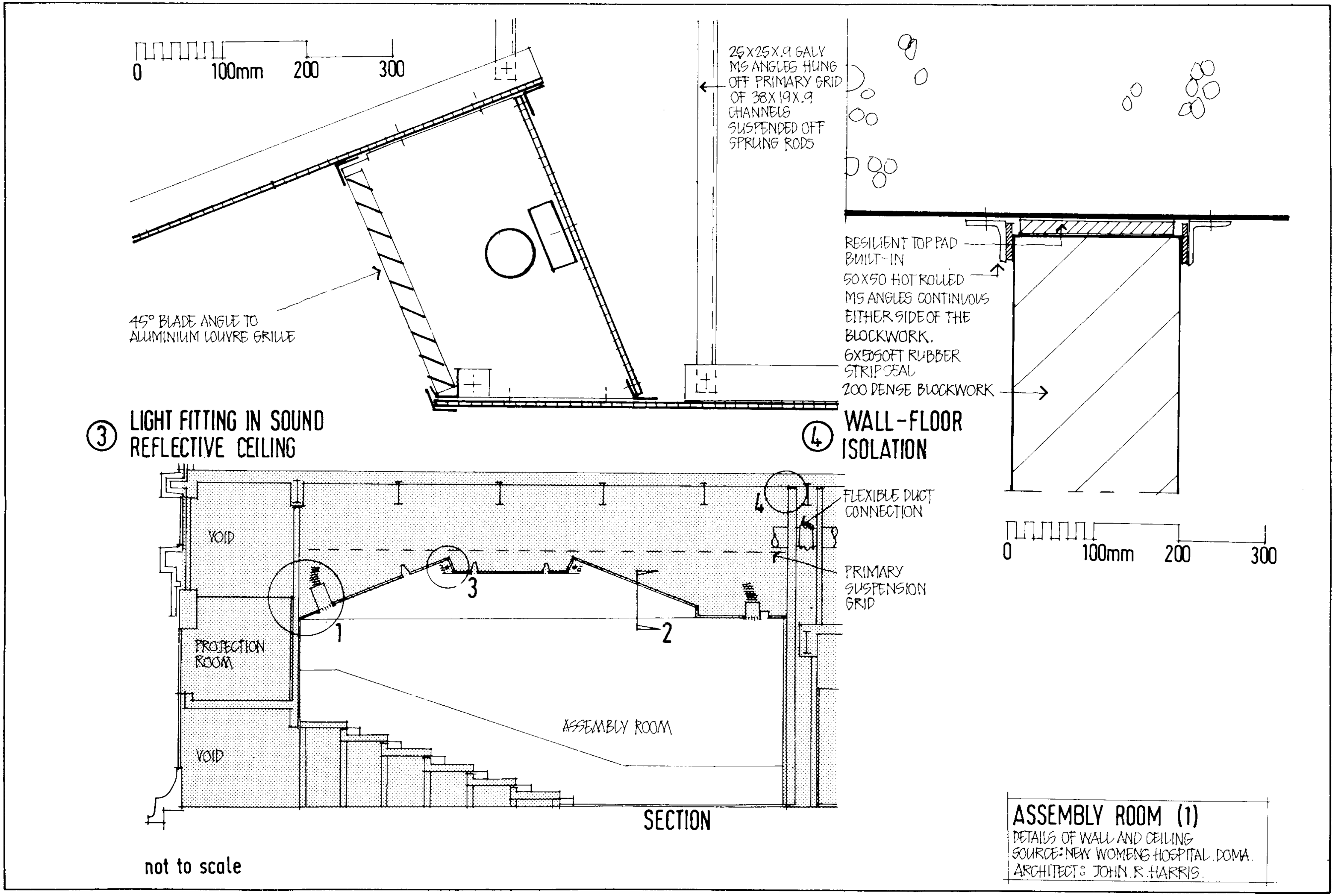
not to scale

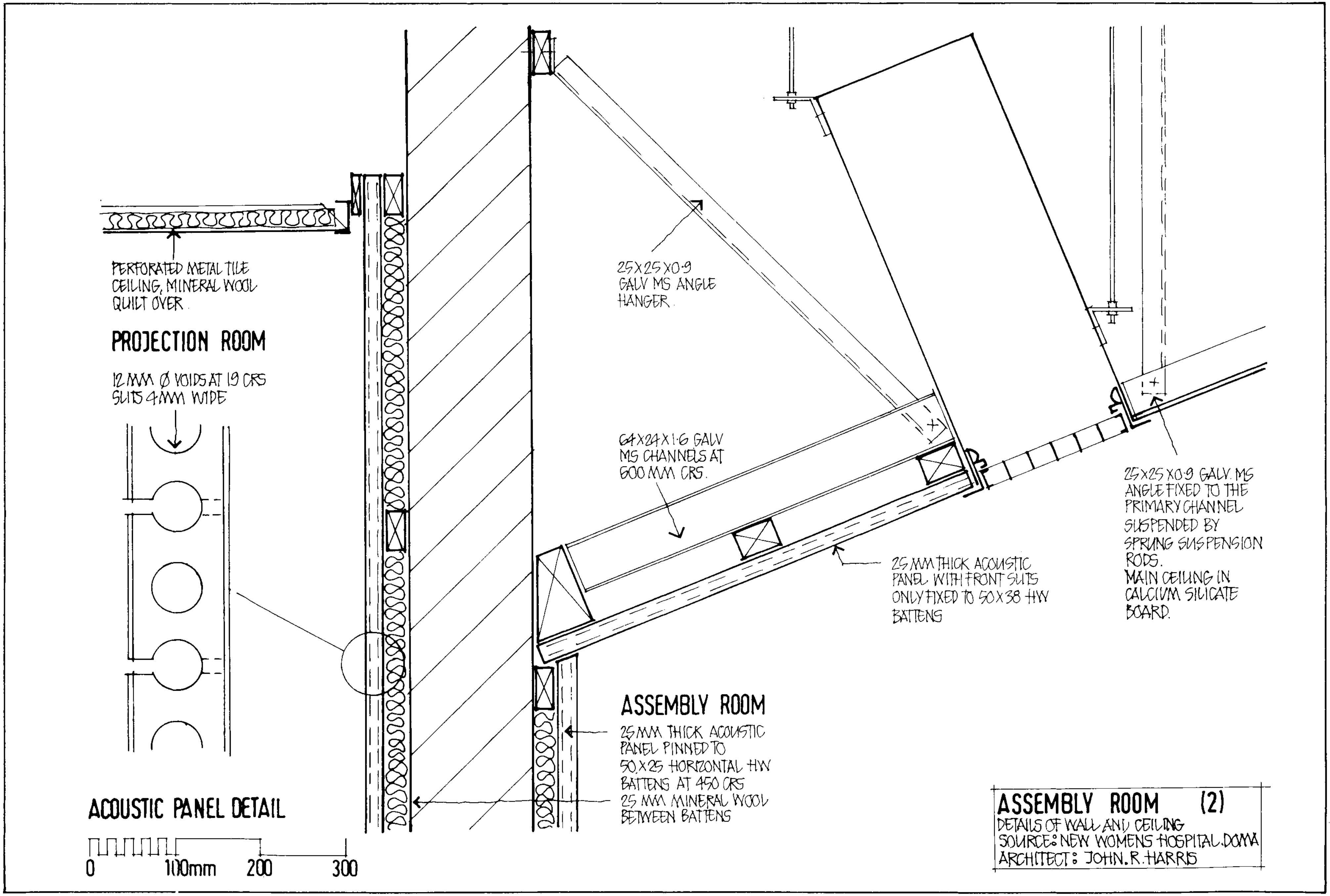


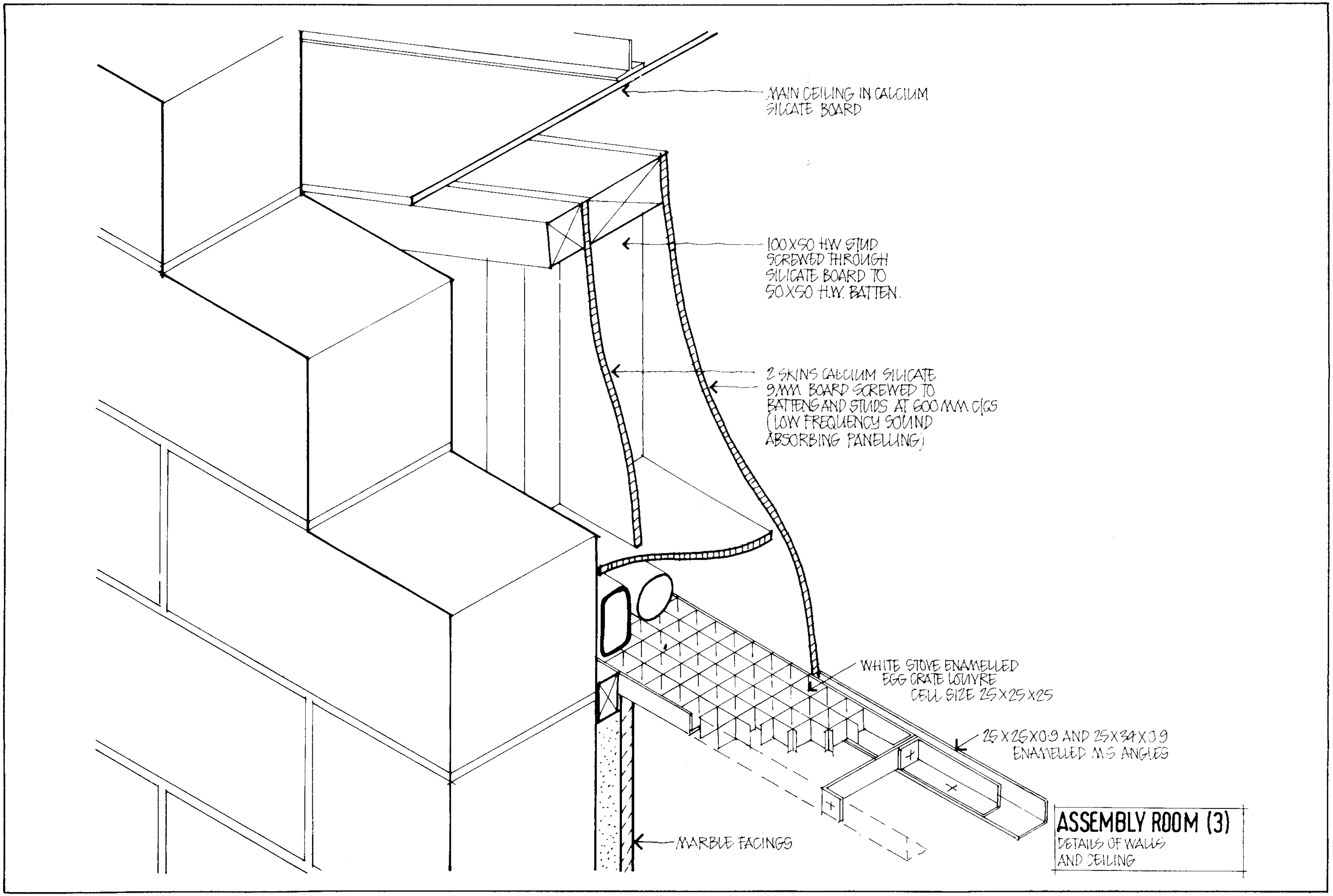
THIS HEAVY ROOF DECK TO PITCHED ROOFS IS PRIMARILY FOR THERMAL MASS AND CEILING VOID DUCTWORK SUSPENSION BUT ALSO SERVES TO KEEP OUT EXTERNAL NOISE, PARTICULARLY FROM AIRCRAFT. CONCRETE ROOF UNITS CAN ALSO BE USED UNDER STEEL DECKING TO ADD SOME MASS TO LONG-SPAN SLOPING AUDITORIA ROOFS.
AA
not to scale
ROOF PLAN
CONCRETE TILES ON BATTENS ON ROOF FELT ON COUNTER-BATTENS TO CONCRETE ROOF UNITS
CEILING VOID
PLASTERBOARD AND SKIM LINING
80 GLASSWOOL BETWEEN CEILING JOISTS
100 SIPOREX AUTOCLAVED AERATED CONCRETE ROOF UNITS—MEAN SOUND REDUCTION 39 dBA THROUGH UNITS ALONE
MS CHANNEL AS EDGE SUPPORT
FRAMED DRY LINING TO 150 BLOCKWORK INNER LEAF
SECTION AA
HOSPITAL
SOURCE:
BUILDING DESIGN PARTNERSHIP
0
100mm
200
300



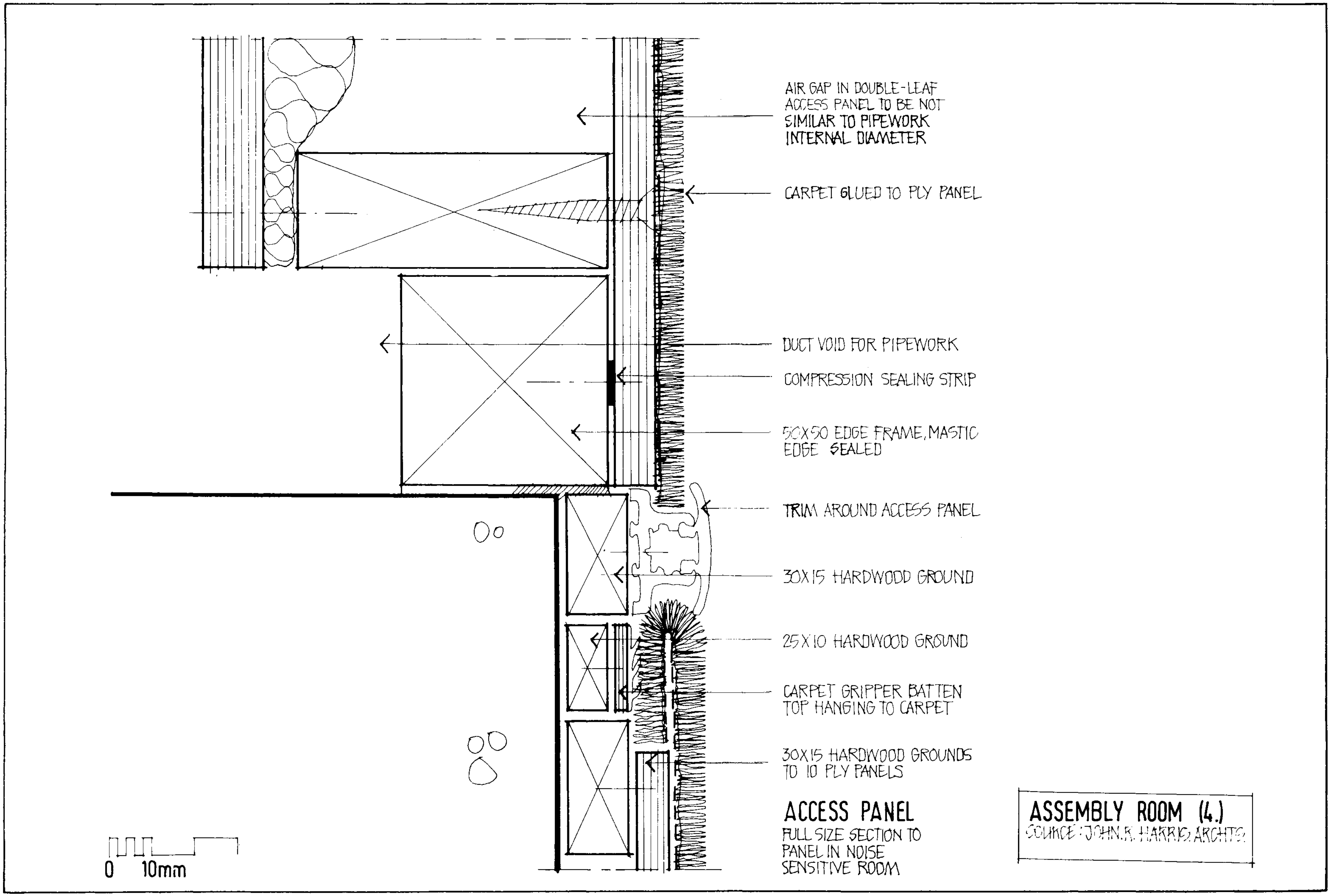
100 BLOCKWORK
CAVITY 300MM
200 BLOCKWORK
'C'
THE PLANT ROOM IS SEPARATELY STRUCTURED AND THE ENCLOSING WALLS BETWEEN COLUMNS SPECIFIED TO SUIT THE SPACES ADJACENT. IE CORRIDOR IS MORE NOISE TOLERANT THAN WARD SO 'B' IS A LESSER SPECIFICATION THAN 'C'. THE ACTION OF 'A' AND 'B' ARE SUFFICIENT TO PREVENT PLANT ROOM NOISE FLANKING THE HIGH DEGREE OF ACOUSTIC ISOLATION ACHIEVED BY 'C'. APPROXIMATE SOUND REDUCTION INDICES:
'A' =45 dBA
'B' =53 dBA.
'C' =54 dBA.
WARD
PLANT ROOM
LINE OF UPSTAND BEAM
300 CAVITY
GAP SO BEAM DOES NOT BRIDGE CAVITY
'A'
CORRIDOR
29 POLYSTYRENE SPACING
'B'
FLEXCELL SPACING FACED IN NON-SETTING MASTIC
TYPE EAFW EXPANSION COVER
HOSPITAL
SOURCE: JOHN.R.HARRIS ARCHTS.
0 100mm

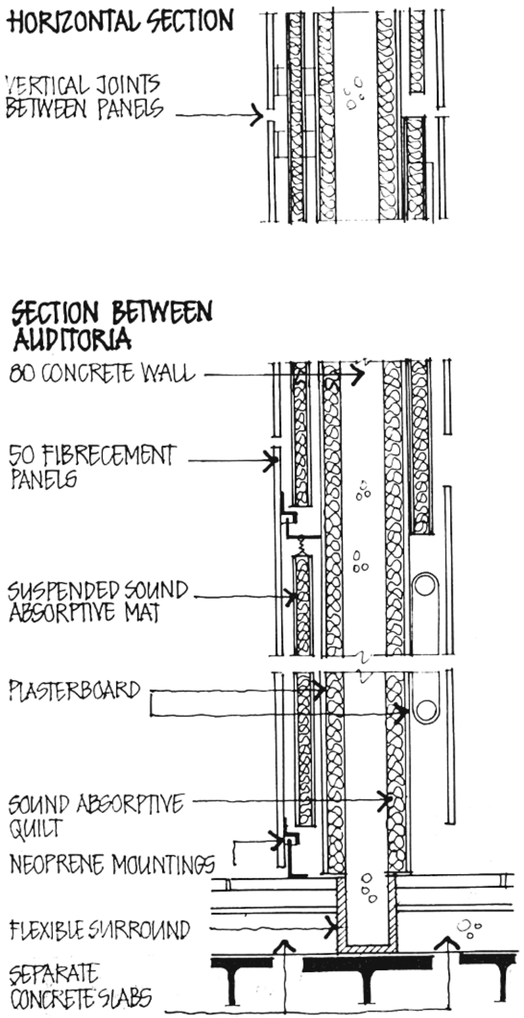

0 100mm 200 300
25X25X.9 GALV MS ANGLES HUNG OFF PRIMARY GRID OF 38X19X.9 CHANNELS SUSPENDED OFF SPRUNG RODS
45° BLADE ANGLE TO ALUMINIUM LOUVRE GRILLE
③ LIGHT FITTING IN SOUND REFLECTIVE CEILING
RESILIENT TOP PAD BUILT-IN
50X50 HOT ROLLED MS ANGLES CONTINUOUS EITHER SIDE OF THE BLOCKWORK.
6X50 SOFT RUBBER STRIP SEAL
200 DENSE BLOCKWORK
④ WALL-FLOOR ISOLATION
0 100mm 200 300
VOID
PROJECTION ROOM
VOID
ASSEMBLY ROOM
1
2
3
4
FLEXIBLE DUCT CONNECTION
PRIMARY SUSPENSION GRID
SECTION
not to scale
ASSEMBLY ROOM (1)
DETAILS OF WALL AND CEILING
SOURCE: NEW WOMENS HOSPITAL, DOMA.
ARCHITECTS: JOHN. R. HARRIS.


