



CP 290 : 1973

UDC 69.025.4 : 691.89

**Code of Practice for
Suspended ceilings and
linings of dry construction
using metal fixing systems**

Gr 8

British Standards Institution



Documents

Document Sharing Hub

THIS CODE OF PRACTICE has been prepared by a Committee convened by the Codes of Practice Committee for Building. Having been endorsed by the Council for Codes of Practice, it was published under the authority of the Executive Board on 12 June 1973.

© British Standards Institution, 1973

ISBN: 0 580 07765 9

Copyright

Users of British Standards are reminded that copyright subsists in all BSI publications. No part of this publication may be reproduced in any form without the prior permission in writing of BSI. This does not preclude the free use, in the course of implementing the standard, of necessary details such as symbols and size, type or grade designations. Enquiries should be addressed to the BSI Secretariat.

Contract requirements

Attention is drawn to the fact that this British Standard does not purport to include all the necessary provisions of a contract.

Revision of British Standards

In order to keep abreast of progress in the industries concerned, British Standards are subject to periodical review. Suggestions for improvements will be recorded and in due course brought to the notice of the committees charged with the revision of the standards to which they refer.

British Standards are revised, when necessary, by the issue either of amendment slips or of revised editions. It is important that users of British Standards should ascertain that they are in possession of the latest amendments or editions. Full information on all BSI publications, numbering over 6000, will be found in the *British Standards Yearbook*. This information is supplemented by details published each month in *BSI News* of new publications, revisions and amendments.

BSI News is available to Subscribing Members of the Institution. All other publications may be purchased direct from Sales Department. Enquiries concerning subscribing membership, which has considerable advantages, will be welcomed, and should be made to Subscriptions Department. Both departments are located at:

101 Pentonville Road, London N1 9ND (Telephone 01-837 8801; Telex 23218).

The following BSI references relate to the work on this code:
Committee reference BLCP/41 Draft for comment 69/7841

Code Drafting Committee BLCP/41

Metal fixings for insulating linings

Mr. E. G. Hutchinson (Chairman)
Mr. C. H. Church (BSI, Committee secretary)

Asbestos Cement Manufacturers' Association

British Construction Steelwork Association

Cold Rolled Sections Association

Department of the Environment—Joint Fire Research Organization of the Fire
Offices Committee

Department of the Environment—Building Research Station

Fibre Building Board Development Organization Limited

Fire Protection Association

Gypsum Products Development Association

Metal Fixing Association for Building Insulation

Royal Institute of British Architects

Structural Insulation Association

The Royal Institute of Chartered Surveyors

Thermal Insulation Contractors' Association

* resigned 16.10.70

† deceased 12.4.69

‡ resigned 6.1.70

* Mr. G. E. Bonnell
† Mr. A. F. Hughes
Mr. R. B. Smith
Mr. K. D. Paice
‡ Mr. R. R. Gavin Orr
Mr. A. L. Randall
Mr. P. D. Keeler

The Director

Mr. J. A. Godfrey

Mr. E. A. Raynham

The Director

Mr. L. F. Allsop

Mr. R. G. Abbott

Mr. G. P. Aylott

Mr. W. H. C. Saxon

Mr. E. G. Hutchinson

Mr. J. Lawrie

Mr. H. F. Tunbridge

Mr. D. S. Male

**CP 290 : June 1973**

UDC 69.025.4 : 691.88

**Code of Practice for
Suspended ceilings and
linings of dry construction
using metal fixing systems**

Amendments issued since publication

Amd. No.	Date of issue	Text affected

British Standards Institution • 2 Park Street • London W1A 2BS
Telephone 01-629 9000
Telex 266933

CP 290 : 1973

Contents

	Page		Page
Foreword	3	7. Work off site	
1. General		7.1 Co-ordination of services, structure etc.	42
1.1 Scope	4	7.2 Soffit fixings	42
2. Materials and components		7.3 Drawings	42
2.1 Choice of materials	4	7.4 Setting out point on drawings	42
2.2 List of materials	4	8. Work on site	
2.3 Metal fixing system components	7	8.1 Sequence of working	42
2.4 Adhesives	9	8.2 Setting out points	43
3. Design of the ceiling and lining system		8.3 Appearance	43
3.1 Design considerations	10	9. Care and maintenance	
3.2 Thermal insulation	11	9.1 Methods	43
3.3 Acoustic absorption and sound insulation	21	9.2 Removal and replacement	43
3.4 Illumination	24	9.3 Decoration	43
3.5 Heated and ventilating ceilings	26	Appendices	
3.6 Special considerations for particular conditions	28	A. Fire performance tests	44
3.7 Panel sizes	29	B. Imperial sizes for Tables 2, 4 and 5	45
4. Fire protection		Figures	
4.1 General	33	1. Diagram of bending moment of a continuous beam under a uniformly distributed load	8
4.2 Function of the ceiling	34	2. Condensation	13
4.3 Design criteria, Category 1	34	3. Method for estimating the risk of interstitial condensation in a structural element	14
4.4 Design criteria, Category 2	37	4. Method for estimating the risk of interstitial condensation in a structural element (alternative)	15
4.5 Design criteria, Category 3	37	5. Cold bridge effect	17
5. Linings		6. Pattern staining	18
5.1 General	38	Tables	
5.2 Roof linings	39	1. List of typical panel materials	5
5.3 Wall linings	39	2. Typical examples of luminous ceilings	6
6. Recommendation for tendering and measurement of suspended ceilings and linings		3. Suggested optimum reverberation times as a function of volume for different types of room	22
6.1 General	39	4. Some typical examples of sound absorption materials	19
6.2 Building owner	39	5. Examples of materials, dimensions and grid measurements for some of the more common panel sizes	31
6.3 Architect (design requirements)	40		
6.4 Quantity surveyor or surveyor	41		
6.5 Main contractor (attendances)	41		

This Code of Practice represents a standard of good practice and therefore takes the form of recommendations. Compliance with it does not confer immunity from relevant statutory and legal requirements.

