

BS 5427:2016+A1:2017



BSI Standards Publication

**Code of practice for the use of profiled
sheet for roof and wall cladding
on buildings**

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Foreword

Publishing information

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 30 April 2016. It was prepared by Subcommittee B/542/6, *Corrugated sheeting materials*, under the authority of Technical Committee B/542, *Roofing and cladding products for discontinuous laying*. A list of organizations represented on these committees can be obtained on request to its secretary.

Supersession

BS 5427:2016 superseded BS 5427-1:1996, which has been withdrawn.

BS 5427:2016+A1:2017 supersedes BS 5427:2016, which is withdrawn.

Information about this document

BS 5427:2016 was a full revision of BS 5427. It took into account recent changes and developments in materials, components, cladding systems and design practice, such as sheeting profiles, surface coatings, fixing systems, thermal insulation, the use of liners, and alleviation of condensation.

Text introduced or altered by Amendment No. 1 is indicated in the text by tags A1 A1. Minor editorial changes are not tagged.

Use of this document

As a code of practice, this British Standard takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

Any user claiming compliance with this British Standard is expected to be able to justify any course of action that deviates from its recommendations.

It has been assumed in the preparation of this British Standard that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its recommendations are expressed in sentences in which the principal auxiliary verb is “should”.

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

1 Scope

This British Standard gives recommendations for the design and construction of external cladding assemblies for roofs and walls of buildings in the UK, using longitudinally profiled sheeting as the external surface, including standing seam. It is not applicable to profiled sheeting used as a supporting substrate, decking, structural liner trays, fully supported profiled sheets, structural composite formations of profiled metal sheeting and concrete, small element cladding or exceptional applications, such as buildings for cold storage.

The principal profiled sheeting materials covered by this British Standard are steel, aluminium, fibre cement, bitumen fibre and plastics, including insulated sandwich panel assemblies of profiled sheeting, thermal insulation and linings.

In addition to referencing performance recommendations, materials and components identified by other British Standards, advice on other materials and components which are in common use but not covered by other British Standards is also given.

This British Standard is intended for use by designers, manufacturers and installers of the roofing products.

A1 This British Standard includes profiled metal sheets which conform to the scope of BS EN 14782 but excludes profiled metal sheets used for structural purposes, which come within the scope of the BS EN 1090 series of standards. **A1**

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Standards publications

BS 476-3, *Fire tests on building materials and structures — Part 3: Classification and method of test for external fire exposure to roofs*

BS 476-6, *Fire tests on building materials and structures — Part 6: Method of test for fire propagation for products*

BS 476-7, *Fire tests on building materials and structures — Part 7: Method of test to determine the classification of the surface spread of flame of products*

BS 476-20, *Fire tests on building materials and structures — Part 20: Method for determination of the fire resistance of elements of construction (general principles)*

BS 476-21, *Fire tests on building materials and structures — Part 21: Methods for determination of the fire resistance of loadbearing elements of construction*

BS 476-22, *Fire tests on building materials and structures — Part 22: Methods for determination of the fire resistance of non-loadbearing elements of construction*

BS 476-23, *Fire tests on building materials and structures — Part 23: Methods for determination of the contribution of components to the fire resistance of a structure*

BS 5250, *Code of practice for control of condensation in buildings*

BS 5516-1, *Patent glazing and sloping glazing for buildings — Part 1: Code of practice for design and installation of sloping and vertical patent glazing*

BS 6100-0, *Building and civil engineering — Vocabulary — Part 0: Introduction and index*

- BS 6229, *Flat roofs with continuously supported coverings — Code of practice*
- BS 8219, *Installation of sheet roof and wall coverings — Profiled fibre cement — Code of practice*
- BS 8490, *Guide to siphonic roof drainage systems*
- BS 8530, *Traditional-style half round, beaded half round, Victorian ogee and moulded ogee aluminium rainwater systems — Specification*
- BS 9101, Steel and aluminium rainwater systems — Specification**
- BS EN 494, *Fibre-cement profiled sheets and fittings — Product specification and test methods*
- BS EN 506, *Roofing products of metal sheet — Specification for self-supporting products of copper or zinc sheet*
- BS EN 508-1, *Roofing and cladding products from metal sheet — Specification for self-supporting of steel, aluminium or stainless steel sheet — Part 1: Steel*
- BS EN 508-2, *Roofing products from metal sheet — Specification for self supporting products of steel, aluminium or stainless steel sheet — Part 2: Aluminium*
- BS EN 508-3, *Roofing products from metal sheet — Specification for self supporting products of steel, aluminium or stainless steel sheet — Part 3: Stainless steel*
- BS EN 534, *Corrugated bitumen sheets — Product specification and test methods*
- BS EN 544, *Bitumen shingles with mineral and/or synthetic reinforcements — Product specification and test methods*
- BS EN 612, *Eaves gutters with bead stiffened fronts and rainwater pipes with seamed joints made of metal sheet*
- BS EN 795, *Personal fall protection equipment — Anchor devices*
- BS EN 1013, *Light transmitting single skin profiled plastics sheets for internal and external roofs, walls and ceilings — Requirements and test methods*
- BS EN 1991-1-1, *Eurocode 1: Actions on structures — Part 1-1: General actions — Densities, self-weight, imposed loads for buildings*
- BS EN 1991-1-3, *Eurocode 1 – Actions on structures — Part 1-3: General actions — Snow loads*
- BS EN 1991-1-4, *Eurocode 1: Actions on structures — Part 1-4: General actions — Wind actions*
- BS EN 1993-1-3, *Eurocode 3 – Design of steel structures — Part 1-3: General rules — Supplementary rules for cold-formed members and sheeting*
- BS EN 10147, *Continuously hot-dip zinc coated structural steels strip and sheet — Technical delivery conditions*
- BS EN 12056-3, *Gravity drainage systems inside buildings — Part 3: Roof drainage, layout and calculation*
- BS EN 12865:2001, *Hygrothermal performance of building components and building elements — Determination of the resistance of external wall systems to driving rain under pulsating air pressure*
- BS EN 13162, *Thermal insulation products for buildings — Factory made mineral wool (MW) products — Specification*
- BS EN 13165, *Thermal insulation products for buildings — Factory made rigid polyurethane foam (PU) products — Specification*
- BS EN 13501-1, *Fire classification of construction products and building elements – Part 1: Classification using test data from reaction to fire tests*

BS EN 13501-2, *Fire classification of construction products and building elements — Part 2: Classification using data from fire resistance tests, excluding ventilation services*

BS EN 14509, *Self-supporting double skin metal faced insulating panels — Factory made products — Specifications*

BS EN 14782, *Self-supporting metal sheet for roofing, external cladding and internal lining — Product specification and requirements*

BS EN 62305-3, *Protection against lightning — Part 3: Physical damage to structures and life hazard*

BS EN ISO 6946, *Building components and building elements — Thermal resistance and thermal transmittance — Calculation method (ISO 6946:2007)*

BS EN ISO 10211, *Thermal bridges in building construction — Heat flows and surface temperatures — Detailed calculations (ISO 10211:2007)*

BS EN ISO 11600, *Building construction — Jointing products — Classification and requirements for sealants*

BS EN ISO 12944-2:1998, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 2: Classification of environments*

BS EN ISO 13788, *Hygrothermal performance of building components and building elements — Internal surface temperature to avoid critical surface humidity and interstitial condensation — Calculation methods (ISO 13788:2012)*

PD CEN/TS 16415, *Personal fall protection equipment – Anchor devices – Recommendations for anchor devices for use by more than one person simultaneously*

Other publications

[N1] THE ADVISORY COMMITTEE FOR ROOFSAFETY. ACR[M]001 – Test for non-fragility of profiled sheeted and large element roofing assemblies. Fourth edition. London, 2011.

