British Standard

BRITISH STANDARD

BS 8202-1: 1995

Coatings for fire protection of building elements —

Part 1: Code of practice for the selection and installation of sprayed mineral coatings

Committees responsible for this British Standard

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Association of Metropolitan Authorities
Association of Specialist Fire Protection Contractors and Manufacturers
British Steel Industry
Department of the Environment (Building Research Establishment)
Department of the Environment for Northern Ireland
Institution of Structural Engineers
Marine Safety Agency
Warrington Fire Research Centre

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Contents

Foreword

This Part of BS 8202 has been prepared under the direction of Technical Committee B/209, General building codes. It supersedes BS 8202-1:1987 which is withdrawn. This Part of BS 8202 covers all types of sprayed mineral coatings, with the exception of sprayed asbestos. The eventual aim is to recommend the standard for adoption by ISO as an international standard.

This edition introduces technical changes but it does not reflect a full review or revision of the standard, which will be undertaken in due course. This edition brings this standard into line with current approval procedures and clarifies application techniques.

This Part of BS 8202 gives recommendations for the selection and installation of sprayed mineral coatings to enhance fire resistance of building elements. However, the same coatings are used for thermal insulation of buildings, pipework and equipment, for noise level reduction and condensation control in buildings and for lining refractories. BS 8216 gives recommendations for the uses of sprayed lightweight mineral coatings for thermal and acoustical purposes.

There are various methods of assessment of fire resistance which may be based in systematic testing or theoretical considerations. For further guidance, see *Fire Protection for Structural Steel in Buildings* [1].

Throughout this edition the method for determining the fire resistance of a structure is referred to as conforming to BS 476-21 which superseded BS 476-8:1992. It should be noted, however, that BS 476-8 is still available and is referred to in regulations.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 20, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This Part of BS 8202 gives recommendations for the selection and installation of sprayed mineral coatings to enhance fire resistance of building elements. It describes methods of application to various types of surface in varying densities and finishes.

This standard is intended for the guidance of specifiers, application specialists and site inspectors.

Annex A describes a method for determining the dry density of the spray application.

NOTE Maximum approved thicknesses should not be exceeded.

2 References

2.1 Normative references

This Part of BS 8202 incorporates, by dated or undated reference, provisions from other publications. These normative references are made at the appropriate places in the text and the cited publications are listed on the inside back cover. For dated references, only the edition cited applies: any subsequent amendments to or revisions of the cited publication apply to this Part of BS 8202 only when incorporated in the reference by amendment or revision. For undated references, the latest edition of the cited publication applies, together with any amendments.

2.2 Informative references

This Part of BS 8202 refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on the inside back cover, but reference should be made to the latest editions.

3 Definitions

For the purposes of this Part of BS 8202, the following definitions apply.

3.1
spray

sprayed mineral coating

3.2
adhesive retention

use of an additional material to improve the bond of the spray to a substrate

3.3
mechanical retention

use of mechanical system(s) to retain the spray in situ

NOTE See clause **7**.

4 Independent validation

4.1 The appropriate independent validation should be provided as evidence that the recommendations of this standard have been followed. For many applications, particularly those relating to building control, it will be necessary for the specifier, manufacturer and/or applicator to produce test reports (or assessments) from an approved testing laboratory (or consultancy) to show that the required performance criteria can be achieved.

Any changes in the spray system, i.e. primer, spray and surface finish, or its method of application may affect its performance. Ideally, performance tests previously carried out should be repeated to ensure that the level of performance is not affected. However, in practice this is not always possible because of the cost of some types of test, particularly fire resistance tests conforming to BS 476-21 and because of the range of variables which may occur, e.g. raw materials may be obtained from several sources or a spray may be required to be used with a large number of different primers. Thus changes in the chemical or physical nature of the components of the spray or their relative proportions should be the subject of a full re-test in accordance with the appropriate performance standard whilst detail changes in the spray system may be validated without repeating the appropriate performance test, using analytical laboratory tests and/or reduced scale performance tests. It is important that any reduced scale tests can be shown to correlate with the appropriate performance standard. In many cases the spray manufacturer/supplier would be the only source of this information. The justification for any assessment of changes in the spray system should be available for inspection as appropriate.

Assessments of the performance of spray systems are often required where it is not practical to test the full range of the substrate shapes and/or sizes with which the system may be used, e.g. structural steelwork. In such cases assessments by an appropriate authority, based on relevant test information relating to the specific spray under consideration, may be accepted in addition to fire performance tests.

4.2 Where materials and methods are used that are not referred to by this standard, their use is not discouraged, provided that:

a) they are proven by test; and

b) they are such as to ensure a level of performance at least equal to that recommended in this standard.

5 General

5.1 Composition

5.1.1 *General*

Spray comprises the principal ingredients given in **5.1.2**, **5.1.3** and **5.1.4**.

5.1.2 *Base*

The base is as given in either a) or b):

a) *various man-made mineral wools,* having a length to breadth ratio of at least 3 to 1;

NOTE Man-made mineral wools consist of fibres of inorganic composition, generally manufactured by a smelting process, usually from blast furnace slag or rock.

b) *exfoliated vermiculite.*

NOTE Vermiculite is the name given to a group of hydrated laminar minerals resembling mica in appearance and composed of hydrated aluminium iron magnesium silicates. When vermiculite is subjected to intense heat, it expands to many times its original volume. This phenomenon is known as exfoliation.

5.1.3 *Binding agent*

Typical examples of binding agents are hydraulic binders, such as Portland cement conforming to BS 12, high alumina cement conforming to BS 915-2 or gypsum plaster conforming to BS 1191-1.

5.1.4 *Fillers*

Typical fillers are hydrated lime, limestone or other aggregate.

5.2 Choice of product

Sprays are versatile materials which will cover areas of irregular size and shape including complex angles and profiles. However, each product should be chosen carefully so as to meet the particular requirements for a given end use. For example, in an external environment or in damp conditions some products may be unsuitable or may require additional weather protection. The variety of products and application methods available enable a wide range of surface finishes to be obtained, ranging from flat surfaces to highly textured surfaces.

5.3 Decorative and protective surface finishes

Where decorative or protective surface finishes are required either initially or subsequently (owing to change of occupancy or use of buildings), it is essential to ensure that the applied finish is compatible with the spray and does not impair its performance. Attention is drawn to the risk of detachment of the spray brought about by excessive weight of the applied finish. This will depend on a number of factors, e.g. orientation of the substrate, type of coating and type of finish, and is particularly important where dense finishes are being applied to low density coatings.

Any surfacing material should satisfy the appropriate requirements of any approving authority.

NOTE Such requirements may include the following:

a) non-combustibility, when tested as described in BS 476-4;

b) fire propagation, when tested as described in BS 476-6;

c) surface spread of flame, when tested as described in BS 476-7;

d) heat emission, when tested as described in BS 476-11.

In all applications the properties of the surfacing finish have to accommodate any dimensional movement of the spray.

5.4 Health and safety considerations

This Part of BS 8202 covers a wide range of different types of material. The need for site controls will vary according to the type of material being used. The application of some types of spray may generate levels of dust and particulate matter sufficient to cause irritation of the skin, eyes and respiratory tracts. For guidance on personal exposure and exposure limits reference should be made to the guidance notes published by the Health and Safety Executive and to manufacturers' health and safety data.

6 Substrate preparation

6.1 General

The purpose of substrate preparation is to ensure that:

a) an adequate bond or retention of the spray is obtained to enable it to perform its required function; and

b) the spray is compatible with the materials to which it is applied.

The surface condition of any substrate is important when considering bonding of any coating to it, i.e. the surface should be free from oil, grease, dirt, dust, scale, loose paint, mould release agents or other materials or conditions likely to impair adhesion.

