Fire protection for structural steel in buildings

THIRD EDITION (Revised June 2004)

Association for Specialist Fire Protection
Steel Construction Institute
Fire Test Study Group

The Association for Specialist Fire Protection (ASFP) was formed in 1976. The objectives of the Association are: to encourage, organise, finance and undertake research and experimental work related to passive fire protection and to promote the consideration and discussion of all questions affecting the fire protection of structural steel and buildings.

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The Steel Construction Institute (SCI) develops and promotes the effective use of steel in construction. It is an independent organisation with member companies drawn from throughout the supply chain in 40 different countries.

The SCI carries out technical projects for members and clients. It provides design development, computing, QA, research, technical advisory and educational service to the building, civil engineering, marine and offshore engineering communities.

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The Fire Test Study Group (UK) (FTSG) is a forum for technical discussions and liaisons between consulting fire test laboratories involved in producing test and assessment information for the purposes of building control.

The member laboratories are all UKAS Accredited for testing and the primary objective of the group is to ensure common technical interpretations of the fire test standards and a common approach to technical appraisals or assessments of products which may be made by the members within the terms of approved document B “Fire Spread” to the Building Regulations 1991 1985.

Members of the FTSG participate on all relevant BSI committees, the equivalent ISO CEN technical committees and are involved in the EEC European Commission technical discussions on harmonisation.

FTSG members have strongly supported the publication of this edition of the “Yellow Book” as it provides specifiers and regulatory bodies with an independently validated comprehensive and concise guide to the performance of materials used to provide fire protection to structural steel.

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Fire protection for structural steel in buildings

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Fire Test Study Group (FTSG) and Steel Construction Institute (SCI)

Foreword

I am delighted to introduce you to this latest and updated issue of the 'Yellow Book' which has, for more than 20 years, been recognised as the definitive guide to the provision of fire protection to structural steel in buildings.

The recent European Construction Products Directive will change the way in which products are tested and assessed and this edition of the 'Yellow Book' explains the changes.

The assessment panel of the ASFP judges the suitability of every product included in this book; users can rest assured that every product included in this book has been tested to the existing BS standards. The book also provides details of the new EN test methods.

Designers, regulators, fire authorities and building owners can all rely on this information and the explanatory notes provided by industry experts on all aspects of the protection requirements.

I extend my congratulations to all those involved with the production of this edition of the 'Yellow Book' which, as always, provides an authoritative source of guidance on the safe provision of fire resistance to the main structural frame of all types of building where steel is used.

Brian Robinson CBE, QFSM, FIFireE
PRESIDENT, ASFP

CONTENTS

PREFACE

This publication has been prepared by members of the ASFP and presents economical methods for the fire protection of structural steelwork to provide compliance with building regulations. It provides a comprehensive guide to proprietary materials and systems all of which are manufactured, marketed or site applied by members of ASFP.

Since the publication of the second edition of this book there have been a number of developments in the field of structural fire engineering. Design codes have been published in the UK and Europe which give the engineer the opportunity to calculate the steel failure temperature as a function of the applied load level. For all fire protection materials the required thickness of fire protection will vary depending on the failure temperature of the steel. This edition therefore contains information for some products showing the variation of protection thickness with steel temperature.

In the new European fire test standards the section factor is referred to as A/V but, in the UK, the term Hp/A has been used for many years to denote the section factor. In order to avoid confusion to the user of this publication, it should be noted that the terms A/V and Hp/A mean exactly the same thing and the reader can use either. The term Hp/A will eventually be replaced in the UK and A/V will become the standard reference throughout Europe.

SCOPE

Section 1
contains some background information into why steel often requires fire protecting and explains the basic concepts of fire testing and how to specify fire protection. It explains how the concept of Section Factor is used in the assessment of protection and gives guidance on the calculation of the Section Factor in some non-standard cases.

Section 2
contains a brief introduction to structural fire engineering and specific recommendations for composite beams.

Section 3
contains fire resistance test and assessment procedures using UK methods. These comprise assessments based on the traditional UK procedure at steel temperatures of typically 550°C or 620°C and assessments based on the traditional UK procedures but at a range of steel temperatures (350°C to 700°C).

Section 4
contains fire resistance assessment procedures based on the new European procedures at a range of steel temperatures. (350°C to 700°C).

Section 5
introduces the material data sheets and contains notes on their use.

Section 6
contains the material data sheets from which a specifier may obtain authoritative information on required thickness and range of application. Data sheets are included for all the assessment procedures.

DEFINITIONS

CEN

European Committee for Standardisation. This committee is responsible for the preparation of European fire related Standards.

Composite beam

A beam comprising a steel I section connected via shear connectors to a reinforced concrete or composite floor slab where the steel section and floor slab are designed to act together.

Critical Temperature

The temperature at which failure of the structural steel element is expected to occur against a given load level.

Fire Load

The energy per square metre of floor area of the combustible material present within the internal bounding surfaces of a room, compartment or building.

Intumescent Coating

A coating which reacts to heat by swelling in a controlled manner to many times its original thickness to produce a carbonaceous char, which acts as an insulating layer to protect the steel substrate.

Limiting steel temperature

The temperature of the critical element of a member at failure under fire conditions

Orientation

Plane in which the exposed face of the test specimen is located, either vertically or horizontally during testing.

Passive fire protection materials

Materials which do not change their physical form on heating, providing fire protection by virtue of their physical or thermal properties.

Plate thermometer

A 100 x 100mm insulated thin steel plate to which a thermocouple is attached, used to measure the fire test furnace temperature(s).

Reactive fire protection materials

Materials which are specifically formulated to provide a chemical reaction upon heating such that their physical form changes and in so doing provide fire protection by thermal insulative and cooling effects.

Section factor A/V (Hp/A)

Profiled: The ratio of the inner surface area of the fire protection material per unit length, to the cross sectional volume (area) of the steel member per unit length.
Boxed: The ratio of the inner surface area of the smallest possible rectangle or square encasement that can be measured round the steel member per unit length to the cross sectional volume (area) of the steel member per unit length.

Stickability

Ability of a fire protection material to remain coherent and in position for a defined range of deformations, furnace and steel temperatures, such that its ability to provide fire protection is not impaired.

UB

Universal Steel Beam to BS 4: Part 1: 1993

UC

Universal Steel Column to BS 4: Part 1: 1993

UKAS (NAMAS)

United Kingdom Accreditation Service (National Accreditation of Measurement and Sampling)

1. ASPECTS OF FIRE PROTECTION

1.1 Introduction

Regulations require certain elements of structure to have fire resistance. Whether or not an element requires fire resistance depends upon such things as size, use of building and the function of the element. When exposed to fire all commonly used structural materials lose some of their strength, for example, concrete can spall exposing reinforcement, timber sections deplete by charring and steel members eventually lose strength. Heavily loaded steel will lose its design margin of safety at temperatures around 550°C regardless of the grade of steel. Members carrying appreciably less than their full capacity may remain stable at temperatures up to, and beyond 700°C.

Fire resistance tests on structural steel members, performed in accordance with BS476-21 or ENV13381-4 (see Section 1.3), have shown, that using the protection products described in this publication, the loadbearing criterion of the standard test can be satisfied over a range of temperatures. Further information on structural fire engineering is given in Section 2.

Where structural steel members are required to have fire resistance, they can be protected by applying insulating materials. Alternatively, in certain cases, fire resistance can be achieved by virtue of their own inherent fire performance. Fire resistance tests on heavily loaded flexural and compression members have demonstrated that in certain cases 30 minutes fire resistance can be achieved without applied protection.

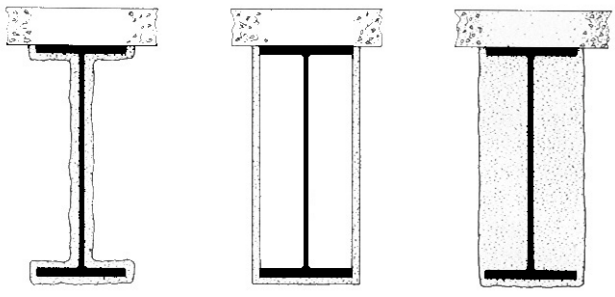
1.2 Protection Methods and Fire Testing

A wide range of materials is available to enhance the fire resistance of structural steel members. They can be applied in a variety of ways to meet specific site requirements. In considering any fire protection system it is important to distinguish between *profile*, *box* and *solid* methods of application (Figs 1 and 2). Sprayed materials would normally be applied to follow the *profile* of the section. Board materials would normally be used to form a *box* around the section and special insulating concretes can be used to form *solid* protection. Details of individual fire protection materials are given in Sections 5 and 6.

Specially designed and constructed suspended ceilings utilising lightweight metal support components, insulating tiles and panels, and sprayed or trowelled compounds on suspended lath, tested in accordance with BS476-23 or ENV13381-1 may also be used for the protection of structural steel but they are beyond the scope of this publication.

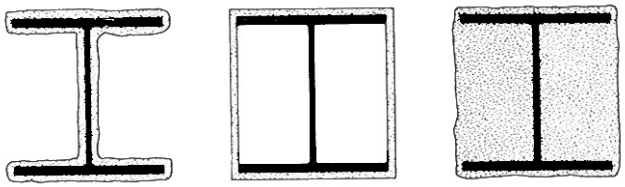
Fire tests on elements of building construction have been carried out in the United Kingdom in accordance with the methods of BS476. Sometime after the start of 2002 the part, relevant to the fire protection of steel, of the BS476 series will be replaced by the new European fire testing standards (See 1.3). The two standards are generally similar but differ in a number of details. Results from one standard may sometimes be able to be interpreted in terms of the other. The adoption of the European standard is intended to remove technical barriers to trade within Europe. The international fire testing standard, ISO834, is similar to the other standards and is in the process of being revised to bring it more in line with the European standard. It is hoped that eventually there will be a basis for international test data exchange.

Figure 1: Protection technique for three-sided protection



Profile | **Box (with or without gap over flanges)** | **Solid**

Figure 2: Protection technique for four-sided protection



Profile **Box (with or without gap over flanges)** **Solid**

The size and construction of a test specimen would ideally be identical with the element in its intended position in a building. In a BS476 test, loaded beams are tested horizontally with protection applied to three sides and with the top flange directly in contact with a floor slab. Columns are tested vertically with the protection applied to all sides. It is therefore common to meet the terms "three sided" and "four sided" exposure when dealing with fire protection to steelwork. When assessing a material to ENV13381-4 the required tests are slightly different. Beams are tested with a layer of insulation between the top flange and the floor slab and a loaded test on a column is generally not required.

It is common when referring to the testing and use of fire protection to use the term "orientation" to mean horizontally, as a beam, or vertically, as a column. The term "orientation" is used throughout this publication.

The data sheets in this publication have largely been derived from tests carried out at the Borehamwood Laboratory of the Loss Prevention Council (LPC) or at the Warrington Fire Research Centre (WFRC), together with support data from other laboratories. The UK test facilities are approved under the UKAS(NAMAS) scheme.

The results of a standard fire resistance test relate to the steel section size and loading, together with the thickness and performance of the protection system. To repeat the procedure to explore those important and numerous variables for all steel sections and protection parameters would be prohibitive. Assessment procedures have therefore been developed which allow the performance of a range of steel sections to be estimated from the information gained from a limited number of tests.

1.3 Fire Resistance Testing

Fire test standards

The general procedures used for determining the fire resistance of loadbearing elements of structure are specified in BS476-20 and 21. In assessing the performance of fire protection materials the relevant parts are:

Part 20 Method of determination of the fire resistance of elements of construction (general principles)

Part 21 Method of determination of the fire resistance of loadbearing elements of construction

Part 20 is concerned with general principles and covers requirements which are common to the other Parts. Part 21 covers the testing of beams, columns, floors and loadbearing walls.

Some European fire testing standards have been published in 2000, others are expected to be published in 2002. In assessing the performance of fire protection materials the relevant part is ENV13381-4 "Test methods for determining the contribution to the fire resistance of structural members Part 4: Applied protection to steel members". This standard makes reference to the EN1363 series of standards which contain general information about conducting fire resistance tests. However, as all the procedures for assessing fire protection are specified in ENV13381-4, it is this standard which is generally referred to in this publication. The European standards will gradually replace the British Standards.

ENV13381-4 has no parallel British Standard. In the UK, it is generally accepted that the procedures for determining the contribution of applied protection to the fire resistance of steel members are covered by this ASFP publication.

In both BS476 and the new European Standards the performance of an element is judged against the three criteria of loadbearing capacity, integrity and insulation. The European Classification System will use the abbreviations of R, E and I respectively for the three criteria,

Loadbearing capacity, R, is the ability of the element to remain in place without excessive deformation.

Integrity, E, is the ability of the element to resist the passage of flame and hot gases and also, not to flame on

the unexposed side.

Insulation, I, is the ability of the element to resist the passage of heat by conduction.

The use of REI terminology is likely to become more common.

Simple linear elements such as beams or columns are only judged against loadbearing capacity for the fire resistance period under consideration. Separating elements, such as floors or walls, are judged against all three criteria.

1.3.1 Description of Fire tests to BS476

Beams are tested horizontally, in conjunction with a floor slab, in a floor furnace (Figure 3) and columns vertically in a column furnace (Figure 4).

In the UK, currently beam tests are carried out on a nominal span of 4.25 metres using a 305x127x42 Universal Beam for passive insulating materials and a 406x178x60 Universal Beam for intumescent coatings.

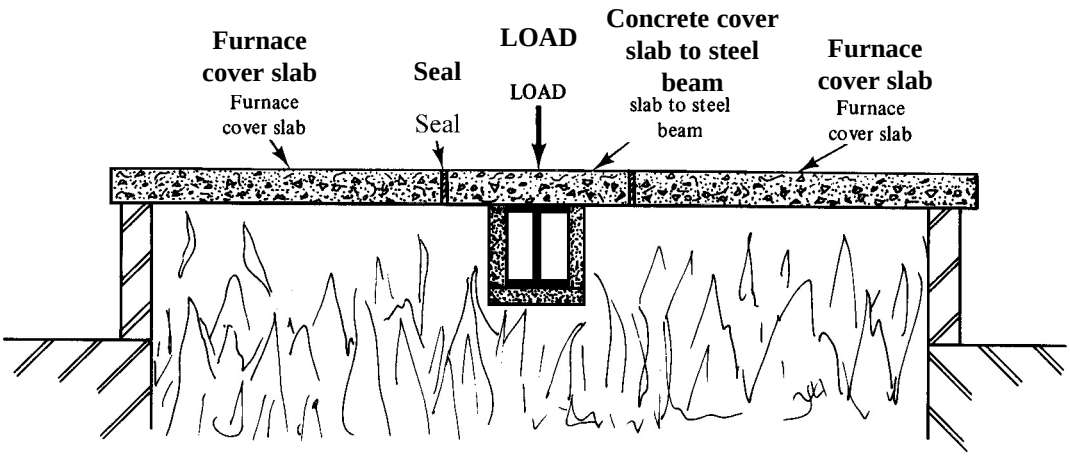
Column tests are normally carried out on a 203x203x52 Universal Column with an exposed length of at least 3 metres (Figure 4). The specimen is held vertically and, although it has freedom to expand longitudinally, its ends are rotationally fixed so that, structurally, an effective length factor of 0.7 can be assumed. It is then axially loaded to develop the required stress which is normally the maximum permitted by design.

In the loaded fire test the exact value of the applied load is not critical. The level of load traditionally used in the UK is slightly lower than that specified in the new European standard. The higher load could make the test more onerous in that the ability of the fire protection to maintain its stickability could be affected. However, any difference in the final assessed thickness of protection required to keep a steel member below a specified temperature is likely to be insignificant.

It is usual to use information on the insulating properties of fire protection materials obtained from tests performed on unloaded exploratory specimens (about 1m in length). This information is used in both the UK and European methods of assessing fire protection materials. This exploratory testing is often combined with loaded tests to form a complete “test package”.

The procedures used in most UK fire testing laboratories have been agreed and standardised through the Fire Test Study Group, which embraces members from some UKAS(NAMAS) approved fire testing laboratories, representatives from the UKAS(NAMAS) executive and the Fire Research Station, to ensure that consistent techniques are adopted in the generation of data for appraisal purposes. It is recognised that varying results can be obtained on identical specimens tested in different furnaces. To reduce the effect of such variations, the UK laboratories use common preparation, testing and measuring techniques.

Figure 3: General arrangement for BS476 fire tests on beams



1.3.2 Description of fire tests to ENV13381-4

The testing programme for the assessment of a fire protection material to ENV13381-4 differs in a number of respects from the BS476 programme. The main difference is that a loaded column test is not required in the European Standard, except for products which are only used for protecting columns. The other main difference is that, for the loaded beam test, a layer of insulation is placed between the top flange of the beam and an ultra lightweight concrete floor slab. This serves to reduce the heat sink effect of the slab and to minimise the effects of

composite action. UK beam tests use a segmented dense concrete slab in intimate contact with the top flange of the beam.

The European procedures do not always require a loaded column to be tested. However, when assessing intumescent coatings, an unloaded column 2000mm high must be tested to assess stickability.

Another major difference between European and UK testing is in the type of furnace thermocouple used. The European test uses a plate thermometer. This a special type of thermocouple used for measuring the temperature within the furnace. It consists of a small plate, insulated on one side, with a thermocouple welded to its centre. The plate thermometer is intended to reduce the differences between fire tests carried out in different furnaces and thus to promote European harmonisation. Compared with BS476, the plate thermometer generally leads to more severe heating conditions.

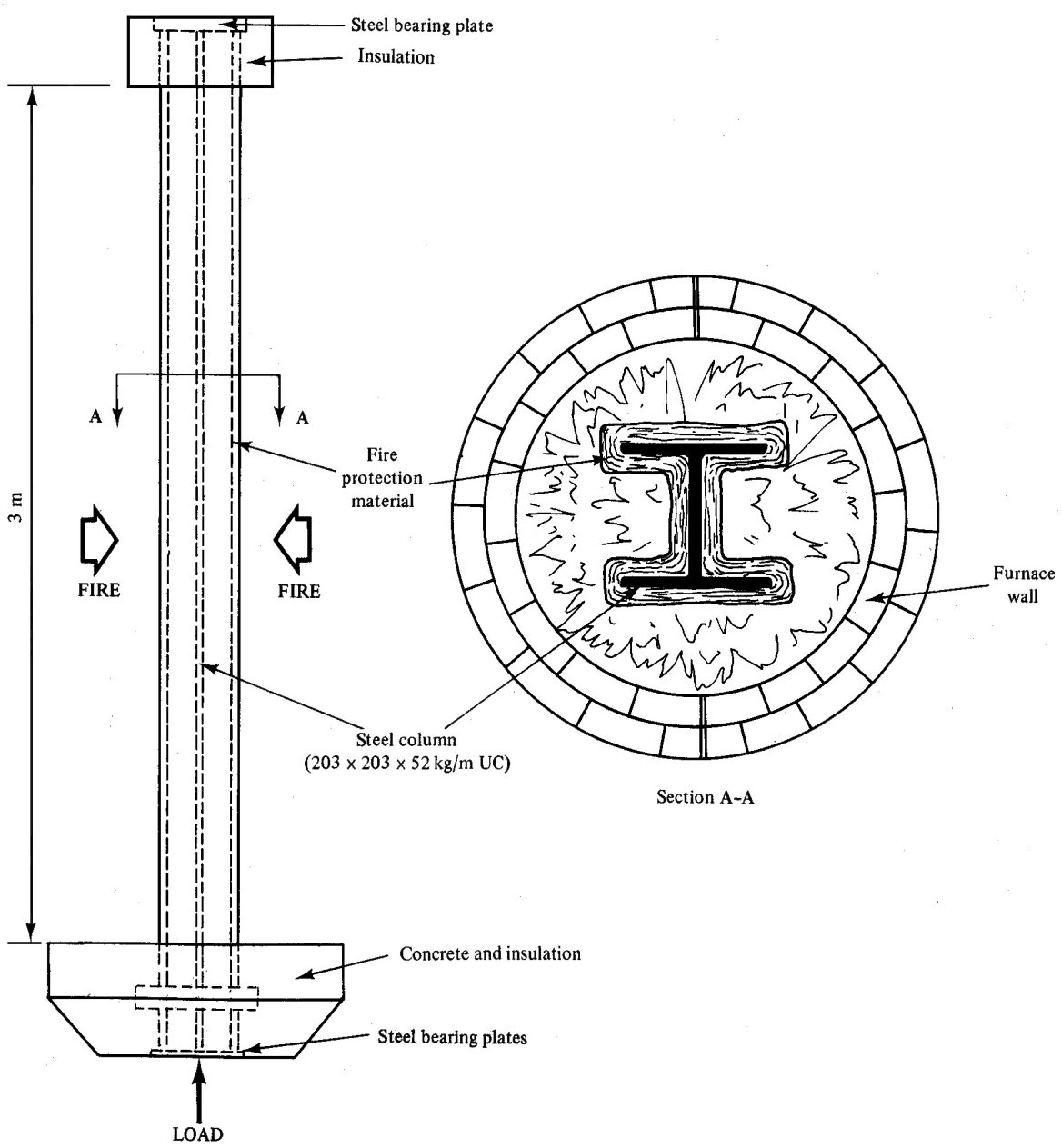


Figure 4: General arrangement for BS476 fire tests on columns

1.4 Assessment of fire protection materials

Methods of assessing the performance of fire protection materials have been developed which enable the thickness of protection for a wide range of situations to be predicted. The procedure is in two parts. Firstly, a carefully designed programme of fire tests is carried out on both loaded and unloaded specimens and, secondly, a mathematical procedure is applied to the results of the tests which enables predictions of required thickness to be made. These programmes of tests are designed to determine both the insulation characteristics of a fire protection material and its physical performance under fire conditions for a range of steel sizes (in terms of Section Factor, protection thicknesses and fire resistance periods). They generate the maximum amount of data from a minimum number of tests.

A method of assessing fire protection materials has been developed and used in the UK for a number of years. It was used to generate the data in the earlier editions of this publication and is one of the methods used in this edition. More recently, European methods of assessing fire protection materials have been developed. These methods have been formally codified, in yet to be published, ENV13381-4. In a similar programme of tests to those already used in the UK both loaded and unloaded specimens are tested and an appraisal of the fire protection material is derived. The method has a number of technical differences from the UK procedure which make an exact comparison difficult.

Further information on fire resistance testing, programming and assessment is given in Section 3 for systems such as boards, mineral sprays and intumescent coatings

The principles used for assessment procedures have been extensively reviewed (and documented) since the first edition of this publication, and are described in detail in Section 3.

1.5 Material thickness and steel temperature

In this publication, the thickness of protection materials to maintain steel sections below specified temperatures is given. It is important that the basis for these temperatures is understood.

In the first and second editions of this publication, the thickness of fire protection was specified such that the maximum temperatures of 550°C for columns, and 620°C for beams (supporting concrete floors), were not exceeded for a given period of fire resistance. This assumed that the structural section was fairly heavily loaded at the time of the fire, together with a simplistic representation of the behaviour of steel at elevated temperatures. Since the introduction of these temperatures, the understanding of how steel columns and beams behave in fire has increased, resulting in the development of fire design codes. It is now known that the original approach was almost invariably conservative, but, in some limited cases can be shown to be unconservative.

Using fire design codes such as BS5950-8 or the Structural Eurocodes, EC3–1.2 and EC4-1.2, designated ENV1993-1.2 and 1994-1.2, the load on the structure at the time of the fire can be calculated by treating it as an accidental limit state. If used, this will allow designers to specify to the protection contractor a limiting or failure temperature for a given structural section. The protection contractor will then be able to use the required thickness of material to ensure that the steel section does not exceed this temperature, within the fire resistance period. This process could be simplified by the designer specifying a maximum steel temperature, based on the worst case, for all beams or columns on one floor level.

If the structural fire design codes are not used to calculate the maximum allowable temperature in the steel sections, then the temperatures of 550°C and 620°C, used earlier, may not always be appropriate and some reference to the usage of the proposed building should be made.

Buildings such as offices, residences, schools, hospitals, etc, which are not used for storage, have a high percentage of non-permanent loads. For this type of building, the structural codes, BS5950-1 and ENV1991-1-1 (the loading code), assume that a proportion of the design load will not be present at the time of the fire. Other types of buildings such as warehouses, libraries, etc are primarily used for storage, so a high percentage of load is permanent, and the codes allow no reduction in design load for the fire condition.

In fire it is permissible to consider only the strength of an element. The fire testing standards, such as BS476, effectively base the failure criteria for loadbearing elements on strength. However, beams are often designed for serviceability (deflection) requirements which mean that their strength is not fully utilised in the cold state and they would therefore have an additional reserve of strength at the fire limit state. Columns are frequently constructed so that a single length will be two or three storeys high. The lowest storey will be the highest loaded but the upper storey will be very lightly loaded. Another factor affecting the failure temperature in fire is that there are only a finite number of serial sizes. The designer is almost invariably forced to use “the next size up”. Steel members which, in terms of strength, are not fully utilised in the normal, cold, state will have reduced load ratios in the fire limit state.

The ratio of the load or moment carried by a member at the time of a fire to the strength of the member at normal temperatures is called the "load ratio". For practical designs the load ratio will vary from approximately 0.4 to 0.65. The higher the load ratio, the lower the failure temperature. The load ratio is discussed in more detail in Section 2.

In buildings with a high degree of non-permanent load (in terms of its duration and magnitude), the load ratio of the structural members is very unlikely to be greater than 0.6. In storage buildings, where the majority of load is permanent, the load ratio would normally be higher but, in any case, is very unlikely to be greater than 0.65.

The limiting temperatures for both categories of buildings are shown in Table 1, for a range of load ratios, based on BS5950-8. The Table is intended to be used in instances when no special calculations are made. For buildings with a high degree of non-permanent load the load ratio is very unlikely to exceed 0.6 and therefore the limiting temperatures shown in bold can be used. This results in temperatures similar to the 550°C and 620°C values recommended in earlier editions of this publication. In storage buildings the load ratio is very unlikely to exceed 0.65 and the limiting temperatures can be used. This results in some limiting temperatures which are lower than the 550°C and 620°C values used in earlier editions.

Roof loading is non-permanent in nature regardless of the use of a building. Therefore, in assessing the appropriate steel temperature of columns and beams supporting roofs in storage buildings, the higher steel temperatures appropriate for offices etc should be used.

Table 1: Maximum allowable steel temperatures

Category	Exposure	Allowable beam temperature (°C)			Allowable column temperature (°C)		
		Load ratio			Load ratio		
		0.55	0.6	0.65	0.55	0.6	0.65
Offices, residences, schools, hospitals, etc	3 sided	635	620 (620)	605	--	--	--
	4 sided	570	555 (550)	540	560	540	525
Storage buildings	3 sided	635	620	605 (600)	--	--	--
	4 sided	570	555	540 (550)	560	540	525 (520)

Note: In buildings for which the load ratio is not calculated, recommended temperatures are shown in brackets

The majority of buildings have a high degree of non-permanent load so, in this edition, the limiting temperatures of 550°C and 620°C are recommended for general use.

All users of the tabulated data should be aware of the lower recommended temperatures for storage buildings. As the limiting temperatures assumed may often affect the thickness and cost of fire protection, users of the data are reminded that the basis on which the thicknesses are specified in contracts should be clear to all parties.

In Section 6, thicknesses are given for a range of steel temperatures. It is the responsibility of the design engineer, using design codes such as BS5950-8 or ENV1993-1-2, to specify the appropriate limiting steel temperatures.

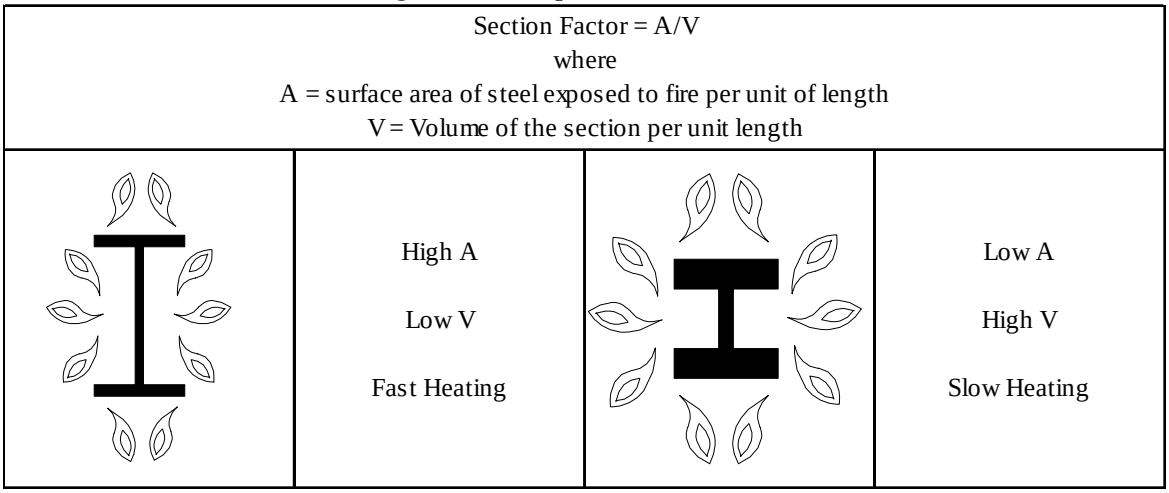
1.6 Thermal Response and Section Factor

The rate of increase in temperature of a steel cross-section is determined by the ratio of the heated surface area (A) to the volume (V). This ratio, A/V, has units of m^{-1} and is known as the "Section Factor". Members with low Section Factors will heat up more slowly, and this is shown diagrammatically in Figure 5.

In earlier editions of this publication the Section Factor was written as Hp/A. In the new European testing and design standards (ENV13381-4, ENV1993-1-2 and ENV1994-1-2) the Section Factor is presented as A/V, which has the same numerical value as Hp/A. It is likely that the designation Hp/A will gradually fall into disuse. Throughout this publication the term A/V will be used.

A steel section with a large surface area (A) will receive more heat than one with a smaller surface area. Also, the greater the volume (V) of the section, the greater is the heat sink. It follows therefore, that a small thick section will be slower to increase in temperature than a large thin one. The Section Factor (A/V) is thus a measure of the rate at which a section will heat up in a fire and the higher its value, the greater will be the protection thickness required. Values of Section Factor, rounded to the nearest 5 units, for the range of sections for fire exposure on both three and four sides are given in Tables 3 to 15. Figure 6 illustrates the appropriate perimeter to be used when calculating the Section Factor for a variety of steel sections in different situations.

Figure 5: Concept of the section factor



In calculating the Section Factor values the full volume, V, is used whether the section is exposed on three or four sides as the whole of the steel section will be receiving heat. A, however, is the exposed surface area and that depends on the configuration of the fire protection. In the case of a "box" protection, the surface area is the sum of the inside dimensions of the smallest possible rectangular or square encasement (except for circular hollow sections - see Figure 6) whilst for a "profile" protection, it is taken as the surface area of the steel section itself. Where a section supports a floor or is against a wall which themselves provide fire protection, the surface in contact is ignored in calculating A. For "solid" protection the Section Factor value should be taken as that for box protection.

Where a spray or trowelled system has been tested as a profile protection, the use of the same material as a box protection is permissible, provided there is adequate evidence of physical performance (commonly referred to as "stickability"). In the absence of a full programme of tests on the system as a boxed protection, the thickness should be derived on the basis of the profile Section Factor.

In some cases the appropriate Section Factor may not be based on simple geometric considerations. Guidance on some common cases is now given.

1.6.1 Section Factor (A/V) for castellated sections, including Cellform® beams

For castellated sections the A/V concept can still be applied. However, test experience has shown that the temperature of protected castellated members increases at a faster rate than conventional sections and that an increase in fire protection thickness is appropriate. It is recommended that to obtain the protection requirement for a castellated section, the thickness should first be obtained based on the original section and then increased by 20%.

For Cellform® beams, in which the holes through the beam are circular, the same 20% increase in thickness should be applied although there is a small loss in volume in forming the circular openings.

The above guidance applies to passive materials. In the case of intumescent coatings, no definitive guidance can be given and each case should be assessed separately.

Figure 6: Protection configurations with values of perimeter Hp for use in the calculation of section factor Hp/A (A/V)

Note: the values are approximate in that radii at corners and roots of all sections are ignored

In this figure Hp/A = A/V

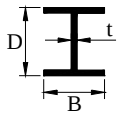
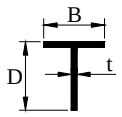
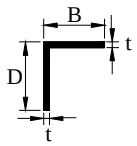
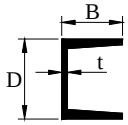
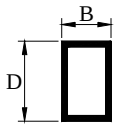
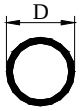
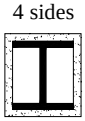
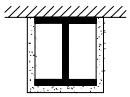
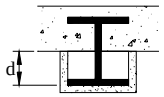
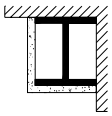
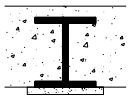
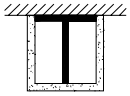
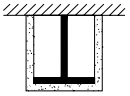
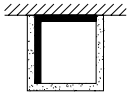
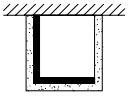
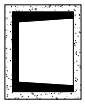
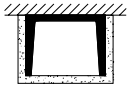
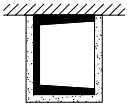
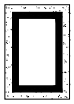
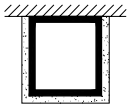
Steel section	Profile protection
Universal beams, universal columns and joists (plain and castellated)  H_p	4 sides: $2B + 2D + 2(B - t) = 4B + 2D - 2t$ 3 sides: $B + 2D + 2(B - t) = 3B + 2D - 2t$ 3 sides, Partially exposed: $B + 2d + (B - t) = 2B + 2d - t$ 2 sides: $B + D + 2(B - t)/2 = 2B + D - t$ 1 side, Partially exposed: B
Structural and rolled tees  H_p	4 sides: $2B + 2D$ 3 sides, Flange to soffit: $B + 2D$ 3 sides, Toe of web to soffit: $B + 2D + (B - t) = 2B + 2D - t$
Angles  H_p	4 sides: $2B + 2D$ 3 sides, Flange to soffit: $B + 2D$ 3 sides, Toe of flange to soffit: $B + 2D + (B - t) = 2B + 2D - t$
Channels  H_p	4 sides: $2B + 2D + 2(B - t) = 4B + 2D - 2t$ 3 sides, Web to soffit: $2B + D + 2(B - t) = 4B + D - 2t$ 3 sides, Flange to soffit: $B + 2D + 2(B - t) = 3B + 2D - 2t$
Hollow sections, *square or rectangular*  H_p	4 sides: $2B + 2D$ 3 sides: $B + 2D$
Hollow sections, *circular*  H_p	πD
Example using 203 x 203 x 52 kg/m universal beam B = 203.9mm; D = 206.2mm t = 8.0 mm. A = 66.4 cm²	a) Profile protection - 4 sided exposure $H_p = 4B + 2D - 2t$ $\therefore H_p = 4 \times 203.9 + 2 \times 206.2 - 2 \times 8.0$ $= 1212$ mm $= 1.212$ m $H_p/A = 1.212/0.00664 = 182.5$ m^{-1} b) Profile protection - 3 sided exposure $H_p = 3B + 2D - 2t$ $\therefore H_p = 611.7 + 412.4 - 16$ $= 1008$ mm $= 1.008$ m $H_p/A = 1.008/0.00664 = 151.8$ m^{-1}

Figure 6 (continued)

In this figure Hp/A = A/V

Steel section	Box and solid protection				
Universal beams, universal columns and joists (plain and castellated)	 4 sides	 3 sides	 3 sides Partially exposed	 2 sides	 1 side Partially exposed
H_p	2B + 2D	B + 2D	B + 2d	B + D	B
Structural and rolled tees	 4 sides	 3 sides Flange to soffit	 3 sides Toe of web to soffit		
H_p	2B + 2D	B + 2D	B + 2D		
Angles	 4 sides	 3 sides Flange to soffit	 3 sides Toe of flange to soffit		
H_p	2B + 2D	B + 2D	B + 2D		
Channels	 4 sides	 3 sides Web to soffit	 3 sides Flange to soffit		
H_p	2B + 2D	2B + D	B + 2D		
Hollow sections, *square or rectangular*	 4 sides	 3 sides			
H_p	2B + 2D	B + 2D			
Hollow sections, *circular*		*Note.* The air space created in boxing a section improves the insulation and a value of Hp/A, and therefore Hp, higher than for profile protection would be anomalous. Hence Hp is taken as the circumference of the tube and not 4D.			
H_p	πD				
Example continued	c) Box - 4 sided exposure H_p = 2B + 2D = 407.8 + 412.4 = 820.2 mm = 0.820 m $\therefore$ H_p/A = 0.82/0.00664 = 123.5 m^{-1}		d) Box - 3 sided exposure H_p = B + 2D = 203.9 + 412.4 = 616.3 mm = 0.616 m $\therefore$ H_p/A = 0.616/0.00664 = 92.8 m^{-1}		

1.6.2 Section Factor (A/V) for structural hollow sections

Other than where stated in Section 2, the fire test data relates specifically to universal beams and columns, as the bulk of test work over the years has concentrated on these sections. However, test data exists on structural hollow sections (SHS) as compression and flexural members, and the comparability between SHS sections and "I" sections in terms of protection thickness related to Section Factor, for rectangular, square and circular sections, has been established.

The same critical temperatures can be adopted for analysis purposes for SHS and "I" sections. The modifications listed below would not apply to intumescent coatings. Guidance on fire protection with intumescent coatings is presented in Section 3 and 4.

- For fire protection materials, whether boards or spray (on lath), whose thicknesses have been assessed from test data on boxed "I" sections (see Figure 2), no change in thickness is required, i.e. the thickness for an SHS of a given Section Factor, is equal to that for the "I" section of the same "box" Section Factor.
- For fire protection materials, whether board or spray whose thickness has been assessed from test data on profiled "I" sections (see Figure 2), some modification in thickness is required. The extent of the modification is related to the Section Factor of the section and is derived as follows:

(i) Establish the Section Factor of the SHS section.

(ii) Establish the required thickness of profiled protection material based upon the tables relating to Section Factor and fire resistance period and protection thickness, derived for "I" sections. This is the thickness "d_p" (mm).

(iii) Increase thickness d_p as follows

For Section Factor up to 250m^{-1}

$$Modified\ thickness = d_p \left(1 + \frac{A/V}{1000}\right)$$

For Section Factor between 250 and 310m^{-1}

$$Modified\ thickness = 1.25\, d_p$$

The maximum thickness that can be applied to SHS sections should not exceed that given for "I" sections listed under **item 11** of the data sheet (see 5.1.2 in Section 5).

It should be noted that any changes resulting from the transposition from "I" sections to SHS sections may affect the retention of the material. Where modifications are considered significant, appropriate loaded fire resistance tests should be carried out.

Where the fire protection thickness of "I" sections has been established by a test conducted on members which were "solid" protected, then a separate appraisal for the hollow section is necessary.

1.6.3 Section Factor for partially exposed members

When a section is partially exposed to fire, for instance when a column is built into a wall or a beam is embedded in a floor slab, and construction materials such as brick, block or concrete have been used, the Section Factor may be calculated as shown in Figure 6. In such situations the same principle is used as for other configurations where A is the surface area of the part of the section exposed to the fire and V is the volume of the section. The Section Factor will change depending upon the degree of exposure and the equations given in Figure 6 should be used.

It should be noted that where the steel section penetrates both sides of the fire resisting construction, the thickness of protection may be determined by other requirements, such as compliance with the appropriate insulation requirements of BS476 for elements performing a fire separation function. As an example, consider a steel section partially exposed on both sides of a wall or floor as shown in Figure 6.

Different approaches should be followed according to the degree of fire resistance required of the wall or floor, whether it be similar to or less than that of the steel member, or zero.

In the case of walls, for example, the following have to be considered:

(i) Solid masonry or concrete wall having comparable fire resistance.

Since the insulation criterion must be satisfied for both steel member and wall, the thickness of

protection on the exposed steel should be sufficient to ensure that the rise in mean surface temperature of the protection on the side remote from the fire does not exceed 140°C, and the rise in maximum surface temperature does not exceed 180°C.

In assessing fire protection requirements to maintain the structural performance of the column, the exposed steel on each side of the wall will have its own heated surface area, A, and therefore its own A/V, consequently different protection thicknesses may be required on each side depending upon the degree of exposure.

(ii) Walls having lower fire resistance or formed from material which will degrade when exposed to fire, e.g. timber stud with combustible facings.

The effective surface area will relate to all steel which has the potential of becoming exposed and the fire protection should be applied in such a manner that its performance is independent of the wall.

In some cases of load bearing walls, simultaneous attack from fire on both sides may occur on columns partially exposed within the wall. Where this occurs, the Section Factor must be based on the sum of the fire exposed areas, either side of the wall, and the total volume of the section.

1.6.4 Section Factor (A/V) for tees, angles, channels

Where these sections are used structurally, it is necessary to determine the A/V values using the surface area, A, values illustrated in Figure 6. Where such members are considered as wind bracing, a modified approach is recommended and is discussed in the following section.

1.6.5 Section Factor (A/V) for wind and stability bracing

The cost of fire protecting bracing members is often high because the members are comparatively light and therefore have high Section Factors and correspondingly require high thicknesses of fire protection. However, for the reasons now discussed it may be possible to use reduced amounts of protection on bracing members and, in some cases, it may not be necessary to fire protect bracing members.

Bracing within a structure has two roles. It resists lateral wind forces but, especially for tall buildings, it contributes to the overall stability of the structure. In fire, it is important to recognise these two roles. In the case of wind some guidance is offered by the structural design codes. BS5950-8 recognises that it is highly unlikely that a fire will occur at the same time that the building is subject to the maximum design wind load and consequently recommends that for buildings over 8m in height only one third of the design wind load need be considered and, for buildings not greater than 8m in height, wind loading may be ignored. It therefore follows that there may be some justification for reducing the degree to which bracing members may need to be protected.

Based on a consideration of the risks and consequences, some recommendations are presented in Table 2 for assessing the necessary protection to bracing. In any case, consideration should be given to:

a) Shielding bracing from fire by installing it in shafts or within walls. The shielding will often provide the necessary fire protection.

b) Masonry walls, although often designed as non-loadbearing, may provide appreciable shear resistance in fire.

c) Bracing systems are often duplicated and loss of one system may be acceptable.

d) In single storey buildings unprotected bracing systems in either the walls or roof can still contribute to the stability of the building during exposure to fire.

e) In many steel frames connections are designed as “pinned”. These connections actually have a reasonable inherent stiffness and will add to building stability.

f) Bracing forming part of a roof structure only would not normally be required to have fire resistance.

Recommendations for fire protection to bracing members are given in Table 2.

Good detailing can reduce the extent of the fire protection required. For instance light tubular members are often selected because they are structurally efficient and architecturally pleasing. However, if these sections are fire protected, high thicknesses are required and alternative design methods can therefore be more cost effective.

Where the protection of a single bracing member is essential to maintain the stability of a structure then it is reasonable to base the thickness on a maximum value of Section Factor of $200m^{-1}$. For practical bracing systems, using a value of $200\ m^{-1}$ leads to a protection thickness close to that which could be derived using the allowable reductions in applied loads in fire given in BS5950-8.

Table 2: Assessment of fire protection requirements for bracing	
Building	Degree of fire protection to bracing system
Single storey Not more than 8m to eaves	None
Single storey More than 8m to eaves	Generally none
Two storey	Generally none Walls and frame stiffness will contribute considerably to stability.
Other multi-storey	Protected to achieve required fire resistance. However the selection of thickness may be based on allowable reductions in applied loads in fire given in BS5950-8

1.6.6 Section Factor (A/V) for lattice members

Ideally, wherever possible, a lattice beam should be judged by a full test as a loaded member. However, with existing fire testing equipment this is not always practicable and recourse to appraisal using A/V can be made.

When the elements of a lattice beam are to be individually protected, the thickness of protection required for each element should be based on the Section Factor of the individual element. Where a lattice beam is to be protected by encasing the entire beam by either boards, or sprays applied to an expanded metal lathing, no recommendation can be given and each case must be considered on its own merits.

The use of the limiting temperature method of BS5950-8 or the similar EC3-1.2 method is not recommended for the diagonal bracing members because these members might be subject to significant thermal stresses from restrained thermal expansion. In the absence of a detailed analysis a general steel temperature of 550°C is recommended. In any case it is important that the final appraisal be based on a broad consideration of the lattice design.

1.6.7 Light gauge cold rolled sections

This type of section would normally necessitate separate appraisal because of the high values of A/V and the manner in which the sections are formed which can influence their failure criteria. Research is continuing to formulate recommendations for the applications of data given in this publication. Some information on the protection of cold formed members is given in the SCI publication 129 - “Building design using cold formed members”.

There are a variety of sections formed from cold rolled sections and normally each would require separate appraisal.

1.6.8 Unprotected steel

Fire resistance tests have demonstrated that 30 minutes fire resistance can be achieved with fully stressed unprotected steel sections as follows:

Columns, four sided exposure - A/V up to $50m^{-1}$

Beams, simply supported, three sided exposure - A/V up to $110m^{-1}$

Where these specific conditions arise on site, protection may not be necessary subject to agreement with the approving authority.

1.6.9 Slimflor and slimdek beams

Slimflor and Slimdek are the trade names for a form of shallow floor construction developed by Corus. There are three forms.

Slimflor with precast planks

In this form, the beam is manufactured by welding a plate to a column section. The floor is then created by laying a precast concrete floor slab on the outstand of the plate.

In situations where fire protection is required, the bottom plate only should be protected. As with standard downstand beams, the protection material thickness is based on the section factor and for calculation purposes, the heated perimeter is the width of the plate plus two times the plate thickness, in metres, divided by the cross sectional area of the column section and plate combined. This will usually result in low section factors.

Slimflor with deep decking

In this form, the beam is also manufactured by welding a plate to a column section. However the floor is then created by laying a deep metal deck on the outstand of the plate. The deck is then filled with in-situ concrete.

When fire protection is required, the bottom plate only should be protected. As with standard downstand beams, the protection material thickness is based on the section factor and this calculation is identical to that for Slimflor with precast planks.

This will also usually result in low section factors.

Slimdek flooring systems

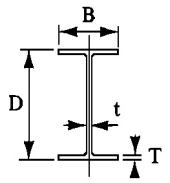
In this form, the beam is a rolled asymmetric section with the lower flange wider than the upper. The floor is created by laying a deep metal deck on the outstand of the bottom plate. The deck is then filled with in-situ concrete.

The beams are normally rolled with a thick web and, in the fire condition, this web takes much of the load shed by the hot bottom flange. Where the thick web is not sufficient to compensate for the loss in strength of the flange, it is usually more economic for the designer to use a beam without a thick web. Asymmetric Slimdek Beams with a fire engineered (thick) web are designated ASB(FE); those without the thick web are designated ASB.

As previously stated, when fire protection is required, the bottom flange only should be protected. For calculation purposes the heated perimeter is also taken as the width of the bottom flange plus two times the bottom flange thickness, in metres, divided by the cross sectional area of the ASB. This will also usually result in low section factors.

For further information relating to the above systems contact should be made with Corus.