Foreword

Suspended ceilings and linings can provide concealment of services, protection of structure against fire, decorative finishes, thermal insulation and illumination. They can also provide heating and ventilation, and contribute to acoustic absorption, sound insulation and the reduction of condensation.

The fixing systems may consist of framework of lightweight, corrosion-resistant steel or aluminium alloy sections with accessories, sometimes in conjunction with timber or plastics components designed to support a variety of sheets and panels fixed by dry construction methods in the form of suspended ceilings, wall and roof linings.

In accordance with the change to the metric system, this Code is expressed in metric terms giving values in terms of SI units, but it should be noted that as imperial sizes of the materials will still be required for some time to come, the Tables, while giving the co-ordinated sizes in the body of the Code, are reproduced in Appendix B with the imperial sizes and metric equivalents. This appendix will be deleted when no longer required. For further information on SI units, reference should be made to BS 3763, International System of units (SI).

The recommendations for the co-ordination of dimensions in building as laid down in BS 4011, Basic sizes for building components and assemblies, BS 4330, Controlling dimensions, and BS 4606, Co-ordinating sizes for rigid flat sheet materials used in building, are embodied where appropriate in this Code.

CP 290 : 1973

Code of Practice for

Suspended ceilings and linings of dry construction using metal fixing systems

1. General

1.1 Scope

This Code deals with the design of suspended ceilings and lining systems for concealment of services etc. including thermal insulation, acoustic absorption, sound insulation, illumination, heating and ventilating ceilings. It also recommends principles of design and construction to establish satisfactory design criteria for the purpose of fire protection and includes recommendations for tendering and measurement procedures, co-ordination of work on and off site and for care and maintenance.

Fixing systems for fibrous plaster panels are included, but grids for wet plasterwork or wood-wool slab installation are not covered by this Code, nor are whole ceilings or linings fixed direct to the structural soffit by means of adhesive.

Thermal insulation by sandwich methods such as double skin panels, which are installed by roofing contractors is excluded from this Code.

NOTE. The titles of British Standards referred to in this Code are listed on the inside back cover.

2. Materials and components

2.1 Choice of materials

The choice of material for the membrane of a suspended ceiling or lining will depend primarily on its main function. The membrane may be required to provide a pre-determined amount of thermal insulation, sound absorption, sound reduction, fire protection, resistance to diffusion of water vapour or a decorative finish. It may also be required to function as the main or partial source of light or illumination.

In general, the ceiling or lining will be divided into regular panels, tiles or boards. The materials for panels, tiles or boards range from insulating panels of various types, to plain or perforated metal tiles and strips supporting acoustic absorbent thermal insulating materials.

2.2 List of materials

Table 1 lists various panels and materials and gives data on their thermal insulating value, appearance and finish. For matters relating to the fire performance of materials see Appendix A. Illuminating ceilings are dealt with separately in Table 2. Reference should also be made to Appendix B for table giving imperial sizes.

2.2.1 Metal fixing systems. A metal fixing system is a framework of lightweight corrosion-resistant steel, aluminium alloy, or other not less suitable material with accessories designed to support a variety of boards, tiles and panels in the form of ceilings, wall or roof linings. The framework can be suspended or fixed hard up to the main structure.

CP 290 : 1973

Table 1. List of typical panel materials

Material	Appearance	Finish Natural (N)* Primed (P) Decorated (D)	Support systems	Thermal conductivity	Approximate weight
Wood or other organic fibre insulating board, bevelled panels and tiles BS 1142	Smooth, textured, plain, perforated, embossed, fissured	N, P, D	Exposed tees or concealed tees Z or C sections	W/(m K) 0.049	kg/m ² 3.7 (12.7 mm thick)
Mineral fibre and wool insulating board, bevelled panels and tiles	Plain, textured, perforated, rilled, fissured	P and D	Exposed tees or concealed tees Z or C sections	0.050 to 0.065	4.9 (12.7 mm thick) 6.1 (15.9 mm thick)
Asbestos insulating board and bevelled panels BS 3536	Plain, textured, perforated	N, D	Exposed tees or concealed tees Z or open or box or channel sections	0.110 to 0.120	4.9 (6.3 mm thick) 8.0 (9.5 mm thick) 8.9 (12.7 mm thick)
Metal tiles, panels and strips	Steel Plain, perforated	D	Panels: concealed split-stalk tees. Strips: concealed channel sections with pressed fixing lugs or exposed bottom tees of angles	0.036 (25 mm mineral wool)	7.3 to 14.6
	Aluminium Plain, perforated	D		0.036 (25 mm mineral wool)	3.7
Gypsum plasterboard	Plain	P	Exposed tees or concealed tees or channels	0.16	10.25 (12.7 mm thick)
Gypsum insulating plasterboard	Plain	N or D		2.39† 2.33†	7.5 (9.56 mm thick) 10.25 (12.7 mm thick)
Glass fibre tiles and boards	Textured, fissured, rilled, pin, perforated	D	Exposed tees or concealed tees Z or C sections	0.035	3.7 (19 mm thick)
Gypsum fibrous plaster bevelled tiles	Plain, perforated, ribbed, slotted, fissured	N, D	Concealed tees or Z sections	0.075	14.7 (15.9 mm thick) 17 (31.8 mm thick)

NOTE. See Table 5 for detailed information on thickness, support centres etc.