When deciding on substrate preparation, which in cases of inadequate bond may involve mechanical retention (see clause **7**), it is essential to consider the following:

1) nature of surface, including any finishes applied prior to application of the spray;

2) geometric shape of the substrate;

3) vibration;

4) thermal movement;

5) properties of the spray;

6) evidence of adequate bond between the spray and the substrate;

7) any possible effects of high temperatures on the bonding or retention of the mix to the substrate.

It is not possible to give recommendations for all types of spray and all surface conditions in this standard. Recommendations for common substrates are given in **6.2**.

6.2 Common substrates

6.2.1 *Painted surfaces*

All old, loose and flaking paint finishes should be removed prior to the application of the spray, unless mechanical retention is being used (see clause **7**). Newly applied compatible primers should not adversely affect the performance of the coating but other paint finishes may require mechanical retention, unless there is fire resistance data showing that the presence of the paint will not affect the performance of the coating. Where mechanical retention is used, it is still necessary to use an alkali-resistant sealer coat (see **6.3**) where the paint is not chemically compatible with the spray.

NOTE Portland cement when wet has an initial pH value of 12 to 12.5 and cement-bound and lime-enriched gypsum mixes may, therefore, attack alkali-sensitive paints, e.g. paints containing alkyd binders. Paints containing water-sensitive binders may also be attacked by sprays.

6.2.2 *Concrete and masonry*

It may be necessary to reduce the suction of masonry depending upon type by applying a light water spray or a suitable sealer (see **6.3**). Normal sound clean concrete surfaces require no particular treatment but very smooth surfaces, as for example concrete cast against a hard impervious form face, are likely to require the use of mechanical retention or other treatment, e.g. abrasive blasting, to provide a suitable key (see also **8.5**).

6.2.3 *Gypsum plaster and plasterboard*

Portland cement-bound sprays should not be applied directly to unsealed gypsum plaster surfaces or plasterboard, as the setting characteristics of the cement can be affected and bond loss may result. Gypsum or lime based sprays may be applied to certain types of plaster based products but guidance should be sought from the spray manufacturer.

6.2.4 *Metals*

Primers are not usually needed for Portland cement-bound sprays if the building environment is such that it will remain dry after construction. Careful consideration should be given to the need for priming of ferrous metal surfaces, bearing in mind possible changes in use or occupancy of the building following application of the spray. Any primer used has to be compatible with the spray to be applied.

NOTE For guidance on protective measures, see BS 5493.

Most plastic coated metals have a smooth surface, which can cause adhesion problems. Mechanical retention will normally be necessary and specialist advice should be sought.

"White rusting" of zinc coated steel, which can result in corrosion of the base steel, may occur in continually damp conditions and where ventilation is poor. Under these conditions it is advisable to prime steel surfaces which have been zinc coated, e.g. galvanized, using a primer system compatible with both the coated steel and the cement based spray. Specialist advice should be sought.

On large flat steel surfaces mechanical retention (see clause **7**) should be used.

Aluminium, aluminium alloys and aluminium coatings should be sealed (see **6.3**) before applying alkaline sprays.

6.2.5 *Plastics materials (including glass reinforced and foam materials)*

Specialist advice should be sought. Many plastics materials are flexible and temperature sensitive.

6.2.6 *Timber and wood-based materials*

Timber and wood-based materials are subject to high drying shrinkage and moisture movement. A water resistant sealer should be used before applying the spray (see **6.3**). Galvanized clout nails and galvanized spider web wiring can be used to aid retention.

6.2.7 *Gaps and joints*

Sprays are suitable for bridging gaps provided an appropriate supporting material, e.g. galvanized expanded metal is fitted before applying the spray.

6.2.8 *Movement joints*

Where movement joints are incorporated into a structure it is essential to ensure the spray does not bridge the joint, as there will be a risk of the movement causing cracking and/or local bond failure of the coating. It is recommended that proprietary stop beads (or similar) are fitted either side of the joint and the spray terminated against them.

6.3 Sealers and bonding agents

Alkali resistant and water resistant sealers may be needed to prime particular surfaces. It is essential to check that the sealer to be used is compatible with the surface to which it is being applied.

Adhesives or key coats may be used to improve bonding of sprays to various substrates.

Special care should be taken to ensure that any primers, adhesives or key coats will not adversely affect the performance of the spray (see **8.5**).

7 Methods of mechanical retention

7.1 General

7.1.1 The need for mechanical retention, and the type and extent to be used, will depend on a number of factors, e.g. proposed use, substrate details, environmental factors and properties of sprayed material. Some particular circumstances in which it is necessary to include mechanical retention are given in clause **8**. Details of the different techniques available for providing mechanical retention are given in **7.2**.

7.1.2 Consideration should be given to the need for mechanical retention to ensure adequate retention to the substrate and/or cohesion within the spray. (Certain types of mechanical retention may not always perform both functions.) If necessary, specialist advice should be sought, e.g. see reference [1].

Lack of adhesion to the substrate can be caused by:

a) the nature of the substrate, e.g. chemical composition, surface texture, orientation and shape; or

b) contamination of the substrate, e.g. by oil; or

c) the existing surface finishes; or

d) environmental factors, e.g. vibration.

Lack of cohesion within a spray can arise in certain circumstances, e.g. where the coating exceeds the approved specified thickness.

7.2 Types of mechanical retention

7.2.1 *Introduction*

A wide range of mechanical retention systems and components are available (see Table 1). The most common of these are described in this clause but other systems or components may be acceptable (see clause **4**). In certain circumstances a combination of systems may be necessary.

The properties of the materials from which the various components are made should be taken into account when deciding on the most appropriate system, e.g. strength, rigidity, resilience, temperature resistance, weather resistance, chemical compatibility, resistance to corrosion.

Galvanized steel components are most commonly used, particularly for fire protection purposes, where good temperature resistance is necessary. Galvanic (bi-metallic) corrosion arising from the use of dissimilar metals is not significant in most cases.

NOTE For further guidance see Appendix A and Table 3 of BS 5493:1977.

Plastics components and organic adhesives are suitable for applications at ambient temperature. Some organic adhesives have been tested and approved for use in fire protection applications.

7.2.2 *Mesh*

7.2.2.1 *Mesh categories*

Wire mesh is commonly used for mechanical retention and can be conveniently classified into the following categories.

a) *Keying mesh,* typically of relatively small aperture size, i.e. 10 mm to 25 mm, which allows some penetration by slurry sprays in order to produce a good key. It is installed in close proximity to the substrate [see Figure 1 a), Figure 1 b) and Figure 1 c)] or to provide a background for the spray to bridge gaps between structures, e.g. to provide a fire barrier or to encase a column.

b) *Reinforcing mesh,* typically of relatively large aperture size, e.g. 50 mm, which allows full penetration by the spray and thereby provides reinforcement. It is located within the spray so as to reinforce the spray [see Figure 1 d)]. It is important that the aperture size is not too small and that the mesh material is not too thick, for otherwise a plane of weakness may be formed within the spray.

NOTE Advice should be sought from the spray manufacturer.