Table 3
Universal beams



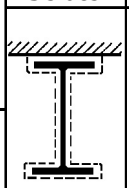
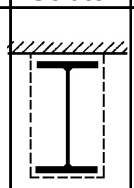
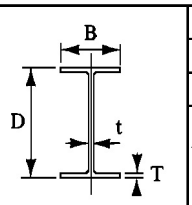
Designation		Depth of section D	Width of section B	Thickness		Area of section	Section factor A/V (Hp/A)			
							Profile		Box	
							3 sides	4 sides	3 sides	4 sides
										
Serial size	Mass per metre			Web t	Flange T					
mm	kg	mm	mm	mm	mm	cm^2	m^{-1}	m^{-1}	m^{-1}	m^{-1}
914 x 419	388	920.50	420.50	21.50	36.60	494.40	60	70	45	55
	343	911.40	418.50	19.40	32.00	437.40	70	80	50	60
914 x 305	289	926.60	307.80	19.60	32.00	368.80	75	80	60	65
	253	918.50	305.50	17.30	27.90	322.80	85	95	65	75
	224	910.30	304.10	15.90	23.90	285.20	95	105	75	85
	201	903.00	303.40	15.20	20.20	256.40	105	115	80	95
838 x 292	226	850.90	293.80	16.10	26.80	288.70	85	95	70	80
	194	840.70	292.40	14.70	21.70	247.10	100	115	80	90
	176	834.90	291.60	14.00	18.80	224.10	110	125	90	100
762 x 267	197	769.60	268.00	15.60	25.40	250.70	90	100	70	85
	173	762.00	266.70	14.30	21.60	220.40	105	115	80	95
	147	753.90	265.30	12.90	17.50	188.00	120	135	95	110
686 x 254	170	692.90	255.80	14.50	23.70	216.50	95	110	75	90
	152	687.60	254.50	13.20	21.00	193.80	110	120	85	95
	140	683.50	253.70	12.40	19.00	178.60	115	130	90	105
	125	677.90	253.00	11.70	16.20	159.60	130	145	100	115
610 x 305	238	633.00	311.50	18.60	31.40	303.70	70	80	50	60
	179	617.50	307.00	14.10	23.60	227.90	90	105	70	80
	149	609.60	304.80	11.90	19.70	190.10	110	125	80	95
610 x 229	140	617.00	230.10	13.10	22.10	178.30	105	120	80	95
	125	611.90	229.00	11.90	19.60	159.50	115	130	90	105
	113	607.30	228.20	11.20	17.30	144.40	130	145	100	115
	101	602.20	227.60	10.60	14.80	129.10	145	160	110	130
533 x 210	122	544.60	211.90	12.80	21.30	155.70	110	120	85	95
	109	539.50	210.70	11.60	18.80	138.50	120	135	95	110
	101	536.70	210.10	10.90	17.40	129.70	130	145	100	115
	92	533.10	209.30	10.20	15.60	117.70	140	160	110	125
	82	528.30	208.70	9.60	13.20	104.40	155	175	120	140
457 x 191	98	467.40	192.80	11.40	19.60	125.20	120	135	90	105
	89	463.60	192.00	10.60	17.70	113.90	130	145	100	115
	82	460.20	191.30	9.90	16.00	104.50	140	160	105	125
	74	457.20	190.50	9.10	14.50	94.98	155	175	115	135
	67	453.60	189.90	8.50	12.70	85.44	170	190	130	150
457 x 152	82	465.10	153.50	10.70	18.90	104.40	130	145	105	120
	74	461.30	152.70	9.90	17.00	94.99	140	155	115	130
	67	457.20	151.90	9.10	15.00	85.41	155	175	125	145
	60	454.70	152.90	8.00	13.30	75.93	175	195	140	160
	52	449.80	152.40	7.60	10.90	66.49	200	220	160	180

Table continued overleaf

Table 3
Universal beams
(continued)



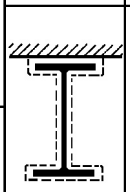
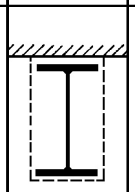
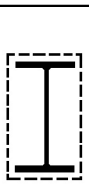
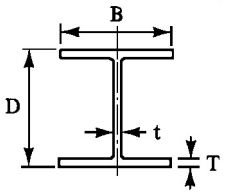
Designation		Depth of section D	Width of section B	Thickness		Area of section	Section factor A/V (Hp/A)			
							Profile		Box	
							3 sides	4 sides	3 sides	4 sides
Serial size	Mass per metre			Web t	Flange T					
mm	kg	mm	mm	mm	mm	cm^2	m^{-1}	m^{-1}	m^{-1}	m^{-1}
406 x 178	74	412.80	179.70	9.70	16.00	94.95	140	160	105	125
	67	409.40	178.80	8.80	14.30	85.49	155	175	115	140
	60	406.40	177.80	7.80	12.80	76.01	175	195	130	155
	54	402.60	177.60	7.60	10.90	68.42	190	215	145	170
406 x 140	46	402.30	142.40	6.90	11.20	58.96	205	230	160	185
	39	397.30	141.80	6.30	8.60	49.40	240	270	190	220
356 x 171	67	364.00	173.20	9.10	15.70	85.42	140	160	105	125
	57	358.60	172.10	8.00	13.00	72.18	165	190	125	145
	51	355.60	171.50	7.30	11.50	64.58	185	210	135	165
	45	352.00	171.00	6.90	9.70	56.96	210	240	155	185
356 x 127	39	352.80	126.00	6.50	10.70	49.40	215	240	170	195
	33	348.50	125.40	5.90	8.50	41.83	250	280	195	225
305 x 165	54	310.90	166.80	7.70	13.70	68.80	160	185	115	140
	46	307.10	165.70	6.70	11.80	58.90	185	210	130	160
	40	303.80	165.10	6.10	10.20	51.50	210	240	150	180
305 x 127	48	310.40	125.20	9.90	14.00	60.83	160	180	125	145
	42	306.60	124.30	8.00	12.10	53.18	180	205	140	160
	37	303.80	123.50	7.20	10.70	47.47	200	225	155	180
305 x 102	33	312.70	102.40	6.60	10.80	41.77	215	240	175	200
	28	308.90	101.90	6.10	8.90	36.30	245	275	200	225
	25	304.80	101.60	5.80	6.80	31.39	285	315	225	260
254 x 146	43	259.60	147.30	7.30	12.70	55.10	170	195	120	150
	37	256.00	146.40	6.40	10.90	47.45	195	225	140	170
	31	251.50	146.10	6.10	8.60	40.00	230	265	160	200
254 x 102	28	260.40	102.10	6.40	10.00	36.19	220	250	170	200
	25	257.00	101.90	6.10	8.40	32.17	245	280	190	225
	22	254.00	101.60	5.80	6.80	28.42	275	315	215	250
203 x 133	30	206.80	133.80	6.30	9.60	38.00	210	245	145	180
	25	203.20	133.40	5.80	7.80	32.31	240	285	165	210
203 x 102	23	203.20	101.60	5.20	9.30	29.00	235	270	175	210
178 x 102	19	177.80	101.60	4.70	7.90	24.20	265	305	190	230
152 x 89	16	152.40	88.90	4.60	7.70	20.50	270	310	190	235
127 x 76	13	127.00	76.20	4.20	7.60	16.80	275	320	195	240

Table 4
Universal columns



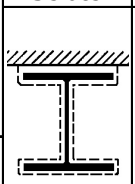
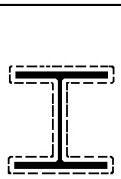
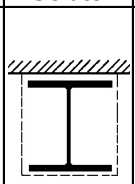
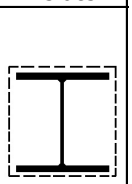
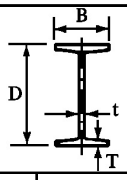
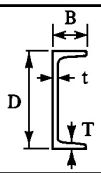
Designation		Depth of section D	Width of section B	Thickness		Area of section	Section factor A/V (Hp/A)			
							Profile		Box	
							3 sides	4 sides	3 sides	4 sides
										
Serial size	Mass per metre			Web t	Flange T					
mm	kg	mm	mm	mm	mm	cm^2	m^{-1}	m^{-1}	m^{-1}	m^{-1}
356 x 406	634	474.70	424.10	47.60	77.00	808.10	25	30	15	20
	551	455.70	418.50	42.00	67.50	701.80	30	35	20	25
	467	436.60	412.40	35.90	58.00	595.50	35	40	20	30
	393	419.10	407.00	30.60	49.20	500.90	40	45	25	35
	340	406.40	403.00	26.50	42.90	432.70	45	55	30	35
	287	393.70	399.00	22.60	36.50	366.00	50	65	30	45
	235	381.00	395.00	18.50	30.20	299.80	65	75	40	50
356 x 368	202	374.70	374.40	16.80	27.00	257.90	70	85	45	60
	177	368.30	372.10	14.50	23.80	225.70	80	95	50	65
	153	362.00	370.20	12.60	20.70	195.20	90	110	55	75
	129	355.60	368.30	10.70	17.50	164.90	105	130	65	90
305 x 305	283	365.30	321.80	26.90	44.10	360.40	45	55	30	40
	240	352.60	317.90	23.00	37.70	305.60	50	60	35	45
	198	339.90	314.10	19.20	31.40	252.30	60	75	40	50
	158	327.20	310.60	15.70	25.00	201.20	75	90	50	65
	137	320.50	308.70	13.80	21.70	174.60	85	105	55	70
	118	314.50	306.80	11.90	18.70	149.80	100	120	60	85
	97	307.80	304.80	9.90	15.40	123.30	120	145	75	100
254 x 254	167	289.10	264.50	19.20	31.70	212.40	60	75	40	50
	132	276.40	261.00	15.60	25.30	167.70	75	90	50	65
	107	266.70	258.30	13.00	20.50	136.60	90	110	60	75
	89	260.40	255.90	10.50	17.30	114.00	110	130	70	90
	73	254.00	254.00	8.60	14.20	92.90	130	160	80	110
203 x 203	86	222.30	208.80	13.00	20.50	110.10	95	110	60	80
	71	215.90	206.20	10.30	17.30	91.10	110	135	70	95
	60	209.60	205.20	9.30	14.20	75.80	130	160	80	110
	52	206.20	203.90	8.00	12.50	66.40	150	180	95	125
	46	203.20	203.20	7.30	11.00	58.80	165	200	105	140
152 x 152	37	161.80	154.40	8.10	11.50	47.40	160	190	100	135
	30	157.50	152.90	6.60	9.40	38.20	195	235	120	160
	23	152.40	152.40	6.10	6.80	29.80	245	300	155	205

Table 5
Joists



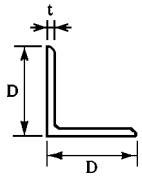
Designation		Depth of section D	Width of section B	Thickness		Area of section	Section factor A/V (Hp/A)			
							Profile		Box	
							3 sides	4 sides	3 sides	4 sides
Serial size	Mass per metre			Web t	Flange T					
mm	kg	mm	mm	mm	mm	cm^2	m^{-1}	m^{-1}	m^{-1}	m^{-1}
254 x 203	81.85	254.00	203.20	10.20	19.90	104.40	95	115	70	90
254 x 114	37.20	254.00	114.30	7.60	12.80	47.40	165	190	130	155
203 x 152	52.09	203.20	152.40	8.90	16.50	66.40	115	140	85	105
203 x 102	25.33	203.20	101.60	5.80	10.40	32.30	205	235	155	190
178 x 102	21.54	177.80	101.60	5.30	9.00	27.40	225	260	165	205
152 x 127	37.20	152.40	127.00	10.40	13.20	47.50	130	155	90	120
152 x 89	17.09	152.40	88.90	4.90	8.30	21.80	245	285	180	220
152 x 76	17.86	152.40	76.20	5.80	9.60	22.80	215	245	165	200
127 x 114	29.76	127.00	114.30	10.20	11.50	37.30	140	175	100	130
127 x 114	26.79	127.00	114.30	7.40	11.40	34.10	155	190	110	140
127 x 76	16.37	127.00	76.20	5.60	9.60	21.00	205	245	155	195
127 x 76	13.36	127.00	76.20	4.50	7.60	17.00	265	310	195	240
114 x 114	26.79	114.30	114.30	9.50	10.70	34.40	145	180	100	135
102 x 102	23.07	101.60	101.60	9.50	10.30	29.40	150	185	105	140
102 x 64	9.65	101.60	63.50	4.10	6.60	12.30	295	345	215	270
102 x 44	7.44	101.60	44.40	4.30	6.10	9.50	320	365	260	305
89 x 89	19.35	88.90	88.90	9.50	9.90	24.90	155	190	105	145
76 x 76	14.67	76.20	80.00	8.90	8.40	19.10	175	220	120	165
76 x 76	12.65	76.20	76.20	5.10	8.40	16.30	205	250	140	185

Table 6
Channels



Designation		Depth of section D	Width of section B	Thickness		Area of section	Section factor A/V (Hp/A)							
							Profile				Box			
							3 sides			4 sides	3 sides			4 sides
Serial size	Mass per metre			Web t	Flange T									
mm	kg	mm	mm	mm	mm	cm^2	m^{-1}	m^{-1}	m^{-1}	m^{-1}	m^{-1}	m^{-1}	m^{-1}	m^{-1}
432 x 102	65.54	431.80	101.60	12.20	16.80	83.49	135	95	75	145	115	75	75	130
381 x 102	55.10	381.00	101.60	10.40	16.30	70.19	145	105	85	160	125	85	85	140
305 x 102	46.18	304.80	101.60	10.20	14.80	58.83	145	110	85	165	120	85	85	140
305 x 89	41.69	304.80	88.90	10.20	13.70	53.11	155	115	90	175	130	90	90	150
254 x 89	35.74	254.00	88.90	9.10	13.60	45.52	160	125	95	180	130	95	95	150
254 x 76	28.29	254.00	76.20	8.10	10.90	36.03	195	145	115	215	160	115	115	185
229 x 89	32.76	228.60	88.90	8.60	13.30	41.73	165	130	95	185	130	95	95	150
229 x 76	26.06	228.60	76.20	7.60	11.20	33.20	195	150	115	220	160	115	115	185
203 x 89	29.78	203.20	88.90	8.10	12.90	37.94	165	135	100	190	130	100	100	155
203 x 76	23.82	203.20	76.20	7.10	11.20	30.34	195	155	115	220	160	115	115	185
178 x 89	26.81	177.80	88.90	7.60	12.30	34.15	170	145	105	195	130	105	105	155
178 x 76	20.84	177.80	76.20	6.60	10.30	26.54	205	170	125	235	165	125	125	190
152 x 89	23.84	152.40	88.90	7.10	11.60	30.36	175	155	110	205	130	110	110	160
152 x 76	17.88	152.40	76.20	6.40	9.00	22.77	220	185	135	255	165	135	135	200
127 x 64	14.90	127.00	63.50	6.40	9.20	18.98	215	185	135	250	165	135	135	200
102 x 51	10.42	101.60	50.80	6.10	7.60	13.28	245	210	155	285	190	155	155	230
76 x 38	6.70	76.20	38.10	5.10	6.80	8.53	285	240	180	330	225	180	180	270

Table 7
Equal angles



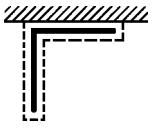
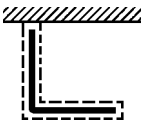
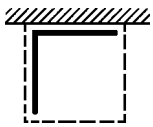
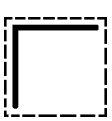
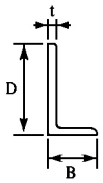
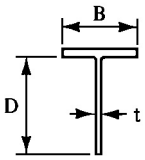
Size D x D	Thickness t	Mass per metre	Area of section	Section factor A/V (Hp/A)				
				Profile			Box	
				3 sides		4 sides	3 sides	4 sides
								
mm	mm	kg	cm^2	m^{-1}	m^{-1}	m^{-1}	m^{-1}	m^{-1}
200 x 200	24	71.10	90.60	65	85	85	65	90
	20	59.90	76.30	75	100	105	80	105
	18	54.20	69.10	85	110	115	85	115
	16	48.50	61.80	95	125	125	95	130
150 x 150	18	40.10	51.00	85	110	115	90	115
	15	33.80	43.00	100	135	135	105	140
	12	27.30	34.80	125	165	170	130	170
	10	23.00	29.30	150	200	200	155	205
120 x 120	15	26.60	33.90	105	135	140	105	140
	12	21.60	27.50	125	170	170	130	175
	10	18.20	23.20	150	200	200	155	205
	8	14.70	18.70	185	250	250	190	255
100 x 100	15	21.90	27.90	105	135	140	105	145
	12	17.80	22.70	130	170	170	130	175
	8	12.20	15.50	185	250	250	195	255
90 x 90	12	15.90	20.30	130	170	175	135	175
	10	13.40	17.10	150	200	205	155	210
	8	10.90	13.90	190	250	250	195	260
	6	8.30	10.60	245	330	330	255	340
80 x 80	10	11.90	15.10	155	205	205	160	210
	8	9.63	12.30	190	250	255	195	260
	6	7.34	9.35	250	330	335	255	340
70 x 70	10	10.30	13.10	155	205	210	160	215
	8	8.36	10.60	190	250	255	195	260
	6	6.38	8.13	250	330	335	255	340
60 x 60	10	8.69	11.10	155	205	210	160	215
	8	7.09	9.03	190	250	260	200	265
	6	5.42	6.91	250	330	335	260	345
	5	4.57	5.82	300	395	400	305	410
50 x 50	8	5.82	7.41	195	255	260	200	270
	6	4.47	5.69	255	335	340	260	350
	5	3.77	4.80	300	400	405	310	415
45 x 45	6	4.00	5.09	255	335	340	265	350
	5	3.38	4.30	300	400	405	310	415
	4	2.74	3.49	370	490	495	385	510
40 x 40	6	3.52	4.48	255	340	345	265	355
	5	2.97	3.79	305	400	410	315	420
	4	2.42	3.08	375	495	500	390	515
25 x 25	5	1.77	2.26	315	415	430	335	445
	4	1.45	1.85	390	515	525	405	545
	3	1.11	1.42	505	680	685	530	710

Table 8
Unequal angles



Designation		Mass per metre	Area of section	Section factor A/V (Hp/A)									
				Profile					Box				
				3 sides				4 sides	3 sides				4 sides
Size D x B	Thickness t												
mm	mm	kg	cm^2	m^{-1}	m^{-1}	m^{-1}	m^{-1}	m^{-1}	m^{-1}	m^{-1}	m^{-1}	m^{-1}	m^{-1}
200 x 150	18	47.10	60.00	110	110	90	80	115	90	85	90	85	115
	15	39.60	50.50	135	135	105	95	135	115	100	110	100	140
	12	32.00	40.80	165	165	130	120	170	135	120	135	120	170
200 x 100	15	33.70	43.00	135	135	115	90	135	115	95	115	95	140
	12	27.30	34.80	165	165	140	110	170	145	115	145	115	170
	10	23.00	29.20	195	195	165	135	200	170	135	170	135	205
150 x 90	15	26.60	33.90	135	135	110	95	140	115	95	115	95	140
	12	21.60	27.50	165	165	140	115	170	140	120	140	120	175
	10	18.20	23.20	200	200	165	140	205	170	140	170	140	205
150 x 75	15	24.80	31.60	135	135	115	90	140	120	95	120	95	140
	12	20.20	25.70	165	165	140	115	170	145	115	145	115	175
	10	17.00	21.60	200	200	170	135	205	175	140	175	140	210
125 x 75	12	17.80	22.70	165	165	140	115	170	145	120	145	120	175
	10	15.00	19.10	200	200	165	140	205	170	145	170	145	210
	8	12.20	15.50	245	245	205	170	250	210	175	210	175	260
100 x 75	12	15.40	19.70	170	170	135	125	175	140	125	140	125	180
	10	13.00	16.60	200	200	160	145	205	165	150	165	150	210
	8	10.60	13.50	250	250	200	180	255	205	185	205	185	260
100 x 65	10	12.30	15.60	200	200	165	140	205	170	145	170	145	210
	8	9.94	12.70	245	245	200	175	255	210	180	210	180	260
	7	8.77	11.20	280	280	230	200	290	235	205	235	205	295
80 x 60	8	8.34	10.60	250	250	200	180	255	210	190	210	190	265
	7	7.36	9.38	285	285	225	205	290	235	215	235	215	300
	6	6.37	8.11	330	330	265	240	335	270	250	270	250	345
75 x 50	8	7.39	9.41	250	250	205	180	260	210	185	210	185	265
	6	5.65	7.19	330	330	270	235	340	275	240	275	240	345
65 x 50	8	6.75	8.60	250	250	205	185	260	210	190	210	190	265
	6	5.16	6.58	335	335	265	245	340	275	250	275	250	350
	5	4.35	5.54	395	395	315	290	405	325	295	325	295	415

Table 9
Structural tees
from universal beams



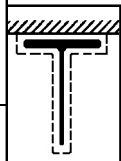
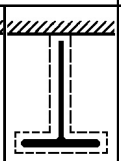
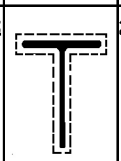
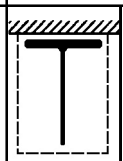
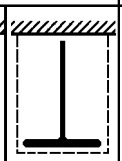
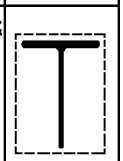
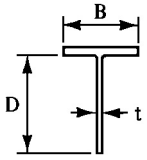
Serial size	Mass per metre	Width of section B	Depth of section D	Thickness t	Area of section	Section factor A/V (Hp/A)					
						Profile			Box		
						3 sides		4 sides	3 sides		4 sides
											
mm	kg	mm	mm	mm	cm^2	m^{-1}	m^{-1}	m^{-1}	m^{-1}	m^{-1}	m^{-1}
419 x 457	194	420.50	460.20	21.50	247.20	55	70	70	55	55	70
	172	418.50	455.70	19.40	218.70	60	80	80	60	60	80
305 x 457	145	307.80	463.30	19.60	184.40	65	80	85	65	65	85
	127	305.50	459.20	17.30	161.40	75	95	95	75	75	95
	112	304.10	455.20	15.90	142.60	85	105	105	85	85	105
	101	303.40	451.50	15.20	128.20	95	115	115	95	95	120
292 x 419	113	293.80	425.40	16.10	144.30	80	95	100	80	80	100
	97	292.40	420.40	14.70	123.50	90	115	115	90	90	115
	88	291.60	417.40	14.00	112.00	100	125	125	100	100	125
267 x 381	99	268.00	384.80	15.60	125.30	80	100	105	85	85	105
	87	266.70	381.00	14.30	110.20	90	115	115	95	95	120
	74	265.30	376.90	12.90	94.03	105	135	135	110	110	135
254 x 343	85	255.80	346.50	14.50	108.20	85	110	110	90	90	110
	76	254.50	343.80	13.20	96.91	95	120	120	95	95	125
	70	253.70	341.80	12.40	89.31	105	130	130	105	105	135
	63	253.00	339.00	11.70	79.81	115	145	145	115	115	150
305 x 305	119	311.50	316.50	18.60	151.80	60	80	80	60	60	85
	90	307.00	308.70	14.10	113.90	80	105	105	80	80	110
	75	304.80	304.80	11.90	95.06	95	125	125	95	95	130
229 x 305	70	230.10	308.50	13.10	89.19	95	120	120	95	95	120
	63	229.00	305.90	11.90	79.77	105	130	135	105	105	135
	57	228.20	303.70	11.20	72.22	115	145	145	115	115	145
	51	227.60	301.10	10.60	64.59	125	160	160	130	130	165
210 x 267	61	211.90	272.30	12.80	77.89	95	120	125	95	95	125
	55	210.70	269.70	11.60	69.29	105	135	135	110	110	140
	51	210.10	268.40	10.90	64.64	115	145	145	115	115	150
	46	209.30	266.60	10.20	58.88	125	160	160	125	125	160
	41	208.70	264.20	9.60	52.22	140	175	180	140	140	180
191 x 229	49	192.80	233.70	11.40	62.63	105	135	135	105	105	135
	45	192.00	231.80	10.60	56.95	115	145	145	115	115	150
	41	191.30	230.10	9.89	52.26	125	160	160	125	125	160
	37	190.50	228.60	9.10	47.49	135	175	175	135	135	175
	34	189.90	226.80	8.50	42.72	150	190	195	150	150	195
152 x 229	41	153.50	232.50	10.70	52.23	115	145	145	120	120	150
	37	152.70	230.60	9.89	47.49	125	155	160	130	130	160
	34	151.90	228.60	9.10	42.70	140	175	175	145	145	180
	30	152.90	227.30	8.00	37.96	160	195	200	160	160	200
	26	152.40	224.90	7.60	33.24	180	220	225	180	180	225

Table continued overleaf

Table 9
Structural tees from universal beams (continued)



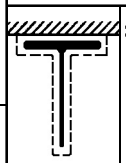
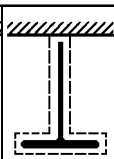
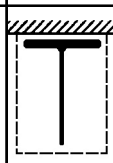
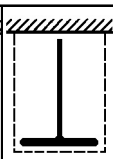
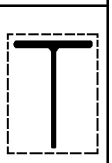
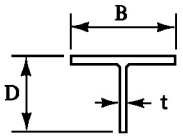
Serial size	Mass per metre	Width of section B	Depth of section D	Thickness t	Area of section	Section factor A/V (Hp/A)					
						Profile			Box		
						3 sides		4 sides	3 sides		4 sides
											
178 x 203	37	179.70	206.40	9.70	47.47	125	160	160	125	125	165
	34	178.80	204.70	8.80	42.74	135	175	175	140	140	180
	30	177.80	203.20	7.80	38.00	150	195	200	155	155	200
	27	177.60	201.30	7.60	34.21	165	215	220	170	170	220
140 x 203	23	142.40	201.20	6.90	29.48	180	230	230	185	185	235
	20	141.80	198.60	6.30	24.70	215	270	270	220	220	275
171 x 178	34	173.20	182.00	9.10	42.71	125	160	165	125	125	165
	29	172.10	179.30	8.00	36.09	145	190	190	145	145	195
	26	171.50	177.80	7.30	32.29	160	210	215	165	165	215
	23	171.00	176.00	6.90	28.48	180	240	240	185	185	245
127 x 178	20	126.00	176.40	6.50	24.70	190	240	240	195	195	245
	17	125.40	174.20	5.90	20.91	220	280	280	225	225	285
165 x 152	27	166.80	155.40	7.70	34.19	135	185	185	140	140	190
	23	165.70	153.50	6.70	29.45	160	210	215	160	160	215
	20	165.10	151.90	6.10	25.75	180	240	245	180	180	245
127 x 152	24	125.20	155.20	8.89	30.41	140	180	180	145	145	185
	21	124.30	153.30	8.00	26.59	160	205	205	160	160	210
	19	123.50	151.90	7.20	23.73	175	225	230	180	180	230
102 x 153	17	102.40	156.30	6.60	20.88	195	240	245	200	200	250
	14	101.90	154.40	6.10	18.15	225	275	280	225	225	280
	13	101.60	152.40	5.80	15.69	255	315	320	260	260	325
146 x 127	22	147.30	129.80	7.30	27.55	145	195	200	150	150	200
	19	146.40	128.00	6.40	23.72	165	225	230	170	170	230
	16	146.10	125.70	6.10	20.00	195	265	270	200	200	270
102 x 127	14	102.10	130.20	6.40	18.09	195	250	255	200	200	255
	13	101.90	128.50	6.10	16.08	220	280	280	225	225	285
	11	101.60	127.00	5.80	14.21	245	315	315	250	250	320
133 x 102	15	133.80	103.40	6.30	19.00	175	245	245	180	180	250
	13	133.40	101.60	5.80	16.15	205	285	285	210	210	290
102 x 102	12	101.60	101.60	5.20	14.50	205	270	275	210	210	280
102 x 89	10	101.60	88.90	4.70	12.10	225	305	310	230	230	315
89 x 76	8	88.90	76.20	4.60	10.20	230	315	315	235	235	325
76 x 64	7	76.20	63.50	4.20	8.39	235	320	325	240	240	335

Table 10
Structural tees
from universal columns



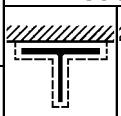
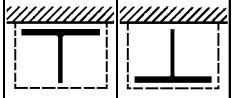
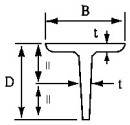
Serial size	Mass per metre	Width of section B	Depth of section D	Thickness t	Area of section	Section factor A/V (Hp/A)					
						Profile			Box		
						3 sides		4 sides	3 sides		4 sides
											
mm	kg	mm	mm	mm	cm^2	m^{-1}	m^{-1}	m^{-1}	m^{-1}	m^{-1}	m^{-1}
406 x 178	118	395.00	190.50	18.50	149.90	50	75	75	50	50	80
368 x 178	101	374.40	187.30	16.80	129.00	55	85	85	60	60	85
	89	372.10	184.20	14.50	112.90	65	95	95	65	65	100
	77	370.20	181.00	12.60	97.60	75	110	110	75	75	115
	65	368.30	177.80	10.70	82.50	85	130	130	90	90	130
305 x 152	79	310.60	163.60	15.70	100.60	60	90	95	65	65	95
	69	308.70	160.30	13.80	87.30	70	105	105	70	70	110
	59	306.80	157.20	11.90	74.90	80	120	120	85	85	125
	49	304.80	153.90	9.90	61.60	95	145	145	100	100	150
254 x 127	66	261.00	138.20	15.60	84.50	65	90	95	65	65	95
	54	258.30	133.40	13.00	68.30	75	110	115	75	75	115
	45	255.90	130.20	10.50	57.00	90	130	135	90	90	135
	37	254.00	127.00	8.60	46.40	105	160	160	110	110	165
203 x 102	43	208.80	111.10	13.00	55.00	75	110	115	80	80	115
	36	206.20	108.00	10.30	45.50	90	135	135	95	95	140
	30	205.20	104.80	9.30	37.90	105	160	160	110	110	165
	26	203.90	103.10	8.00	33.20	120	180	180	125	125	185
	23	203.20	101.60	7.30	29.40	135	200	205	140	140	205
152 x 76	19	154.40	80.90	8.10	23.70	130	195	195	135	135	200
	15	152.90	78.70	6.60	19.10	160	235	240	160	160	240
	12	152.40	76.20	6.10	14.90	200	300	305	205	205	310

Table 11
Rolled tees



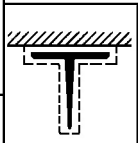
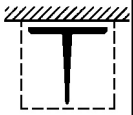
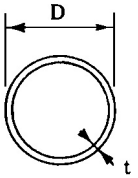
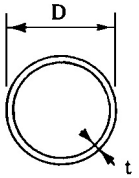
Serial size	Mass per metre	Width of section B	Depth of section D	Thickness t	Area of section	Section factor A/V (Hp/A)				
						Profile			Box	
						3 sides		4 sides	3 sides	4 sides
										
mm	kg	mm	mm	mm	cm^2	m^{-1}	m^{-1}	m^{-1}	m^{-1}	m^{-1}
51 x 51	6.92	50.8	50.8	9.5	8.82	175	220	230	175	230
	4.76	50.8	50.8	6.4	6.06	250	325	335	250	335
44 x 44	4.11	44.4	44.4	6.4	5.24	255	325	340	255	340
	3.14	44.4	44.4	4.8	4.00	335	430	445	335	445

Table 12
Circular hollow sections



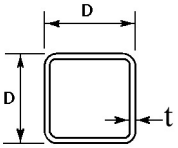
Designation		Mass per metre	Area of section	Section factor A/V (Hp/A) Profile or Box
Outside diameter	Thickness t			
mm	mm	kg	cm^2	m^{-1}
21.3	3.20	1.43	1.82	370
26.9	3.20	1.87	2.38	355
33.7	2.60	1.99	2.54	415
	3.20	2.41	3.07	345
	4.00	2.93	3.73	285
42.4	2.60	2.55	3.25	410
	3.20	3.09	3.94	340
	4.00	3.79	4.83	275
48.3	3.20	3.56	4.53	335
	4.00	4.37	5.57	270
	5.00	5.34	6.80	225
60.3	3.20	4.51	5.74	330
	4.00	5.55	7.07	270
	5.00	6.82	8.69	220
76.1	3.20	5.75	7.33	325
	4.00	7.11	9.06	265
	5.00	8.77	11.20	215
88.9	3.20	6.76	8.62	325
	4.00	8.38	10.70	260
	5.00	10.30	13.20	210
114.3	3.60	9.83	12.50	285
	5.00	13.50	17.20	210
	6.30	16.80	21.40	170
139.7	5.00	16.60	21.20	205
	6.30	20.70	26.40	165
	8.00	26.00	33.10	135
	10.00	32.00	40.70	110
168.3	5.00	20.10	25.70	205
	6.30	25.20	32.10	165
	8.00	31.60	40.30	130
	10.00	39.00	49.70	105
193.7	5.00	23.30	29.60	205
	6.30	29.10	37.10	165
	8.00	36.60	46.70	130
	10.00	45.30	57.70	105
	12.50	55.90	71.20	85
	16.00	70.10	89.30	70
219.1	5.00	26.40	33.60	205
	6.30	33.10	42.10	165
	8.00	41.60	53.10	130
	10.00	51.60	65.70	105
	12.50	63.70	81.10	85
	16.00	80.10	102.00	65
	20.00	98.20	125.00	55

Table 12 (continued)



Designation		Mass per metre	Area of section	Section factor A/V (Hp/A) Profile or Box
Outside diameter	Thickness t			
mm	mm	kg	cm^2	m^{-1}
244.5	6.30	37.00	47.10	165
	8.00	46.70	59.40	130
	10.00	57.80	73.70	105
	12.50	71.50	91.10	85
	16.00	90.20	115.00	65
	20.00	111.00	141.00	55
	25.00	135.00	172.00	45
273	6.30	41.40	52.80	160
	8.00	52.30	66.60	130
	10.00	64.90	82.60	105
	12.50	80.30	102.00	85
	16.00	101.00	129.00	65
	20.00	125.00	159.00	55
	25.00	153.00	195.00	45
323.9	6.30	49.30	62.90	160
	8.00	62.30	79.40	130
	10.00	77.40	98.60	105
	12.50	96.00	122.00	85
	16.00	121.00	155.00	65
	20.00	150.00	191.00	55
	25.00	184.00	235.00	45
355.6	8.00	68.60	87.40	130
	10.00	85.20	109.00	100
	12.50	106.00	135.00	85
	16.00	134.00	171.00	65
	20.00	166.00	211.00	55
	25.00	204.00	260.00	45
406.4	10.00	97.80	125.00	100
	12.50	121.00	155.00	80
	16.00	154.00	196.00	65
	20.00	191.00	243.00	55
	25.00	235.00	300.00	45
	32.00	295.00	376.00	35
457	10.00	110.00	140.00	105
	12.50	137.00	175.00	80
	16.00	174.00	222.00	65
	20.00	216.00	275.00	50
	25.00	266.00	339.00	40
	32.00	335.00	427.00	35
	40.00	411.00	524.00	25
508	10.00	123.00	156.00	100
	12.50	153.00	195.00	80
	16.00	194.00	247.00	65
	20.00	241.00	307.00	50
	25.00	298.00	379.00	40
	32.00	376.00	479.00	35
	40.00	462.00	588.00	25
	50.00	565.00	719.00	20

Table 13
Rectangular hollow sections (square)

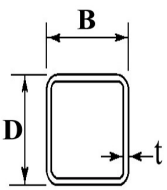


Designation		Mass per metre	Area of section	Section factor A/V (Hp/A)	
				3 sides	4 sides
Size D x D	Thickness t				
mm	mm	kg	cm^2	m^{-1}	m^{-1}
40 x 40	2.50	2.92	3.72	325	430
	3.00	3.45	4.40	275	365
	3.20	3.66	4.66	260	345
	4.00	4.46	5.68	210	280
	5.00	5.40	6.88	175	235
50 x 50	2.50	3.71	4.72	320	425
	3.00	4.39	5.60	270	355
	3.20	4.66	5.94	255	335
	4.00	5.72	7.28	205	275
	5.00	6.97	8.88	170	225
	6.30	8.49	10.80	140	185
60 x 60	3.00	5.34	6.80	265	355
	3.20	5.67	7.22	250	330
	4.00	6.97	8.88	205	270
	5.00	8.54	10.90	165	220
	6.30	10.50	13.30	135	180
	8.00	12.80	16.30	110	145
70 x 70	3.00	6.28	8.00	265	350
	3.60	7.46	9.50	220	295
	5.00	10.10	12.90	165	215
	6.30	12.50	15.90	130	175
	8.00	15.30	19.50	110	145
80 x 80	3.00	7.22	9.20	260	350
	3.60	8.59	10.90	220	295
	5.00	11.70	14.90	160	215
	6.30	14.40	18.40	130	175
	8.00	17.80	22.70	105	140
90 x 90	3.60	9.72	12.40	220	290
	5.00	13.30	16.90	160	215
	6.30	16.40	20.90	130	170
	8.00	20.40	25.90	105	140
100 x 100	4.00	12.00	15.30	195	260
	5.00	14.80	18.90	160	210
	6.30	18.40	23.40	130	170
	8.00	22.90	29.10	105	135
	10.00	27.90	35.50	85	115
120 x 120	5.00	18.00	22.90	155	210
	6.30	22.30	28.50	125	170
	8.00	27.90	35.50	100	135
	10.00	34.20	43.50	85	110
	12.50	41.60	53.00	70	90
140 x 140	5.00	21.10	26.90	155	210
	6.30	26.30	33.50	125	165
	8.00	32.90	41.90	100	135
	10.00	40.40	51.50	80	110
	12.50	49.50	63.00	65	90

Table 13
continued

Designation		Mass per metre	Area of section	Section factor A/V (Hp/A)	
				3 sides	4 sides
Size D x D	Thickness t				
mm	mm	kg	cm^2	m^{-1}	m^{-1}
150 x 150	5.00	22.70	28.90	155	210
	6.30	28.30	36.00	125	165
	8.00	35.40	45.10	100	135
	10.00	43.60	55.50	80	110
	12.50	53.40	68.00	65	90
	16.00	66.40	84.50	55	70
160 x 160	5.00	24.20	30.90	155	205
	6.30	30.30	38.50	125	165
	8.00	37.90	48.30	100	135
	10.00	46.70	59.50	80	110
	12.50	57.30	73.00	65	90
180 x 180	6.30	34.20	43.60	125	165
	8.00	43.00	54.70	100	130
	10.00	53.00	67.50	80	105
	12.50	65.20	83.00	65	85
	16.00	81.40	104.00	50	70
200 x 200	5.00	30.50	38.90	155	205
	6.30	38.20	48.60	125	165
	8.00	48.00	61.10	100	130
	10.00	59.30	75.50	80	105
	12.50	73.00	93.00	65	85
	16.00	91.50	117.00	50	70
250 x 250	6.30	48.10	61.20	125	165
	8.00	60.50	77.10	95	130
	10.00	75.00	95.50	80	105
	12.50	92.60	118.00	65	85
	16.00	117.00	149.00	50	65
300 x 300	6.30	57.90	73.80	120	165
	8.00	73.10	93.10	95	130
	10.00	90.70	116.00	80	105
	12.50	112.00	143.00	65	85
	16.00	142.00	181.00	50	65
350 x 350	8.00	85.70	109.00	95	130
	10.00	106.00	136.00	75	105
	12.50	132.00	168.00	65	85
	16.00	167.00	213.00	50	65
400 x 400	10.00	122.00	156.00	75	105
	12.50	152.00	193.00	60	85
	16.00	192.00	245.00	50	65
	20.00	237.00	302.00	40	55

Table 14
Rectangular hollow sections



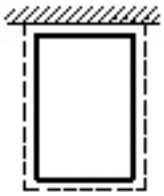
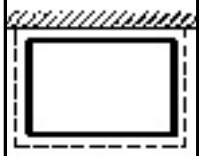
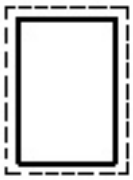
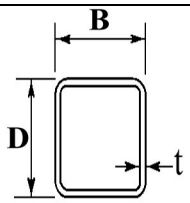
Designation		Mass per metre	Area of section	Section factor A/V (Hp/A)		
				3 sides		4 sides
Size D x B	Thickness t					
mm	mm	kg	cm^2	m^{-1}	m^{-1}	m^{-1}
50 x 30	2.50	2.92	3.72	350	295	430
	3.00	3.45	4.40	295	250	365
	3.20	3.66	4.66	280	235	345
	4.00	4.46	5.68	230	195	280
	5.00	5.40	6.88	190	160	235
60 x 40	2.50	3.71	4.72	340	295	425
	3.00	4.39	5.60	285	250	355
	3.20	4.66	5.94	270	235	335
	4.00	5.72	7.28	220	190	275
	5.00	6.97	8.88	180	160	225
	6.30	8.49	10.80	150	130	185
80 x 40	3.00	5.34	6.80	295	235	355
	3.20	5.67	7.22	275	220	330
	4.00	6.97	8.88	225	180	270
	5.00	8.54	10.90	185	145	220
	6.30	10.50	13.30	150	120	180
	8.00	12.80	16.30	125	100	145
90 x 50	3.00	6.28	8.00	290	240	350
	3.60	7.46	9.50	240	200	295
	5.00	10.10	12.90	180	145	215
	6.30	12.50	15.90	145	120	175
	8.00	15.30	19.50	120	95	145
100 x 50	3.00	6.75	8.60	290	235	350
	3.20	7.18	9.14	275	220	330
	4.00	8.86	11.30	220	175	265
	5.00	10.90	13.90	180	145	215
	6.30	13.40	17.10	145	115	175
	8.00	16.60	21.10	120	95	140
100 x 60	3.00	7.22	9.20	285	240	350
	3.60	8.59	10.90	240	200	295
	5.00	11.70	14.90	175	150	215
	6.30	14.40	18.40	140	120	175
	8.00	17.80	22.70	115	95	140
120 x 60	3.60	9.72	12.40	240	195	290
	5.00	13.30	16.90	180	140	215
	6.30	16.40	20.90	145	115	170
	8.00	20.40	25.90	115	95	140
120 x 80	5.00	14.80	18.90	170	150	210
	6.30	18.40	23.40	135	120	170
	8.00	22.90	29.10	110	95	135
	10.00	27.90	35.50	90	80	115
150 x 100	5.00	18.70	23.90	165	145	210
	6.30	23.30	29.70	135	120	170
	8.00	29.10	37.10	110	95	135
	10.00	35.70	45.50	90	75	110
	12.50	43.60	55.50	70	65	90

Table continued overleaf

Table 14
Rectangular hollow sections (continued)



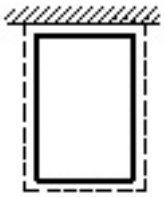
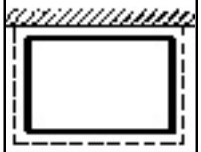
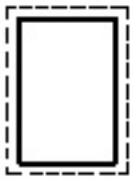
Designation		Mass per metre	Area of section	Section factor A/V (Hp/A)		
				3 sides		4 sides
Size D x B	Thickness t					
mm	mm	kg	cm2	m-1	m-1	m-1
160 x 80	5.00	18.00	22.90	175	140	210
	6.30	22.30	28.50	140	110	170
	8.00	27.90	35.50	115	90	135
	10.00	34.20	43.50	90	75	110
	12.50	41.60	53.00	75	60	90
200 x 100	5.00	22.70	28.90	175	140	210
	6.30	28.30	36.00	140	110	165
	8.00	35.40	45.10	110	90	135
	10.00	43.60	55.50	90	70	110
	12.50	53.40	68.00	75	60	90
	16.00	66.40	84.50	60	45	70
200 x 120	5.00	24.20	30.90	170	140	205
	6.30	30.30	38.50	135	115	165
	8.00	37.90	48.30	110	90	135
	10.00	46.70	59.50	85	75	110
	12.50	57.30	73.00	70	60	90
250 x 150	5.00	30.50	38.90	165	140	205
	6.30	38.20	48.60	135	115	165
	8.00	48.00	61.10	105	90	130
	10.00	59.30	75.50	85	75	105
	12.50	73.00	93.00	70	60	85
	16.00	91.50	117.00	55	45	70
300 x 200	6.30	48.10	61.20	130	115	165
	8.00	60.50	77.10	105	90	130
	10.00	75.00	95.50	85	75	105
	12.50	92.60	118.00	70	60	85
	16.00	117.00	149.00	55	45	65
400 x 200	8.00	73.10	93.10	105	85	130
	10.00	90.70	116.00	85	70	105
	12.50	112.00	143.00	70	55	85
	16.00	142.00	181.00	55	45	65
450 x 250	8.00	85.70	109.00	105	85	130
	10.00	106.00	136.00	85	70	105
	12.50	132.00	168.00	70	55	85
	16.00	167.00	213.00	55	45	65
500 x 200	8.00	85.70	109.00	110	85	130
	10.00	106.00	136.00	90	65	105
	12.50	132.00	168.00	70	55	85
	16.00	167.00	213.00	55	40	65
500 x 300	10.00	122.00	156.00	85	70	105
	12.50	152.00	193.00	65	55	85
	16.00	192.00	245.00	55	45	65
	20.00	237.00	302.00	45	35	55

Table 15 Castellated Sections

Castellated Universal Beams		
Serial size		Mass per metre
Original	Castellated	
mm	mm	kg
914 x 419	1371 x 419	388
		343
914 x 305	1371 x 305	289
		253
		224
		201
838 x 292	1257 x 292	226
		194
		176
762 x 267	1143 x 267	197
		173
		147
686 x 254	1029 x 254	170
		152
		140
		125
610 x 305	915 x 305	238
		179
		149
610 x 229	915 x 229	140
		125
		113
		101
533 x 210	800 x 210	122
		109
		101
		92
		82
457 x 191	686 x 191	98
		89
		82
		74
		67

Castellated Universal Beams (continued)		
Serial size		Mass per metre
Original	Castellated	
mm	mm	kg
457 x 152	686 x 152	82
		74
		67
		60
		52
406 x 178	609 x 178	74
		67
		60
		54
406 x 140	609 x 140	46
		39
356 x 171	534 x 171	67
		57
		51
		45
356 x 127	534 x 127	39
		33
305 x 165	458 x 165	54
		46
		40
305 x 127	458 x 127	48
		42
		37
305 x 102	458 x 102	33
		28
		25
254 x 146	381 x 146	43
		37
		31
254 x 102	381 x 102	28
		25
		22
203 x 133	305 x 133	30
		25

Castellated Universal Columns		
Serial size		Mass per metre
Original	Castellated	
mm	mm	kg
356 x 406	546 x 406	634
		551
		467
		393
		340
		287
		235
356 x 368	534 x 368	202
		177
		153
		129
305 x 305	458 x 305	283
		240
		198
		158
		137
		118
		97
254 x 254	381 x 254	167
		132
		107
		89
		73
203 x 203	305 x 203	86
		71
		60
		52
		46
152 x 152	228 x 152	37
		30
		23

Table 15 Castellated Sections (continued)

Castellated Joists		
Serial size		Mass per metre
Original	Castellated	
mm	mm	kg
254 x 203	381 x 203	81.85
254 x 114	381 x 114	37.20
203 x 152	305 x 152	52.09
203 x 102	305 x 102	25.33
178 x 102	267 x 102	21.54
152 x 127	228 x 127	37.20
152 x 89	228 x 89	17.09
152 x 76	228 x 76	17.86
127 x 114	191 x 114	29.76
127 x 114	191 x 114	26.79
127 x 76	191 x 76	16.37
127 x 76	191 x 76	13.36
114 x 114	171 x 114	26.79
102 x 102	153 x 102	23.07
89 x 89	134 x 89	19.35
76 x 76	114 x 76	12.65

Castellated Channels		
Serial size		Mass per metre
Original	Castellated	
mm	mm	kg
432 x 102	648 x 102	65.54
381 x 102	572 x 102	55.10
305 x 102	458 x 102	46.18
305 x 89	458 x 89	41.69
254 x 89	381 x 89	35.74
254 x 76	381 x 76	28.29
229 x 89	344 x 89	32.76
229 x 76	344 x 76	26.06
203 x 89	305 x 89	29.78
203 x 76	305 x 76	23.82
178 x 89	267 x 89	26.81
178 x 76	267 x 76	20.84
152 x 89	228 x 89	23.84
152 x 76	228 x 76	17.88
127 x 64	191 x 64	14.90
102 x 51	153 x 51	10.42
76 x 38	114 x 38	6.70

2. STRUCTURAL FIRE ENGINEERING

Many structural design codes now include “fire resistant” design. In the UK the steel design code is BS5950 and Part 8 is called “Code of practice for fire resistant design”. In the Eurocodes EC3 is the design code for steel and EC4 is the code for composite steel and concrete structures. The fire resistant design parts of these codes is Part 1.2 (ENV1993-1-2 and 1994-1-2). All these codes cover the design of a number of types of steel element and they also include guidance on the methods for the appraisal of the thickness of fire protection. An important feature of these codes is that they introduce the concept of a variable steel failure, or critical temperature. Guides to the background and use of these codes are given in: “Fire resistant design of steel structures, A handbook to BS 5950-8” (P080 1990) and “Structural fire design to EC3 and EC4, and comparison with BS 5950” (P159 1996) both published by The Steel Construction Institute, Lawson R M and Newman G M.

All Eurocodes have National Application Documents. These are “official” national deviations from the published codes. An NAD normally contains small changes to safety factors to bring the Eurocode in line with existing national standards but it can contain more fundamental changes. The NAD for ENV1993-1-2 is expected to allow fire protection materials to be specified using the earlier edition of this publication. By implication, this edition would also be acceptable.

For the purpose of assessing the thickness of fire protection materials, a detailed knowledge of these codes is not required but the basic concepts are now explained.

2.1 Strength of steel at elevated temperature

As steel is heated it will gain strength up to a temperature of about 200°C and then, on further heating, lose strength. It melts at about 1600°C. The variation of effective yield strength factor with temperature for the normal structural steels is given in Table 16. The effect of the initial gain in strength is normally ignored. The data is for grades S275 and S355 steels (formerly grades 43 and 50) and is taken from ENV1993-1-2. The values given are extremely close to the equivalent data in BS5950-8. For other grades expert advice should be sought. However, for stainless steel the data may be used as it loses strength more slowly with increasing temperature.

In all design there is a built in factor of safety, based on strength, of at least 1.5 and for various reasons designers may chose to use a higher factor. In fire, it is permissible to reduce this factor to one, or less, and thus, a steel element (beam or column) will be able to resist the applied loads at temperatures in excess of

Table 16 Variation of the effective yield strength factor of normal structural steels with temperature

Temperature (°C)	20	100	200	300	400	500	600	700	800
Effective yield strength factor	1.00	1.00	1.00	1.00	1.00	0.78	0.47	0.23	0.11

Note: The factors are applied to the “cold” strength of the steel to obtain the elevated temperature strength.
For example, at 600°C the effective yield strength of S275 steel is 0.47 x 275 = 129.3 N/mm^2

500°C. The exact temperature will depend on the type of element and the initial “cold” factor of safety.

2.2 Load ratio

BS5950-8 uses the concept of load ratio as a measure of the applied load that a member can resist at the time of a fire. The Eurocodes use a similar concept of load level. The load ratio is defined as:

$$Load\ ratio = \frac{Load\ or\ moment\ at\ time\ of\ \ fire}{Member\ strength\ at\ 20^{o}C}$$

The load ratio can be seen as the ratio of the factors of safety for fire and normal design. If the factor of safety used for the original, “cold”, design was, say, 1.7 and the factor for fire was 1.0, then the load ratio would be 1/ 1.7, i.e. 0.59. Often, the permitted factor of safety for fire design is less than unity, in which case, the load ratio, in the example, might be less than 0.59. This would arise because BS5950-8 allows the imposed load on floors to be reduced to 80% of the nominal value in many cases and the Eurocodes allow the imposed load to be reduced to 50%. These reductions in loading can be justified using statistical evidence of actual measured imposed floor loading.

The load ratio is a useful concept because it allows different size elements to be considered in the same way.

A 200 mm deep beam will fail at approximately the same temperature as a 400mm deep beam if they are both working at the same load ratio. In practical designs the load ratio will vary from 0.45 to 0.55. Load ratios much higher than 0.6 are very rare although the maximum value could be as high as 0.7 for an element carrying purely the dead weight of the structure!