* N can also be decorated after fixing.

† Conductance value W/(m² K), assuming air space (minimum 20 mm) in conjunction with aluminium foil backing.

CP 290 : 1973

Table 2. Typical examples of luminous ceilings (see also Appendix B, Table 2a)

Type	Appearance	Support system	Dimensions (Co-ordinated size)	Approx. weight	Light transmission, manufacturers' information	Shielding angle	Remarks
Louvered							
Polystyrene, light stabilized, opal, clear or metalized	Square, circular or diamond mesh 9.5 to 50.8 mm range of sizes	Exposed or concealed supports formed of metal or plastics components	mm 600 × 600 600 × 1200 900 × 900	kg/m ² 4.9	30% to 85%	30° to 45°	—
PVC rigid	Circular or square 12.7 mm cells	Exposed tee aluminium track system	600 × 600	4.9	50%	30° to 45°	—
Metal	Square, wave patterned castellated or expanded mesh	An exposed tee system	600 × 600 600 × 1200 1200 × 1200	0.5 to 5	Approx. 50% to 70%	30° to 45°	Types available with adjustable blade to control direction and intensity of lighting
Closed diffuser							
PVC sheet non-laminated	Flat or vacuum-formed to a large number of designs	An exposed tee system	600 × 600	2.3	50% to 60%	—	—
Acrylic/PVC laminated sheets and panels	Flat or 31.8 mm corrugated sheets; vacuum-formed panels	An exposed tee system	600 × 600 600 × 1200	2.3	50%	—	Acoustic/luminous material 80% sound absorption at 1000 Hz (see Table 4)
Acrylic sheets and panels, usually opal	Flat or extruded sheet with or without surface texturing or needling. Vacuum forming possible	An exposed tee system	600 × 600 and derived sizes from sheet (thickness depends on panel size)	Weight depends on panel size	50% to 60%	—	Excellent properties of diffusion and light stability
PVC corrugated diffusing membrane	31.8 mm pitch normal corrugation	Supported at edges in aluminium track	1000	0.3	50% to 60%	—	Strip can be rolled back, edges of material can be damaged by careless handling
PVC flexible tensioned film stretched around metal frames to form panels	Variety of colours, light transmissions and embossed textures	An exposed tee system	600 × 600 900 × 900 1000 × 1000 1500 × 1000	5	49% to 90%	—	Double membrane types available which give better screening of lamps, avoid dust deposited on top of panels being seen from below. Also improved thermal insulation. Obtainable in colour and opaque black
Moulded and extruded polystyrene panels, opal or clear	Not available in metric sizes						
Glass fibre reinforced resins	Flat or corrugated, corrugation parallel to length	An exposed tee system	To suit current cladding sheet widths	4.9	Up to 80%	—	Less efficient diffuser than other materials listed. Normally employed for industrial application

NOTE 1. See 4.5 in relation to fire safety recommendations for the selection of type and material. Regular cleaning is essential to maintain light transmission (see clause 9, Care and maintenance).

NOTE 2. Other sizes of some material may be available; consult manufacturers.

2.3 Metal fixing system components

The order of reference is from the structural soffit to the finished face of the ceiling or lining. Most of the terms relating to ceilings also apply to linings.

2.3.1 Anti-corrosive treatments. It is essential that all components made from steel should be protected against corrosion.

Suitable painting systems are recommended in CP 2008.

Anti-corrosion treatment may be applied to the steel before forming but choice of protection should be such as will not be materially affected during the forming operation. Treatment may be applied after forming. If steel components are to be used in severe environmental conditions it may be necessary to provide additional protection after forming such as a coating of epoxy resin or chlorinated rubber or plastics.

System manufacturers should be able to give guidance on the protection of section components under abnormal conditions.

Aluminium alloy sections and components may be further protected by anodizing to the requirements of BS 1615.

When steel and aluminium components are used in conjunction it is advisable to prevent electrolytic action by paint treatment between the surfaces in contact or by placing an electrolytically inert spacer between such surfaces.

2.3.2 Soffit fixings. Galvanized or suitably protected steel tabs, sockets bolts or anchors are cast or grouted in the structural floors or walls in positions predetermined by the specialist, who may alternatively drill the structure to insert proprietary plugs, drill-anchors etc. Shot fired fixings should only be permitted with the approval of the engineer or architect. Where such approval is given it is essential that information is provided as to the position of the reinforcement, and also that the load carrying capacity of these fixings when subject to tension or shear is examined.

In thermal insulation lining work brackets, straps (particularly with the flattened section types of external sheet cladding), clips and wires are used to secure grid-work members to purlins, sheeting rails, and trusses.

2.3.3 Hangers. These can be:

- (1) steel wires, 3.15—2.00 mm diameter (the wire should be straightened before fixing);
- (2) steel straps, 1.60—0.80 mm thick (these can also be used to suspend the panel grid from the primary grid);
- (3) M/S rod, 5.00—16.00 mm diameter;
- (4) combinations of the above or other suitable alternatives to provide adequate adjustment of grid level and to simplify and accelerate the speed of fixing.

2.3.4 Primary grid. The primary grid is used where necessary to carry the panel grid (see 2.3.5) and enables fewer soffit fixings and hangers to be used (hanger positions are often determined by the structure) without increasing the strength of the panel grid sections. Primary grid sections are usually of channel or tee 1.6—0.9 mm section rolled steel, generally fixed above and in opposite direction to the panel grid. Primary grid sections should be joined between $\frac{1}{3}$ and $\frac{1}{4}$ of the distance between the point of support, unless the means of jointing is such that sections are acting as continuous beams (see Fig. 1).