PERFORATED METAL TILE CEILING, MINERAL WOOL QUILT OVER.
PROJECTION ROOM
12 MM Ø VOIDS AT 19 CRS SLITS 4 MM WIDE
ACOUSTIC PANEL DETAIL
0
100mm
200
300
25 X 25 X 0·9 GALV MS ANGLE HANGER.
64 X 24 X 1·6 GALV MS CHANNELS AT 600 MM CRS.
25 MM THICK ACOUSTIC PANEL WITH FRONT SLITS ONLY FIXED TO 50 X 38 HW BATTENS
25 X 25 X 0·9 GALV. MS ANGLE FIXED TO THE PRIMARY CHANNEL SUSPENDED BY SPRUNG SUSPENSION RODS.
MAIN CEILING IN CALCIUM SILICATE BOARD.
ASSEMBLY ROOM
25 MM THICK ACOUSTIC PANEL PINNED TO 50 X 25 HORIZONTAL HW BATTENS AT 450 CRS
25 MM MINERAL WOOL BETWEEN BATTENS
ASSEMBLY ROOM (2)
DETAILS OF WALL AND CEILING
SOURCE: NEW WOMENS HOSPITAL. DOMA
ARCHITECT: JOHN. R. HARRIS

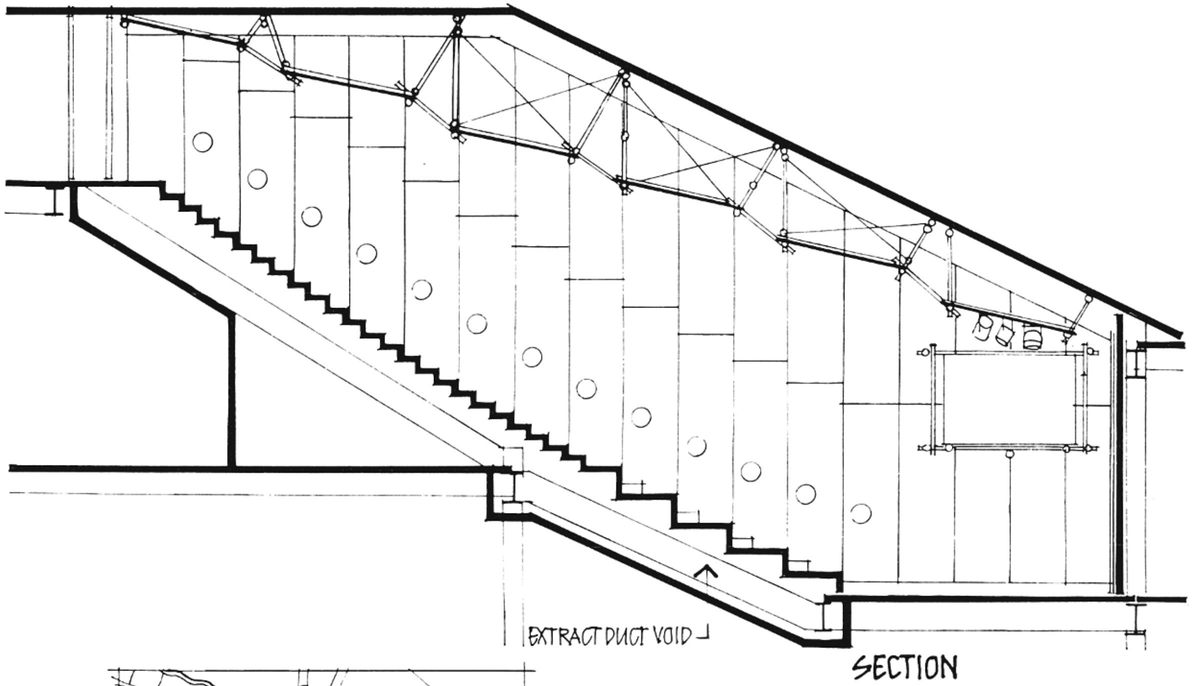


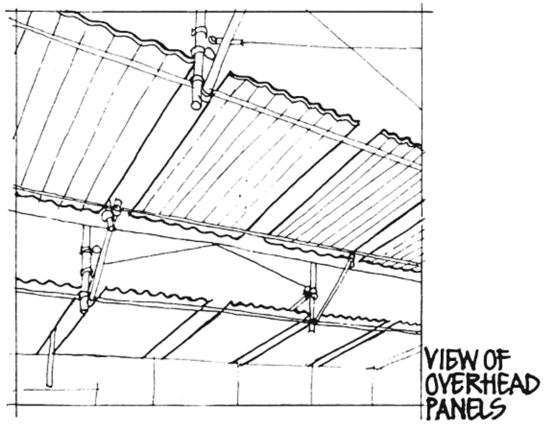
MAIN CEILING IN CALCIUM SILICATE BOARD
100X50 H.W. STUD SCREWED THROUGH SILICATE BOARD TO 50X50 H.W. BATTEN.
2 SKINS CALCIUM SILICATE 9MM BOARD SCREWED TO BATTENS AND STUDS AT 600MM C/CS (LOW FREQUENCY SOUND ABSORBING PANELLING)
WHITE STOVE ENAMELLED EGG CRATE LOUVRE CELL SIZE 25X25X25
25X25X0.9 AND 25X34X0.9 ENAMELLED M.S. ANGLES
MARBLE FACINGS
ASSEMBLY ROOM (3)
DETAILS OF WALLS AND CEILING


AIR GAP IN DOUBLE-LEAF ACCESS PANEL TO BE NOT SIMILAR TO PIPEWORK INTERNAL DIAMETER
CARPET GLUED TO PLY PANEL
DUCT VOID FOR PIPEWORK
COMPRESSION SEALING STRIP
50X50 EDGE FRAME, MASTIC EDGE SEALED
TRIM AROUND ACCESS PANEL
30X15 HARDWOOD GROUND
25X10 HARDWOOD GROUND
CARPET GRIPPER BATTEN TOP HANGING TO CARPET
30X15 HARDWOOD GROUNDS TO 10 PLY PANELS
ACCESS PANEL
FULL SIZE SECTION TO PANEL IN NOISE SENSITIVE ROOM
ASSEMBLY ROOM (4.)
SOURCE: JOHN R. HARRIS ARCHTS.
0 10mm



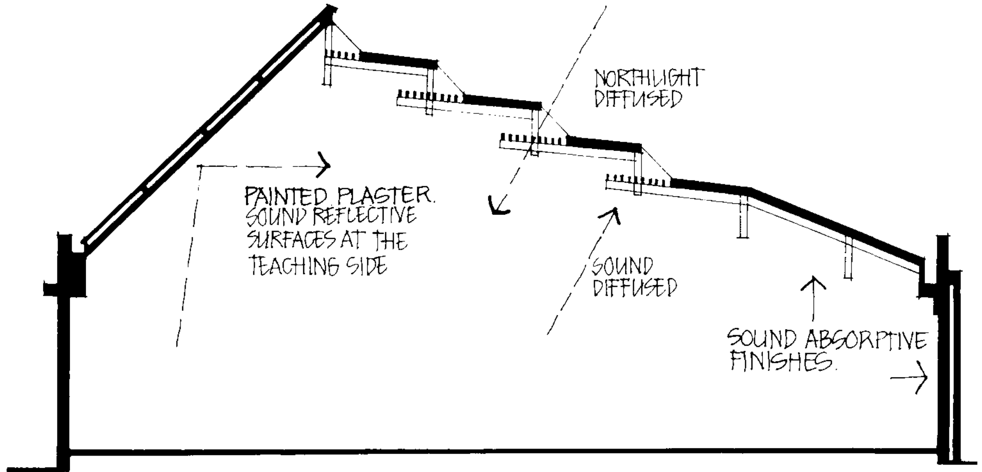
not to scale





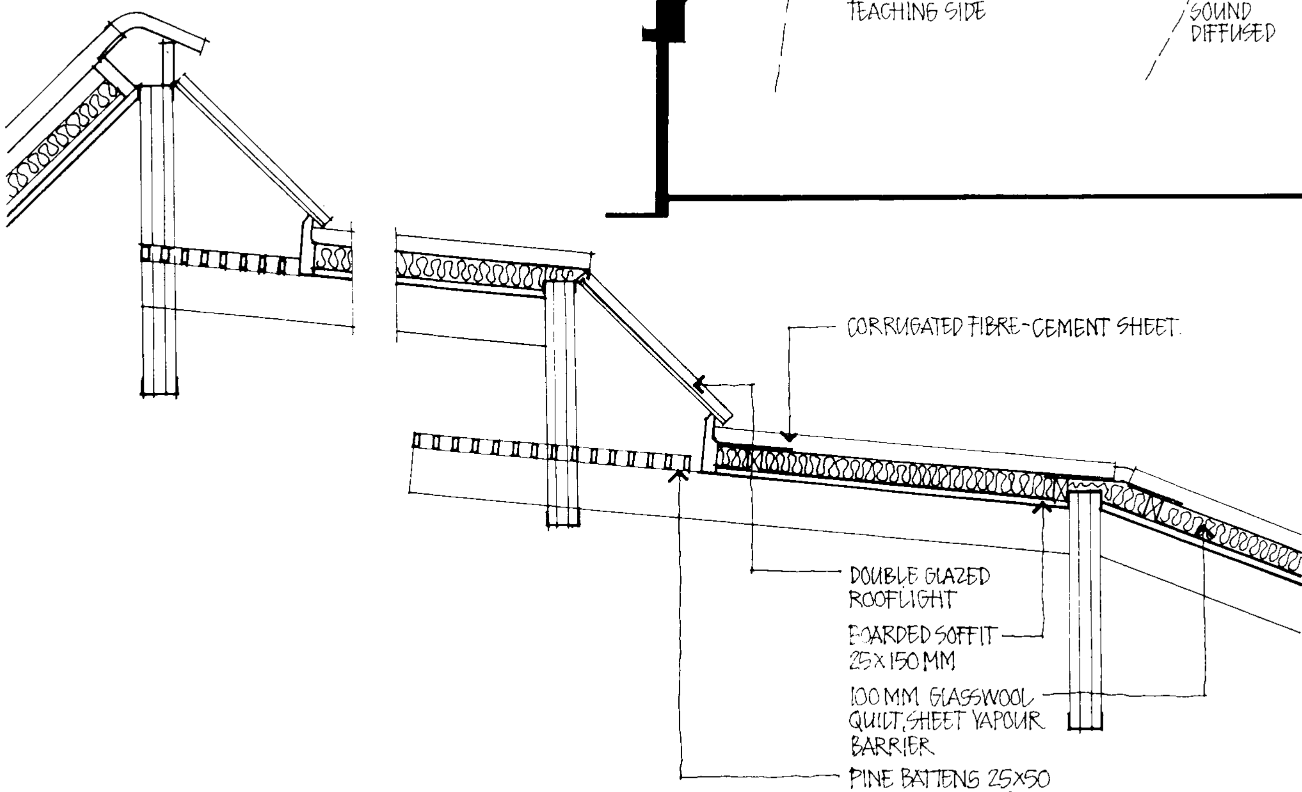
LECTURE THEATRE

[LOCATION: DEPT OF BUILDING TECHNICAL COLLEGE, BERLIN]



SECTION

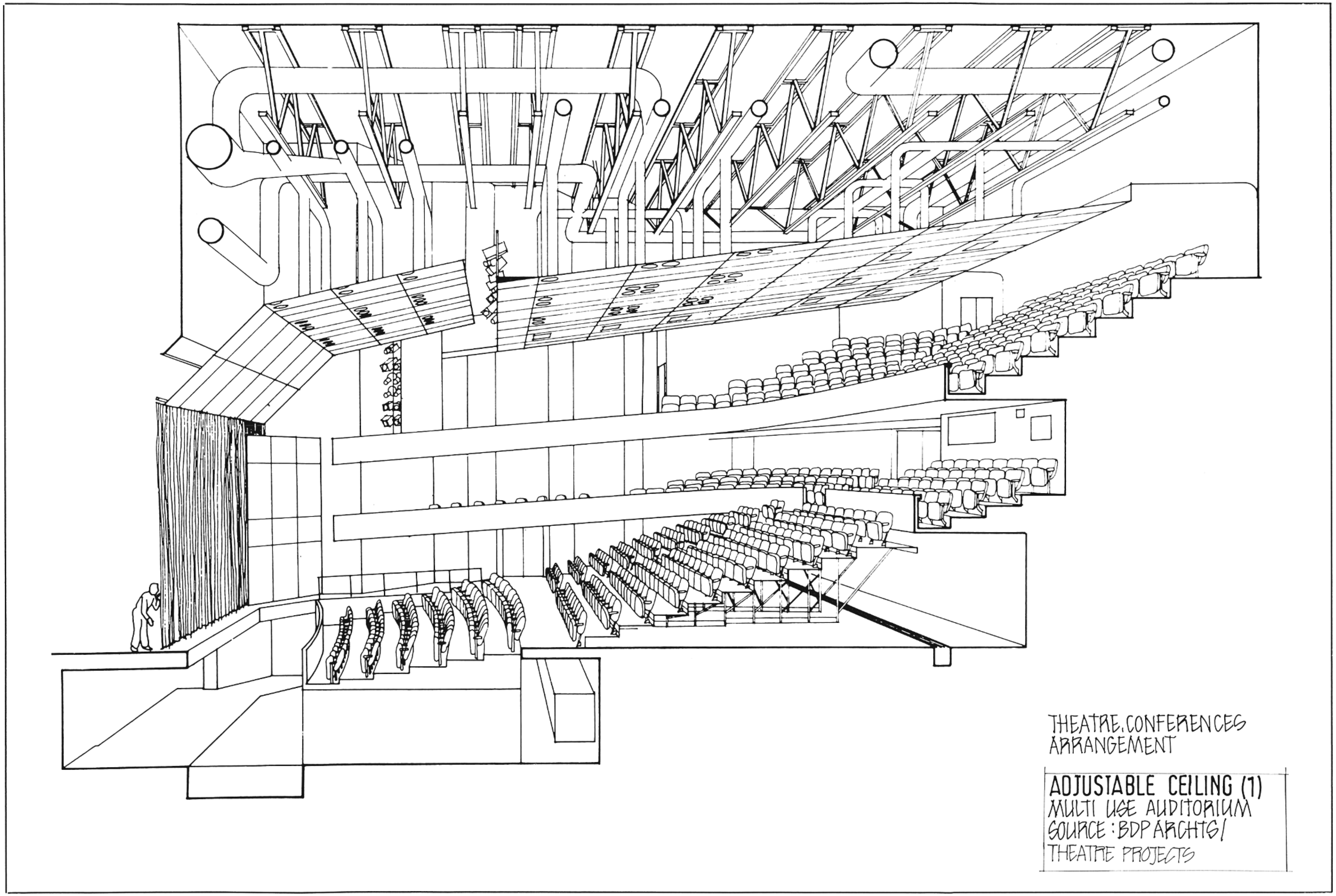
REFLECTIVE FINISHES AT FRONT ALLOW VOICE PROJECTION TO REAR OF ROOM
SOUND ABSORPTIVE FINISHES TO BE USED AT REAR OF ROOM
DESIGN RT AT APPROX 0·75 SECONDS