3 Terms and definitions

For the purposes of this British Standard, the terms and definitions given in BS 6100-0 and the following apply.

NOTE Geometrical definitions of profiles are illustrated in [Figure 1](#).

Figure 1 — Geometrical definitions of profiles

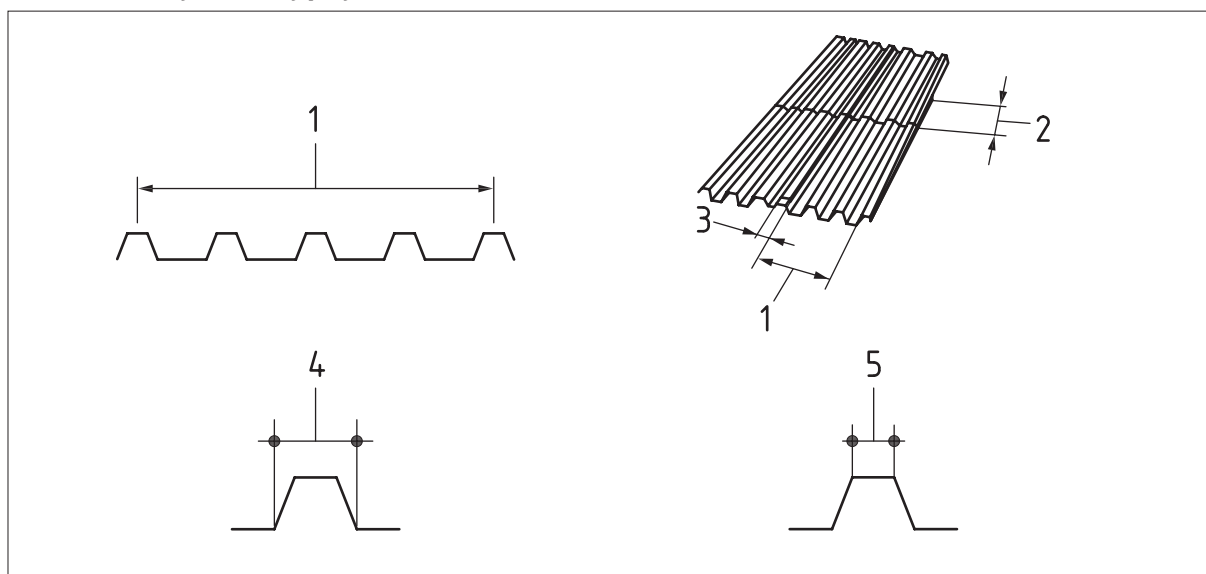


Figure 1 (continued)

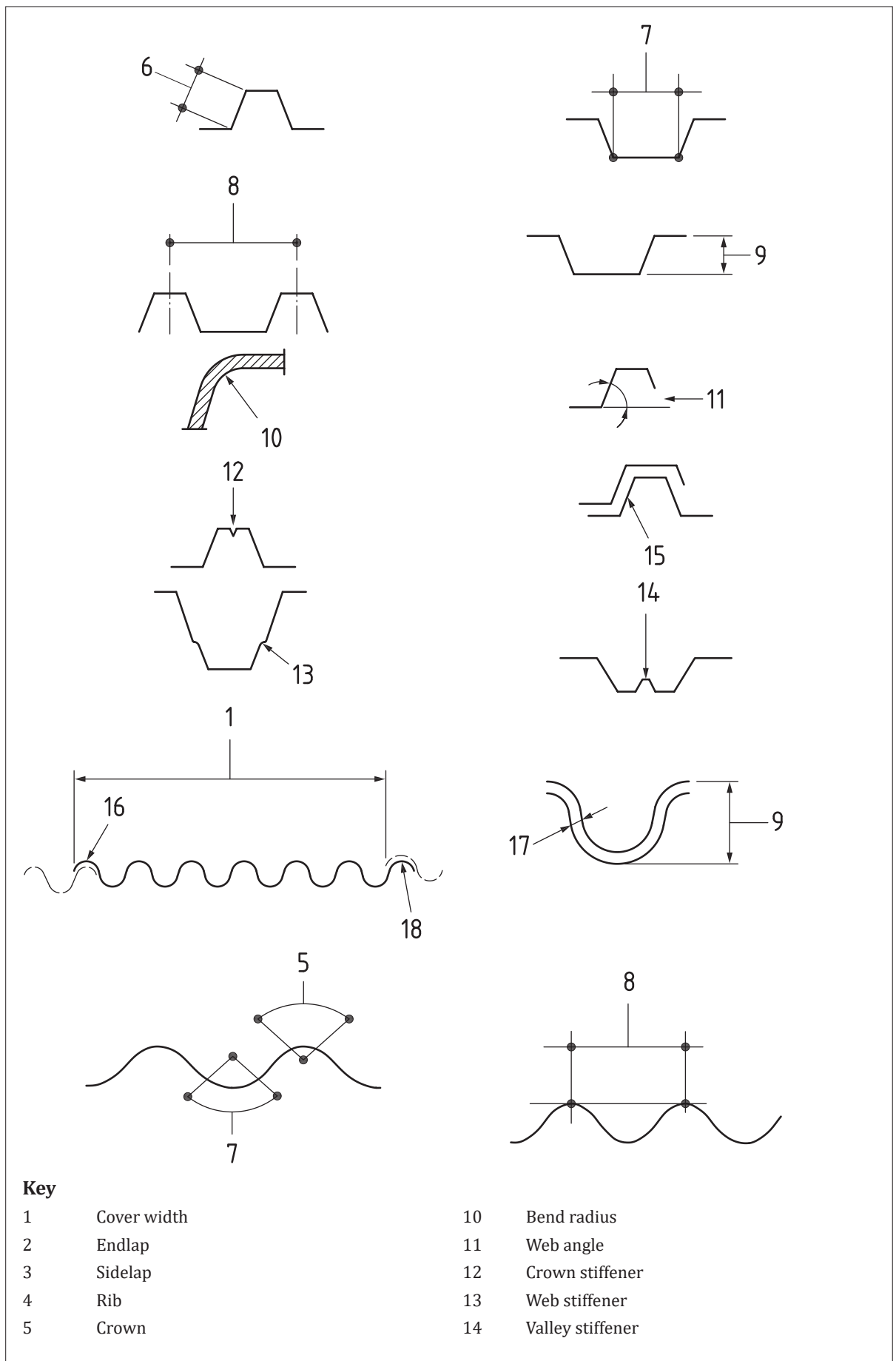


Figure 1 (continued)

6	Web	15	Supported side lap rib
7	Trough or valley	16	Overlap
8	Pitch	17	Thickness for fibre cement
9	Depth	18	Underlap

3.1 airtightness

resistance to passage of air through a building envelope

3.2 bonded panel

panel that consists of a flat or longitudinally profiled sheeting bonded to rigid insulation

NOTE For example polyisocyanurate (PIR) or mineral fibre.