2.3.5 Panel grid. The panel grid supports the ceiling or lining panels and is supported by the primary grid (see 2.3.4) or by direct hangers. The panel grid is formed from a variety of steel or aluminium alloy sections or tees or modified tees (including Z and split stem), open or box channels, H (beam) 1.6—5 mm. Bearing flanges varying from 19—50.8 mm overall are in use, but the choice would depend upon the panel material selected. Practical limits of deflection between points of support for ceilings should be not more than 1/450 of the span up to 1830 mm and 1/600 for spans exceeding 1830 mm.

Flanges of exposed systems generally require to have a durable decorative finish. This is achieved by roll-forming sections from prepainted strip or by capping the galvanized flanges with pre-painted aluminium or steel sleeves. Site applied finishes include preformed plastic sleeves or adhesive backed plastic tape. These latter should be applied to the section before the panels are installed, to ensure that the tape is carried round the edge of the flanges. Anodizing may be used on aluminium alloy sections as a decorative finish (see 2.3.1). The methods of joining panel grid sections, either by joint plate or by interlocking section ends, result in the sections acting as continuous beams (see Fig. 1).

Where the methods of joining are not specifically designed to achieve this, then panel grid sections in all

CP 290 : 1973

cases should be jointed between $\frac{1}{3}$ and $\frac{1}{4}$ of the distance between the points of support (see 2.3.4). Extra support and trimming should be provided at recessed luminaires etc.

Where the ceiling is required to provide fire protection, provision should be made within the grid assembly to accommodate the thermal expansion that will be experienced in fire and enable the ceiling to provide the requisite fire resistance of the element of structure (see 4.3.1).

Panel grid members may be required to provide support and/or lateral stabilization to partition head members in which case extra hangers may be required.

Extra stiffeners may be required where the partition system subjects the head member to an upward thrust.

Noggings are versions of panel grid sections used to ensure support to edges of panels where required.

Steel, aluminium, fibre or plastics splines or plates are used to line up cross joints between adjacent panels with concealed fixing systems, and are usually flat strips which may be reinforced with stamped, longitudinal ribs. Splines provide sealing-off to the joint between the adjacent panels. Slotted holes drilled in splines to engage with holes of similar shape formed in the edges of adjacent tiles (to the whole tile thickness) can give, with a simple sliding action, controlled outlets to ventilating ceilings.

Spacing of grids is dependent on the arrangements of noggings and the limitations of panel materials, but their span may be increased by reinforcing members secured to the back of the panel material (see Table 5 and Appendix B).

In certain heated ceiling systems, pipework is designed to provide fixing for ceiling panels.

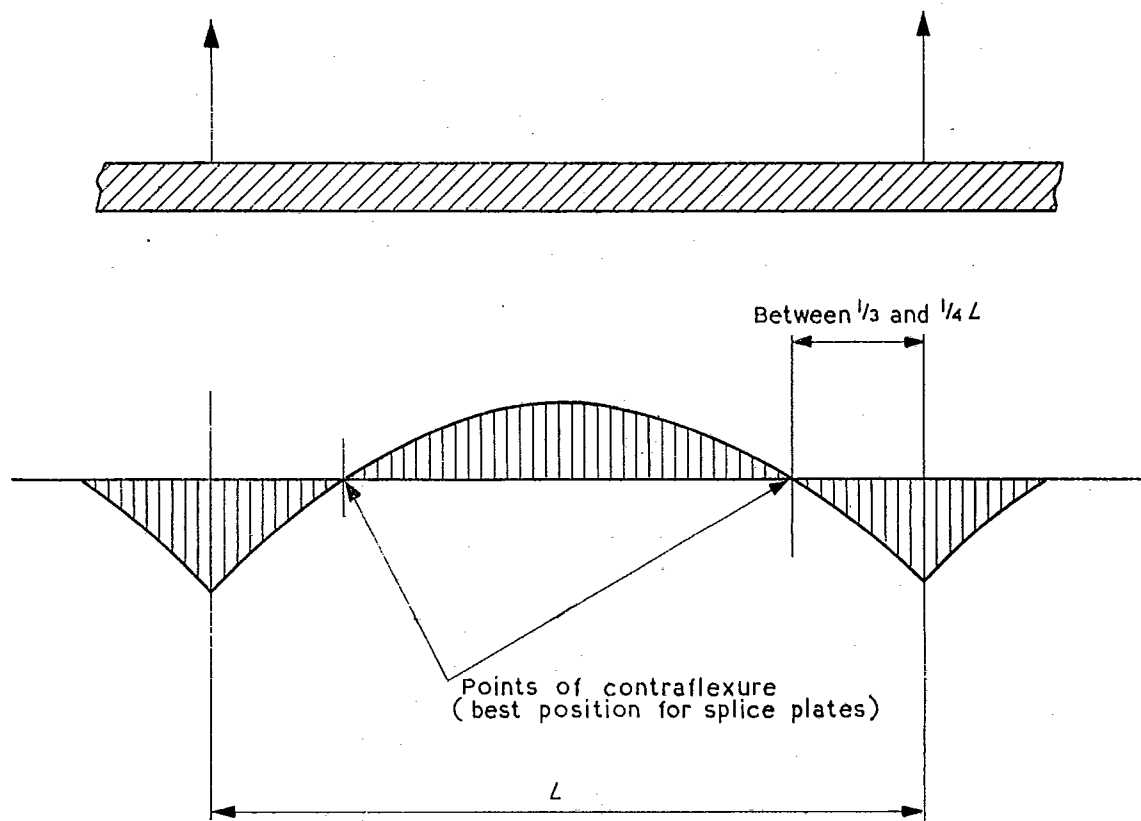


Fig. 1. Diagram of bending moment of a continuous beam under a uniformly distributed load

2.3.6 Perimeter trims. Perimeter trims comprise angle or channel members similar to panel grid sections above. The absence of trims or cover fillets will give rise to costly cutting and shaping of panels. Where timber cover moulds or fillets are used they are generally provided by other trades. Where the ceiling is to provide fire protection, expansion should be allowed for at the junctions between wall and ceiling (see 4.3.3).