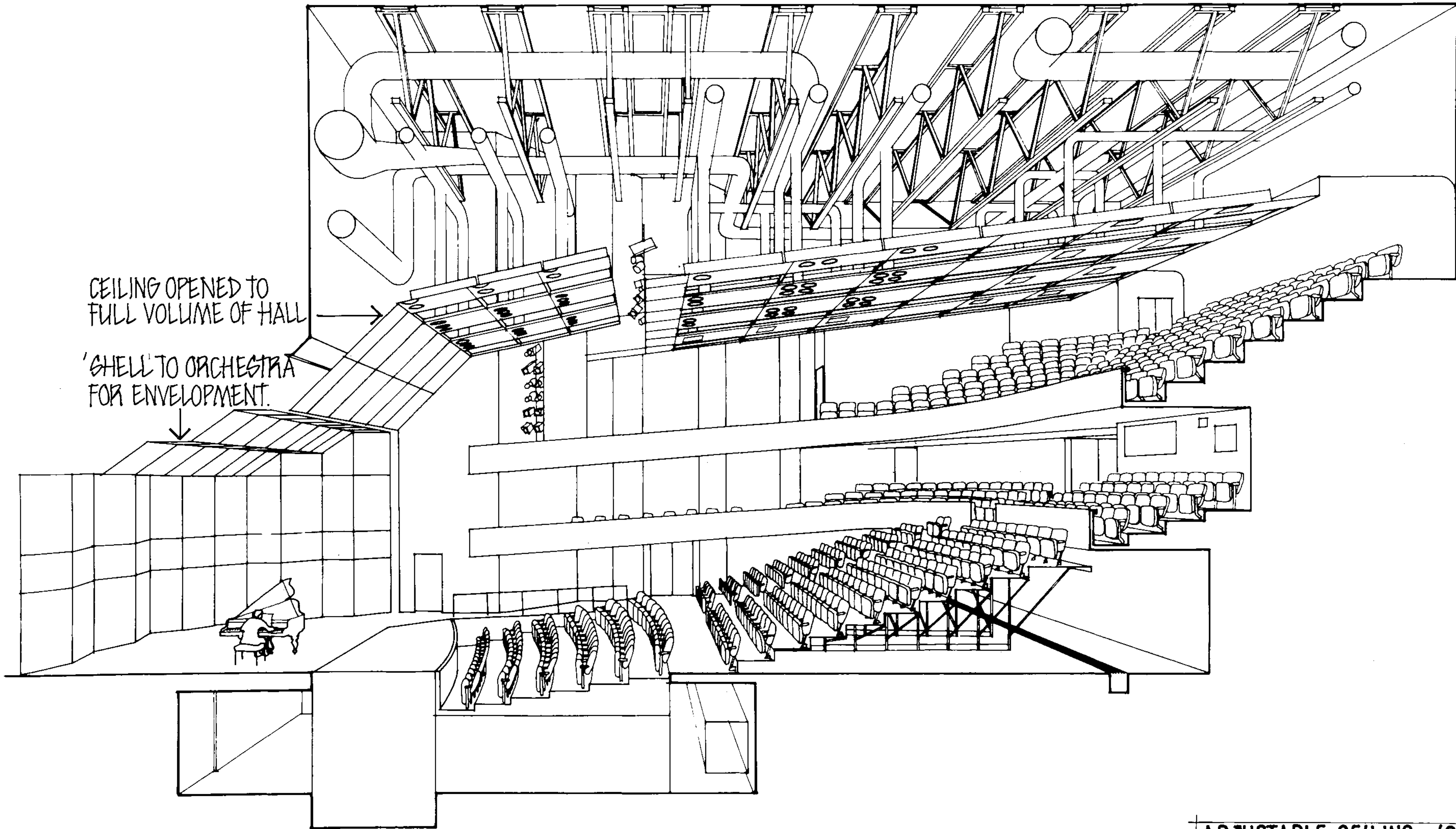


DETAIL SECTION

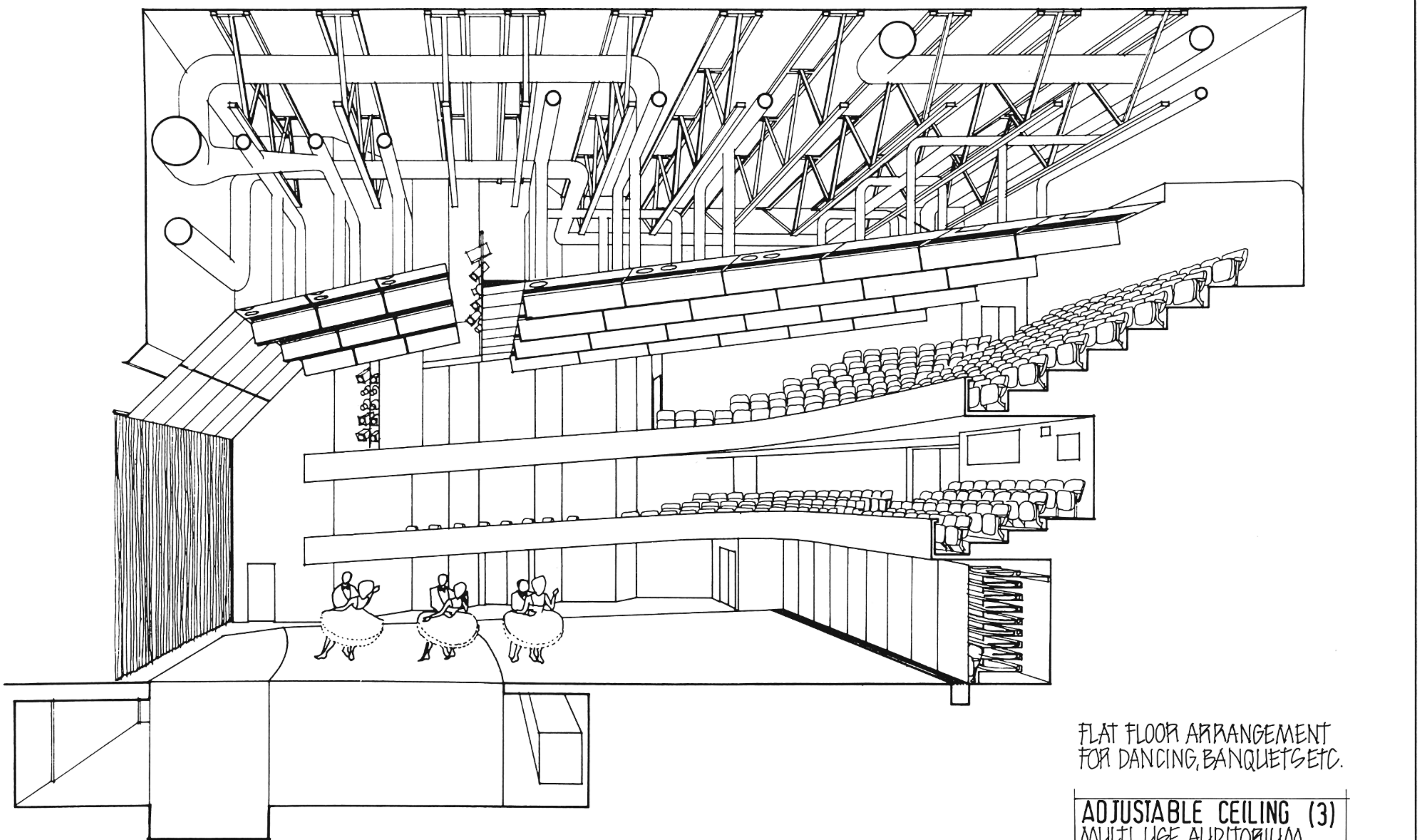
CLASSROOM

not to scale


THEATRE, CONFERENCES
ARRANGEMENT
ADJUSTABLE CEILING (1)
MULTI USE AUDITORIUM
SOURCE : BDP ARCHTS/
THEATRE PROJECTS

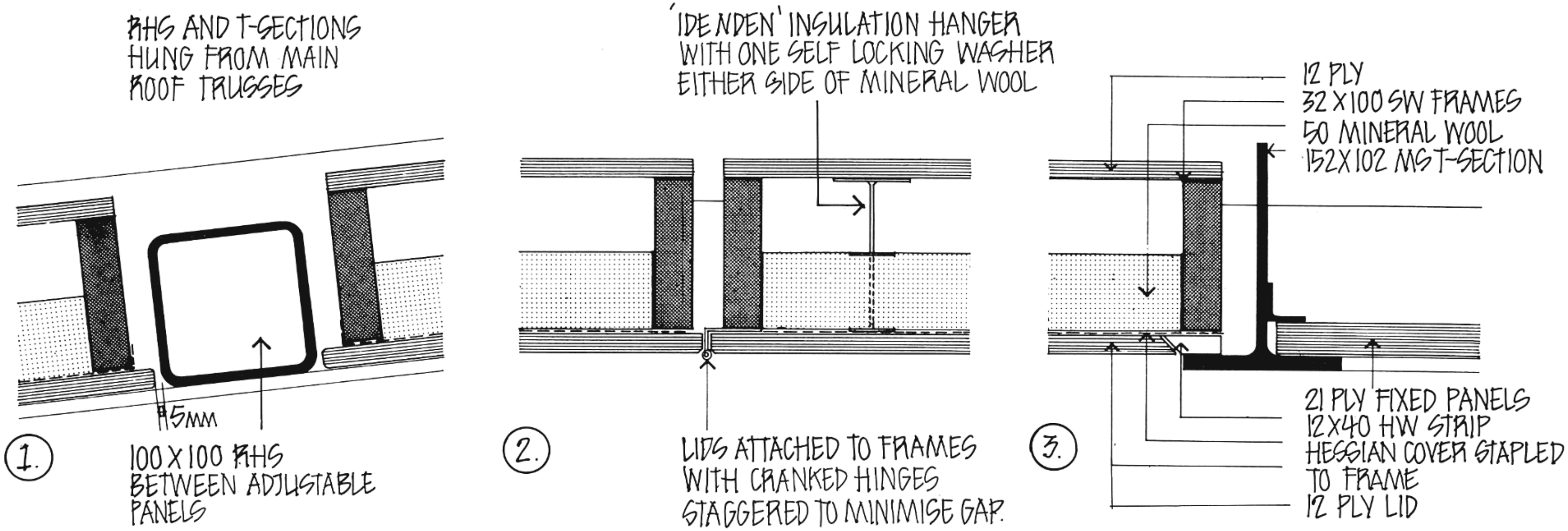


ADJUSTABLE CEILING (2)
MULTI USE AUDITORIUM
SOURCE: BDP ARCHTS/
THEATRE PROJECTS

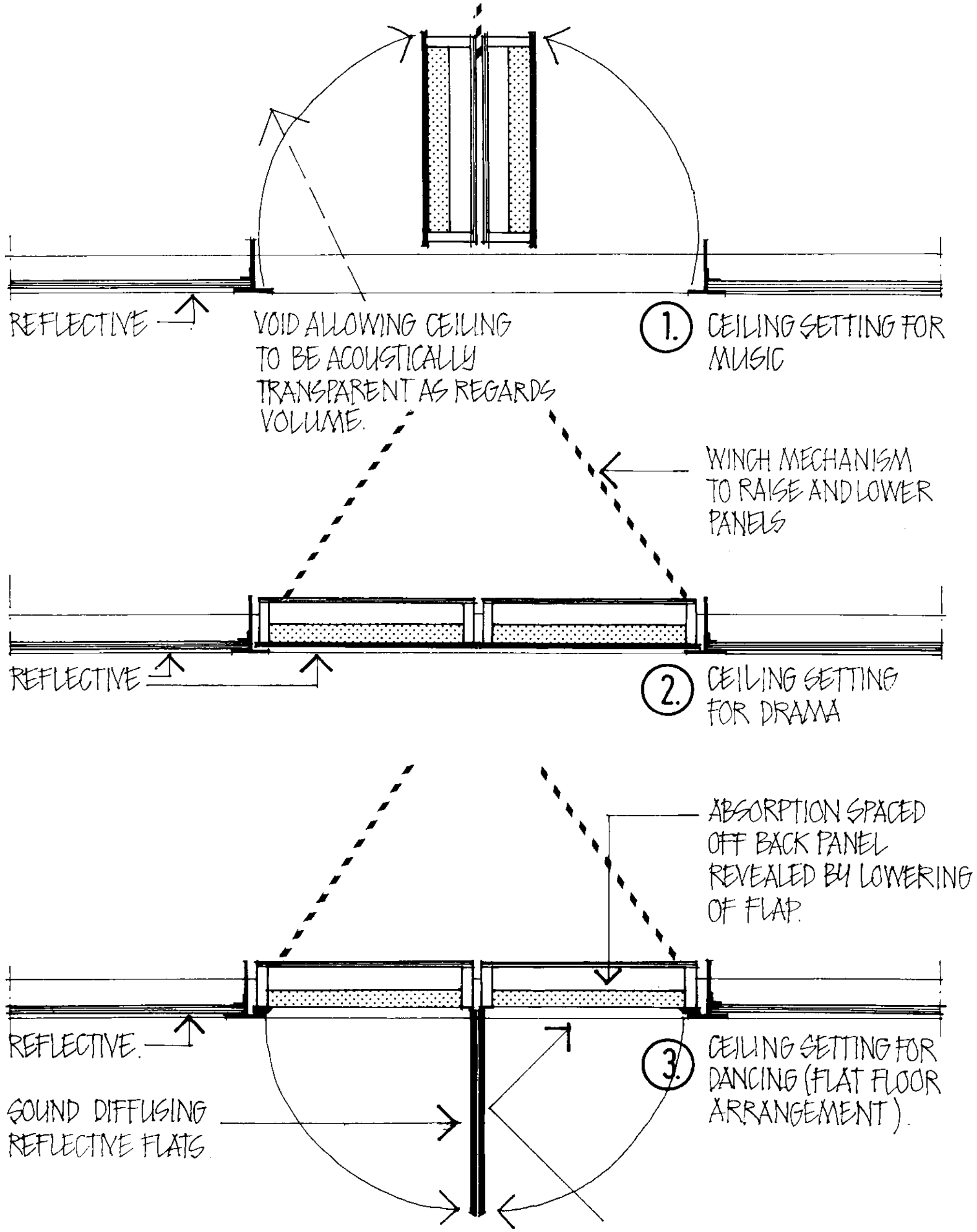


FLAT FLOOR ARRANGEMENT
FOR DANCING, BANQUETS ETC.

ADJUSTABLE CEILING (3)
MULTI USE AUDITORIUM
SOURCE: BDP ARCHTS/
THEATRE PROJECTS



ADJUSTABLE CEILING (4)
MULTI-USE AUDITORIUM
SOURCE: BDP ARCHTS/
THEATRE PROJECTS

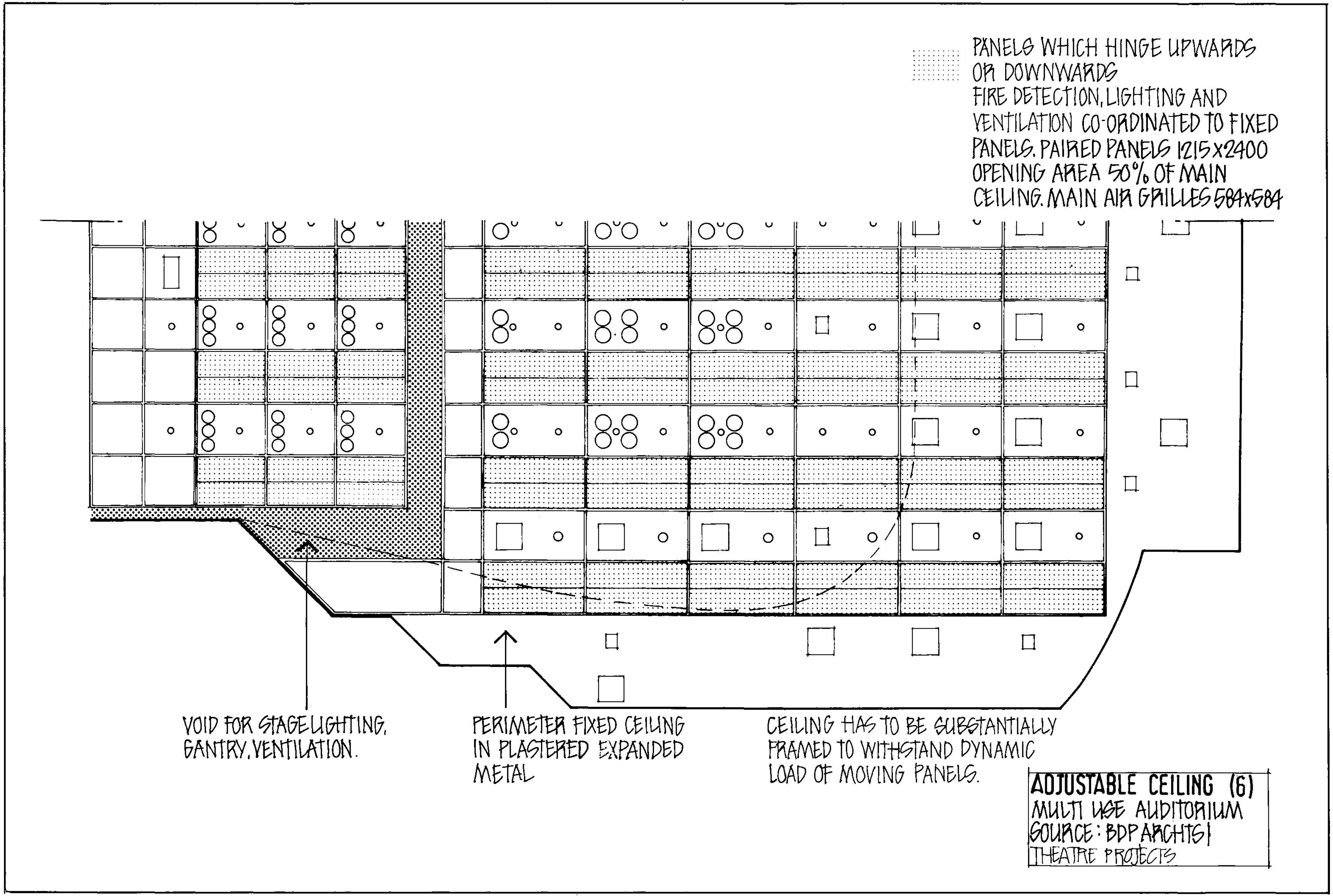


THE DESIGN R.T. FROM MODEL STUDIES IS 1·50 SECONDS AT MID. FREQUENCIES FOR MUSIC, 1·30 SECONDS FOR FLAT FLOOR AND 1·00 SECONDS FOR DRAMA.

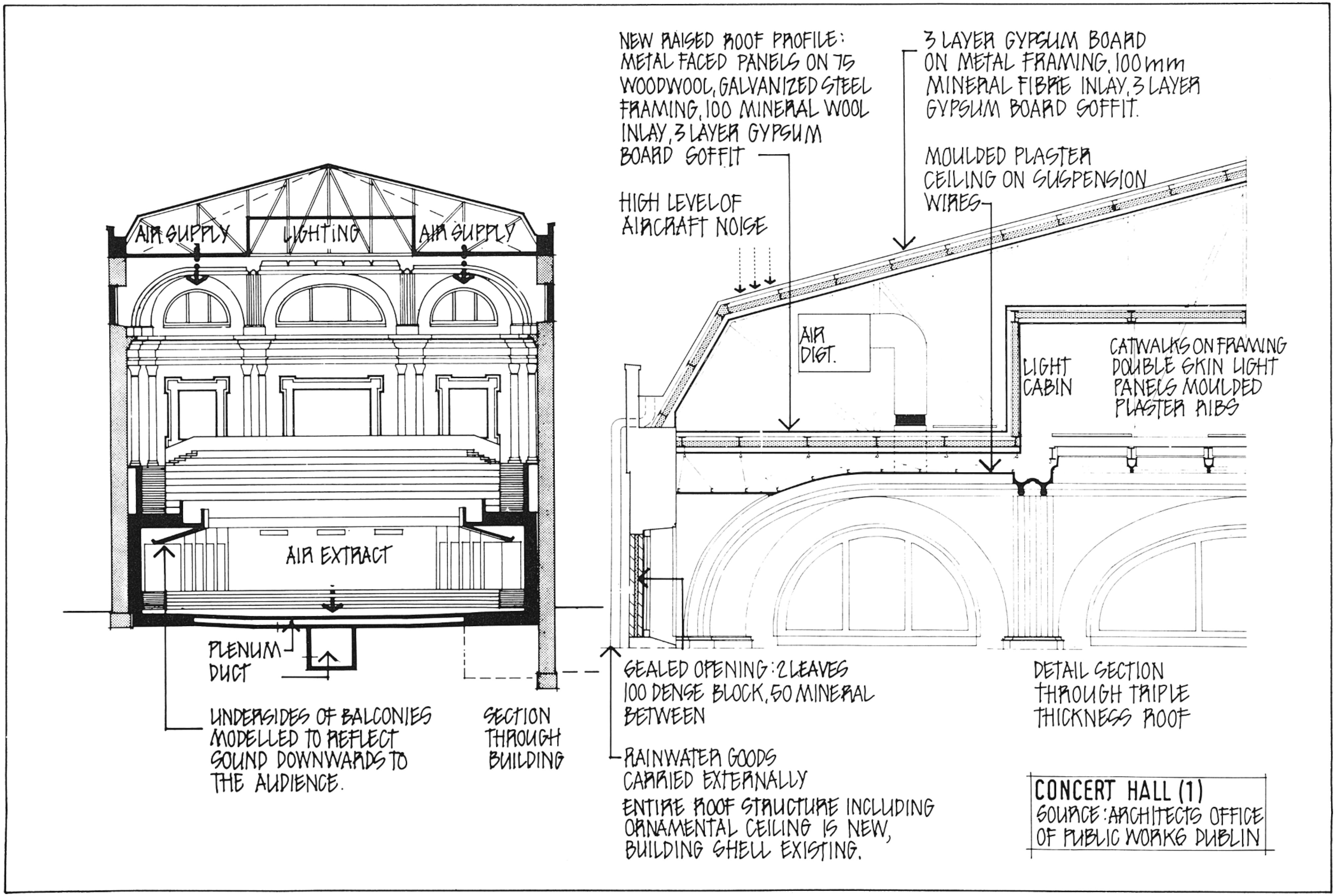
OVERHEAD EARLY REFLECTIONS (UNDER 50 MS.) ARE USEFUL FOR REINFORCING LOUDNESS AND INTELLIGIBILITY OF SPEECH. LOW FREQUENCY MEMBRANE ABSORBERS ARE INCORPORATED ELSEWHERE TO PREVENT REVERBERANT MASKING OF HIGH FREQUENCY SPEECH SOUNDS.

ABSORPTION AND DIFFUSION OFFSET REMOVAL OF SEATING BELOW.

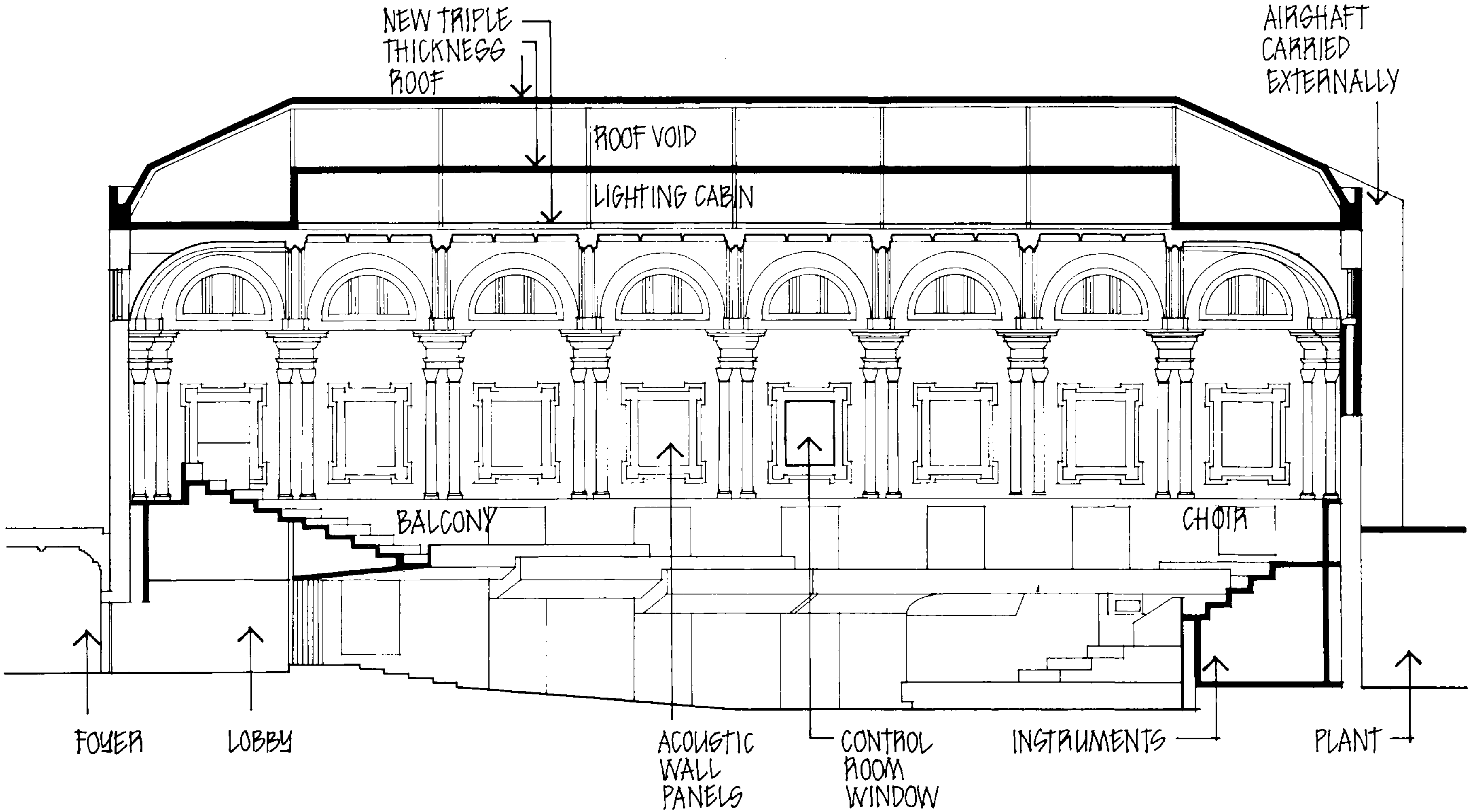
ADJUSTABLE CEILING (5)
SOURCE: BDP ARCHITECTS / THEATRE PROJECTS



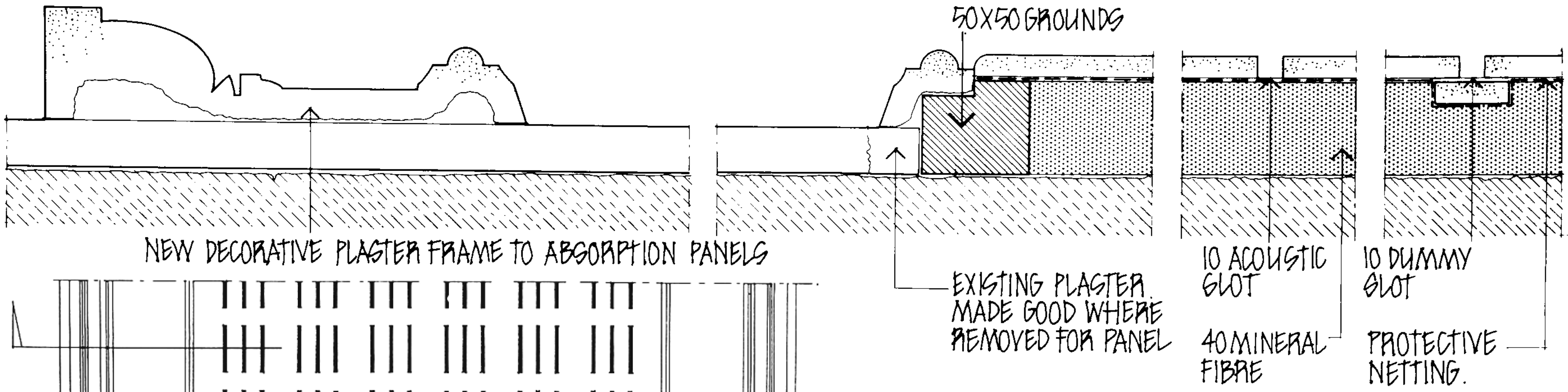
ADJUSTABLE CEILING (6)
MULTI USE AUDITORIUM
SOURCE: BDP ARCHTS / THEATRE PROJECTS

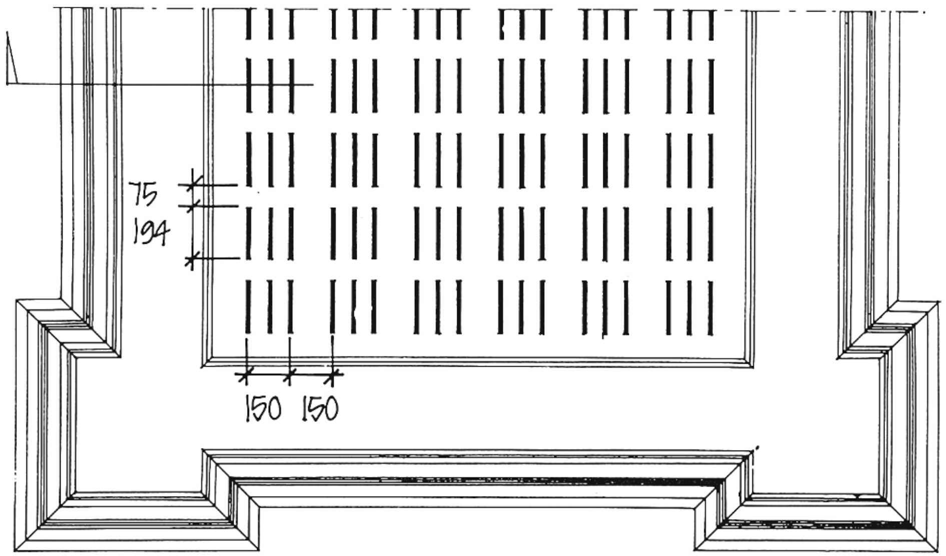


CONCERT HALL (1)
SOURCE: ARCHITECTS OFFICE OF PUBLIC WORKS DUBLIN



CONCERT HALL (2)
SOURCE: ARCHITECTS OFFICE OF PUBLIC WORKS DUBLIN



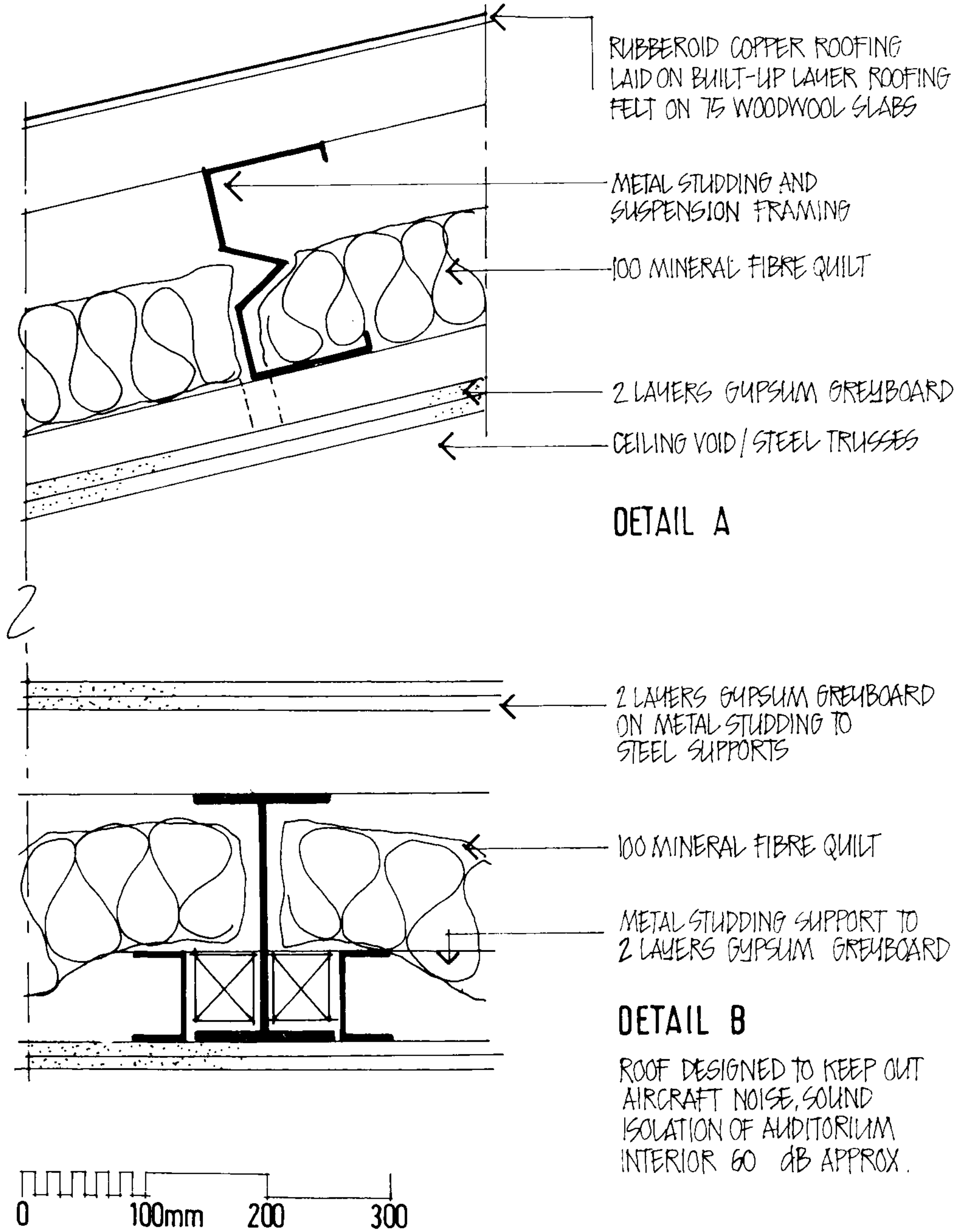


ADDITION OF PANELS ENABLED 'TUNING' OF AUDITORIUM DURING COMMISSIONING TO PROVIDE ABSORPTION AT A PARTICULAR MID-FREQUENCY RANGE TO ACHIEVE A FLAT REVERBERATION TIME CHARACTERISTIC THROUGHOUT THE FREQUENCY RANGE. PANELS ARE EVENLY DISTRIBUTED TO ACHIEVE EVEN SOUND QUALITY THROUGHOUT THE HALL. HELMHOLTZ RESONATOR EFFECT OF SLOTS RESTRICT PANELS USE TO NARROW BAND ABSORPTION.