3.3 cladding assembly

roof or wall covering system which can be a site assembly of liner, spacer and profiled sheeting elements together with insulation and vapour control layers, an insulated sandwich panel, composite panel or a bonded panel

3.4 dew point

temperature at which air becomes saturated with water vapour

3.5 fastener

connecting device for a fixing

3.6 fibre cement

cement reinforced with natural or man-made fibres

NOTE Where significant differences are evident between the different fibres used to reinforce the cement matrix these are detailed in this British Standard.

3.7 fixing

system of connection between two or more profiled sheets or between profiled sheets or accessories and a supporting structure

3.8 in-plane rooflight

translucent or transparent profiled sheet to match the surrounding profile and installed in the same plane as the surrounding profiled sheet that admits daylight into the building

3.9 insulated sandwich panel

self-supporting panel that consists of two parallel flat or profiled sheets separated by factory-filled insulation adhering to the profiled sheets

NOTE Also known as insulated composite panels.

3.10 non-rigid fastener

connecting device for fixings that, by the nature of their design, can permit thermal or other movement to take place between the connecting materials

NOTE Typical fasteners are hook bolts and bolts with elastomeric sleeves. Self-drilling and self-tapping screws can also be used where clearance holes or slots in the sheeting, together with purpose designed washers, allow movement.

3.11 out-of-plane rooflight

translucent or transparent product installed onto kerbs or upstands above the plane of the surrounding roof that admits daylight into the building

NOTE These products include dome, barrel vault, pyramid or flat glazing systems.

3.12 primary fastener

connecting device for a fixing that secures flat or profiled sheeting or lining to the supporting structure

NOTE The supporting structure could be the structural frame, sheeting rail or purlin, and any spacer system.

3.13 profiled sheeting

self-supporting sheeting, longitudinally formed with regularly spaced shapes of corrugated or trapezoidal cross-sections

NOTE This includes substantially flat sheeting with side lapping profiles, which can support load over a span.

3.14 rigid fastener

connecting device for a fixing that rigidly connects materials together

NOTE These are typified by self-drilling and self-tapping screws where any movement is accommodated by the connecting materials themselves, i.e. roof sheet and/or spacer or structure. No allowance for movement is required in the connection itself.

3.15 secondary fastener

connecting device for a fixing that secures the laps of profiled sheets to each other but not to the supporting structure and can be used to attach flashings and accessories

3.16 vapour control layer

material with water vapour resistance in excess of 200 MN·s/g

3.17 weathertightness

resistance of profiled sheet and walls to the penetration of precipitation and dynamic wind loads to the inside of the building

3.18 design life

DEPRECATED: intended service life; expected service life service life intended by the designer

NOTE As stated by the designer to the client to support specification decisions.

[SOURCE: BS ISO 15686-1:2011, 3.3]

3.19 service life

period of time after installation during which a facility or its component parts meet or exceed the performance requirements

[SOURCE: Adapted from DD ISO/TS 15686-9:2008, 3.4]

3.20 secret fix system

self-supporting metal profiled with virtually no through fixings

NOTE Various expressed as concealed fixing, standing seam, clip fix raised seam.

4 Design

4.1 General

The design of profiled sheet cladding systems for roofs and walls should include careful consideration of, but not limited to, the following factors:

- a) weathertightness (see [Clause 6](#));
- b) strength and rigidity (see [7.2](#));
- c) safety and non-fragility (see [7.3](#));
- d) control of condensation (see [7.4](#));
- e) thermal performance (see [5.7](#) and [7.5](#));
- f) air permeability (see [7.5](#));
- g) sound insulation (see [7.6](#));
- h) fire resistance and fire precautions (see [7.7](#));
- i) daylighting (see [7.8](#));
- j) appearance (see [7.9](#));
- k) durability (see [7.9](#));
- l) lightning protection (see [7.11](#));
- m) external attachments (see [5.11](#), [5.12](#), [5.13](#) and [5.14](#));
- n) maintenance, remedial work and renewal (see [Clause 8](#)); and
- o) all relevant harmonized standards quoted in this British Standard.

At the design stage the principal designer should define the methodology for erecting and fitting the cladding system on the building during construction.

Roof constructions should be capable of withstanding being walked upon without damage or failure. Roof constructions should also be designed to be classed as non-fragile (see [7.3](#)).

NOTE 1 Walkability and non-fragility are completely separate issues. See [7.3](#), Note 4.

NOTE 2 A roof assembly, if tested to ACR[M]001 [N1] and supported by [Annex C](#) from ACR[CP]001:2014 [1] can be regarded as a method of preventing a person from falling through the fully and finally fixed assembly. It does not necessarily indicate whether walking on the roof would damage the roofing product.

NOTE 3 Walkable refers to an assembly that when walked upon normally neither fails nor shows signs of physical damage.

NOTE 4 Attention is drawn to the Construction (Design and Management) Regulations 2015 [2] (see [7.3](#)).

NOTE 5 Minimum performance requirements for weathertightness, structural stability, air leakage thermal insulation, fire precautions and durability are laid down in the relevant Building Regulations for England [3], Northern Ireland [4], Scotland [5], and Wales [6]. More detailed performance criteria and other recommendations are discussed in this British Standard.

In addition to satisfying the employer's specification, the design should involve choosing from many alternative combinations of materials and systems for the profiled sheeting, surface finishes, thermal insulation, condensation control layers and linings, to best suit the technical and aesthetic requirements of the client.

Cladding products and systems should satisfy the relevant performance requirements and recommendations by reference to BS EN ISO 6946 and BS EN ISO 10211, or established methods of predictive calculations, including thermal performance and thermal bridging.

NOTE 6 Any subsequent painting, sealing or insulation could considerably change the intended performance of the roofing or wall system.

4.2 Weatherproofing properties of profiled roofing and wall cladding

A1 In selecting profiled roofing and wall cladding for its weatherproofing properties, the following criteria should be satisfied.

- a) It should have proven weatherproofing performance.
- b) It should have capacity to drain the run-off at the relevant roof slope and length from maximum rainfall without immersing the side lap.
- c) It should be satisfactorily side-lapped, and, where appropriate end lapped/jointed and sealed with sealant to form weathertight joints.
- d) It should allow fixings to be made to secure the sheeting against dead, imposed and wind loads.

Weatherproofing of a complete sandwich panel system should be tested in accordance with the test method of water permeability in BS EN 14509, when a test is recommended to conform to that standard. **A1**

NOTE 1 Recommendations for the strength and stiffness of profiled sheeting are given in [Annex C](#).

NOTE 2 Profiles for roofs are generally suitable for walls but the reverse might not be true due to the greater drainage capacity required for roof sheeting.

5 Components

5.1 Profiled sheeting

COMMENTARY ON 5.1

Profiled roofing and cladding systems are widely specified and used across a range of domestic and non-domestic buildings including agricultural, industrial and commercial, warehouses, education and leisure, healthcare, transport and infrastructure.

5.1.1 General

The profiled sheeting, the materials from which it is made and its use, should conform to the relevant British Standards as listed in [Table 1](#).

NOTE 1 Profiled sheeting is available in copper, coated steel, stainless steel, aluminium, zinc, fibre cement, and various plastics, in addition to the profiles covered by the British Standards listed in [Table 1](#). There are many other proprietary profiles and sheeting systems in common use, including standing seam or concealed-fixed cladding systems with wide troughs and narrow upstands for seamed, snap-on or sprung-fixed side lapping.

