
British Standard

Structural use of timber

Part 4. Fire resistance of timber structures

Section 4.2. Recommendations for calculating fire resistance
of timber stud walls and joisted floor constructions

Utilisation de bois en construction

Partie 4. Résistance au feu des structures en bois

Section 4.2 Recommandations pour le calcul de la résistance au feu des cloisons
de colombage et planchers à solives en bois

Verwendung von Holz im Bauwesen

Teil 4' Feuerbeständigkeit von Holzbauten

Abschnitt 4.2 Empfehlungen für die Berechnung der Feuerbeständigkeit von
Fachwerkwänden und Balkendecken

Foreword

This Section of BS 5268 has been prepared under the direction of the Civil Engineering and Building Structures Standards Policy Committee.

The Code of Practice CP 112 'The structural use of timber' has been allocated the new number BS 5268 as part of the integration of work on codes and standards.

Other Parts of this British Standard will be as follows.

- Part 1 Limit state design, materials and workmanship (for later publication).
- Part 2 Permissible stress design, materials and workmanship.
- Part 3 Trussed rafters for roofs.
- Part 4 Fire resistance of timber structures
 - Section 4.1. Recommendations for calculating fire resistance of timber members.
 - Section 4.2. Recommendations for calculating fire resistance of timber stud walls and joisted floor constructions.
- Part 5 Preservation treatment for constructional timber*
- Part 6 Timber frame wall design
 - Section 6.1. Dwellings not exceeding three storeys
- Part 7 Recommendations for the calculation basis for span tables
 - Section 7.1. Domestic floor joists
 - Section 7.2. Joists for flat roofs
 - Section 7.3. Ceiling joists
 - Section 7.4. Ceiling binders
 - Section 7.5. Domestic rafters†
 - Section 7.6. Purlins†
 - Section 7.7. Purlins supporting sheeting or decking†

BS 5268 : Part 4 gives information by which the fire resistance of timber elements of construction may be calculated. Such calculations are possible because, in fire, the behaviour of timber, with many common materials used in association with it, is predictable with regard to the rate of charring and loss of strength. Timber itself has very low coefficients of thermal expansion and conductivity and does not undergo any rapid change of state.

Section 4.1 of BS 5268 : Part 4 gives information required for the calculation of fire resistance for individual timber members. This Section of BS 5268 extends the code to include composite timber elements.

Fire resistance is related to elements of construction and not to individual materials; the appropriate test on which this document is based is described in BS 476 : Part 8*. The stability (resistance to structural failure), integrity and insulation criteria may all be applicable. The performance of an element is expressed in terms of the periods of time for which it satisfies the appropriate criteria.

This Section of BS 5268 lays down methods for calculating fire resistance which relate to the standard procedures for fire resistance testing. It should not be assumed that the performance of elements in real fire situations will necessarily be the same.

Care should be taken when applying this method of calculation to existing construction to take account of the actual condition of the construction.

NOTE. The results obtained from fire resistance tests in accordance with BS 476 : Part 8†, on any specific construction take precedence over results derived from the information given in this Section of BS 5268. Assessments by a competent authority of a particular construction are as valid as the result of the method of calculation given in this Section of this standard.

New information on the fire resistance performance of composite timber elements and their component materials is continually being obtained from fire tests. Competent authorities may use such new information in conjunction with this Section of BS 5268 to provide assessments of the performance of individual constructions where appropriate. However, information from other fire resistance testing should not be used to generate new or additional values for the various tables without formal endorsement by the committee responsible for preparing this Section of BS 5268.

This Section of BS 5268 does not include constructions which include proprietary or generic materials for which there are no British Standards. For information on such constructions reference should be made to test results provided by manufacturers or suppliers, or published lists of tested constructions.

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

*Revision in preparation.

†In preparation

‡The test methods specified in BS 476 : Part 8 have been revised and replaced by BS 476 : Parts 20 to 23. The calculations and methods of BS 5268 : Part 4 rely essentially on data gathered from tests to BS 476 : Part 8. In due course data will become available from the revised testing procedures which will then be incorporated into Section 4.2 of BS 5268. The definitions and terminology of BS 476 : Part 8 will be maintained until these revisions are published.