ACOUSTIC WALL PANEL DETAILS

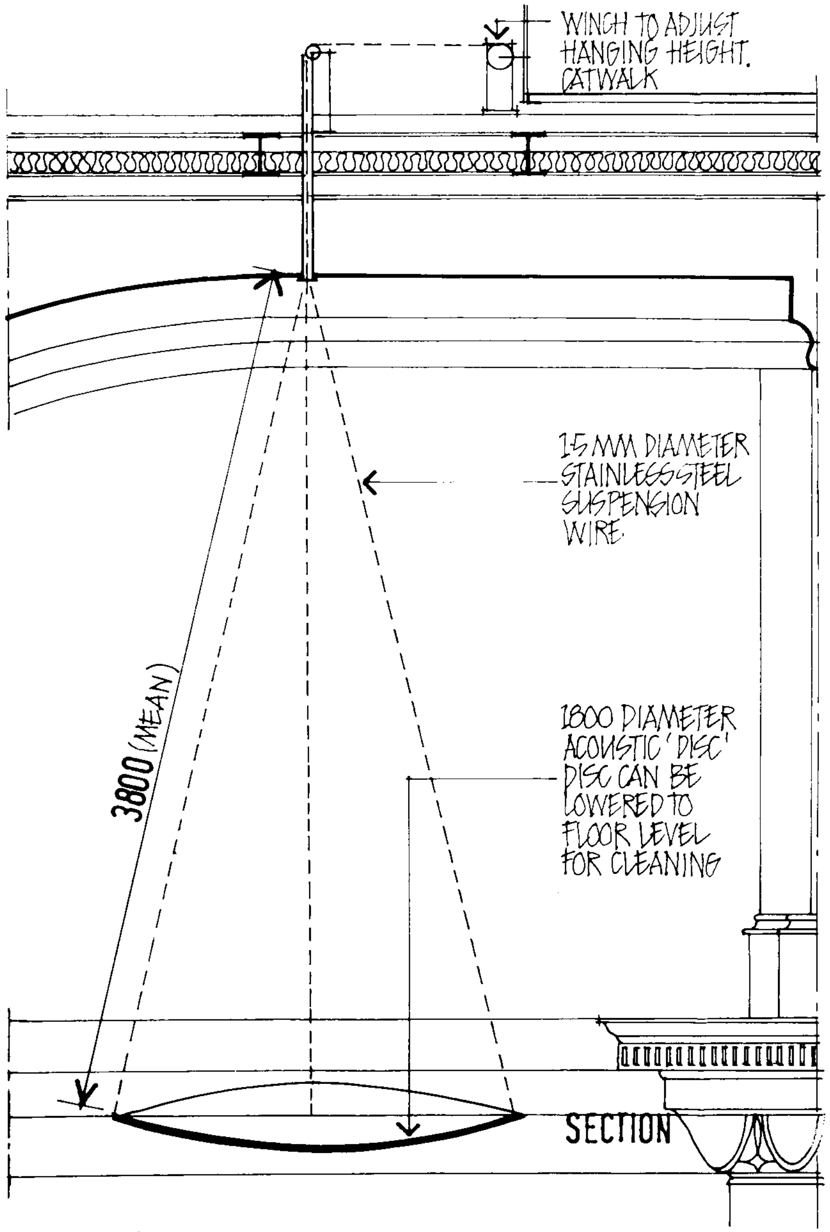
CONCERT HALL (3)
SOURCE: ARCHITECTS. OFFICE OF PUBLIC WORKS DUBLIN.

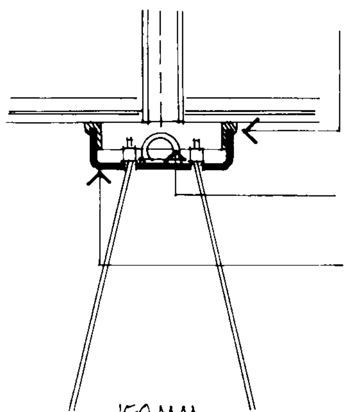
not to scale

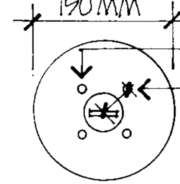


ROOF TO THE NATIONAL CONCERT HALL DUBLIN, DOUBLE AND TRIPLE LAYER ROOF.

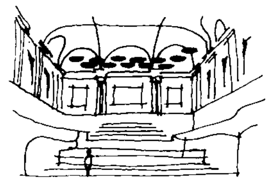
CONCERT HALL (4)
SOURCE: OFFICE OF BUILDING WORKS ARCHTS.







IN THIS HALL 12 ASYMMETRICALLY-PLACED ACOUSTIC 'DISCS' OR 'CLOUDS' ARE USED TO GIVE LOCAL REFLECTION OVER THE STAGE TO ENABLE INDIVIDUAL PLAYERS TO DISTINGUISH THEIR OWN AND OTHER INSTRUMENTS DURING ORCHESTRAL PERFORMANCE. THEY CAN ALSO CORRECT FOR ACOUSTICAL DEFICIENCIES EG. ALBERT HALL LONDON 'SAUCERS.' REFLECTING SURFACES SHOULD BE SMOOTH, HIGH DENSITY, NON POROUS, AT LEAST 5 KG.M^{-2} FOR SPEECH ONLY AND 25 KG.M^{-2} FOR MUSIC. (IN ORDER TO MINIMIZE LOW FREQUENCY ABSORPTION) TO GIVE REFLECTION OF EQUAL CHARACTER OVER A WIDE FREQUENCY SPECTRUM, A LARGE SURFACE AREA IS NECESSARY. MATERIAL: ACRYLIC OR GRP.

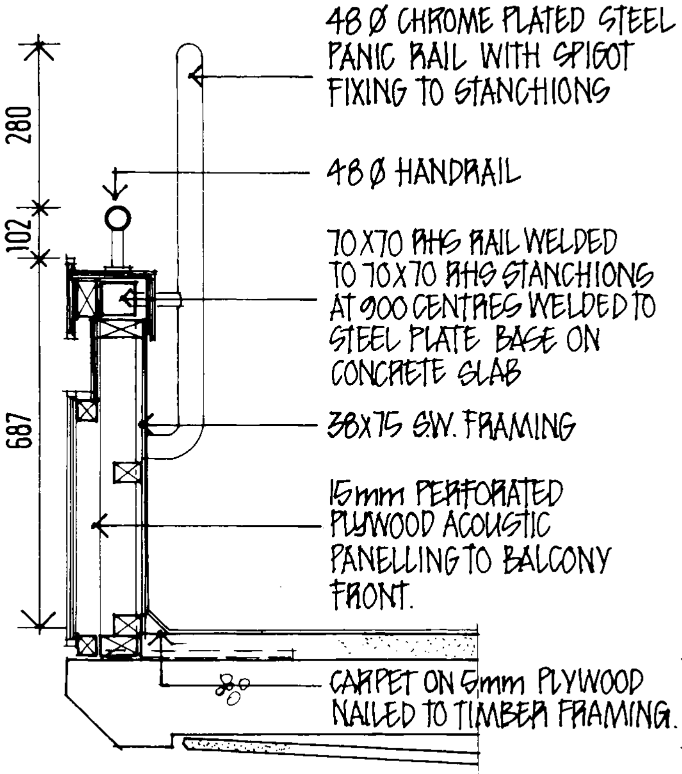


SKETCH OF THE INTERIOR OF THE NATIONAL CONCERT HALL DUBLIN

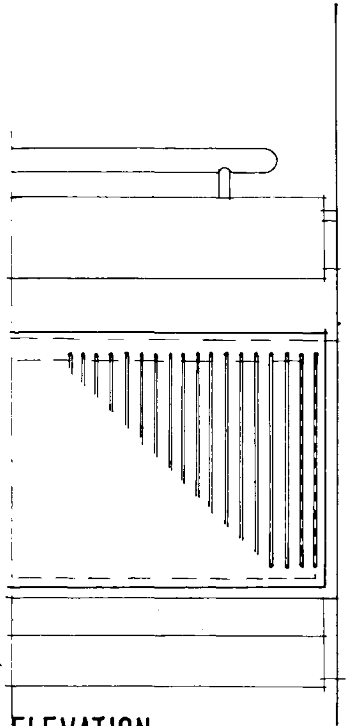
CONCERT HALL (5)

SOURCE: ARCHITECTS OFFICE OF PUBLIC WORKS DUBLIN.

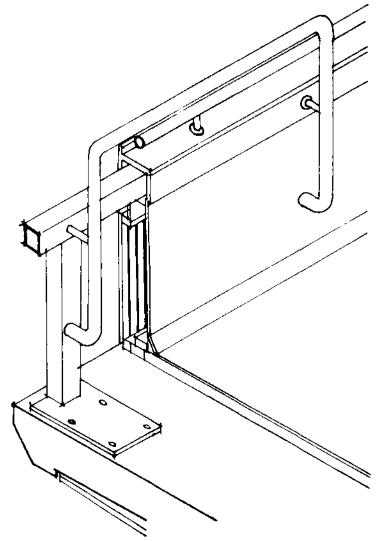
not to scale



SECTION



ELEVATION

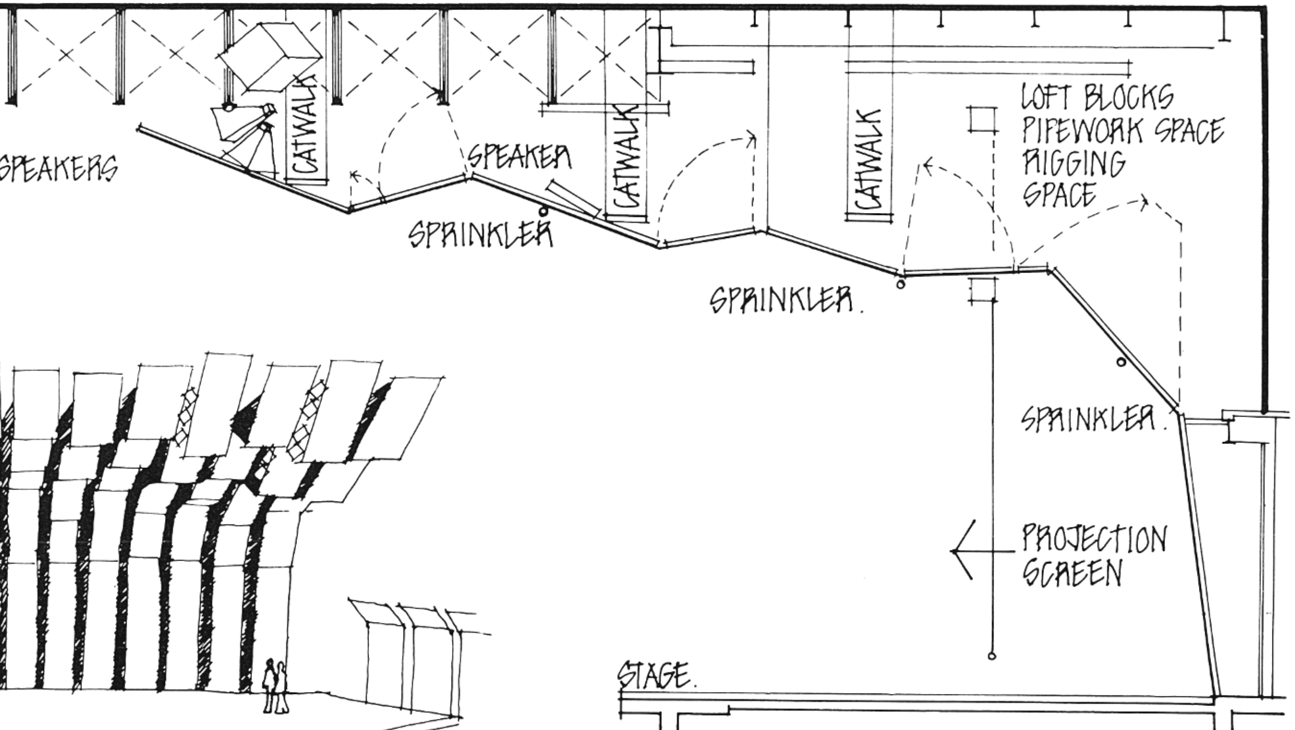


CUTAWAY AXONOMETRIC THEATRE ROYAL PLYMOUTH.

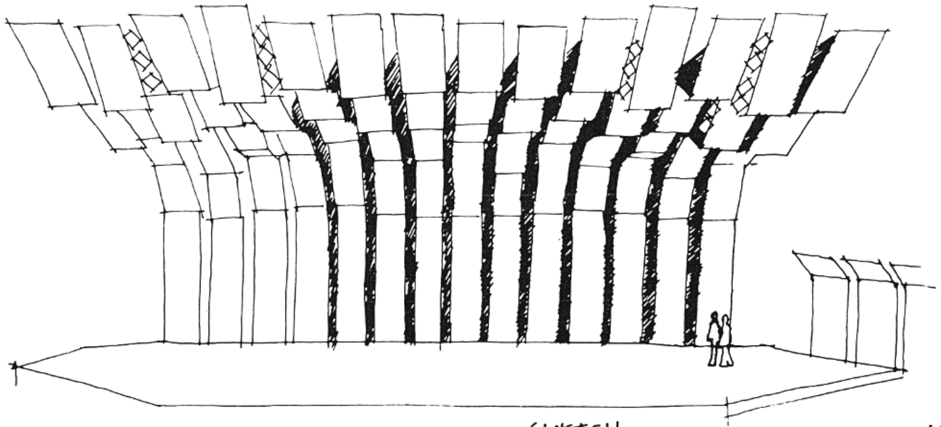
MANY AUDITORIA HAVE AS 'TUNING' TO THE NATURAL ACOUSTICS ARISING FROM FINISHES AND SEATING **SOUND ABSORBING** PANELLING OR WALL LININGS. THE PANELS ABSORB SOUND WELL AT A SELECTED **FREQUENCY RANGE**. BY A COMBINATION OF HELMHOLTZ AND RESONATOR ACTION. WHERE ACOUSTIC PANELLING IS REQUIRED IN SPACES IT MAKES ECONOMIC SENSE FOR IT TO BE BUILT IN AND FULFILL A USEFUL FUNCTION AS ILLUSTRATED RATHER THAN BEING HUNG ON A WALL AS AN AFTER THOUGHT.

THEATRE BALCONY
SOURCE: PETER MORO PINRSHIP ARCHTS / AJ

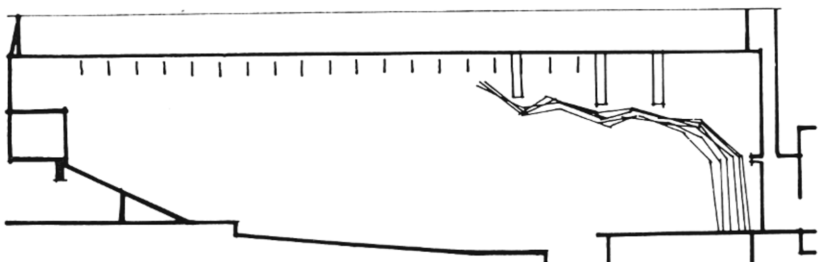
not to scale



DETAIL SECTION



SKETCH

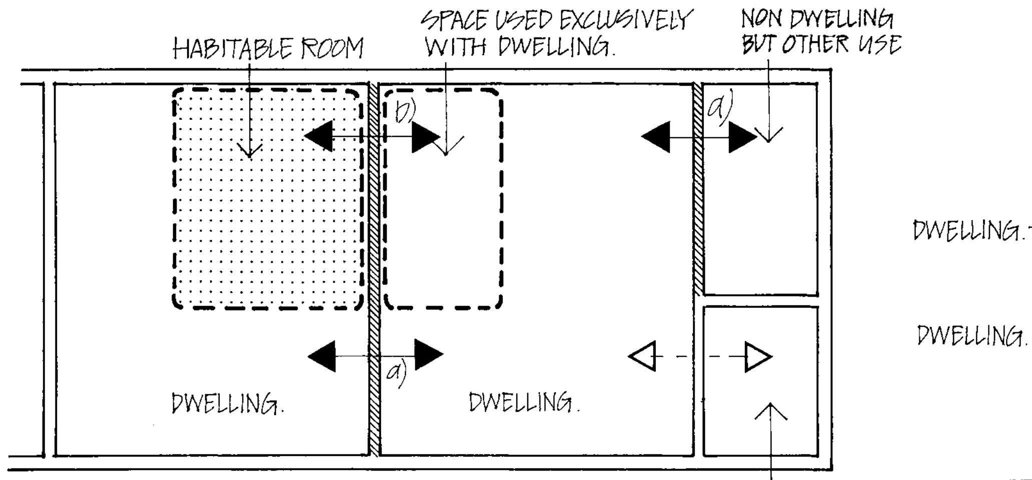


SECTION

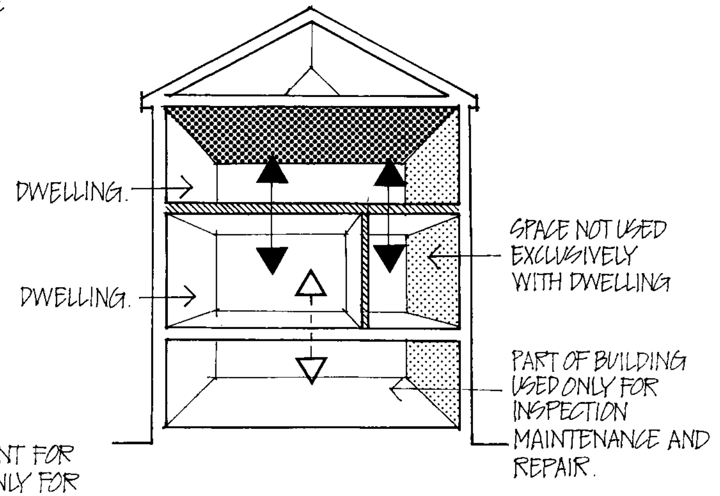
ADJUSTABLE PANELS, ASSEMBLED TOGETHER AS HINGED 'RIBBONS' WERE INCLUDED IN A REFURBISHMENT OF 2250-SEAT 58M DIAMETER CIRCULAR AUDITORIUM USED FOR ORCHESTRAL MUSIC, CINEMA, LECTURES, COMMUNITY AND UNIVERSITY EVENTS. ACOUSTICS IN THE HALL WERE PREVIOUSLY POOR BUT NOW REVIEWS COMMEND LACK OF DEAD SPOTS IN THE AUDITORIUM AND MUSICIANS REPORT EXCELLENT RECEPTION OF OTHER INSTRUMENTS. PANELS ARE REFLECTIVE GYPSUM BOARD ON METAL FRAMES

STAGE CANOPY
ARCHITECTS: MITCHELL/GIURGOLA
NEW YORK.

not to scale

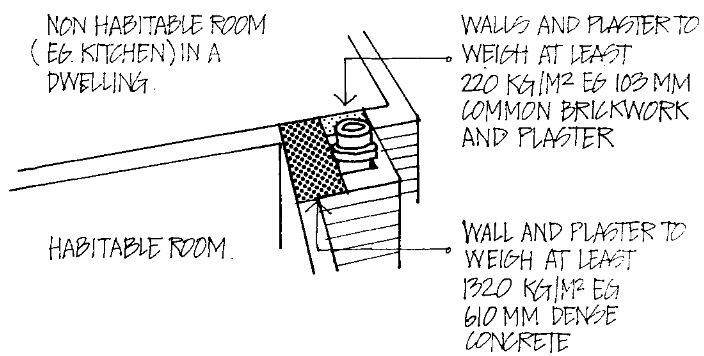


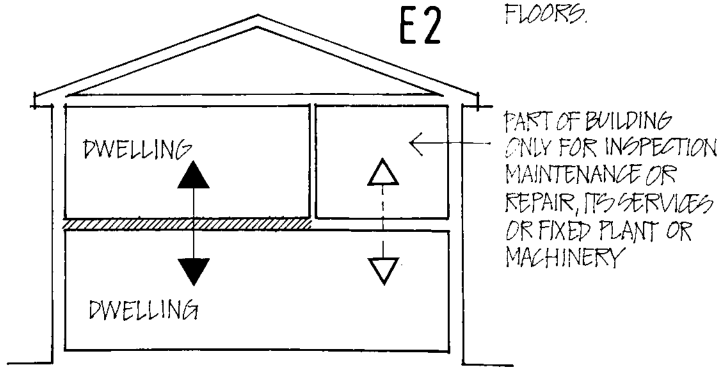
E1 (1) APPROVED DOCUMENT REQUIREMENTS: WALLS.



E2 AIRBORNE SOUND: FLOORS.