For a given load or stress level, the maximum permitted temperature is termed the limiting temperature in BS5950-8 and the critical temperature in the Eurocodes. The appraisal of the limiting or critical temperature of any member should be only be carried out by a qualified engineer and will normally be done by the consulting engineer for the job.

For illustrative purposes only, the load ratios and limiting temperatures for columns and laterally restrained

Table 17: Limiting temperature for columns and beams

Description of member	Limiting temperature (°C) for a load ratio of:					
	0.7	0.6	0.5	0.4	0.3	0.2
Typical multistorey building column	510	540	580	615	665	710
Typical multistorey building beam	590	620	650	680	725	780

beams supporting concrete slabs or composite slabs (the most common type in multistorey buildings) are given in Table 17. The data is taken from BS5950-8.

2.3 Composite beams

When a composite beam is constructed using a profiled steel deck, a potential void is created between the deck and the top flange of the beam. With open trapezoidal steel decks this void is comparatively large and could be 180mm wide and 60mm high. With a “closed dovetail” deck the void is much smaller with an opening of between 12 and 15mm. In the case of the open trapezoidal deck the fire resistance of the composite beam may be reduced because of the effects of additional heat entering the steel beam through the top surface of the flange. The effect of filling or not filling voids was investigated by SCI and ASFP and others in a series of fire tests NEWMAN, G.M., LAWSON, R. M. Technical Report: The fire resistance of composite beams Steel Construction Institute, P109, 1991.

Although it is very rare for a steel beam supporting a composite floor slab not to be designed to act compositely with the floor slab, a fire protection contractor will normally not be able to tell whether a beam is composite simply by visual inspection. In a finished beam, the shear connectors will be covered by the floor slab and so the contractor will have to obtain confirmation from an appropriate engineer.

Recommendations were prepared by SCI on when voids could be left unfilled. This was published separately by SCI and ASFP. The guidance was based on the protection thickness for the beam being taken from the previous edition of this publication (2nd edition, revised) and was based on limiting temperatures of either 550°C or 620°C.

When the void above a composite beam is left unfilled two effects occur. Firstly, the rate at which heat enters the section is increased. The temperatures of all parts of the section are increased, although the increase on the bottom flange is small. Secondly, the increased temperatures cause the section to lose strength at a faster rate. These two effects can both be expressed in terms of a temperature increase compared to a protected beam with “filled voids” carrying the same loading. For 60 minutes fire resistance the effective increase is approximately 70°C and for 90 minutes 90°C. These increases should be subtracted from the temperature, based on load carrying capacity, in assessing the fire protection requirements. Thus, if based on BS5950-8 the limiting temperature is 630°C, a beam with unfilled voids should be considered to be at 560°C for 60 minutes or 540°C for 90 minutes fire resistance. This analysis has been carried out for beams with a high degree of shear connection and is conservative for beams designed with a low degree of shear connection.

The temperature modifications are appropriate to both passive and reactive fire protection.

The existing guidance states that if the fire protection is based on a steel temperature of 550°C (for 60 minutes) then no increase in fire protection thickness is required. A beam with unfilled voids will actually be at a temperature of 550°C plus 70°C, i.e. 620°C. From BS5950-8, the load ratio at 620°C is 0.6. For buildings with largely non-permanent loading (See 1.5) this level of loading is almost never exceeded so, no increase in fire protection is required.

Voids may only be left unfilled on beams that do not form part of a compartment wall otherwise the integrity of the wall will be breached.

For decks running parallel to beams no special recommendations are made for spray applied materials but, for board protection, the boards should be taken past the edge of the flange to abut the underside of the deck.

When filling voids above beams protected with a passive fire protection material it is not necessary to use the same material to fill the voids as was used to protect the beam. Any noncombustible material may be used. If, in Table 18 or 19, "fill voids" is specified and an intumescent coating is being used then it may be interpreted that the upper surface of the top flange should have the same coating thickness as the other parts of the beam. The physical filling of the void is not necessary.

If the protection to a beam is not based on any structural fire engineering analysis then the recommendations for when voids may be left unfilled are given in Table 18. This applies to thicknesses specified using section 1

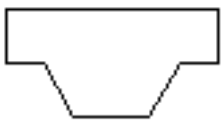
Table 18: Recommendations for beams assessed at 550°C or 620°C (using section 1 of this publication)

Trapezoidal deck				
Beam type	Fire protection on beam	Fire resistance (minutes)		
		Up to 60	90	Over 90
Composite	Materials assessed at 550°C	No increase in thickness	Increase thickness by 10 % or assess thickness using A/V increased by 15%*	Fill voids
	Materials assessed at 620°C	Increase thickness by 20 % or assess thickness using A/V increased by 30%*	Increase thickness by 30 % or assess thickness using A/V increased by 50%*	Fill voids
Non-composite	All types	Fill voids		
* The least onerous option may be used				
Dovetail decks				
Beam type	Fire protection on beam	Up to 60	90	Over 90
Any	All types	Voids may be left unfilled for all periods of fire resistance		

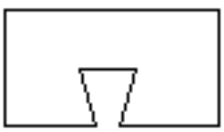
of this publication. If the design specifies a limiting temperature the temperature modifications should be taken from Table 19. This applies to thicknesses specified using section 3 or 4 of this publication.

Table 19: Temperature modifications for beams with specified limiting temperature

Trapezoidal deck				
Beam type	Temperature reductions for fire resistance (minutes) of			
	30	60	90	Over 90
Composite	50°C	70°C	90°C	Fill voids
Non-composite	Fill voids			
Dovetail decks				
Beam type	30	60	90	Over 90
Any	No temperature modifications are required			



Trapezoidal Deck



Dovetail Deck

3 U.K. TEST & ASSESSMENT PROCEDURES

Methods of assessing the performance of fire protection materials have been developed in the UK which enable the thickness of protection for a wide range of situations to be predicted. The assessment procedures were developed by the ASFP in conjunction with:

Building Research Establishment Fire Research Station
London Scientific Services
Loss Prevention Council and
Warrington Fire Research Centre

in consultation with Industry, with a view to:

1. Making assessments more consistent from different sources.
2. Establishing more consistent acceptance criteria.
3. Providing guidance to manufacturers on testing requirements.
4. Providing practical guidance for evaluation of constructions which are untestable.
5. Consolidating available information on the performance of fire protection materials.

Separate procedures are given for intumescent coatings and passive materials in recognition of the technical differences and physical performance characteristics of these materials.

Guidance on the test and assessment procedures of European Standard ENV 13381-4 is given in Section 4.

3.1 General guidelines for fire protection materials

The appropriate procedures detailed in this document have resulted from discussions of the ASFP Technical Committee. These procedures are based on the best available knowledge at the time of writing and are considered to provide a reliable means of evaluating the performance of fire protection materials and coatings in terms of BS476-21. The assessment procedures use data generated either from tests on loaded beams and columns to BS476-21, in conjunction with tests on unloaded beams and columns exposed to the heating conditions specified in BS476-20, or from tests on loaded beams and unloaded beams and columns to ENV 13381-4, in conjunction with tests on loaded columns to BS476-21. However, many factors can affect the performance of fire protection materials and coatings under test conditions and some minor variation between the performance in tests and that predicted by these assessment methods may occur.

The scope of a product assessment need not cover all the shapes and orientations detailed in this document. Where a product is intended to be used only on beams or only on columns an assessment can be carried out, but at least two loaded tests on beams or columns respectively would be required to investigate both maximum and minimum thicknesses for the required fire resistance periods. In addition, some unloaded sections would be required. The programme of tests need not be restricted to one steelwork shape, but additional loaded tests may then be necessary.

Similarly an assessment need not cover all the steelwork shapes. An assessment can be restricted to one or more shapes alone, e.g."I" sections only, but at least three loaded tests plus unloaded sections would be required to cover both orientations and a range of thicknesses.

3.2 Test programmes and test procedures

The assessments will be primarily based on test information from UKAS(NAMAS) approved laboratories. Appropriate data from other independently validated sources may be used to supplement the assessment but will not be used as the main basis of the evaluation.

Where BS476-21 or ENV 13381-4 does not provide full details of test procedures, it is recommended that the resolutions of the Fire Test Study Group and the scheme described in section 3.2.2 and 3.2.4 "Test Procedures" below, should be followed.

The potential fissuring, cracking or detachment of a fire protection material or coating may only become apparent during full scale loaded fire resistance tests. The loaded tests are therefore designed to provide information regarding the physical/mechanical performance of fire protection under the following conditions:

1. Vertical and horizontal orientations (columns and beams) as appropriate.
2. Maximum and minimum protection thicknesses.
3. Maximum and minimum fire resistance periods under consideration.

To demonstrate the retention of the fire protection material, loaded beam tests should be continued until the deflection at mid-span reaches a minimum value of span/35. Loaded column tests should be continued until structural failure is imminent.

3.2.1 Test programme (passive protection materials)

For a passive fire protection material being evaluated to BS476-21, a typical exploratory testing programme would include the following combinations of steel sizes and orientations over the range of manufactured/applied thicknesses.

Table 20

	A/V Profile Protection	A/V Box Protection	Thickness Factor K
Loaded steel I section beams			
305 x 127mm x 42kg/m	180	140	1.0
305 x 127mm x 42kg/m	180	140	0.0
Loaded steel I section column			
203 x 203mm x 52kg/m	180	125	1.0
1m long unloaded specimens			
Beams			
305 x 102mm x 25kg/m	285	225	0.2
305 x 102mm x 25kg/m	285	225	0.8
254 x 146mm x 31kg/m	230	160	0.5
254 x 146mm x 43kg/m	170	120	0.4
356 x 171mm x 67kg/m	140	105	0.5
356 x 171mm x 67kg/m	140	105	0.8
Columns			
203 x 203mm x 52kg/m	180	125	1.0
254 x 254mm x 89kg/m	130	90	0.2
152 x 152mm x 30kg/m	235	160	0.0
254 x 254mm x 132kg/m	90	65	0.3

K = thickness factor = $(d_p - d_{pmin}) / (d_{pmax} - d_{pmin})$, where

d_{pmax} = maximum thickness to be assessed (mm)

d_{pmin} = minimum thickness to be assessed (mm)

d_p = average thickness of fire protection material applied (mm)

If reinforcement is used over part of the thickness range additional loaded tests will be required.

Details of the programme of sections to be tested for the European Standard are given in ENV 13381-4. The data from the fire tests is used for the UK assessment procedures without the inclusion of any of the correction factors described in the European Standard.

3.2.2 Test procedure (passive protection materials)

These procedures are additional to, or highlight those, specified in BS476-21 or ENV 13381-4.

1. The materials and standards of workmanship of the test specimens shall be representative of good site practice. The applied thickness of protection should generally be maintained within 15% of the mean applied thickness.
2. Test specimens shall be conditioned in such a manner that they correspond as closely as possible, in temperature, moisture content and state of cure to the expected state of a similar element in service.
3. When possible the moisture content or state of cure should be measured immediately prior to test.
4. Loaded specimens should comply with the dimensional requirements of BS476-21 or ENV 13381-4 and non-loaded specimens used to provide temperature data should have a length of at least 1 metre.
5. To provide maximum information tests should ideally be continued until all steel sections have reached a mean temperature of 700°C (or other maximum assessment temperature required by the sponsor) or until the insulation system has suffered a significant detachment from the steel section.
6. If loadbearing capacity failure of a loaded beam occurs (or for columns is imminent) the load should be removed and the test continued until the conditions given in (5) are achieved.

7. The mean steel temperature shall be calculated at intervals not exceeding 2 minutes. The mean steel temperatures are defined as follows:

   i) I-section beams with three sided exposure:
   (mean temperature of lower flange + mean web temperature)/2

   ii) I-section columns with four sided exposure:
   (mean temperature of both flanges + mean web temperature)/2

   iii) RHS beams with three sided exposure:
   mean temperature of the three exposed faces

   iv) RHS/CHS columns with four sided exposure:
   mean temperature of thermocouples on all faces of column

8. The load applied to loaded specimens shall either be equal to the maximum permissible load calculated in accordance with BS449-2 (including amendments 1 to 7 but excluding subsequent amendments) or comply with the requirements of ENV 13381-4.

9. Mineral or ceramic fibre insulation should be provided between the top flange of all unloaded beam sections and the concrete cover slabs.

10. Loaded beams shall be tested with their ends simply supported.
    Columns should be axially loaded with their ends fixed (i.e. restrained in direction and against rotation).

In certain cases it may not be practical to comply with all the above requirements. In such cases all variations should be agreed with the assessor and the reasons for, and details of the variation, will be included in the assessment report.

3.2.3 Test programme (intumescent coatings)

There is no fixed programme of tests specified for intumescent coatings in terms of BS476-21, as each fire protection material will have a different performance and target market. (See ENV 13381-4 for the programme of tests to the European Standard). However, to maintain a consistency of approach and to enable the test laboratories to maintain a stock of appropriate test specimens, the following steel sections are suggested for the development of a test programme.

"I" Sections	**Rectangular Hollow Sections**
305 x 102mm x 25kg/m	80 x 80 x 3.6mm
254 x 146mm x 31kg/m	120 x 60 x 3.6mm
356 x 171mm x 67kg/m	150 x 150 x 5.0mm
203 x 203mm x 52kg/m	200 x 200 x 6.3mm
254 x 254mm x 89kg/m	150 x 100 x 8.0mm
254 x 254mm x132kg/m	300 x 200 x 8.0mm
406 x 178mm x 60kg/m	140 x 140 x 5.0mm
305 x 127mm x 42kg/m	250 x 250 x 12.5mm
254 x 146mm x 43kg/m	100 x 100 x 5.0mm
152 x 152mm x 30kg/m	300 x 300 x 12.5mm
610 x 305mm x 238kg/m	

The scope of the assessment will depend upon the nature of tests carried out and the performance of the material in those tests.

For a system which is to be used over a range of thicknesses, steel shapes and critical steel temperatures the following loaded tests are considered appropriate. Thicknesses refer to dry film thickness (see section 3.4.2, Item 4).

For approval of "I" Sections

406 x 178mm x 60kg/m Beam	Maximum thickness
203 x 203mm x 52kg/m Column	Maximum thickness

For approval of Rectangular Hollow Sections

200 x 200 x 6.3mm Column	Maximum thickness
300 x 200 x 6.3mm Beam	Maximum thickness

Plus at least one of any of the above at minimum thickness.
If reinforcement is used over part of the thickness range additional loaded tests will be required.

A test programme for unloaded sections is required to explore the relationship between fire resistance, dry film thickness and section factor. A typical programme will include at least ten sections where a range of dry film thicknesses is required. The sections are generally selected from the list given above.

To establish the performance of a material on deep web sections a deep web unloaded beam section (e.g. 610mm x 305mm x 238kg/m) should be included in the test package.

The I-Sections and RHS-sections shape groups are treated separately for the purposes of assessments. Assessments for circular sections may normally be based on tests on square sections. Alternatively tests on circular sections may be evaluated separately.

3.2.4 Test procedure (intumescent coatings)

These procedures are additional to or highlight those specified in BS476-21 or ENV 13381-4.

1. The materials and standards of workmanship of the test specimens shall be representative of good site practice. For test purposes the coating should be applied such that the standard deviation of dry film thickness about the mean is not more than 15%. Assuming that the readings are normally distributed this implies that:

   a) 68% of readings are within 15% of mean
   b) 95% of readings are within 30% of mean
   c) 99% of readings are within 45% of mean

2. Test specimens shall be conditioned in such a manner that they correspond as closely as possible, in temperature, solvent content and state of cure to the expected state of a similar element in service.

Items 3 to 10 of section 3.2.2 also apply.

3.3 Assessment of performance of passive protection materials

3.3.1 Basis of Assessment

The aspects considered in the assessment of test data are:

Section Factor (A/V)
Shape of section (e.g. I-section, rectangular hollow section)
Size of section
Fire resistance period
Temperatures attained by steel sections
Critical temperature
Orientation of section
Thickness and density of applied protection
Surface preparation of steel
Reinforcement (if any)
Primer compatibility
Fixing and support detail
Physical performance and retention of protection material
Overcoating

The thickness of material required to provide specific standards of fire resistance, at a given critical temperature for the steel, is derived by means of an empirical relationship.

Fire resistance time, in minutes, $t = a_o + a_1 d_p V/A + a_2 d_p$

Where a_o, a_1, a_2 = constants applicable to the material, d_p = thickness of fire protection material (mm) and A/V = Section Factor (m^{-1}).

The values of the constants a_o, a_1 and a_2 are determined by means of multiple linear regression using information from the unloaded sections only as input data. These data may be from tests to either BS476-21 or ENV 13381-4. For the purposes of analysis, the fire resistance time is taken as the time for the steel sections to achieve the given critical temperature.

The analysis may be repeated at other critical temperatures. The range of critical temperatures agreed for this publication is 350°C to 700°C, usually in 50°C steps.

With many fire protection materials it is possible to achieve a coefficient of determination (r^2) in excess of 0.95, which indicates a high level of agreement between test and predicted data.

If the coefficient of determination is found to be less than 0.95, further investigations must be carried out to

determine the reasons for the discrepancy and an appropriate safety factor may be included in the analysis to compensate for the variation.

By re-arranging the equation and substituting values of a_o a_1 a_2 derived from the regression analysis it is possible to derive protection thicknesses for given values of A/V and derive tables of the form presented in the Data Sheets (Section 6).

$$d_p = \frac{t - a_o}{(a_1 \, V/A + a_2)}$$

The tests on the loaded sections are carried out with the loads on the specimen calculated to give a critical temperature of 550°C for columns and 620°C for beams. If the results of the loaded tests are worse than those of the short sections at the same critical temperature or if the mean temperature of the loaded section at failure is less than 550°C (columns) or 620°C (beams) then further investigations must be carried out to determine the reasons for the discrepancy and an appropriate safety factor may be included in the analysis to compensate for the variation.

A coefficient of determination less than 0.9 indicates an inadequate correlation which could arise because:

(i) the standard equation is unsuitable for the specific product (e.g. due to a high combined moisture level).

(ii) the test data are unreliable due to excessive density variation, loss of material during test, etc.

In either case the assessing body should seek to establish the reason for the variation.

In the case of (i) an appropriate assessment technique should be adopted. The basis for the justification of the alternative technique should be documented in detail in the assessment report. In the case of (ii) the data should be rejected and further tests carried out or suitable safety factors included in the analysis.

3.3.2 Assessment procedures

The following general conditions are applied to the assessment of passive fire protection materials.

1. Assessments are only made regarding the performance of horizontal elements if the loaded beam test with maximum thickness in accordance with BS476-21 or ENV 13381-4 has achieved the maximum fire resistance under consideration. If this criterion is not met (e.g. a beam fails at 210min rather than 240min or more) the result may still be acceptable provided that the load is removed after a deflection of at least span/35 has occurred and the test is run-on until the full period is completed. The material should remain intact during this over-run period for the extrapolation to be considered.
2. Assessments are only made regarding the performance of vertical elements if a loaded column has been tested and meets requirements similar to those noted for steel beams under (1).
3. The average thickness of material applied to a test specimen is used in the analysis. The predicted thicknesses are always considered as the minimum required for on-site application.
4. Assessments only apply to the specific formulation tested.
5. In certain cases the standard method of assessment may not be appropriate (e.g. for materials containing significant quantities of combined water) and alternative or modified methods of analysis are not precluded; however, any alternative approach must be fully documented and justified in the assessment report.
6. The acceptable range of thicknesses is related to the maximum and minimum thicknesses tested on loaded sections. The extrapolation of maximum thickness will normally only be acceptable by up to 10% of the maximum thickness tested. The extrapolation of minimum thickness will normally only be acceptable by up to 10% of the minimum thickness tested.
7. The assessments derived from the procedures detailed in this document may be applied directly to steel sections having the following properties:

   Re-entrant profile

   Profiles that are not re-entrant provided that the fixing of the protection system is equivalent to that tested

   Depth not exceeding 686mm

   Width not exceeding 325mm

   Where any of the above criteria are not met additional assessment and/or test work will be required to

ensure that the fire protection material will be retained in position under fire conditions.

8. In the computation of required spray material thickness for presentation in the product data sheet the calculated value shall be rounded as in the following example:

   15.1 or above becomes 16mm
   15.09mm becomes 15mm.

9. In the computation of the maximum Section Factor (A/V) for a stated board thickness for presentation in the product data sheet the calculated value shall be rounded down to the nearest whole number.

3.4 Assessment of performance of intumescent coatings

3.4.1 Basis of Assessment

The aspects considered in the assessment of test data are:

Section Factor (A/V)
Shape of section (e.g. I-section, rectangular hollow section)
Size of section
Fire resistance period
Temperatures attained by steel sections
Critical temperature
Orientation of section
Thickness and density of applied protection
Surface preparation of steel
Reinforcement (if any)
Primer compatibility
Manner of application (brush/spray)
Effects of overcoating
Number of coats
Physical performance and retention of protection material

3.4.2 Assessment procedures

The following general conditions are applied to the assessment of intumescent fire protection materials.

1. Assessments will only be made regarding the performance of horizontal elements if a loaded beam test in accordance with BS476-21 or ENV 13381-4 has been successfully completed. In this context successfully means that the specimen tested has achieved the specified standard of fire resistance, in terms of BS476-21 or ENV 13381-4, under consideration (e.g. 30min or 60min).

2. Assessments will only be made regarding the performance of vertical elements if a loaded column test in accordance with BS476-21 has been successfully completed, as for steel beams (under 1).

3. If, during a loaded test, loadbearing capacity failure of the specimen occurs before the appropriate fire resistance period is achieved, (i.e. 115min rather than 120min or more) the result may still be acceptable provided that, for beams, the load is removed after a deflection of at least span/35 has occurred or, for columns, the load is removed when structural failure is imminent and the test is run-on until the full period is completed. The material should remain intact during this over-run period for the extrapolation to be considered.

4. The average total dry film thickness (dft) will be used as a basis for assessments. The assessment should take account of the individual dft's of primer, intumescent and top coats. If the criteria specified in section 3.2.4, (1) are not met the thickness distribution should be considered in detail by the assessor and where appropriate safety factors introduced into the assessment to take account of the variability.

5. Assessments only apply to the specific formulations tested.

6. The acceptable range of thicknesses is related to the maximum and minimum thicknesses tested on loaded sections. The extrapolation of maximum thickness will normally only be acceptable by up to 10% of the maximum thickness tested. The extrapolation of minimum thickness will normally only be

acceptable by up to 10% of the minimum thickness tested.

7. For assessment purposes steel section shapes will be divided into the following groups:

   I section (or other section shape providing a re-entrant profile).
   a) Horizontal
   b) Vertical
   Square/rectangular section
   a) Horizontal
   b) Vertical

8. Each of the shape groups detailed in (7), is treated separately for the purposes of assessments. Assessments for circular sections may normally be based on tests on square sections. Alternatively test on circular sections may be evaluated separately.

9. To establish the performance of a material on deep web sections a deep web unloaded beam section should be included in the test package. Where this information is not available the following constraints shall apply based on the size of loaded beam tested.

Beam size tested	Maximum web/flange size for assessment purposes
305 x 127mm x 42kg/m	457mm/210mm
406 x 178mm x 60kg/m	686mm/305mm

10. When considering the performance of elements fully loaded in accordance with BS449-2 the following criteria shall apply. The assessment shall be carried out separately for beams and columns. The temperature used for the assessment shall be the lowest temperature at failure of the appropriate beam or column when tested in accordance with BS476-21 or ENV 13381-4 except that this temperature should not exceed 550°C (except for beams with 3 sided exposure and supporting concrete slabs where the temperature should not exceed 620°C). Analyses may be carried out at other critical steel temperatures between 350°C and 700°C provided that the protection system has proved to be effective and intact at those temperatures, fire resistance periods and Section Factors.

11. The use of the regression analysis, which has been successfully used for passive materials, is usually not applicable to intumescent coatings. Where the regression technique is not applicable the analysis of data will be carried out on the basis of linear interpolation between data points using a plot of V/A versus fire resistance.

12. Situations may arise where certain of the above principles are not appropriate to a particular assessment. In such circumstances the reason for the variation and the justification for the alternative approach must be clearly detailed in the assessment report.

3.5 Assessment report

Following the completion of the appropriate test and assessment package a fully documented report should be prepared by the assessor for consideration by the ASFP Technical Review Panel. The assessment report will fully detail the scope of approval, basis of the assessment and justification for any deviations from the procedures detailed in this document. All test data used in the preparation of the assessment should be fully referenced by test number, test standard and type of test (beam/column, loaded/unloaded, full scale/small scale, etc).

The format of the report should provide the following minimum details:

1. Fire protection material - Brief description of generic types.
2. Test specimens - Number of specimens and sizes used in the analyses.
3. Limits of acceptability - Details of any constraints.
4. Predictive analyses at each critical temperature with summary of test results and summary of analysis data.
5. Predicted thicknesses for various Section Factors and critical temperatures.
6. Data sheets (details as Section 6).
7. The test reports used for the assessment should be appended to the assessment report.
8. Physical performance and retention of material.

3.6 Performance of steel encased passive protection systems

To assess the performance of a steel encased protection system, a fire resistance test should be performed for the maximum fire resistance period on a fully loaded specimen in the orientation in which the system is to be assessed.

The fire resistance test shall be performed on the steel encased protection system incorporating the board to be used in practice.

The performance of the structural member fitted with the steel encased protection system in the test shall be compared with the value(s) taken from the appropriate data sheet(s) at the required critical steel temperature(s) derived from tests of the structural member protected with the same material but without the steel encasement.

If the fire performance achieved by the steel encased specimen is greater than, or equal to the fire performance of the specimen without the steel encasement, the data sheets for the protection material without the encasement can be used for the steel encased protection system without correction. The same test data may be used to show the suitability of other protection materials of similar type.

If the fire performance achieved at the required critical steel temperature is less than the value expected from test data for the protection system without the steel encasement the data sheet for the encased system shall be modified by the use of a correction factor to bring the two sets of information into agreement.

4. TEST AND ASSESSMENT METHODS TO THE EUROPEAN STANDARD ENV 13381-4

4.1 Introduction

The European standard adopts a slightly different approach to the assessment of fire protection to structural steelwork when compared to that currently used in the UK. Therefore it may be helpful to consider briefly the basic philosophies of the two approaches before discussing in detail the requirements of the European standard.

The UK approach in earlier publications of this document considered the ability of the protection material to maintain the steel temperature below that at which structural failure occurs under the maximum permissible design loading. Consequently the appraisal of the fire resistance of protected steel is usually confined to this critical temperature. The testing programme and assessment procedures are designed to utilise the critical temperature obtained from tests on fully loaded steel members. The critical temperature may be different for columns and beams and therefore two design temperatures may be used in the assessment.

It is well documented that the ability of structural steel components to support load varies with temperature, consequently the individual components of the steel frame of a building can be designed such that they are able to support the applied load at temperatures other than that related to the maximum permissible loading.

Increasingly, buildings constructed using structural steel, particularly complex ones, are being designed using fire engineering principles which provide for protection thicknesses which are related to the loadbearing capability of the steel member insitu. For further information see Sections 2.1 & 2.2.

The European approach given in the ENV allows for a wider range of steel design temperatures (generally 350ºC to 700ºC) to be used, consequently the thickness of applied fire protection may be varied in accordance with the load carried by the individual steel member.

The European document is in two main parts. The ‘Fire Test’ which specifies the tests required to provide information about the physical and thermal performance of the protection material and the ‘Assessment’ which prescribes how the data from the fire test is analysed.

4.2 General

The standard is designed to cover a range of thicknesses of applied protection material, a range of steel sizes, a range of design temperatures and a range of fire protection periods. The evaluation consists of a test and a subsequent assessment protocol based on the data obtained from the tested sections. There are three basic assessment protocols which initially refer to I-shaped or H-shaped sections. Other shaped sections, e.g. hollow sections, are dealt with by modifying the I or H section data or including additional test specimens.

The test specifies the test specimens appropriate to the assessment method and determines the ability of the fire protection material to remain coherent and fixed to the steelwork (stickability) and provides data on the thermal characteristics of the material.

The test is carried out on loaded sections and unloaded short sections and may include a 2m tall column if the protective system is reactive e.g. an intumescent product.

The loaded beam sections are subjected to a total load which represents 60% of the design moment resistance according to ENV 1993-1-1, calculated using the nominal steel strength and the recommended values given in ENV 1993-1-1.

The loaded column sections are subjected to an axially applied load which represents 60% of the design buckling resistance according to ENV 1993-1-1, calculated using the nominal steel strength and the recommended values given in ENV 1993-1-1.

The test loading required by the standard is largely similar to that adopted for tests to BS476-21.

The assessment procedure is used to establish:

(a) a correction factor for the physical performance (stickability) of the material based on the temperature data derived from the testing of loaded and unloaded sections.

(b) the thermal properties of the material derived from the testing of short steel columns.

The standard defines criteria for acceptability which must be met for the assessment to be valid. It also defines the limitations of the assessment and the permitted direct application of the results to variations in the tested system e.g. different shaped sections.

A number of methods of analysing the test data are defined since there is unlikely to be a single method which is suitable for all protection materials. The methods are listed as follows:

(a) Differential equation based on thermal conductivity (variable and constant)

(b) Multiple linear regression

(c) Graphical

The first analysis of the data is normally on the basis of either differential equation or numerical regression methods.

Also defined is an evaluation of reactive systems against a slow heating regime which may be required in some areas of Europe such as Germany.

4.3 Testing Protocol

The selection of the number and section size (section factor A/V) of the test specimens is decided based upon the assessment method which largely relates to whether the protection is a passive material or a reactive one. Generally, the standard adopts the principle that passive materials are likely to be more predictable than reactive systems. Consequently, a lower number of test specimens will be needed to satisfy the criteria of acceptability of the standard.

The methods associated with physical principles (thermal conductivity) and statistical analysis (multiple linear regression) generally require less specimens than the graphical approach.

The assessment can be limited to 3 and 4 sided protection (beams and columns) or 4 sided protection (columns only) at the request of the test sponsor.

Table 21

Specimen	Loading	Equivalent Section Size mm x mm x kg/m	Section Factor A/V Profiled	Section Factor A/V Boxed	Thickness
Beam	loaded	406 x 178 x 67	155	115	min
Beam	unloaded	406 x 178 x 67	155	115	min
Beam	loaded	406 x 178 x 67	155	115	max
Beam	unloaded	406 x 178 x 67	155	115	max
Column	loaded or unloaded	305 x 305 x 97	145	100	max

Typically the sections listed in Table 21 are to be tested in order to establish the physical properties of the material (stickability):

The section sizes shown in Table 21 are the nearest UK equivalent of the sections listed in the European document.

The unloaded sections are 1000 $\pm$ 50mm in length. The loaded beams have a heated length of not less than 4000mm *;* they also contain web stiffening at supports and loading points.

A tall column (305mm x 305mm x 97kg/m) with maximum thickness is also required for reactive systems.

For a separate assessment for columns only (4 sided protection) the above tall column and loaded beams may be substituted by two tests on loaded columns (maximum and minimum thickness).

The standard selection of short columns for the differential equation or the regression analysis methods (generally passive protection materials although they may be suitable for reactive systems if additional specimens are included) is based on a minimum of 10 specimens and that for the graphical method (generally thin film reactive systems) is 18 specimens. The test protocol specifies the particular section size and thickness of material to be tested.

Additional specimens may be needed to provide additional data points and the standard test packages may be varied if the thickness of the protection is provided in a number of discrete thicknesses

4.4 Test Conditions

The furnace pressure and heating conditions are specified in EN 1363-1 and are similar to those given in BS476-20. The temperature of the furnace is controlled using plate thermometers rather than the thermocouples specified by the British standard. A description of the plate thermometer is given in Section 1.3.2.

When loaded beams are tested with short columns, plate thermometers located in the vicinity of the short columns are used to control the furnace rather than those in the region of the loaded beam.

4.5 Properties of Test Component Materials

The properties of the test specimens, including steel section size, protection material thickness and distribution and, where appropriate, the density of the material, are required to be measured for each specimen. The measured properties are required to satisfy certain rules in order for the temperature data from the specimens to be acceptable for the analysis.

4.6 Validity of the Temperature Data

The standard requires certain rules to be followed in order for the temperature data from the sections to be considered valid for the analysis. These rules take into account malfunction of thermocouples and could lead to the rejection of all the data obtained on a particular section. However, the standard requires a high number of thermocouples on each section which makes the complete rejection of data from a section unlikely.

4.7 Correction of Temperature Data

Only temperature data from the short columns is used for the basic analysis and this data must be corrected for stickability and for any difference in protection thickness between the loaded sections and their respective short section. For reactive systems correction is also made against the tall column.

The passive and reactive systems are treated slightly differently in respect of data correction, which also relates to the method of analysis adopted.

In all cases the correction factors are calculated on the basis of steel temperature.

It should be noted that the correction factors are based on the characteristic temperature which is the sum of the mean temperature and the maximum temperature divided by 2.

For the analysis, the mean temperatures of the short steel columns are used.

4.8 Assessment Methods

Assessment of the thermal performance of the protective materials for all methods uses the corrected data for the short columns.

4.8.1 Differential Equation

The two methods using the differential equation are based on a one dimensional heat flow equation and assume the predominant heat flow is conduction through the protection material with the outer face assumed to be at the standard fire temperature. The protection material is described using its thermal conductivity, specific heat and density and the moisture content is also taken into account. The basic equation (Equation 1) is:

$$\Delta\theta = \left[\frac{\lambda_{p,t} / d_p}{C_a \rho_a} \times \frac{A_p}{V} \times \frac{1}{1 + \phi/3} \times (\theta_t - \theta_{a,t}) . \Delta t \right] - \left(e^{\phi/10} - 1\right) . \Delta\theta$$

where $$\phi = \frac{C_p \rho_p}{C_a \rho_a} \times d_p \times \frac{A_p}{V}$$

Where $\Delta\theta$ = incremental increase in steel temperature in time interval Δt (ºC)
$\lambda_{p,t}$ = thermal conductivity of protection material (W/m ºC) at time t (variable)
d_p = thickness of protection material (m)
C_a = specific heat of steel (J/kg ºC)
C_p = specific heat of protection material (J/kg ºC)
ρ_a = density of steel (kg/m^3)

ρ_p = density of protection material (kg/m^3)
A/V = section factor (m^{-1})
θ_t = furnace temperature at time t (ºC)
$\theta_{a,t}$ = steel temperature at time t (ºC)
Δt = time interval (secs)
$\Delta\theta_t$ = increase in the furnace temperature during time interval Δt (ºC)

The differential equation is solved to give thermal conductivity as a function of time. The thermal conductivity is then adjusted until the criteria for acceptability given in the document are just satisfied. The results are presented to give the thickness of protection material required to provide specified fire resistance periods to various section factors for various design temperatures.

4.8.2 Numerical Regression Analysis

The numerical regression analysis is a statistical approach which has time to reach a specified design temperature, steel temperature, section factor and protection thickness as variables.

The multiple linear regression is performed using the following equation (Equation 2):

$$t = a_0 + a_1 d_p + a_2 \frac{d_p}{A/V} + a_3\theta + a_4 d_p\theta + a_5 d_p \frac{\theta}{A/V} + a_6 \frac{\theta}{A/V} + \frac{a_7}{A/V}$$

Where t = time to design steel temperature (mins)
d_p = thickness of protection material (mm)
A/V = section factor (m^{-1})
a_0 - a_7 = regression coefficients
θ = steel temperature (ºC)

Transposition of Equation (2) to determine protection thickness gives (Equation 3):

$$d_p = \frac{t - a_o - a_3\theta - \left(\frac{a_6\theta}{A/V}\right) - \left(\frac{a_7}{A/V}\right)}{a_1 + a_4\theta + \left(\frac{a_2}{A/V}\right) + \left(\frac{a_5\theta}{A/V}\right)}$$

Using the corrected data from the short columns, the regression coefficients are determined and modified if necessary to satisfy the criteria for acceptability. The coefficients are used to predict the thickness of protection material required to provide specified fire resistance periods to various section factors for various design temperatures.

4.8.3 Graphical Approach

At each design temperature the corrected data from each short column is used to provide plots of time to reach the particular design temperature against protection thickness for constant section factors.

From each of these graphs and for each thickness of protection material a second series of graphs are plotted showing the variation in time to reach the design temperature as a function of section factor.

When these graphs are plotted a number of simple rules must be applied. These rules are summarised as follows:

1. The points on the graph are connected by straight lines, i.e. curve fitting is not allowed.
2. The time to the design temperature must also increase as the thickness of material increases.
3. The time to the design temperature must decrease as the section factor increases.

If rules 2 and 3 are not satisfied the relevant point is omitted.

From the second series of graphs the variation in section factor against temperature for each thickness of material and for each specified period of fire resistance is plotted.

4.9 Criteria for Acceptability

For the assessment to be valid, the following criteria for acceptability must be met :

(a) For each short column section the predicted time to reach each design temperature shall not exceed the time for the corrected temperature to reach the design temperature by more than 30%.

(b) The mean value of all percentage differences in time shall be less than zero.

(c) A maximum of 20% of individual values of all percentage differences in time shall be more than zero.

4.10 Direct Application of Results

Permitted extension of the variables evaluated during the test is dependent upon the assessment method adopted and is given in Table 22.

Table 22

Assessment Method	Differential Equation (variable l)	Differential Equation (fixed l)	Numerical Regression	Graphical
Section Factor A/V	-20% to +50%	-20% to +50%	-10% to +10%	0%
Material Thickness	-20% to +20%	-5% to +5%	-5% to +5%	0%
Design Temperature	-0% to +10%	-0% to +7.5%	-0% to +5%	0%

4.11 Presentation of the Results

An example of a method of presenting the results is given in Table 23:

Table 23: Fire Resistance Classification R30 (30 minutes)

Design Temp ºC	350	400	450	500	550	600	650	700	limit
A/V	Thickness of material required in mm								
40									
60									
etc to limit									

The limits on section factor, material thickness and temperature are those determined by Table 22. The section factor interval may be varied as required.

The results may also be presented graphically.

4.12 Applicability of the Results of the Assessment to Other Section Shapes

4.12.1 Structural Hollow Sections - Passive Protection Systems

For boxed protection systems the thickness for circular or rectangular hollow sections is equal to that for the I or H section of the same boxed section factor.

For profiled protection systems the required thickness for circular or rectangular hollow sections is based on the following modification to the equivalent thickness for I or H sections:

(a) For A/V values up to 250 m^{-1} (Equation 4)

$$\text{modified thickness} = \mathbf{d_p}\left(\mathbf{1}+\frac{\mathbf{A/V}}{\mathbf{1000}}\right) \qquad \text{Equation (4)}$$

where d_p = thickness of protection based on I or H section data

A/V = section factor for hollow section

(b) For A/V values higher than 250 m^{-1}

modified thickness = $\mathbf{1.25d_p}$

where d_p = thickness of protection based on I or H section data

The maximum thickness assessed for I or H sections should not be exceeded.

4.12.2 Structural Hollow Sections - Reactive Protection Systems

In order to adapt the data derived from I or H sections to circular or rectangular hollow sections, it is necessary to provide additional test evidence to confirm the stickability of sections which have no re-entrant detail.

The test specimens are tall 2m circular or rectangular columns protected with both minimum and maximum material thickness. For circular sections the nominal size recommended is 76.1mm diameter by 5mm wall thickness (A/V = 214 m^{-1}) and for rectangular sections the nominal size recommended is 100mm by 100mm by 7.1 mm wall thickness (A/V = 147 m^{-1}).

The temperature data obtained from the hollow sections is used to correct the data from the short I or H section columns in a similar manner to that referred to in the main body of this section of the document.

The maximum value of any correction factor should not exceed 1.5. If this value is exceeded the correction of the I or H section data to suit hollow sections is deemed inappropriate and a new testing programme should be undertaken involving hollow sections.

The maximum thickness assessed for I or H sections should not be exceeded unless substantiated by test.

4.12.3 Angles, Channels and T-Sections

The standard does not give specific guidance on the protection to these types of sections but merely refers to obtaining advice from appropriate design codes such as those referred to in Section 1.

In the absence of a definitive European approach to assessing the required protection for these types of sections it is considered reasonable to adopt the assessment method referred to in Section 3.

4.13 Assessment of Existing BS 476 Test Data to ENV 13381- 4

The test protocol and the assessment methodology of ENV 13381-4 differs with respect to the testing procedure of BS476-21 and the current UK assessment techniques in a number of important aspects, the most critical are summarised as follows:

(a) The upper flange of the loaded beam is insulated from the lightweight slab above by an insulating gasket compared with insitu cast high density concrete used for the BS test.

(b) The temperature of the upper flange is measured and used in the calculation of the characteristic temperature. These temperatures may not be available with existing data.

(c) A greater number of thermocouples are fixed to the sections.

(d) The loading is applied to the top of the beam and not via the concrete slab.

(e) The loaded section contains web stiffeners.

(f) The short sections which provide the data for the analysis are columns only whereas existing data is likely to be a mixture of beams and columns which may not be as specified by the test protocol.

(g) The data must be corrected for stickability and if appropriate for discrepancy in thickness. Without identical unloaded reference beams it may not be possible to correct the data as required.

(h) The furnace temperature must be controlled using plate thermometers which were unlikely to be available at the time the existing test data was generated.

Due to differences highlighted above, and different assessment methods, BS476 test data is unlikely to be an acceptable basis for assessing to the requirements of ENV 13381-4.

5. MATERIAL DATA SHEETS AND THEIR APPLICATION

5.1 Structural fire protection using passive materials

5.1.1 Introduction

The data sheets in Section 6 for the various passive fire protection materials describe their characteristics and recommended fixing systems. The data sheets enable the required thickness of fire protection, for any given fire resistance period, critical steel temperature and Section Factor (A/V), to be chosen for any steel section, without recourse to individual assessment.

Values of A/V for various sections for three and four sided protection are tabulated in Section 1, which also shows in Fig. 6 how A/V values may be calculated for any protection configuration and sets out modified procedures which may be required in respect of castellated sections and bracings, etc.

Each product has been the subject of test and has been assessed by one of the methods described in Sections 3 or 4. These are:

a) Tests and assessment based on the traditional UK procedure at steel temperatures of typically 550°C and/or 620°C.

b) Assessment based on the traditional UK procedure but at a range of steel temperatures from 350°C to 700°C. Test data from BS476-21 or ENV 13381-4 (+loaded column if vertical members are to be included).

c) Tests and assessment based on the ENV 13381-4 procedures.

The assessments are based on the critical steel temperatures listed above, stickability and any limitations which must be imposed on the basis of the physical characteristics of the materials.

The assessment methods can be used to derive thicknesses, for any specified critical steel temperature, provided the necessary tests have been programmed correctly.

5.1.2 Notes on the application of the data sheets

In the following any reference made to “the manufacturer” is intended to imply manufacturer, supplier or applicator as appropriate.

1. In respect of fire resistance, A/V and thickness, together with protection details, no deviation can be made except for specific situations where some variation may be necessary. Such variations must be validated by an independent authority, such as the BRE, or an appropriate testing laboratory, or consultants as defined in Appendix A of Approved Document B to the Building Regulations 1991. Ancillary data, contained in items *12 to 16*, are provided by the manufacturer for information and guidance only.

2. The protection techniques referred to as Profile and Box are explained in Section 1 (Figs. 1 and 2).

3. It is emphasised that the selection of the fire protection material should not be based on consideration of fire resistance alone, but should involve other important aspects such as interior or exterior application, impact and abrasion resistance. Guidance on these aspects can be found in the appropriate part of BS8202 “Coatings for fire protection of building elements”.

4. The thicknesses of protection embody safety factors which are incorporated within the EN assessment procedure or which, in the UK assessment procedure, are due to the need to round up the calculated thicknesses of board products to fit the range of thicknesses supplied and, in the case of spray products, converting the calculated average thickness to a minimum on site.

5. Thicknesses of fire protection required for different A/V values, fire resistance periods and critical steel temperatures are given in tabular form. Interpolation is permissible to determine thickness. However, if the A/V of a section coincides with the cut off between two board product thicknesses, the lesser thickness shall be used. In using the data it is imperative that any “constraints for fire resistance” (item *11* in data sheets) are implemented.

6. For the surface preparation of the steel with respect to fire performance, reference should be made to the individual data sheets. Where a direct bond to the steel is required, the normal recommendation is for the steel to be de-greased and loose scale and rust removed. Where a steel primer is specified it should be compatible with the protection and advice should be obtained from the manufacturer of the protection material. For pre-formed casings, or board or spray applied to mesh, no preparation of the steel is required. It does not matter if the steel is primed eg for

corrosion purposes, except in those instances where the protection is bonded to the steel section, when the primer must be compatible with the adhesive used.

7. The thickness of protection to be applied to a section having a calculated A/V less than the minimum A/V given in the data sheets is the thickness required at that minimum value. If the calculated A/V of a section exceeds the maximum figure in the data sheets reference should be made to the manufacturer for an individual assessment by an appropriate authority as defined in (1).

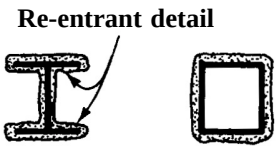
8. For wet applied protection, thicknesses given are minimum on site. The data sheets specify the dry thickness. Where the thickness is found to be less than that specified it may still be acceptable provided that:

   (i) The thickness is not less than 85% of the specified thickness, the deficient area does not exceed $1m^2$ and no other deficient area occurs within 3m of this area; or

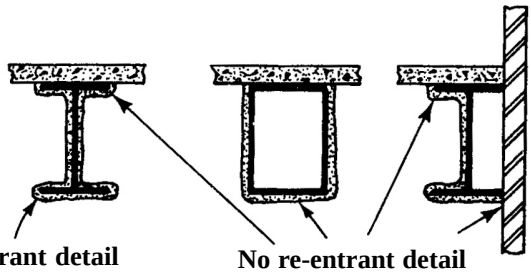
   (ii) The thickness is not less than 75% of the specified thickness, the deficient area does not exceed $0.2m^2$ and no other deficient area occurs within 1m of this area.

9. Some materials undergo dimensional changes after application, and special care should be taken to recognise this factor for site control purposes (see data sheets for information where appropriate).

10. In the case of sprayed/trowelled protection, special consideration may have to be given to the need for reinforcement or modified/additional support if the sections on site do not allow for encapsulation or if there is no re-entrant detail, unless specific tests have been carried out. (See fig. 24)



Examples showing encapsulation



Examples showing no re-entrant detail

Figure 24: Protection Configurations

11. In the case of sprayed or trowelled protection to deep web or wide flange sections, “in-depth” reinforcement in the form of a corrosion protected wire mesh, 25, 38 or 50mm x 0.9mm, should be included where:

    Web depth between flanges exceeds 650mm or flange width exceeds 325mm except where applicable test data is available to show such reinforcement is unnecessary. The mesh should preferably be in the middle third of the thickness and be retained by welded pins and non-return washers at nominal 500mm centres. The use of expanded metal lath as a support medium does not obviate the need for this additional reinforcement.

12. Where expanded steel lathing is used to form a hollow encasement, it should be spaced from any steel surface to allow penetration of the lath by the fire protection material to form a mechanical key. A method for achieving this is to wire 6mm diameter steel rods to the lath prior to fitting.

13. Sprayed mineral materials should comply with BS8202-1 “Code of practice for the selection and installation of sprayed mineral coatings”.

14. The data sheet includes information on the limiting Section Factors (A/V) which can be protected with each system.

5.1.3 Application of data sheets

The following examples demonstrate how the data sheets, tables and constraints should be interpreted and applied for some of the protection systems which may be encountered. (Any similarities between any of the examples and real products are unintentional.)

Example 1

A 406mm x 178mm x 60kg/m universal beam is to be protected on three sides using a spray applied profile protection to provide fire resistance of 120 minutes at a critical steel temperature of 620°C.

(i) Determine the A/V value from tables in Section 1. In this case the A/V value is 175m^{-1} (Table 3).

(ii) Consult the data sheet in Section 6 for the product selected to determine the thickness required. Product "T" was chosen and an extract from its data sheet for a critical steel temperature of 620°C follows:

Extract from datasheet for product "T" critical steel temperature 620°C						
A/V	Thickness in mm to provide fire resistance of (minutes):					
	30	60	90	120	180	240
150	10	12	25	36	57	79
170	10	13	26	38	60	83
190	10	13	27	40	63	87
210	10	14	28	41	65	90

This table indicates that the thickness required for a A/V of 170m^{-1} and fire resistance of 120 minutes would be 38mm, whilst that for a A/V of 190m^{-1} would be 40mm. By linear interpolation the theoretical thickness for a A/V of 175m^{-1} is 38.5mm. This should be rounded up and 39mm would be the minimum on site thickness for the beam in question.

Constraints for fire resistance, item 11 in the data sheet, have next to be considered. They are:

(i) Minimum dry thickness - 10mm

(ii) Maximum dry thickness for 60 minutes fire resistance -19mm

(iii) Maximum dry thickness for 120 minutes fire resistance - 42mm

(iv) Maximum unreinforced thickness for up to and including 240 minutes fire resistance - 70mm

It will thus be seen that 39mm, unreinforced, is acceptable for 120 minutes fire resistance.

Example 2

A universal beam section 762mm x 267mm x 173 kg/m is used as a column and it is required to be protected on four sides using a box encasement to provide fire resistance of 240 minutes at a critical steel temperature of 550°C.

The A/V value from Table 3 in Section 1 is 95m^{-1}. Product "U" was selected and part of the block diagram relating A/V to thickness of protection and fire resistance period at a critical steel temperature of 550°C, given in its data sheet, is presented below as an extract from the data sheet.

Extract from table for "product U"							
Section factor A/V (Hp/A)	Fire resistance period (minutes) 550°C						Product thickness
	30	**60**	**90**	**120**	**180**	**240**	
						89	30mm
						95	36mm
						101	45mm
						110	48mm
						119	54mm

From the table it will be seen that the A/V value coincides with the boundary between 45mm and 36mm. Hence in accordance with Note 5 in 5.1.2 the requirement is 36mm, the lesser protection thickness.