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Recommendations

1 Scope

This Section of Part 4 of BS 5268 gives recommendations for calculating the fire resistance of timber framed walls and partitions and joisted floors as an alternative to testing. The recommendations are applicable to single and double leaf walls and partitions; and to floors in which the joists are fully or partly concealed.

The recommendations are applicable to loadbearing wall and partition constructions where actual stud sizes are not less than 62 mm x 37 mm (depth x breadth) (see figure 1) and to non-loadbearing wall and partition constructions where the actual stud sizes are not less than 48 mm x 37 mm (depth x breadth) (see 6.2.2 and 6.4).

The recommendations are also applicable to joisted floor constructions where the actual joist breadth is not less than 37 mm.

This Section of BS 5268 : Part 4 is limited to constructions having a fire resistance requirement of 1 hour or less.

NOTE 1. The minimum dimensions of timber (depth x breadth, see figure 1) given in this Section of this British Standard are based on the actual sizes of studs and joists tested. They do not have any relationship to the dimensions of softwood given in BS 4471.

NOTE 2. The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

For the purpose of this Section of this British Standard, the definitions given in BS 6100, BS 4422 : Part 2 and in clause 2 of BS 5268 : Part 2 apply, together with the following.

2.1 fire resistance performance. Combination of appropriate stability, integrity and insulation values respectively, expressed in minutes, e.g. 30 min stability, 30 min integrity and 15 min insulation are expressed at 30 : 30 : 15 min (see clause 3).

2.2 contribution indices. Contribution values to the fire resistance performance of linings, claddings, infill materials (in association with specific linings) and framing members.

NOTE. Contribution indices have been specifically devised for this Section of this British Standard.

2.3 load ratio. Ratio of the actual axial load to the permissible axial load in a stud in the cold condition, expressed as a percentage.

2.4 exposed lining. Face of the wall exposed to fire in a fire test.

2.5 unexposed lining. Face of the wall remote from fire in a fire test.