2.3.7 Special sections. Special sections are formed of steel, plastics or extruded aluminium alloy sections usually of inverted complex channel shape with suitable flange extension, used for carrying electrical wiring

etc., and which may form part of the panel grid. These are often closed with metal or plastic cover strips, expressed on the ceiling surface. Surface mounted luminaires may be supported by such members (in conjunction with patent bolt assemblies).

These sections may also provide lateral stabilization to the heads of demountable partition systems.

Where a ceiling is required to contribute to the fire resistance of the structure these exposed sections should be given special consideration (see 4.3.2).

2.3.8 Methods of panel fixing. Panels may be provided with permanent or demountable fixings. In concealed grid systems panels may be fixed to panel grids with clips (these can be exposed on the face, but are more often concealed on the upper edge or side edge), or with screws (with metal or plastic cups when required). In exposed grid systems the panels rest on the flanges of panel grid sections and may be retained by holding down clips or other suitable fixings to provide either permanent or demountable installations.

Fixing to all edges is often required, although panels with interlocking edges may form part of the fixing system. The centres of panel screws or pin fixings vary according to the material.

Panels can also be supplied for concealed fixing with kerfed and cut-back edges to engage with the flanges of panel grid sections whilst clearance is allowed for their stalks (see 3.7).

In the case of metal panels the edges are suitably 'pipped' and 'stopped' to engage in split-stalk tees and it is essential that these are demounted with special extractors to provide additional safeguards against their unauthorized removal (see 4.3.2.1).

2.3.8.1 Access panel grids. In concealed fixing systems where kerfed and rebated panels are used, a panel grid comprising main sections, cross noggings and cross splines at right angles to the cross noggings is often used to provide access to services within the ceiling void. The cross noggings are in two separate but engaging parts. By such a system immediate access is obtained to a proportion of the panels and further panels can then be demounted.

2.3.8.2 Access panels. Panel holding clips are sometimes provided so that a simple turning action at the ceiling soffit can permit screwed panels to be readily demounted (see 4.3.9). Access panels in basically fixed systems, such as fibre-board panels with tongued and grooved or kerfed and rebated edges, require a metal or timber frame around all four edges and the opening in the grid may require extra noggings or trimmers.

In exposed metal fixing systems where permanent holding down clips are used these may be replaced with clips which although initially retaining the panel in position will permit panels to be demounted.

2.3.9 Independent luminaires (lighting fittings). (See 3.4.) Many luminaires can often be supported by the primary grid and in some cases by the panel grid members capable of providing support. When necessary, hangers (sometimes attached to the luminaires) are required to take the weight of the luminaire plus the panel grid which may need cutting and supporting with additional primary members (see 4.3.9). Ceiling panels themselves are not intended to take the weight of luminaires and where the point of support occurs at mid-panel, extra grid, panel reinforcing, noggings and hangers may be required. Conduit runs, particularly the screwed tube or copper sheathed mineral core varieties, should be independently supported and back-entry conduit boxes may be necessary to permit the runs of conduit to clear the suspension system. Allowance should be made in the depth of ceiling suspension for this.

The support for the luminaires should allow them to be removable for routine maintenance without disturbing the ceiling supporting system or damaging the ceiling panels. Some luminaires are specially designed to fit into grid systems but others may necessitate the interruption of the grid members which will then require trimming and supporting; further support may be required for the panel edges adjacent to the luminaire. The joint between the luminaire and the ceiling panels should be sealed or covered with a flange.

2.4 Adhesives

Generally suitable for small tile units. When the structural undecorated soffit has slight irregularities, then 300 mm × 300 mm tiles can be fixed with gap filling (generally dabs) adhesives. When the soffit is smoother, larger tiles or panels can be fixed with contact adhesive. In all cases it is essential that the adhesive manufacturers' recommendations are followed, and particular care should be taken in selecting adhesives for use with plastics panels which should have overall adhesive. To achieve an acceptable surface for tile fixing, if irregularities cannot be eradicated by gap filling adhesives it may be necessary to render the soffit. Priming of the soffit may be required when lime is present in plasterwork, and priming of the tiles if the contact surfaces of these are dusty. This type of fixing is unsuitable for flaking and damp surfaces.

CP 290 : 1973

3. Design of the ceiling and lining system

3.1 Design considerations

Suspended ceilings in particular, and linings to a lesser extent, are available to meet the multiplicity of purpose and function. The following requirements should be considered, and account must be taken of statutory requirements.

3.1.1 Functional requirements

3.1.1.1 *Concealment of:*

- (1) structure
- (2) services

3.1.1.2 *Provision of:*

- (1) decorative appearance
- (2) thermal insulation
- (3) sound absorption
- (4) sound reduction
- (5) vapour diffusance
- (6) fire protection
- (7) illumination
- (8) heating or air-conditioning

3.1.2 Appearance and design

3.1.2.1 *Accessibility:*

- (1) all panels fully demountable
- (2) certain panels demountable
- (3) specific trap-door access
- (4) panels not removable

3.1.2.2 *Panel shape:*

- (1) square
- (2) rectangular and strip
- (3) special shapes

3.1.2.3 *Determine position of:*

- (1) luminaires
- (2) ventilator grilles
- (3) sprinklers or fire detectors
- (4) loud-speakers, signs etc.
- (5) partition heads
- (6) services

3.1.2.4 *Perimeter treatment:*

- (1) walls and partitions
- (2) columns and beams
- (3) blind boxes, roof lights, lay lights and glazing
- (4) changes in level

3.1.3 Position

- (1) height from finished floor level
- (2) depth of ceiling void
- (3) position with reference to the structural frame
- (4) more than one level

3.2 Thermal insulation

3.2.1 General. Suspended ceilings and linings can contribute to the overall thermal insulation of a structural element (i.e. roof or wall) by the intrinsic insulation value of the lining itself, by forming additional cavities and by supporting comparatively lightweight materials of high insulation values (e.g. mineral wool, glass fibre, expanded plastics, and aluminium foil).