Table 1 — Types of mechanical retention

Category	Type	Uses
Keying mesh: typically mesh of relatively small aperture size, e.g. 10 mm to 25 mm, which allows some penetration by spray to produce a good key	EML[a]	Installed in close proximity to the substrate [see Figure 1 a), Figure 1 b) and Figure 1 c)] or to provide a background for the spray to bridge gaps between structures
	Ribbed EML	
	Welded mesh	
	Woven hexagonal mesh	
Reinforcing mesh: typically mesh of a relatively large aperture size, e.g. 50 mm, which allows full penetration by the spray and thereby provides reinforcement	Welded mesh	Located within the spray so as to reinforce it [see Figure 1 d)]
	Woven hexagonal mesh	
Discontinuous fixings	Metal pins	Used particularly for sprayed mineral wool insulation but also sometimes used for sprayed slurry mixes [see Figure 1 d) and Figure 1 e)]
	Mesh pieces	
	Metal washers	

[a] EML: Expanded metal lath

7.2.2.2 *Types of mesh*

Types of mesh in common use are as follows.

a) *Expanded metal lath* (EML), prepared from a sheet of steel that has been cut at frequent intervals and stretched to form diamond-shaped apertures. The nominal mesh size ranges from 6 mm to 20 mm. It is used only as a keying mesh.

b) *Ribbed EML,* similar to EML [see **7.2.2.2** a)] but having a ribbed surface. It is primarily used as a keying mesh.

c) *Welded mesh,* prepared from wire strands that are spot welded together to form a rectangular mesh. The minimum mesh aperture is normally 25 mm and may be as large as 150 mm. The wire diameter is typically 1 mm to 1.5 mm for apertures up to 50 mm but may be up to 3 mm for apertures of 75 mm to 150 mm. It is used as a reinforcing or keying mesh.

d) *Woven hexagonal mesh* (chicken wire mesh), prepared from wire that is woven to form hexagonal apertures and is similar to welded mesh [see **7.2.2.2** c)]. It is used as a reinforcing mesh and should conform to BS 1485.

7.2.2.3 *Mesh fixing systems*

Since the function of the mesh is to retain the spray in position, it is normally fixed to the substrate by an appropriate means. Some examples are given in items a) and b) and the mesh and/or spray manufacturer's advice should also be followed where applicable.

a) *Encapsulation of substrate.* Where the mesh can be completely wrapped around the substrate, e.g. around a tube, it may not be necessary to use mesh fixings attached to the substrate. The mesh should be overlapped at the joints and tied together. Where additional retention and/or support of the mesh is required, e.g. hollow encasement of "I" sections, this can be accomplished by using stainless steel or galvanized steel banding, strong wire strands, lightweight galvanized steel channel or angle section supports. Pins welded to the substrate may also be used.

b) *Application to flat surfaces.* When applying mesh to a flat surface, a positive means of retaining the mesh and spray is necessary, unless adequate bond of the spray can be obtained under both ambient and fire conditions. Welded, shot-fired or threaded fixings may be used and sufficient fixings should be attached to the substrate to support the spray under the conditions of use. Attachment of the fixings to the mesh can be carried out by using spring clips, wire ties or by bending over the welded pins after pushing on the mesh.

Plastics pins or adhesive fixed pins are generally unsuitable, due to their low resistance to high temperatures.

7.2.3 *Continuous fixings*

Where it is not possible to wrap mesh completely around the substrate, welded, shot fired or threaded fixings may be fitted to the substrate. Attachment of the mesh to the fixings can be carried out by using spring clips, wire ties or bending over the welded pins after pushing on the mesh [see Figure 1 d)]. This method is used particularly for spray slurry mixes.

7.2.4 *Discontinuous fixings*

Mechanical retention may be provided by individual components attached to the substrate at suitable intervals, e.g. pins welded to the substrate and bent over or split within the sprayed insulation to provide retention or by attaching pieces of mesh or large diameter non-return spring washers to welded fixings [see Figure 1 e)]. This method of retention is used particularly for sprayed mineral wool insulation but is also sometimes used for sprayed slurry mixes.

Plastics components or adhesive fixed components have a low temperature resistance and are generally unsuitable for fire protection purposes.

Discontinuous fixings should be spaced 250 mm apart unless there is independent validation (see clause **4**) to support other spacings.

8 Structural fire protection

8.1 General

Sprays can be used to provide or improve the fire resistance of various structural elements.

NOTE The method for determining the fire resistance of an element of structure is given in BS 476-21.

In all cases where fire resistance is required, the acceptability of a spray should be judged on the basis of an independent validation (see clause **4**). Because of the wide range of variations in structural design, assessments based on test data will often be required.

The guidance given in this clause should be followed unless the evidence from fire resistance tests indicates that an alternative approach may be adopted.

8.2 Structural steel

In BS 476-21 the fire resistance of a steel beam or column is defined only in terms of its stability (i.e. its ability to support the imposed load). The fire resistance time achieved in a test will be influenced by the properties of the steel section, the imposed load and any applied fire protection. Because of the wide range of steel sections available it is impracticable to test every combination of steel size and protection thickness. The fire protection requirements of structural steel are therefore usually based on assessments derived from tests in accordance with the heating conditions of BS 476-21.

The assessments should take into account:

a) the ability of the spray to remain in place around the steel section;

b) the thickness of spray required to prevent the steel temperature reaching the critical value at which structural failure occurs.

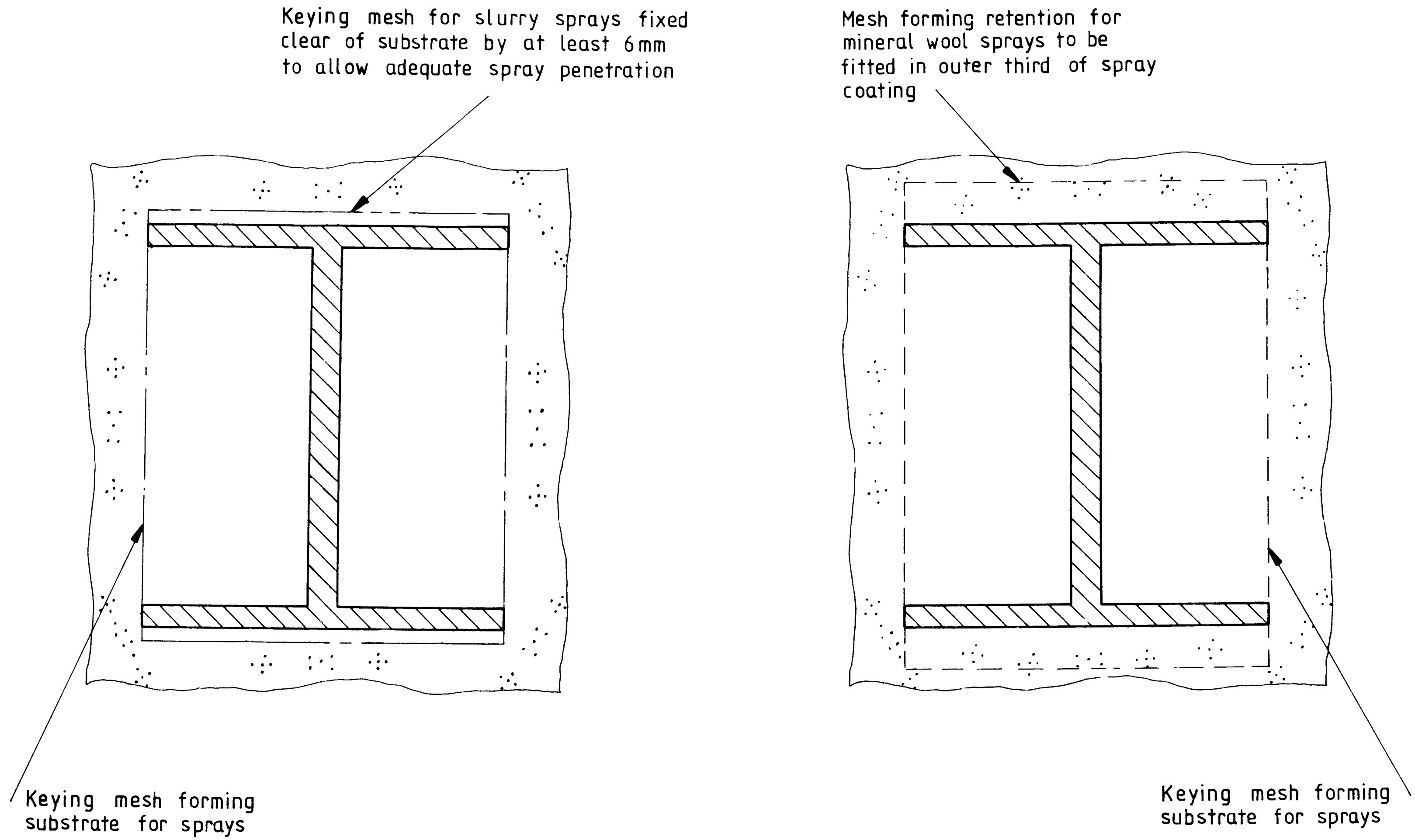
NOTE Details of a method of assessment can be found in reference [1].