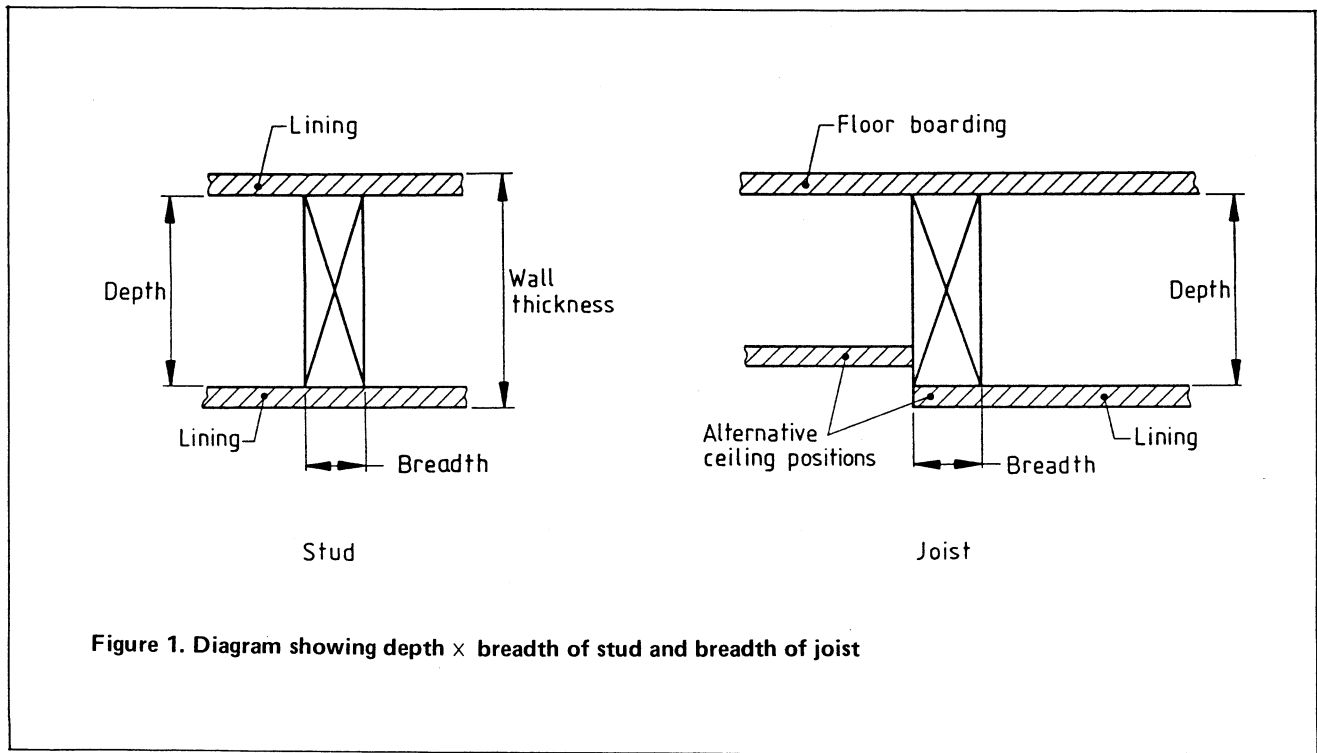


Figure 1. Diagram showing depth x breadth of stud and breadth of joist

3 Fire resistance criteria

The criteria for stability, integrity and insulation used throughout this Section of this British Standard are given in BS 476 : Part 8. In the case of stability, it should be emphasized that the criterion relates to the strength and deflection characteristics of an element, i.e. its ability to sustain the applied load throughout the period of the fire test and satisfy the reload criteria and, in the case of horizontal elements, its ability to comply also with a deflection limitation.

4 Materials

4.1 General

The methods of calculation used in this Section of this British Standard are only valid if the materials used in the construction of walls and floors, i.e. structural wall framing and joists, linings, claddings and infill insulation materials are supplied or manufactured in accordance with the requirements given in 4.2 to 4.11.

NOTE. Although the use of asbestos based insulating board is not recommended by this British Standard, reference is made to it here to cover existing structures. It should not be used in new structures, where equivalent materials of comparable fire performance should be used.

4.2 Timber

Timber should be as follows.

- (a) Structural wall framing and floor joists using species and grades of timber listed in BS 5268 : Part 2.
- (b) Softwood boarding for floors and ceilings which comply with BS 1297 and the following specific requirements.
 - (i) Minimum density 420 kg/m^3 .
 - (ii) For tongued and grooved (T and G) flooring, the tongue and groove shall comply with BS 1297.
 - (iii) Tongued and grooved ceiling boards. The tongue and groove machined to the profile given in figure 2.
- (c) Hardwood tongued and grooved ceiling boards with a minimum density 650 kg/m^3 with the tongue and groove machined to the profile given in figure 2.

4.3 Plywood

Plywood should be as follows.

- (a) Square edge and tongued and grooved floor boarding of species and grades listed in BS 5268 : Part 2.
- (b) Wall linings contributing to the calculated structural stability of the wall using species and grades listed in BS 5268 : Part 6 : Section 6.1.
- (c) Other wall linings and claddings of minimum density 500 kg/m^3 .

4.4 Wood chipboard

Wood chipboard should be as follows.

- (a) Square edge and tongued and grooved floor boarding, ceiling linings which comply with BS 5669.
- (b) Wall linings contributing to the calculated structural stability of the wall: boards included in BS 5268 : Part 6 : Section 1.
- (c) Other wall linings which comply with BS 5669.

4.5 Hardboards and fibre insulating boards

Hardboards and fibre insulating boards should be as follows.

- (a) Medium boards of type HME or HMN which comply with BS 1142 : Part 2.
- (b) Tempered hardboard of type TE or TN which complies with BS 1142 : Part 2.
- (c) Bitumen impregnated insulating board which complies with BS 1142 : Part 3 with minimum density of 285 kg/m^3 .

4.6 Gypsum products

Gypsum products should be as follows.

- (a) Neat gypsum plaster which complies with BS 1191 : Part 1.
- (b) Lightweight gypsum plaster which complies with BS 1191 : Part 2.
- (c) Plasterboard which complies with BS 1230 : Part 1.
- (d) Plasterboard jointing materials which comply with BS 6214.

4.7 Woodwool slabs

Woodwool slabs should comply with BS 1105 with a minimum density of 650 kg/m^3 .