NOTE 2 All profiled roof sheeting is designated as fragile by Management of Health and Safety at Work Regulations 1999 [\[7\]](#) and Health and Safety at Work, etc. Act 1974 [\[8\]](#) unless fully installed in accordance with a method as tested by a competent person for determination of non-fragility in accordance with ACR[M]001 [\[N1\]](#). Guidance on health and safety regulations is given in HSG 33 [\[9\]](#).

NOTE 3 The maximum length of profiled sheeting available depends on the method of manufacture and the convenience of handling, transport and erection. Long lengths laid continuously over several supports reduce the number of end laps and risk of rain penetration.

NOTE 4 For further guidance on standing seam metal sheets for fully supported applications see BS EN 14783 and the relevant metal product standards.

Table 1 — *Harmonized European self-supporting profiled sheet standards*

Profiled sheet	Product material	Product standard (if different from harmonized standard)	Harmonized standard
Bitumen fibre	—	—	BS EN 544
Fibre cement	—	—	BS EN 494
Insulated sandwich panels	—	—	BS EN 14509
Metal	Aluminium	BS EN 508-2	BS EN 14782
	Copper and zinc	BS EN 506	—
	Steel	BS EN 508-1	—
	Stainless steel	BS EN 508-3	—
Translucent rooflights	Glass reinforced plastic, polycarbonate	—	BS EN 1013

5.1.2 Data on structural properties of profiled sheeting

The following properties of profiled sheeting or panels should be available where applicable for referencing during the design process:

- profile type and code, including profile dimensions, material thickness, with sketches of the cross-section;
- cover width;
- mass per unit area;
- moment of inertia per metre width at a specified stress;
- effective cross-sectional area per metre width;
- moment of resistance per metre width for both directions of loading;
- yield stress or 0.2% proof stress of material;
- modulus of elasticity of the material; and
- load-span tables stating the basis of the design.

Published load/span tables should be expressed as safe working loads, including:

- maximum allowable permanent loads and imposed roof loads or undrifted snow loads with specified deflection limits and maximum allowable concentrated imposed load;
- maximum allowable wind uplift loads, and where appropriate, the maximum allowable uplift limited by fixings or concealed attachment devices (e.g. clips, halters etc.) with specified deflection limits;
- maximum concentrated load or maximum span to meet concentrated load in [C.5.4.3](#);
- maximum allowable bending moment due to permanent load and drifted snow load; and
- maximum allowable bending moment due to permanent and exceptional snow load.

The maximum allowable loads should distinguish between values for single spans and equal or unequal continuous spans, with specified deflection limits.

NOTE For profiled metal sheets this British Standard covers products intended for use in constructions in accordance with BS EN 14782. Products for use in constructions in accordance with BS EN 1090-4 and Class I and Class II in accordance with BS EN 1993-1-3 intended to contribute to the global or partial stability of the building structure by providing racking resistance are not covered. Profiled sheets are available for these applications for example over-laid with concrete but in those applications more stringent structural properties are required in accordance with the Eurocodes. **A1**

Data on the impact resistance of wall sheeting for specified categories of public access should also be specified. Where the impact resistance relies on the composite action of the sheeting and substrate, details of the composite construction should be recorded.

5.1.3 Minimum roof pitch

The supporting structure should be designed at a pitch of 1.5° more than the minimum pitch specified by the client for the sheeting, to allow for tolerances and onsite variations, unless justified by more detailed structural analysis of the main frame and secondary steelwork to account for deflections/settlement.

To allow free drainage off the roof, the minimum finished roof pitch in all cases should be greater than or equal to 1° (2.5° design pitch).

Where through fixed trapezoidal profiled sheeting/sandwich panels are to be used roofs should be designed for a finished pitch of at least 4° (5.5° design pitch).

For very low pitch roofs of less than 4° (less than 5.5° design pitch), including the apex of a curved roof which approaches flat, endlaps should be avoided and secret fixed types of profiled sheeting or sandwich panels with raised side laps in continuous lengths should be used.

NOTE 1 Proprietary secret fixed roofing systems with properly engineered endlaps can be purchased where all aspects of performance have been proven by independent testing. The guidance for minimum recommended pitch of endlaps in these proprietary systems is outside the scope of [5.1.3](#).

NOTE 2 Complete proprietary roofing systems of both profiled sheeting, spacers, insulation, sealants and fasteners or sandwich panels with sealants and fasteners are available and can be purchased where all aspects of performance have been proven by independent testing. The guidance for minimum recommended pitch for these proprietary systems is outside the scope of [5.1.3](#).

Manufacturers should be consulted about the design and performance of the roof if the intended use of their proprietary systems is outside the scope of [5.1.3](#).

NOTE 3 Workmanship and quality of installation of roof systems becomes more critical as roof pitch decreases. The risk of leaks occurring as a result of small variations from system manufacturers recommendations (including specification and relevant position of fasteners and sealants and steelwork tolerances) increases as roof pitch decreases.

When specified, designed and installed all details and tolerances should be agreed between the system manufacturer, steelwork contractor and roofing contractor before installation.

NOTE 4 See SCI P346 [\[10\]](#) and MCRMA GD24 [\[11\]](#) together with MCRMA GD20 [\[12\]](#).

5.2 Built-up metal

5.2.1 General

Built-up metal based roofing and cladding systems are constructed on-site from a series of component parts and should provide a weatherproof structural envelope to the building. The built-up metal envelope should also perform an aesthetic function and an environmental function to separate the building's internal and external atmospheres. The component parts used in the construction and assembly of such systems should be specified to ensure individual elements are functionally

compatible with other associated components within the assembly. However, some elements might not be interchangeable and therefore the specifier should ensure that individual elements meet with the manufacturer's or system supplier's recommendations.

NOTE Layered built-up metal roofing and cladding systems offer many different design options. The specification of individual component parts (i.e. profile shape and material, insulation type, thermal performance, acoustic performance, construction detail and assembly) enables the specifier to tailor the system or assembly to meet the specification design parameters.

The performance should be tailored for the application by the specifier or building designer in consultation with the supplier and manufacturer.

5.2.2 Function

COMMENTARY ON 5.2.2

The primary function of a built-up roofing and cladding system is to provide a weather proof and thermal barrier to keep the weather out of the building and the internal environment in.

To meet the primary function the outer sheet of a built-up metal system should be effectively sealed at both side and end laps to ensure weathertightness from the outside.

NOTE 1 Effective seal may be achieved for example by use of sealants or from the inherent nature of the profile or by welding.

NOTE 2 Other functions can include meeting specified performance levels for air leakage, thermal, fire and acoustic performance, etc.

The liner sheet should be sealed to minimize air-permeability and perform as a vapour seal to minimize the risk of condensation within the construction (see 7.4.1).

NOTE 3 This can be achieved by sealing end and side laps or by use of a separate sealed vapour control membrane.

Where the liner is perforated a separate sealed vapour control membrane should be used. The liner sheets (and any vapour control membrane) should be sealed around the roof perimeter and all penetrations and roof lights.

In addition to the primary function of the built-up metal system the construction should be capable of providing structural capacity to support both dead and imposed design loads, which it might be subjected to during its functional life (see 7.2).

For buildings which are unheated such as agricultural storage sheds, some animal housing, certain warehouses and buildings where the internal processes generate excessive amounts of heat, the built-up system might take the form of a single skin construction; this type of construction should provide a structurally sound weather shield.

5.2.3 Fire

A1 Where insulated built-up metal systems with different levels of fire resistance are specified, the manufacturer's recommendations should be followed. **A1**

NOTE Fire performance might be specified to meet the relevant Building Regulations [3], [4], [5] and [6] and/or specifiers or insurers requirements.