As there is no defined procedure for testing protected members in tension, it is necessary to assess their performance on the basis of data from compressive and flexural tests.

8.3 Composite constructions

8.3.1 *Composite floors*

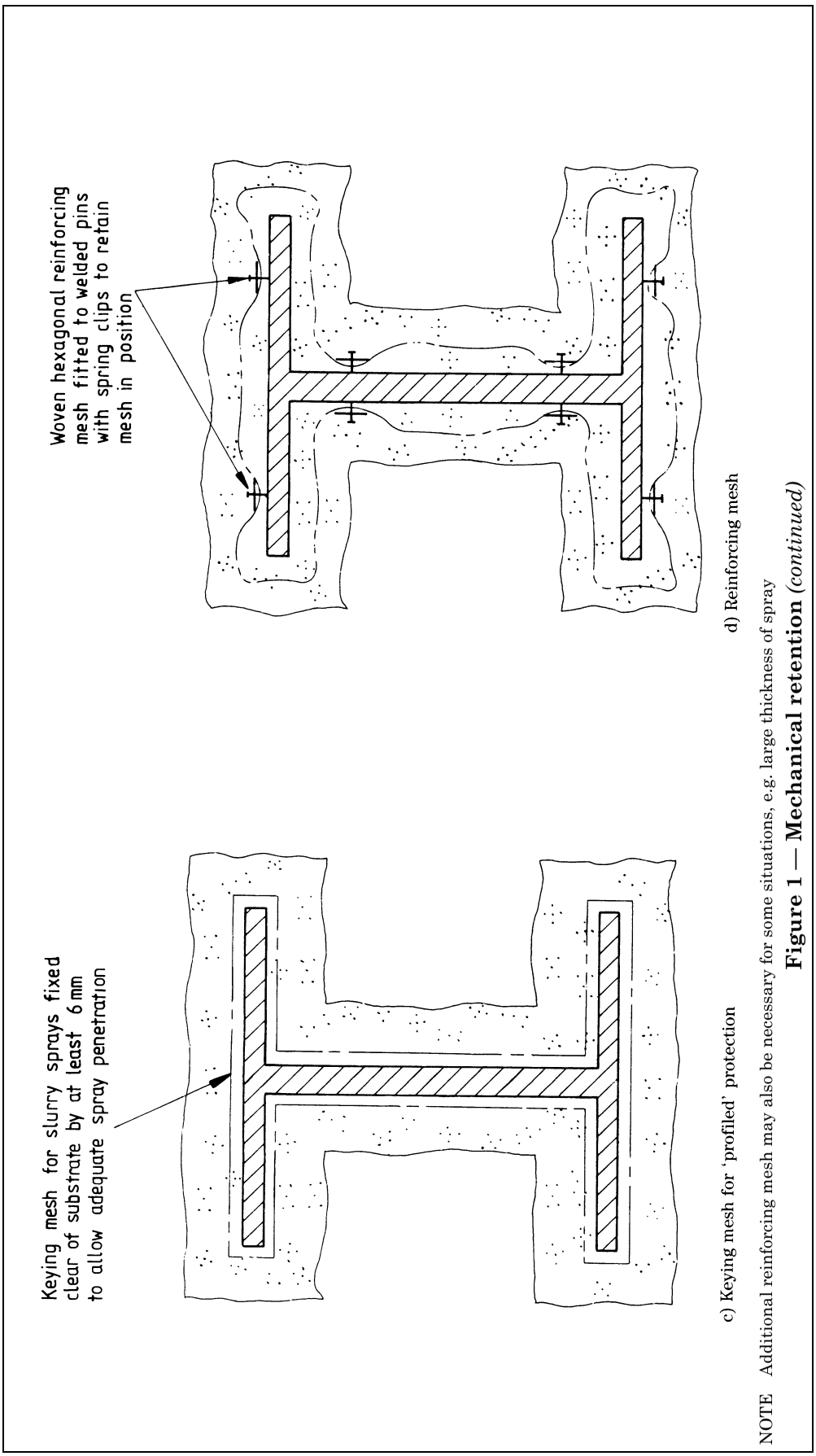
Sprays may be used to provide fire protection to composite floors incorporating steel decking. The primary function of the spray is usually to ensure that the steel decking will not reach a temperature at which collapse of the floor will occur. It may also be used to compensate for an inadequate thickness of concrete topping.



a) Keying mesh for hollow (boxed) encasement protection using slurry sprays

b) Keying/retention mesh for hollow (boxed) encasement protection using mineral wool sprays

Figure 1 — Mechanical retention

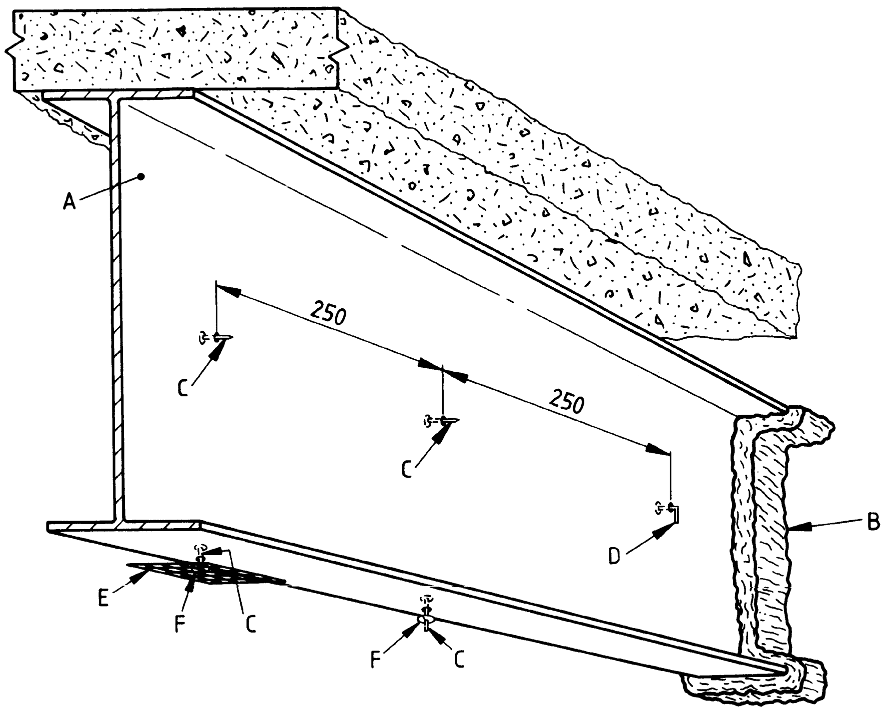


c) Keying mesh for 'profiled' protection

d) Reinforcing mesh

NOTE Additional reinforcing mesh may also be necessary for some situations, e.g. large thickness of spray

Figure 1 — Mechanical retention *(continued)*



Key

A Steel structure
B Spray
C Steel pin (straight)
D Steel pin (bent)
E Mesh pad approximately 100 mm square
F Steel spring non-return washer

NOTE Various methods of retention shown on beam soffit

e) Discontinuous fixings

Figure 1 — Mechanical retention *(concluded)*

Floors using steel decking can be expected to undergo substantial deflection prior to collapse. It is therefore important to ensure that the spray will remain bonded to the decking whilst undergoing deflection. This can only be substantiated by a test in accordance with BS 476-21 for the required fire resistance period. In the absence of specific test information a spray may be used, provided that it is retained in place by a keying mesh (see **7.2.2.1**). The thickness of spray has to be sufficient to prevent the steel decking reaching a temperature at which collapse will occur. Depending on the thickness of the spray and the type of spray, a reinforcing mesh may also be required. Alternatively, if the decking provides a mechanical key, e.g. as a re-entrant profile decking with the re-entrant details at not greater than 150 mm centres, a spray may be used, provided that the temperature of the decking is kept below that at which significant deflections will occur, e.g. deflections greater than 50 mm in a span of 4 m. The spray has to fill the re-entrant detail to ensure that a mechanical key is formed.