The data sheet must also be consulted to check that 36mm for 240 minutes fire resistance is within the limitations imposed by the constraints and to establish how 36mm can be obtained within the thicknesses available. The following extracts from the data sheet are therefore reproduced:

9. Thickness range

   Nominally 12,15, 18 and 21mm in single layers but may be laminated to produce greater thicknesses.

10. Fire resistance range:

   (i) 30 to 240 minutes
   (ii) A/V: 17-260m^{-1}

11. Constraints for fire resistance

   (i) Minimum thickness - 12mm
   (ii) Maximum single layer thickness - 21mm
   (iii) Maximum multi-layer thickness - 63mm
   (iv) No more than 3 laminates may be used to provide the thickness and the thickest laminate should be on the outside
   (v) Minimum thickness for 180 minutes - 18mm
   (vi) Minimum thickness for 240 minutes - 21mm
   (vii) For 240 minutes fire resistance in laminated panels, the outer layer should not be less than 18mm.

The board thickness information indicates that a laminated system is required and constraint (iv) requires that not more than three laminates may be used. Further, constraints (iv) and (vii) state that the thickest layer should be on the outside and not less than 18mm thick. To make 36mm therefore requires two layers each 18mm thick.

Example 3 - Castellated beam

A 762mm x 267mm x 173kg/m universal beam (as used for Example 2) is the original section from which a 1143mm x 267mm x 173kg/m castellated section is fabricated. Paragraph 1.6.1 of Section 1 recommends that an increase of 20% should be applied to the thickness of protection required for the original section. The thickness of Product “U” (as used for Example 2) to provide 240 minutes fire protection to a castellated section of this size and weight is therefore 36 x 1.2 = 43.2mm which is rounded up to 45mm laminated from a layer each of 12, 15 and 18mm, the 18mm thick layer being on the outside.

Failure Temperatures

For the purpose of consistency in earlier editions of this publication, all assessments of passive fire protection materials were assessed on the basis of a failure temperature of 550°C. A failure temperature of 620°C could however be adopted for passive materials when applied to steel beams supporting a concrete slab provided test data was available to support this critical temperature. Intumescent coatings were generally assessed on the basis of 620°C for beams with concrete slabs over. 550°C has generally been used for columns and other beams.

However, as described in Section 1.5 of Section 1, many structural design codes now include “fire resistant” design, introducing the concept of a variable steel failure or critical temperature. As such, this publication now includes assessments at a range of critical steel temperatures from 350°C to 700°C (usually in 50°C steps) based on either the traditional UK procedure or on the EN procedures.

Manufacturers may utilise data based upon other failure temperatures where this is appropriate to the design of the structure and the data has been assessed by an appropriate independent body.

5.2 Structural fire protection using intumescent coatings

5.2.1 Introduction

The data sheets for the various intumescent coatings describe their characteristics and application techniques to enable the correct thickness of coating for any given fire resistance period to be chosen for any steel section, given its A/V and critical steel temperature, without recourse to individual assessment.

Values of A/V for various sections for three and four sided protection are tabulated in Section 1 which also shows (Fig. 6) how A/V values may be calculated for any protection configuration.

Each product has been the subject of test and has been assessed by one of the methods described in Sections 3 or 4. These are:

a) Tests and assessment based on the traditional UK procedure at steel temperatures of typically 550°C and/or 620°C.

b) Assessment based on the traditional UK procedure but at a range of steel temperatures from 350°C to 700°C. Test data from BS476-21 or ENV 13381-4 plus a loaded column if vertical members are to be included.

c) Tests and assessment based on the ENV 13381-4 procedures.

The assessments are based on the critical steel temperatures listed above, stickability and any limitations which must be imposed on the basis of the physical characteristics of the materials.

The assessment method can be used to derive thicknesses for any specified critical temperature, provided the necessary tests have been programmed correctly.

5.2.2 Notes on the application of the data sheets

In the following any reference made to "the manufacturer" is intended to imply manufacturer, supplier or applicator as appropriate.

1. In respect of fire resistance, A/V and thickness (together with protection details) no deviation can be made except for specific situations where some variation may be necessary. Such variations must be evaluated by an independent authority such as the BRE or an appropriate testing laboratory or consultant, as defined in Appendix A of Approved Document B to the Building Regulations 1991. Ancillary data, contained in items *12 to 16*, are provided by the manufacturer for information and guidance only.
2. The protection techniques referred to as Profile and Box, are explained in Section 1 (Figs. 1 and 2).
3. It is emphasised that the selection of the fire protection material should not be based on consideration of fire resistance alone, but should involve other important aspects such as interior or exterior application, impact and abrasion resistance. Guidance on these aspects of performance is included in BS8202-2 "Code of practice for the use of intumescent coating systems to metallic substrates for providing fire resistance". The specifier should satisfy himself regarding the manufacturer's claims associated with durability.
4. Thicknesses of fire protection required for different A/V values, fire resistance periods and critical steel temperatures are given in tabular form. Interpolation is permissible to determine thickness. In using the data it is imperative that any "constraints for fire resistance" noted in data sheets are implemented.
5. Preparation of steel is given against each product.
6. The thickness of protection to be applied to a section having a calculated A/V less than the minimum A/V given in the data sheets is the thickness required at that minimum value. If the calculated A/V of a section exceeds the maximum figure in the data sheets reference should be made to the manufacturer for an individual assessment by an appropriate authority as defined in (1) which will take into account all aspects of the project.
7. The data sheets specify the dry film thickness.
8. Some materials undergo dimensional changes after application, and special care should be taken to recognise this factor for site control purposes (see data sheets for information where appropriate).
9. The data sheet includes information on the limiting section factors (A/V) which can be protected with each system.
10. Items 1 to 10 on the Intumescent Material(s) data sheets have been checked and verified by the Technical Review Panel. Other items of information have been provided by the actual manufacturer of the material.

Application of data sheets

The following examples demonstrate how the data sheets, tables and constraints should be interpreted and applied for some of the protection systems which may be encountered. Any similarities between any of the examples and real products are unintentional

Example 1

A 406 x 178mm x 60kg/m universal beam is to be protected on three sides using an intumescent coating to provide fire resistance of 30 minutes at a critical steel temperature of 620°C.

1. Determine the A/V value from tables in Section 1, in this case the A/V value is 175m^{-1} (Table 3).
2. Consult the data sheet in Section 6 for the product selected to determine the dry film thickness required for this A/V value along with other constraints on usage and the manufacturer's claims regarding durability. Product "M" was chosen and an extract from its data sheet for a critical steel temperature of 620°C follows:

   > For A/V up to and including 191m^{-1} use 1.8mm dry film thickness to provide 30 minutes fire resistance for flexural members. For A/V up to and including 285m^{-1} use 2.3mm dry film thickness to provide 30 minutes fire resistance for flexural members.

3. The data indicates that the dry film thickness required for an A/V of 175mm^{-1} and fire resistance of 30 minutes would be 1.8mm.

Example 2

A circular hollow section column of external diameter 219.1mm and wall thickness 10mm is to be used as a compression member and to be profile protected using an intumescent coating at a critical steel temperature of 550°C.

1. Determine the A/V value from Table 12 in Section 1. In this case the A/V value is 105m^{-1}.
2. Consult the data sheet in Section 6 for the product selected to determine the dry film thickness for this A/V value along with other constraints on usage and the manufacturer's claims regarding durability. Product "S" was chosen and the following figures were extracted from the data sheet at a critical steel temperature of 550°C as shown:

	60 minutes
Compression CHS	For A/V up to 140m^{-1} use 2.5mm
	For A/V 141 - 200m^{-1} use 4.5mm

3. The table indicates that a minimum dry film thickness of 2.5mm is required for a compression member with an A/V value of 105m^{-1}.

Before the intumescent coating is applied by spray or trowel the steel should be shot blasted and primed. Reference should be made to the manufacturer for advice on suitable primers, and on the durability of the coating if the column is in an external location.

5.3 Fire Protection using Generic Materials

In earlier editions of this publication a section was included on the use of plasterboard as a generic material for the protection of structural steelwork. The fire tests on structural steelwork protected with plasterboard and plaster on which the section was based were carried out to British Standards which have now been withdrawn or to procedures which do not comply with the current test standards. Also many fire resistance tests have been carried out to the current test standards on various types and makes of plasterboard. It was therefore decided that this section is no longer applicable to current test methods and practice and it has been omitted from this edition.

PRODUCT DATA SHEETS

Boards

Casings

Intumescents

Spray Coatings

CAFCO® BOARD

1. Product description

Resin bonded rock fibre semi-rigid insulation board

2. Manufacturer

Cafco International
Bluebell Close, Clover Nook Industrial Park, Alfreton, Derbyshire DE55 4RA
T: 01773 837900 F: 01773 836710 W: www.cafcointl.com

3. Availability

Contact manufacturer for information and names and addresses of applicators

4. Protection technique

Box

5. Application technique

Cafclip® method:
Locate Cafclips at 750mm centres. Web and flange boards impaled on Cafclips and secured with non return washers. Web and flange board overlap connected with spiral screws at 250mm centres. Web and flange board butt joints can be secured with or without Quickset adhesive.
Nogging method:
Noggings made of cover board thickness (min 30mm) 100mm wide located at 1.2m centres are glued to steel. Web cover board glued or screwed to noggings. Flange board glued or screwed to web board overlap. Board butt joints glued.
Pin Fix:
Stud weld pins at 750mm centres. Secure board over pins with non return washers. Screw or glue web board overlap to flange board. Glue web and flange butt joint.

6. Site preparation

Remove oil, grease, loose or foreign matter at contact point with adhesive or pins.

7. Additional mechanical fixing

For steel over 500mm deep, use T shaped or solid noggings

8. Nominal density

155 kg/m³

9. Thickness range

20 - 110mm

10. Fire resistance range

(a) Up to 4 hours
(b) Hp/A 20 - 260m^{-1}

11. Constraints for fire resistance

Minimum thickness - 20mm
Maximum thickness per single layer - 110mm

12. Appearance

Two finishes are available
(a) Plain - light green textured one side with white glass scrim
(b) Foil faced - bright aluminium skin

13. On site use

For internal and protected external applications

14. Durability

Moisture resistant. Resistant to vermin

15. Performance in other BS and EN fire tests

Non-combustible in accordance with BS476-4, so complies with Class 0 and is a Material of Limited Combustibility as defined in the Building Regulations 1991

16. Other applications

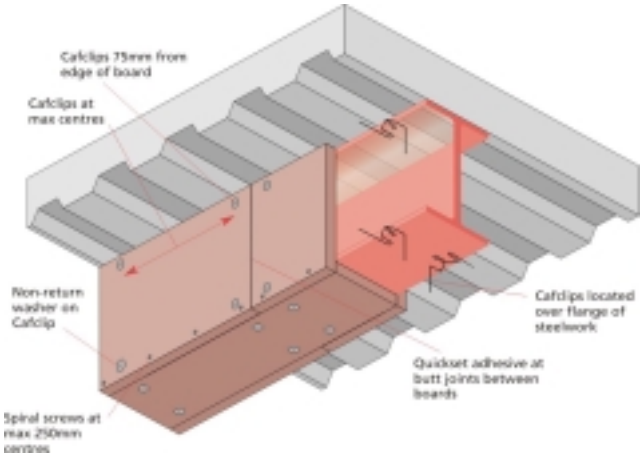
(a) Condensation control
(b) Sound insulation
(c) Thermal insulation
(d) Marine fire protection
(e) Ductwork

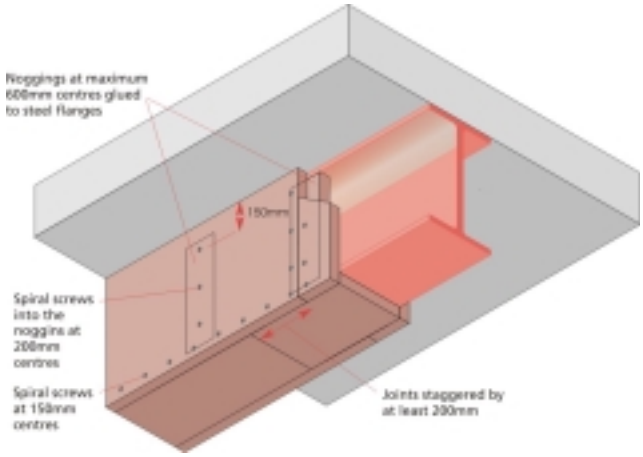
BEAMS

Section factor A/V (Hp/A)	Fire resistance period (minutes)														Product thickness
	Cafclip partial adhesive fixing system or Noggings and screw fixing system				Cafclip glueless fixing system or Stud welded pins and screw fixing system				Stud welded pins and adhesive fixing system or Noggings and adhesive fixing system						
	30	**60**	**90**	**120**	**30**	**60**	**90**	**120**	**30**	**60**	**90**	**120**	**180**	**240**	
	260	260	133	73	260	182	74	46	260	260	133	74	39		20mm
			176	95		245	95	59			173	95	50	34	25mm
			223	117		260	117	72			223	117	60	41	30mm
			260	141			141	86			260	141	72	48	35mm
				167			167	101				167	83	55	40mm
				194			194	114				194	95	63	45mm
				223			222	130				222	107	71	50mm
				260			260	162				260	133	87	60mm
								197					161	103	70mm
								235					190	121	80mm
								260					222	139	90mm
													257	158	100mm
														179	110mm

COLUMNS

Section factor A/V (Hp/A)	Fire resistance period (minutes)						Product thickness
	30	**60**	**90**	**120**	**180**	**240**	
	260	185	74	46			20mm
		250	96	59			25mm
		260	119	73	41		30mm
			143	86	48		35mm
			169	101	56	38	40mm
			196	116	63	43	45mm
			226	131	71	49	50mm
			260	164	87	59	60mm
				200	104	70	70mm
				239	122	82	80mm
				260	141	94	90mm
					160	106	100mm
					181	118	110mm





COLUMNCLAD

1. Product description

Gypsum based type 5F, moisture resistant rigid board, reinforced with glass fibre and vermiculite, with a non-combustible mineral tissue surface.

2. Supplier

Rockwool Ltd.
Pencoed, Bridgend CF35 6NY
T: 01656 862621 F: 01656 862302 www.rockwool.co.uk

3. Availability

National network of Rockwool distributors – contact Supplier for list. Recommended to be fixed by specialist fire protection contractors.

4. Protection technique

Box

5. Application technique

4 sided column encasement – 100mm wide ColumnClad noggins wedged between flanges, behind board joints (at 1.8m maximum centers) and at head and base of column. Facing boards fixed to noggins and each other using 50mm staples at 150mm centers.
3 sided beam encasement – secure 25mm x 25mm steel angles to top flanges of beam. Insert noggins between flanges at 900mm maximum centers and behind board joints. Screw fix facing boards to metal angles at 300mm centers. Facing boards fixed to noggins and each other using 50mm staples at 150mm centers.
Double layer encasement – Where 15mm and 20mm boards are required, apply 20mm layer first.

6. Steel preparation

None required

7. Maximum density

900kg/m³

8. Thickness available

15 and 20mm

9. Fire resistance range

a) 1½ hours Hp/A up to 260
b) 2 hours Columns (critical temperature 550°C) - Hp/A up to 260
Beams (critical temperatures 550°C & 620°C) - Hp/A up to 218

10. Appearance

Flat, white mineral tissue surface which can be decorated directly; or by applying a plaster skim coat prior to decoration.

11. On site use

For internal use only. If subjected to moisture during installation, prior to the building envelope being sealed, the boards will regain their strength and fire resistance when allowed to dry naturally.

12. Durability

Resistant to vermin, mould growth and moisture tolerant.
Impact resistant to BS 5234/2 – 15mm severe duty, 20mm severe duty.

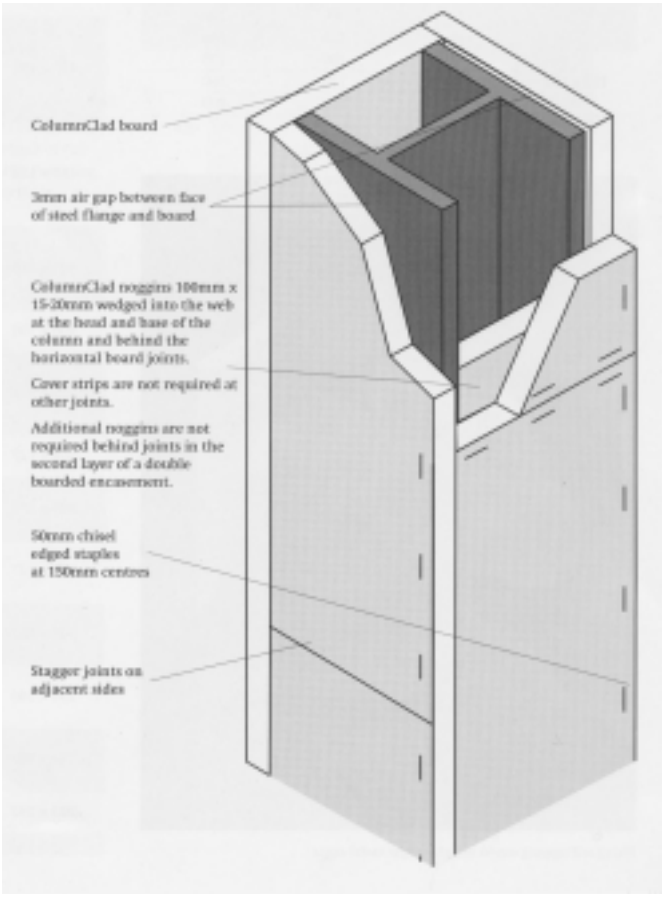
13. Performance in other BS tests

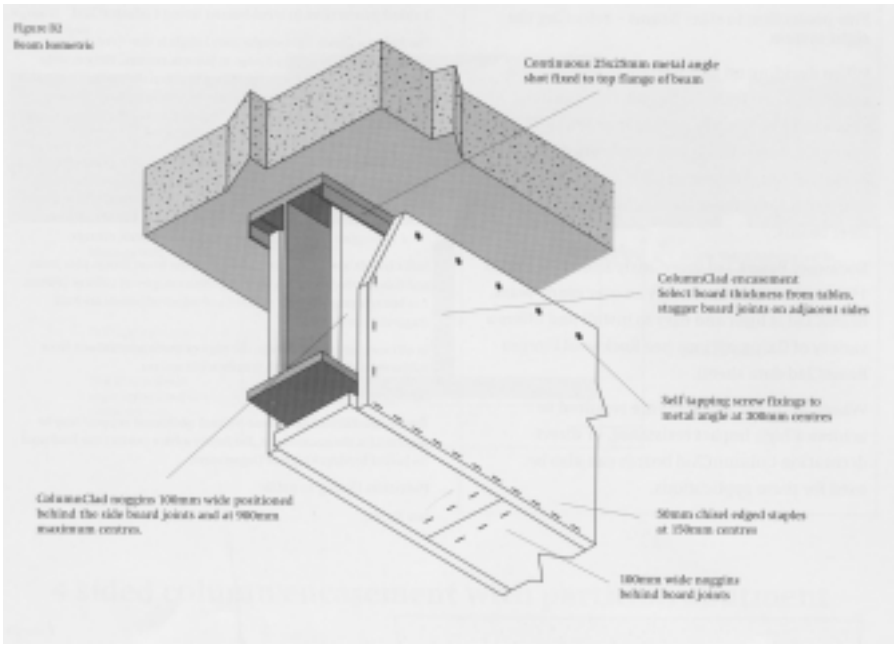
BS 476:Part 4 – Non combustible (Reaction to Fire)
BS EN 13501-1 – Euroclass A1 (Reaction to Fire)
BS EN ISO 9002 – Quality assured

14 Specification of system

Typical specifications available from data sheet – refer to supplier

COLUMNS					
Section factor Hp/A $^{(m-1)}$	Fire resistance period (minutes) 550^{o}C				Product thickness
	30	**60**	**90**	**120**	
	260	260	113	63	15mm
	260	260	198	96	20mm
	260	260	260	206	30mm
	260	260	260	260	35mm





BEAMS					
Section factor Hp/A $^{(m-1)}$	Fire resistance period (minutes) 550^{o}C				Product thickness
	30	**60**	**90**	**120**	
	260	260			15mm
	260	260	148		20mm
	260	260	260	157	30mm
	260	260	260	218	35mm

BEAMS					
Section factor Hp/A $^{(m-1)}$	Fire resistance period (minutes) 620^{o}C				Product thickness
	30	**60**	**90**	**120**	
	260	260			15mm
	260	260	159		20mm
	260	260	260	165	30mm
	260	260	260	218	35mm

CONLIT 150 SYSTEMS

1. Product description

Resin bonded rock fibre rigid insulation

2. Manufacturer

Rockwool Ltd
Pencoed, Bridgend CF35 6NY
T: 01656 862621 F: 01656 862302 www.rockwool.co.uk

3. Availability

Main insulation stockists - contact Manufacturer for list. Fixing by recognised fire protection contractors.

4. Protection technique

Box or profile

5. Application technique

a) Clip fixing and/or stud welded pins, spiral screws with dry joints: Friction fitted clips or stud welded pins at 800mm maximum centres and board retained with non-returnable spring washers. Spiral fixings applied between web boards and flange soffit boards at 150mm maximum centres.

b) Glued noggins with dry joints: Conlit 150 noggins (see 7 below) glued into webs at 900mm maximum centres. Facing boards retained with spiral screw fixings at 120mm maximum centres. Joints between web boards and glange soffit boards sealed with sprial screw fixings at 200mm maximum centres.

c) Stud welded pins & glued joints: Stud welded pins to flange tips at 800mm maximum centres and boards retained with non-returnable spring washers. All board to board joints filled with Conlit adhesive and secured with nails at 450mm maximum centres.

d) Glued noggings and glued joints: Noggins applied as in (b) above. Facing boards to noggins with Conlit adhesive and nailed at 150mm maximum centres. All board to board joints filled with Conlit adhesive and secured with nails at 450mm maximum centres.

6. Steel preparation requirements

Steel must be degreased and rust or loose scale removed where adhesive is to be applied

7. Additional mechanical fixing

Where the section depth exceeds 500mm T-shaped or full depth (flange tip to web) noggins of Conlit 150 must be used. Below 500mm depth, noggins of 100mm width and the same thickness as the facing board are acceptable

8. Nominal density

165 - 180 kg/m^3

9. Thickness range

25 to 100mm

10. Fire resistance range

(a) Up to 4 hours
(b) Hp/A 17 to 260 m^{-1}

11. Constraints for fire resistance

(a) Minimum thickness supplied 25mm
(b) Maximum thickness supplied 100mm

12. Appearance

Four finishes are available
(a) Plain green textured surface (150P)
(b) Glass tissue faced (150T/F)
(c) Reinforced aluminium foil faced (150A/F)
(d) Glass scrim faced (150S/F)

13. On site use

For internal and protected external surfaces

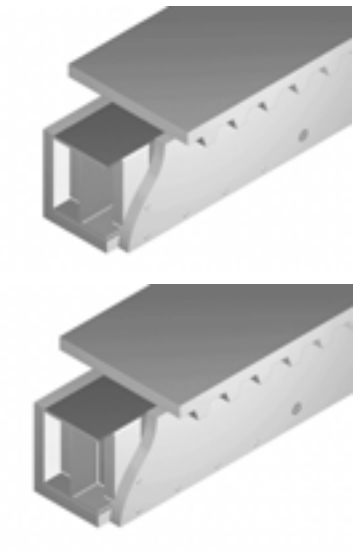
14. Durability

Water repellant, resistant to vermin and mould growth. The choice of surface facings provide the opportunity to match other service finishes in the plenum area, and increase resistance to impact and abrasion

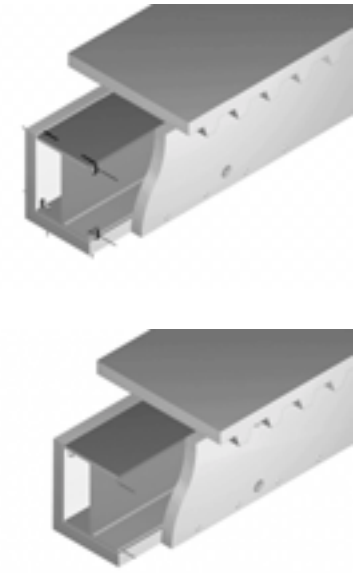
15. Performance in other BS fire tests

Class 0 surface as defined in the Building Regulations 1995

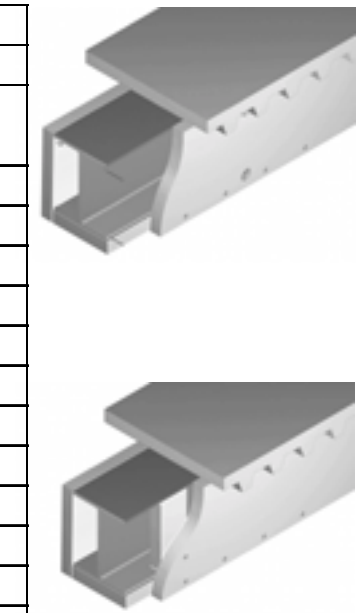
Glued Noggins, Dry Joints BEAMS AND COLUMNS					
Section factor Hp/A (m-1)	Fire resistance period (minutes)				Product thickness
	30	**60**	**90**	**120**	
	260	260	146	65	25mm
			202	83	30mm
			260	103	35mm
				126	40mm
				153	45mm
				184	50mm
				221	55mm
				260	60mm



Clip fixing and/or stud welded pin, dry joints									
	BEAMS supporting concrete or metal composite decks				**BEAMS & COLUMNS 4 sided protection**				Product thickness
Section factor Hp/A (m-1)	Fire resistance period (minutes)								
	30	**60**	**90**	**120**	**30**	**60**	**90**	**120**	
	260	260	201	77	260	260	148	65	25mm
			260	100			206	84	30mm
				126			260	104	35mm
				158				128	40mm
				195				155	45mm
				240				187	50mm
				260				225	55mm
								260	60mm



Stud welded pins, glued joints and Glued noggins, glued joints													
	BEAMS						**COLUMNS**						
Section factor Hp/A (m-1)	Fire resistance period (minutes)												Product thickness
	30	**60**	**90**	**120**	**180**	**240**	**30**	**60**	**90**	**120**	**180**	**240**	
	260	260	260	98			260	260	149	65			25mm
				130	50	31			207	83	38	24	30mm
				168	61	37			260	104	45	29	35mm
				216	73	43				128	54	34	40mm
				260	85	50				155	62	39	45mm
					99	57				187	72	44	50mm
					114	65				225	82	50	55mm
					131	73				260	92	55	60mm
					170	90					116	68	70mm
					219	109					143	81	80mm
					260	131					176	96	90mm
						157					214	124	100mm



CONLIT TUBE

1. Product description

Rigid resin bonded, rock wool fire protection - preformed circular section

2. Manufacturer

Rockwool Ltd
Pencoed, Bridgend CF35 6NY
T: 01656 862621 F: 01656 862302 www.rockwool.co.uk

3. Availability

Main insulation stockists - contact manufacturer for list. Fixing by recognised fire protection contractors.

4. Protection technique

Profile

5. Application technique

All joints and slits in the Conlit Tube Sections are filled with Conlit Glue and held tightly closed using binding wire (or similar) until the Conlit Glue has cured

6. Steel preparation requirements

None

7. Additional mechanical fixing

None

8. Minimum density

110 kg/m^3

9. Thickness range

25-120mm (thickness availability dependent upon Conlit Tube bore)

10. Fire resistance range

(a) Up to 4 hours
(b) Hp/A up to 315m^{-1}

11. Constraints for fire resistance

(a) Minimum thickness - 25mm
(b) Maximum single layer thickness - 80mm
(c) Minimum thickness for 3 and 4 hours fire resistance - 40mm

12. Appearance

Muted green/brown mineral wool surface

13. On site use

For internal and weather protected external applications

14. Durability

Non hygroscopic, resistant to vermin and mould growth. Protection may need to be provided against impact and abrasion

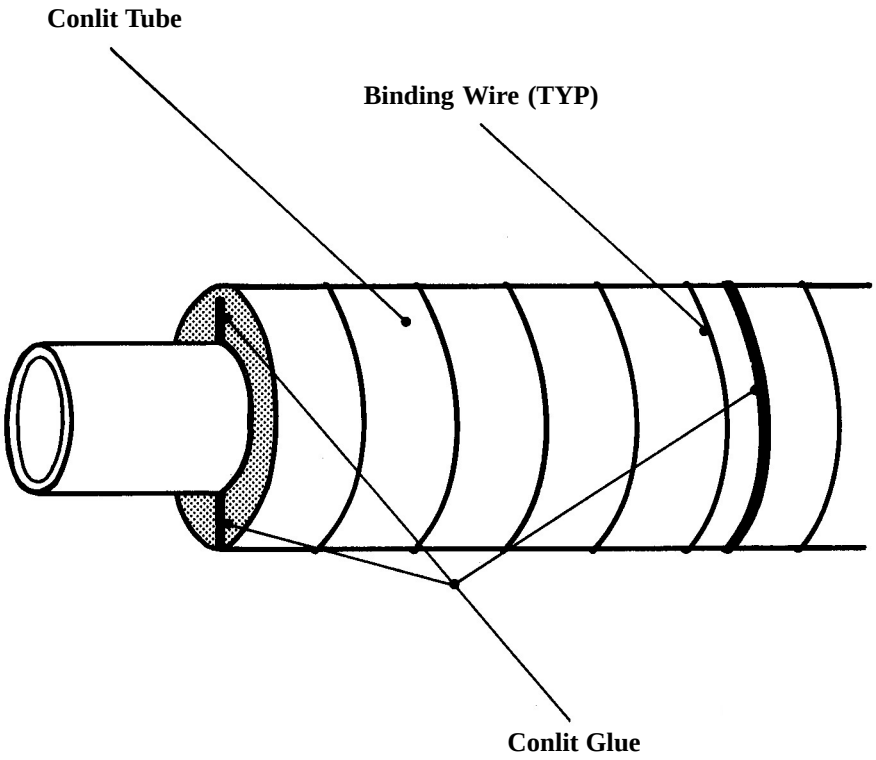
15. Performance in other BS fire tests

Non-combustible in accordance with BS476-4, so complies with Class 0 and is a Material of Limited Combustibility as defined in the Building Regulations 1991

16. Other applications

(a) Fire Protection of metallic and non-metallic pipework and contents - subject to separate approval by Rockwool Limited
(b) Thermal Insulation
(c) Sound absorption and attenuation
(d) Condensation control (separate vapour barrier required)

Section factor Hp/A $^{(m-1)}$	Fire resistance period (minutes) 550°C						Product thickness
	30	**60**	**90**	**120**	**180**	**240**	
	260	260	110	65			25mm
			241	124	63	42	40mm
			260	178	85	55	50mm
				260	122	77	65mm
					152	93	75mm
					170	102	80mm



FIRECHECK BOARD

1. Product description

Gypsum wallboard containing glass fibres and fillers in the core

2. Manufacturer

Lafarge Plasterboard Ltd
Marsh Lane, Easton-in-Gordano, Bristol BS20 0NF
T: 01275 377773 F: 01275 377737

3. Availability

Main stockists and builders merchants

4. Protection technique

Box

5. Application technique

The boards are secured to a galvanised steel framework with Lafarge drywall screws. The framework comprises longitudinal steel sections connected by snap on clips at 600m centres. Up to three layers of board may be used. All surface joints are filled, reinforced and finished and external angles are finished with Lafarge corner tape or angle beads.

6. Steel preparation requirements

None

7. Additional mechanical fixing

On beams the steel support angles are shot fired on to the beam flange or concrete floor soffit.

8. Nominal density

850 kg/m³

9. Thickness range

12.5mm, 15mm and 25mm

10. Fire resistance range

(a) Up to 4 hours
(b) Hp/A 17-260m^{-1} for compression members
17-230m^{-1} for flexural members

11. Constraints for fire resistance

(a) Minimum thickness - 12.5mm
(b) Maximum multi-layer thickness - 75mm

12. Appearance

Ivory paper surface suitable to receive most forms of decoration. 25mm board has green moisture resistant paper which can be painted over

13. On site use

For internal applications only

14. Durability

Resistant to vermin and mould growth, minor impact and abrasion

15. Performance in other BS fire tests

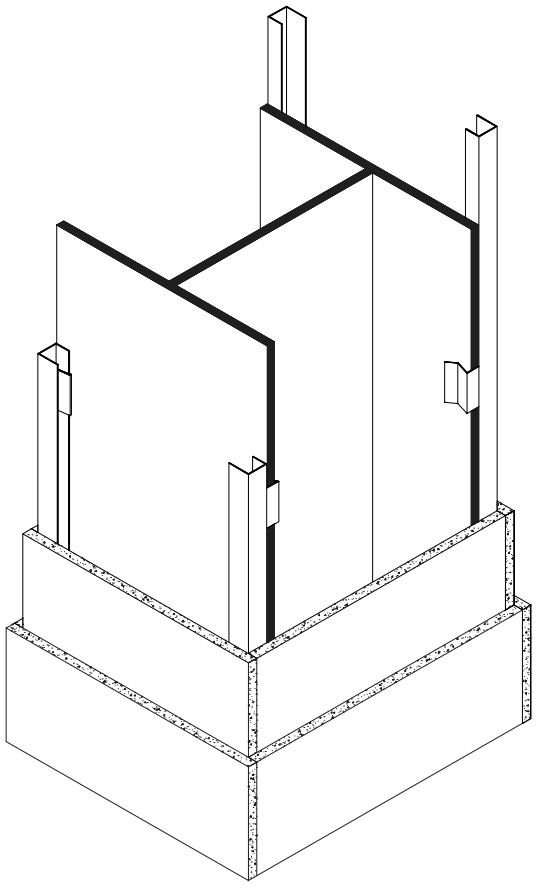
BS476-7 - Class I; BS476-6 - Fire propagation - indices of performance I not exceeding 12 and a sub-index i_1 not exceeding 6

16. Other applications

(a) Internal lining of buildings
(b) Fire protection ceilings
(c) Fire resisting door construction
(d) Fire resisting partition and wall construction
(e) Cavity barriers
(f) Lining to load bearing steel studding

BEAMS					
Section factor Hp/A $^{(m-1)}$	Fire resistance period (minutes)				Product thickness (mm)
	30	**60**	**90**	**120**	
	260	110			12.5
		260	50		15
			260		25 (or 2x12.5)
				90	27.5 (15+12.5)
				125	30 (2x15)
				260	37.5 (25+12.5 or 3x12.5)

COLUMNS					
Section factor Hp/A $^{(m-1)}$	Fire resistance period (minutes)				Product thickness (mm)
	30	**60**	**90**	**120**	
	260	260			12.5
			110		15
			260	135	25 (or 2 x 12.5)
				175	27.5
				225	30
				260	37.5



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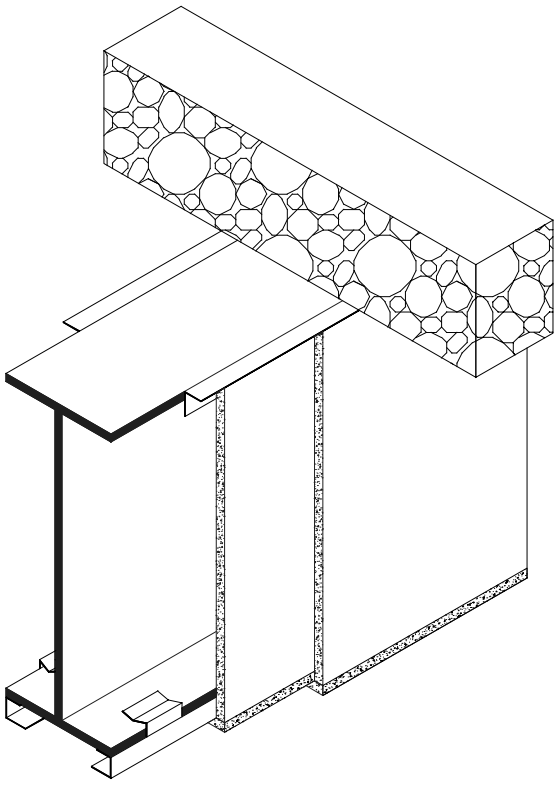


BEAMS

FIREMASTER 607 BLANKET

1. Product description

Glass oxide insulating blanket (or ceramic fibre blanket)

2. Manufacturer

Thermal Ceramics UK Ltd
Tebay Road, Bromborough, Wirral, Cheshire CH62 3PH
T: 0151 334 4030 F: 0151 334 1684 W: www.thermal-ceramics-firemaster.co.uk

3. Availability

Direct from manufacturer

4. Protection technique

Profile or boxed

5. Application technique

Mechanical support structure using CD welded pins over which one or more layers of blanket are impaled and retained using friction fit washers. Alternatively a wire mesh fixing grid is formed around the steel section and the mesh cut to form a fixing grid. The blanket is impaled over the fixing grid. The blanket is impaled over the fixing grid in one or more layers and retained by spring washers.

6. Steel preparation requirements

None, apart from preparation of steel for CD pin welding

7. Additional mechanical fixing

Use of more than one layer may benefit from use of fixing washers on each layer. An overlay of chicken wire mesh can be used in some situations

8. Nominal density

96 kg/m^3 (other densities are available)

9. Thickness range

6 to 63 mm

10. Fire resistance range

Up to 4 hours

11. Constraints for fire resistance

(a) Minimum thickness - 1 layer of 12mm
(b) Maximum thickness - 2 layers of 38mm
(c) Where multiple layers are used the thinnest material is used on the outside of the protection
(d) Multi-layer protection systems only with staggered joints
(e) Single layer systems use a compressed butt joint

12. Appearance

A white fibrous flexible blanket. Usually covered with aluminium foil or sometimes glass cloth on one or both sides

13. On site use

For internal applications. Can be and has been used externally with protective cladding.

14. Durability

Not permanently affected by oil, water and steam. Resistant to vermin and mould growth. Can be supplied in water repellant grade.

15. Performance in other BS and EN fire tests

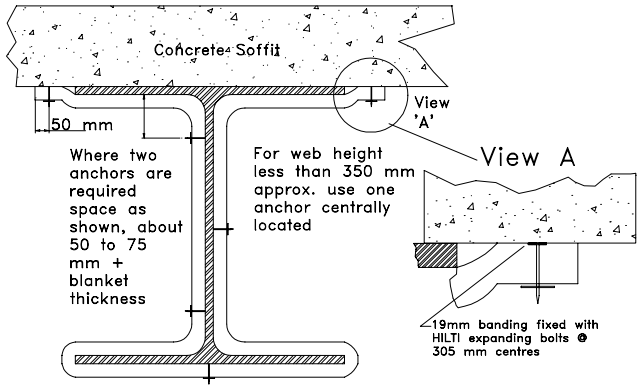
Non-combustible in accordance with BS476-4, so complies with Class 0 and is a Material of Limited Combustibility as defined in the Building Regulations 1991

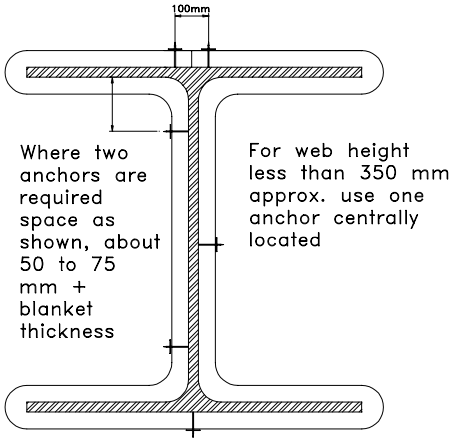
16. Other applications

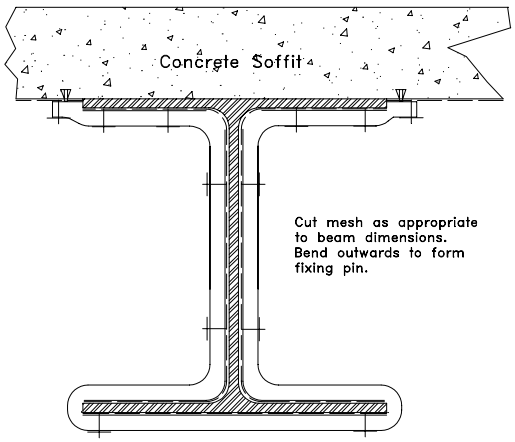
(a) Fire rated ductwork protection
(b) Hydrocarbon fire protection of structural steel offshore
(c) Marine fire protection of steel, composite and aluminium bulkhead and decks
(d) Hydrocarbon fire rated bulkheads, decks, cable trays, process vessels and pipes on offshore installations
(e) Jet fire protection of pipes and vessels offshore and inshore processing plants

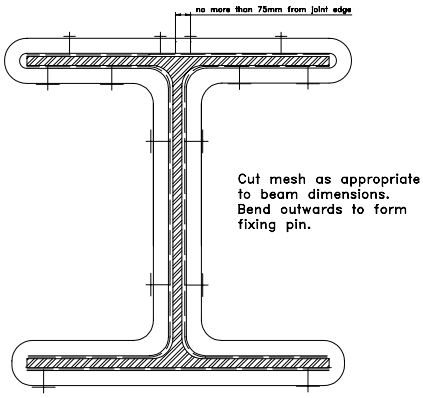
Section factor Hp/A (m-1)	Fire resistance period (minutes) 500°C						Product thickness
	30	**60**	**90**	**120**	**180**	**240**	
	260	106	54				12mm
		166		55			19mm
		233	82	74			25mm
		260	160	120	80	50	38mm
			264	168	97	69	50mm
			315	273	135	108	38 + 38mm

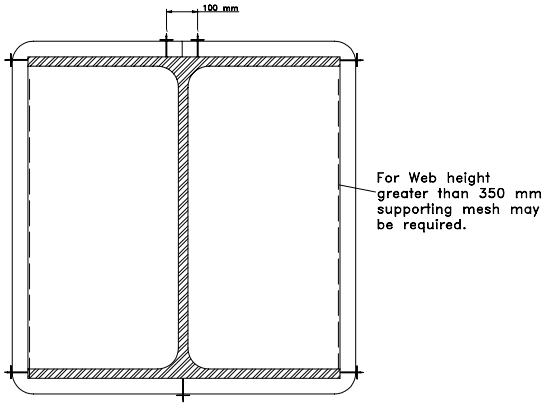
Note: all thicknesses up to 50mm may be applied in one single layer with compressed butt joints.
For thicknesses above 50mm, or if two layers are preferred,
the thinner layer should be applied on outside.

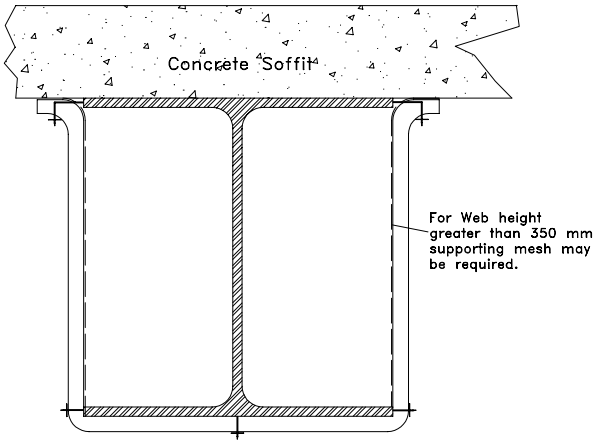












GLASROC FIRECASE S

1. Product description

Glass fibre reinforced gypsum board incorporating integral glass fibre membranes

2. Manufacturer

British Gypsum Limited
East Leake, Loughborough, Leicestershire LE12 6NP
T: 08705 456 123 F: 08705 456 356 W: www.british-gypsum.co.uk

3. Availability

Fire protection distributors and builders merchants

4. Protection technique

Box

5. Application technique

The boards are secured with direct screw or staple fixing through abutting boards to 4 sided column protection. On 3 sided columns or beams protection of steel angle sections may be used in conjunction with Glasroc FireCase S backing strips or alternatively Glasroc FireCase S soldiers can be used for fire protection periods up to and including 90 minutes. Jointing and finishing is not a requirement to meet the fire protection levels given, however Gyproc Jointing systems or Thistle plastering systems may be used.

6. Steel preparation requirements

None

7. Additional mechanical fixing

On beams the steel support angles are shot fired to both sides of the section

8. Nominal density

820 kg/m³

9. Thickness range

15mm, 20mm, 25mm and 30mm

10. Fire resistance range

(a) Up to 2 hours
(b) Hp/A 17-260m^{-1}

11. Constraints for fire resistance

(a) Minimum thickness - 15mm
(b) Maximum thickness - 35mm

12. Appearance

Smooth gypsum surface suitable for most forms of decoration

13. On site use

For internal and semi-exposed applications

14. Durability

Resistant to vermin and mould growth, minor impact and abrasion

15. Performance in other BS fire tests

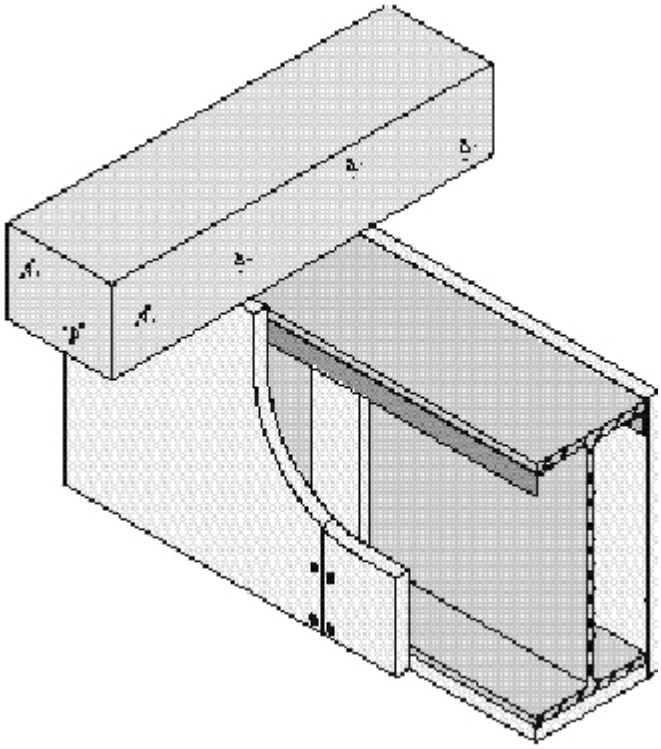
BS476-4 - non combustible

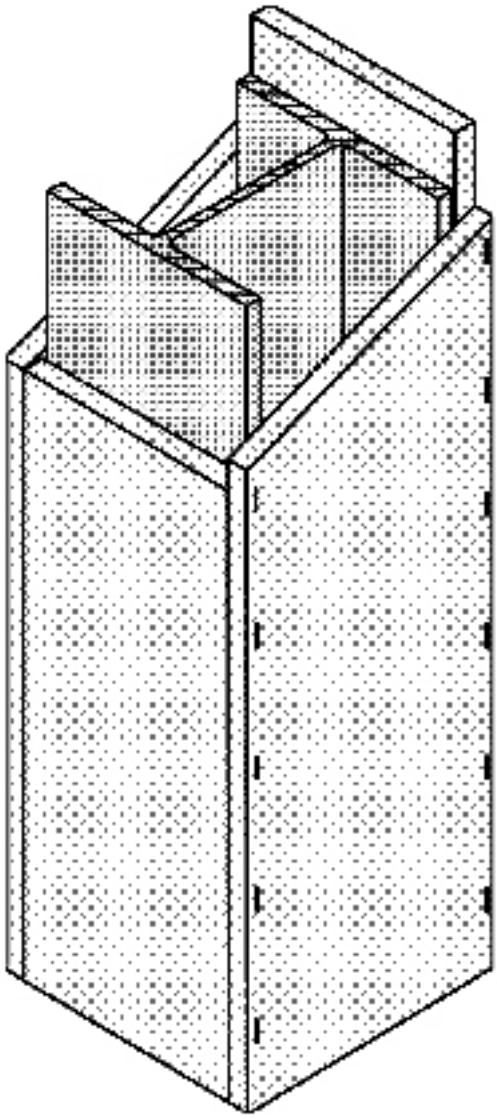
16. Other applications

(a) Internal lining of buildings
(b) Fire protecting ceilings
(c) Fire resisting partition and wall construction
(d) Cavity barriers

Section factor Hp/A (m-1)	Fire resistance period (minutes) 550°C				Product thickness
	30	**60**	**90**	**120**	
	260	260	105	65	15mm
			180	90	20mm
			260	100	25mm
				250	30mm
				260	35mm

Section factor Hp/A (m-1)	Fire resistance period (minutes) 620°C				Product thickness
	30	**60**	**90**	**120**	
	260	260	130	70	15mm
			190	90	20mm
			260	110	25mm
				260	30mm





GYPROC GYPLYNER™ ENCASE

1. Product description

Gyproc Fireline Board - Gypsum wallboard containing glass fibres and vermiculite in the core

2. Manufacturer

British Gypsum Limited
East Leake, Loughborough, Leicestershire LE12 6NP
T: 08705 456 123 F: 08705 456 356 W: www.british-gypsum.co.uk

3. Availability

Main stockists and builders merchants.

4. Protection technique

Box

5. Application technique

The boards are secured to a galvanised steel framework using Gyproc Drywall Screws. The framework comprises Gyproc Gyplyner GL1 longitudinal sections, attached to the steel section using Gyproc Gyplyner GL10 clips at 800mm centres. Up to three layers of board may be used, all surface joints are filled, reinforced and finished using Gyproc Jointing compounds and tapes.