Frequently, the same lining can also provide a useful measure of acoustic absorption (see 3.3), as the physical properties which contribute to thermal insulation and acoustic absorption are generally compatible. However, the properties which ensure good thermal insulation are not similar to those required for good sound insulation, as this depends mainly on mass and air tightness.

In assessing the thermal insulation value of a structural element containing a suspended ceiling or lining it is essential that the thermal resistances of all components of the structural element (materials, cavities and surfaces) are considered. The conditions of exposure should also be ascertained as these will affect the thermal resistance values of the external surfaces.

Condensation and pattern staining are additional problems associated with thermal insulation and can affect the design of a suspended ceiling or lining system (see 3.2.6 and 3.2.7).

3.2.2 Statutory requirements

3.2.2.1 Industrial buildings. For industrial buildings, minimum standards of thermal insulation are laid down by the Regulations under the Thermal Insulation (Industrial Buildings) Act, 1972. These standards only apply to the roofs of new industrial buildings and extensions to old ones, and are governed by the temperatures to be maintained by the heating plant. Exemption is granted to unheated buildings, boiler houses and buildings in which the space heating is derived entirely as a by-product of the manufacturing process. Full details are given in the Explanatory Memorandum. (See 5.1.)

3.2.2.2 Dwellings. The minimum standards of thermal insulation for roofs, external walls and ground floors of dwellings are specified in The Building Regulations, 1972, Part F and the Building Standards (Scotland) Consolidated Regulations, 1971. An explanation of the Statutory requirements is given in the explanatory memoranda to these regulations.

3.2.3 Calculation of thermal insulation values

3.2.3.1 Thermal transmittance (U) values. The thermal transmittance of construction or an element of structure (e.g. wall, floor, roof), the U value, is defined as the quantity of heat that flows through unit area in unit time, per unit difference of temperature between the internal and external environments, and is expressed in $W/(m^2 K)$. The thermal transmittance can be calculated from data on the thermal resistances of the various components making up the structural element, including the thermal resistances of the internal and external surfaces exposed to the air and the thermal resistances of any cavities. Further guidance is given in the IHVE Guide Book A (1970) and BRS Digest 108*.

3.2.3.2 Thermal conductivity. Thermal conductivity (k) is a property of a material, independent of thickness and is a measure of the rate at which heat will flow through a material when a difference exists between the temperatures of its surface. It differs from the term U (described above) in so much as it is a measure of the rate of heat transfer per unit thickness, whereas the U value refers to the overall heat transfer for a construction or element of structure. It is expressed in $W/(m K)$.

3.2.3.3 Thermal resistivity. Thermal resistivity ($1/k$) is also a property of a material regardless of size or thickness; it is the reciprocal of conductivity and is expressed in $m K/W$.

3.2.3.4 Thermal conductance. Thermal conductance (C) is the thermal transmittance between the inner and outer surfaces of a construction depending on the thickness and thermal properties of the materials making up that construction but ignoring the resistance of the inner and outer surfaces. It is given in $W/(m^2 K)$. For a construction of one material only,

$$\text{thermal conductance} = \frac{k}{L} \text{ where } L \text{ is the thickness of the component.}$$

* BRS Digest 108, Standardized U-Values.

CP 290 : 1973

3.2.3.5 Thermal resistance. Thermal resistance (R) is the reciprocal of thermal conductance and is the measure of the overall thermal resistance of a material or combination of materials to heat flow. The total thermal resistance of an element of structure, including the resistance of the inner and outer surfaces and any enclosed cavities, is the reciprocal of the total thermal transmittance, i.e. $1/U$. It is expressed in $\text{m}^2 \text{K/W}$.

3.2.3.6 Thermal emissivity. The ability of a surface to radiate heat energy is usually expressed relative to that of a perfect radiator (i.e. a black body at the same temperature) and is known as its emissivity. At normal room temperatures (i.e. $10\text{--}25^\circ\text{C}$), emissivity of non-metallic surfaces is high, being in the range $85\text{--}100\%$. The materials which have a low heat emissivity are the materials with a highly polished metallic surface, such as aluminium foil. Because of their low emissivity, coupled with their low thermal capacity, the aluminium foils are useful as insulators when used in conjunction with cavity construction (which should not be less than 20 mm), for example, as a backing to ceiling linings. (See 3.2.4.)

3.2.4 Tests. The basic data on which U values are calculated are derived from the thermal conductivity and thermal emissivity values for the materials of construction. Appropriate tests for these properties are given in BS 874 which also includes definitions of thermal insulating terms.

3.2.5 Materials. For the purpose of thermal insulation, materials for suspended ceilings or linings can be divided broadly into three categories.

- (1) Relatively dense materials, such as metal or hardboard formed into thin panels or sheets which in themselves have insignificant insulation value, but can contribute to the overall insulation value of the structure by virtue of the enclosed ceiling void.
- (2) Rigid board and sheet materials which have significant insulation value.
- (3) Flexible materials of low density and high insulation value all of which require support by rigid panels or sheets forming the ceiling surface.