8.3.2 *Composite beams*

Under certain conditions (composite construction and fire resistance up to 60 min with materials assessed at 550 °C) the voids formed between the metal deck and the beam do not require infilling. For periods up to 90 min fire resistance, the voids in the metal deck do not require infilling if a modified thickness of spray coating is applied to the beam. The voids in non-composite steel decks should be filled.

If the beam is on the line of a compartment or separating wall, or if the required period of fire resistance exceeds 90 min, the void has to be filled. For further information refer to *The fire resistance of composite beams* [2].

It is recommended that the application of the spray material is applied after the concrete has been poured onto the metal decking.

8.4 Structural materials other than steel

8.4.1 *Non-ferrous metals*

The criteria given for steel members in **8.2** should be used.

NOTE The critical temperature varies according to the metal.

8.4.2 *Concrete*

Recommendations for the design of concrete elements for fire resistance are given in section 4 of BS 8110-2:1985. To satisfy all the criteria given in BS 476-21, sprays may be needed to impart additional fire protection to concrete elements, particularly when upgrading existing structures. Particular consideration should be given to bond characteristics when using sprays on concrete (see **8.5.2** a).

8.4.3 *Timber*

When determining the thickness of spray for fire protection of timber, it is essential to consider the charring characteristics and support at the interface. The structural properties of the residual timber section after exposure to fire should be assessed following the recommendations in BS 5268-4.1.

8.4.4 *Masonry*

When considering the upgrading of fire walls used in a separating function, it may be necessary, in some cases, to improve inherent masonry fire resistance. Recommendations on the fire resistance performance of masonry are given in BS 5628-3.

8.5 Retention of spray

8.5.1 *General*

The ability of the spray to remain in place under fire resistance test conditions is influenced by:

a) the nature of the substrate;

b) the degree of cleanliness of the substrate;

c) the presence of a primer or other surface finish;

d) the properties of the spray material (including adhesive and cohesive properties);

e) the shape, properties and dimensions of the structural member;

f) the retention system used (if any).

8.5.2 *Mechanical retention*

Mechanical retention should be provided unless:

a) there is evidence from fire resistance tests to show that there is adequate bond between the spray and the substrate (including primers or other coatings); or

b) the spray is locked in position by virtue of the shape of the element.

Figure 2 illustrates a number of horizontal and vertical cross sections where mechanical retention is not usually required, either because of the presence of a re-entrant angle or because of the encapsulation by the spray.

Figure 3 gives examples of typical cases where there is no re-entrant profile or encapsulation and mechanical retention is required.

Where the dimensions of the cross section are very large (i.e. web greater than 650 mm and flange greater than 325 mm), mechanical retention may be required (see reference [1]).

9 Fungal growth

Sprays are durable materials the inherent composition of which does not give rise to the growth of fungi. In cases where damp conditions are likely to be encountered and where the processes or storage of materials are likely to give off nutrients for fungi, e.g. food factories, breweries, dye-houses, a fungicide may be required to inhibit the growth of fungi.

Care should be taken when selecting and applying fungicides to minimize any toxic or irritant effects or any incompatibility with the coating. Some fungicides will only be effective for a limited period and a further surface application in the form of a paint or spray may be necessary in due course.

10 Workmanship

10.1 Protection and storage

10.1.1 It is essential to protect the spray materials from ingress of moisture before, during and after delivery to site.

10.1.2 Care should be taken to ensure that the material is stored and used in accordance with the manufacturer's recommendations, as some materials are affected by excessive compression.

10.2 Care of equipment

The application and ancillary equipment should be regularly checked to ensure:

a) it is clean and free from loose material;

b) all components are in good working order, e.g. fans, blowers, mixers, drives, conveying and shredding mechanisms;

c) air and mix spray nozzles are free from obstruction;

d) rotary valves, material hoses, compressed air hoses and water hoses are free from leaks.

10.3 Services

Checks should be made to ensure that services are adequate, i.e.:

a) voltage is correct and constant;

b) water is potable and can be supplied at adequate volume and constant pressure;

c) clean compressed air is available at the correct pressure.

In some cases ancillary services, e.g. generators, pumps, water pressure pots, will be necessary.

10.4 Preparatory work

All substrates should be prepared as described in clause **6**. Where necessary, mechanical retention should be provided, positioned and fixed as shown in Figure 1 and Figure 3.

The two most common methods of applying sprays are as follows:

a) premixing of minerals and binders for wetting at the gun, generally used for dry sprayed mineral wool [see Figure 4 a)];

b) slurry mixing and application, generally used for wet sprayed mineral wool, and vermiculite [see Figure 4 b)].

10.5 Application technique

Particular care should be taken to ensure that the required thickness is built up in the recommended manner so that good cohesive strength is obtained. The thickness of an individual layer will vary considerably according to the type of material, the orientation of the substrate, the nature of the substrate and the skill of the operator. Any spillage or overspray should be cleaned off at the end of each working period. When using adhesives, the adhesive manufacturers' recommendations should be followed.

Different spray systems require different methods of application and specialist contractors should be sought. The names of such contractors are available from manufacturers.

The finished density of spray should lie within ± 15 % of the density stated by the manufacturer. The density and mix proportions of the spray should be chosen to suit its use for fire protection.

10.6 Fungicides

When using fungicides, the spray should either be allowed to cure and dry before application or the fungicide should be added to the water used for spraying or a fungicide powder should be added to the dry mix.

10.7 Protection of adjacent areas

Where work is to be carried out above or near machinery or other equipment, or adjacent to open vats or air vents, special precautions should be taken to prevent ingress of overspray or spillage, e.g. a temporary staging with waterproof covers.

10.8 Protection during application of spray

Spray is affected by some environmental conditions up to the time of final set. It is therefore essential during this period to prevent exposure to rapid drying, wind-driven rain, running water, freezing or near freezing conditions, structural movement, vibration or impact.

10.9 Measurement of thickness for site control

10.9.1 *General*

To achieve the required performance, it is necessary to ensure that the sprays are applied to the design thickness. The uniformity of thickness will depend on the characteristics of the spray, the skill of the spray operator and the complexity of the surface to be sprayed. The spray should maintain its dimensional stability during curing and drying but minor variations in dimensions do not affect its performance.

For the purposes of site control, the thickness measured as described in **10.9.2** and **10.9.3** should meet the criteria given in **10.9.4**.

10.9.2 *Thickness gauges*

Where possible, a direct reading thickness gauge should be used.

NOTE Figure 5 shows a typical gauge. The needle of this type of gauge should be pressed into the spray material until its point makes contact with the surface of the substrate and the sliding part should then be moved towards the coating until the circular base plate is in contact with the surface of the spray. An accurate reading on the scale can then be made. This type of gauge can be damaged on site and should be regularly checked for accuracy.