6. Steel preparation requirements

None

7. Additional mechanical fixing

On beams the steel support angles are shot fired on to the beam flange or concrete floor soffit

8. Nominal density

900 kg/m³

9. Thickness range

12.5mm and 15mm

10. Fire resistance range

(a) Up to 2 hours
(b) Hp/A 17-260m^{-1} for compression members
17-230m^{-1} for flexural members

11. Constraints for fire resistance

(a) Minimum thickness – 12.5mm
(b) Maximum multi-layer thickness - 42.5mm

12. Appearance

Pink paper liner suitable to receive most forms of decoration

13. On site use

For internal applications only

14. Durability

Resistant to vermin and mould growth, minor impact and abrasion

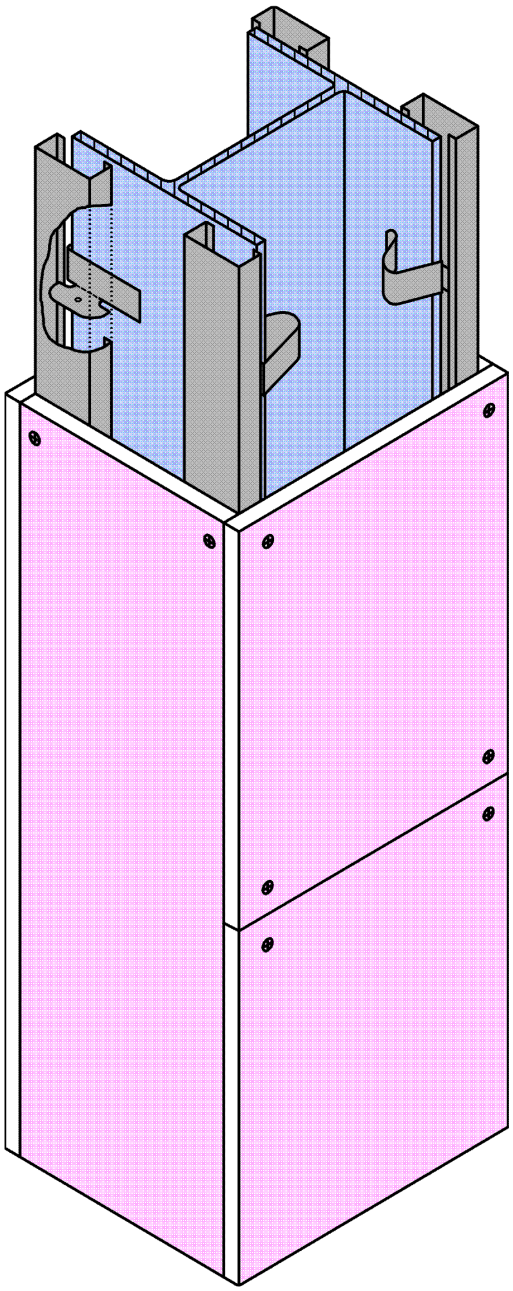
15. Performance in other BS fire tests

BS476-7 - Class I; BS476-6 - Fire propagation - indices of performance I not exceeding 12 and a sub-index i_1 not exceeding 6.

16. Other applications

(a) Internal lining of buildings
(b) Fire protecting ceilings
(c) Fire resisting partition and wall construction
(d) Cavity barriers

Section factor Hp/A $^{(m-1)}$	Fire resistance period (minutes) 550°C				Product thickness
	30	**60**	**90**	**120**	
	260	165			12.5mm
		195			15mm
		260	200		12.5 + 12.5mm
			260		15 + 12.5mm
				110	15 + 15mm
				190	12.5 + 12.5 + 12.5mm
				225	15 + 12.5 + 12.5mm
				260	15 + 15 + 12.5mm



PROMALIT

1. Product description

Resin bonded rock fibre panels

2. Manufacturer

Promat UK Ltd
The Sterling Centre, Eastern Road, Bracknell, Berkshire RG12 2TD W: www.promat.co.uk
Technical: T: 01344 381400 F: 01344 381401 E: technicaluk@promat.co.uk
Marketing: T: 01344 381350 F: 01344 381401 E: marketinguk@promat.co.uk
Sales: T: 01344 381381 F: 01344 381380 E: salesuk@promat.co.uk

3. Availability

Supply through nominated distributors, many offering specialist cutting facilities; list of distributors and recommended contractors available from manufacturer

4. Protection technique

Box

5. Application technique

For beam and column casings, Promalit soldiers are wedged and bonded with Vicubond WR adhesive between flanges at 600mm centres. The soldiers are a minimum of 100mm x casing thickness (40mm minimum). The boards are fixed to the soldiers and to each other using Promalit Spring Screws. The soffit boards sit between the side boards in the case of beams.

6. Steel preparation requirements

None except for regions where soldiers are to be fixed. These must be degreased and have loose scale and rust removed

7. Additional mechanical fixing

For beams with web depths more than 500mm, T - shaped or solid soldiers should be used. For beams with flange widths more than 400mm, the Promalit soffit board should also be retained using welded pins and spring steel washers fixed direct to the beam flanges. A central row of pins should be positioned at 300mm centres. Alternatively self drilling self tapping screws with washers could be used, if acceptable to the structural engineer. Where 1, 2, or 4-sided protection to beams, or 1, 2 or 3-sided protection to columns is required, contact Promat Technical Services for advice.

8. Nominal density

160 kg/m^3

9. Thickness range

Standard boards - 20, 25, 30, 35, 40, 45, 50 and 55mm

10. Fire resistance range

(a) Up to 3 hours
(b) Hp/A 17-260m-1

11. Constraints for fire resistance

(a) Minimum thickness - 20mm
(b) Maximum single layer thickness - 55mm

12. Appearance

Light green and is available unfaced or faced with reinforced aluminium foil

13. On site use

For internal and semi exposed applications

14. Durability

Resistant to vermin, mould growth, minor impact and abrasion, odourless and moisture tolerant

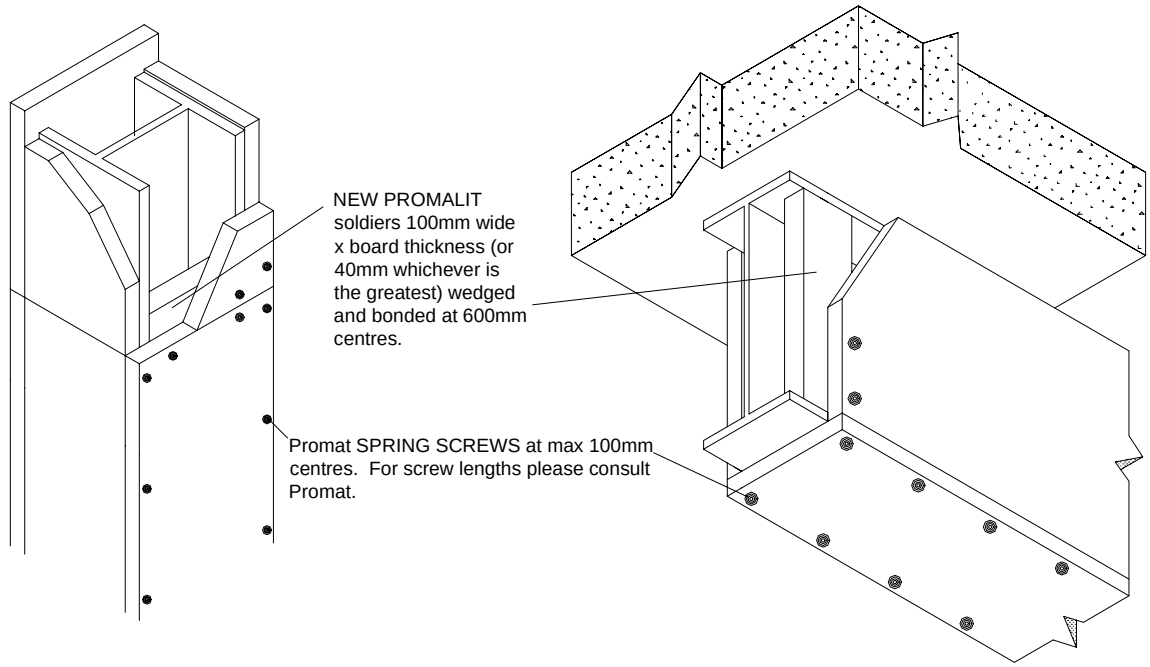
15. Performance in other BS fire tests

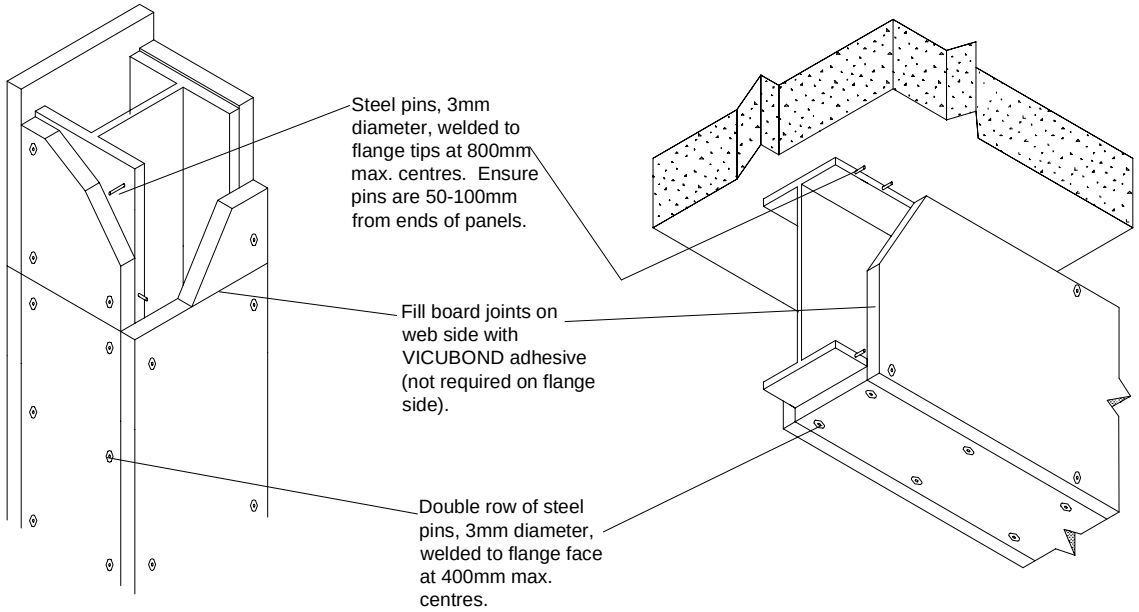
Non-combustible in accordance with BS476-4, so complies with Class 0 and is a Material of Limited Combustibility as defined in the Building Regulations 1991. For information on performance in relation to EN fire tests, contact Promat Technical Services for advice

16. Other applications

(a) Thermal Insulation
(b) Cavity Barriers
(c) Cavity Fire Stops
(d) Core for fire resisting doors

Section factor Hp/A $^{(m-1)}$	Fire resistance period (minutes) 550°C					Product thickness
	30	**60**	**90**	**120**	**180**	
	260	260	135	65	30	20mm
			190	85	40	25mm
			260	105	50	30mm
				130	60	35mm
				160	70	40mm
				190	80	45mm
				230	90	50mm
				260	105	55mm
For product thickness required at different temperatures please consult Promat						





PROMATECT 250

1. Product description

Non-combustible mineral bound board

2. Manufacturer

Promat UK Ltd
The Sterling Centre, Eastern Road, Bracknell, Berkshire RG12 2TD W: www.promat.co.uk
Technical: T: 01344 381400 F: 01344 381401 E: technicaluk@promat.co.uk
Marketing: T: 01344 381350 F: 01344 381401 E: marketinguk@promat.co.uk
Sales: T: 01344 381381 F: 01344 381380 E: salesuk@promat.co.uk

3. Availability

Supply through nominated distributors, many offering specialist cutting facilities; list of distributors and recommended contractors available from manufacturer

4. Protection technique

Box

5. Application technique

For four-sided column casings, PROMATECT 250 soldiers are wedged between the flanges at maximum 2500mm centres. The soldiers are 120mm wide x casing thickness. The boards are fixed to the soldiers and to each other using staples, 50mm long, at 150mm centres. Soldiers must coincide with board joints. Cover strips are not required over joints in the boards covering flanges. For three-sided beam casings, the fixing method is the same except the soldiers are located at maximum 1250mm centres and the soffit board is fitted between the side boards. For double-layer casings, the first layer is the thickest of the two layers, and is fixed as a single-layer casing. The outer layer is then secured through the first layer into the soldiers, and to each other using staples, 50mm long, at 150mm centres.

6. Steel preparation requirements

None

7. Additional mechanical fixing

a) Where 1, 2, 3 or 4-sided protection to beams contact Promat Technical Services for advice
b) For 1, 2 and 3-sided protection to columns contact Promat Technical Services for advice
c) For beams and columns more than 400mm deep, the soldier may need to be strengthened contact Promat Technical Services for advice

8. Nominal density

700kg/m^3

9. Thickness range

Standard boards – 15, 18, 20, 22, and 25mm

10. Fire resistance range

a) up to 2½ hours
b) Hp/A 17 – 260m^{-1}

11. Constraints for fire resistance

a) Minimum thickness – 15mm
b) Maximum single layer thickness – 25mm
c) Maximum double layer thickness – 38mm

12. Appearance

Off-white, smooth surface suitable to receive most forms of decoration

13. On site use

For internal and semi exposed applications

14. Durability

Resistant to vermin, minor impact and abrasion, and moisture tolerant.

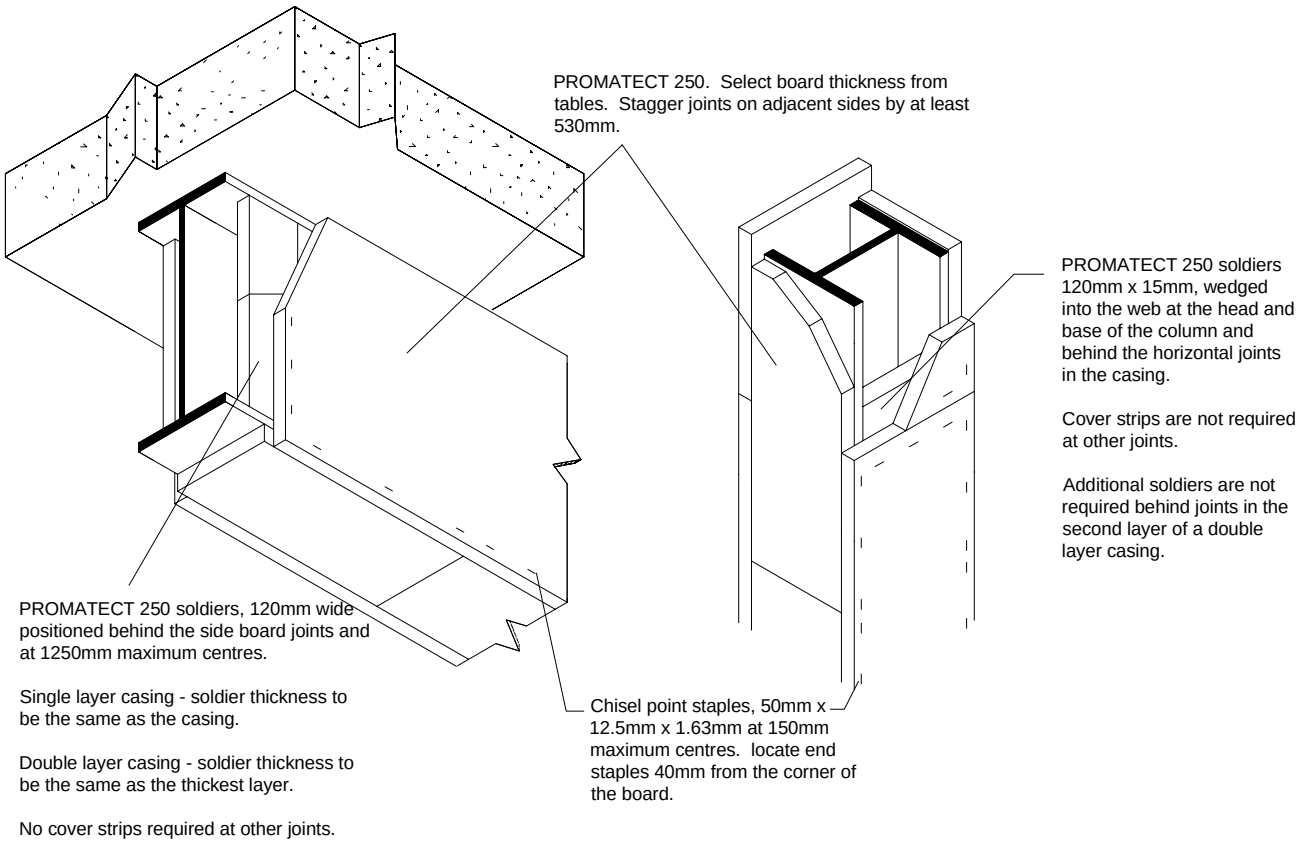
15. Performance in other BS tests

Non-combustible to BS476-4 and complies with Class O and is a material of limited combustibility as defined by the Building Regulations 1991. For information on performance in relation to EN fire tests, contact Promat Technical Services for advice

16. Other applications

a) Fire resisting partitions
b) Fire resisting ceilings

Section factor Hp/A $^{(m-1)}$	Fire resistance period (minutes)															Product thickness
	Columns 550°C					Beams 550°C					Beams supporting and connected to concrete deck 620°C					
	30	**60**	**90**	**120**	**150**	**30**	**60**	**90**	**120**	**150**	**30**	**60**	**90**	**120**	**150**	
	260	260	114	68		260	260	102			260	260	115			15mm
			153	87	61			135					173			18mm
			185	102	70			162	92				232	94		20mm
			223	118	80			192	106				260	113		22mm
			260	145	96			249	129	87				149	85	25mm
				201	126			260	176	114				243	120	30mm (15+15)
				243	147				211	132				260	148	33mm (15+18)
				260	163				238	146					171	35mm (15+20)
					190				260	168					213	38mm (20+18)



SPIRALITE GLUE FIX

I. Product description

Resin bonded mineral fibre panels

2. Manufacturer

Cryotherm Insulation Limited
Hirst Wood Road, Shipley West Yorkshire BDl8 4BU
T: 01274 589175 F: 01274 593315 enq@cryotherm.co.uk

3. Availability

From manufacturer and stockists. Supply and fix service by approved contractors, names and addresses from manufacturer

4. Protection technique

Profile or box. Profile for web depths exceeding 900mm

5. Application technique

For box protection Spiralite noggings are glued between the flanges, flush with the flange tips and parallel to the web. Panels are glued and fastened to the noggings and to each other using Rockbond WR adhesive and wire nails. For beam protection the web panels oversail the flange panel

6. Steel preparation requirements

No special requirement

7. Additional mechanical fixing

Where noggings cannot be used the panels can be secured using shot fired pins or stud welded pins and non return washers, consult the manufacturers for details

8. Nominal density

200 kg/m³

9. Thickness range

Nominal thicknesses are 20 to 110mm in 5mm increments

10. Fire resistance range

(a) Up to 4 hours
(b) Hp/A 20-260m^{-1} for boxed protection
30-310m^{-1} for profile protection

11. Constraints for fire resistance

(a) Minimum thickness - 20mm
(b) Maximum thickness - 110mm

12. Appearance

Light green, faced with glass wool tissue

13. On site use

For internal and temporary external use

14. Durability

Resistant to vermin, mould growth and adverse weather conditions. Resistant to minor impact and abrasion

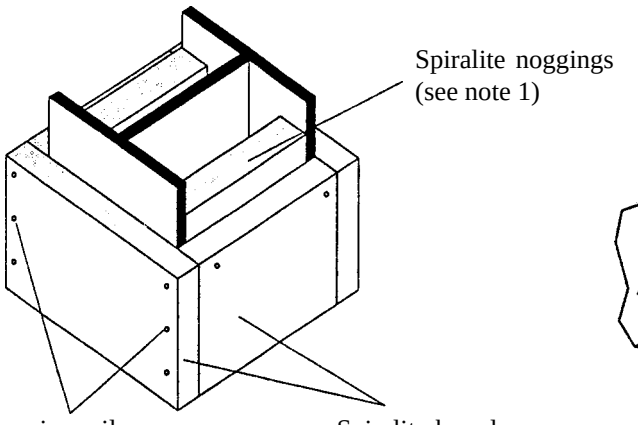
15. Performance in other BS fire tests

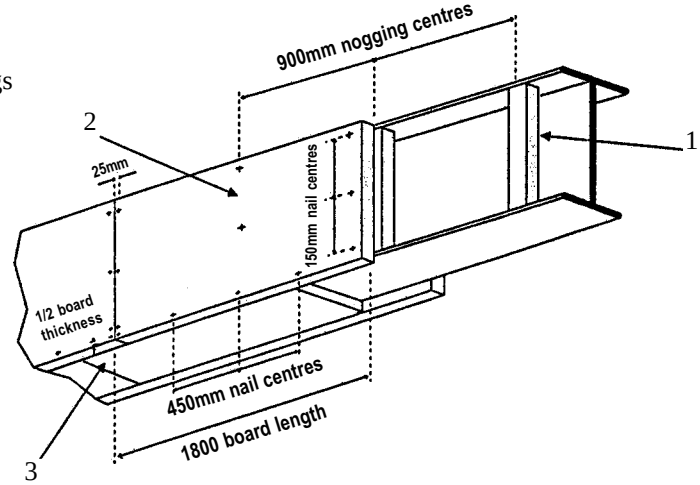
Class 1 to BS476-7, I<12 i<6 to BS476-6, A_o on and A_o off <1 to BS6853 Ap B

16. Other applications

(a) Thermal insulation
(b) Fire protection of ducting
(c) Fire resisting partition and wall construction
(d) Cavity barriers
(e) Cavity fire stops
(f) Fire protection of concrete construction

Section factor Hp/A $^{(m-1)}$	Fire resistance period (minutes) 550°C				Product thickness
	90	**120**	**180**	**240**	
	201	88	41	27	20mm
	260	118	53	34	25mm
		153	67	42	30mm
		194	80	51	35mm
		243	95	59	40mm
		260	112	68	45mm
			129	78	50mm
			148	88	55mm
			168	98	60mm
			190	109	65mm
			215	121	70mm
			242	133	75mm
			260	146	80mm
				159	85mm
				174	90mm
				189	95mm
				205	100mm
				241	110mm
Beams only					





Notes
1. Nogging thickness to be same as protection thickness with a minimum of 30mm
2. Rockbond WR adhesive used on all board to board joints and noggings
3. Nail length = 2 x protection thickness
4. Nogging to be placed at top and bottom of column

- All noggings are 100mm wide with a nominal thickness as protection with a minimum of 30mm
- Rockbond WR adhesive applied to all board to board joints
- Wire nails of length 2 x protection thickness to secure board whilst adhesive cures
- Maximum web depth 600mm (for web depths >600mm see fixing detail ref 201)
- Maximum flange width 315 mm (for flange width >315mm see fixing detail ref 201)
- Nogging to be placed on both ends of beam

SPIRALITE SCREW FIX

1. Product description

Resin bonded mineral fibre panels

2. Manufacturer

Cryotherm Insulation Limited
Hirst Wood Road, Shipley West Yorkshire BDl8 4BU
T: 01274 589175 F: 01274 593315 enq@cryotherm.co.uk

3. Availability

From manufacturer and stockists. Supply and fix service by approved contractors, names and addresses from manufacturer

4. Protection technique

Profile or box. Profile for web depths exceeding 900mm

5. Application technique

For box protection Spiralite noggings are friction fitted between the flanges, flush with the flange tips and parallel to the web. Panels are fastened to the noggings and to each other using Spiralite screws. For beam protection the web panels oversail the flange panel

6. Steel preparation requirements

No special requirement

7. Additional mechanical fixing

Where noggings cannot be used the panels can be secured using shot fired pins or stud welded pins and non return washers, consult the manufacturers for details

8. Nominal density

200 kg/m³

9. Thickness range

Nominal thicknesses are 20 to 55mm in 5mm increments

10. Fire resistance range

(a) Up to 2 hours
(b) Hp/A 20-260m^{-1} for boxed protection
30-310m^{-1} for profile protection

11. Constraints for fire resistance

(a) Minimum thickness - 20mm
(b) Maximum thickness - 55mm

12. Appearance

Light green, faced with glass wool tissue

13. On site use

For internal and temporary external use

14. Durability

Resistant to vermin, mould growth and adverse weather conditions. Resistant to minor impact and abrasion

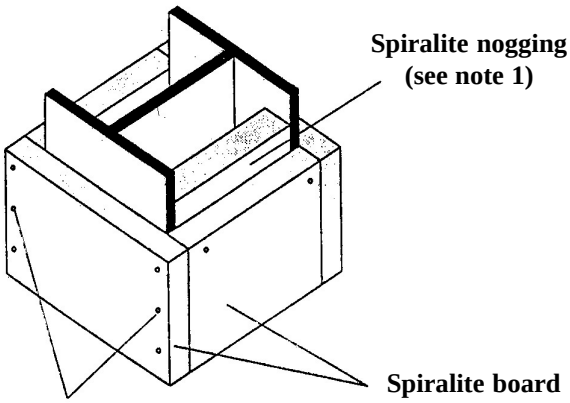
15. Performance in other BS fire tests

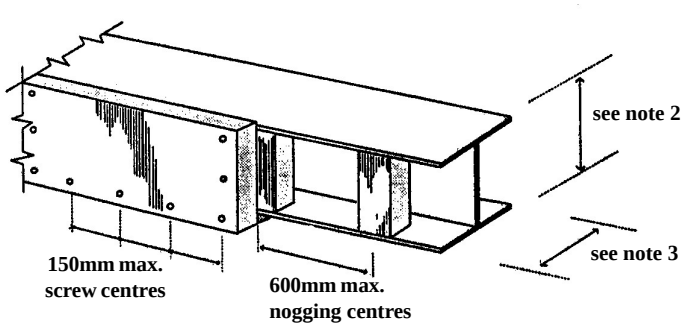
Class I to BS476-7, 1<12 i<6 to BS476-6, A_o on and A_o off <I to BS6853 Ap B

16. Other applications

(a) Thermal insulation
(b) Fire protection of ducting
(c) Fire resisting partition and wall construction
(d) Cavity barriers
(e) Cavity fire stops
(f) Fire protection of concrete construction

Section factor Hp/A $^{(m-1)}$	Fire resistance period 550°C				Product thickness
	30	**60**	**90**	**120**	
	260	260	168	94	20mm
			215	119	25mm
			260	144	30mm
				171	35mm
				198	40mm
				225	45mm
				254	50mm
				260	55mm





NOTES
1. Nogging thickness to be same as protection thickness with a minimum of 30mm
2. Optimum screw length = 2 x Protection Thickness - 5mm, longer screws may be used
3. No adhesive or filler required
4. Nogging to be placed at top and bottom of column

NOTES
1. All joints are square butt joints, no adhesive or filler is required
2. All noggings are 100mm wide with a nominal thickness as protection thickness with the following contraints:

a) minimum nogging thickness 30mm up to web depths of 425mm
b) minimum nogging thickness 40mm for web depths between 425mm and 480mm
c) T-nogging required for web depths between 48mm and 900mm (minimum 40mm thickness) see fixing detail ref 101)

3. Maximum flange width 315mm

a) for flange widths >315mm but <600mm, one row of 3mm dia steel stud welded pins centrally positioned at 350mm centres required (for flange >600mm see fixing detail ref 101)

4. Optimum screw length is protection thickness + nogging thickness - 5mm. Longer screws may be used
5. Nogging to be placed at both ends of beam

(see standard fixing details for full specifications)

SUPALUX

1. Product description

Fibre reinforced calcium silicate insulating board.
(Quality assurance to BS EN ISO 9002)

2. Manufacturer

Promat UK Ltd
The Sterling Centre, Eastern Road, Bracknell, Berkshire RG12 2TD W: www.promat.co.uk
Technical: T: 01344 381400 F: 01344 381401 E: technicaluk@promat.co.uk
Marketing: T: 01344 381350 F: 01344 381401 E: marketinguk@promat.co.uk
Sales: T: 01344 381381 F: 01344 381380 E: salesuk@promat.co.uk

3. Availability

Supply through nominated distributors, many offering specialist cutting facilities; list of distributors and recommended contractors available from manufacturer

4. Protection technique

Box

5. Application technique

Mechanical fixing to framing of light gauge steel angles

6. Steel preparation requirements

None

7. Additional mechanical fixing

For 3-sided applications, a steel angle is fixed to wall or floor soffit. For information on 1 and 2-sided applications, contact Promat Technical Services

8. Nominal density

875 kg/m^3

9. Thickness range

Standard thicknesses are 6, 9, 12 and 15mm

10. Fire resistance range

(a) Up to 2 hours
(b) Hp/A up to 260m^{-1}

11. Constraints for fire resistance

(a) Minimum thickness - 6mm
(b) Maximum thickness - 15mm
(c) Single layer protection

12. Appearance

Off-white, smooth surface, suitable to receive most forms of decoration

13. On site use

For internal and semi-exposed applications

14. Durability

High resistance to high humidity and temperature, abrasion, impact, vermin attack and mould growth

15. Performance in other BS fire tests

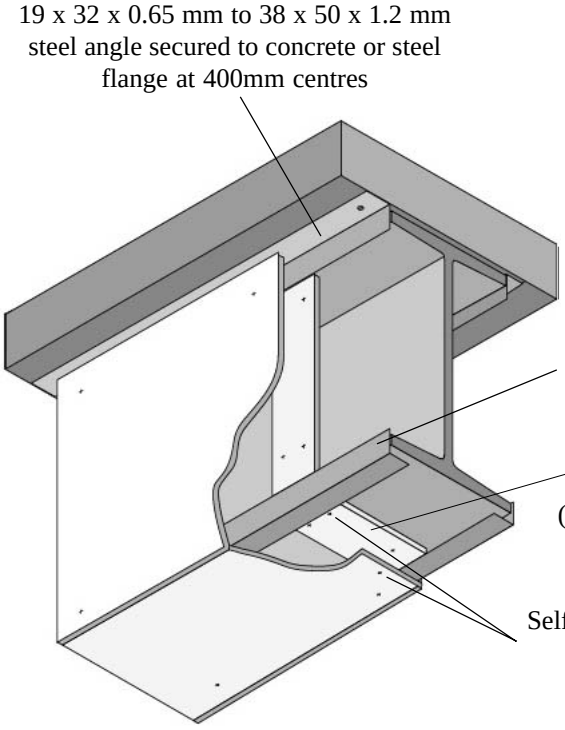
Non-combustible in accordance with BS476-4, so complies with Class 0 and is a Material of Limited Combustibility as defined in the Building Regulations 1991. For information on performance in relation to EN fire tests, contact Promat Technical Services for advice.

16. Other applications

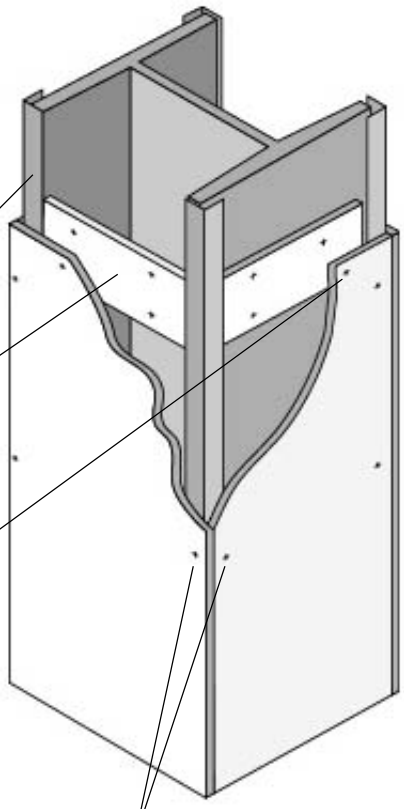
(a) Industrial linings
(b) Fire resisting partitions
(c) Fire resisting ceilings
(d) Upgrade of doors for fire resistance
(e) Fire resisting ductwork
(f) Cavity barriers
(g) Fire protecting membrane ceilings

Section factor Hp/A $^{(m-1)}$	Fire resistance period (minutes) 550°C				Product thickness
	30	**60**	**90**	**120**	
	260	64			6mm
		107	52		9mm
		158	73	47	12mm
		224	96	61	15mm

SUPALUX BEAM CASING



SUPALUX COLUMN CASING



VERMICULUX

1. Product description

Lightweight reinforced calcium silicate insulating board.
(Quality assurance to BS EN ISO 9002).

2. Manufacturer

Promat UK Ltd
The Sterling Centre, Eastern Road, Bracknell, Berkshire RG12 2TD W: www.promat.co.uk
Technical: T: 01344 381400 F: 01344 381401 E: technicaluk@promat.co.uk
Marketing: T: 01344 381350 F: 01344 381401 E: marketinguk@promat.co.uk
Sales: T: 01344 381381 F: 01344 381380 E: salesuk@promat.co.uk

3. Availability

Supply through nominated distributors, many offering specialist cutting facilities; list of distributors and recommended contractors available from manufacturer

4. Protection technique

Box

5. Application technique

a) Casings assembled by edge screwing
b) Nogging and staple fix option available - contact Promat Technical Services for advice

Joints between panels, of half lap type, are formed by the factory cut rebated edges; no cover fillets are required. The web panels are cut to oversail the flange panels.

6. Steel preparation requirements

None

7. Additional mechanical fixing

For 3-sided applications, a steel angle is fixed to wall or floor soffit. For information on 1 and 2-sided applications, contact Promat Technical Services for advice

8. Nominal density

500 kg/ m^3

9. Thickness range

20 to 60mm in 5mm increments

10. Fire resistance range

(a) Up to 4 hours
(b) Hp/A up to 260m^{-1}
(c) For critical temperature of 620^{o}C, contact Promat Technical Services for advice

11. Constraints for fire resistance

(a) Single thickness casing system with minimum thickness of 20mm and maximum thickness of 60mm
(b) Minimum screw penetration - 30mm

12. Appearance

Off-white with smooth sanded surface to both faces

13. On site use

Internal and semi exposed applications can be installed before building envelope is completed. For external applications contact Promat Technical Services for advice.

14. Durability

High resistance to high humidity and temperature, abrasion, light impact, vermin attack and mould growth.

15. Performance in other BS fire tests

Non-combustible in accordance with BS476-4, so complies with Class 0 and is a Material of Limited Combustibility as defined in the Building Regulations 1991. For information in relation to EN fire tests, contact Promat Technical Services for advice.

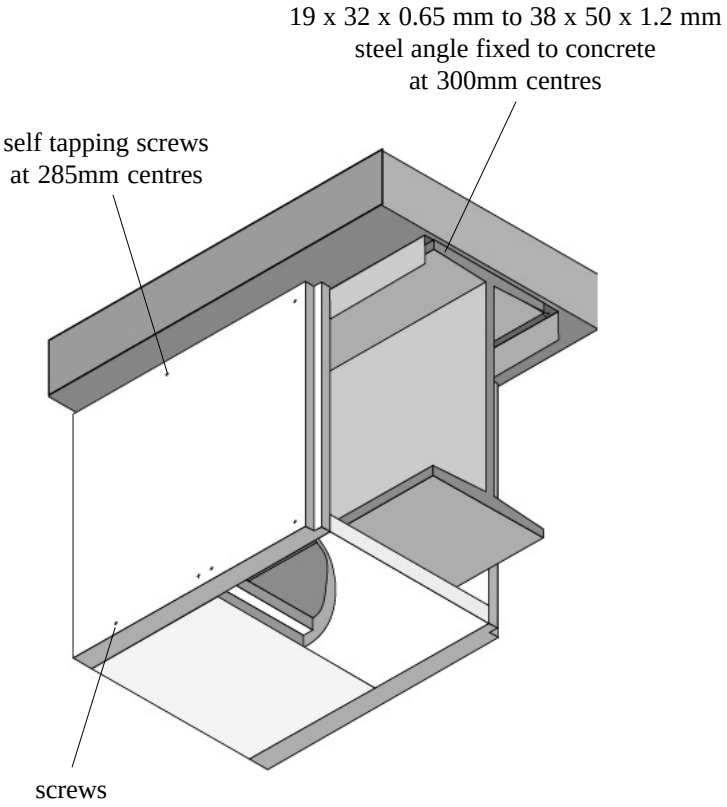
16. Other applications

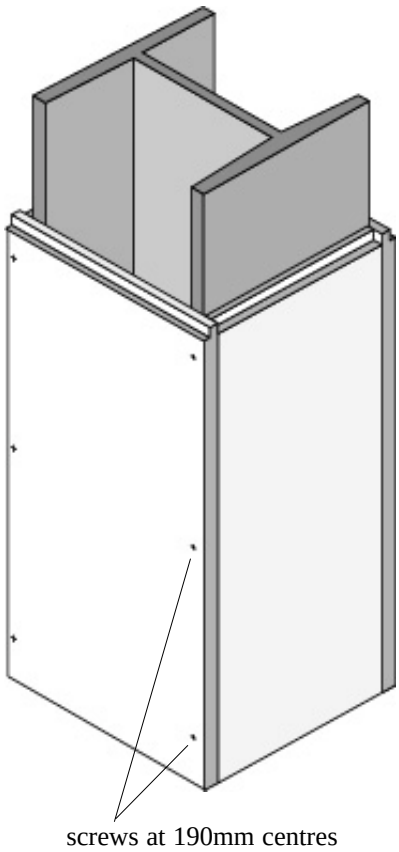
(a) Fire resisting ductwork
(b) Fire protection of services, cables etc
(c) Fire resisting ceilings

Section factor Hp/A(m-1)	Fire resistance period (minutes) 550°C						Product thickness
	30	**60**	**90**	**120**	**180**	**240**	
	260	260	202	114	61		20mm
			260	159	81	54	25mm
				215	103	67	30mm
				260	128	82	35mm
					156	98	40mm
					189	115	45mm
					227	134	50mm
					260	155	55mm
						178	60mm
						227	2 x 35mm
						260	2 x 40mm

TRANSVERSE JOINTS STAGGERED BY 240MM BETWEEN WEB AND FLANGE FACES

TRANSVERSE JOINTS COINCIDENT BETWEEN ADJACENT SIDES





VICUTUBE

1. Product description

Rigid, exfoliated vermiculite, silicate bonded, semi-circular pipe sections

2. Manufacturer

Promat UK Ltd
The Sterling Centre, Eastern Road, Bracknell, Berkshire RG12 2TD W: www.promat.co.uk
Technical: T: 01344 381400 F: 01344 381401 E: technicaluk@promat.co.uk
Marketing: T: 01344 381350 F: 01344 381401 E: marketinguk@promat.co.uk
Sales: T: 01344 381381 F: 01344 381380 E: salesuk@promat.co.uk

3. Availability

Supply through nominated distributors, many offering specialist cutting facilities; list of distriubtors and recommended contractors available from manufacturer.

4. Protection technique

Profile

5. Application technique

The semi-circular sections are held in position by a special cement filling the joints. Temporary wires or tapes can be used to provide support while the cement sets. The cement should be either CV powder / liquid K or ready mixed VICUBOND.

6. Steel preparation requirements

None

7. Additional mechanical fixing

None

8. Nominal density

430 kg/m^3

9. Thickness range

30, 40, 50mm

10. Fire resistance range

(a) Up to 2 hours

(b) Hp/A 45 - 335m^{-1} (circular hollow sections up to 273mm diameter). The data may also be applied to rectangular hollow sections

11. Constraints for fire resistance

(a) Minimum thickness - 30mm

(b) Maximum thickness - 50mm

12. Appearance

Even surface, oatmeal in colour. Decorative finishes, plaster, or sand/cement render may be applied

13. On site use

For internal and semi exposed applications

14. Durability

Resistant to short term moisture exposure, vermin, mould growth, minor impact and abrasion

15. Performance in other BS fire tests

Non-combustible in accordance with BS476-4, so complies with Class 0 and is a Material of Limited Combustibility as defined in the Building Regulations 1991. For information in relation to EN fire tests, contact Promat Technical Services for advice

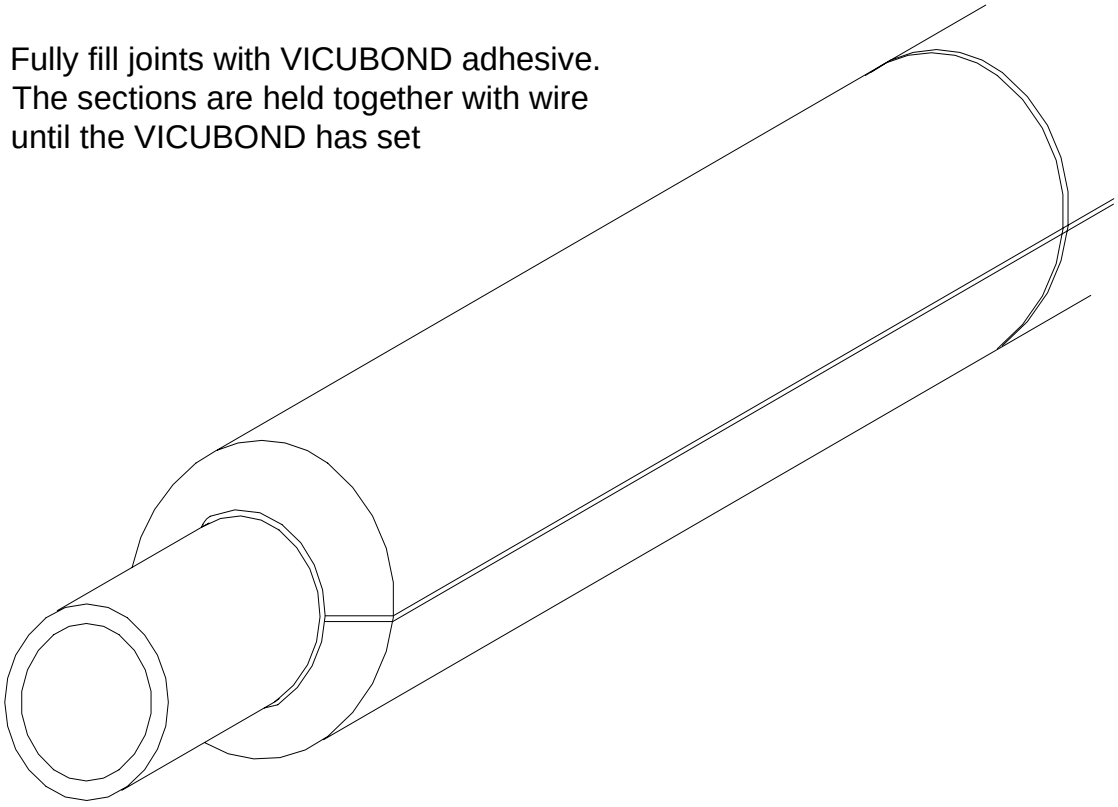
16. Other applications

(a) High temperature thermal insulation

(b) Encasement of boiler flues and PVC pipes

Outside diameter of CHS	Steel Wall thickness	Hp/A	Thickness in mm of casing to provide fire resistance of (minutes)			
			30	60	90	120
48	3.2/4.0	335/275	30	40	50	-
	5.0	330/270	30	30	40	50
60	3.2/4/0	325/270	30	40	50	-
	5.0	220	30	30	40	50
76	3.2/4.0	325/265	30	40	50	-
	5.0	215	30	30	40	50
89	3.2/4.0	325/260	30	40	50	-
	5.0	210	30	30	40	50
114	3.6	285	30	40	50	-
	5.0/6.3	210/170	30	30	40	50
140	5.0/6.3	205/165	30	30	40	50
	8.0/10.0	135/110	30	30	30	40
168	5.0/6.3	205/165	30	30	40	50
	8.0/10.0	130/105	30	30	30	40
219	5.0/6.3	205/165	30	30	40	50
	8.0 to 20.0	130 to 55	30	30	30	40
245	6.3	165	30	30	40	50
	8.0 to 20.0	130 to 55	30	30	30	40
273	6.3	160	30	30	40	50
	8.0 to 25.0	130 to 45	30	30	30	40
For CHS wind bracings use the above thicknesses to a maximum of 30, 40 and 50mm for 60, 90 and 120 mins fire resistance respectively						
Other sizes may be available on request. Not all the wall thicknesses given are readily available. The correct thickness should be confirmed by Promat before specifying.						

Fully fill joints with VICUBOND adhesive.
The sections are held together with wire
until the VICUBOND has set



PROMACASE

1. Product description

A preformed steel encasement incorporating VICUCLAD

2. Manufacturer

Promat
Iver Lane, Uxbridge, Middlesex UB8 2JQ W: www.promat.co.uk
Technical: T: 01895 463400 F: 01895 463401
Marketing: T: 01895 463300 F: 01895 463301
Sales: T: 0141 558 6144 F: 0141 558 2437

3. Availability

Supply through nominated distributors, many offering specialist cutting facilities; list of distributors and recommended contractors available from manufacturer.

4. Protection technique

Box

5. Application technique

VICUCASE components are prefabricated in galvanised, stainless or PVC coated 0.7mm (22swg) sheet steel, folded to suit beams and columns in different sizes and situations. The components, factory lined with the VICUCLAD boards are clipped together to form a locked joint. In inaccessible situations, the components may be screwed together.

6. Steel preparation requirements

None

7. Additional mechanical fixing

Where the casing abuts fire resisting walls, refer to the manufacturer

8. Nominal density

VICUCLAD 350 - 455 kg/m^3. Varies with thickness

9. Thickness range

VICUCLAD 18mm and 20mm to 80mm in 5mm increments

10. Fire resistance range

(a) Up to 4 hours
(b) Hp/A 17 - 260m^{-1}

11. Constraints for fire resistance

See table on opposite page for thickness of VICUCLAD boards for lining VICUCASE.

12. Appearance

Depends upon form of steel sheeting used

13. On site use

For internal and semi exposed applications. External applications may be considered with modification to jointing and fixing to prevent water ingress.

14. Durability

Resistant to impact and abrasion

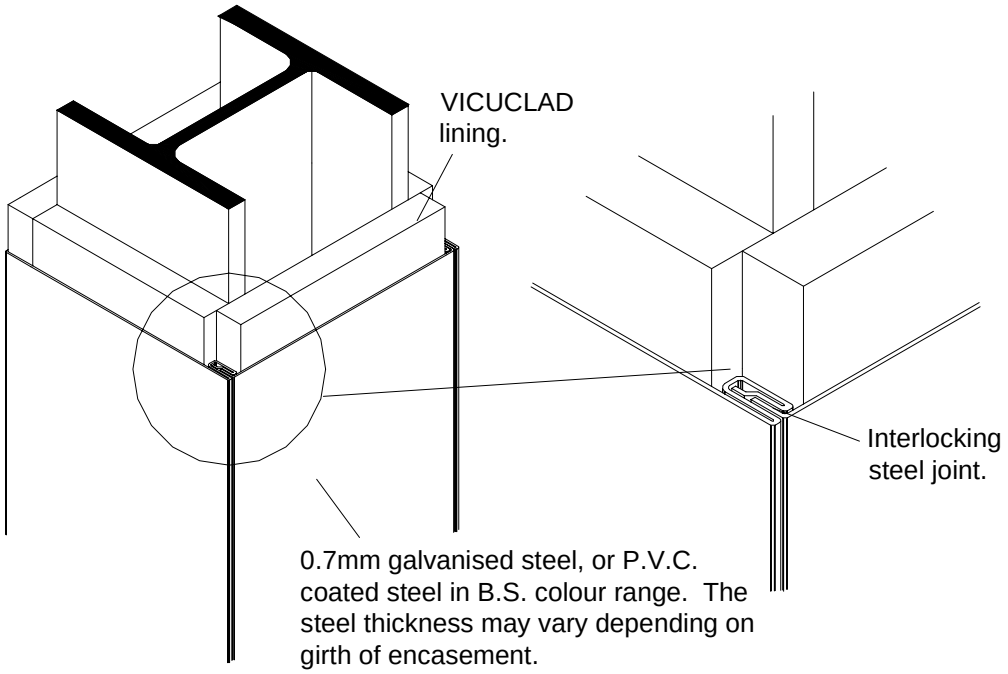
15. Performance in other BS fire tests

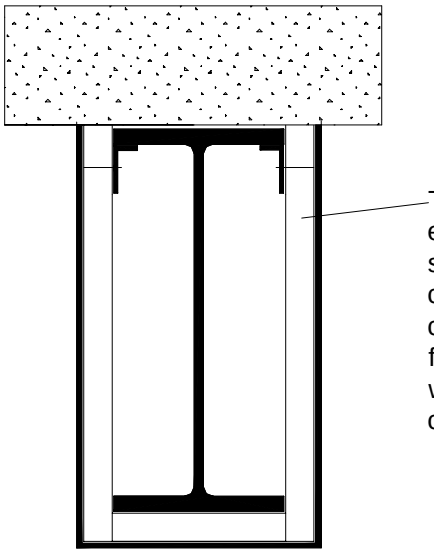
VICUCLAD non-combustible in accordance with BS476: Part 4, complies with Class 0 and is a material of Limited Combustibility as defined by the Building Regulations 1985. For information on performance in relation to EN fire tests, contact Promat Technical Services for advice.