4.8 Expanded steel lath

Expanded steel lathing should comply with BS 1369.

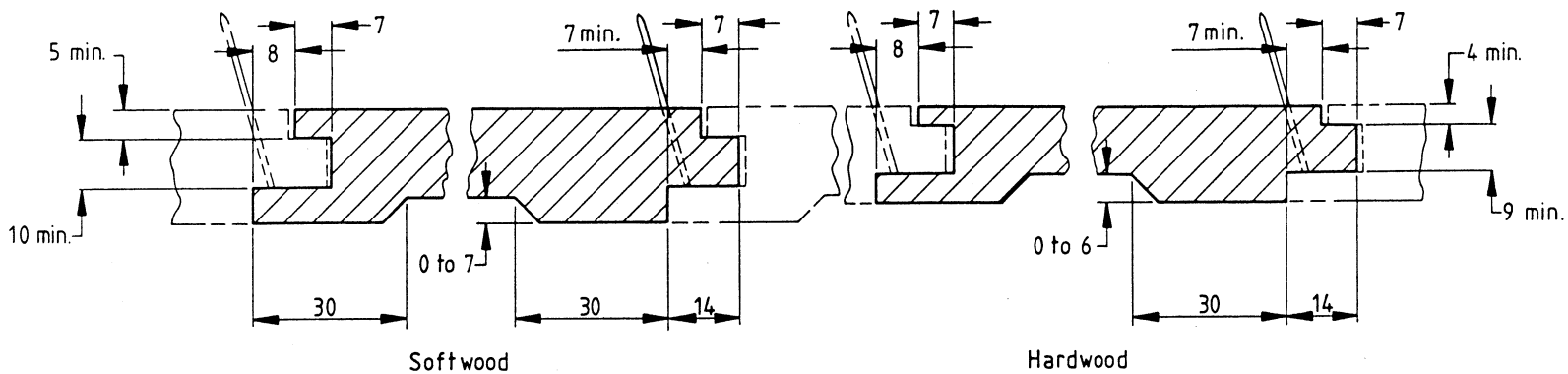
4.9 Chicken wire

Chicken wire of 50 mm maximum mesh should comply with BS 1485.

4.10 Tile hanging

Tile hanging should be as follows.

- (a) Clay tiles should comply with BS 402.
- (b) Concrete tiles should comply with BS 473 and BS 550.



All dimensions are in millimetres.

Figure 2. Profiles for tongued and grooved ceiling boards

5 Construction details

5.1 General

The fire resistance of a wall or floor is dependent upon the construction details employed. For the contributions to fire resistance assumed in this Section of this British Standard to be valid it is essential that fixings and jointing methods are in accordance with the requirements of this clause and tables 7 and 11.

5.2 Fixings of linings

The spacings of fastenings given in tables 7 and 11 should not be exceeded and recommended edge distances should be observed. Fastenings should penetrate the supporting surface of the stud or joist whilst maintaining the edge distance. Particular attention should be given in this regard to the fixing of ceiling linings.

5.3 Joints in linings

Special regard should be given to the manner in which joints are made as the detail requirements for fire resistance may be different from and more stringent than those required for normal service conditions. All joints between board materials in single layer wall linings and claddings should be supported by timber or, where appropriate, fillets of the same material as the board. In multi-layer constructions all joints in the separate layers should be staggered.

The joints of tapered edged plasterboard sheets should be taped and filled. Square edge plasterboard sheets should be either tightly butted or the gaps filled with a gypsum based bedding compound. Bevel edged boards should have closely butted joints. Joints between boards of other types should be tightly butted or filled with an appropriate bedding compound. Where joints are emphasized by the intentional separation of adjacent boards particular attention should be paid to the adequacy of fixings and width of timber bearing. If the width of such an expressed joint exceeds 10 mm and penetrates to the stud or joist, fillets of a material of equivalent performance to the lining should be fixed over the stud or joist.

Negative tolerances on nominal board sizes should not be allowed to accumulate to the extent or prejudicing the fixing to stud or joist.