5.2.4 Insulation

For buildings, built-up metal roof and cladding systems should include thermal insulation material of a type, quality and thickness to ensure adequate thermal performance.

NOTE 1 Minimum standards for thermal insulation are laid down in the relevant Building Regulations for England, Northern Ireland, Scotland, and Wales [3], [4], [5] and [6].

The insulation should be installed between the inner lining and external profiled sheet in accordance with the manufacturer's recommendations.

NOTE 2 Installed thermal insulation might also provide an acoustic benefit to limit noise attenuation between the inside and outside of a building (see 7.6).

Where specific acoustic insulation is needed, additional layers of acoustic material should be included in the construction to provide the necessary performance (see 7.6). Manufacturers should be consulted for specific advice and recommendations. Where additional layers of insulation need to be added to improve inherent acoustic performance it might be necessary to install the acoustic layer over a perforated liner; in this case a separate vapour control layer should be included on the warm side of the thermal insulation and in a position to ensure moisture from within the construction does not create a risk of condensation (see 7.4).

Condensation risk analysis, in accordance with 7.4.1, should be undertaken to ensure insulation layers are not subjected to the ingress of moisture and the temperature of surface layers are above the local dew point temperature.

5.2.5 Profile types

COMMENTARY ON 5.2.5

Built-up metal roof and wall constructions provide the opportunity to specify, within limits, the shape, form, structural strength and aesthetics of both the internal liner and the external profile. External profiles are available in a wide range of profile shapes which provide both an aesthetic and functional weather layer. External profiles are produced for both roof and wall applications.

Profiles with narrow ribs and wide troughs should be chosen for roof applications that enable the profile to shed rainwater. Wall profiles are produced with both wide and narrow external ribs and should be specified to meet structural and aesthetic needs.

External profiles are mostly manufactured in a factory but in some cases the roof profiles are manufactured on-site and close to the building for final installation; the latter should be used as the preferred method of manufacture for standing seam or concealed fix profiles, which are designed to minimize end laps for roofing applications.

NOTE Minimizing end laps increases individual sheet length and therefore the ease of transport and delivery might be an influencing or limiting factor. The cross-sectional shape of the manufactured profile or the method of attachment to the sub-structure usually defines the name of the profile. Profiles include: sinusoidal; trapezoidal; secret fix (including standing seam); and bespoke.

5.2.6 Performance

The structural performance of built-up metal roofing and cladding systems and its component parts should be determined and assessed in accordance with the recommendations contained in the following clauses:

- 7.2.6 and Table 9 and Table 10 for structure;
- 5.2.10.2 for metal liners;
- 5.8.1 for bracket and bar spacer kits;
- 7.2.7 for stressed skin;
- 7.2.8 for restraint to purlin; and
- 7.3 for safety and non-fragility.

5.2.7 Materials

Substrate material used to form the external profiles and the internal lining used in the assembly of built-up metal roofing and cladding systems should conform to the relevant British Standards in [Table 1](#).

NOTE The substrate material used can be steel, aluminium, stainless steel and other metals such as copper or zinc.

5.2.8 Coatings

NOTE 1 Depending upon the environmental application and aesthetic demands the substrate material (see [5.2.7](#)) can be uncoated or coated with either a metal sacrificial coating plus an organic coating for both the top surface and the underside surface.

The durability of the surface organic coatings should be determined in accordance with [7.9](#) and the relevant British Standard listed in [Table 12](#). The performance should be assessed in accordance with the manufacturer's declared values.

NOTE 2 Further information is available in [7.9](#), [Table 12](#) and [Annex A](#) on the durability of coated metal profiles when subject to various exposure conditions.

5.2.9 Position of thermal insulation in cladding

Roofs and walls should be classified into different types of design for thermal insulation and condensation control, according to the position in which the thermal insulation layer is placed, as shown in [Figure 2](#).

NOTE Warm roofs or warm walls, in which the principal thermal insulation layer is placed immediately inside the outer profiled sheeting, result in the supporting structure and any voids being at a temperature close to that of the interior of the building. The condensation risk plane is also at the outer face of the insulation.

Figure 2 — Schematic showing cross section of popular roofing and cladding systems

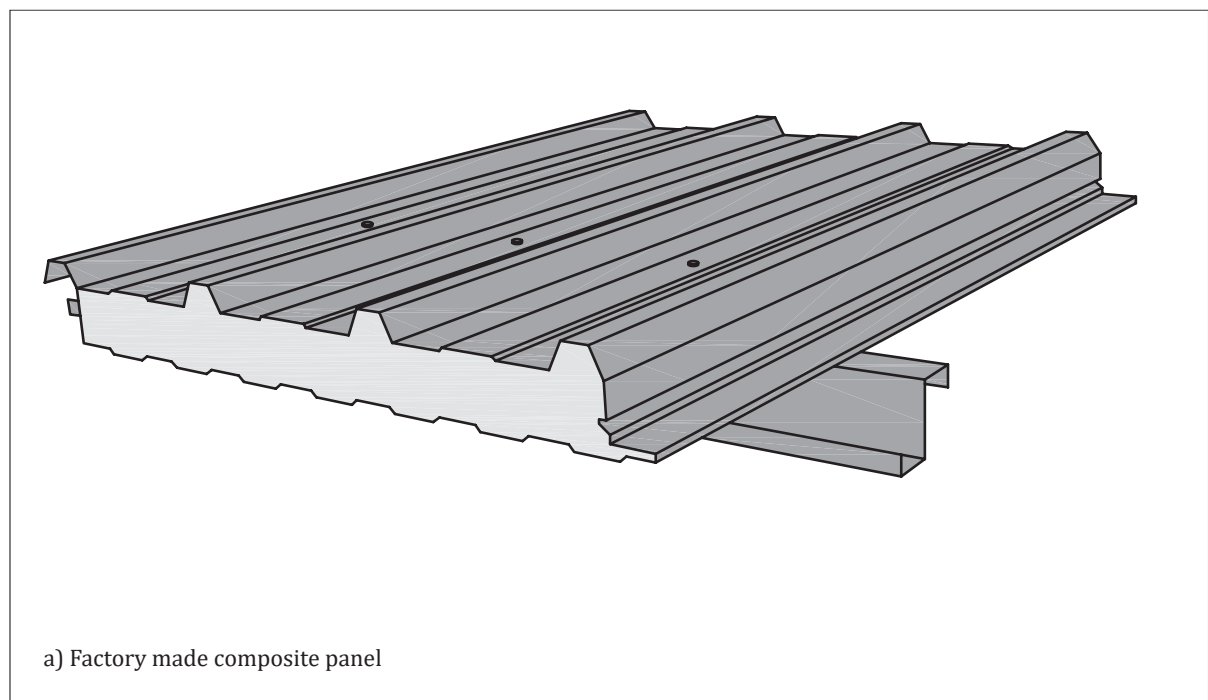
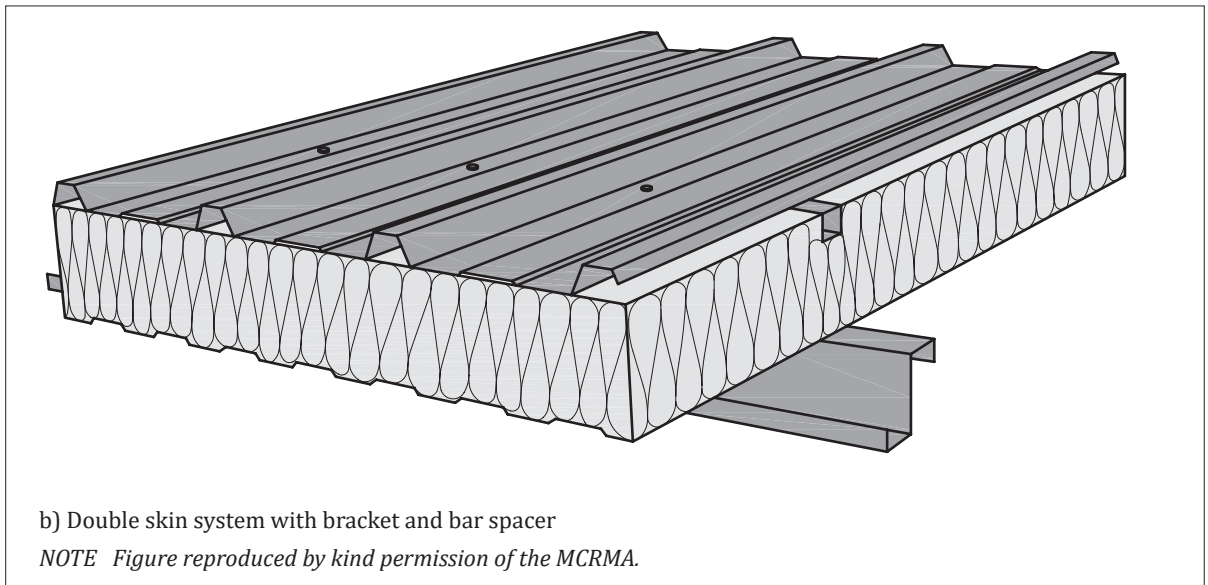