16. Other applications

(a) Ducting
(b) Panelling
(c) Soffit trays
(d) Impact resistant linings

Section factor Hp/A (m-1)	Fire resistance period (minutes)						Product thickness
	30	60	90	120	180	240	
	260	135					18mm
		260	70	40			20mm
			125	55			25mm
			205	85			30mm
			260	120			35mm
				185	65		40mm
				260	80		45mm
					95		50mm
					120	65	55mm
					150	75	60mm
					200	90	65mm
					260	105	70mm
						120	75mm
						140	80mm





ROCKLINER CASING

1. Product description

A preformed steel encasement lined with Rockpan or Spiralite fire protection board. The steel encasement is 22SWG OR 16SWG sheet galvanised painted or PVC coated

2. Manufacturer

Cryotherm Insulation Limited
Hirst Wood Road, Shipley West Yorkshire BDl8 4BU
T: 01274 589175 F: 01274 593315 enq@cryotherm.co.uk

3. Availability

Supply and fix service by approved applicators

4. Protection technique

Standard box, profile or circular

5. Application technique

Casings are prefabricated to suit varying steel sizes and situations. The components are joined by either screw or lock form methods

6. Steel preparation requirements

None

7. Additional mechanical fixing

Rockpan noggings (13mm minimum thickness) or Spiralite noggings (30mm minimum thickness) are bonded to the web at 1.5m centres and at all horizontal joints using suitable adhesive

8. Nominal density

Depends on fire lining board used

9. Thickness range

13 - 40mm Rockpan
20 - 70mm Spiralite

10. Fire resistance range

(a) Hp/A 17 - 260m^{-1}
(b) Up to 2 hours - See table
(c) For 2-4 hours contact the manufacturer

11. Constraints for fire resistance

Depends upon fire lining board used, see the appropriate data sheets in this publication

12. Appearance

Plain metal finish up to high quality decorative finish

13. On site use

For interior and external applications

14. Durability

Resistant to impact or abrasion

15. Performance in other BS fire tests

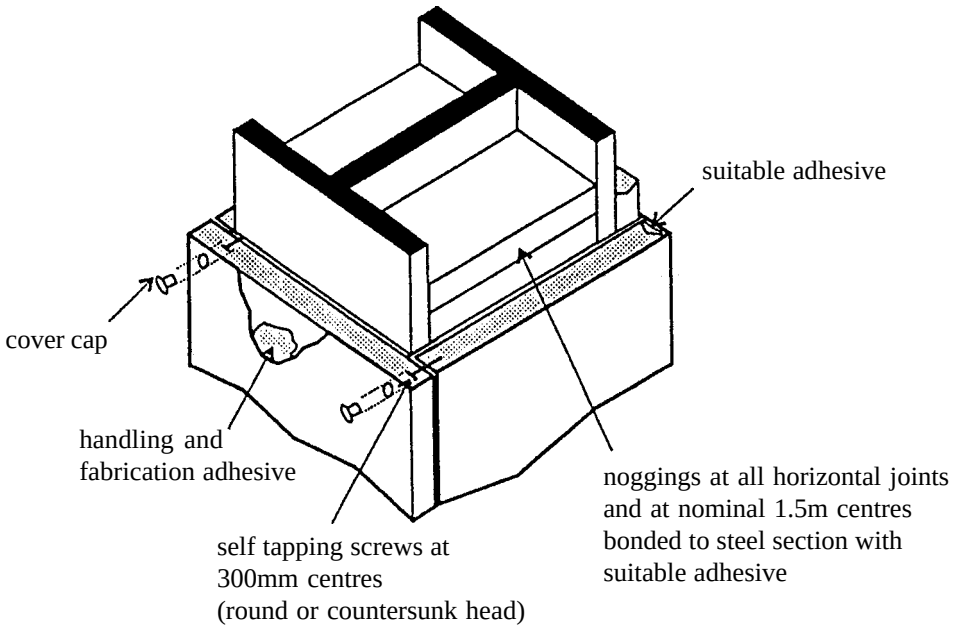
Non-combustible in accordance with BS476: Part 4 so complies with Class 0 as defined in the Building Regulations 1985. Coatings on the metal may not achieve Class 0

16. Other applications

Fire resisting wall and partition systems. Profile and circular sections available

ROCKLINER CASING WITH ROCKPAN					
	Fire resistance period (minutes)				Product thickness
	30	60	90	120	
Section factor Hp/A $^{(m-1)}$	260	184	67	40	13mm
		217	73	44	14mm
		260	90	52	16mm
			99	57	17mm
			131	71	20mm
			212	101	25mm
			260	131	28mm
				148	30mm
				169	32mm
				194	34mm
				221	36mm
				260	40mm

ROCKLINER CASING WITH SPIRALITE					
	Fire resistance period (minutes)				Product thickness
	30	60	90	120	
Section factor Hp/A $^{(m-1)}$	260	260	114	69	20mm
			145	88	25mm
			176	106	30mm
			209	125	35mm
			243	144	40mm
			260	164	45mm
				184	50mm
				204	55mm
				225	60mm
				245	65mm
				260	70mm



BOLLOM FIRESHIELD

1. Product description

Solvent based, thin film intumescent coating

2. Manufacturer

Bollom Fire Protection
PO Box 78, Croydon Road, Beckenham, Kent BR3 4BL
T: 020 8658 2299 F: 020 8658 8672 W: www.bollom.com

3. Availability

Supplied direct from Bollom Fire Protection

4. Nominal specific gravity

1.25 (Practical volume solids 70%)

5. Wet coverage rates

½ hour from 0.36 to 0.71 litres/m^2
1 hour from 0.36 to 4.71 litres/m^2
1½ hour from 1.46 to 4.46 litres/m^2

6. Appearance

Smooth satin finish, with Fireshield Flame Retardant top coat in gloss and eggshell finishes, available in the full Bollom 1000 colour range

7. On site use

Internal and limited external during construction phase or permanent exposed areas, e.g. canopies

10. Other applications

Upgrading cast iron columns Upgrading concrete structures

A. Protection technique

Profile

B. Application technique

Brush or airless spray applied

C. Specification of the system

(a) Degrease steel, remove scale and rust, blast clean to Swedish standard SA2½

(b) Prime with JWB Zinc Phosphate or JWB Zinc Chromate Primer or other approved primers to a dry film thickness of 25-50 microns

(c) Apply Bollom Fireshield to a total loading to achieve ½ hour, I hour or I½ hour fire protection. Application must be carried out by trained and approved applicators in accordance with the manufacturers recommendations. A list of applicators is available upon request.

(d) After application of Bollom Fireshield apply one coat of Fireshield Flame Retardant Top Coat Sealer, to a nominal dry film thickness of 50 microns, choosing a finish, gloss or eggshell, from the Bollom 1000 colour range.
Where Bollom Fireshield has been applied externally, two coats of Fireshield Top Coat Sealer gloss must be applied

	Fire resistance period (minutes)								Product thickness (mm): dry film thickness / wet film thickness
	30	30	60	60	60	30	60	90	
	Universal beam & columns Case A	Beams Case B & Columns	Universal beams	Universal beam Case A	Universal beam Case B	RHS & CHS columns	RHS & CHS columns	Universal beam Case A	
Section factor A/V (Hp/A)	310								0.28 / 0.4
		300				85			0.35 / 0.5
		310				110			0.525 / 0.75
			140	170	140	140			0.7 / 1.0
			175	210	175	165			0.875 / 1.25
			215	260	215	195	35	160	1.05 / 1.50
			225	275	225	220	50	170	1.225 / 1.75
			235	290	235	250	60	180	1.4 / 2.0
			250	310	250	275	75	195	1.575 / 2.25
			270		270	305	85	210	1.75 / 2.5
			295		295	310	100	225	1.925 / 2.75
			310		310		110	245	2.10 / 3.00
							125	250	2.275 / 3.25
							135	260	2.45 / 3.50
							150	265	2.625 / 3.75
							160	275	2.80 / 4.00
							175	285	2.975 / 4.25
							185	295	3.15 / 4.50
							200		3.325 / 4.75

Case A = Beams with concrete cast in contact with top flange
Case B = Beams in cases other than Case 'A' above

BROSTEEL

1. Product description

Water based, thin film Intumescent Coating

2. Manufacturer

Bollom Fire Protection
PO Box 78, Croydon Road, Beckenham, Kent BR3 4BL
T: 020 8658 2299 F: 020 8658 8672 W: www.bollom.com

3. Availability

Bollom Fire Protection Depots and approved Decorators Merchants

4. Nominal specific gravity

1.25 (Practical Volume Solids 60%)

5. Wet coverage rates

½ hour from 0.425 to 1.25 litres/m^2
1 hour from 1.25 to 6.0 litres/m^2

6. Appearance

Smooth satin finish, with a range of decorative top coats in gloss and satin finishes, available in the full BS4800 Colour Range

7. On site use

Internal use only

8. Durability

Tested to BS3900 E3 (Impact Resistance)

9. Performance in other BS and EN fire tests

None

10. Other applications

Upgrading Cast Iron Columns
Upgrading Concrete Structures

A. Protection technique

Profile

B. Application technique

Brush or Airless Spray applied, Graco 433 Airless Unit recommended

C. Specification of the system

(a) Blast clean to Swedish standard SA2½
(b) Prime with JWB Zinc Phosphate or JWB Zinc Chromate Primer or other approved Primers to a dry Film Thickness of 25-50 microns.
(c) Apply Brosteel to a total loading to achieve ½ hour or 1 hour fire protection. It is recommended application is carried out by Bollom's trained and approved applicators or contractors in accordance with the manufacturer's recommendations. A list of applicators/contractors is available upon request.
(d) After application of Brosteel, apply one coat of Chlorcoat, Flame Retardant top coat sealer to a nominal dry film thickness of 50 microns, choosing a finish, gloss or eggshell from the BS4800 (82) colour range.

	Fire resistance period (minutes)								Product thickness
	30	30	30	60	60	60	30	60	
	Universal beams & columns	Beams Case A	Beams Case B	Universal columns	Universal beams Case A	Universal beams Case B	RHS & CHS columns	RHS & CHS columns	
Section factor Hp/A $^{(m-1)}$	225	310	225						0.25mm
	255								0.5mm
	310			135	160	135	200		0.75mm
				145	170	145	210	85	1.0mm
				160	180	160	230		1.25mm
				175	195	175	245	100	1.50mm
				185	205	185	260		1.75mm
				200	220	200	270	110	2.0mm
				225	240	225	305	125	2.25mm
				240	275	240	310	140	2.5mm
				255	310	255		160	2.75mm
				310		310		180	3.00mm
								200	3.4mm

Case A = Beams with concrete cast in contact with top flange
Case B = Beams in cases other than Case 'A' above

FIRESTEEL 47-1

1. Product description

Water based intumescent coating

2. Manufacturer

Firetherm Intumescent & Insulation Supplies Ltd
Unit F Acorn Industrial Park, Crayford Road, Crayford, Kent DA1 4FT
T: 01322 551010 F: 01322 552727 W: www.firetherm.com

3. Availability

Supplied direct from the manufacturers or local distributors overseas.

4. Nominal specific gravity

Basecoat: 1.34 volume solids 75%
Top seals: check individual top seals with manufacturer

5. Wet coverage rates

By brush: 500 microns wet film
By spray: up to 2000 microns wet film depending on conditions

6. Appearance

A bright white, smooth, fibre free basecoat giving a good decorative appearance on its own. A wide variety of water-based, solvent and two pack top seals available in a range of BS 4800, BS 381C and RAL colours, to suit environmental conditions and specified colour choice.

7. On site use

Internal use only

8. Durability

Firesteel provides a hard strong film that is highly resistant to knocks and abrasion when fully cured.

10. Other applications

Suitable for use on a range of suitably primed substrates such as galvanised steel, cast iron and stainless steel. Contact manufacturer for details of other substrates.

A. Protection technique

Profile

B. Application technique

Brush, roller or airless spray

C. Specification of the system

a) Degrease if necessary and remove general contamination prior to blasting
b) Blast clean to Swedish Standard SIS 05 5900 Sa2½ (BS 7079 or equivalent)
c) Apply suitable primer. Most common primers such as single and two-pack zinc phosphates are compatible, contact Firetherm for details or for confirmation of compatibility.
d) Apply basecoat to specified thickness. See table - primer thickness already substracted.
e) Apply topseal if required.

	Total material thickness in mm for fire resistance periods (mins)							
	30	60	90	30	60	90	30	60
$Hp/A^{(m-1)}$	Univeral columns & beams (4-sided)			Universal beams (concrete slab over)			HS columns & beams (4-sided) *	
63					0.39			
70					0.40			
75		0.59			0.42			1.28
80		0.60			0.43			1.47
85		0.61	1.21		0.44			1.65
90		0.64	1.30 (to 91)		0.45			1.84
95		0.67	1.36		0.47			2.03
100		0.70	1.43		0.48			2.22
105		0.73	1.51		0.49	1.16		2.40
110		0.76	1.58		0.51			2.59
115	0.19	0.79	1.65		0.52	1.3 (to 114)		2.71
120	0.20	0.82	1.73		0.53	1.39		2.81
125	0.21	0.85	1.80		0.54	1.47	0.40	2.90
130	0.22	0.88	1.90		0.56	1.54	0.44	3.00
135	0.23	0.91	2.00		0.57	1.62	0.48	3.10
140		0.95	2.10		0.59	1.69	0.51	3.14
145	0.24	0.98			0.61	1.80 (to 147)	0.54	3.18
150	0.25	1.01			0.63	1.84	0.57	3.22
155		1.04			0.65	1.92	0.60	3.26
160	0.26	1.07			0.67	1.99	0.63	3.30
165		1.10			0.69	2.06	0.67	3.34
170	0.27	1.13			0.71	2.10	0.70	3.39
175	0.28	1.16			0.73		0.76	3.43
180		1.19			0.75		0.79	3.47
185	0.29	1.22			0.77		0.82	3.51
190		1.25			0.79		0.85	3.55
195	0.30	1.28			0.81		0.88	3.59
200	0.31	1.31			0.82		0.91	3.63
205		1.34			0.84		0.94	
210	0.32	1.37			0.86		0.96	
215	0.33	1.40			0.88		0.99	
220	0.34	1.43			0.90		1.02	
225		1.46			0.92		1.05	
230	0.35	1.49			0.94		1.08	
235	0.36	1.52		0.20	0.96		1.11	
240	0.37	1.56		0.21	0.98		1.14	
245		1.59		0.22	1.00		1.17	
250	0.38	1.62		0.23	1.02		1.19	
255	0.39	1.65		0.24	1.04		1.22	
260		1.68		0.26	1.06		1.25	
265	0.40	1.70		0.27	1.08		1.28	
270	0.41	2.10		0.28	1.10		1.33	
275				0.29	1.12		1.38	
280	0.42			0.30	1.14		1.38	
285	0.43			0.31	1.16		1.44	
290	0.44			0.32	1.18		1.49	
295	0.45			0.33	1.20		1.54	
300				0.35	1.22		1.59	
305	0.46			0.36	1.24		1.64	
310	0.48			0.37	1.26		1.70	
315	0.49			0.38	1.28		1.75	
320				0.39	1.30		1.80	

* based upon a steel default temperature of 510°C

FIRETEX M51

1. Product description

Firetex M51 water based thin film intumescent coating
Firetex M52 decorative and protective top sealer

2. Manufacturer

Leigh's Paints
Tower Works, Kestor Street, Bolton BL2 2AL
T: 01204 521771 F: 01204 382115 W: www.wjleigh.co.uk

3. Availability

Supplied direct from the manufacturer or regional office

4. Nominal specific gravity

Firetex M51:
Nominal Density 1.4 kg/ltr
Nominal Volume Solids (ASTM 2697) 70%
Firetex M52:
Nominal Density 1.2 kg/ltr
Nominal Volume Solids (ASTM 2697) 36%

5. Wet coverage rate

Firetex M51 - maximum application rates
per spray coat 1070 microns wet / 750 microns dry
per brush coat 430 microns wet / 300 microns dry
Firetex M52 -nominal application rate
per spray coat 138 microns wet / 50 microns dry
per brush coat 138 microns wet / 50 microns dry

6. Appearance

When topcoated with M52 a smooth semi-gloss finish is available in a limited range of shades. May also be overcoated with Firetex M71.

7. On site use

Dry internal areas only. Covering a wide range of A/V (Hp/A) values in 1 coat, with multicoats required for the higher A/V (Hp/A) range.

8. Durability

Firetex M51 / M52 is suitable for use in dry internal areas only.

9. Performance in other BS tests

For details consult manufacturer

10. Other applications

For details consult manufacturer

A Protection technique

Profile

B Application technique

Firetex M51 Spray or brush
Firetex M52 Spray or brush

C Specification of system

Application - min. temp. of 5°C and Max. humidity of 85%

(a) Blast clean to a min. standard of SA 2½ and apply an approved primer. Consult manufacturer for details of approved primers.
(b) See thickness table for required loading
(c) The thicknesses in the table are M51 only

UNIVERSAL SECTIONS						
Section factors Hp/A(m-1)	Product thickness (mm) for Fire resistance period (minutes)					
	30	**60**	**30**	**60**	**30**	**60**
	3 sided beams		4 sided beams		columns	
50				0.28		0.28
75						0.44
85				0.50		
100				0.59		0.59
120		0.28				
135				0.81		
150		0.44		0.90		0.90
180		0.60		1.06		1.06
190				1.10		
200		0.70		1.13		1.13
220		0.80		1.16		
250		0.96				1.30
280		1.11				1.39
310						1.49
330	0.27		0.27		0.27	1.56

HOLLOW SECTIONS				
Section factors Hp/A(m-1)	Product thickness (mm) for Fire resistance period (minutes)			
	30	**60**	**30**	**60**
	CHS columns		SHS/RHS columns	
100		0.81		0.81
130		1.22		1.22
150		1.54		1.54
180		2.01		2.01
220		2.80		2.80
245		3.32		3.32
257		3.56		3.56
320	0.85		0.85	

FIRETEX M77 / M71

1. Product description

Solvent based thin film intumescent coating with decorative top sealer

2. Manufacturer

Leigh's Paints
Tower Works, Kestor Street, Bolton BL2 2AL
T: 01204 521771 F: 01204 382115 W: www.wjleigh.co.uk

3. Availability

Supplied direct from the manufacturer or regional office

4. Nominal specific gravity

Firetex M77: Nominal Density 1.3 kg/ltr
Nominal Volume Solids (ASTM 2697) 70%
Firetex M71: Nominal Density 1.2 kg/ltr
Nominal Volume Solids (ASTM 2697) 40%

5. Wet coverage rate

Firetex M77 - maximum application rates
per spray coat 1428 microns wet giving 1000 microns dry
per brush coat 585 microns wet giving 410 microns dry
Firetex M71 -nominal application rate
per spray coat 250 microns wet giving 100 microns dry
per brush coat 125 microns wet giving 50 microns dry

6. Appearance

When topcoated with M71 a smooth semi-gloss finish is available in a range of BS4800 and RAL shades

7. On site use

Internal and limited external during construction, or permanent partially exposed areas, e.g. canopies. Covering a wide range of Hp/A values in 1 coat, with multicoats required for the higher Hp/A range

8. Durability

Firetex M77 can be left externally for up to 9 months without topcoat.

9. Performance in other BS tests

None

10. Other applications

Fire protection of G.R.P., Aluminium, Galvanised Steel and Cast Iron

A Protection technique

Profile

B Application technique

Spray or Brush

C Specification of system

Application - min. temp. of 5°C and Max. humidity of 85%

(a) Blast clean to a min. standard of SA 2½ and apply an approved primer. Consult manufacturer for details of approved primers.
(b) See thickness table for required loading
(c) The thicknesses in the table are M77 thickness only.
(d) An intumescent mastic, Firetex M72, is available for repair of damaged areas.

UNIVERSAL SECTIONS											
Section factors Hp/A(m-1)	Product thickness (mm) for Fire resistance period (minutes)										
	30	60	90	120	30	60	90	30	60	90	120
	3 sided beams				4 sided beams			columns			
30			0.700						0.375	0.800	1.130
50				2.300							
55						0.775					
75							1.600			1.600	
78			1.450								
85		0.275									
100									0.480		3.000
120		0.460		4.400							
135			1.900								
150							2.275		0.990	2.275	
157				4.800							
175				5.000							3.875
180		0.680	2.275						1.140		
185										2.775	
190					0.275	1.175		0.275			
192							2.875				
200											4.975
220		0.790							1.350		
230										3.875	
250		0.880							1.500		
260										4.975	
280						2.095					
300		1.08							1.650		
310	0.275				0.375	2.375		0.375			
325		1.19				2.775			1.730		
360	0.875				0.875			0.880			

HOLLOW SECTIONS										
Section factors Hp/A(m-1)	Product thickness (mm) for Fire resistance period (minutes)									
	30	60	30	60	30	60	90	120	30	60
	CHS columns		SHS/RHS columns		3 sided SHS/RHS beam				4 sided SHS/RHS	
55		0.775		0.875						0.875
75				1.275						1.275
90		1.275						4.775		
100										
110		1.975					3.175			
130		2.375					4.775			
135				2.175						2.175
145		2.875								
150						0.675				
170		3.375								
180				2.775						2.775
195						0.875				
220		4.375		4.375						4.375
245										4.775
270	0.775								0.875	
280										
310		5.875		5.875	0.275	2.875			1.475	
360	0.875		0.875		0.875					

FIRETEX M78

1. Product description

Solvent based thin film intumescent coating, designed for in-shop application

2. Manufacturer

Leigh's Paints
Tower Works, Kestor Street, Bolton BL2 2AL
T: 01204 521771 F: 01204 382115 W: www.wjleigh.co.uk

3. Availability

Supplied direct from the manufacturer

4. Nominal specific gravity

Firetex M78:
Nominal Density 1.3 kg/ltr
Nominal Volume Solids (ASTM 2697) 70%
Firetex M71:
Nominal Density 1.2 kg/ltr
Nominal Volume Solids (ASTM 2697) 40%

5. Wet coverage rate

Firetex M70 -maximum application rates
per spray coat 1428 microns wet giving 1000 microns dry
per brush coat 585 microns wet giving 410 microns dry
Firetex M71 -nominal application rate
per spray coat 250 microns wet giving 100 microns dry
per brush coat 125 microns wet giving 50 microns dry

6. Appearance

When topcoated with M71 a smooth semi-gloss finish is available in a range of BS4800 and RAL shades

7. On site use

Internal and limited external during construction, or permanent partially exposed areas. Covering a wide range of Hp/A values in 1 coat, with multicoats required for the higher Hp/A range

8. Durability

Firetex M78 can be left externally for up to 9 months without topcoat

9. Performance in other BS and EN tests

For details consult manufacturer

10. Other applications

For details consult manufacturer

A Protection technique

Profile

B Application technique

Spray or Brush

C Specification of system

Application - min. temp. of 5°C and Max. humidity of 85%

(a) Blast clean to a min. standard of SA 2½ and apply an approved primer. Consult the manufacturer for details of approved primers.
(b) See thickness table for required loading.
(c) The thicknesses in the table are M78 thickness only.
(d) An intumescent mastic, Firetex M72, is available for repair of damaged areas.

UNIVERSAL SECTIONS											
Section factors Hp/A(m-1)	Product thickness (mm) for Fire resistance period (minutes)										
	30	60	90	120	30	60	90	30	60	90	120
	3 sided beams				4 sided beams			columns			
30			0.700						0.375	0.800	1.130
50				2.300							
55						0.775					
75							1.600			1.600	
78			1.450								
85		0.275									
100									0.480		3.000
120		0.460		4.400							
135			1.900								
150							2.275		0.990	2.275	
157				4.800							
175				5.000							3.875
180		0.680	2.275						1.140		
185										2.775	
190					0.275	1.175		0.275			
192							2.875				
200											4.975
220		0.790							1.350		
230										3.875	
250		0.880							1.500		
260										4.975	
280						2.095					
300		1.08							1.650		
310	0.275				0.375	2.375		0.375			
325		1.19				2.775			1.730		
360	0.875				0.875			0.880			

HOLLOW SECTIONS										
Section factors Hp/A(m-1)	Product thickness (mm) for Fire resistance period (minutes)									
	30	60	30	60	30	60	90	120	30	60
	CHS columns		SHS/RHS columns		3 sided SHS/RHS beam				4 sided SHS/RHS	
55		0.775		0.875						0.875
75				1.275						1.275
90		1.275						4.775		
100										
110		1.975					3.175			
130		2.375					4.775			
135				2.175						2.175
145		2.875								
150						0.675				
170		3.375								
180				2.775						2.775
195						0.875				
220		4.375		4.375						4.375
245										4.775
270	0.775								0.875	
280										
310		5.875		5.875	0.275	2.875			1.475	
360	0.875		0.875		0.875					

NONFIRE S167

1. Product description

Water based intumescent coating

2. Manufacturer

Tikkurila Coatings Ltd
Kelvin Way, West Bromwich, West Midlands B70 7JZ
Tel: 0121 525 5665
Fax: 0121 553 2787
Web: www.tikkurila.co.uk

3. Availability

Supplied direct from Tikkurila Coatings

4. Nominal specific gravity

Nominal Density: 1.27 kg/l
Nominal Volume Solids: 70%

5. Wet coverage rate

Airless spray: Maximum wet film thickness per coat – 2285 microns, giving 1600 microns dry.
Brush/roller: maximum wet film thickness per coat - 714 microns, giving 500 microns dry, for higher cosmetic finish. Where cosmetic finish is not important, product may be applied up to 1428 microns wet, giving 1000 microns dry.

6. Appearance

Smooth matt off-white finish. Gloss or semi-gloss finish in a wide range of colours available when topcoated.

7. On site use

Internal use only. Recommended for ISO 12944 C1 or C2 conditions.

8. Durability

Consult Manufacturer for details.

9. Performance in other BS and EN tests

Consult manufacturer for details.

10. Other applications

Consult manufacturer for details.

A Protection technique

Profile

B Application technique

Airless Spray, brush & roller

C Specification of system

a) Blast clean to Sa2½ and apply approved primer – consult manufacturer's technical information for details of range of approved primers.
b) Apply Nonfire S167 to appropriate thickness – consult loading table.
c) Apply Tikkurila topseal as required (not required for C1 environments).

Consult manufacturers technical literature for full details.

UNIVERSAL SECTIONS						
Section factors Hp/A(m-1)	Product thickness (mm) for Fire resistance period (minutes)					
	30	60	90	30	60	90
	columns at 550°C			beams at 620°C (90 mins at 528°C)		
50		0.30				
55						1.70
60		0.35			0.30	1.75
65		0.40				1.80
70		0.45			0.35	1.85
75						1.95
80		0.50			0.40	2.00
85		0.55				2.05
90		0.60				2.15
95					0.45	2.20
100		0.65	1.70			2.25
105		0.70	1.80		0.50	2.35
110		0.75	1.90			2.40
115			2.00		0.55	2.50
120		0.80	2.10			2.55
125		0.85	2.20		0.60	2.60
130		0.90	2.30			2.70
135			2.40		0.65	2.75
140		0.95	2.50			2.80
145		1.00	2.60		0.70	2.90
150		1.05	2.70			2.95
155			2.80		0.75	3.00
160		1.10	2.90			3.10
165		1.15	3.00			3.15
170		1.20	3.10		0.80	3.20
175			3.15			3.25
180		1.25	3.30		0.85	3.35
185		1.30	3.40			3.40
190		1.35	3.45		0.90	
195			3.55			
200		1.40	3.60		0.95	
205		1.45	3.70			
210		1.50	3.80		1.00	
215	0.25					
220		1.55			1.05	
225		1.60				
230		1.65				
235	0.30				1.10	
240		1.70				
245		1.80			1.15	
250	0.35	1.85				
255		1.95			1.20	
260		2.00				
265		2.10			1.25	
270	0.40	2.15				
275		2.25			1.30	
280		2.30				
285		2.40			1.35	
290	0.45	2.45				
295		2.55				
300		2.60		0.25	1.40	
305	0.50	2.70				
310		2.75			1.45	
315		2.80				
320	0.55	2.90		0.30	1.50	
325		3.00				
330	0.60	3.05		0.35	1.55	

HOLLOW SECTIONS columns 522oC						
Section factors Hp/A(m-1)	60	90		Section factors Hp/A(m-1)	30	60
45	0.54					
50	0.62			235		
55	0.71			240		2.40
60	0.79			245		2.45
65	0.87	3.10		250		
70	0.96			255		2.50
75	1.04			260		
80	1.12			265		2.55
85	1.20			270	0.5	
90	1.29	3.15		275		2.60
95	1.37			280	0.55	2.65
100	1.45	3.20		285		
105	1.54	3.25		290	0.6	2.70
110	1.62			295		
115	1.70	3.30		300	0.7	2.75
120				305		
125	1.75	3.35		310	0.75	2.80
130	1.80			315	0.8	2.85
135		3.40		320	0.85	
140	1.85			325		2.90
145		3.45		330	0.9	
150	1.90	3.50		335		2.95
155				340	0.95	
160	1.95	3.55		345	1	3.00
165	2.00			350	1.05	3.05
170				360	1.1	3.10
175	2.05			365	1.15	
180				370		3.15
185	2.10			375	1.2	
190				380	1.25	3.20
195	2.15			390	1.3	3.25
200	2.20			395	1.35	3.30
205				400	1.4	
210	2.25			405		3.35
215				410	1.45	
220	2.30			415	1.50	3.40
225				425	1.55	3.45
230	2.35			430	1.60	3.50

NONFIRE S168

1. Product description

Water borne intumescent coating

2. Manufacturer

Tikkurila Coatings Ltd
Kelvin Way, West Bromwich, West Midlands B70 7JZ
Tel: 0121 525 5665
Fax: 0121 553 2787
Web: www.tikkurila.co.uk

3. Availability

Supplied direct from Tikkurila Coatings

4. Nominal specific gravity

Nominal Density: 1.35 kg/l
Nominal Volume Solids: 70%

5. Wet coverage rate

Airless spray: Maximum wet film thickness per coat – 2285 microns, giving 1600 microns dry. Brush/roller: maximum wet film thickness per coat - 714 microns, giving 500 microns dry, for higher cosmetic finish. Where cosmetic finish is not important, product may be applied up to 1428 microns wet, giving 1000 microns dry.

6. Appearance

Smooth matt off-white finish. Gloss or semi-gloss finish in a wide range of colours available when topcoated.

7. On site use

Internal use only. Recommended for ISO 12944 C1 or C2 conditions.

8. Durability

The coating has been tested to BS3900-E3 (impact resistance) and BS3900-E2 (scratch resistance) with good results and is therefore shown to be able to resist reasonable levels of 'wear and tear' for good long term performance.

9. Performance in other BS and EN tests

Consult manufacturer for details.

10. Other applications

Consult manufacturer for details.

A Protection technique

Profile

B Application technique

Airless Spray, brush & roller

C Specification of system

a) Blast clean to Sa2½ and apply approved primer – consult manufacturer's technical information for details of range of approved primers.
b) Apply Nonfire S168 to appropriate thickness – consult loading table.
c) Apply Tikkurila topseal as required (not required for C1 environments).

Consult manufacturers technical literature for full details.

Universal beams (3 sided exposure) critical temperature 620°C			
$Hp/A^{(m-1)}$	Basecoat dft required for fire resistance periods of (minutes):		
	30	**60**	90
100			0.72
105			0.77
110			0.82
115			0.87
120			0.92
125			1.02
130			1.07
135		0.20	1.12
140		0.21	1.17
145		0.23	1.22
150		0.25	1.27
155		0.27	1.32
160		0.29	1.40
165		0.31	
170		0.33	
175		0.35	
180		0.37	
190		0.39	
195		0.41	
200		0.43	
205		0.45	
210	0.20	0.47	
215		0.49	
220		0.51	
225	0.21	0.53	
230		0.55	
235		0.56	
240	0.22	0.57	
245		0.58	
250		0.60	
255	0.23	0.61	
260		0.62	
265	0.24	0.63	
270		0.65	
275		0.66	
280	0.25	0.67	
285		0.68	
290		0.69	
295	0.26	0.71	
300		0.72	
305		0.77	
310	0.27	0.82	
315		0.87	
320	0.28	0.97	
325		1.02	
330		1.07	

Universal columns (4 sided exposure) critical temperature 462°C			Universal beams (4 sided exposure) critical temperature 550°C		
$Hp/A^{(m-1)}$	Basecoat dft required for fire resistance periods of (minutes):		Basecoat dft required for fire resistance periods of (minutes):		
	30	**60**	**30**	**60**	**90**
45					0.72
50					0.75
55					0.78
60					0.81
65					0.84
70					0.90
75					0.93
80		0.52			0.96
85		0.54			0.99
90		0.56			1.02
95		0.58			1.05
100		0.60			1.08
105					1.14
110		0.62			1.17
115	0.20	0.64			1.20
120		0.66			1.23
125	0.21	0.68			1.26
130		0.70		0.20	1.29
135	0.22	0.72		0.25	1.32
140		0.74		0.28	1.35
145	0.23	0.76		0.31	1.40
150	0.24	0.78		0.35	
155				0.38	
160	0.25	0.80		0.41	
165		0.82	0.20	0.45	
170	0.26	0.85		0.48	
175		0.88		0.51	
180	0.27	0.91	0.21	0.55	
185		0.94		0.56	
190	0.28	1.00		0.58	
195		1.03	0.22	0.59	
200	0.29	1.06		0.60	
205		1.09		0.62	
210	0.30	1.12	0.23	0.63	
215		1.15		0.65	
220	0.31	1.18		0.66	
225		1.24		0.68	
230	0.32	1.27	0.24	0.69	
235		1.30		0.70	
240	0.33	1.33		0.72	
245	0.34	1.36	0.25	0.76	
250		1.40		0.80	
255	0.35	1.43		0.84	
260		1.46	0.26	0.88	
265	0.36	1.49		0.92	
270		1.52		0.96	
275	0.37	1.58		1.00	
280		1.60	0.27	1.04	
285	0.38			1.08	
290				1.12	
295	0.39		0.28	1.16	
300				1.20	
305	0.40			1.24	
310			0.29	1.28	
315	0.41			1.32	
320	0.42			1.36	
325				1.40	
330	0.43		0.30		

NULLIFIRE SYSTEM S602 / S603

1. Product description

Solvent based thin film intumescent coating with decorative topseal range
S602 brush/spray grade
S603 high build spray grade

2. Manufacturer

Nullifire Limited
Torrington Avenue, Coventry CV4 9TJ
T: 02476 855000 F: 02476 469547 W: www.nullifire.com

3. Availability

UK Mainland: immediate supply direct from Nullifire Ltd
Overseas: direct UK supply or through local distributors

4. Nominal Density (g/ml)

Basecoat: 1.27-1.31 (Practical Volume Solids 70%)
Topcoat: varies with topseal type

5. Wet coverage rates

Max. basecoat wet application rates/coat:-

	S602	S603
Brush	500 g/m²	n/a
Roller	800 g/m²	n/a
Spray	1000 g/m²	1500 g/m²

Relationship between wet application rate and dry film thickness is as follows

Application rate (g/m²)	D.F.T. (mm)	Application rate (g/m²)	D.F.T (mm)
500	0.27	3500	1.88
1000	0.54	4000	2.15
1500	0.81	4500	2.42
2000	1.08	5000	2.69
2500	1.35	5500	2.96
3000	1.62	6000	3.23

NB. Values relate to basecoat only. An allowance should be made for primer and topseal

6. Appearance

Smooth fibre free basecoat
Full range of BS4800 / RAL colour decorative topseals available

7. On site use

Internal: limited external during construction phase, and partial external e.g. canopies

8. Durability

Good resistance to impact and abrasion. Successfully fire tested utilising structural sections after extensive accelerated and natural ageing.

9. Performance in other BS and EN fire tests

Manufactured in accordance with the requirements of ISO 9000

10. Other applications

Suitable for the fire protection of galvanised steel and cast iron.

A. Protection technique

Profile

B. Application technique

Airless spray, roller or brush

C. Specification of system

(a) Blast clean to SA 2½ (preferred) or wire brush and degrease millscaled steel
(b) Apply Nullifire Carboline or other compatible primer
(c) Apply basecoat to required thickness (see table)
(d) Apply selected decorative topseal

Universal beams and columns (4 sided exposure) critical temperature 550°C		
$Hp/A^{(m-1)}$	Basecoat dft required for fire resistance periods of (minutes):	
	30	**60**
40	0.70	0.90
50		
60		
70		
80		
90		0.95
100		1.05
110		1.10
120		1.15
130		
140		1.20
150		1.25
160		
170	0.75	1.30
180		1.35
190	0.80	1.40
200		
210	0.85	1.45
220		1.50
230		1.55
240	0.90	1.60
250		
260		1.65
270	0.95	1.70
280		1.75
290		
300	1.00	1.80
310		1.85
320		1.90
0.1mm should be allowed for the primer and topseal		

RHS columns & beams (4 sided exposure) critical temperature 419°C		
$Hp/A^{(m-1)}$	Basecoat dft required for fire resistance periods of (minutes):	
	30	**60**
40	1.60	1.70
50		
60		
70		
80		
90		
100		1.80
110		1.95
120		2.25
130		2.55
140		2.85
150		3.15
160		3.45
170		
180		
190	1.65	
200	1.70	
210	1.80	
220	1.85	
230	1.90	
240	1.95	
250		
260	2.00	
270	2.05	
280	2.15	
290	2.20	
300	2.30	
310	2.35	
320	2.45	
0.1mm should be allowed for the primer and topseal		

CHS columns & beams critical temperature 511°C		
$Hp/A^{(m-1)}$	Basecoat dft required for fire resistance periods of (minutes):	
	30	**60**
40	1.60	1.60
50		
60		
70		
80		
90		
100		
110		
120		1.70
130		1.95
140		2.10
150		2.20
160		2.30
170		2.35
180		2.45
190		2.55
200		2.60
210		2.70
220		2.75
230		2.85
240		2.95
250	1.70	3.00
260	1.75	
270	1.85	
280	2.00	
290	2.10	
300		
310	2.15	
320	2.20	
0.1mm should be allowed for the primer and topseal		

I beam (3-sided exposure) critical temperature 590°C		
$Hp/A^{(m-1)}$	Basecoat dft required for fire resistance periods of (minutes):	
	30	**60**
204		1.80
320	1.05	
0.1mm should be allowed for the primer and topseal		

RHS beam (3-sided exposure) critical temperature 603°C			
$Hp/A^{(m-1)}$	Basecoat dft required for fire resistance periods of (minutes):		
	30	**60**	90
157			1.80
245		1.80	
320	1.80		
0.1mm should be allowed for the primer and topseal			

NULLIFIRE SYSTEM S605

1. Product description

Solvent based thin film intumescent coating with decorative topseal range

2. Manufacturer

Nullifire Limited
Torrington Avenue, Coventry CV4 9TJ
T: 02476 855000 F: 02476 469547 W: www.nullifire.com

3. Availability

UK Mainland: immediate supply direct from Carboline Europe
Overseas: direct UK supply or through local distributors

4. Nominal density (g/ml)

Basecoat: 1.33-1.36 (Practical Volume Solids 68%)
Topseal: varies with topseal types

5. Wet coverage rates

Max. basecoat wet application rates/coat:
Brush 750 g/m^2
Airless spray 1500 g/m^2 (spray grade)
Relationship between wet application rate and dry film thickness:

Application rate (g/m^2)	D.F.T. (mm)	Application rate (g/m^2)	D.F.T. (mm)
500	0.25	6500	3.22
1000	0.50	7000	3.47
1500	0.75	7500	3.72
2000	0.99	8000	3.97
2500	1.24	8500	4.22
3000	1.49	9000	4.46
3500	1.74	9500	4.71
4000	1.98	10000	4.96
4500	2.23	10500	5.21
5000	2.48	11000	5.46
5500	2.73	11500	5.71
6000	2.98	12000	5.95

NB. Values relate to basecoat only. An allowance should be made for primer and topseal

6. Appearance

Smooth fibre free basecoat
Full range of BS4800 / RAL colour decorative topseals available

7. On site use

Internal and external. Can be used on steelwork immediately following erection. Can be left up to 12 months without top sealing once fully cured.

8. Durability

Good resistance to impact and abrasion. Successfully fire tested utilising structural sections after extensive accelerated and natural ageing.

9. Performance in other tests

Manufactured in accordance with the requirements of ISO 9000

10. Other applications

Suitable for the fire protection of a range of steel and cast iron.

A. Protection technique

Profile

B. Application technique

Airless spray, roller or brush

C. Specification of system

(a) Blast clean to SA 2½ (preferred) or wire brush and degrease mill scaled steel
(b) Apply Nullifire Carboline or other compatible primer
(c) Apply basecoat to required thickness (see table)
(d) Apply selected decorative topseal

Universal beams (4 sided exposure) critical temperature 544°C

Hp/A (m-1)	dft required for fire resistance periods of (minutes):			
	30	60	90	120
20				1.30
30			1.30	1.60
40			1.35	1.85
50			1.40	2.10
60			1.45	2.35
70			1.55	2.65
80			1.60	2.90
90		0.80	1.65	3.15
100		0.85	1.80	3.60
110		0.90	1.90	4.20
120		0.95	1.95	4.60
130	0.35	1.00	2.05	4.75
140	0.45	1.05	2.10	4.90
150	0.50	1.25	2.15	5.05
160	0.55	1.40	2.25	5.20
170	0.65	1.45	2.30	5.35
180	0.70	1.55	2.35	5.50
190	0.75	1.60	2.40	5.60
200		1.65	2.65	6.25
210	0.80	1.75	3.15	
220		1.80	3.70	
230	0.85	1.90	4.20	
240		1.95	4.70	
250	0.90	2.05	5.20	
260		2.10	5.70	
270	0.95	2.20	6.25	
280		2.25		
290	1.00	2.35		
300	1.05	2.40		
310	1.15	2.50		
320	1.20	2.70		

0.1mm should be allowed for the primer and topseal

Universal beams (3 sided exposure) critical temperature 592 & 620°C

Hp/A (m-1)	dft required for fire resistance periods of (minutes):			
	30	60	90	120
20				
30				
40				
50				
60				
70				
80				
90				
100				
110				
120				
130				
140				
150				
160				
170		0.85	1.95	4.90
180			2.05	
190		0.90	2.15	
200		0.95	2.25	
210	0.35	1.00	2.3	
220		1.05	2.4	
230	0.40	1.10	2.5	
240		1.15	3.95	
250	0.45	1.20		
260		1.25		
270		1.30		
280	0.50	1.35		
290		1.45		
300	0.55	1.50		
310		1.60		
320	0.60	1.65		

0.1mm should be allowed for the primer and topseal

Universal columns (4 sided exposure) critical temperature 544°C

Hp/A (m-1)	dft required for fire resistance periods of (minutes):			
	30	60	90	120
20				1.30
30			1.30	1.60
40			1.35	1.85
50			1.40	2.10
60			1.45	2.35
70			1.55	2.65
80			1.60	2.90
90		0.80	1.65	3.15
100		0.85	1.80	3.60
110		0.90	1.90	4.20
120		0.95	1.95	4.60
130	0.35	1.00	2.05	4.75
140	0.45	1.05	2.10	4.90
150	0.50	1.25	2.15	5.05
160	0.55	1.40	2.25	5.20
170	0.65	1.45	2.30	5.35
180	0.70	1.55	2.35	5.50
190	0.75	1.60	2.40	5.60
200		1.65	2.65	6.25
210	0.80	1.75	3.15	
220		1.80	3.70	
230	0.85	1.90	4.20	
240		1.95	4.70	
250	0.90	2.05	5.20	
260		2.10	5.70	
270	0.95	2.20	6.25	
280		2.25		
290	1.00	2.35		
300	1.05	2.40		
310	1.15	2.50		
320	1.20	2.70		

0.1mm should be allowed for the primer and topseal

CHS columns & beams critical temperature 500°C

Hp/A (m-1)	dft required for fire resistance periods of (minutes):			
	30	60	90	120
29				2.70
40		1.05	1.75	
50				
60		1.20	2.35	
70			2.60	
80		1.50		
90				
100	1.05	1.80		
110				
120	1.10	2.10		
130				
140	1.20	2.40		
150				
160	1.30	2.70		
170				
180	1.45	3.20		
190				
200	1.55			
210				
220	1.65			
230				
240	1.75			
250				
260	1.90			
270				
280	2.00			
290				
300	2.10			
310				
320	2.20			

0.1mm should be allowed for the primer and topseal

RHS columns & beams critical temperature 530°C

Hp/A (m-1)	dft required for fire resistance periods of (minutes):			
	30	60	90	120
33				2.70
40		1.05	1.45	
50				
60		1.10	2.10	
70			2.75	
80		1.30		
90				
100		1.55		
110				
120	1.05	1.75		
130				
140	1.10	2.00		
150				
160	1.20	2.20		
170				
180	1.30	2.85		
190				
200	1.40	3.05		
210				
220	1.50	3.25		
230				
240	1.65			
250				
260	1.75			
270				
280	1.85			
290				
300	1.95			
310				
320	2.05			

0.1mm should be allowed for the primer and topseal

NULLIFIRE S606

1. Product description

Solvent based thin film intumescent coating with decorative topseal range

2. Manufacturer

Nullifire Limited
Torrington Avenue, Coventry CV4 9TJ
T: 02476 855000 F: 02476 469547 W: www.nullifire.com

3. Availability

UK Mainland: immediate supply direct from Nullifire Ltd
Overseas: direct UK supply or through local distributors

4. Nominal density (g/ml)

Basecoat: 1.34-1.37 (Practical volume solids 68%)
Topseal: varies with topseal types

5. Wet coverage rates

Max. basecoat wet application rates/coat:
Brush 750 g/m^2
Airless spray 1500 g/m^2 (spray grade)
Relationship between wet application rate and dry film thickness:

Application rate (g/m^2)	D.F.T. (mm)	Application rate (g/m^2)	D.F.T. (mm)
500	0.25	6500	3.22
1000	0.50	7000	3.47
1500	0.75	7500	3.72
2000	0.99	8000	3.97
2500	1.24	8500	4.22
3000	1.49	9000	4.46
3500	1.74	9500	4.71
4000	1.98	10000	4.96
4500	2.23	10500	5.21
5000	2.48	11000	5.46
5500	2.73	11500	5.71
6000	2.98	12000	5.95

NB. Values relate to basecoat only. An allowance should be made for primer and topseal

6. Appearance

Smooth fibre free basecoat
Full range of BS4800 / RAL colour decorative topseals available

7. On site use

Internal and semi-external. Can be used on steelwork immediately following erection. Can be left up to three months without top sealing.

8. Durability

Good resistance to impact and abrasion. Successfully fire tested utilising structural sections after extensive accelerated and natural ageing.

9. Performance in other tests

Manufactured in accordance with the requirements of ISO 9000

10. Other applications

Suitable for the fire protection of a range of other substances including galvanised steel and cast iron.

A. Protection technique

Profile

B. Application technique

Airless spray, roller or brush

C. Specification of system

(a) Blast clean to SA 2½ (preferred) or wire brush and degrease mill scaled steel
(b) Apply Nullifire Carboline or other compatible primer
(c) Apply basecoat to required thickness (see table)
(d) Apply selected decorative topseal

Fire resistance period 30 minutes					
Hp/A(m-1)	Universal Beams (3-sided) **	Universal Columns & Beams (4-sided) ***	RHS Columns & Beams ***	CHS Columns & Beams ***	Dry film thickness (mm) *
	320	320			0.32
			260	240	0.55
				260	0.60
* 0.02mm should be allowed for primer					

For all tables:
**** Tested using critical temperature of 620°C**
***** Tested using critical temperature of 550°C**

Fire resistance period 60 minutes					
Hp/A (m-1)	Universal Beams (3-sided) **	Universal Beams & Columns (4-sided) ***	RHS Columns & Beams (4 sided) ***	CHS Columns & Beams ***	Total dry film thickness (mm) *
	40				0.32
		40			0.35
	60				0.40
	80	60			0.50
			80		0.55
	100			70	0.60
	120	80			0.70
			100	80	0.75
	140	100			0.80
	160				0.90
		120			0.95
	180			100	1.00
			120		1.05
	200	140			1.10
	220	160			1.20
	240				1.30
	260	180			1.35
			140		1.36
				120	1.40
	280	200			1.45
	300	220			1.55
	320				1.60
		240			1.65
			160		1.70
		260			1.80
				140	1.85
		280			1.90
		300			2.00
		320			2.10
			180		2.15
				160	2.25
			200	180	2.65
			220		2.91
				200	3.00
			240		3.20
				220	3.30
			260		3.50
				240	3.65
				260	3.95
* 0.02mm should be allowed for primer					

Fire resistance period 90 minutes					
Hp/A (m-1)	Universal Beams (3-sided) **	Universal Beams (4-sided) ***	RHS Columns & Beams (4 sided) ***	CHS Columns & Beams ***	Total dry film thickness (mm) *
	40				0.60
	60				0.80
		40			0.90
	80				1.00
		60			1.05
	100				1.20
		80			1.25
	120				1.40
		100			1.45
	140		70		1.60
		120			1.70
			80		1.75
	160				1.80
	180		100		2.00
		140		70	2.05
	200				2.15
				80	2.20
		160			2.30
	220				2.35
		180		100	2.55
	240				2.60
			120		2.65
		200			2.75
	260				2.80
	280	220			3.00
	300	240			3.25
				120	3.35
			140		3.40
	320	260			3.45
		280			3.70
				130	3.90
		300			3.95
		320			4.15
* 0.02mm should be allowed for primer					

Fire resistance period 120 minutes				
Hp/A (m-1)	Universal Beams (3-sided) **	Universal Beams (4-sided) ***	RHS Columns & Beams (4 sided) ***	Total dry film thickness (mm)*
	40			1.05
	60			1.25
	80	40		1.45
		60		1.65
	100			1.75
		80		2.00
	120			2.30
		100		2.40
	140			2.70
		120		2.95
	160			3.10
	180			3.40
		140		3.55
	200			3.75
		160		3.85
	220			4.05
		180	100	4.10
	240			4.30
		200		4.55
		220		5.35
		240		6.15
* 0.02mm should be allowed for primer				

NULLIFIRE S607 HB

1. Product description

Water-borne based thin film intumescent coating with decorative topseal range

2. Manufacturer

Nullifire Limited
Torrington Avenue, Coventry CV4 9TJ
T: 02476 855000 F: 02476 469547 W: www.nullifire.com

3. Availability

UK Mainland: immediate supply direct from Nullifire Ltd
Overseas: direct UK supply or through local distributors

4. Nominal density (g/ml)

Basecoat: 1.36 - 1.39
Topseal: varies with topseal types

5. Wet coverage rates

Max. basecoat wet application rates/coat:
Brush 1000 g/m^2
Airless spray 1500 g/m^2
Relationship between wet application rate and dry film thickness:

Application rate (g/m^2)	D.F.T. (mm)	Application rate (g/m^2)	D.F.T. (mm)
500	0.22	6500	2.90
1000	0.45	7000	3.12
1500	0.67	7500	3.35
2000	0.89	8000	3.57
2500	1.12	8500	3.79
3000	1.34	9000	4.01
3500	1.56	9500	4.24
4000	1.78	10000	4.46
4500	2.01	10500	4.68
5000	2.23	11000	4.91
5500	2.45	11500	5.13
6000	2.68	12000	5.35

NB. Values relate to basecoat only. An allowance should be made for primer and topseal

6. Appearance

Smooth fibre free basecoat
Full range of BS4800 / RAL colour decorative topseals available

7. On site use

Internal only. Can be used on steelwork immediately following erection providing basecoat is kept dry.