3.2.6 Condensation. For buildings or parts of buildings with humid internal climates (e.g. kitchens, swimming baths and laundries), condensation, either interstitially or on the surface of the lining exposed to the room, can be a problem. For fuller understanding of the problem refer to CP 3 Chapter II.

Thermal insulation alone, as explained in the following paragraphs, is seldom the complete answer.

The manner in which interstitial or surface condensation can arise is explained diagrammatically in Fig. 2.

There are several methods for estimating the risk of interstitial condensation in a structural element. The method put forward in CP 3 Chapter II, is to determine the temperature and vapour pressure gradients through the various components forming a structural element on the assumption that in all buildings heated and occupied in winter the air temperature and vapour pressure indoors will be in excess of those outside. The resulting flow of heat and water vapour through the fabric depends on the resistance of the various components making up a structure.

The method of calculation described in CP 3 Chapter II takes into account the vapour pressure drop through each component of structure which in turn determines the vapour pressure gradient and the associated dew point curve. Steady-state heat conditions are assumed. Fig. 3 shows in graphical form this method of calculation applied to a typical roof construction, and the position where the dew point temperature coincides with the structural temperature curve and where interstitial condensation could occur. To avoid condensation it is essential that a vapour barrier be sited on the warm side of this point, i.e. to the right of the intersection. In practical terms this would mean placing the vapour barrier between the mineral wool layer and the ceiling panels.

An alternative method is to ignore the effect of vapour diffusance through the individual components making up a structural element and to assume that the dew point temperature in the room will be the same right through the structural element. Thus by plotting graphically the thermal resistances of the individual elements, including any cavities, and the external and internal surface resistances on a linear horizontal scale against a vertical temperature scale as in Fig. 4, the point where the dew point temperature intersects the temperature gradient indicates where interstitial condensation may occur. It can be argued that it is a less precise method than the first method but it has the merit of simplicity and ease of setting out as the temperature gradient is simply a straight line drawn between the given external and internal ambient air temperatures. It has the further merit of a factor of safety as can be seen from comparing the results of the two methods plotted on Fig. 3. In any case, the most convenient position for the vapour barrier is as before, between the mineral wool layer and the ceiling panels.

CP 290 : 1973

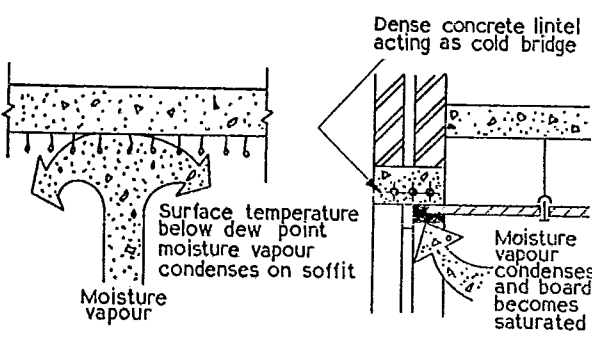
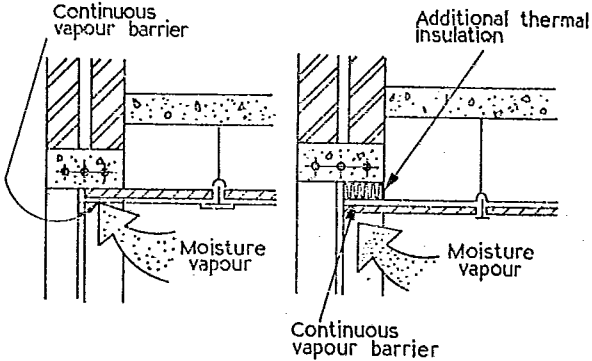
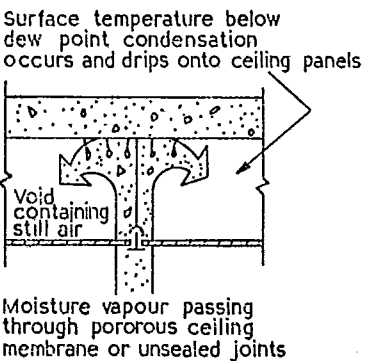
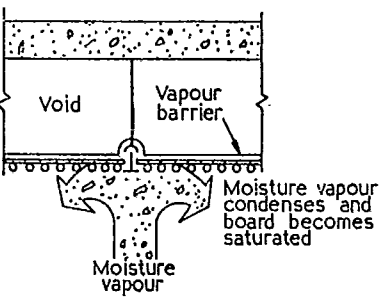
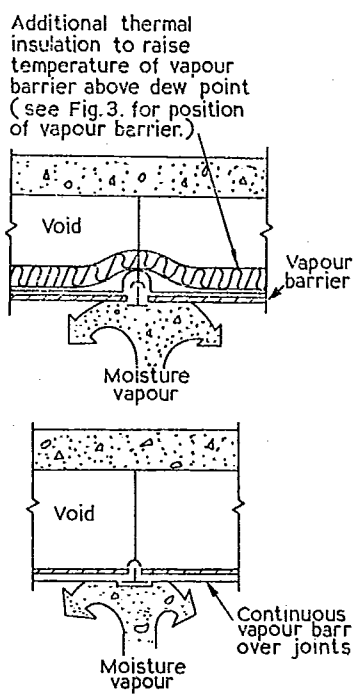
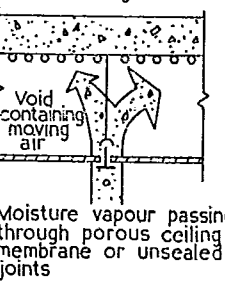
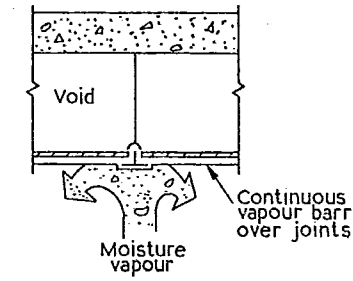
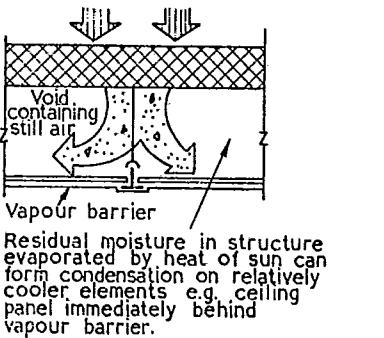
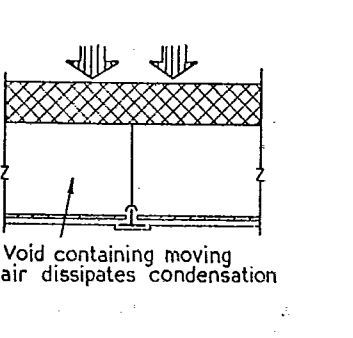
	Causes	Remedial treatment
Surface condensation		
Interstitial condensation	Surface temperature below dew point condensation occurs and drips onto ceiling panels  	Additional thermal insulation to raise temperature of vapour barrier above dew point (see Fig.3. for position of vapour barrier.)  Surface temperature below dew point condensation still occurs but is dissipated by diffusion due to through ventilation  
Condensation from reversed temperature gradient		