REFUSE CHUTES





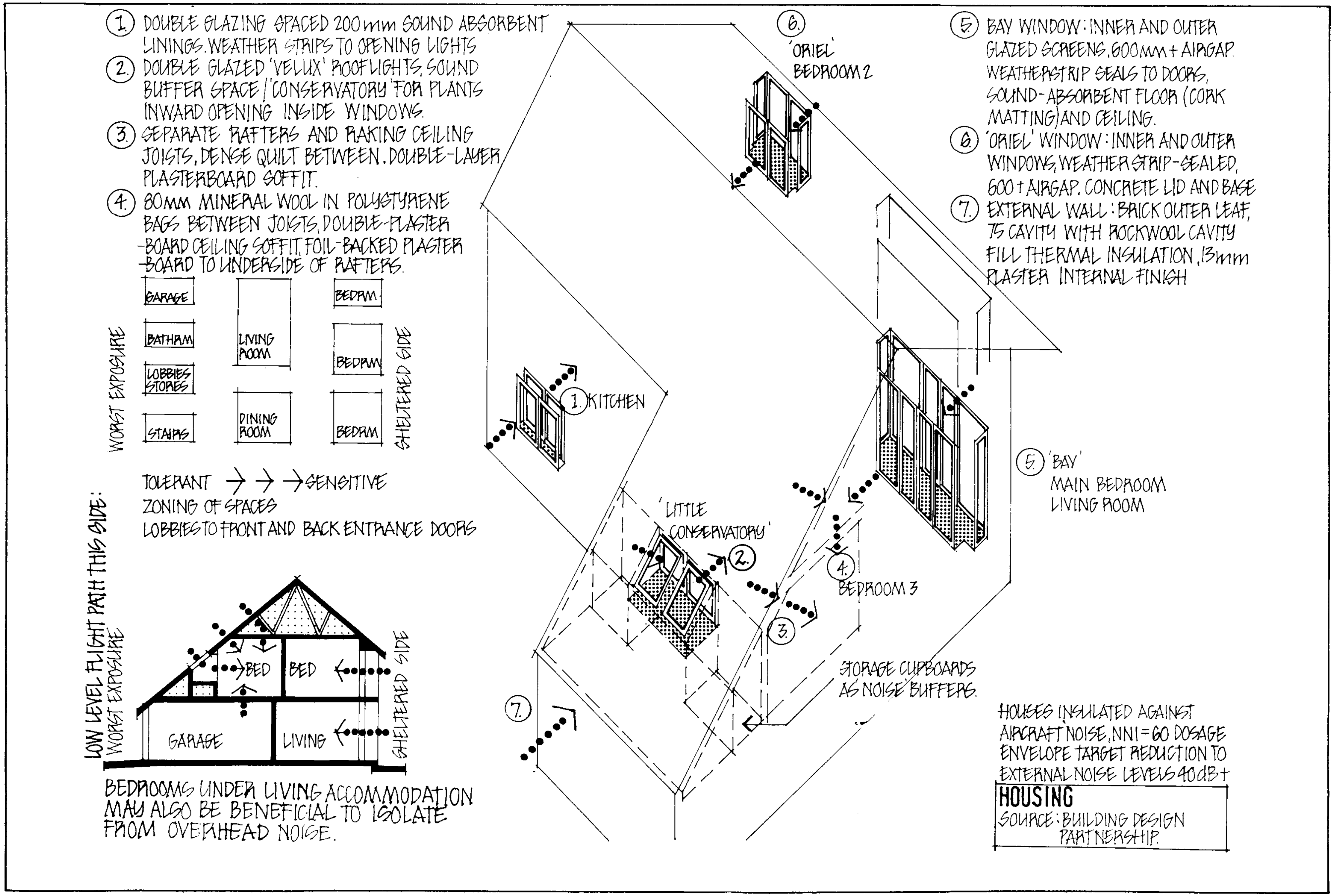
E3 IMPACT SOUND: FLOORS.

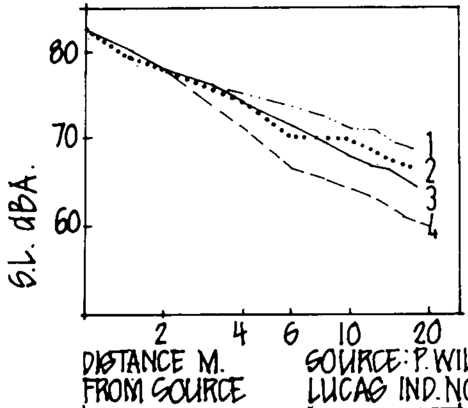
WALL OR FLOOR TO REASONABLE RESISTANCE TO AIRBORNE SOUND (REFER TO APPROVED DOCUMENT)

FLOOR TO HAVE REASONABLE RESISTANCE TO IMPACT SOUND.

HOUSING

BUILDING REGULATIONS 1985 REQUIREMENTS.


1 DOUBLE GLAZING SPACED 200 mm SOUND ABSORBENT LININGS. WEATHER STRIPS TO OPENING LIGHTS
2. DOUBLE GLAZED 'VELUX' ROOFLIGHTS, SOUND BUFFER SPACE / 'CONSERVATORY' FOR PLANTS INWARD OPENING INSIDE WINDOWS.
3. SEPARATE RAFTERS AND RAKING CEILING JOISTS, DENSE QUILT BETWEEN. DOUBLE-LAYER PLASTERBOARD SOFFIT.
4. 80MM MINERAL WOOL IN POLYSTYRENE BAGS BETWEEN JOISTS, DOUBLE-PLASTER-BOARD CEILING SOFFIT, FOIL-BACKED PLASTER-BOARD TO UNDERSIDE OF RAFTERS.
GARAGE
BATHRM
LOBBIES STORES
STAIRS
LIVING ROOM
DINING ROOM
BEDRM
BEDRM
BEDRM
WORST EXPOSURE
SHELTERED SIDE
TOLERANT → → → SENSITIVE
ZONING OF SPACES
LOBBIES TO FRONT AND BACK ENTRANCE DOORS
LOW LEVEL FLIGHT PATH THIS SIDE:
WORST EXPOSURE
BED
BED
GARAGE
LIVING
SHELTERED SIDE
BEDROOMS UNDER LIVING ACCOMMODATION MAY ALSO BE BENEFICIAL TO ISOLATE FROM OVERHEAD NOISE.
6. 'ORIEL' BEDROOM 2
1. KITCHEN
'LITTLE CONSERVATORY'
2.
3.
4. BEDROOM 3
5. 'BAY' MAIN BEDROOM LIVING ROOM
7.
STORAGE CUPBOARDS AS NOISE BUFFERS.
5. BAY WINDOW: INNER AND OUTER GLAZED SCREENS, 600MM + AIRGAP. WEATHERSTRIP SEALS TO DOORS, SOUND-ABSORBENT FLOOR (CORK MATTING) AND CEILING.
6. 'ORIEL' WINDOW: INNER AND OUTER WINDOWS, WEATHER STRIP-SEALED, 600 + AIRGAP. CONCRETE LID AND BASE
7. EXTERNAL WALL: BRICK OUTER LEAF, 75 CAVITY WITH ROCKWOOL CAVITY FILL THERMAL INSULATION, 13mm PLASTER INTERNAL FINISH
HOUSES INSULATED AGAINST AIRCRAFT NOISE, NNI = 60 DOSAGE ENVELOPE TARGET REDUCTION TO EXTERNAL NOISE LEVELS 40dB+
HOUSING
SOURCE: BUILDING DESIGN PARTNERSHIP.



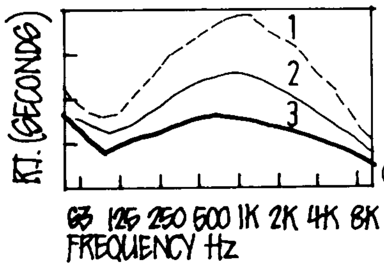
SOURCE: P. WILSON
LUCAS IND. NOISE CENTRE

(1)

1. OPEN GANGWAY, UNTREATED FACTORY
2. ACROSS BENCHES, UNTREATED FACTORY
3. OPEN GANGWAY, ABSORBENT-LINED FACTORY
4. ACROSS MACHINES, ABSORBENT LINED MACHINES

FACTORY TYPE	DECAY RATE: dB/DOUBLING DISTANCE
HARD EMPTY	−3
HARD WITH SCATTER ELEMENTS	−4
ABSORBENT LINED EMPTY	−4
ABSORBENT LINED WITH SCATTER ELEMENTS	−5

(2)



(3)

1. NO MACHINES
2. 25 MACHINES
3. 50 MACHINES

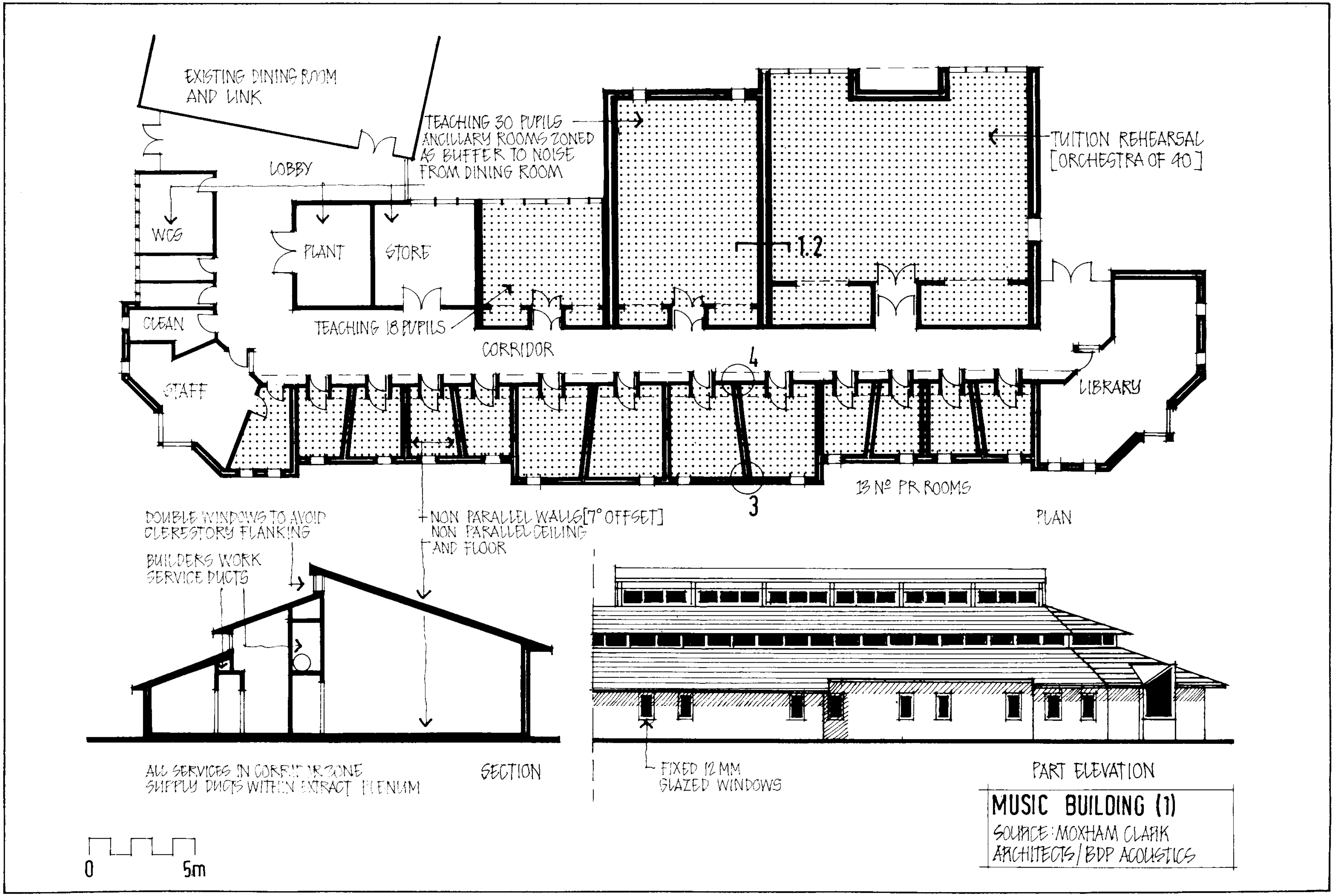
FACTORY 45X43X4-3m
HARD FINISHES
SOURCE: M. HODGSON
UNIVERSITY CAMBRIDGE

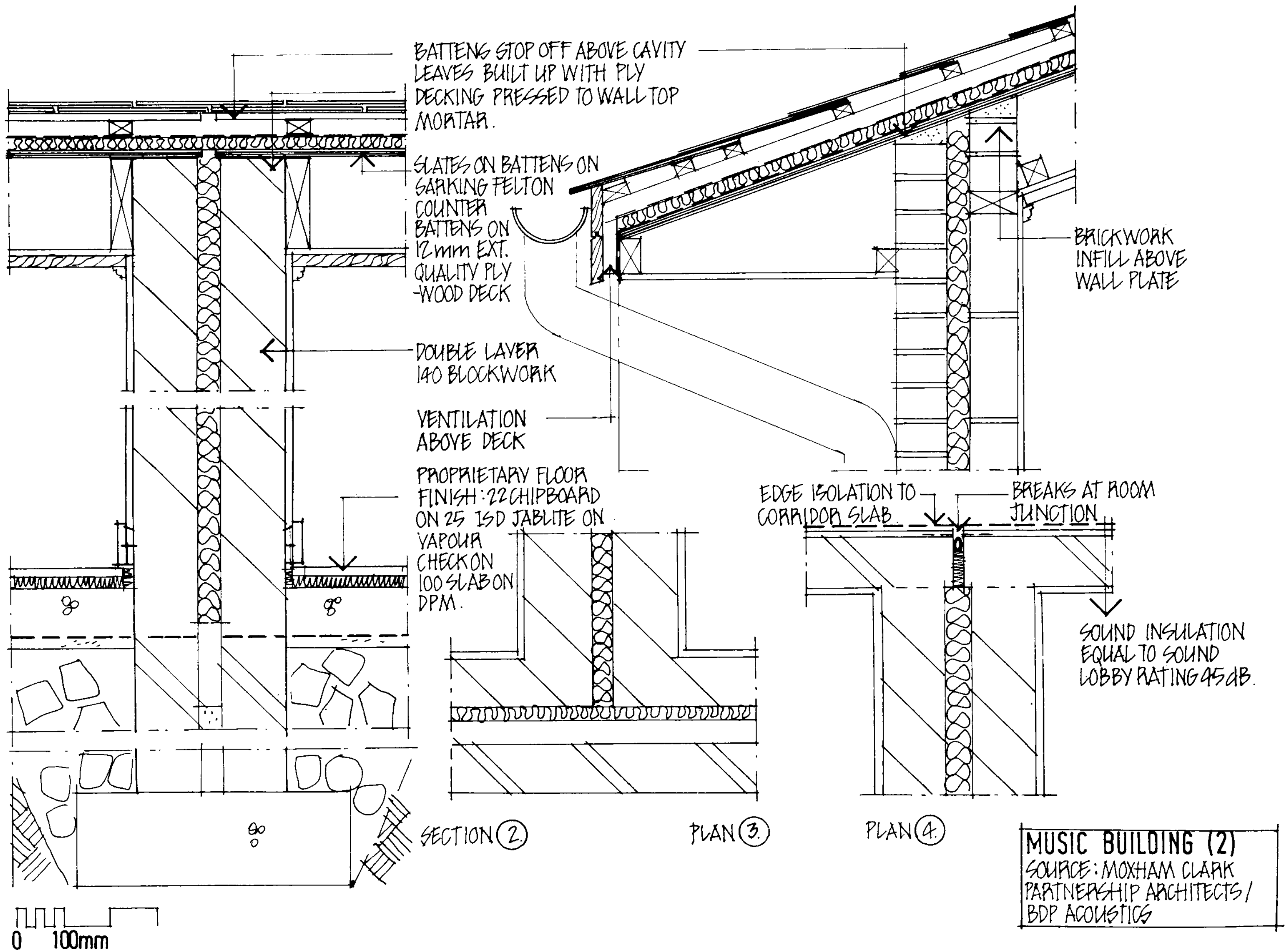
DESIGN GUIDE

1. WHERE EMPLOYEES EXPOSED TO ⩾ 8HR LEQ. OF 90 dB(A)*, NOISE REDUCTION MEASURES TO BE TAKEN AS FAR AS REASONABLY PRACTICABLE. EAR DEFENDERS TO BE WORN.
2. CLASSICAL DESCRIPTION OF SOUND IN ENCLOSURES (eg. SABINE) NOT APPLICABLE. TENDENCY FOR ABSENCE OF CONSTANT REVERBERANT SOUND LEVEL OUTSIDE DIRECT SOUND FIELD OF SOURCES. THIS MEANS ABSORBENT TREATMENTS DO NOT NECESSARILY PRODUCE MARKED SOUND LEVEL REDUCTIONS IF REMOTE.
3. LACK OF REVERBERANT SOUND FIELD MEANS ZONING OF NOISY FROM QUIET PROCESSES AND LOCAL SCREENING ARE EFFECTIVE MEASURES
4. OVERHEAD SUSPENDED ABSORBERS COUPLED WITH LOCAL SCREENING ARE OFTEN THE BEST FORM OF INCORPORATING SOUND ABSORPTION.
5. OPERATOR EXPERIENCE OF NOISE IS NOT IMPROVED BY TREATMENT IN FACTORY SPACE – NO VARIATION IN DECAY RATE >2M. (1).
6. FOR DECAY RATE FROM AN OMNIDIRECTIONAL SOURCE IN A FACTORY SPACE. GUIDE LINES (2.) MAY BE CONSIDERED
7. MACHINERY AND PLANT THEMSELVES PROVIDE SIGNIFICANT SCATTER AND ABSORPTION (3.).

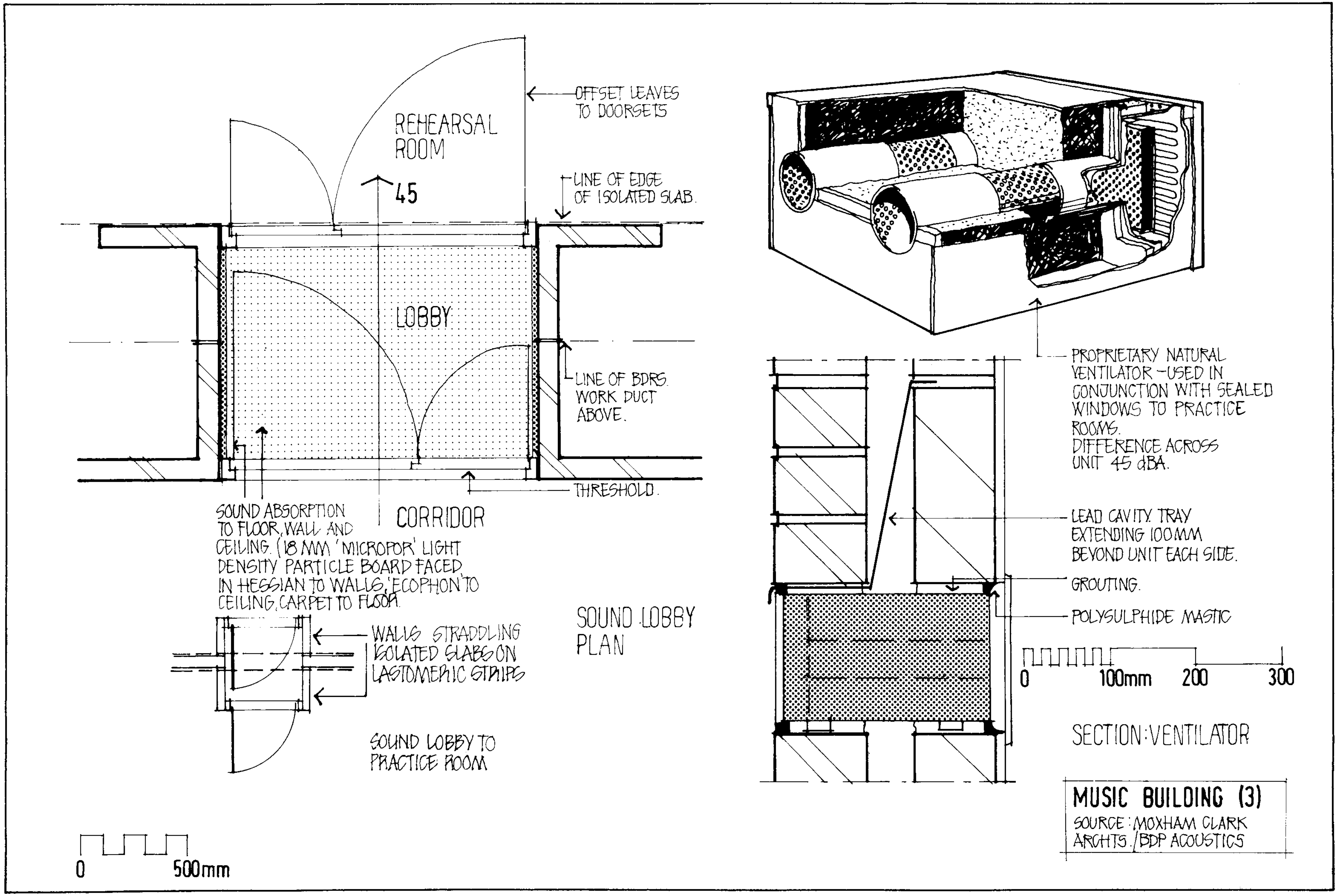
* EEC PROPOSAL FOR COUNCIL DIRECTIVE (18 OCTOBER 1982): DAILY EXPOSURE MUST NOT EXCEED 85 dB(A) BUT TO TAKE ACCOUNT OF FEASIBILITY 5 YEARS ARE TO BE ALLOWED FOR IMPLEMENTATION