8. Durability

Good resistance to impact and abrasion. Successfully fire tested utilising structural sections after extensive accelerated and natural ageing.

9. Performance in other tests

Manufactured in accordance with the requirements of ISO 9000

10. Other applications

Suitable for the fire protection of a range of other substances including galvanised steel and cast iron.

A. Protection technique

Profile

B. Application technique

Airless spray, roller or brush

C. Specification of system

(a) Blast clean to SA 2½ (preferred) or wire brush and degrease mill scaled steel
(b) Apply Nullifire Carboline or other compatible primer
(c) Apply basecoat to required thickness (see table)
(d) Apply selected decorative topseal

Fire resistance period 30 minutes					
Hp/A (m-1)	Universal Beams (3-sided) ***	Universal beams & columns (4-sided) **	RHS Columns & Beams	CHS Columns & Beams ****	Dry film thickness (mm) *
		120			0.25
	210	160			0.30
		190			0.35
	280	200			0.40
		210			0.45
	320	230	210	210	0.50
		240			0.55
		250			0.60
		280			0.65
		300			0.70
		320			0.75
			320	320	1.70
* dft's for universal beams and columns 4 sided basecoat only * dft's for all other sections should allow 0.1mm for primer and topseal as per assessment.					
** Tested using a critical temperature of 548°C					
*** Tested using a critical temperature of 620°C					
**** Tested using a critical temperature of 515°C					

Fire resistance period 60 minutes					
Hp/A (m-1)	Universal Beams (3-sided)	Universal Beams & Columns (4-sided)	RHS Columns & Beams (4 sided)	CHS Columns & Beams	Total dry film thickness (mm)*
		40			0.30
		50			0.40
		60			0.45
	130	70			0.50
	185	90			0.60
		110			0.65
	245	120			0.70
		130			0.75
	260	140			0.80
	275	150			0.90
		160			0.95
	295	170			1.00
		190			1.05
	315	210			1.10
		230			1.15
	320	240			1.20
		260			1.25
		280			1.30
		300			1.35
		310			1.40
		320		130	1.45
			70		1.70
				160	2.40
			105		2.60
* dft's for all other sections should allow 0.1mm for primer and topseal.					
** Tested using a critical temperature of 548°C					
See above table for other F/Ts					

Fire resistance period 90 minutes			
Hp/A (m-1)	Universal Beams (3-sided)	Universal beams & columns (4-sided) **	Total dry film thickness (mm)*
		40	0.60
	55		0.70
		50	0.80
	90		0.90
		60	0.95
		70	1.05
	130		1.10
		80	1.15
		90	1.25
	165		1.30
		100	1.35
		110	1.40
		120	1.50
* dfts for universal beams and columns 4 sided basecoat only dft's for all other sections should allow 0.1mm for primer and topseal			
** Tested using a critical temperature of 548°C			
See above table for other F/Ts			

NULLIFIRE S607-Plus Intumescent Basecoat

1. Product description

Single pack water-borne based thin film intumescent coating with decorative topseal range

2. Manufacturer

Nullifire Limited
Torrington Avenue, Coventry CV4 9TJ
T: 02476 855000 F: 02476 469547 W: www.nullifire.com

3. Availability

UK Mainland: immediate supply direct from Nullifire Ltd
Overseas: direct supply or through local distributors

4. Nominal density (g/ml)

Basecoat: 1.39
Topseals: varies depending on type

5. Wet coverage rates

Maximum coverage wet application rates:
Brush 1.1mm
Airless spray 1.4mm
Volume solids content: 70% (+ or - 2%)
Theoretical coverage in g/m2, dry film thickness (DFT) and wet film thickness (WFT)
444 g/m^2 = 0.32mm (WFT) = 0.22mm (DFT)

6. Appearance

Smooth light white finish
Full range of BS4800 / RAL colour decorative top seals available

7. On site use

Site applied systems for internal applications

8. Durability

This fast drying system offers a durable and robust finish, which gives exceptional resistance to wear and damage during service.

9. Performance in other tests

Manufactured in accordance with the requirements of BS EN ISO 9001

A. Protection technique

Profile

B. Application technique

Airless spray, roller or brush

C. Specification of system

(a) Blast clean to SA 2½ (preferred) or wire brush and degrease mill scaled steel
(b) Apply Nullifire S620 or equivalent compatible primer
(c) Apply S607plus basecoat to required thickness (refer to loading tables)
(d) Apply selected decorative topseal if required

Universal beams (3 sided exposure) critical temperature 620°C			
Hp/A $^{(m-1)}$	dft required for fire resistance periods of (minutes):		
	30	**60**	**90**
42			0.55
51			0.60
55			0.62
59		0.22	
60			0.65
65		0.27	0.67
70		0.31	0.70
75		0.35	0.72
80		0.39	0.75
85		0.43	0.77
90		0.47	0.80
95		0.51	0.83
100		0.55	0.85
105			0.88
106		0.60	
110		0.61	0.90
115		0.62	0.93
120		0.63	0.95
125		0.64	0.98
130		0.65	1.01
135		0.66	1.03
140		0.67	1.06
145		0.68	1.08
150		0.69	1.11
155		0.70	
156			1.14
160		0.72	
165		0.73	1.18
170		0.74	
175		0.75	
180		0.76	
185		0.77	
190		0.78	
195		0.79	
200		0.80	
205		0.81	
210		0.82	
215		0.83	
220		0.84	
225		0.86	
230		0.87	
235		0.88	
240		0.89	
245		0.90	
250		0.91	
255		0.92	
260		0.93	
265		0.94	
270		0.95	
275		0.96	
280		0.97	
285		0.98	
290		1.00	
295		1.01	
300		1.02	
305		1.03	
310		1.04	
315		1.05	
320	0.22	1.06	

Universal beams (4 sided exposure) critical temperature 550°C			
Hp/A $^{(m-1)}$	dft required for fire resistance periods of (minutes):		
	30	**60**	**90**
36		0.24	0.50
40		0.27	
42			0.60
45		0.30	0.65
50		0.34	0.73
55		0.37	0.81
60		0.41	0.89
65		0.45	0.97
70		0.48	1.05
75		0.52	1.13
80		0.55	1.20
85			1.28
87		0.60	
90		0.62	
91			1.38
95		0.65	1.39
100		0.68	1.41
105		0.72	1.42
110		0.75	1.44
115		0.78	1.46
120		0.81	1.47
125		0.84	1.49
130		0.88	1.50
135		0.91	1.52
140		0.94	1.54
145		0.97	1.55
150		1.01	1.57
155		1.04	1.58
160		1.07	1.60
165		1.10	
170		1.14	
175		1.17	
176			1.65
180		1.20	
185		1.23	
190		1.26	
195		1.30	
200		1.33	
205		1.36	
208		1.38	
215		1.39	
220		1.40	
225		1.41	
230		1.42	
235		1.43	
240		1.44	
245		1.45	
250	0.22	1.46	
255	0.23	1.47	
260	0.25	1.48	
265	0.26	1.49	
270	0.27	1.50	
275	0.28	1.51	
280	0.30	1.52	
285	0.31	1.53	
290	0.32	1.54	
295	0.33	1.55	
300	0.35	1.56	
305	0.36	1.57	
310	0.37	1.58	
315	0.38	1.59	
320	0.40	1.60	

For both tables:
All dft's are for basecoat only

NULLIFIRE S609

1. Product description

Single pack solvent-borne thin film intumescent coating for off-site (shop application) with decorative topseal range

2. Manufacturer

Nullifire Limited
Torrington Avenue, Coventry CV4 9TJ
T: 02476 855000 F: 02476 469547 W: www.nullifire.com

3. Availability

UK Mainland: immediate supply direct from Nullifire Ltd
Overseas: direct supply or through local distributors

4. Nominal density (g/ml)

Basecoat: 1.39
Topseals: varies depending on type

5. Wet coverage rates

Maximum coverage wet application rates:
Brush 1.1mm
Airless spray 1.4mm
Volume solids content: 73% (+ or - 2%)
Theoretical coverage in g/m^2, dry film thickness (DFT) and wet film thickness (WFT)
444 g/m^2 = 0.32mm (WFT) = 0.23mm (DFT)

6. Appearance

Smooth light grey finish
Full range of BS4800 / RAL colour decorative top seals available

7. On site use

Shop applied systems for internal and semi-exposed applications

8. Durability

This fast drying system offers a durable and robust finish, which gives exceptional resistance to wear and damage during transit, site erection and in service.

9. Performance in other tests

Manufactured in accordance with the requirements of BS EN ISO 9001

A. Protection technique

Profile

B. Application technique

Airless or automated spray equipment, roller or brush

C. Specification of system

(a) Blast clean to SA 2½ (preferred) or wire brush and degrease mill scaled steel
(b) Apply Nullifire S620 or equivalent compatible primer
(c) Apply S609 basecoat to required thickness (refer to loading tables)
(d) Apply selected decorative topseal if required

Universal columns (4 sided exposure) critical temperature 550°C				
Hp/A $^{(m-1)}$	dft required for fire resistance periods of (minutes):			
	30	60	90	120
40			0.40	
50			0.47	0.6
60			0.53	
70			0.61	
80		0.23	0.77	
90		0.25	0.93	
100		0.29	1.09	
110		0.34	1.25	
120		0.39	1.42	
130		0.45	1.58	
140		0.49	1.74	
150		0.53	1.84	
160		0.57	1.94	
170		0.60	2.03	
180		0.66	2.13	
190		0.79	2.67	
200		0.99		
210		1.10		
220		1.16		
230		1.23		
240		1.44		
250		1.50		
260		1.57		
270		1.64		
280	0.23	1.70		
290	0.24	1.77		
300	0.25	1.85		
310	0.26	1.92		
320	0.33	2.00		
dft's given are for basecoat only				

Universal beams (4 sided exposure) critical temperature 550°C				
Hp/A $^{(m-1)}$	dft required for fire resistance periods of (minutes):			
	30	60	90	120
40		0.24	0.44	0.65
50		0.28	0.51	
60		0.31	0.58	
70		0.34	0.68	
80		0.36	0.80	
90		0.39	0.92	
100		0.42	1.03	
110		0.45	1.15	
120		0.48	1.27	
130		0.50	1.38	
140		0.54	1.50	
150		0.57	1.62	
160		0.61	1.73	
170		0.67	1.85	
180		0.74	2.04	
190	0.24	0.83		
200	0.25	0.92		
210	0.26	1.02		
220	0.28	1.08		
230	0.30	1.15		
240	0.33	1.21		
250	0.35	1.27		
260	0.38	1.33		
270	0.40	1.41		
280	0.43	1.73		
290	0.45	2.23		
300	0.47			
310	0.49			
320	0.52			
dft's given are for basecoat only				

Universal beams (3 sided exposure) critical temperature 620°C				
Hp/A $^{(m-1)}$	dft required for fire resistance periods of (minutes):			
	30	60	90	120
40			0.34	0.49
50			0.39	0.61
60			0.43	
70			0.48	
80			0.52	
90		0.24	0.57	
100		0.25	0.61	
110		0.28	0.68	
120		0.33	0.75	
130		0.38	0.82	
140		0.40	0.89	
150		0.42	0.95	
160		0.44	1.02	
170		0.45	1.09	
180		0.49	1.23	
190		0.54	1.47	
200		0.59	1.81	
210		0.71	2.15	
220		0.79	2.44	
230		0.88		
240		0.96		
250		1.03		
260	0.24	1.06		
270	0.25	1.09		
280	0.26	1.20		
290	0.27	1.40		
300	0.29	1.60		
310	0.31	1.80		
320	0.33	2.00		
dft's given are for basecoat only				

NULLIFIRE S706

1. Product description

Single pack solvent-borne thin film intumescent coating with decorative topseal range

2. Manufacturer

Nullifire Limited
Torrington Avenue, Coventry CV4 9TJ
T: 02476 855000 F: 02476 469547 W: www.nullifire.com

3. Availability

UK Mainland: immediate supply direct from Nullifire Ltd
Overseas: direct supply or through regional distributors

4. Nominal density (g/ml)

Basecoat: 1.39
Topseals: varies depending on type

5. Wet coverage rates

Maximum coverage wet application rates:
Brush 1.1mm
Airless spray 1.4mm
Volume solids content: 70% (+ or - 2%)
Theoretical coverage in g/m^2, dry film thickness (DFT) and wet film thickness (WFT)
444 g/m^2 = 0.22mm (WFT) = 0.32mm (DFT)

6. Appearance

Smooth light white finish
Full range of BS4800 / RAL colour decorative top seals available

7. On site use

Site applied systems for internal and semi-exposed applications

8. Durability

This fast drying system offers a durable and robust finish, which gives exceptional resistance to wear and damage during service.

9. Performance in other tests

Manufactured in accordance with the requirements of BS EN ISO 9001

A. Protection technique

Profile

B. Application technique

Airless spray, roller or brush

C. Specification of system

(a) Blast clean to SA 2½ (preferred) or wire brush and degrease mill scaled steel
(b) Apply Nullifire S620 or equivalent compatible primer
(c) Apply S706 basecoat to required thickness (refer to loading tables)
(d) Apply selected decorative topseal if required

Universal columns (4 sided exposure) critical temperature 550°C				
Hp/A $^{(m-1)}$	dft required for fire resistance periods of (minutes):			
	30	60	90	120
40			0.40	
50			0.47	0.60
60			0.53	
70			0.61	
80		0.23	0.77	
90		0.25	0.93	
100		0.29	1.09	
110		0.34	1.25	
120		0.39	1.42	
130		0.45	1.58	
140		0.49	1.74	
150		0.53	1.84	
160		0.57	1.94	
170		0.60	2.03	
180		0.66	2.13	
190		0.79	2.67	
200		0.99		
210		1.10		
220		1.16		
230		1.23		
240		1.44		
250		1.50		
260		1.57		
270		1.64		
280	0.23	1.70		
290	0.24	1.77		
300	0.25	1.85		
310	0.26	1.92		
320	0.33	2.00		
dft's are given for basecoat only				

Universal beams (4 sided exposure) critical temperature 550°C				
Hp/A $^{(m-1)}$	dft required for fire resistance periods of (minutes):			
	30	60	90	120
40		0.24	0.44	0.65
50		0.28	0.51	
60		0.31	0.58	
70		0.34	0.68	
80		0.36	0.80	
90		0.39	0.92	
100		0.42	1.03	
110		0.45	1.15	
120		0.48	1.27	
130		0.50	1.38	
140		0.54	1.50	
150		0.57	1.62	
160		0.61	1.73	
170		0.67	1.85	
180		0.74	2.04	
190	0.24	0.83		
200	0.25	0.92		
210	0.26	1.02		
220	0.28	1.08		
230	0.30	1.15		
240	0.33	1.21		
250	0.35	1.27		
260	0.38	1.33		
270	0.40	1.41		
280	0.43	1.73		
290	0.45	2.23		
300	0.47			
310	0.49			
320	0.52			
dft's given are for basecoat only				

Universal beams (3 sided exposure) critical temperature 620°C				
Hp/A $^{(m-1)}$	dft required for fire resistance periods of (minutes):			
	30	60	90	120
40			0.34	0.49
50			0.39	0.61
60			0.43	
70			0.48	
80			0.52	
90		0.24	0.57	
100		0.25	0.61	
110		0.28	0.68	
120		0.33	0.75	
130		0.38	0.82	
140		0.40	0.89	
150		0.42	0.95	
160		0.44	1.02	
170		0.45	1.09	
180		0.49	1.23	
190		0.54	1.47	
200		0.59	1.81	
210		0.71	2.15	
220		0.79	2.44	
230		0.88		
240		0.96		
250		1.03		
260	0.24	1.06		
270	0.25	1.09		
280	0.26	1.20		
290	0.27	1.40		
300	0.29	1.60		
310	0.31	1.80		
320	0.33	2.00		
dft's given are for basecoat only				

PYROPLAST-STEEL D

1. Product description

Water based thin film intumescent coating with water based primer (pyroplast AC primer) and water based top sealer (pyroplast AC top).

2. Manufacturer

Rutgers Organics GmbH
Sandhofer Strasse 96, D-68305 Mannheim, Germany

3. Availability

Supplied in the UK by: Coatmaster
Brewery Road, Pampisford, Cambridge, CB2 4HG
Tel: 01223 832005 Fax: 01223 837215 e-mail: info@coatmaster.co.uk

4. Nominal specific gravity

Nominal Density **1.27 g/cm^3**
Nominal Volume Solids 67%

5. Wet coverage rate

Maximum application rates per coat

Brush 600g/m^2	472 microns wet	318 microns dry
Roller 400g.m^2	315 microns wet	212 microns dry
Airless spray 1400g/m^2	1103 microns wet	742 microns dry

6. Appearance

White matt finish.
Top sealer (pyroplast-AC top) available in RAL colour shades in sheen finish

7. On site use

Dry internal areas only.
Minimum application and drying temperature 10^{o}c.
Maximum application and drying humidity 85%

8. Durability

Suitable for dry internal areas

9. Performance in other BS and EN tests

For details consult Coatmaster

10. Other applications

For details consult Coatmaster

A Protection technique

Profile

B Application technique

Brush, roller, airless spray

C Specification of system

Blast clean steel to min SA $2^1/_2$ standard.
Apply pyroplast AC primer or other approved by Coatmaster
Apply pyroplast Steel D to required loading (see table)
Apply pyroplast AC top to specified RAL colour shade

Hp/A$^{(m-1)}$	Universal columns critical temperature 550°C: Basecoat dft required for fire resistance periods of (minutes): 30	60	90	Universal beams (3 sided exposure) critical temperature 620°C: Basecoat dft required for fire resistance periods of (minutes): 30	60	90
45						
50		0.30				
55						1.70
60		0.35			0.30	1.75
65		0.40				1.80
70		0.45			0.35	1.85
75						1.95
80		0.50			0.40	2.00
85		0.55				2.05
90		0.60				2.15
95					0.45	2.20
100		0.65	1.70			2.25
105		0.70	1.80		0.50	2.35
110		0.75	1.90			2.40
115			2.00		0.55	2.50
120		0.80	2.10			2.55
125		0.85	2.20		0.60	2.60
130		0.90	2.30			2.70
135			2.40		0.65	2.75
140		0.95	2.50			2.80
145		1.00	2.60		0.70	2.90
150		1.05	2.71			2.95
155			2.80		0.75	3.00
160		1.10	2.90			3.10
165		1.15	3.00			3.15
170		1.20	3.10		0.80	3.20
175			3.15			3.25
180		1.25	3.30		0.85	3.35
185		1.30	3.40			3.40
190		1.35	3.45		0.90	
195			3.55			
200		1.40	3.60		0.95	
205		1.45	3.70			
210		1.50	3.80		1.00	
215	0.25					
220		1.55			1.05	
225		1.60				
230		1.65				
235	0.30				1.10	
240		1.70				
245		1.80			1.15	
250	0.35	1.85				
255		1.95			1.20	
260		2.00				
265		2.10			1.25	
270	0.40	2.15				
275		2.25			1.30	
280		2.30				
285		2.40			1.35	
290	0.45	2.45				
295		2.55				
300		2.60		0.25	1.40	
305	0.50	2.70				
310		2.75			1.45	
315		2.80				
320	0.55	2.90		0.30	1.50	
325		3.00				
330	0.60	3.05		0.35	1.55	

Hp/A$^{(m-1)}$	Hollow section columns critical temperature 522°C: Basecoat dft required for fire 30	60	90
65			3.10
90			3.15
100			3.20
105			3.25
115		1.70	3.30
125		1.75	3.35
130		1.80	3.40
140		1.85	3.45
150		1.90	3.50
160		1.95	3.55
165		2.00	
175		2.05	
185		2.10	
195		2.15	
200		2.20	
210		2.25	
220		2.30	
230		2.35	
240		2.40	
245		2.45	
255		2.50	
265		2.55	
270	0.50		
275		2.60	
280	0.55	2.65	
290	0.60	2.70	
295	0.65		
300	0.70	2.75	
310	0.75	2.80	
315	0.80	2.85	
320	0.85		
325		2.90	
330	0.90		
335		2.95	
340	0.95		
345	1.00	3.00	
350	1.05	3.05	
360	1.10	3.10	
365	1.15		
370		3.15	
375	1.20		
380	1.25	3.20	
390	1.30	3.25	
395	1.35	3.30	
400	1.40		
405		3.35	
410	1.45		
415	1.50	3.40	
425	1.55	3.45	
430	1.60	3.50	

SPRAYFILM WB2

1. Product description

Water based intumescent coating

2. Manufacturer

Cafco International
Bluebell Close, Clover Nook Industrial Park, Alfreton, Derbyshire DE55 4RA
T: 01773 837900 F: 01773 836710 W: www.cafcointl.com

3. Availability

Supply and fix service by recognised applicators. Details from the manufacturer.

4. Nominal specific gravity (g/ml)

Volume Solids 70% +/-1%

5. Wet coverage rate

Basecoat:
24m^2 25kg pail at 0.5mm dft

6. Appearance

White with a slight sheen. Decorative topseals may be applied as required. Contact Manufacturer for details of topseal.

7. On site use

Internal applications

8. Durability

Good resistance to impact and abrasion.
Durometer hardness: 80 shore D (tested to ASTM D2240)
Impact resistance: 0.30kg/m (tested to ASTM D2794)
Abrasion resistance: 0.7411g/1000 cycles (tested to ASTM D4060)

9. Performance in other BS and EN tests

Manufactured in accordance with ISO 9000 requirements

10. Other applications

Fully tested to UL standards
Tested to various European standards

A Protection technique

Profile

B Application technique

Airless spray, roller or brush

C Specification of system

(a) Blast clean to SA 2½ (preferred) or remove millscale with wire brush and degrease.
(b) Apply compatible primer
(c) Apply SprayFilm WB2 to the required thickness (see tables)
(d) Apply a decorative topseal if required

	Universal beams (3 sided exposure)			Universal columns & beams (4 sided exposure)			Hollow Section Columns (4 sided exposure)		
	critical temperature 620°C			critical temperature 550°C			critical temperature 532°C		
$Hp/A^{(m-1)}$	Basecoat dft required for fire resistance periods of (minutes):			Basecoat dft required for fire resistance periods of (minutes):			Basecoat dft required for fire resistance periods of (minutes):		
	30	60	90	30	60	90	30	60	90
75		0.245							
80		0.265			0.600				
85		0.284			0.640				
90		0.304			0.680				
95		0.323							3.08
100		0.343			0.720				
105		0.362			0.760				
110		0.382			0.800				
115		0.401			0.840				
120		0.421			0.880				
125		0.440							
130		0.460			0.920				
135		0.480			0.960				
140		0.499			1.000				
145		0.519			1.010				
150		0.538		0.230	1.020	1.500		3.08	
155		0.558		0.240	1.030				
160		0.577		0.250	1.040				
165		0.597			1.050				
170		0.616			1.060				
175		0.636		0.260	1.070				
180		0.655	1.195	0.270	1.080				
185		0.675		0.280	1.090				
190		0.695		0.290	1.110				
195		0.714		0.300	1.120				
200		0.734		0.310	1.130				
205		0.753		0.320	1.140				
210		0.773		0.330	1.150				
215		0.792			1.160				
220		0.812		0.340	1.170				
225		0.831		0.350	1.180				
230	0.230	0.851		0.360	1.190				
235	0.235	0.870			1.200				
240	0.245	0.890		0.370	1.23				
245	0.255	0.914		0.380	1.260				
250	0.265	0.932			1.29				
255	0.275	0.938		0.390	1.320				
260	0.285	0.985		0.400	1.35				
265	0.295	1.009		0.410	1.370				
270		1.033		0.420	1.400				
275	0.305	1.057		0.430	1.430				
280	0.315	1.081			1.460				
285	0.325	1.105		0.440	1.490				
290	0.335	1.126			1.520				
295	0.345	1.152			1.550				
300	0.355	1.176		0.450	1.580				
305	0.365	1.200		0.460					
310	0.375	1.224			1.610				
315	0.385	1.248		0.470					
320	0.395	1.272		0.480					
375							3.08		

SPRAYFILM WB3

1. Product description

Water based intumescent coating

2. Manufacturer

Cafco International
Bluebell Close, Clover Nook Industrial Park, Alfreton, Derbyshire DE55 4RA
T: 01773 837900 F: 01773 836710 W: www.cafcointl.com

3. Availability

Supply and fix service by recognised applicators. Details from the manufacturer.

4. Nominal specific gravity (g/ml)

Volume Solids 72% +/-1%

5. Wet coverage rate

Basecoat:
26m^2 per 25kg pail at 0.5mm dft

6. Appearance

White with a slight sheen. Decorative topseals may be applied as required. Contact Manufacturer for details of topseal.

7. On site use

Internal applications

8. Durability

Good resistance to impact and abrasion.
Durometer hardness: 80 shore D (tested to ASTM D2240)
Impact resistance: 0.18kg/m (tested to ASTM D2794)
Abrasion resistance: 0.6505g/1000 cycles (tested to ASTM D4060)

9. Performance in other BS and EN tests

Manufactured in accordance with ISO 9000 requirements

10. Other applications

Fully tested to UL standards

A Protection technique

Profile

B Application technique

Airless spray, roller or brush

C Specification of system

(a) Blast clean to SA 2½ (preferred) or remove millscale with wire brush and degrease.
(b) Apply compatible primer
(c) Apply SprayFilm WB3 to the required thickness (see tables)
(d) Apply a decorative topseal if required

	Hollow Columns (4 sided exposure)		
	critical temperature 532°C		
$Hp/A^{(m-1)}$	Basecoat dft required for fire resistance periods of (minutes):		
	30	**60**	**90**
60			1.80
65			1.90
70			2.00
75			2.10
80			2.19
85			2.29
90		0.61	2.39
95		0.69	2.49
98			2.55
100		0.78	
105		0.86	2.62
110		0.94	2.67
117		1.06	2.72
120		1.08	2.77
125		1.11	2.83
130		1.14	2.88
135		1.17	2.93
140		1.20	2.98
145		1.23	3.03
150		1.26	3.08
155		1.29	3.13
160		1.32	3.18
165		1.35	3.25
170		1.38	3.29
175		1.41	3.34
180		1.45	3.39
185		1.48	3.44
190		1.51	3.51
195		1.54	3.61
200		1.57	3.77
205		1.60	3.93
210		1.63	4.08
215		1.66	4.24
220		1.69	4.40
225		1.72	4.56
230		1.75	4.72
235		1.78	4.88
240		1.83	5.04
245		1.91	5.20
250		1.99	5.36
255		2.07	5.52
260		2.15	5.68
265		2.23	5.84
270		2.31	6.00
275		2.39	
280		2.47	
285		2.55	
290		2.62	
295		2.68	
300		2.75	
305		2.82	
310		2.88	
315		2.95	
320	0.61	3.02	

STEELGUARD FM549

1. Product description

Thin film intumescent coating for internal and semi-exposed structural steelwork with decorative topseal range.

2. Manufacturer

Ameron International
Blackwell Road, Huthwaite, Sutton-in-Ashfield, Notts NG17 2RL
T: 01623 511000 F: 01623 559616 W: www.ameron-bv.com

3. Availability

Supplied direct from the manufacturer or distributor network

4. Nominal specific gravity

Nominal Density 1.3 kg/l
Nominal Volume Solids 68% +/- 3%

5. Wet coverage rate

Theoretical coverage 0.97 square metres/litres at 700 microns (typical dft)

6. Appearance

White, matt when dry
Decorative topseals available in full Ral & BS4800 colour range including metallic & MIO shades

7. On site use

Normally used for on site application by airless spray. VOC compliant as an intumescent coating in accordance with PG6/23. Can be left up to 4 weeks externally plus up to 8 weeks in sheltered areas without a topseal.

8. Durability

The Steelguard FM549 system has been successfully fire tested after extensive accelerated testing and natural ageing. Good impact and abrasion resistance.

9. Performance in other BS tests

Manufactured in accordance with BS EN ISO 9001

10. Other applications

Alternative critical temperature data available on request, also tested and approved in various European Countries

A Protection technique

Profile

B Application technique

Airless spray or brush

C Specification of system

Application - Surface temperature min 5°C max 40°C and max. humidity of 85%

(a) Abrasive blast clean to ISO 8501-1 Sa 2½. The blast profile achieved should be approximately 75 microns and should not exceed 100 microns.
(b) Apply Ameron approved primer - please consult manufacturer for individual project recommendations
(c) Apply Steelguard FM549 - see thickness table.
(d) Apply topseal if necessary - no topseal required for dry internal C1 conditions (ISO 12944) - please consult manufacturer for invidiual project recommendations
(e) Steelguard FM549 can be left externally without a topseal for up to 1 month. During this period, however, Steelguard FM549 must be protected from pooling water, hot humid environments or immersed conditions.
(f) Refer to Steelguard FM549 product data sheet before using.

Universal beams (3 sided exposure) critical temperature 620°C				
Hp/A (m-1)	Basecoat dft required for fire resistance periods of (minutes):			
	30	60	90	120
40	0.25	0.25	0.40	0.90
50			0.50	1.10
60			0.60	1.35
70		0.30	0.70	1.60
80			0.80	1.80
90		0.35	0.95	2.05
100			1.05	2.25
110		0.40	1.15	2.50
120		0.45	1.25	
130			1.35	
140		0.50	1.45	
150			1.55	
160		0.55	1.65	
170			1.75	
180	0.30	0.60	1.85	
190			1.90	
200		0.65	1.95	
210		0.70	2.05	
220		0.75	2.10	
230	0.35	0.85	2.15	
240		0.90	2.25	
250		1.00	2.30	
260		1.10	2.35	
270		1.15	2.45	
280		1.25	2.50	
290		1.30		
300		1.40		
310	0.40	1.50		
320		1.60		

CHS columns (4 sided exposure) critical temperature 550°C				
Hp/A (m-1)	Basecoat dft required for fire resistance periods of (minutes):			
	30	60	90	120
30				2.20
35				2.55
40	0.25	0.45	1.60	2.90
50		0.55	2.05	3.60
60		0.65	2.45	4.35
70	0.30	0.80	2.75	
80		0.90	3.10	
90	0.35	1.00	3.40	
100	0.40	1.15	3.75	
110	0.45	1.25	4.05	
120	0.50	1.35	4.40	
130	0.55	1.50		
140	0.60	1.65		
150		1.85		
160	0.65	2.05		
170	0.70	2.25		
180	0.75	2.45		
190	0.80	2.60		
200	0.85	3.05		
210	0.90	3.50		
220		3.90		
230	0.95	4.30		
240	1.00	4.65		
250	1.05			
260	1.15			
270	1.25			
280	1.35			
290	1.45			
300	1.55			
310	1.65			
320	1.75			

Universal columns & beams (4 sided exposure) critical temperature 550°C				
Hp/A (m-1)	Basecoat dft required for fire resistance periods of (minutes):			
	30	60	90	120
40	0.25	0.40	0.50	1.65
50		0.45	0.65	
60			0.80	
70		0.50	0.90	
80		0.55	1.05	
90			1.20	
100		0.60	1.35	
110		0.65	1.45	
120			1.60	
130		0.70	1.75	
140		0.75	2.05	
150		0.80	2.30	
160		0.90	2.55	
170		0.95	2.70	
180		1.05	2.85	
190		1.15	2.95	
200		1.20	3.00	
210		1.30	3.10	
220	0.30	1.40	3.15	
230		1.45	3.20	
240		1.60	3.25	
250	0.35	1.70	3.35	
260		1.75	3.40	
270		1.80	3.45	
280			3.55	
290	0.40	1.85		
300		1.90		
310		1.95		
320		2.00		

RHS columns (4 sided exposure) critical temperature 500°C				
Hp/A (m-1)	Basecoat dft required for fire resistance periods of (minutes):			
	30	60	90	120
40	0.25	0.60	2.00	2.6
50		0.75	2.17	
60		0.90	2.34	
70	0.30	1.05	2.51	
80	0.35	1.20	3.00	
90	0.40	1.35	3.80	
100	0.45	1.50	4.60	
110	0.50	1.65		
120	0.55	1.80		
130	0.60	1.95		
140	0.65	2.10		
150	0.70	2.30		
160	0.75	2.45		
170	0.80	2.60		
180	0.85	2.75		
190	0.9	2.95		
200	0.95	3.50		
210	1.00	4.20		
220	1.10			
230	1.20			
240	1.30			
250	1.40			
260	1.50			
270	1.60			
280	1.70			
290	1.85			
300	1.95			
310	2.05			
320	2.15			

RHS beams (3 sided exposure) critical temperature 575°C			
Hp/A (m-1)	Basecoat dft required for fire resistance periods of (minutes):		
	30	60	90
40	0.25	0.25	0.55
50		0.30	0.65
60		0.40	0.80
70		0.45	0.95
80		0.50	1.10
90		0.60	1.20
100		0.65	1.35
110		0.70	1.50
120		0.80	1.65
130	0.30	0.85	1.75
140		0.95	1.85
150	0.35	1.05	1.95
160		1.40	2.00
170	0.40	1.60	2.10
180		1.65	2.15
190	0.45	1.70	
200		1.75	
210	0.50	1.80	
220		1.85	
230		0.55	1.90
240		0.60	1.95
250		0.65	2.00
260		0.70	2.05
270		0.75	2.10
280		0.80	2.15
290		0.85	
300		0.90	
310		0.95	
320		1.00	

STEELGUARD FM550

1. Product description

Thin film intumescent coating for internal and external structural steelwork with decorative topseal range. Steelguard FM560 faster drying off site grade is also available.

2. Manufacturer

Ameron International
Blackwell Road, Huthwaite, Sutton-in-Ashfield, Notts NG17 2RL
T: 01623 511000 F: 01623 559616 W: www.ameron-bv.com

3. Availability

Supplied direct from the manufacturer or distributor network

4. Nominal specific gravity

Nominal Density 1.3 kg/l
Nominal Volume Solids 68 +/- 3%

5. Wet coverage rate

Theoretical coverage 0.97 square metres/litres at 700 microns (typical dft)

6. Appearance

White or grey, matt when dry
Decorative topseals available in full Ral & BS4800 colour range including metallic & MIO shades

7. On site use

Normally used for on site application by airless spray. VOC compliant as an intumescent coating in accordance with PG6/23. Can be left up to 52 weeks externally without a topseal.

8. Durability

The Steelguard FM550 system has been successfully fire tested after extensive accelerated testing and natural ageing. Good impact and abrasion resistance.

9. Performance in other BS tests

Manufactured in accordance with BS EN ISO 9001

10. Other applications

Alternative critcal temperature data available on request, also tested and approved in various European Countries

A Protection technique

Profile

B Application technique

Airless spray or brush

C Specification of system

Application - Surface temperature min 5°C max 40°C and max. humidity of 85%

(a) Abrasive blast clean to ISO 8501-1 Sa 2½. The blast profile achieved should be approximately 75 microns and should not exceed 100 microns.
(b) Apply Ameron approved primer - please consult manufacturer for individual project recommendations
(c) Apply Steelguard FM550 - see thickness table.
(d) Apply topseal if necessary - no topseal required for dry internal C1 conditions (ISO 12944) - please consult manufacturer for invidiual project recommendations
(e) Steelguard FM550 can be left externally without a topseal for up to 52 weeks. During this period, however, Steelguard FM550 must be protected from pooling water, hot humid environments or immersed conditions.
(f) Refer to Steelguard FM550 product data sheet before using.

Universal beams (3 sided exposure) critical temperature 620°C				
Hp/A (m-1)	Basecoat dft required for fire resistance periods of (minutes):			
	30	60	90	120
40	0.25	0.25	0.40	0.90
50			0.50	1.10
60			0.60	1.35
70		0.30	0.70	1.60
80			0.80	1.80
90		0.35	0.95	2.05
100			1.05	2.25
110		0.40	1.15	2.50
120		0.45	1.25	
130			1.35	
140		0.50	1.45	
150			1.55	
160		0.55	1.65	
170			1.75	
180	0.30	0.60	1.85	
190			1.90	
200		0.65	1.95	
210		0.70	2.05	
220		0.75	2.10	
230	0.35	0.85	2.15	
240		0.90	2.25	
250		1.00	2.30	
260		1.10	2.35	
270		1.15	2.45	
280		1.25	2.50	
290		1.30		
300		1.40		
310	0.40	1.50		
320		1.60		

CHS columns (4 sided exposure) critical temperature 550°C				
Hp/A (m-1)	Basecoat dft required for fire resistance periods of (minutes):			
	30	60	90	120
30				2.20
35				2.55
40	0.25	0.45	1.60	2.90
50		0.55	2.05	3.60
60		0.65	2.45	4.35
70	0.30	0.80	2.75	
80		0.90	3.10	
90	0.35	1.00	3.40	
100	0.40	1.15	3.75	
110	0.45	1.25	4.05	
120	0.50	1.35	4.40	
130	0.55	1.50		
140	0.60	1.65		
150		1.85		
160	0.65	2.05		
170	0.70	2.25		
180	0.75	2.45		
190	0.80	2.60		
200	0.85	3.05		
210	0.90	3.50		
220		3.90		
230	0.95	4.30		
240	1.00	4.65		
250	1.05			
260	1.15			
270	1.25			
280	1.35			
290	1.45			
300	1.55			
310	1.65			
320	1.75			

Universal columns & beams (4 sided exposure) critical temperature 550°C				
Hp/A (m-1)	Basecoat dft required for fire resistance periods of (minutes):			
	30	60	90	120
40	0.25	0.40	0.50	1.65
50		0.45	0.65	
60			0.80	
70		0.50	0.90	
80		0.55	1.05	
90			1.20	
100		0.60	1.35	
110		0.65	1.45	
120			1.60	
130		0.70	1.75	
140		0.75	2.05	
150		0.80	2.30	
160		0.90	2.55	
170		0.95	2.70	
180		1.05	2.85	
190		1.15	2.95	
200		1.20	3.00	
210		1.30	3.10	
220	0.30	1.40	3.15	
230		1.45	3.20	
240		1.60	3.25	
250	0.35	1.70	3.35	
260		1.75	3.40	
270		1.80	3.45	
280			3.55	
290	0.40	1.85		
300		1.90		
310		1.95		
320		2.00		

RHS columns (4 sided exposure) critical temperature 500°C				
Hp/A (m-1)	Basecoat dft required for fire resistance periods of (minutes):			
	30	60	90	120
40	0.25	0.60	2.00	2.6
50		0.75	2.17	
60		0.90	2.34	
70	0.30	1.05	2.51	
80	0.35	1.20	3.00	
90	0.40	1.35	3.80	
100	0.45	1.50	4.60	
110	0.50	1.65		
120	0.55	1.80		
130	0.60	1.95		
140	0.65	2.10		
150	0.70	2.30		
160	0.75	2.45		
170	0.80	2.60		
180	0.85	2.75		
190	0.9	2.95		
200	0.95	3.50		
210	1.00	4.20		
220	1.10			
230	1.20			
240	1.30			
250	1.40			
260	1.50			
270	1.60			
280	1.70			
290	1.85			
300	1.95			
310	2.05			
320	2.15			

RHS beams (3 sided exposure) critical temperature 575°C			
Hp/A (m-1)	Basecoat dft required for fire resistance periods of (minutes):		
	30	60	90
40	0.25	0.25	0.55
50		0.30	0.65
60		0.40	0.80
70		0.45	0.95
80		0.50	1.10
90		0.60	1.20
100		0.65	1.35
110		0.70	1.50
120		0.80	1.65
130	0.30	0.85	1.75
140		0.95	1.85
150	0.35	1.05	1.95
160		1.40	2.00
170	0.40	1.60	2.10
180		1.65	2.15
190	0.45	1.70	
200		1.75	
210	0.50	1.80	
220		1.85	
230	0.55	1.90	
240	0.60	1.95	
250	0.65	2.00	
260	0.70	2.05	
270	0.75	2.10	
280	0.80	2.15	
290	0.85		
300	0.90		
310	0.95		
320	1.00		

STEELGUARD FM560

1. Product description

Thin film fast drying off site intumescent coating for internal and external structural steelwork with decorative topseal range.

2. Manufacturer

Ameron International
Blackwell Road, Huthwaite, Sutton-in-Ashfield, Notts NG17 2RL
T: 01623 511000 F: 01623 559616 W: www.ameron-bv.com

3. Availability

Supplied direct from the manufacturer or distributor network

4. Nominal specific gravity

Nominal Density 1.3 kg/l
Nominal Volume Solids 68 +/- 3%

5. Wet coverage rate

Theoretical coverage 0.97 square metres/litres at 700 microns (typical dft)

6. Appearance

White or grey, matt when dry
Decorative topseals available in full Ral & BS4800 colour range including metallic & MIO shades

7. On site use

Normally used for on site application by airless spray. VOC compliant as an intumescent coating in accordance with PG6/23. Can be left up to 52 weeks externally without a topseal.

8. Durability

The Steelguard FM560 system has been successfully fire tested after extensive accelerated testing and natural ageing. Good impact and abrasion resistance.

9. Performance in other BS tests

Manufactured in accordance with BS EN ISO 9001

10. Other applications

Alternative critcal temperature data available on request, also tested and approved in various European Countries

A Protection technique

Profile

B Application technique

Airless spray or brush

C Specification of system

Application - Surface temperature min 5°C max 40°C and max. humidity of 85%

(a) Abrasive blast clean to ISO 8501-1 Sa 2½. The blast profile achieved should be approximately 75 microns and should not exceed 100 microns.
(b) Apply Ameron approved primer - please consult manufacturer for individual project recommendations
(c) Apply Steelguard FM560 - see thickness table.
(d) Apply topseal if necessary - no topseal required for dry internal C1 conditions (ISO 12944) - please consult manufacturer for invidiual project recommendations
(e) Steelguard FM560 can be left externally without a topseal for up to 52 weeks. During this period, however, Steelguard FM560 must be protected from pooling water, hot humid environments or immersed conditions.
(f) Refer to Steelguard FM560 product data sheet before using.

Universal beams (3 sided exposure) critical temperature 620°C				
$Hp/A^{(m-1)}$	Basecoat dft required for fire resistance periods of (minutes):			
	30	**60**	**90**	**120**
40	0.25	0.25	0.40	0.90
50			0.50	1.10
60			0.60	1.35
70		0.30	0.70	1.60
80			0.80	1.80
90		0.35	0.95	2.05
100			1.05	2.25
110		0.40	1.15	2.50
120		0.45	1.25	
130			1.35	
140		0.50	1.45	
150			1.55	
160		0.55	1.65	
170			1.75	
180	0.30	0.60	1.85	
190			1.90	
200		0.65	1.95	
210		0.70	2.05	
220		0.75	2.10	
230	0.35	0.85	2.15	
240		0.90	2.25	
250		1.00	2.30	
260		1.10	2.35	
270		1.15	2.45	
280		1.25	2.50	
290		1.30		
300		1.40		
310	0.40	1.50		
320		1.60		

CHS columns (4 sided exposure) critical temperature 550°C				
$Hp/A^{(m-1)}$	Basecoat dft required for fire resistance periods of (minutes):			
	30	**60**	**90**	**120**
30				2.20
35				2.55
40	0.25	0.45	1.60	2.90
50		0.55	2.05	3.60
60		0.65	2.45	4.35
70	0.30	0.80	2.75	
80		0.90	3.10	
90	0.35	1.00	3.40	
100	0.40	1.15	3.75	
110	0.45	1.25	4.05	
120	0.50	1.35	4.40	
130	0.55	1.50		
140	0.60	1.65		
150		1.85		
160	0.65	2.05		
170	0.70	2.25		
180	0.75	2.45		
190	0.80	2.60		
200	0.85	3.05		
210	0.90	3.50		
220		3.90		
230	0.95	4.30		
240	1.00	4.65		
250	1.05			
260	1.15			
270	1.25			
280	1.35			
290	1.45			
300	1.55			
310	1.65			
320	1.75			

Universal columns & beams (4 sided exposure) critical temperature 550°C				
$Hp/A^{(m-1)}$	Basecoat dft required for fire resistance periods of (minutes):			
	30	**60**	**90**	**120**
40	0.25	0.40	0.50	1.65
50		0.45	0.65	
60			0.80	
70		0.50	0.90	
80		0.55	1.05	
90			1.20	
100		0.60	1.35	
110		0.65	1.45	
120			1.60	
130		0.70	1.75	
140		0.75	2.05	
150		0.80	2.30	
160		0.90	2.55	
170		0.95	2.70	
180		1.05	2.85	
190		1.15	2.95	
200		1.20	3.00	
210		1.30	3.10	
220	0.30	1.40	3.15	
230		1.45	3.20	
240		1.60	3.25	
250	0.35	1.70	3.35	
260		1.75	3.40	
270		1.80	3.45	
280			3.55	
290	0.40	1.85		
300		1.90		
310		1.95		
320		2.00		

RHS columns (4 sided exposure) critical temperature 500°C				
$Hp/A^{(m-1)}$	Basecoat dft required for fire resistance periods of (minutes):			
	30	**60**	**90**	**120**
40	0.25	0.60	2.00	2.6
50		0.75	2.17	
60		0.90	2.34	
70	0.30	1.05	2.51	
80	0.35	1.20	3.00	
90	0.40	1.35	3.80	
100	0.45	1.50	4.60	
110	0.50	1.65		
120	0.55	1.80		
130	0.60	1.95		
140	0.65	2.10		
150	0.70	2.30		
160	0.75	2.45		
170	0.80	2.60		
180	0.85	2.75		
190	0.9	2.95		
200	0.95	3.50		
210	1.00	4.20		
220	1.10			
230	1.20			
240	1.30			
250	1.40			
260	1.50			
270	1.60			
280	1.70			
290	1.85			
300	1.95			
310	2.05			
320	2.15			

RHS beams (3 sided exposure) critical temperature 575°C			
$Hp/A^{(m-1)}$	Basecoat dft required for fire resistance periods of (minutes):		
	30	**60**	**90**
40	0.25	0.25	0.55
50		0.30	0.65
60		0.40	0.80
70		0.45	0.95
80		0.50	1.10
90		0.60	1.20
100		0.65	1.35
110		0.70	1.50
120		0.80	1.65
130	0.30	0.85	1.75
140		0.95	1.85
150	0.35	1.05	1.95
160		1.40	2.00
170	0.40	1.60	2.10
180		1.65	2.15
190	0.45	1.70	
200		1.75	
210	0.50	1.80	
220		1.85	
230	0.55	1.90	
240	0.60	1.95	
250	0.65	2.00	
260	0.70	2.05	
270	0.75	2.10	
280	0.80	2.15	
290	0.85		
300	0.90		
310	0.95		
320	1.00		

STEELGUARD FM580

1. Product description

Thin film water-borne intumescent coating for internal C1 (ISO 12944) exposed structural steelwork with decorative topseal range.

2. Manufacturer

Ameron International
Blackwell Road, Huthwaite, Sutton-in-Ashfield, Notts NG17 2RL
T: 01623 511000 F: 01623 559616 W: www.ameron-bv.com

3. Availability

Supplied direct from the manufacturer or distributor network

4. Nominal specific gravity

Nominal Density 1.3 kg/l
Nominal Volume Solids 70 +/- 3%

5. Wet coverage rate

Theoretical coverage 1.75 square metres/litres at 400 microns (typical dft)

6. Appearance

White, matt when dry
Decorative topseals available in full Ral & BS4800 colour range

7. On site use

Normally used for on site application by airless spray. VOC compliant as an intumescent coating in accordance with PG6/23.

8. Durability

Good impact and abrasion resistance.