Figure 2 (continued)

5.2.10 Liner sheets

5.2.10.1 General

The structural stability of the liner system should have sufficient strength and stiffness to support its own weight, the dead weight of the insulation, the vapour control layer and other attachments.

Liners should be able to resist internal pressures from both wind suction and positive pressure in accordance with BS EN 1991-1-4 including appropriate allowance for any dominant opening. Where liners need to provide temporary cover to the building during construction before the cladding installation is completed, they should be able to resist wind loads of the appropriate return period in accordance with BS EN 1991-1-4, and any other construction loads.

Where the client requires a specific limit on air permeability, a sealed lining system should usually form either part of or the complete air barrier. An air barrier should extend over the whole of the element into which it is incorporated and should be integrated with and sealed to adjoining elements, such as junctions, penetrations and glazing systems, and any air barrier in those elements.

Where a manufacturer offers roofing and cladding systems as systems that meet the relevant Building Regulations [3], [4], [5] and [6] minimum requirements, evidence that the systems are fit for their intended purpose should be recorded.

5.2.10.2 Metal liners

COMMENTARY ON 5.2.10.2

Metal liners are available in the form of pre-coated profiled sheets of steel or aluminium, or in the form of liner trays that incorporate an integral spacer or structural element. Metal liners are usually used in conjunction with rigid foam or mineral fibre insulation. When used with sealed joints, metal liners can act as a vapour control layer and air barrier.

The purlin manufacturer should provide details of their minimum requirements for the provision of restraint to the supporting purlins, (see SCI P346 [10]).

Lighter weight metal sheets or shallower profiles cannot usually provide significant restraint to purlins; the designer should specify the cladding system accordingly where it is expected that purlin restraint is to be provided partially or fully by the cladding system.

NOTE Perforated metal liners might be used to reduce the volume of internally reflected sound. However, when perforated liners are included in the design they might not provide lateral restraint.

The liner manufacturer should provide details of their minimum fastener requirements for non-fragility (see 7.3).

5.2.10.3 Walkable and/or non-fragile liners

A1 COMMENTARY ON 5.2.10.3

Walking on roofs during the construction phase or to carry out maintenance poses a risk of falling and imparting an impact load on the roof.

Liner systems which are non-fragile and/or walkable are not essential but should be used wherever practicable. (There are benefits to having liner systems which are both non-fragile and walkable combining the benefits outlined in Note 1 and 2.)

NOTE 1 There are benefits to using liner systems which are non-fragile (but not necessarily walkable) as they allow safety nets to be removed at an earlier stage during construction. In addition during refurbishment work they might avoid the need for safety nets if the outer sheet is removed.

NOTE 2 There are benefits to using liner systems which are walkable (but not necessarily non-fragile) as they can provide a working platform during construction.

NOTE 3 Walkability and non-fragility are completely separate issues. Advice is available from the Advisory Committee for Roofsafety (ACR) website (www.roofworkadvice.info [last accessed 14 November 2017]) and in their publications, including the "Red Book" ACR[M]001 [N1].

NOTE 4 Walkability is not a clearly defined term and does not mean the same thing as non-fragility, so it is not related directly to safety: some roofs might be non-fragile (used with caution) but damaged by foot traffic or a falling person (necessitating repair) whilst others might be undamaged by foot traffic but could fail under the impact of a falling person (so fragile). **A1**

5.2.10.4 Rigid board liners

Rigid board liners of plasterboard and faced insulation have been superseded in most applications by self-supporting profiled liner sheets; where edge support for board type liners is required the board manufacturer's advice should be sought.

NOTE Liner systems based on panels of gypsum plasterboard or rigid insulation materials are available with galvanized T-bar supports and fixing straps.

The joints between the board and supporting T-bars, and gaps that occur where the lining is penetrated, e.g. at rooflights or ventilators, should be sealed in accordance with the manufacturer's instructions to prevent risk of condensation by reducing the entry of humid air into the roof cavity from inside the building.

5.3 Sandwich panels

COMMENTARY ON 5.3

Sandwich panels are building products consisting of two metal faces positioned on either side of a core that is a thermally insulating material and firmly bonded to both metal faces so that the three components act as a composite when under load. The most common insulating materials are polyisocyanurate (PIR) or alternatively mineral fibre (see Table 2).

Sandwich panels are available with a wide range of profiles, side joints, exposed fixings, concealed fixings, secret fixings and varying aesthetic appearance options for roof and wall cladding applications.

Trapezoidal or sinusoidal profiled through fixed sandwich panels, with over-lapping side joints and over-lapping end laps, can be installed on walls in horizontal and vertical applications.

Secret fix panels, with concealed fixings, with a male/female type interlocking joint, with heavy louvre profile, half round, lightly profiled or un-profiled (flat) external facings, are available for aesthetic options, and can be installed on walls in horizontal and vertical applications.

For aesthetic reasons, sandwich panel cover widths can be available with varying sizes for secret fix type panels with a male/female type joint designed to also conceal the primary fixings.

5.3.1 General

Sandwich panels when fixed to spaced structural supports should be capable of supporting – by virtue of their materials and shape – their own weight and all applied loadings (e.g. snow and wind) and also be capable of transmitting these loadings to the supports.

5.3.2 Function

COMMENTARY ON 5.3.2

The primary function of a composite sandwich panel roofing and cladding system is to provide a weather proof and thermal barrier to keep the weather out of the building and the internal environment in.

To meet the primary function the sandwich panel system should be effectively sealed at both side and end laps to ensure weathertightness from the outside.

NOTE 1 Effective seal may be achieved for example by use of sealants or from the inherent nature of the profile.