5.4 Installation of insulation materials

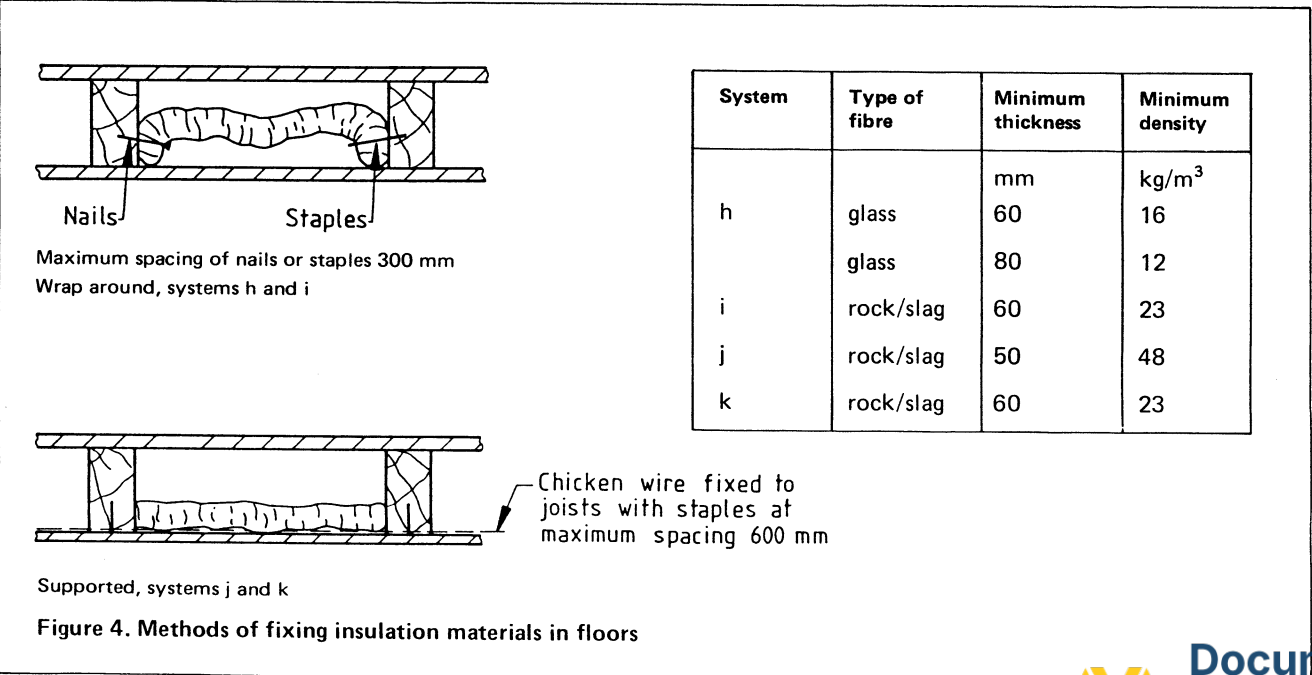
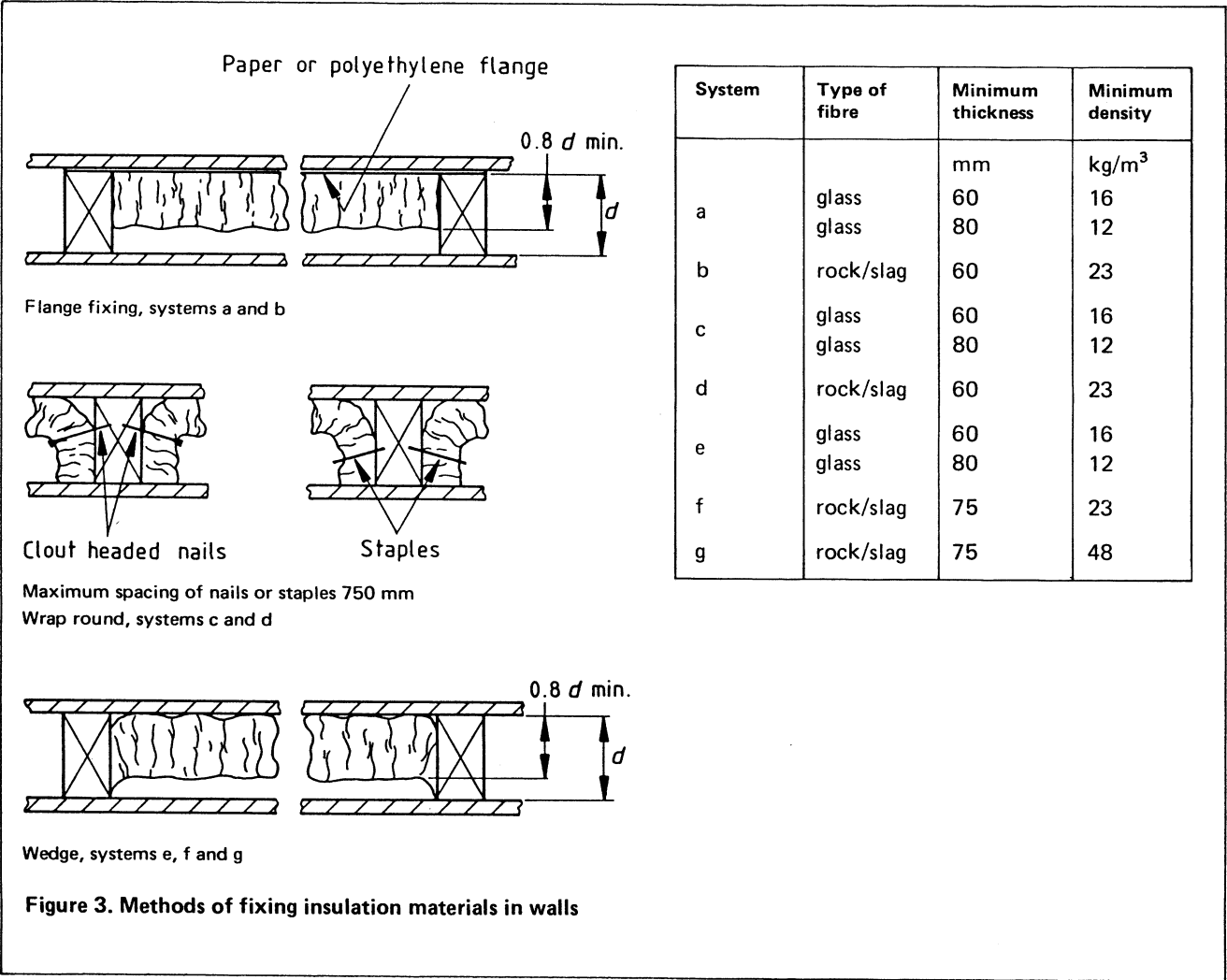
5.4.1 General. The performance in fire of a particular construction can often be improved by an appropriate combination of an insulation material and lining. These insulating materials may already be included in the construction for other reasons, e.g. thermal or sound insulation. To achieve this enhancement of fire resistance it is essential that the material and its fitting and fixing should comply with the requirements given in **5.4.2** and **5.4.3**. This may require a different or more stringent specification than would normally be employed for, say, thermal insulation.