9. Performance in other BS tests

Manufactured in accordance with BS EN ISO 9001

10. Other applications

Alternative critcal temperature data available on request, also tested and approved in various European Countries

A Protection technique

Profile

B Application technique

Airless spray or brush

C Specification of system

Application - Surface temperature min 5°C max 40°C and max. humidity of 80%

(a) Abrasive blast clean to ISO 8501-1 Sa 2½. The blast profile achieved should be approximately 75 microns and should not exceed 100 microns.
(b) Apply Ameron approved primer - please consult manufacturer for individual project recommendations
(c) Apply Steelguard FM580 - see thickness table.
(d) Apply topseal if necessary
(e) Refer to Steelguard FM580 product data sheet before using

Universal beams (3 sided exposure) critical temperature 620°C		
$Hp/A^{(m-1)}$	Basecoat dft required for fire resistance periods of (minutes):	
	30	**60**
40		
50		
60		
70		0.17
80		
90		
100		
110		
120		0.23
130		0.31
140		0.39
150		0.43
160		0.46
170		0.49
180	0.16	0.52
190		0.55
200		0.58
210		0.61
220		0.64
230		0.67
240		0.70
250		0.73
260		
270		
280		
290		
300		
310		
320		

Universal beams (4 sided exposure) critical temperature 550°C		
$Hp/A^{(m-1)}$	Basecoat dft required for fire resistance periods of (minutes):	
	30	**60**
40		
50		
60		
70		0.37
80		
90		
100		
110		0.45
120		0.57
130		0.65
140		0.70
150		
160		
170		
180	0.37	
190		
200		
210		
220		
230		
240		
250		
260		
270		
280		
290		
300		
310		
320		

Universal columns (4 sided exposure) critical temperature 550°C		
$Hp/A^{(m-1)}$	Basecoat dft required for fire resistance periods of (minutes):	
	30	**60**
40		
50		
60		
70		0.37
80		
90		
100		
110		0.45
120		0.57
130		0.65
140		0.70
150		0.74
160		0.78
170		0.81
180	0.37	0.84
190		0.88
200		0.91
210		0.94
220		0.98
230		1.01
240		1.04
250		1.08
260		1.11
270		1.14
280		1.17
290		1.20
300		1.22
310		
320		

UNITHERM 38091 (interior) 38091 (exterior)

1. Product description

Solvent based intumescent coating

2. Manufacturer

Permatex GmbH
Rieter Tal D71665, Vaihingen Enz, Germany
T: +49 70421090 F: +49 7042109180 W: www.permatex.de

3. Supplier

Permatex Protective Coatings
79 Elm Park Way, Rooley Moor, Rochdale OL12 7JQ
t: 01706 638616 f: 01706 711351 e: unitherm@freeuk.com

4. Nominal specific gravity

Basecoat: 1.24 g/cm^3
Topcoat Unitherm 7854: 1.32 g/cm^3

5. Wet coverage rates

Brush	800 gm/m^2
Airless spray	1400 gm/m^2
For exterior use	800 gm/m^2

6. Appearance

White smooth. Coloured top coat only required for decorative finish and exterior performance

7. On site use

External or internal. VOC 380 g/litre

8. Durability

Is being officially tested according to German approval rules for reactive fire protection systems 1997 for 2, 5 and 10 years

9. Performance in other BS and EN Tests

Quality Assurance to ISO 9001, Lloyds Register, BAM (Germany), Certifire (UK)

10. Other applications

Suitable for the fire protection of galvanised steel and cast iron

A. Protection technique

Profile following

B. Application technique

Airless spray, roller or brush

C. Specification of system

(a) Blast clean to SA 2½
(b) Apply suitable primer see technical data sheet on primers
(c) Apply 38091 to required thickness (see table)
(d) Apply 1 coat decorative top coat if required for appearance or 2 coats for exterior resistance

UNITHERM 38091 (interior) 38091 (exterior)

Fire resistance period 30 minutes

Hp/A (m-1)	I Beams (3-sided)	I beams & columns (4-sided)	RHS & CHS columns & beams (4 sided)*	RHS beams (3 sided) **	Total dry film thickness (mm)
	117	90			0.25
	180	120			0.30
	215				0.34
		150			0.35
	250				0.38
		180			0.40
	285				0.42
		215			0.45
	320				0.46
		250			0.50
		285			0.55
		320	166	192	0.60
			173		0.65
			180	207	0.70
			187	214	0.75
			194	221	0.80
			202	228	0.85
			209	236	0.90
			216	243	0.95
			223	250	1.00
			230	285	1.05
			255	320	1.10
			288		1.20
			320		1.30

* critical temperature 520°C
** critical temperature 590°C

Fire resistance period 90 minutes

Hp/A (m-1)	I Beams (3-sided)	I beams & columns (4-sided)	RHS & CHS columns & beams (4 sided) *	RHS beams (3 sided) **	Total dry film thickness (mm)
	85		25	25	1.30
	96				1.40
		90			1.65
	125	97			1.70
	155	110			1.80
		123			1.90
	185	137			2.00
		150			2.10
	220	168			2.20
		185			2.30
	235	189			2.40
	250	198	90		2.60
				180	2.70
	268	206			2.80
	285	215			3.00
		228			3.20
		240			3.40

* critical steel temperature 520°C
** critical steel temperature 590°C

Fire resistance period 60 minutes

Hp/A (m-1)	I Beams (3-sided)	I beams & columns (4-sided)	RHS & CHS columns & beams (4 sided) *	RHS beams (3 sided) **	Total dry film thickness (mm)
	44	37			0.25
	50	42			0.30
	55	46			0.35
	61	51			0.40
	66	55			0.45
	72	60			0.50
	77	64			0.55
	98	81	67		0.60
	118	98	71	78	0.65
	138	115	75	79	0.70
	159	132	79	80	0.75
	179	149	84	81	0.80
	199	165	88	82	0.85
	219	182	92	84	0.90
	240	199	96	85	0.95
	260	216	100	86	1.00
			105	87	1.06
	285	250	110	100	1.10
		252			1.15
	291	255	120	133	1.20
	298	259	130	165	1.30
	304	264	150	172	1.40
	310	269	170	180	1.50
	317	273	190	190	1.60
	320				1.65
		278		200	1.70
			200	210	1.80
		285			1.85
		303		220	1.90
		320			1.95
			210		2.05
				240	2.10
			223		2.30
				270	2.40
			235		2.50
				285	2.60
				295	2.70
			260		2.75

* critical temperature 520°C
** critical temperature 590°C

Fire resistance period 120 minutes

Hp/A (m-1)	I Beams (3-sided)	I beams & columns (4-sided)	Total dry film thickness (mm)
	25	25	1.00
	130	105	2.40
	142	113	2.60
	154	122	2.80
	165	130	3.00
	177	150	3.20
	190	170	3.40

UNITHERM DISPERSAL WATER BASED (38320)

1. Product description

Water based intumescent coating for interior use

2. Manufacturer

Permatex GmbH
Rieter Tal D71665, Vaihingen Enz, Germany
T: +49 70421090 F: +49 7042109180 W: www.permatex.de

3. Supplier

Permatex Protective Coatings
79 Elm Park Way, Rooley Moor, Rochdale OL12 7JQ
t: 01706 638616 f: 01706 711351 e: unitherm@freeuk.com

4. Nominal specific gravity

Basecoat: 1.34 g/cm^3
Topcoat Unitherm 7363: 1.21 g/cm^3 or 7854: 1.32 g/cm^3

5. Wet coverage rates

Brush	800 gm/m^2
Airless spray	1400 gm/m^2

6. Appearance

White smooth. Coloured top coat only required for decorative finish

7. On site use

Internal. VOC 40 g/litre

8. Durability

Is being officially tested according to German approval rules for reactive fire protection systems 1997 for 2, 5 and 10 years

9. Performance in other BS and EN Tests

Quality Assurance to ISO 9001, Lloyds Register, BAM (Germany), Certifire (UK)

10. Other applications

Suitable for the fire protection of galvanised steel and cast iron

A. Protection technique

Profile following

B. Application technique

Airless spray, roller or brush

C. Specification of system

(a) Blast clean to SA 2½
(b) Apply suitable primer see technical data sheet on primers
(c) Apply 38320 to required thickness (see table)
(d) Apply 1 coat decorative top coat if required for appearance

UNITHERM DISPERSAL WATER BASED (38320)

Fire resistance period 30 minutes					
Hp/A (m-1)	I beams (3-sided)	I beams (4 sided)	RHS beams (3-sided) +	RHS & CHS beams & columns (4-sided) *	Total dry film thickness (mm)
	210	200			0.38
			295		0.48
			308		0.52
			320		0.56
	320	320			0.57
				220	0.72
				250	0.80
				280	0.90
				320	1.03
* Tested to 530°C + Tested to 600°C					

Fire resistance period 90 minutes			
Hp/A (m-1)	I beams (3-sided)	RHS beams (3-sided) *	Total dry film thickness (mm)
	90		1.40
	98		1.50
	106		1.60
	114		1.70
	122		1.80
	130		1.90
	148		2.10
	165		2.30
		160	2.75
* Tested to 600°C			

Fire resistance period 60 minutes					
Hp/A (m-1)	I beams (3-sided)	I beams (4 sided)	RHS beams (3-sided) +	RHS & CHS beams & columns (4-sided) *	Total dry film thickness (mm)
			115		0.48
			116		0.5
			120		0.55
			124		0.6
	80		127		0.65
	110		131		0.7
			134		0.75
	130		138		0.80
			141		0.85
	150	100	145		0.90
			148		0.95
	170	120	151		1.00
	190	140	157		1.10
	210	160	163		1.20
	230	180	169		1.30
				90	1.35
	250	200	175		1.40
	265				1.48
			182		1.50
		210			1.53
	280		189		1.60
				115	1.63
	300				1.68
		220	196		1.70
	320		203		1.80
			210	120	1.90
		240	216		2.00
				130	2.10
			230		2.21
		260		140	2.30
		273		150	2.50
			250		2.52
			258		2.64
		285			2.65
				160	2.70
			265		2.75
				170	2.95
				180	3.18
				190	3.43
				200	3.67
				210	3.91
				220	4.15
* Tested to 530°C + Tested to 600°C					

CAFCO® 300

1. Product description

Gypsum based vermiculite spray

2. Manufacturer

Cafco International
Bluebell Close, Clover Nook Industrial Park, Alfreton, Derbyshire DE55 4RA
T: 01773 837900 F: 01773 836710 W: www.cafcointl.com

3. Availability

Supply and fix service by recognised applicators. Details from manufacturer

4. Protection technique

Profile, box or solid

5. Application technique

Factory prepared pre-packed, mixed with water on site and sprayed through standard slurry pump.

6. Steel preparation requirements

Steel must be de-greased and have loose scale and rust removed. Pre-treatment using a primer/ adhesive is necessary in most cases when applying 300 to steelwork with painted surfaces.

7. Additional mechanical fixing

None within the scope of the following table

8. Nominal density

310 kg/m^3

9. Thickness range

10 - 70mm

10. Fire resistance range

(a) Up to 4 hours
(b) Hp/A: 30 - 310 Profile

11. Constraints for fire resistance

(a) Minimum dry thickness 10mm
(b) Maximum unreinforced dry thickness 70mm

12. Appearance

Off-white textured finish. Surface finishes may be used

13. On site use

Internal -semi exposed (canopies)

14. Durability

Resistant to frost, vermin and mould growth and limited attack by water.

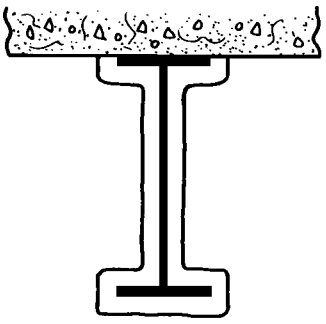
15. Performance in other BS and EN fire tests

Non-combustible in accordance with BS476-4, so complies with Class 0 requirements as defined in the Building Regulations 1991. EN test for fire protection to concrete.

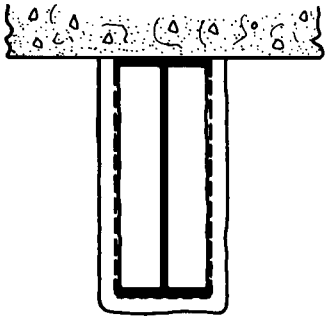
16. Other applications

(a) Fire protection of concrete
(b) Marine protection (internal)
(c) Cavity fire barrier
(d) Acoustic correction
(e) Fire protection of ductwork

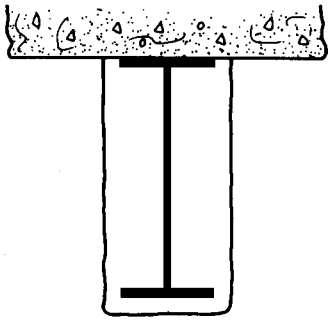
Hp/A up to	Dry thickness in mm to provide fire resistance (mins) of					
	30	**60**	**90**	**120**	**180**	**240**
30	10	10	10	12	17	23
50	10	10	13	16	24	32
70	10	10	15	20	29	38
90	10	12	17	22	32	43
110	10	13	18	24	35	46
130	10	14	19	25	37	49
150	10	14	20	27	39	52
170	10	15	21	28	41	53
190	10	15	22	29	42	55
210	10	16	22	29	43	57
230	10	16	23	30	44	58
250	10	16	23	30	45	59
270	10	17	24	31	45	60
290	10	17	24	31	46	61
310	10	17	24	32	47	61
Linear interpolation is permissable between values of Hp/A						



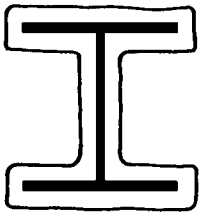
Profile



Box



Solid



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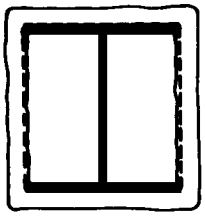

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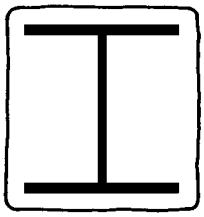


Solid

CAFCO® BLAZE-SHIELD II

1. Product description

Sprayed mineral wool

2. Manufacturer

Cafco International
Bluebell Close, Clover Nook Industrial Park, Alfreton, Derbyshire DE55 4RA
T: 01773 837900 F: 01773 836710 W: www.cafcointl.com

3. Availability

Supply and fix service by recognised applicators. Details from manufacturer

4. Protection technique

Profile, box or solid

5. Application technique

Air-borne spray mixed with water at gun

6. Steel preparation requirements

The steel must be degreased and have loose scale and rust removed. The steel may be primed with a zinc epoxy primer or any other compatible type. No preparation is necessary for box protection

7. Additional mechanical fixing or reinforcement

None for up to 65mm and 4 hours fire resistance for 3 or 4 sided applications. Mesh or equivalent (i.e. steel pins with spring washers) may need to be introduced for other applications

8. Nominal density

250 - 280 kg/m^3

9. Thickness range

10 - 70mm

10. Fire resistance range

(a) Up to 4 hours
(b) Hp/A: 26 - 315m^{-1} for profile protection
17 - 260m^{-1} for box or solid protection

11. Constraints for fire resistance

(a) Minimum dry thickness - 10mm
(b) Maximum unreinforced dry thickness - 65mm
(c) For 3 and 4 hours fire resistance thicknesses in excess of 65mm require reinforcement and reference should be made to the manufacturer

12. Appearance

White rough textured

13. On site use

Internal

14. Durability

Resistant to local short term water attack, vermin and mould growth

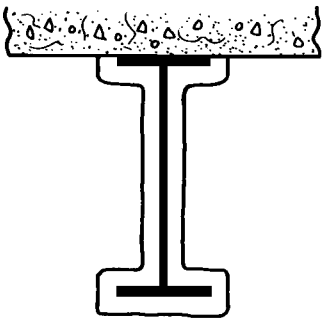
15. Performance in other BS and EN fire tests

Non-combustible in accordance with BS476-4, so complies with Class 0 as defined in the Building Regulations 1991

16. Other applications

(a) Thermal insulation
(b) Acoustic correction
(c) Condensation control
(d) Sound insulation
(e) Fire protection of ductwork
(f) Fire protection of concrete
(g) General fire protection - external walls, cavity barriers, etc
(h) Marine fire protection

Hp/A up to	Dry thickness in mm to provide fire resistance (mins) of					
	30	**60**	**90**	**120**	**180**	**240**
30	10	12	12	12	17	25
50	10	12	12	16	26	36
70	10	12	15	21	34	46
90	10	12	17	25	40	55
110	10	12	20	29	46	64
130	10	13	22	32	51	70
150	10	14	24	35	56	
170	10	15	26	37	60	
190	10	16	28	40	64	
210	10	16	29	42	67	
230	10	17	30	43	70	
250	10	18	31	45		
270	10	18	33	47		
290	10	19	34	48		
310	10	19	35	50		
Linear interpolation is permissable between values of Hp/A						



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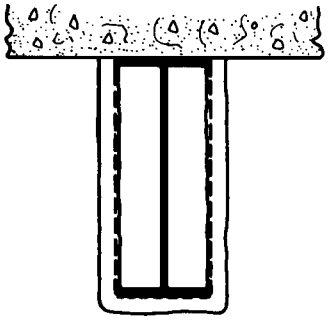

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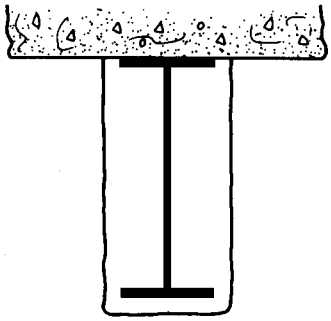

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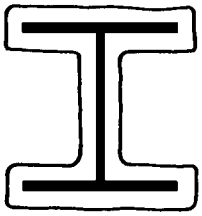

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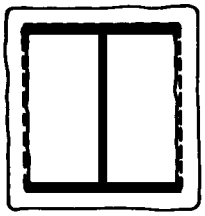

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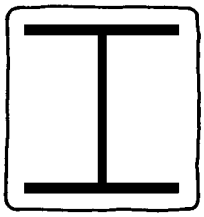


Solid

CAFCO® SPRAYDON FG

1. Product description

Sprayed mineral wool

2. Manufacturer

Cafco International
Bluebell Close, Clover Nook Industrial Park, Alfreton, Derbyshire DE55 4RA
T: 01773 837900 F: 01773 836710 W: www.cafcointl.com

3. Availability

Supply and fix service by recognised aplicators. Details from manufacturer.

4. Protection technique

Profile, box or solid

5. Application technique

Air-borne spray mixed with water at the gun

6. Steel preparation requirements

Steel must be degreased and have loose scale and rust removed. Steel primers acceptable, spraying to high gloss paint not acceptable and requires wire brushing

7. Additional mechanical fixing

None up to a thickness of 60mm on horizontal faces and 90mm on vertical faces

8. Nominal density

200 kg/m^3

9. Thickness range

10 - 94 mm

10. Fire resistance range

(a) Up to 4 hours
(b) Hp/A: 30 - 315 m^{-1} for profile protection

11. Constraints for fire resistance

(a) Minimum dry thickness - 10mm
(b) Maximum dry thickness unreinforced - 83mm

12. Appearance

White

13. On site use

Internal application

14. Durability

Resistant to local short term water attack

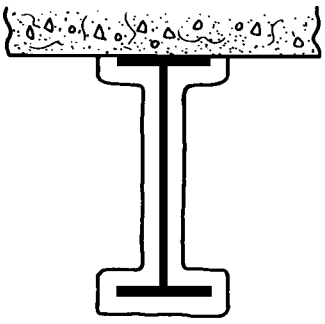
15. Performance in other BS fire tests

Non-combustible in accordance with BS476-4, so complies with Class 0 as defined in the Building Regulations 1991

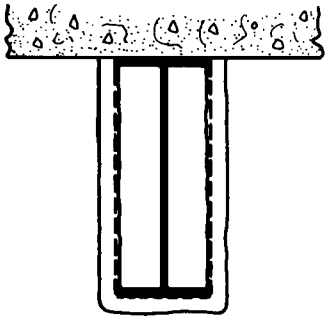
16. Other applications

(a) Thermal insulation
(b) Acoustic insulation
(c) Condensation control
(d) Sound control
(e) Fire protection of concrete

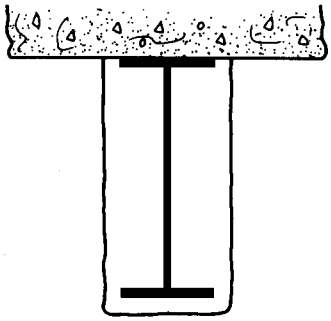
Hp/A up to	Dry thickness in mm to provide fire resistance (mins) of					
	30	**60**	**90**	**120**	**180**	**240**
30	10	10	10	13	16	28
50	10	10	10	14	28	39
70	10	10	10	19	34	51
90	10	10	12	27	40	60
110	10	10	17	31	42	66
130	10	10	20	32	45	70
150	10	10	21	33	48	75
170	10	10	22	34	51	77
190	10	10	24	35	52	80
210	10	11	27	35	54	81
230	10	12	27	36	56	81
250	10	13	28	36	58	81
270	10	14	28	37	60	82
290	10	15	30	38	62	82
310	10	16	32	40	64	83
Linear interpolation is permissable between values of Hp/A						



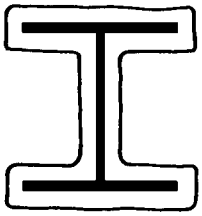
Profile



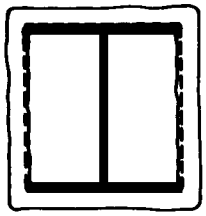
Box



Solid



Profile



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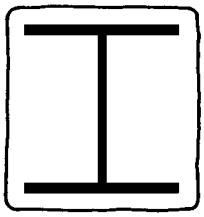


Solid

CAFCOTE® 280

1. Product description

Cementitious mineral fibre spray

2. Manufacturer

Cafco International
Bluebell Close, Clover Nook Industrial Park, Alfreton, Derbyshire DE55 4RA
T: 01773 837900 F: 01773 836710 W: www.cafcointl.com

3. Availability

Supply and fix service by recognised applicators. Details from manufacturer

4. Protection technique

Profile, box or solid

5. Application technique

Factory prepared pre-packed, mixed with water on site and sprayed through standard slurry pump. Thicknesses up to 15mm can be applied in one pass. The material can be hand trowelled.

6. Steel preparation requirements

Steel must be de-greased and have loose scale and rust removed. 280 is compatible with most conventional steel primers. For exceptionally smooth finish primer refer back to the manufacturer

7. Additional mechanical fixing

None within the scope of the following table

8. Nominal density

300 kg/m^3

9. Thickness range

10 - 100mm

10. Fire resistance range

(a) Up to 4 hours
(b) Hp/A: 26 - 315 Profile
17 - 260 Solid

11. Constraints for fire resistance

(a) Minimum dry 10mm
(b) Maximum unreinforced 70mm

12. Appearance

Off-white textured finish. Surface finishes may be used

13. On site use

Internal -semi exposed (canopies)

14. Durability

Resistant to frost, vermin and mould growth and limited attack by water.
Surface damage can be easily repaired by hand trowelling standard Cafcote 280

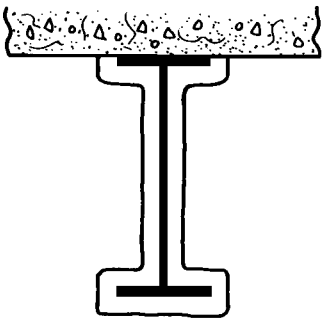
15. Performance in other BS fire tests

Non-combustible in accordance with BS476-4, so complies with Class 0 requirements as defined in the Building Regulations 1991

16. Other applications

(a) Thermal insulation
(b) Acoustic correction
(c) Fire protection of ductwork
(d) Fire protection of concrete
(e) Marine protection (internal)
(f) Cavity fire barrier

Hp/A up to	Dry thickness in mm to provide fire resistance (mins) of					
	30	**60**	**90**	**120**	**180**	**240**
30	10	10	10	11	16	25
50	10	10	11	15	23	31
70	10	10	14	19	29	39
90	10	11	17	23	34	46
110	10	12	19	25	38	51
130	10	13	20	28	42	56
150	10	14	22	29	45	60
170	10	15	23	31	47	63
190	10	16	24	33	50	67
210	10	16	25	34	52	69
230	10	17	26	35	53	
250	10	17	27	36	55	
270	10	18	27	37	56	
290	10	18	28	38	58	
310	10	19	29	39	59	
Linear interpolation is permissable between values of Hp/A						



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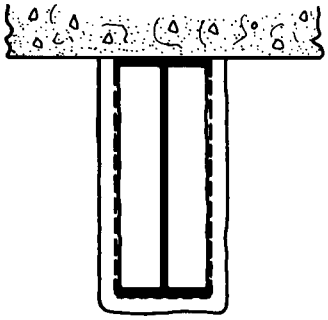

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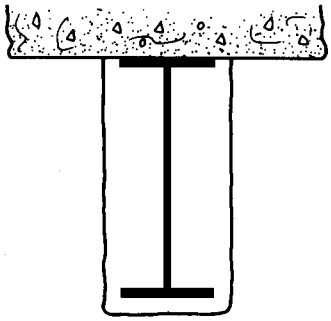
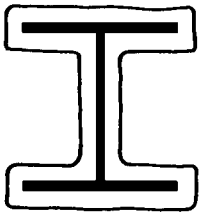


Solid



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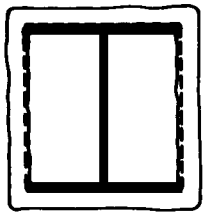

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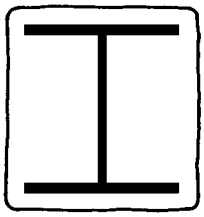


Solid

CAFCOTE® 800

1. Product description:
Sprayed mineral fibre cement

2. Manufacturer
Cafco International
Bluebell Close, Clover Nook Industrial Park, Alfreton, Derbyshire DE55 4RA
T: 01773 837900 F: 01773 836710 W: www.cafcointl.com

3. Availability
Supply and fix service by recognised applicators. Details from manufacturer

4. Protection technique
Profile, box or solid

5. Application technique
Factory prepared pre-packed, mixed with water on site and sprayed through standard slurry pump. Thicknesses up to 15mm can be applied in one pass. The material can be hand trowelled.

6. Steel preparation
The steel must be degreased and have loose scale and rust removed.
If the steel is to be primed, compatibility should be determined by the manufacturer.

7. Additional mechanical reinforcement
Mesh reinforcement is recommended for thicknesses in excess of 50mm

8. Nominal density
800 kg/m³

9. Thickness range
45mm

10. Fire resistance range
(a) Up to 3 hours
(b) Hp/A: 30 - 310 m^{-1}

11. Constraints for fire resistance
(a) Minimum dry thickness 45mm, 3 hrs fire resistance
(b) Applicable to columns only

12. Appearance
White, textured finish which can be trowelled smooth if necessary

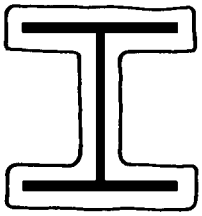
13. On site use
For interior and exterior applications suitable for nuclear washdown requirements

14. Durability
Resistant to weather, vermin, impact and mould growth

15. Performance in other BS fire tests
Non-combustible in accordance with BS476-4, so complies with Class 0 requirements as defined in the Building Regulations 1991. Tested to hydrocarbon heating conditions

16. Other applications
(a) Fire protection of concrete
(b) General fire protection -external wall, cavity, barrier, etc
(c) Fire protection of storage vessels
(d) Fire protection of petrochemical plant
(e) Marine and off shore platform protection
(f) Hydrocarbon applications

Hp/A up to	Dry thickness in mm to provide fire resistance (mins) of				
	30	**60**	**90**	**120**	**180**
30	45	45	45	45	45
50	45	45	45	45	45
70	45	45	45	45	45
90	45	45	45	45	45
110	45	45	45	45	45
130	45	45	45	45	45
150	45	45	45	45	
170	45	45	45	45	
190	45	45	45	45	
210	45	45	45	45	
230	45	45	45	45	
250	45	45	45	45	
270	45	45	45	45	
290	45	45	45	45	
310	45	45	45	45	
Linear interpolation is permissable between values of Hp/A					



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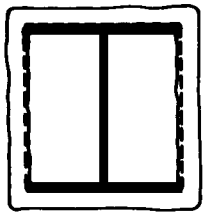
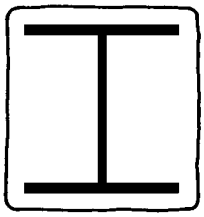


Box



Solid

MANDOLITE CP2

1. Product description

Cement based vermiculite spray

2. Manufacturer

Cafco International
Bluebell Close, Clover Nook Industrial Park, Alfreton, Derbyshire DE55 4RA
T: 01773 837900 F: 01773 836710 W: www.cafcointl.com

3. Availability

Supply and fix service by recognised applicators. Details from manufacturer

4. Protection technique

Profile or solid

5. Application technique

Factory prepared pre-mix, mixed with water on site and spray applied

6. Steel preparation requirements

The steel must be degreased and have loose scale and rust removed. If the steel is primed reference must be made to the manufacturer

7. Additional mechanical fixing or reinforcement

None for up to 73mm and 4 hours resistance for 3 or 4 sided applications. Mesh or equivalent may be needed for other cases

8. Nominal density

390 kg/m^3

9. Thickness range

8 to 100mm

10. Fire resistance range

(a) Up to 4 hours
(b) Hp/A 26 - 315 m^{-1} for profile protection
17 - 260 m^{-1} for solid protection

11. Constraints for fire resistance

(a) Minimum thickness - 8mm
(b) Maximum unreinforced thickness - 73mm

12. Appearance

Off-white textured surface. Surface finishes may be used

13. On site use

For interior and limited exterior exposure (during construction)

14. Durability

Resistant to frost, vermin and mould growth and limited attack by water. Surface damage can be made good with CP2 Patch Mix

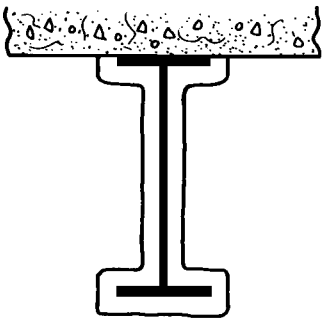
15. Performance in other BS fire tests

Non-combustible in accordance with BS476-4 so complies with Class 0 as defined in the Building Regulations 1985

16. Other applications

(a) Fire protection of ductwork
(b) Fire protection of concrete elements and composite floors
(c) General fire protection -interior surfaces of external walls, cavity barriers, etc

Hp/A up to	Dry thickness in mm to provide fire resistance (mins) of					
	30	**60**	**90**	**120**	**180**	**240**
30	8	8	10	13	19	25
50	8	10	14	18	25	33
70	8	12	16	21	30	39
90	8	13	18	23	33	43
110	9	14	19	25	35	46
130	9	15	20	26	37	48
150	10	15	21	27	39	50
170	10	16	22	28	40	52
190	10	16	22	29	41	53
210	10	17	23	29	42	54
230	11	17	23	30	42	55
250	11	17	24	30	43	56
270	11	17	24	30	44	57
290	11	18	24	31	44	57
310	11	18	24	31	45	58
Linear interpolation is permissable between values of Hp/A						



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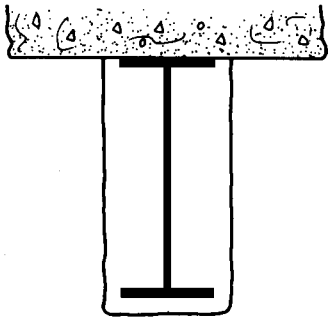

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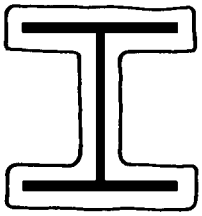

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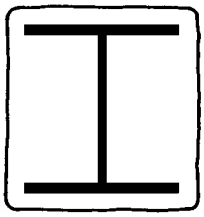


Solid

MANDOLITE HS3

1. Product description

Lightweight aggregate cementitious mix

2. Manufacturer

Cafco International
Bluebell Close, Clover Nook Industrial Park, Alfreton, Derbyshire DE55 4RA
T: 01773 837900 F: 01773 836710 W: www.cafcointl.com

3. Availability

Supply and fix service by recognised applicators. Details from manufacturer

4. Protection technique

Profile, box or solid

5. Application technique

Factory prepared pre-mix, mixed with water on site and spray applied (can be trowel finished)

6. Steel preparation requirements

The steel must be degreased and have loose scale and rust removed. If the steel is primed reference must be made to the manufacturer

7. Additional mechanical fixing

None for up to 58mm and 4 hour's resistance for three or four sided applications. Mesh or fixing equivalent may be needed for other cases. Mesh required for Box systems

8. Nominal density

750 kg/ m^3

9. Thickness range

8 to 100mm

10. Fire resistance range

(a) Up to 4 hours
(b) Hp/A: 26 - 330 m^{-1} for profile protection
17 - 260m^{-1} for box or solid protection

11. Constraints for fire resistance

(a) Minimum dry thickness 8mm
(b) Maximum unreinforced dry thickness 58mm

12. Appearance

Off white textured or smooth surface suitable for top coating if required

13. On site use

For interior and exterior applications

14. Durability

Resistant to weather, impact, vermin and mould growth

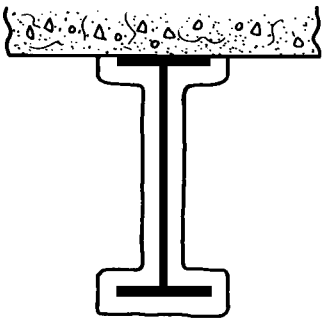
15. Performance in other BS fire tests

Non-combustible in accordance with BS476-4 so complies with Class 0 as defined in the Building Regulations 1991

16. Other applications

(a) Fire protection of concrete
(c) General fire protection

Hp/A up to	Dry thickness in mm to provide fire resistance (mins) of					
	30	**60**	**90**	**120**	**180**	**240**
30	8	8	9	11	17	23
50	8	8	12	16	24	33
70	8	9	14	19	29	39
90	8	11	16	22	33	45
110	8	12	18	24	36	49
130	8	12	19	26	39	52
150	8	13	20	27	41	55
170	8	13	21	28	43	58
190	8	14	22	29	44	
210	8	14	22	30	46	
230	8	15	23	31	47	
250	8	15	23	31	48	
270	8	15	24	32	49	
290	8	16	24	33	49	
310	8	16	24	33	50	
Linear interpolation is permissable between values of Hp/A						



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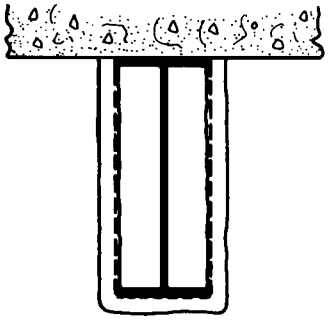
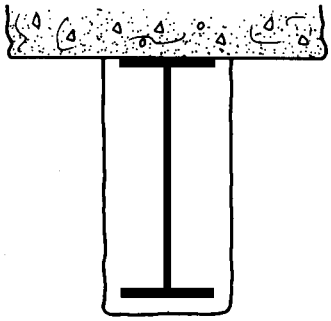
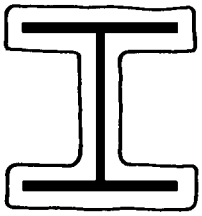


Box



Solid



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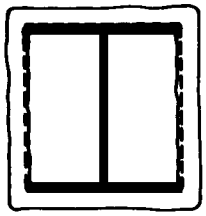

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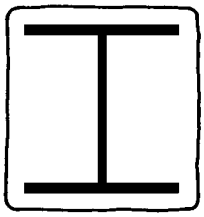


Solid

MANDOLITE TG

1. Product description

Trowel grade lightweight aggregate cementitious mix

2. Manufacturer

Cafco International
Bluebell Close, Clover Nook Industrial Park, Alfreton, Derbyshire DE55 4RA
T: 01773 837900 F: 01773 836710 W: www.cafcointl.com

3. Availability

Supply and fix service by recognised applicators. Details from manufacturer.

4. Protection technique

Profile, box or solid

5. Application technique

Factory prepared pre-mix, mixed with water on site and applied by trowel

6. Steel preparation requirements

The steel must be degreased and have loose scale and rust removed. If the steel is primed reference must be made to the manufacturer. No preparation is necessary for box protection

7. Additional mechanical fixing

Mesh may be required for specific applications. Mesh required for Box systems

8. Nominal density

675kg/ m^3

9. Thickness range

8 to 100mm

10. Fire resistance range

(a) Up to 4 hours
(b) Hp/A: 26 - 330m^{-1} for profile protection
17 - 260m^{-1} for box or solid protection

11. Constraints for fire resistance

(a) Minimum dry thickness 8mm
(b) Maximum unreinforced dry thickness 58mm

12. Appearance

Off white smooth surface suitable for top coating if required

13. On site use

For interior and exterior applications

14. Durability

Resistant to weather, impact, vermin and mould growth

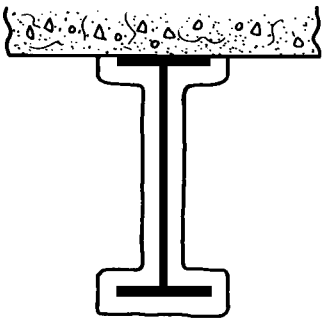
15. Performance in other BS fire tests

Non-combustible in accordance with BS476, Part 4, so complies with Class 0 as defined in the Building Regulations 1991.

16. Other applications

(a) Hand repairs to Mandolite HS3
(b) Fire protection of concrete
(c) General fire protection of building structures

Hp/A up to	Dry thickness in mm to provide fire resistance (mins) of					
	30	**60**	**90**	**120**	**180**	**240**
30	8	8	9	11	17	23
50	8	8	12	16	24	33
70	8	9	14	19	29	39
90	8	11	16	22	33	45
110	8	12	18	24	36	49
130	8	12	19	26	39	52
150	8	13	20	27	41	55
170	8	13	21	28	43	58
190	8	14	22	29	44	
210	8	14	22	30	46	
230	8	15	23	31	47	
250	8	15	23	31	48	
270	8	15	24	32	49	
290	8	16	24	33	49	
310	8	16	24	33	50	
Linear interpolation is permissable between values of Hp/A						



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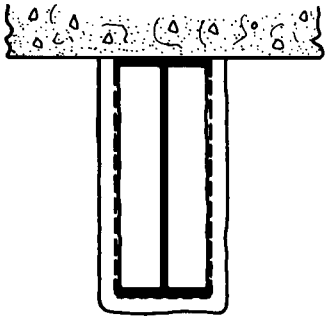
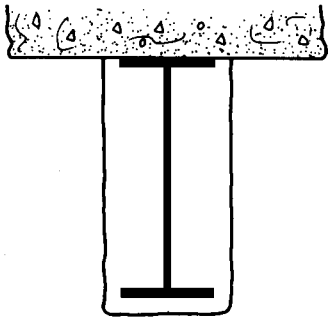
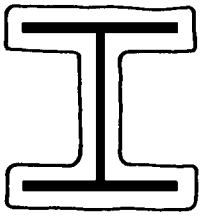


Box



Solid



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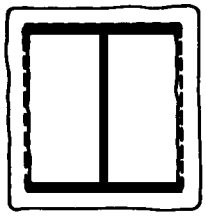

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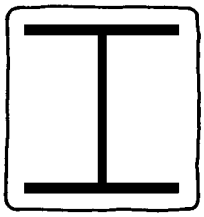


Solid

MONOKOTE MK6

1. Product description

Gypsum based mixture containing synthetic aggregate

2. Manufacturer

Grace Construction Products
Ajax Avenue Slough, Berkshire SL1 4BH
T: 01753 692929 F: 01753 691623 W: www.gcp-grace.com

3. Availability

Through manufacturers approved applicators

4. Protection technique

Profile to beams, columns and soffits

5. Surface preparation requirements

Remove mill scale and contaminates. For compatible primers refer to manufacturer.

7. Additional mechanical fixing

None required for I beams with depths up to 1000mm, and I columns with flange widths up to 500mm

8. Nominal density

Monokote MK-6S 315 kg/m³
Monokote MK6-HY 260 kg/m³

9. Thickness range

10 to 84mm

10. Fire resistance range

Up to and including 4 hours

11. Constraints for fire resistance

(a) Minimum thickness - 10mm
(b) Maximum thickness - 84mm

12. Appearance

Sprayed, textured, light grey, other colours available

13. On site use

For internal applications only

14. Durability

Resistant to vermin, mould growth and minor impact and abrasions

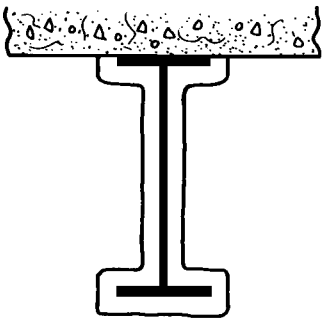
15. Performance in other BS tests

Non-combustible BS 476-6, Class 0 BS 476-7

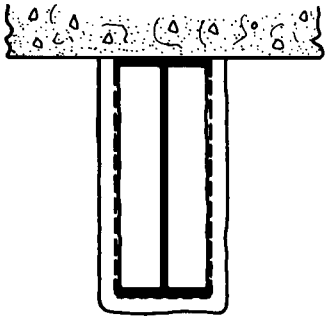
16. Other applications

Thermal insulation
Acoustic control

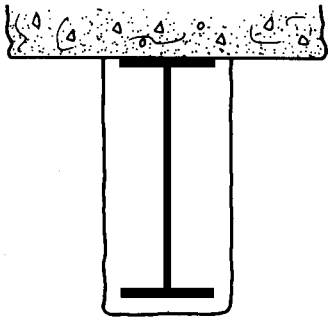
Hp/A up to	Dry thickness in mm to provide fire resistance (mins) of					
	30	**60**	**90**	**120**	**180**	**240**
30	10	10	10	10	12	16
50	10	10	10	12	18	25
70	10	10	11	15	24	33
90	10	10	13	18	29	40
110	10	10	15	21	33	46
130	10	10	16	23	37	51
150	10	10	18	25	41	56
170	10	11	19	27	44	60
190	10	12	20	29	47	64
210	10	12	21	31	49	68
230	10	13	23	32	52	71
250	10	13	23	34	54	74
270	10	14	24	25	56	77
290	10	14	25	36	58	79
310	10	15	26	37	59	82
Linear interpolation is permissable between values of Hp/A						



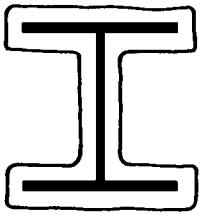
Profile



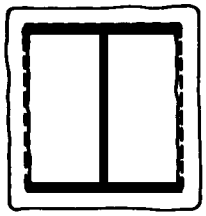
Box



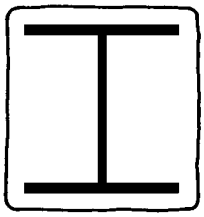
Solid



Profile



Box



Solid

MONOKOTE Z106

1. Product description
Portland cement based mixture containing synthetic aggregate

2. Manufacturer
Grace Construction Products
Ajax Avenue Slough, Berkshire SL1 4BH
T: 01753 692929 F: 01753 691623 W: www.gcp-grace.com

3. Availability
Grace Construction Products

4. Protection technique
Profile to beams, columns and soffits

5. Application technique
Spray

6. Surface preparation
Remove mill scale and contaminates. For compatible primers refer to manufacturer

7. Additional mechanical fixing
None required

8. Nominal density
360 kg/m^3

9. Thickness range
10 to 80mm

10. Fire resistance range
Up to and including 4 hours

11. Constraints for fire resistance
(a) Minimum thickness - 10mm
(b) Maximum thickness - 65mm

12. Appearance
Sprayed, textured, light grey

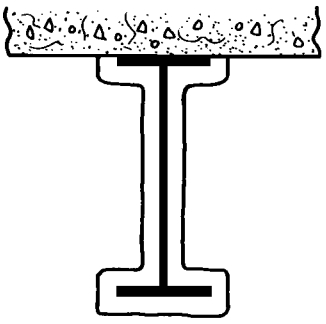
13. On site use
For both internal and external applications

14. Durability
Resistant to vermin, mould growth and minor impact and abrasions

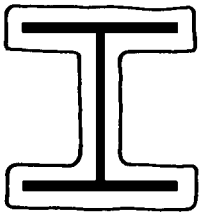
15. Performance in other BS fire tests
No data

16. Other applications
(a) Thermal insulation
(b) Acoustic control

Hp/A up to	Dry thickness in mm to provide fire resistance (mins) of					
	30	**60**	**90**	**120**	**180**	**240**
30	10	10	10	10	13	17
50	10	10	10	12	19	25
70	10	10	11	15	23	31
90	10	10	13	18	27	36
110	10	10	15	20	30	41
130	10	10	16	22	33	44
150	10	11	17	23	35	47
170	10	12	18	24	37	50
190	10	12	19	25	39	52
210	10	13	20	26	40	54
230	10	13	20	27	41	56
250	10	13	21	28	43	57
270	10	14	21	29	44	59
290	10	14	22	29	45	60
310	10	14	22	30	45	61
Linear interpolation is permissable between values of Hp/A						



Profile



Profile

MONOKOTE Z146

1. Product description
Portland cement based mixture containing synthetic aggregate

2. Manufacturer
Grace Construction Products
Ajax Avenue Slough, Berkshire SL1 4BH
T: 01753 692929 F: 01753 691623 W: www.gcp-grace.com

3. Availability
Grace Construction Products approved applicators

4. Protection technique
Profile and box

5. Application technique
Suply and installation by Team One approved contractors

6. Surface preparation
Remove mill scale and contaminates. For compatible primers refer to manufacturer

7. Additional mechanical fixing
None required for profile. Expanded metal lath for box

8. Nominal density
675 kg/m^3

9. Thickness range
6 to 46 mm

10. Fire resistance range
Up to and including 4 hours

11. Constraints for fire resistance
(a) Minimum thickness - 6 mm
(b) Maximum thickness - 46 mm

12. Appearance
Sprayed, textured, light grey

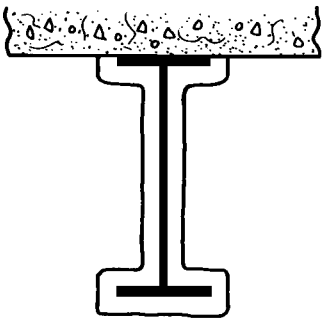
13. On site use
For both internal and external applications

14. Durability
Resistant to vermin, mould growth and minor impact and abrasions

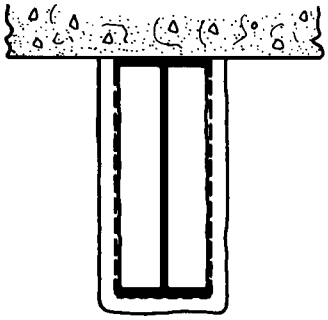
15. Performance in other BS fire tests
No data

16. Other applications
None

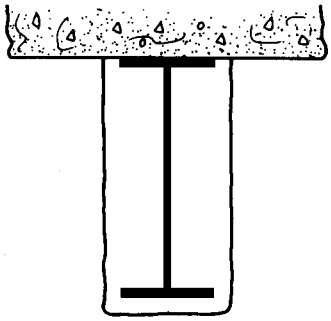
Hp/A up to	Dry thickness in mm to provide fire resistance (mins) of					
	30	**60**	**90**	**120**	**180**	**240**
30	5	8	10	13	18	24
50	6	9	13	16	22	29
70	7	10	14	18	25	32
90	7	11	15	19	26	34
110	8	12	15	19	27	35
130	8	12	16	20	28	36
150	8	12	16	20	29	37
170	8	12	17	21	29	38
190	8	12	17	21	30	38
210	8	13	17	21	30	38
230	8	13	17	21	30	39
250	8	13	17	22	30	39
270	8	13	17	22	31	39
290	9	13	17	22	31	40
310	9	13	18	22	31	40
Linear interpolation is permissable between values of Hp/A						



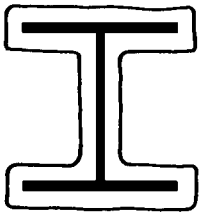
Profile



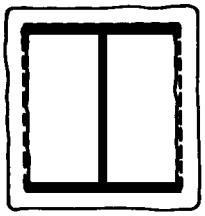
Box



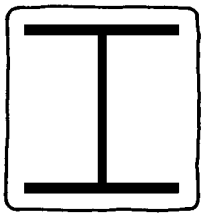
Solid



Profile



Box



Solid

ASSOCIATION FOR SPECIALIST FIRE PROTECTION
On Site measurement of intumescent coatings: Part 1 Technical guidance note for measurement of dry film thicknesses (dft's) for intumescent coatings (ASFP TGN 003: Part l) ASFP, 1996

BRITISH STANDARDS INSTITUTION
BS 476: Fire tests on building materials and structures
BS 476-4:1970 (1984): Non - combustibility test for materials
BS 476-20:1987: Method for determination of the fire resistance of load bearing elements of construction (general principles)
BS 476-21:1987: Methods for determination of the fire resistance of loadbearing elements of construction
BS 476-22:1987: Methods for determination of the fire resistance of non-loadbearing elements of construction
BS 476-23:1987: Methods for determination of the contribution of components to the fire resistance of a structure
BS 5950: The structural use of steelwork in buildings
BS 5950-1:1990: Code of Practice for Design in Simple and Continuous Construction
BS 5950-3: Design in Composite Construction, Section 3.1 Code of Practice for Design in Simple and Continuous Composite Beams
BS 5950-8:1990: Code of practice for fire resistant design in Simple and Continuous Construction
BS 8202: Coatings for fire protection of building elements
BS 8202-1:1995: Code of practice for the selection and installation of sprayed mineral coatings
BS8202-2:1992: Code of practice for the use of intumescent coating systems to metallic substrates for providing fire resistance
BS ENV 1991: Eurocode 1: Basis of design and actions on structures
Part 1: Basis of design and Part 2.2: Actions on structures exposed to fire. 1994
BS ENV 1993: Eurocode 3: Design of steel structures
Part 1.2 Structural fire design
BS ENV 1994: Eurocode 4: Design of composite steel and concrete structures
Part 1.2 Structural fire design

THE BUILDING REGULATIONS
Approved Document B, Fire Safety
Department of the Environment and The Welsh Office, HMSO
The Building Standards (Scotland) Regulations
Scottish Office, HMSO
The Building Regulations (Northern Ireland)
Department of the Environment, HMSO

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ISO 834: Fire resistance tests - elements of construction. ISO, 1985

LAWSON R.M and NEWMAN G,M
Structural fire design to EC3 and EC4, and comparison with BS 5950
The Steel Construction Institute, 1996

LOSS PREVENTION COUNCIL
Design Guide for Fire Prevention of Buildings
The Loss Prevention Council, 1996

MORRIS, W. A., READ, R. E. H., and COOKE, G. M. E.
Guidelines for the construction of fire resisting structural elements
Building Research Establishment Report No. BR 128, BRE, 1998

NEWMAN G, M.
The fire resistance of composite floors with steel decking (2nd edition)
The Steel Construction Institute, 1991 British Steel, 1992