Gauges fixed to the substrate before spraying begins may be used. When these prefixed gauges are left in position within the spray, test evidence should be produced to show that their use does not impair fire performance. However, where the gauges are formed from plastics material and are not more than 20 mm^2 in cross-sectional area or longer than the depth of the spray coat, they may be left in situ.

For sprays applied to an expanded metal lath, or similar, that spans a void, it is not always possible to use needle type direct reading gauges, since it is difficult to make direct contact with the surface of the lath. Measurements should therefore be made either by using pre-fixed gauges or by using a rule as the work proceeds. Removing spray in local areas until the lath is exposed may be necessary to check previously unmeasured work.

10.9.3 *Frequency of measurements*

10.9.3.1 *Flat substrates*

As a guide, the frequency of measurements should be one thickness measurement for each unit of area 1.5 m × 1.5 m, i.e. four measurements for an area 3 m × 3 m. For areas greater than 3 m × 3 m, an additional thickness measurement should be made for each unit area of 3 m × 3 m. Measurements should be made in areas where the spray thickness seems to be deficient. Random checks should also be made, taking care to avoid damage to the spray.

Where profiled substrates, e.g. corrugated sheet, are to be finished flat, the measurements should be taken in positions which give the minimum thickness when related to the profile of the substrate.

All measurements should be recorded and retained for future reference.

10.9.3.2 *Contoured substrate*

Contoured substrates should generally be treated as a flat surface but for trapezoidal shapes random measurements should be taken at positions where there is a change in plane, e.g. on the sides of walls of a trapezoidal deck.

When each surface is required to have the same thickness, e.g. in steel "I" section columns and beams, at least one thickness measurement every 3 m should be taken on each surface, e.g. each surface of the flanges and the web.

On steel "I" sections, the spray on the flange should not be permitted to taper to the flange edges. Where there appears to be such tapering, the thickness should be checked across the flange and over the flange edges at the recommended 3 m intervals.

10.9.3.3 *Substrate overlaid with metal lath*

When substrates are overlaid with metal lath, for example keying mesh, the recommendations in **10.9.3.1** and **10.9.3.2** should be followed. The spray thickness should be taken to be the thickness measured to the face of the lath (see Figure 6).

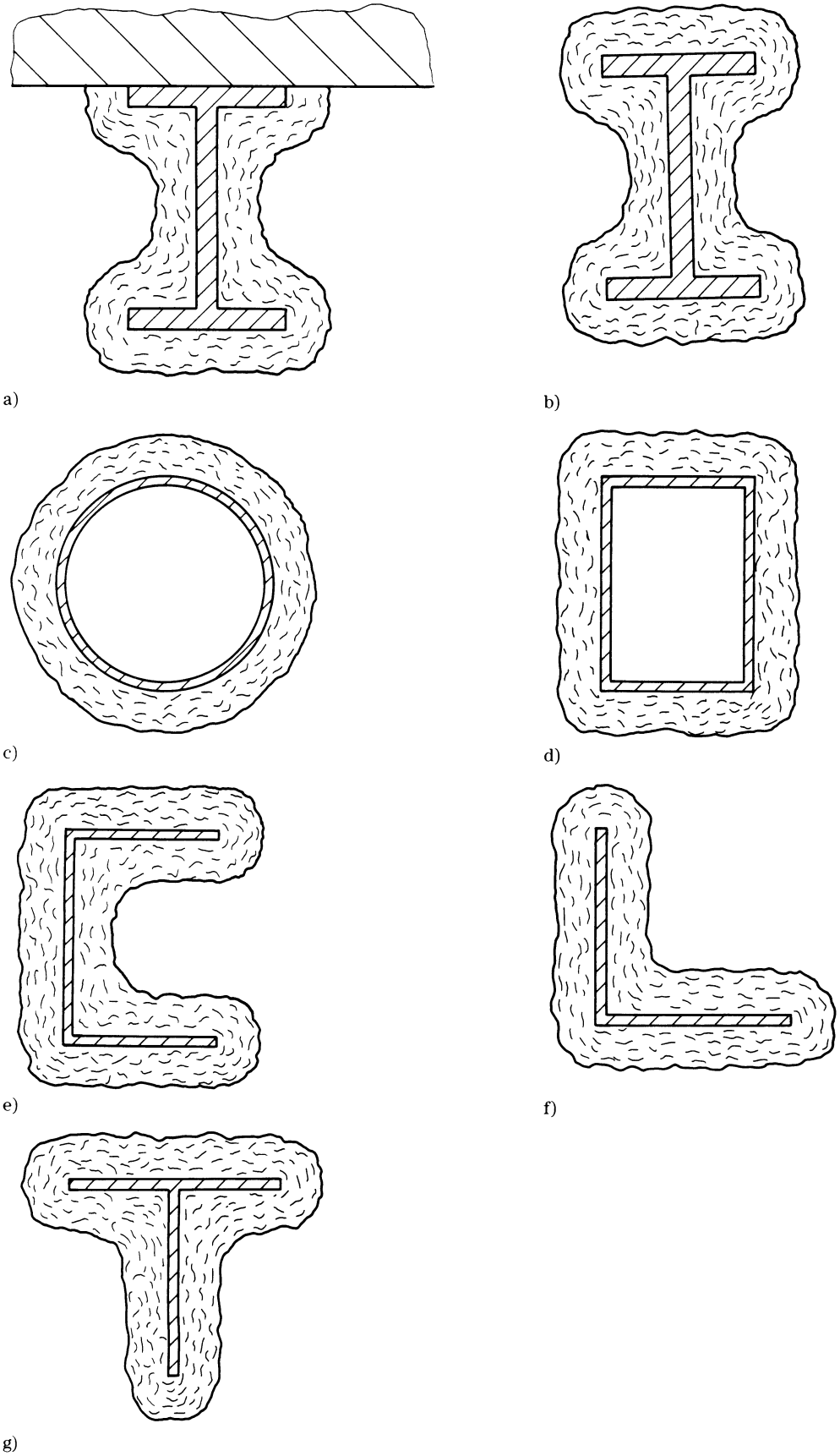
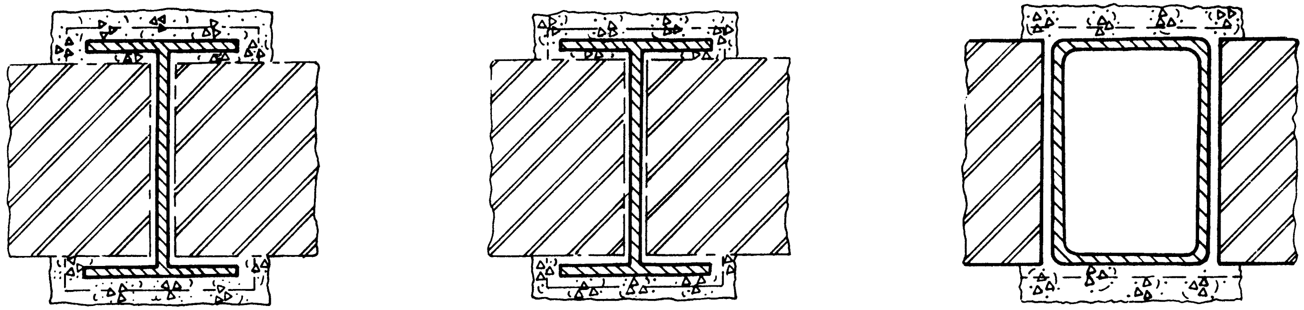
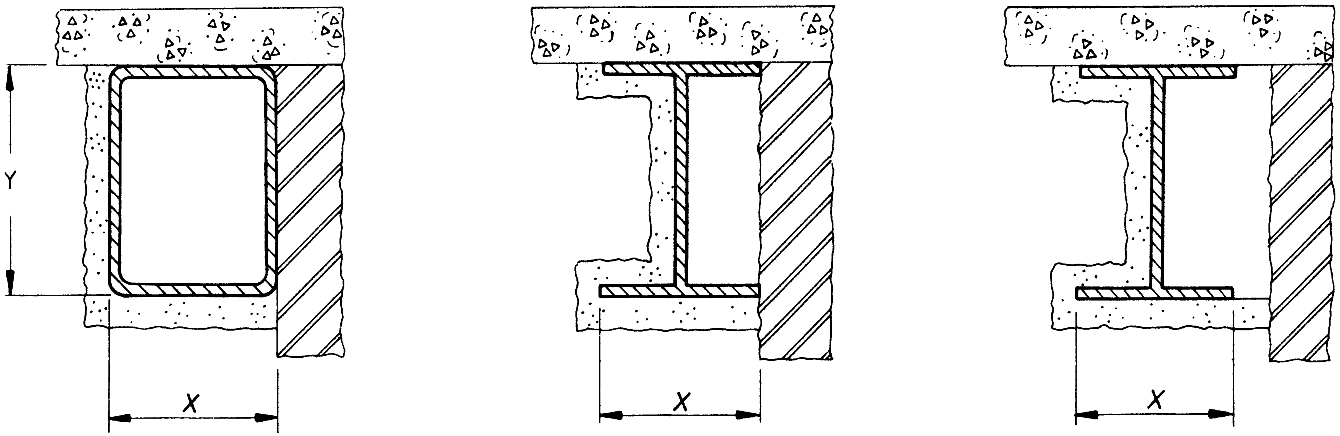