5.4.2 Insulation materials in walls. The three recommended methods of installing wall insulation are given in figure 3. For each type of mineral fibre (glass or rock/slag) the thickness quoted is the minimum for that particular density. The overall thickness or method of fixing should be such that 80 % of the depth of the stud is covered by the insulating material. The systems (a) to (g) in figure 3 are used in tables 1 to 6 in combination with the lining material closest to the fire (exposed lining). There is no improvement in the performance of the lining remote from the fire (unexposed lining) and the contribution indices for this lining are the same as those for the particular board material without insulation.

5.4.3 Insulation materials in floors. The two recommended methods of installing floor insulation are shown in figure 4. For each type of fibre (glass or rock/slag) the thickness quoted is the minimum for a particular density. The systems (h) to (k) in figure 4 are used in table 9 in combination with particular ceiling linings.

5.5 Fixing of ceiling linings between exposed joists

The ceiling lining should be fixed to timber battens (not less than 25 mm × 25 mm in cross section) as shown in figure 5. The battens should be positioned so the exposed part of the joist below the ceiling level meets the stability criterion for the required period of fire resistance when calculated in accordance with **4.1** of this British Standard. The battens should be fastened to the sides of the joists with 60 mm long nails spaced at centres not exceeding 300 mm.



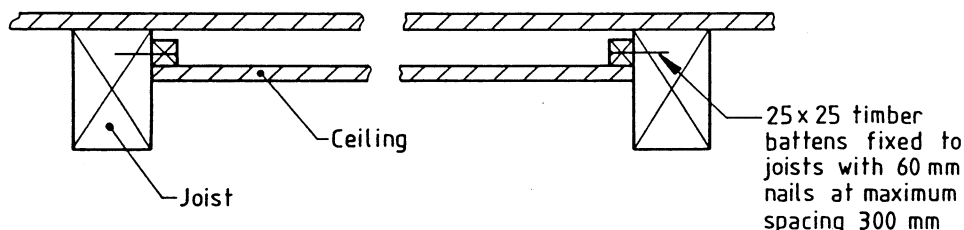


Figure 5. Method of fixing ceiling linings to exposed joists

6 Calculation method

6.1 General

For the purposes of this Section of this British Standard, the fire resistance of a timber framed wall or joisted floor construction is considered to be the sum of the contribution indices of its various components, i.e. studs, linings, etc., to the stability, integrity and insulation performance of the whole element.

Account has been taken of interactions between component parts in arriving at the contribution indices, in some cases by combining cavity insulation options with specific lining materials.

A wall or ceiling lining exposed to fire will protect the loadbearing timber structure depending on such factors as the composition of the lining, its thickness and the method by which it is fixed to the timber structure. The integrity and insulation characteristic of a construction can be improved by the inclusion of certain insulating materials within the cavities of a wall or floor. These materials may also protect the structural members and the 'linings' on the side of the element remote from the fire.

In view of the dependence of the performance of the element as a whole on its components and its assembly, it is essential that the requirements of clauses 4 and 5 with regard to materials, fixing and jointing are met if the potential fire resistance performance is to be realised.

NOTE. This Section of this British Standard may be used to confirm that linings, bracings, sheathings, etc., which are essential for the stability of a wall or floor in normal service conditions will continue to be adequate for the required period of fire resistance. When used to design constructions to give a necessary period of fire resistance, other requirements such as structural adequacy in normal conditions, thermal and sound insulation, durability and surface spread of flame characteristics should be considered separately.

6.2 Basis of the calculation method

6.2.1 General. A series of tables has been compiled on the basis of a large number of tests carried out in the UK over many years relating to different types of elements and required fire resistance performances. These tables give notional values for the contribution indices of the compo-

nents of an element to its fire resistance. The assigned values are conservative reflecting the predictability of the particular component under fire test conditions and the confidence that can be placed on the test information available. The values presented are based as far as possible on test evidence relating to BS 476 : Part 8. Where information has been used from tests performed to BS 476 : Part 1, its relationship to the later test method has been assessed.

The contribution values tabulated should not be used in isolation nor those from different tables combined nor indices from other sources introduced. Similarly, only one contribution index for each component in an element should be used, see 6.2.3. Any construction that does not totally comply with the requirements given in tables 1 to 11 should be tested or assessed by an appropriate authority.

6.2.2 Stud sizes. The tables relating to walls give values of contribution indices for stability for 100 % and 60 % load rates for stud breadth of (a) 37 mm to 43 mm, (b) 44 mm and greater, and a minimum depth of stud of 63 mm. For studs less than 63 mm depth the contribution index for stability for studs should be taken as zero.

NOTE. Insufficient information is available for stud breadth greater than 47 mm, but the application of the values for (b) will be conservative. When studs of breadth greater than 47 mm are used it is probable that either the insulation or the integrity criterion will control the choice of linings so that the larger timber sections will be unlikely to improve the overall performance of the wall; the influence of linings and insulations provided to meet the integrity and insulation criteria of the overall construction is one reason why it is not possible to apply the principles of BS 5268 : Part 4 : Section 4.1 to assess the stability contribution of timber sizes or load ratios beyond those tabulated. Such constructions should be tested or individually assessed.

6.2.3 Multiple layer linings. The contribution index of only one example of each component part of an element should be claimed. If a lining is to be used in double thickness its contribution index may not be doubled. If the contribution index of the double component is not listed separately, no more than the contribution of a single layer may be claimed.