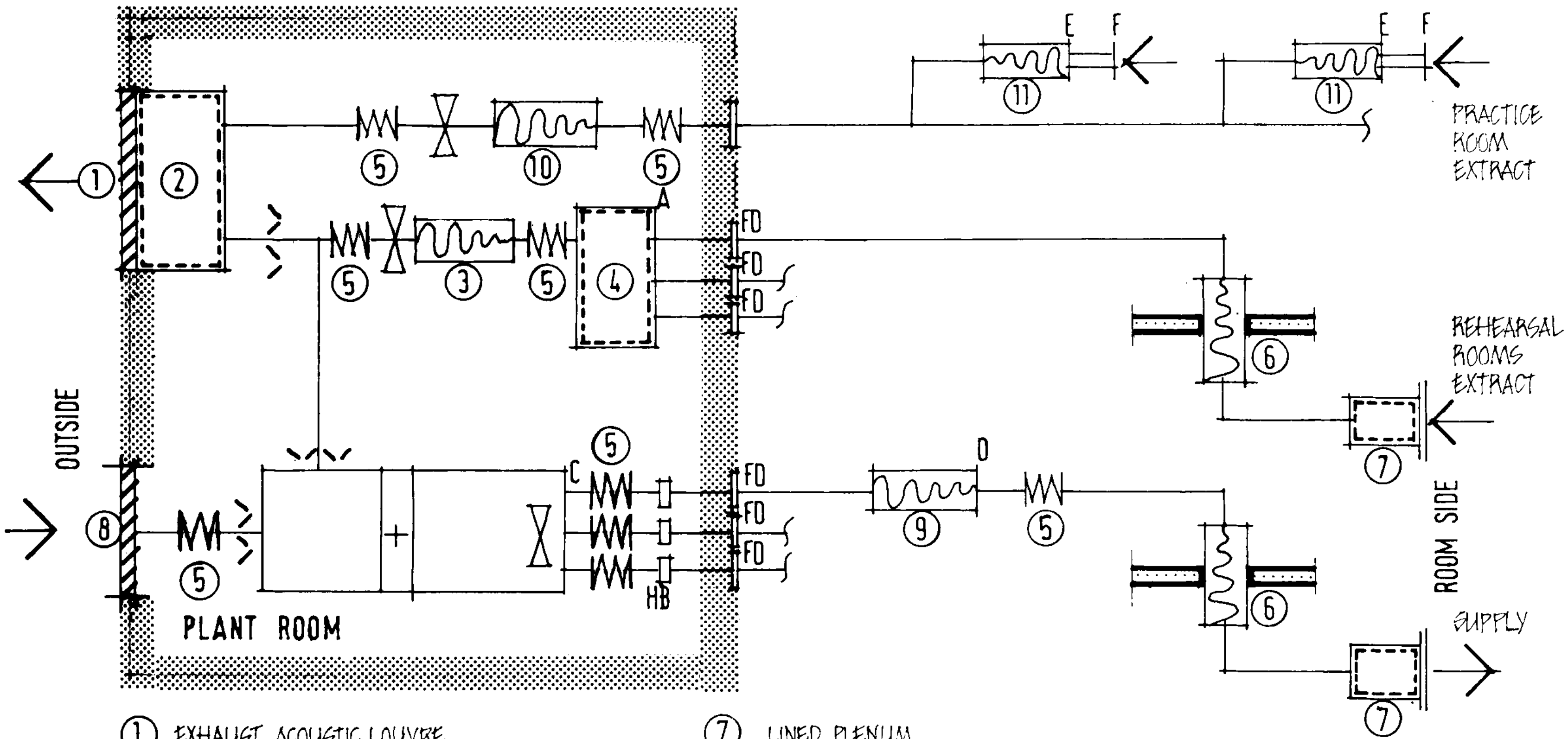
INDUSTRIAL BUILDINGS


EXISTING DINING ROOM AND LINK
TEACHING 30 PUPILS
ANCILLARY ROOMS ZONED AS BUFFER TO NOISE FROM DINING ROOM
TUITION REHEARSAL [ORCHESTRA OF 40]
LOBBY
WCS
PLANT
STORE
1.2
CLEAN
TEACHING 18 PUPILS
CORRIDOR
4
STAFF
LIBRARY
3
13 Nº PR ROOMS
PLAN
DOUBLE WINDOWS TO AVOID CLERESTORY FLANKING
BUILDERS WORK SERVICE DUCTS
NON PARALLEL WALLS [7° OFFSET] NON PARALLEL CEILING AND FLOOR
ALL SERVICES IN CORRIDOR ZONE SUPPLY DUCTS WITHIN EXTRACT PLENUM
SECTION
FIXED 12 MM GLAZED WINDOWS
PART ELEVATION
MUSIC BUILDING (1)
SOURCE: MOXHAM CLARK ARCHITECTS / BDP ACOUSTICS
0
5m



MUSIC BUILDING (2)
SOURCE: MOXHAM CLARK PARTNERSHIP ARCHITECTS / BDP ACOUSTICS


REHEARSAL ROOM
OFFSET LEAVES TO DOORSETS
45
LINE OF EDGE OF ISOLATED SLAB.
LOBBY
LINE OF BDRS. WORK DUCT ABOVE.
THRESHOLD.
CORRIDOR
SOUND ABSORPTION TO FLOOR, WALL AND CEILING. (18 MM 'MICROPOR' LIGHT DENSITY PARTICLE BOARD FACED IN HESSIAN TO WALLS, 'ECOPHON' TO CEILING, CARPET TO FLOOR.
SOUND LOBBY PLAN
WALLS STRADDLING ISOLATED SLABS ON LASTOMERIC STRIPS
SOUND LOBBY TO PRACTICE ROOM
0
500mm
PROPRIETARY NATURAL VENTILATOR – USED IN CONJUNCTION WITH SEALED WINDOWS TO PRACTICE ROOMS.
DIFFERENCE ACROSS UNIT 45 dBA.
LEAD CAVITY TRAY EXTENDING 100MM BEYOND UNIT EACH SIDE.
GROUTING.
POLYSULPHIDE MASTIC
0
100mm
200
300
SECTION: VENTILATOR
MUSIC BUILDING (3)
SOURCE: MOXHAM CLARK ARCHTS./BDP ACOUSTICS



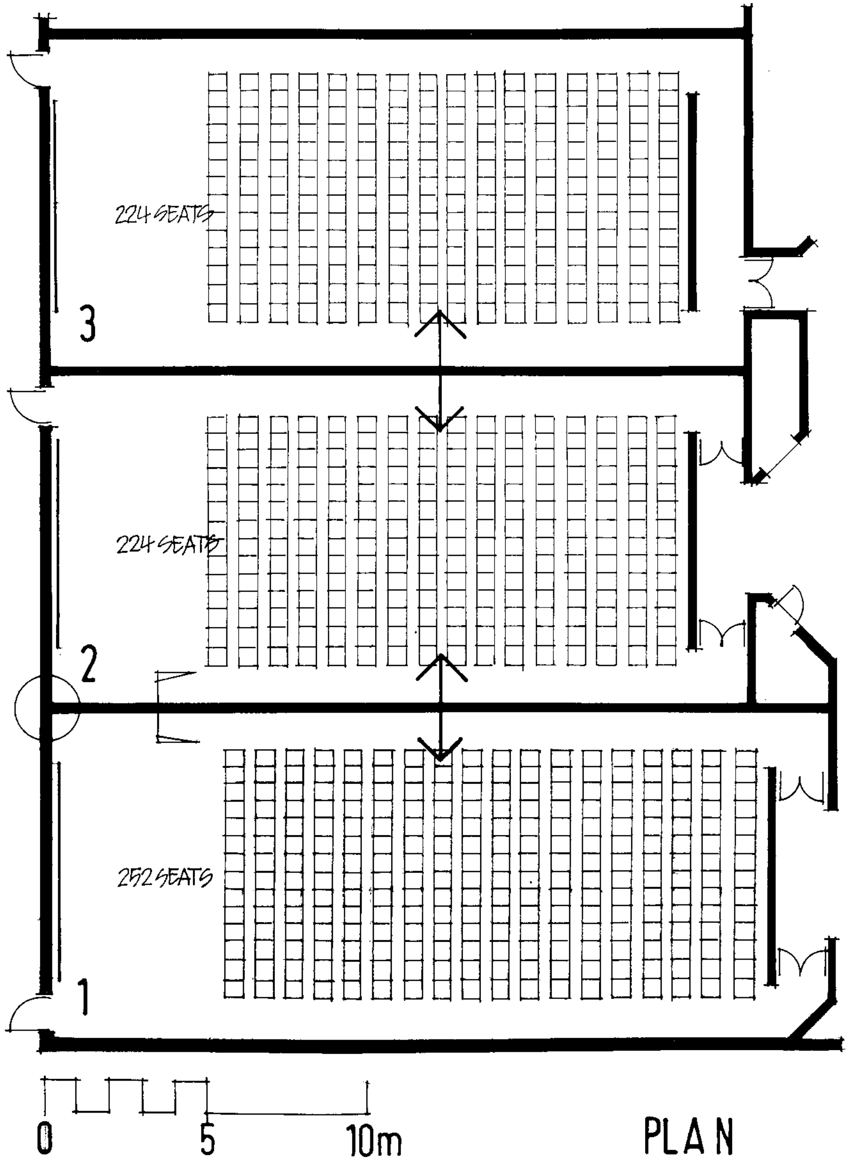
① EXHAUST ACOUSTIC LOUVRE
② EXHAUST CHAMBER (LINED)
③ RETURN AIR ATTENUATOR
④ RETURN AIR CHAMBER (LINED)
⑤ FLEXIBLE CONNECTION
⑥ CROSS TALK ATTENUATOR
⑦ LINED PLENUM
⑧ INLET ACOUSTIC LOUVRE
⑨ SUPPLY AIR ATTENUATOR
⑩ PR ROOMS RETURN AIR FAN ATTENUATOR
⑪ EXTRACT CROSS TALK ATTENUATOR.

VENTILATION PLANT:
ACOUSTIC SCHEMATIC

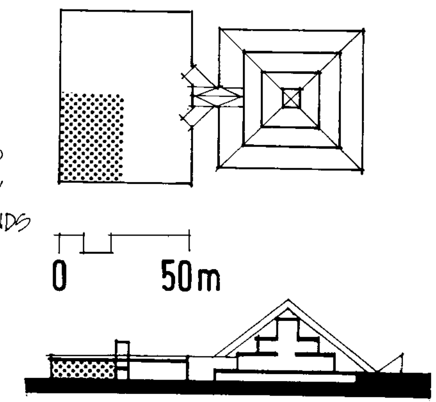
FD FIRE DAMPER.
HB HEATER BATTERY.

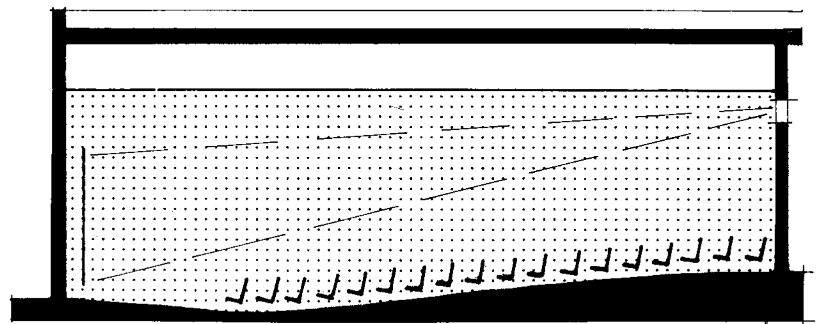
MUSIC BUILDING (4)
SOURCE: MOXHAM CLARK ARCHITECTS / BDP ACOUSTICS

10 SCREEN MULTIPLEX CINEMA AND ENTERTAINMENT COMPLEX AT MILTON KEYNES, TOTAL SEATING OVER 2000. PARTITIONS DESIGNED FOR A HIGH STANDARD OF SOUND INSULATION TO AVOID THE SOUND TRACK BEING HEARD IN ADJACENT CINEMAS. MID FREQUENCY RT MEASURED AT TYPICALLY 0·5 SECONDS



PLAN

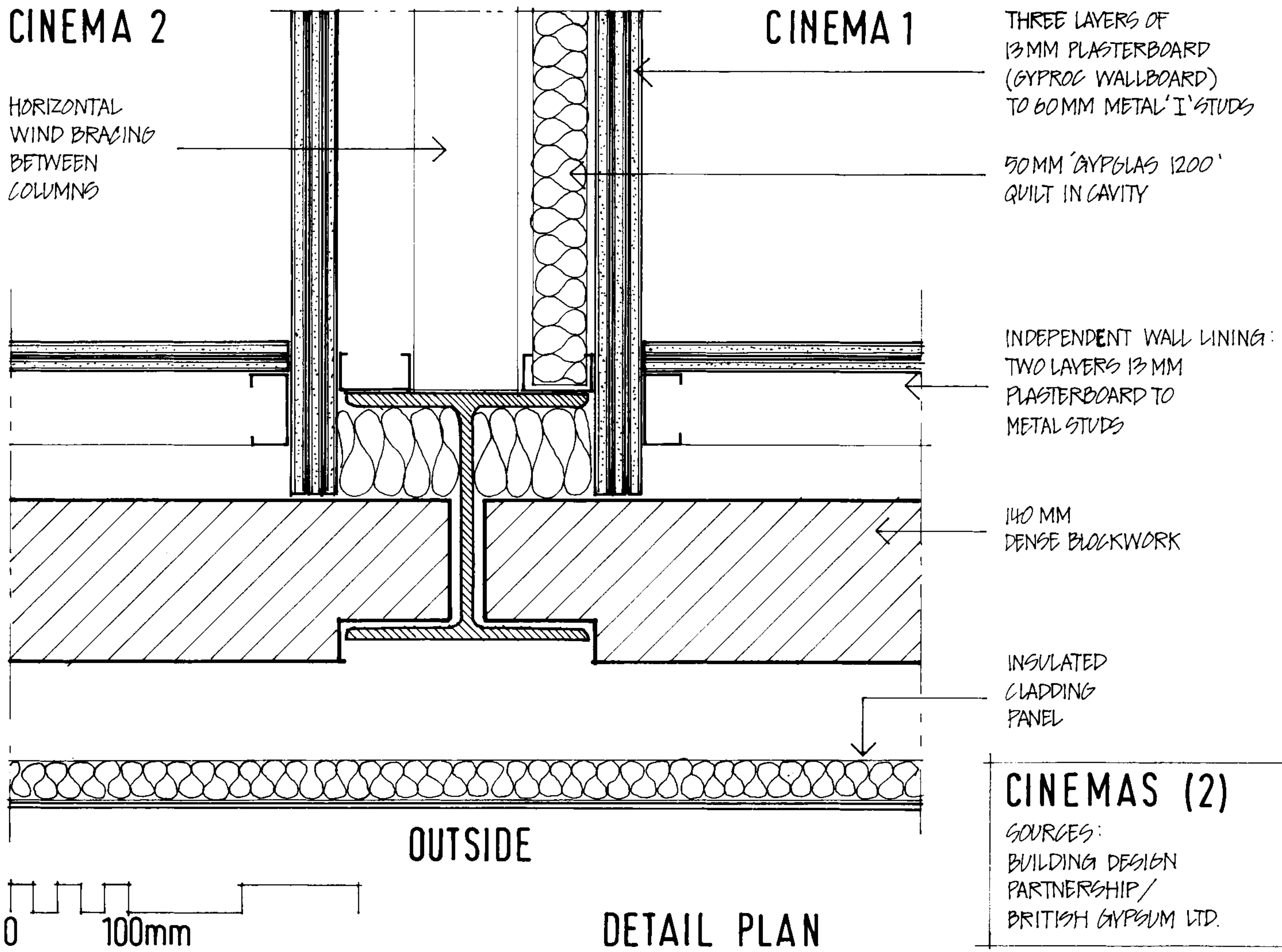




SECTION

CINEMAS (1)

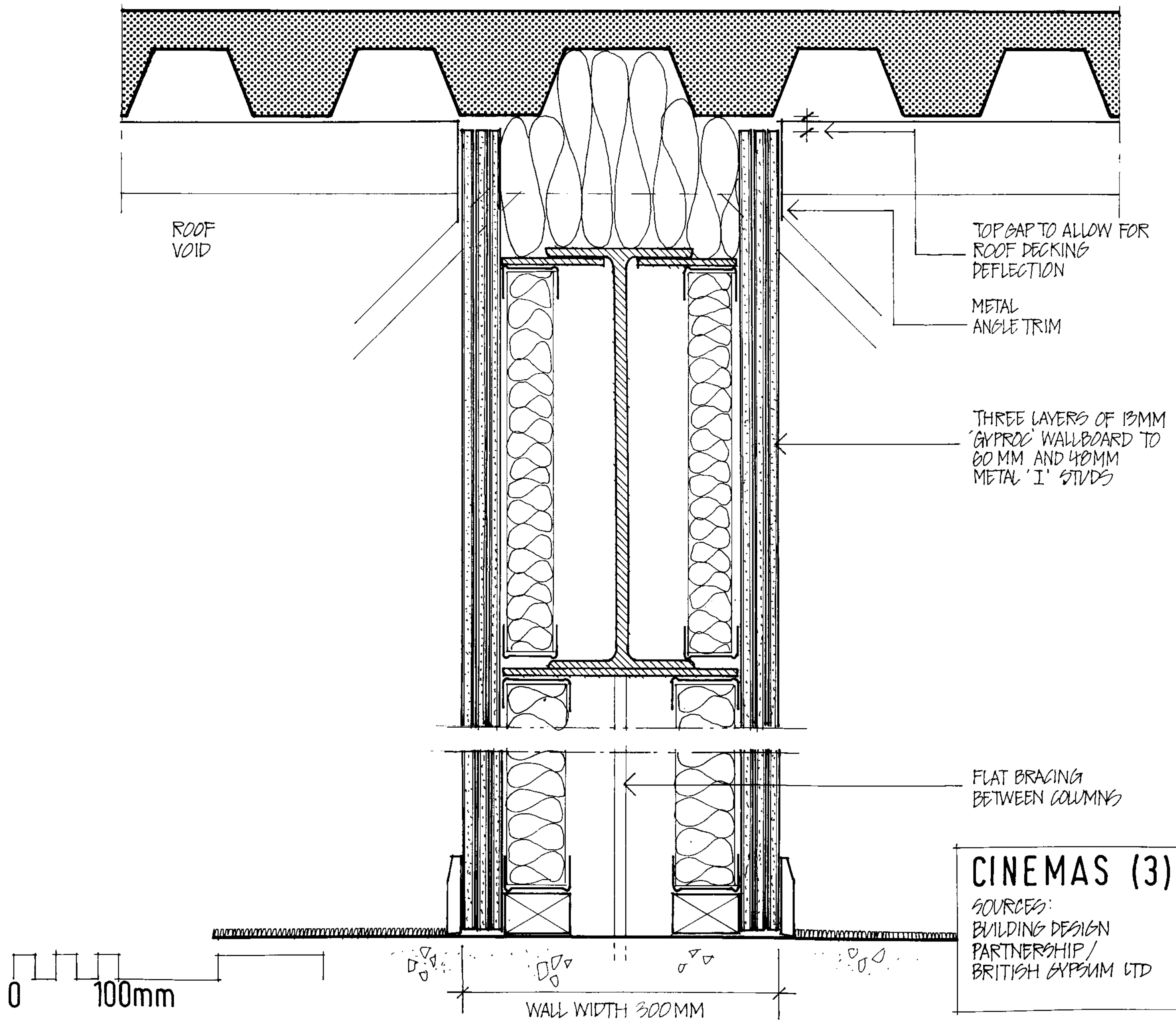
SOURCES:
BUILDING DESIGN PARTNERSHIP / BRITISH GYPSUM LTD



DETAIL PLAN

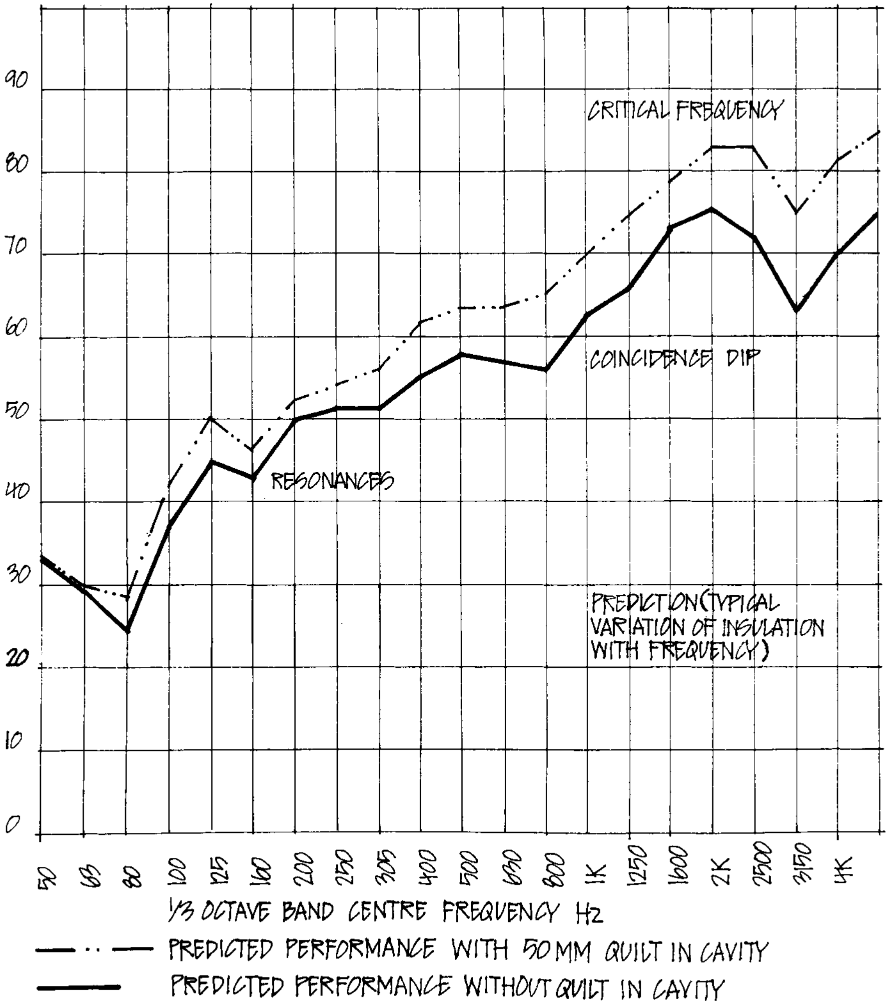
CINEMAS (2)

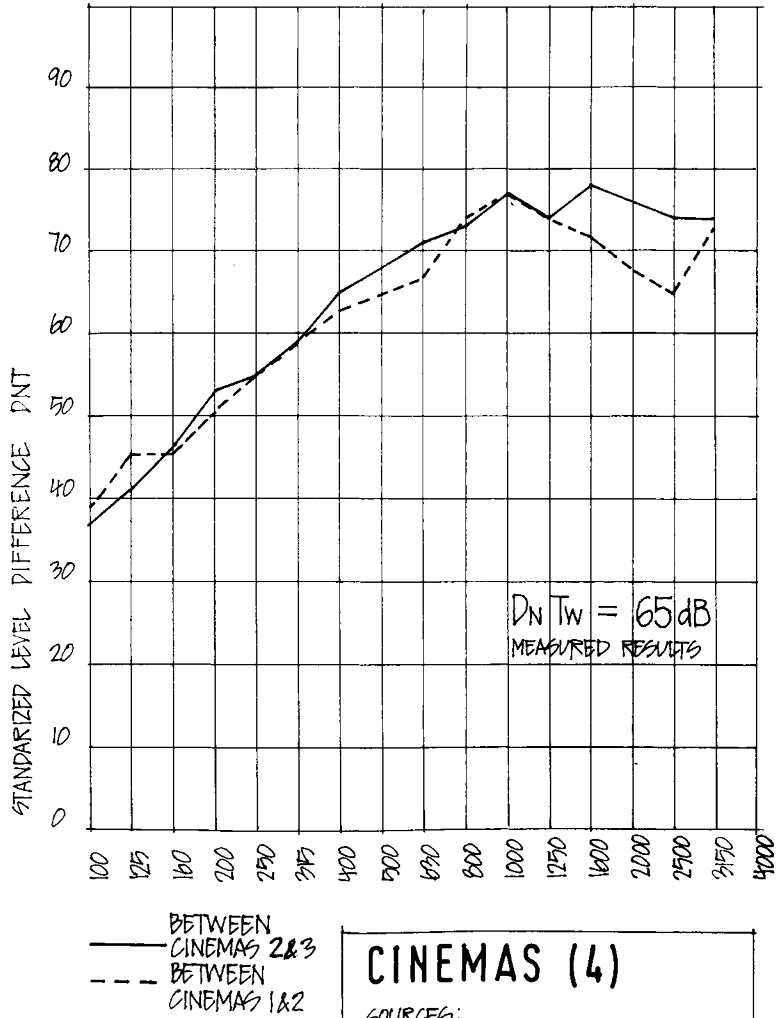
SOURCES:
BUILDING DESIGN PARTNERSHIP/
BRITISH GYPSUM LTD.