NOTE 2 Other functions can include meeting specified performance levels for air leakage, thermal, fire and acoustic performance, etc.

5.3.3 Fire

Where sandwich panels with different levels of fire resistance are specified the manufacturer's recommendations should be followed.

NOTE Fire performance might be specified to meet the relevant Building Regulations [3], [4], [5] and [6] and/or specifiers or insurers requirements

5.3.4 Roof applications

COMMENTARY ON 5.3.4

Trapezoidal or sinusoidal profiled through fixed sandwich panels with over-lapping side joints and over-lapping end laps can be installed for roof slopes down to 4° after deflection.

Pantile effect stamped/profiled through fixed sandwich panels with over-lapping side joints and over-lapping end laps can be installed for roof slopes down to 12° after deflection.

Recommendations for minimum pitch should be carried out in accordance with [5.1.3](#).

5.3.5 Performance

The deflection under a uniformly distributed load of sandwich panels in single, double and multi-span conditions should be determined by calculation and/or testing in accordance with BS EN 14509, and should be confirmed together with load/span tables by the manufacturer.

NOTE 1 See [7.2.6](#) and [Table 9](#) and [Table 10](#) for maximum permissible deflection for sandwich panels under distributed loads.

Panels with through fixings either with an exposed or a concealed appearance, or with attachments via a bracket or halter, concealed within the panel side joint, can provide restraint to the top flange of the roof purlin, and should be in accordance with the manufacturer's recommendations.

NOTE 2 See also 7.2.8 for restraint to purlin.

Sandwich panels should also conform to 7.3 for safety and non-fragility.

5.3.6 Facing materials

The facing materials used in the manufacture of sandwich panels should be in accordance with BS EN 14509.

5.3.7 Coatings

Surface coatings should be in accordance with 5.2.8.

5.3.8 Fixings and fasteners

Special designs of dual-threaded fastener should be used with sandwich panels for the primary locations, with an appropriate lower thread for fixing into the support member and a second larger diameter high-thread under the fastener head; the high-thread is to support the outer skin of the sandwich panel when combined with a bonded washer that contributes to long term weathertightness.

High-thread sandwich panel type fixings are generally not needed for secret fix wall applications, and the need for their use should be confirmed by the manufacturer.

Fasteners for sandwich panels should be selected according to the panel manufacturer's recommendations to suit the specific system and application.

NOTE Further information can be found in 5.9.

5.4 Rooflights

5.4.1 General

Rooflights save energy by allowing electric lights to be turned off; electric lighting systems should always be automatically controlled to realize the full potential benefits of available daylight (see 7.8).

NOTE 1 For many larger buildings (including most buildings with profiled sheeted roofs) windows are ineffective for much of the interior of the building, and rooflights are the only practical method of admitting sufficient daylight.

NOTE 2 Rooflights in well-designed buildings give a good spread of natural light and when used in conjunction with automatic lighting controls offer a dramatic reduction in a building's total energy consumption and in the associated CO₂ emissions. A naturally lit interior reduces building operating costs and provides a more pleasant environment than artificial lighting which can help people feel better and work more efficiently.

5.4.2 Rooflight layout and area

Rooflight layout and area should be designed to provide the best internal illumination levels, ensure ease of installation, reliability of weathertightness and safe roof access. The distribution of daylight within a building should also ensure that there are no dark areas and no direct solar glare; use of diffusing rather than transparent rooflights is recommended for this reason.

The rooflight area should be sufficient to minimize the use of the electric lighting system for as many hours per annum as possible, saving energy, operating costs and minimizing CO₂ emissions to conform to relevant Building Regulations [3], [4], [5] and [6].

A1 *NOTE 1 The Simplified Building Energy Model (SBEM) used for conformance to the relevant Building Regulations [3], [4], [5] and [6] incorporates a 12% rooflight area in the toplit notional building. For a typical large span building clad with profiled sheeting the total CO₂ emissions can increase dramatically if the rooflight area is*

reduced significantly below this notional level, and can be reduced if the rooflight area is increased above this value in many but not all circumstances. The optimum rooflight area for any particular building could be higher or lower than 12%, dependant on a number of factors including rooflight specification and light transmission, and desired illumination level; in many cases the optimal rooflight area for larger buildings is likely to be between 10% and 15% of the floor area. Full details are provided in NARM Technical Document NTD06.2 [13]. ^(A1)

NOTE 2 The best layout of in-plane rooflights in profiled sheeted roofs is often runs of rooflight from near the ridge to near the eaves, with opaque sheeting on either side. Special consideration is needed if rooflights are positioned within 1.5 m of ridge or eaves to ensure safe roof access and positioning of fall protection systems, resistance to accidental mechanical damage, satisfactory fixing of accessories such as ridge flashings and resistance to localized zones of high wind/snow load.

Factory assembled in-plane rooflights should generally not be installed in runs across the roof, with large numbers of rooflights adjacent to one another, as this would give a risk of cover width tolerances accumulating, making it difficult to fit the rooflights correctly

5.4.3 Thermal insulation of rooflights

Rooflights in heated buildings should always be specified to achieve a U value of at least $2.2 \text{ W/m}^2\text{K}$ or better; there should be a minimum of triple-skin rooflights, which should always be specified by the manufacturer and fitted to reduce heat loss and minimize condensation.

NOTE Attention is drawn to the relevant Building Regulations [3], [4], [5] and [6].

The U value should be calculated or tested to take into account any framing or glazing bars.

Manufacturers should be able to quote rooflight U values, and it should be reported and made clear whether quoted values are in the vertical or horizontal plane.

For out-of-plane rooflights this limiting value should be based on the developed area of the rooflight (U_d value) rather than the area of the rooflight aperture (see [14] for full details).

Patent glazing should be designed and detailed in accordance with BS 5516-1.

5.4.4 In-plane rooflight

In-plane rooflights (light transmitting sheets replacing one or more opaque profiled sheets in the roof) are generally suitable for use at finished roof pitches in accordance with the guidance on minimum pitch for through fix sheets given in 5.1.3; at lower pitches, out-of-plane rooflights should generally be used (see 5.4.5).

NOTE 1 Lighter weight in-plane rooflights are more flexible allowing them to deflect under loading to a greater extent without being damaged than those made from metal or fibre cement. This flexibility increases the reliance on good workmanship and the risk of poor workmanship causing problems at low pitch.

Heavier weight in-plane rooflights are available which are more rigid, offering improved compression of sealants and less deflection around fixings, ensuring there is no greater risk of poor workmanship resulting in any problems than there is with surrounding opaque sheets, and should be considered for use at low pitch.

The maximum deflection of the rooflights should meet the following criteria:

- a) At the design stage of wind suction loading, the deflection should be limited to $L/30$ (L = span) and be not greater than 50 mm to prevent fixing holes becoming oval, which could result in failure due to pullover or localized cracking.
- b) When subject to imposed snow loads, deflection should not exceed $L/30$ (L = span) and be not greater than 50 mm to avoid the disruption of sealants at end laps.

The deflection of the rooflights under self-load should not be so great that it creates a negative pitch, as this results in ponding, which leaves dirt deposits after drying which are unsightly and impair light transmission.

NOTE 2 Risk of ponding is affected by profile, pitch and rooflight specification, but is only likely at very low pitch, and is more likely on single span sheets which deflect further than multispan sheets.