Fig. 2. Condensation

CP 290 : 1973

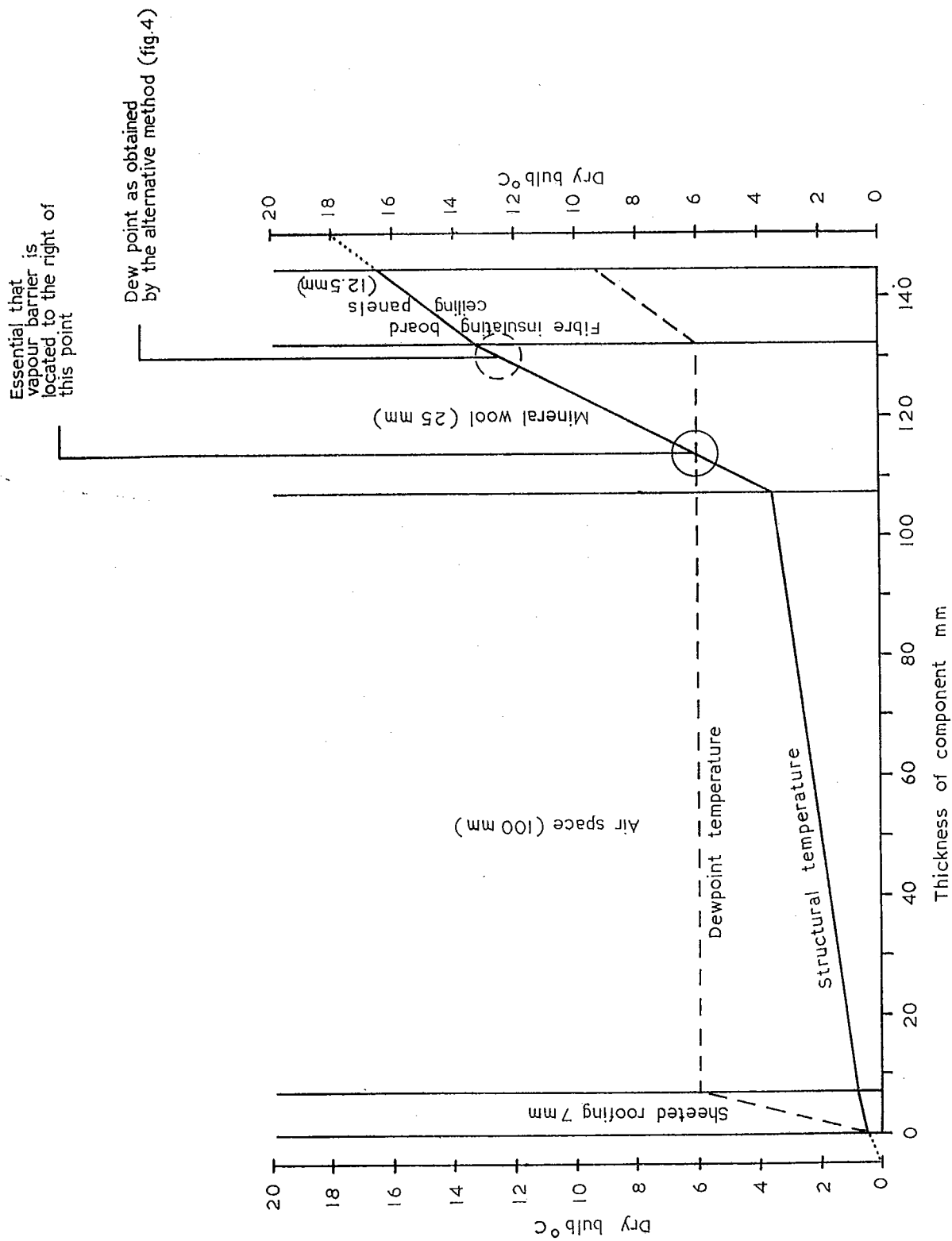


Fig. 3. Method for estimating the risk of interstitial condensation in a structural element