CINEMAS (3)

SOURCES:
BUILDING DESIGN
PARTNERSHIP/
BRITISH GYPSUM LTD



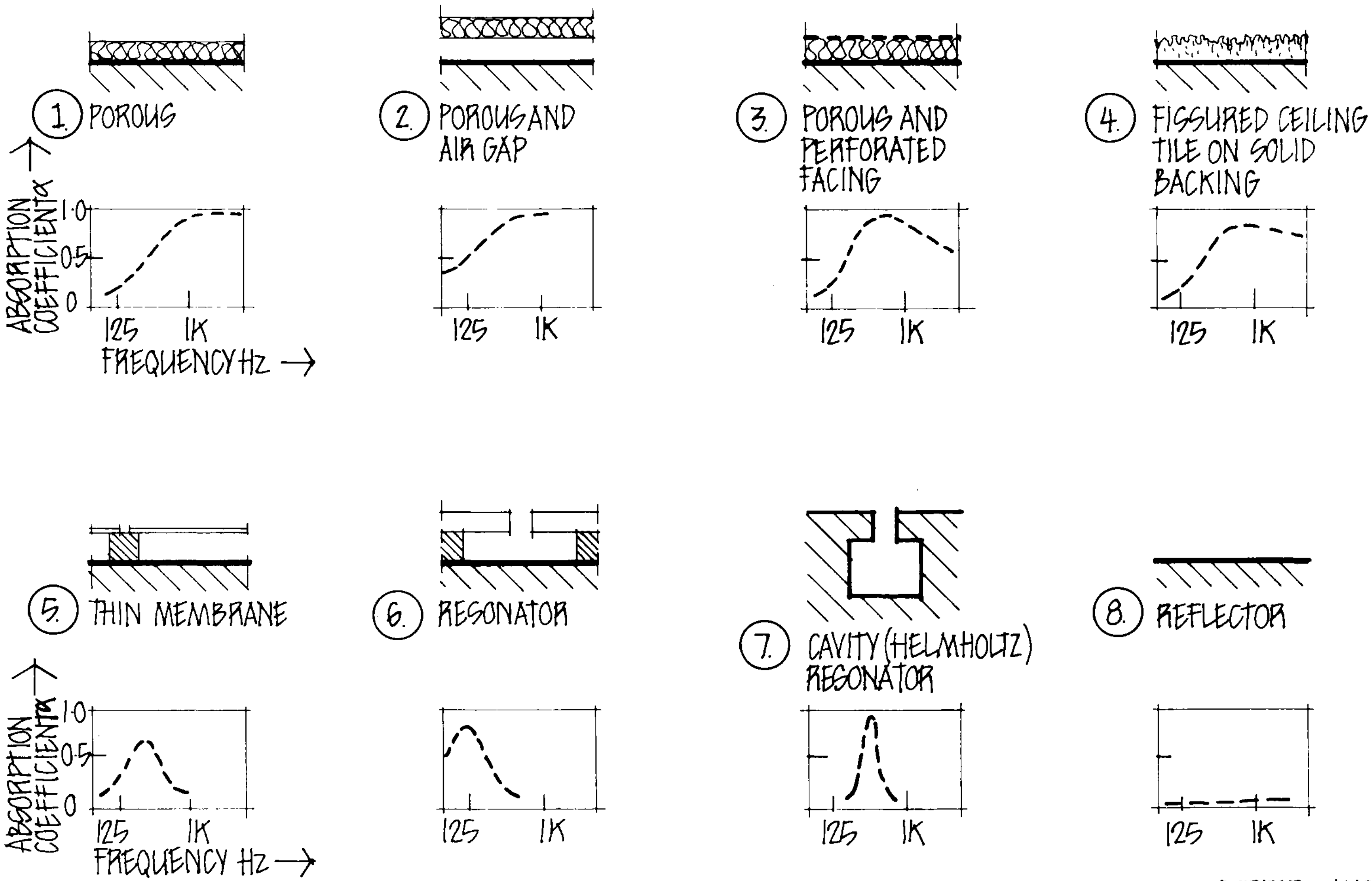


CINEMAS (4)

SOURCES:
BUILDING DESIGN PARTNERSHIP/
BRITISH GYPSUM LTD

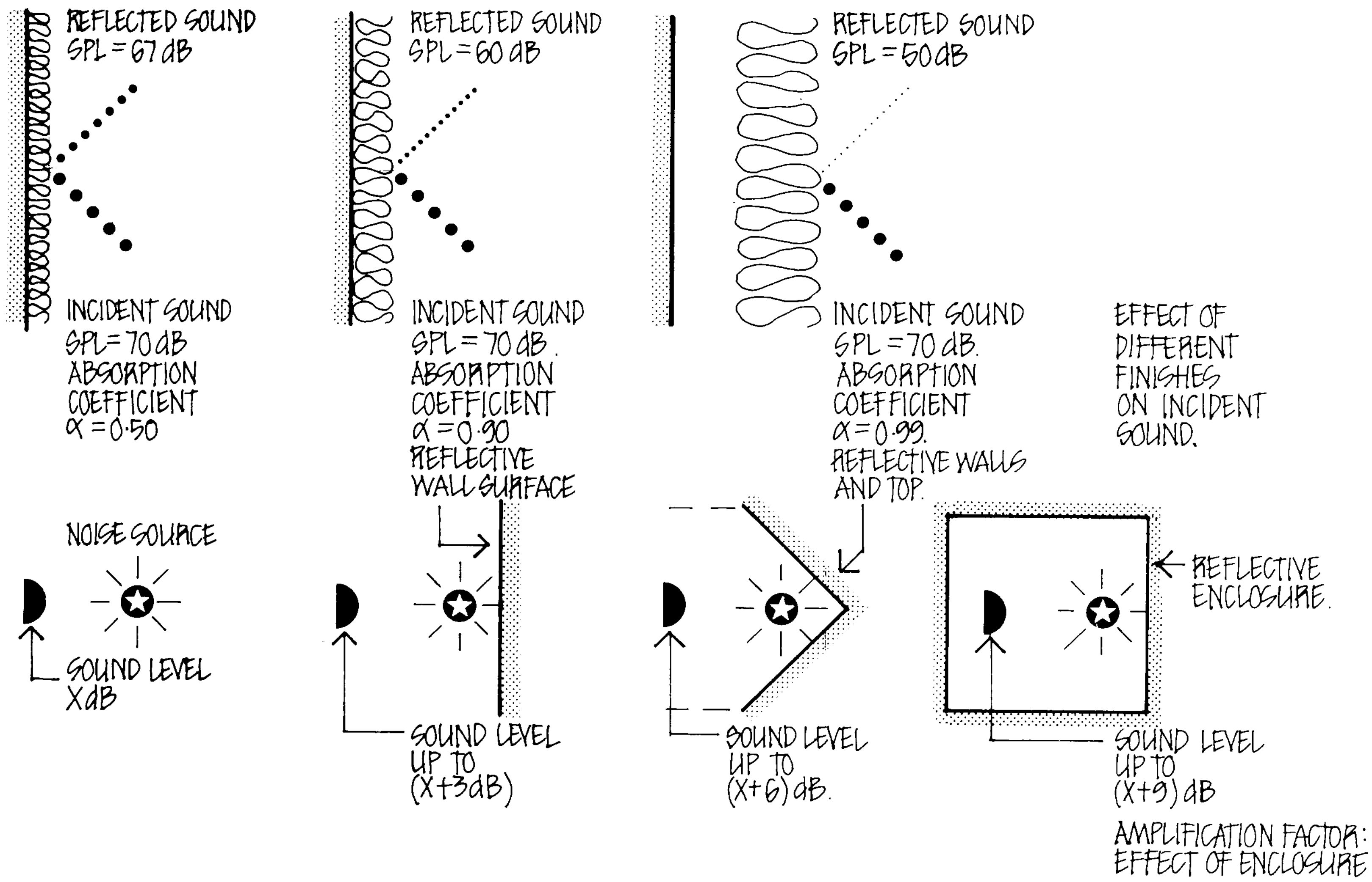
3 APPENDIX A

SOUND ABSORPTION



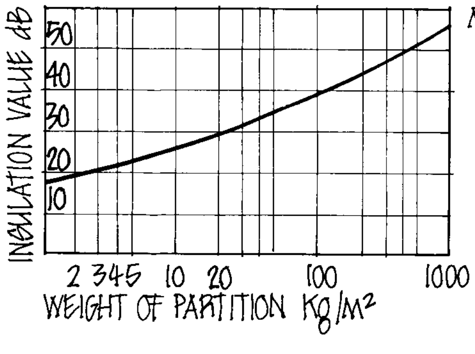
PERFORMANCE OF DIFFERENT WALL OR CEILING FINISHES

SOUND ABSORPTION



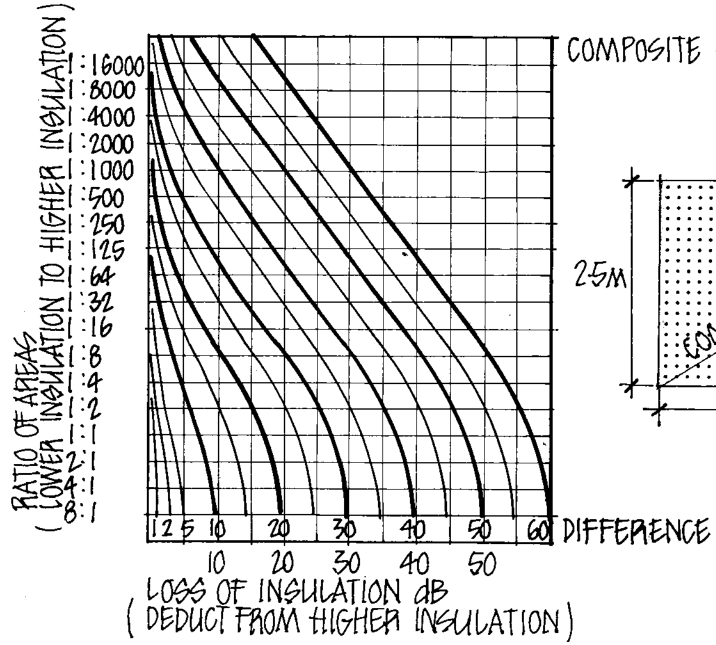
SOUND ABSORPTION

SOUND INSULATION

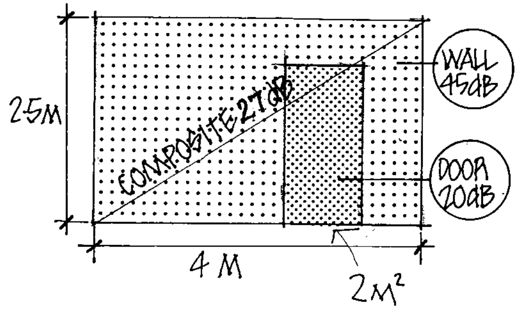


MASS LAW FOR SOUND INSULATION

FOR SINGLE WALLS THE WEIGHT PER UNIT AREA IS AN INDICATION OF INSULATION VALUE ONLY. RESULTS BELOW MASS EXPECTATION MAY OCCUR BECAUSE OF: RESONANCE AND COINCIDENCE EFFECT; FLANKING; EDGE FIXING. COMPOSITE CONSTRUCTION OF A SERIES OF LAYERS IMPROVES THE SOUND INSULATION ABOVE MASS LAW EXPECTATION AS DOES: RESILIENT MOUNTING OF PANELS; DISCONTINUITY OF CONSTRUCTION; DOUBLE OR TRIPLE LAYERS WITH WIDE AIR SPACE. A HEAVY DIVIDING ELEMENT IS PARTICULARY EFFECTIVE FOR LOW FREQUENCY SOUND.

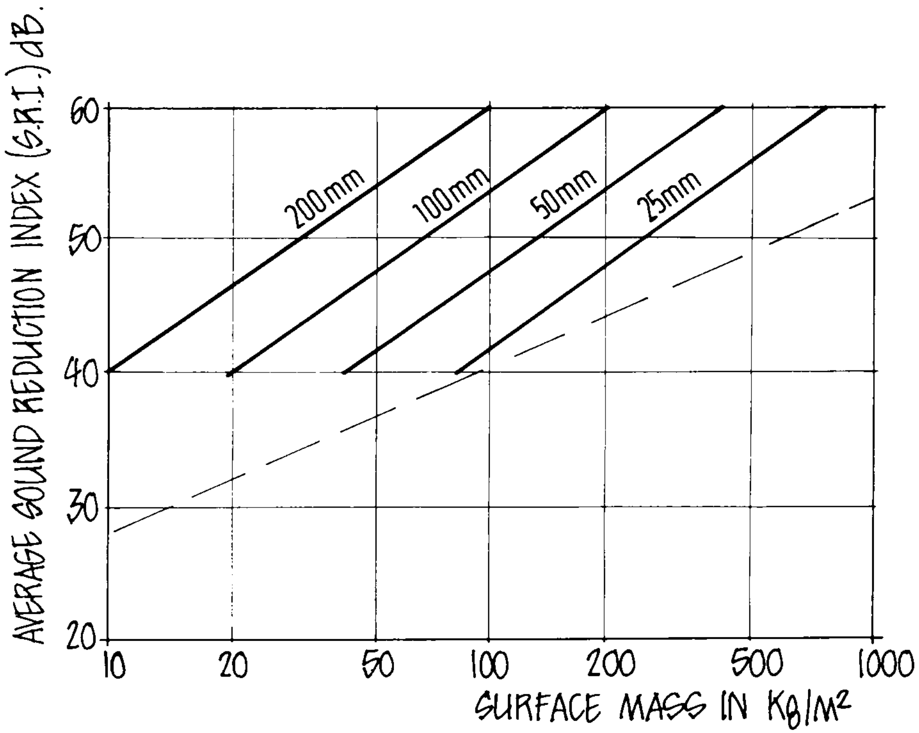


COMPOSITE ELEMENTS OF STRUCTURE



THE COMPOSITE SOUND REDUCTION INDEX (S.R.I.) OF PARTITION BETWEEN 2 ROOMS, OR OUTSIDE WALLS WITH WINDOWS IN A ROOM, CAN BE OBTAINED FROM THE FIGURE AT LHS. AN EXAMPLE OF THE EFFECT IS ALSO SHOWN AT LHS. A HOLE IN A 10 SQ.M. 45 dB-RATED WALL OF 100mm×100mm DOWN RATES THE COMPOSITE RATING TO 30 dB

SOUND INSULATION
SOURCE: PARKIN HUMPREYS AND COWELL

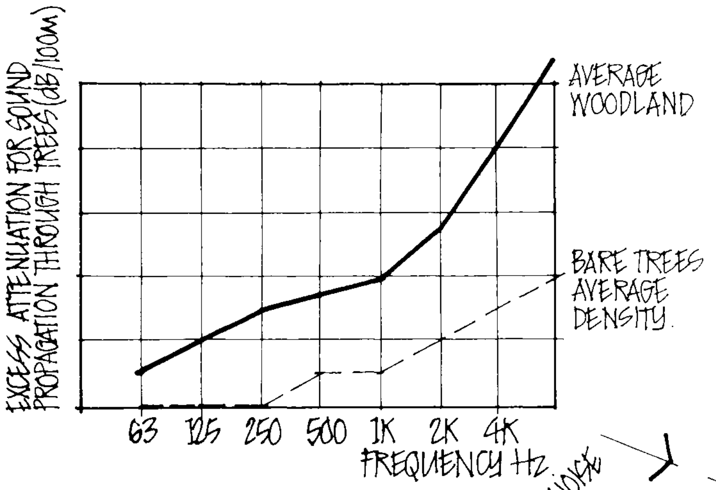


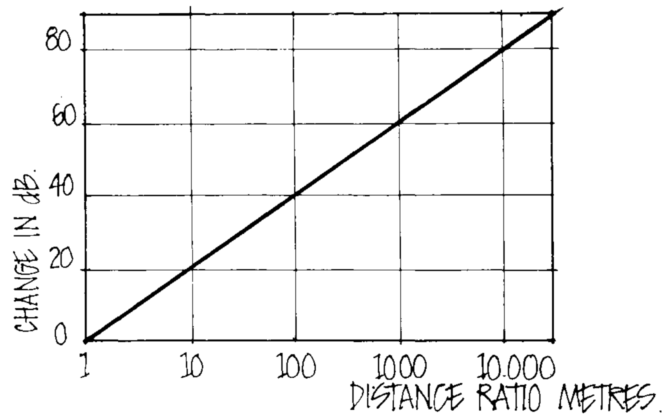
THE 'MASS LAW' FOR SINGLE WALLS HAS A CORRESPONDING EMPIRICAL RELATIONSHIP BETWEEN S.R.I. AND WEIGHT PER UNIT AREA FOR DOUBLE LEAF PARTITIONS. AS WITH SINGLE WALLS, THESE CURVES ARE AN INDICATION ONLY BECAUSE THE S.R.I. WILL VARY WITH FREQUENCY.

EMPIRICAL RELATIONSHIP FOR A DOUBLE SKIN PARTITION
– – – – SINGLE SKIN PARTITION
DIMENSIONS ARE FOR DIFFERENT CAVITY WIDTHS BETWEEN LEAVES.

SOUND INSULATION

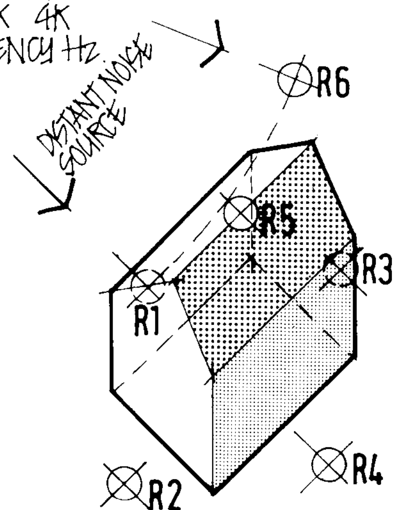
EXTERNAL NOISE





PLANTING.

PLANTING IS OF SOME BENEFIT FOR HIGH FREQUENCY ATTENUATION BUT OTHERWISE OF LIMITED USE IN SCREENING, SAY, TRAFFIC NOISE COMPARED WITH MOUNDING.



NOISE LEVEL AT FRONT	**R1**	= X
NOISE LEVEL AT SIDES	**R2**	= X-6dB
	R3	= X-6dB
NOISE LEVEL AT REAR	**R4**	= X-10dB
NOISE LEVEL AT ROOF	**R5**	= X-3dB
NOISE LEVEL WITH NO BUILD-UP RESULTING FROM WALL BEHIND	**R6**	= X-2·5dB

DISTANCE

THE MAIN FACTOR AFFECTING REDUCTION OF NOISE LEVEL WITH DISTANCE IS THE SPREAD OF ENERGY. DOUBLING DISTANCE TENDS TO CAUSE A REDUCTION OF 6dB. OTHER FACTORS AFFECT THE REDUCTION WITH DISTANCE: GROUND EFFECTS, TEMPERATURE, WIND, FOG, SNOW AND RAIN. FOR A LINEAR NOISE SOURCE LIKE TRAFFIC, THE REDUCTION WITH DISTANCE IS MUCH LESS - 3dB / DOUBLING.

BUILDINGS

BUILDINGS AND WALLS AFFECT SOUND LEVELS LOCALLY, SO LOCATING ROOMS AND WINDOWS TO MORE SHELTERED ELEVATIONS WILL GIVE USEFULLY LOWER INTRUSIVE NOISE LEVELS WITHIN.

EXTERNAL NOISE

4 APPENDIX B

DEFINITIONS

Absorption
The ability of a material to absorb sound is measured by its 'absorption coefficient' α which is defined as the fraction of energy incident on its surface which is not reflected. The higher the decimal fraction value, the better the absorptive property of the material. This does not imply that some of the energy does not continue on through the material. The absorption A of a surface of area S is then given by:

$$A = S\,\alpha \quad \cdots\cdots$$

and if there are several absorbing surfaces of areas, S_1, S_2, S_3 etc. the total absorption A_T is obtained by:

$$A_T = \alpha_1 S_1 + \alpha_2 S_2{:} + \alpha_3 S_3 \quad \cdots\cdots$$

There are different types of absorber: porous absorbers where the sound energy falling on them is dissipated by viscous losses within the pores of the material, and resonant absorbers. Resonant absorbers themselves are grouped into those on the Helmholtz resonator principle, an example of which is a perforated panel separated from a solid backing containing some porous absorbent, and membrane resonators, where a solid panel is spaced off a solid backing but by virtue of panel flexibility and its thickness (less than 20 mm) vibrates on the trapped layer of air. For Helmholtz resonators, the frequency at which maximum absorption takes place is a function of the thickness of the panel, the area of the perforations and the spacing behind the panel. For membrane resonators, the frequency at which maximum absorption occurs depends on the spacing panel to backing, the superficial weight of the panel and whether the panel-backing cavity has any porous absorbent within. Both types of resonant absorber are used for low-frequency absorption, and combination of the two types is possible.

Acoustic, Acoustical
The adjectives are almost interchangeable in use. Acoustic tends to apply in describing the basic property of the sense of hearing. Acoustical is used to describe devices or personnel in the field of acoustics.

Acoustics
The science of sound (from the Greek, akouo, to hear).

Acoustical treatment
The application of design principles in architectural acoustics to isolate noise or vibration and to correct acoustical faults in spaces by addition of absorption, reflectors or other devices.