Figure 2 — Encapsulation and re-entrant profiles

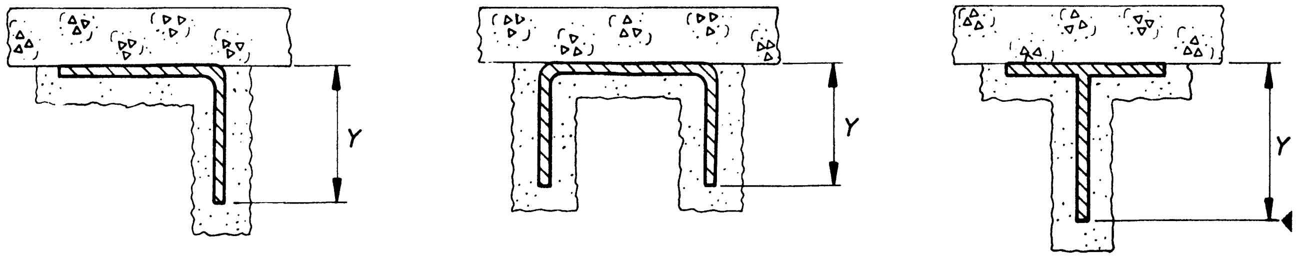


a) Reinforcement required in all cases. The mesh may be fixed to the wall or steelwork but not, under any circumstances, to both. If using expanded metal mesh squares fixed with speed-fix washers, as non-continuous reinforcement, pins should be fitted at 250 mm centres. Continuous mesh reinforcement may also be fixed to the flange of the steel section by means of pins and speed-fix washers.

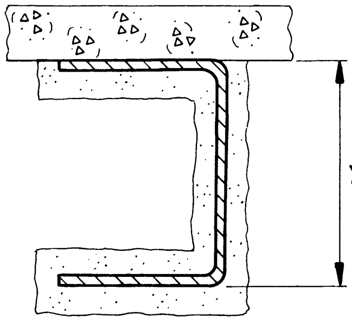


b) If distance *X* exceeds 160 mm, mesh reinforcement should be fixed to the bottom flange. Mesh reinforcement should only be fixed to the steel section when bridging gaps. If distance *Y* exceeds 325 mm mesh reinforcement should be fixed to a steel section.

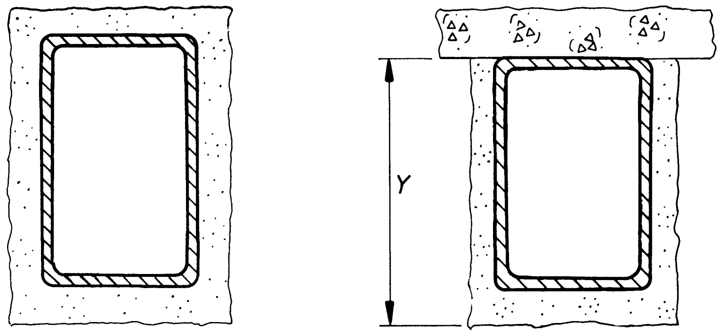
Figure 3 — Cases where there is no re-entrant profile or encapsulation



c) If distance *Y* exceeds 325 mm, mesh reinforcement should be fixed to the steel section.

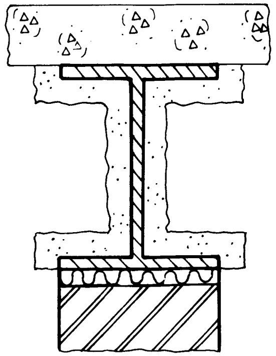


d) If distance *Y* exceeds 325 mm, mesh reinforcement should be fixed to the steel section.

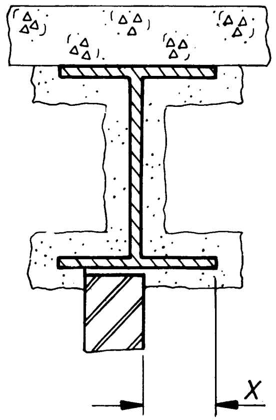


e) Circular hollow sections do not require to be reinforced unless they exceed 325 mm diameter. Rectangular hollow sections used as beams should be reinforced when any one face exceeds 325 mm (*Y*). When used as columns any face exceeding 325 mm should be reinforced.

Figure 3 — Cases where there is no re-entrant profile or encapsulation *(continued)*

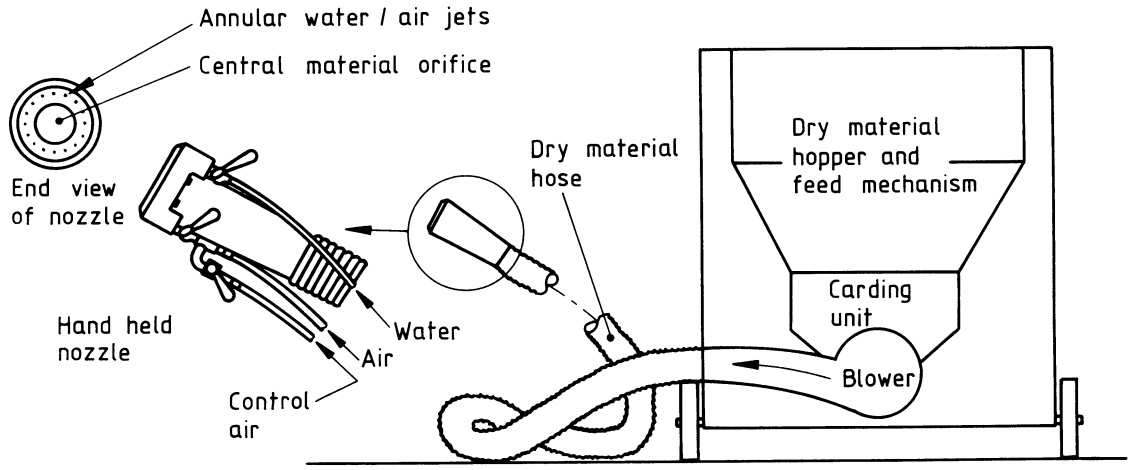


f) If a compartment wall incorporates an intumescent (or similar) expansion joint the spray should not cover the joint. It is essential that the expansion joint material used does not erode and expose the soffit of the flange.