Ambient noise
Background or general noise level characteristic of an area, often used in comparison with a specific noise source overlay. Sound pressure level in dBA exceeded for 90% of the time (L_{90}). Ambient noise control may be by use of rating curves—see text.

Assisted resonance
An electronic method of lengthening the reverberation time of a hall by means of a series of channels each consisting of a microphone mounted in a tuned resonator in the ceiling feeding on an amplifier connected to a loudspeaker also in the ceiling.

Brilliance
Attribute of a hall with clear sound, prominent in treble, rich in harmonics.

Clarity (Deutlichkeit)
Defined as 10 log (energy over first 80 milliseconds expressed as a fraction of the remaining energy). The degree of clarity in sound reception depends on the strong receipt of direct rather than reverberant sound.

Coincidence
This occurs when the wavelength of the incident sound wave projected onto a partition or panel matches the bending wavelength of the partition or panel.

Critical frequency
Lowest frequency when coincidence occurs. Critical frequency is raised for thinner and less stiff surfaces in the sound path.

Decibel
Sound pressure level is the usual characteristic expressed in decibels. The scale is based on 10 times $\log_{10}$ of the relative intensity of a sound and a

reference pressure. 'dBA' is a decibel unit with an 'A' weighting applied. This weighting has reduced response to extremes of frequency in order to simulate the response of the human ear.

Definition
Ratio of useful energy arriving within the first 50 milliseconds to total energy comprising signal; high figure means good definition.

Diffraction
Ability of a sound to pass round a screen or barrier. Lower frequency sounds can diffract around obstacles more easily because of their longer wavelength.

Diffusion
Complexity of reflecting surfaces causing an even dispersion of sound in a room, with no directionality of sound waves.

Dryness
A characteristic of an auditorium which has a short reverberation time; to some extent the opposite of 'richness'.

Echo
Reflected sound discernible as separate from the initial sound, by virtue of the long reflected sound path.

Flanking
Ability of acoustic energy to by-pass a sound barrier at the edges. Good airborne sound insulation through a floor construction, for example, may be flanked by sound transmission down the walls or through ducts.

Flutter
Rapid echo pattern between parallel walls which can be discerned.

Focusing
Acoustic energy, like light energy, can be reflected from concave surfaces into a concentrated focus. This may leave 'dead spots' elsewhere.

Frequency
The number of cycles per second that a vibrating system completes. Units of frequency are cps. or more usually Hertz; both have identical value. The audibility of a sound depends on its level and also on its frequency. The human ear can detect sounds with frequencies ranging from 20 to 20,000 Hz although increasing age reduces the upper limit. The frequency, f, velocity, C, and the wavelength, λ, of the sound waves are related by the expression:

$$C = f\lambda \qquad \ldots\ldots$$

Intimacy
Impression in sound quality, sometimes called 'presence', that the source is near. In an auditorium this can occur in surprisingly distant seat locations if they benefit from close reflecting surfaces.

L_{10}
Noise level in dBA which is exceeded for 10% of the time.

L_{90}
Noise level in dBA which is exceeded for 90% of the time (background or lower limit noise condition).

L_{eq} (equivalent continuous sound level)
A-weighted energy mean averaged over the measurement period, ie the continuous steady noise level which would have the same total A-weighted acoustic energy as the real fluctuating noise measured over the same time.

Liveness
Attribute of a reverberant hall, imparting fullness of tone to music in high and mid frequencies.

Loudness
The subjective judgement of sound intensity by an individual which tends to be influenced by sound pressure and frequency. A typical response is for a three-fold change of sound pressure level to be considered a doubling of loudness.

Loudness level
The loudness level in phons of a noise is defined as the sound pressure level in decibels of a 1000 Hz tone which sounds equal in loudness to the sound which is being rated.

Masking
The effect whereby the threshold of audibility of a sound is raised by the presence of another sound. Masking is most effective when the masking sound is of lower frequency than the sound to be masked.

Membrane absorber
A component assembly whereby a solid thin panel is spaced off a solid backing but by virtue of panel flexibility vibrates on the trapped layer of air. The frequency at which maximum absorption occurs depends on the spacing panel to backing and the superficial weight of the panel.

Noise
Sound unwanted by the recipient.

Noise reduction coefficient (NRC)
A single value to express absorption coefficients averaged over the octave bands centred on 250, 500, 1K and 2K Hz.

Normalized level difference
Difference in dB between energy levels in rooms on opposite sides of a partition corrected for a standard amount of absorption representative of normal furnished conditions in the receiving room.

Normalized level difference, $Dn = L_1 - L_2 + 10 \text{ Log } RT - 10 \text{ Log } .5$dB where RT = measured reverberation time in the receiving room during tests.

Pitch
The pitch of a sound is the frequency of an equally loud pure tone which on average is judged to occupy the same position on a musical scale.

Porous absorber
Sound-absorbing finish where the sound energy falling on it is dissipated by viscous losses within the pores of the material.

Pure tone
Sound at a finite, very narrow, frequency band and at no other.

Reflection
Sound energy returned after impact on a surface, rather than being absorbed as heat energy within the surface.

Resonance
The natural vibration of an area of material at a particular frequency as a result of excitation by a sound at that frequency.

Reverberation
The effect whereby a sound builds up in a space or at a point in a space because of multiple reflections from surrounding enclosing walls, floors and ceiling. This may enhance the sound if constant and the sound will gradually die away after the sound source ceases.

Reverberation time
The reverberation time of a room is the time taken for a steady sound when switched off to die away to inaudibility. More exactly, it is the time taken for the sound pressure level to fall by 60 dB. The reverberation time, T, is related to the volume of the room and the total absorption of the room by:

$$T = \frac{0.16V}{A} \text{ (seconds)} \quad \ldots\ldots$$

where V = volume in m^3, A = absorption in m^2 units.

Richness
A property of sound in an auditorium where there are many repetitions and reflections within a short period. Said to occur higher up in an auditorium because the sound is arriving up from more surfaces.

Room-to-room transmission
When a sound is transmitted from a reverberant room through a partition with sound reduction index (SRI) and Area S, into a room of absorption A, then the sound pressure level in the second room is:

$$SPL_2 = SPL_1 - SRI + 10 \text{ Log} \frac{S}{A} \text{ (dB)} \quad \ldots\ldots$$

SPL_1 in this expression is the average sound pressure level in the first room. If the sound power level is known for the first room, then SPL_1 can be found from the equation:

$$SPL_1 = SWL - 10 \text{ Log } A + 6 \text{ (dB)} \quad \ldots\ldots (6)$$

If instead of a second room there is just open air, then the difference in sound pressure levels between one side of the partition and the other is:

$$SPL_1 - SPL_2 = SRI + 6 \text{ (dB)} \quad \ldots\ldots$$

If SPL_1 near the inside of the wall of a building is known, then SPL_2 at some distance from the building is found from:

$$SPL_2 = SPL_1 - SRI + 10 \text{ Log } S - 20 \text{ Log } r - 14 \text{ (dB)} \quad \ldots\ldots$$

Sensitivity
The ear's sensitivity varies with frequency. It is much less sensitive at low rather than high frequencies, reaching a maximum at or around 1000 Hz. The sound pressure levels of sounds which are perceived as of equal loudness are referred to as equal loudness contours.

Simple sound source
A sound source radiating sound equally in all directions is called a simple source. The sound pressure level at a distance r from the source is given by:

$$SPL = SWL + 10 \text{ Log} \left(\frac{1}{4 \pi r^2}\right) \text{ (dB)} \quad \ldots\ldots$$

$$\text{or } SPL = SWL - 20 \text{ Log } r - 11 \text{ (dB)} \quad \ldots\ldots$$

This is modified by different constraints which depend on the directivity of the source. As an example, if the sound source is close to the ground the sound radiates into a hemisphere and then 3 dB must be added to the SPL:

$$SPL = SWL - 20 \text{ Log } r - 8 \text{ (dB)} \quad \ldots\ldots$$

6 dB would be added if the source were situated in the angle between two walls. If the sound source is in a reverberant room rather than outdoors, the average reverberant level will be:

$$SPL = SWL - 10 \text{ Log } A + 6 \text{ (dB)} \quad \ldots\ldots$$

The total sound pressure level resulting from the combination of reverberant and direct sound fields is given by:

$$SPL = SWL + 10 \text{ Log} \left(\frac{1}{4 \pi r^2} + \frac{4}{A}\right) \text{ (dB)} \quad \ldots\ldots$$

Sound
Sensation of hearing wave motion in an elastic medium.

Sound insulation
The fraction of incident sound energy falling per second on a partition which is transmitted through it is called the transmission coefficient τ and depends on mechanical and material properties of that partition. The performance of a partition is given in terms of an index known as the sound reduction index (SRI):

$$SRI = 10 \text{ Log} \left(\frac{1}{\tau}\right) \text{ (dB)} \quad \ldots\ldots$$

The SRI varies with frequency and is measured in a laboratory in either octave or one-third octave bands.

Sound power level
When a source of sound radiates sound waves in all directions, the total energy radiated in one second is called the sound power of the source and is measured in watts. The decibel range is again used to define sound power level (SWL) as follows:

$$SWL = 10 \text{ Log} \left(\frac{W}{Wo}\right) \text{ (dB)} \quad \ldots\ldots$$

W is the sound power of the source and Wo is the internationally recognized reference power 10^{-12} watts.

Sound pressure level
The ear responds to the average value of pressure in the wave or root-mean-square pressure. The smallest detectable pressure is 2×10^{-5} N m^{-2} or 2×10^{-5} Pa

(Pascals) and the largest tolerable pressure is 20 Pa, referred to as the threshold of pain. The ear is approximately a logarithmic detector of pressure and so it is convenient to express sound pressure in decibels, and the sound pressure level (SPL) is defined as:

$$SPL = 20 \text{ Log} \left(\frac{P}{Po}\right) \text{ (dB)} \qquad \ldots\ldots$$

Po is 2×10^{-5} Nm^{-2} and P is the sound pressure of interest.

Sound reduction index
Difference in dB measured between the amount of energy flowing towards the wall in the source room and the total amount of energy entering the receiving room (usual range 100–3150 Hz).

$SRI = L_1 - L_2 + 10 \text{ Log } S - 10 \text{ Log } A$ (dB) (for negligible flanking)

Where S = common area of partition in m^2, or more conveniently:

$$SRI = L_1 - L_2 + 10 \text{ Log} \frac{ST}{0.16V} \text{(dB)}$$

Sound spectrum
Sounds can be analysed to reveal their frequency content. This can be achieved by dividing the frequencies into octave or one-third octave bands and the sound pressure levels measured in those bands.

Sound transmission class (STC)
Single-figure rating used mainly in the USA for comparing partitions for general building design purposes. Sound transmission losses in sixteen test bands from 125 to 4K Hz are compared with a reference contour as defined in ASTM E 413-73.

Sound waves
Sound waves are longitudinal pressure waves usually propagated through the air but also through solid material. In air they travel with a speed of 343 ms^{-1} at 20°C.

Standardised level difference, DnT.

Difference (1S0 140) is given by $DnT = 10 \log_{10} \frac{T}{To}$ dB

Where D is level difference
T is receiving room RT, seconds
To is reference RT, 0.5 seconds.
Single figure value given as weighted standardised level difference, DnTW.

Standardised impact sound pressure level, L'nt
The standardised impact sound pressure level in dB, is given by

$$L'nT = L_i + 10 \log \frac{To}{T}$$

where L_i is average sound pressure level
To is reference RT, 0.5 seconds
T is receiving roan RT, seconds.
Single-figure value is given as weighted standardised impact sound pressure level L'ntW.

Structure-borne sound
Sound energy that has passed through the solid elements of the building structure.

Warmth
Fullness of bass tone relative to mid-frequency response.

5 APPENDIX C

C1 Typical sound reduction index values for elements of structure (20–50 m^2 size), in dB

	Average	Octave band centre frequency (Hz)					
		125	250	500	1K	2K	4K
Sheet materials							
3 mm sheet lead	34	30	31	27	38	44	33
6 mm steel plate	38	27	35	41	39	39	46
20 sw profiled steel sheet	18	8	14	29	26	32	36
Floors							
T & G Boards (or chipboard) to joists, plasterboard and skim soffit	35	18	29	37	49	44	46
As above with fibreglass under chipboard, 50 mm sound pugging on mesh-backed plasterboard	51	37	42	47	52	60	64
50 mm screed on 125 mm reinforced concrete	47	35	37	42	49	58	63
As above with 13 mm fibreglass under screed	51	38	43	48	54	60	64
50 mm screed on 200 mm reinforced concrete	51	38	45	47	52	60	64
Doors							
Flush hollow doors, normal edge gaps	16	12	13	14	16	18	24
Solid door, normal edge cracks	26	17	21	26	29	31	34
Acoustic metal doorset, double seals	47	36	39	44	49	54	57
Folding steel door	25	16	23	26	27	28	27
Walls and partitions							
Single leaf fairfaced brick 102 mm	45	36	37	40	46	54	56
Single leaf brickwork plastered on both sides 13/102/13	47	34	36	41	51	58	60
Double leaf brickwork plastered on both sides 13/214/13	51	41	45	48	56	58	60
Cavity brickwork with ties 102/50/102 plastered on both sides	52	34	34	40	56	73	76
Fairfaced 115 mm lightweight concrete blockwork	38	32	32	33	41	49	57
Fairfaced 115 mm light concrete blockwork + 13 mm plaster on both sides	41	32	34	37	45	52	57
Fairfaced 115 mm light concrete blockwork + 12.7 mm plasterboard on plaster dabs on both sides	44	28	34	45	53	55	52
Fairfaced 215 mm light concrete blockwork	44	35	38	43	49	54	58
Fairfaced 215 mm light concrete blockwork + 13 mm plaster on both sides	47	37	39	46	53	57	61
Fairfaced 215 mm light concrete blockwork + 12.7 mm plasterboard on dabs on both sides	47	33	39	50	55	56	50
Double wall of two 100 mm dense concrete blocks with 50 mm cavity + 13 mm plaster on both sides	52	35	41	49	58	67	75

	Average	Octave band centre frequency (Hz)					
		125	**250**	**500**	**1K**	**2K**	**4K**
Double partition of two 12.5 mm plasterboard skins with 50 mm cavity completely filled with glass fibre quilt	40	21	35	45	47	47	43
Double partition of two 12.5 mm plasterboard skins with 75 mm cavity – glass fibre blanket suspended within	39	24	37	44	42	43	44
Double partition of two 12.5 mm plasterboard sheets on each side of 50 mm cavity completely filled with glass fibre quilt	47	33	45	51	52	52	52
Double partition two 12.5 mm plasterboard skins on 75 × 50 mm staggered timber studding	37	24	28	37	46	46	38
50 mm woodwool cement slabs sealed on one side only	30	26	28	30	32	33	36
Sealed on both sides	33	25	31	36	35	35	37
100 mm woodwool cement slabs sealed on one side only	31	28	28	32	34	33	38
Sealed on both sides	35	29	30	32	36	39	46
50 mm woodwool cement slabs with 100 mm concrete on one face	42	36	36	42	44	46	53
50 mm standard woodwool cement/200 mm airspace/2 × 9.7 mm plasterboard attached to legs of units	51	34	44	51	57	61	60
150 mm concrete supporting on resilient mounts 100 mm prescreeded woodwool cement slabs – large airspace	71	60	66	77	83	not measurable	
38 mm × 22 SWG profiled steel cladding sheet/ 60 mm glass fibre/9.5 mm plasterboard. Mounted on 50 × 50 mm timber spacers	39	18	30	41	46	49	50
38 mm × 22 SWG profiled steel cladding sheet/ 146 mm space containing 60 mm glass fibre/ 2 × 12.7 mm plasterboard. Mounted on 146 mm steel studs at 600 mm centres	47	32	41	47	49	53	58
Glazing							
Single – non-openable							
4 mm	28	20	22	28	34	34	29
6 mm	29	18	26	31	36	30	38
6.4 mm laminated	30	22	24	30	36	33	38
12 mm	34	28	31	35	34	39	37
4 mm glass in aluminium frame 100 mm opening	11	10	10	11	12	12	13
Sealed units – non-openable							
4/12/4 mm	29	22	17	24	38	42	38
6/12/6 mm	30	20	20	29	30	36	46

	Average	Octave band centre frequency (Hz)					
		125	250	500	1K	2K	4K
4/12/10 mm	34	25	22	33	41	44	44
4/12/10 mm + SP6	36	22	19	43	44	47	47
6/12/10 mm	34	26	27	35	41	39	47
6/150/4 mm	44	29	35	45	56	52	51
Sealed units – openable							
3/6/3 mm Weather stripped	26	25	22	25	28	27	31
Dual units – non-openable							
4/200/4 mm with absorbent reveals and separate heavy frames	42	37	37	44	53	47	36
6/200/6 mm with absorbent reveals in separate heavy frames	46	37	41	48	54	47	47
Openable							
4/200/4 mm with absorbent reveals in aluminium frames	39	27	33	39	42	46	44
4/200/4 mm with absorbent reveals in aluminium frames – opposite ends open 25 mm	27	15	23	34	32	28	32
Opposite ends open 100 mm	22	10	16	27	25	27	27

These are typical values measured in the laboratory. Field tests may give lower values.

C2 Typical coefficients of sound absorption

	Octave band centre frequency (Hz)					
	125	250	500	1K	2K	4K
Ceiling						
Overhead sound absorbers, one 1200 × 450 × 50 mm panel every sq m, parallel pattern	.28	.58	.96	.91	.86	.81
Fissured mineral tiles, 300 mm ceiling void	.3	.35	.4	.55	.8	.7
Metal tiles (5% perforated), 20 mm fibreglass quilt, ceiling void	.13	.27	.55	.79	.9	1.0
Metal planks, slots between planks (14% free area)	.5	.7	.8	1.0	1.0	1.0
13 mm plasterboard ceiling over large air space	.2	.2	.2	.1	.05	.05
13 mm acoustic plaster on metal lathing	.05	.2	.5	.8	.8	.8
Profiled metal deck	.1	.3	.3	.1	.1	.2
Walls and linings						
Brickwork – fairfaced	.02	.02	.02	.03	.04	.05
– painted	.01	.01	.01	.02	.02	.02
– plastered	.02	.02	.03	.03	.04	.05
Blockwork – fairfaced	.2	.5	.5	.4	.5	.4
Concrete – textured finish	.01	.02	.04	.06	.08	.1
9 mm acoustic plaster on solid wall	.02	.08	.3	.6	.8	.9
Woodwool slabs on solid backing						
– 50 mm thick	.2	.2	.6	.8	.7	.9
– 100 mm thick	.3	.8	.9	.7	.7	.8
Prescreed woodwool slabs on 600 mm air gap	.4	.4	.7	.7	.7	.8
9 mm plasterboard on 18 mm air space filled with fibreglass to solid backing	.3	.2	.2	.05	.05	.05
12 mm plywood on 30 mm airspace filled with fibreglass, to solid backing	.4	.2	.2	.1	.1	.05
6 mm glass, large panes	.3	.3	.2	.1	.05	.05
Stretched, lightweight fabric wall hanging	.04	.1	.2	.5	.6	.5
Heavy curtain material hung in folds	.06	.16	.3	.55	.65	.65
Fibreglass quilt to solid backing						
25 mm thick	.1	.4	.6	.7	.8	.8
50 mm thick	.3	.6	.8	.9	.8	.8
100 mm thick	.5	.8	.8	.9	.9	.9
Fibreglass 100/100 mm airspace	.5	1.0	.9	.8	.6	.4
Mineral wool to solid backing						
– 25 mm thick	.01	.3	.7	1.0	1.0	1.0
– 50 mm thick	.3	.8	1.0	1.0	1.0	1.0
Mineral wool 25/25 mm airspace	.1	.4	.7	1.0	1.0	1.0
50/50 mm airspace	.5	.7	.9	.9	.9	.8
Floors						
Thin contract carpet on solid floor	.01	.04	.05	.18	.3	.2

	Octave band centre frequency (Hz)					
	125	**250**	**500**	**1K**	**2K**	**4K**
Thick carpet on underlay	.07	.23	.69	1.0	1.0	1.0
Rubber flooring, vinyl sheet	.02	.04	.05	.05	.05	.05
Marble, ceramic tiles	.05	.05	.05	.05	.05	.05
Reinforced concrete, grano	.02	.02	.02	.04	.05	.05
Water (swimming pool), ice (rink)	.01	.01	.01	.02	.02	.03
Other						
Seated audience, per person*	.33	.4	.44	.45	.45	.45
Standing adults, per person*	.15	.38	.42	.43	.45	.45
Wooden seats*	.1	.2	.3	.3	.3	.35
Upholstered seats*	.24	.26	.27	.31	.37	.38
Shading reduction factors (for floor finishes absorption under seating)	−20%	−30%	−40%	−50%	−60%	−80%

*These figures are the total absorption in m^2.

6 GUIDE TO FURTHER READING

American Society for Testing and Materials
Annual Book of ASTM Standards, Part 18
US 1982

BBC Engineering
Guide to Acoustic Practice
1980

Brick Development Association
Low Rise Domestic Construction in Brick: Part 3 Thermal and Sound Insulation
1979

British Gypsum
White Book
5th Edition 1984

Construction Industry Research and Information Association (CIRIA)
Report 1988: Sound Insulation of House Separating and External Walls
1981 (R H Clough and R D Jones)

Cremer, Muller, Schultz
Principles and Applications of Room Acoustics
vols 1 and 2
Applied Science Publishers Ltd 1982

Department of the Environment
Planning and Noise
Circular 16/73, 1973

Department of the Environment
Sound Insulation in Buildings: Cost and Performance of Walls and Floors
1971 (H R Humphrey and D J Melluish)

Fader, Bruce
Industrial Noise Control
Wiley-Interscience US 1981

Furrer and Lauber
Raum und Bauakustic Lärm Abwehr
Birkhauser-Verlag
Basel and Stuttgart 1972

K B Ginn
Architectural Acoustics
Brüel and Kjaer 1978

Herman Miller Research Corporation
The Action Office Acoustic Handbook

Heinrich Kuttruff
Room Acoustics
Applied Science Publishers Ltd
2nd Edition 1979

Lord, Gatley and Evenson
Noise Control for Engineers
McGraw-Hill, US 1980

J E Moore
Design for Good Acoustics and Noise Control
The MacMillan Press Limited 1978

K A Mulholland and K Attenborough
Noise Assessment and Control
Construction Press 1981

P H Parkin, H R Humphreys and J R Cowell
Acoustics, Noise and Buildings
Faber and Faber
4th Edition 1979

Ian Sharland
Woods Practical Guide to Noise Control
Woods of Colchester Limited 1972

Theodore J Schultz
Community Noise Rating
Applied Science Publishers Ltd
2nd Edition 1982

Sound Research Laboratories
Practical Building Acoustics
SRL Limited 1976

Lyle F Yerges
Sound, Noise and Vibration Control
2nd Edition 1978

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