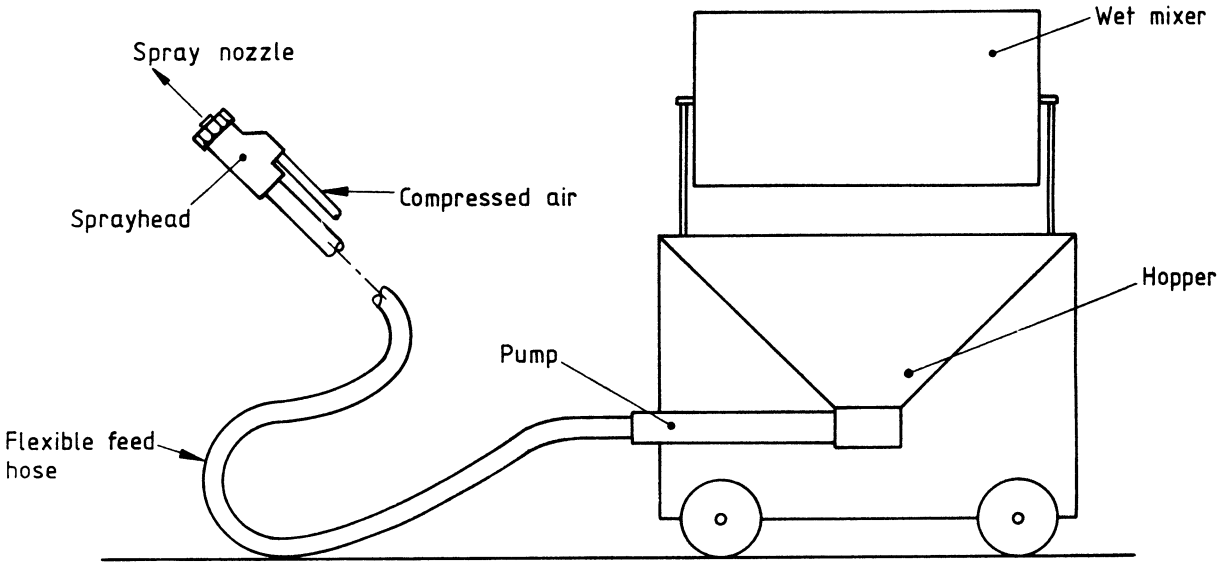


g) If distance *X* exceeds 160 mm, mesh reinforcement should be fixed to the overhanging bottom flange.

Figure 3 — Cases where there is no re-entrant profile or encapsulation *(concluded)*



a) Equipment for sprays wetted at the gun



b) Equipment for slurry sprays

NOTE With certain types of equipment, an air feed to the gun is unnecessary.

Figure 4 — Principle of application of sprays

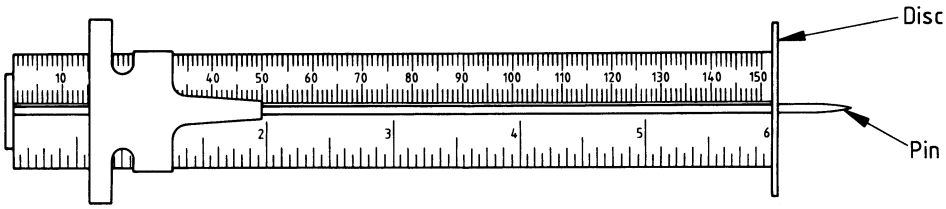


Figure 5 — Typical needle gauge for direct measurement of coating thickness

10.9.4 ***Criteria for thickness control***

When checking the thickness of spray on site, a deficient area may be considered acceptable if either:

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

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

10.9.5 ***Density***

When tested in accordance with Annex A, the applied density should be within ± 15 % of the manufacturer's stated average density.

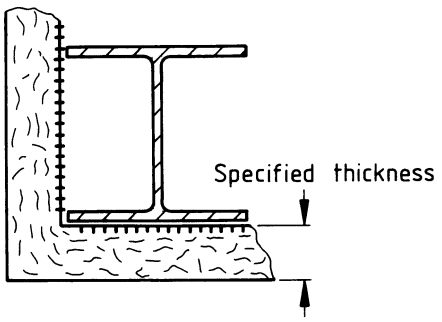


Figure 6 — Measurement of coating thickness to the face of metal lath

Annex A (normative) Determination of density

A.1 Apparatus

A.1.1 *Steel rule,* capable of measuring to an accuracy of 1 mm.

A.1.2 *Thickness gauge,* as described in **10.9.2**.

A.1.3 *Balance,* capable of weighing test specimens to an accuracy of not less than 1 %.

A.1.4 *Rectangular template,* of known length and width, of area not less than 0.1 m^2 and having one dimension not less than 150 mm.

A.1.5 *Knife,* for cutting test specimens from spray.

A.1.6 *Drying oven.*

A.2 Procedure

Using the template (**A.1.4**), mark off a known area of the spray. Measure the thickness at not less than 10 positions using the thickness gauge (**A.1.2**). Cut the substrate along the perimeter of the template and carefully remove the cut-out section from the spray. Dry the test specimen at 50 °C until constant mass is achieved. Weigh the dried test specimen immediately.

A.3 Calculation of dry density

Calculate the dry density of the spray, ρ (in kg/m^3), using the following formula:

$$\rho = \frac{m}{L \times W \times t} \times 10^9$$

where

m is the mass of dried spray (in kg);

L is the length of the test specimen (in mm);

W is the width of the test specimen (in mm);

t is the average thickness of the test specimen (in mm).

blank

List of references (see clause 2)

Normative references

BSI publications

BRITISH STANDARDS INSTITUTION, London

BS 5268, *Structural use of timber.*

BS 5268-4, *Fire resistance of timber structures.*

BS 5268-4.1:1978, *Recommendations for calculating fire resistance of timber members.*

Informative references

BSI publications

BRITISH STANDARDS INSTITUTION, London

BS 12:1991, *Specification for Portland cement.*

BS 476, *Fire tests on building materials and structures.*

BS 476-4:1970, *Non-combustibility test for materials.*

BS 476-6:1989, *Method of test for fire propagation for products.*

BS 476-7:1987, *Method for classification of the surface spread of flame of products.*

BS 476-11:1982, *Method for assessing the heat emission from building materials.*

BS 476-21:1987, *Methods for determination of fire resistance of loadbearing elements of construction.*

BS 915, *Specification for high alumina cement.*

BS 915-2:1972, *Metric units.*

BS 1191, *Specification for gypsum building plasters.*

BS 1191-1:1973, *Excluding premixed lightweight plasters.*

BS 1485:1983, *Specification for zinc coated hexagonal steel wire netting.*

BS 5628, *Code of practice for use of masonry.*

BS 5628-3:1985, *Materials and components, design and workmanship.*

BS 8110, *Structural use of concrete.*

BS 8110-2:1985, *Code of practice for special circumstances.*

BS 5493:1977, *Code of practice for protective coating of iron and steel structures against corrosion.*

BS 8216:1991, *Code of practice for use of sprayed lightweight mineral coatings used for thermal insulation and sound absorption in buildings.*

Other references

[1] ASSOCIATION OF STRUCTURAL FIRE PROTECTION CONTRACTORS AND MANUFACTURERS. *Fire protection for structural steel in buildings.* 2nd ed. London: ASFPCM, 1992[1)].

[2] NEWMAN, G M., and LAWSON, R.M. *The fire resistance of composite beams.* Steel Construction Institute Publication No. P109, 1991[2)].

[1)] Available from Association of Structural Fire Protection Contractors and Manufacturers (ASFPCM), Association House, 235 Ash Road, Aldershot, Hampshire GU12 4DD.

[2)] Available from the Steel Construction Institute, Silwood Park, Buckhurst Road, Ascot, Berkshire SL5 7QN.

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