Out-of-plane rooflights eliminate risk of this problem and should be considered for very low pitch applications

Site-assembled in-plane rooflights, consisting of an external sheet conforming to the roof sheet profile and a separate inner liner sheet conforming to the lining sheet profile, with a separate light transmitting insulating core, should generally be used with built-up profiled sheeting roofs (as detailed in [5.2](#)).

For site-assembled rooflights used in conjunction with sealed metal lining systems, the translucent liner should form an integral part of the vapour sealed liners, and therefore end laps and side laps should be sealed.

NOTE 3 Closures can be used between the sheet skins around the perimeter of the rooflights to prevent the ingress of insulation materials between the translucent panels.

Although in-plane plastic rooflights are available to match most metal and fibre cement sheet profiles, the availability of such rooflights conforming to BS EN 1013 should be confirmed with the manufacturer before specifying.

Factory-assembled in-plane rooflights consisting of an external sheet conforming to the profile of the composite panel, with a flat or profiled liner forming a box with an integral light transmitting insulating core should generally be used with profiled composite panel roofs (as detailed in [5.3](#)).

NOTE 4 The correct selection of site-assembled or factory-assembled rooflights is dictated by the roof construction: incorrect selection (e.g. use of factory-assembled rooflights in a built up roof, or site assembled rooflights in a composite panel roof) can increase risk of condensation in both the rooflight and surrounding roof (see [7.4.5.3](#)).

Although factory-assembled triple-skin units are more rigid than single-skin sheets, the manufacturer's recommended purlin centres should not be exceeded as any excessive deflection could strain or weaken bonding joints.

Factory assembled in-plane rooflights should generally not be installed in runs across the roof, with large numbers of rooflights adjacent to one another (see [5.4.2](#)).

NOTE 5 Purlin extension plates might be necessary at end lap positions in composite panel systems, including at end laps between composite panels and factory assembled rooflights (see [6.1](#))

Manufacturers should provide evidence of satisfactory performance with regard to manufacturing tolerances, proper nesting of end laps and side laps with appropriate metal or fibre cement sheeting, weathertightness, strength, light transmission, thermal insulation, solar heat input, condensation risk, fire rating and method of fixing.

NOTE 6 The deflection of rooflight liners with shallow depths that need to match the metal liner can determine purlin centres.

NOTE 7 The type and method of fasteners used to secure in-plane rooflights might be different to the surrounding opaque sheet. In particular, larger washers – typically 29 mm in diameter – and/or saddle washers might be needed (see [5.9.7](#)). Also, special sidelap fasteners might also be needed where a rooflight is the underlapping material (see [6.4.3](#)).

The method of installation of in-plane rooflights might be different to the surrounding opaque sheet (see [15] and 6.4 for guidance); detailed installation recommendations should always be sought from the manufacturer of the specific rooflight used, and should be followed.

NOTE 8 See BS EN 1013 for material and performance requirements in regards to corrugated sheets for translucent and transparent profiled rooflight sheets.

5.4.5 Out-of-plane rooflight

COMMENTARY ON 5.4.5

Out-of plane rooflights (bespoke designs to fit onto separate kerbs or upstands above the plane of the roof, such as barrel vault or dome rooflights) are available for use on any very low pitch, flat or curved roofs, or special applications (such as running along the ridge of a roof).

Detail of out-of-plane rooflights can vary from one manufacturer to another, and many systems and applications are bespoke; the relevant manufacturer should be consulted and their installation recommendations followed.

NOTE See BS EN 1873, BS EN 14963 and [16] for material and performance requirements for out-of-plane rooflights.

5.4.6 Rooflight materials and surface protection

COMMENTARY ON 5.4.6

In-plane and out-of-plane rooflights are both available in a number of alternative glazing materials, typically glass reinforced polyester (GRP) or polycarbonate. Some out-of-plane rooflights are also available in glass.

Plastics rooflights are classified as either thermosetting or thermoplastic. Thermosetting plastics, such as GRP, pass through a chemical action during manufacture and become permanently set. Polycarbonate are typical thermoplastics which soften when heated and can be remoulded into different shapes after manufacture.

All offer good properties as rooflight glazing materials when correctly applied, but each has different properties, affecting their suitability for specific applications. Detailed information on the different properties of these materials and their suitability for different rooflight applications is given in [17].

Guidance on expected durability is given in Table 15.

All plastic rooflights should be protected with an ultra-violet (UV) absorbing surface coating (see 7.9.4.2).

Rooflight materials should be compatible with surrounding materials; polycarbonate should be isolated from plastisol coated sheets and should not be allowed into contact with some specific sealant materials (see 7.10).

Thermal movement of rooflight materials can be greater than the surrounding opaque sheeting or the structure, and measures to accommodate this movement should be taken, particularly if long sheet lengths are specified (see 6.4 and 7.2).

To prevent damage during and after installation, the handling, drilling and fixing of polycarbonate in-plane rooflights should be carefully managed and the manufacturer's written instructions should be adhered to.

5.4.7 Condensation in rooflights

COMMENTARY ON 5.4.7

Rooflights are often not as well insulated as surrounding opaque roofing, so can be at a greater risk of condensation in certain circumstances; if condensation does occur, it is visible so can cause an aesthetic problem.

Particular care should be taken to alleviate the risk of condensation in rooflights (see [7.4.5.3](#)).

Where high internal humidities increase condensation problems, confirmation of the suitability of rooflights should be obtained from the manufacturer.

5.4.8 Structural performance of rooflights

Rooflights should be specified to resist relevant wind and snow loads (see [7.2](#)); correctly specified and fixed, they can generally resist loads as high as the surrounding opaque roof without a problem, although rooflights are significantly more flexible than surrounding sheet and should not be considered as part of a stressed skin construction (see [7.2.7](#)).

Rooflights or plastics sheet liners cannot usually provide lateral restraint to the supporting purlins or rails; they should only be used as such where confirmation is given by the designer that it is safe to do so.

Rooflights should be specified to ensure an assembly of the roof, including rooflights, achieves the same non-fragility classification as the roof without rooflights, otherwise the non-fragility classification of the entire roof is reduced (see [7.2.1](#) and [7.3](#)).

5.4.9 Solar gain

A1 Solar gain is often a benefit, countering any additional heat loss due to poorer insulation of the rooflight compared to surrounding opaque sheeting; however, care should be taken to avoid direct solar glare, or excessive solar gain which could lead to building overheating, especially if the rooflight area exceeds 15% of the roof or where there are particularly high process gains.

NOTE Many factors, including building geometry and use, rooflight specification (including total solar transmittance) and other internal gains affect building overheating risk. **A1**

5.4.10 Fire

NOTE Rooflights are generally available in a range of fire ratings to British or European standard to meet the various requirements of relevant Building Regulations [\[3\]](#), [\[4\]](#), [\[5\]](#) and [\[6\]](#), for both inner and outer skins of roof and wall.

The necessary fire ratings should be specified (see also [7.7](#)).

5.5 Fibre cement

5.5.1 Profiled fibre cement sheets for roofing applications should have sufficient profile depth to achieve the intended span length when tested in accordance with the method in BS EN 494; shallower profiles are only suitable for wall cladding.

5.5.2 On heated buildings, the fibre cement sheets should be installed over insulation which can be either self-supporting boards or laid on a supporting liner sheet, as recommended by the sheet and insulation manufacturers.

5.5.3 Roof sheets should have sufficient depth of profile to drain rain to the gutters without risk of leaks through side laps.

NOTE Roof sheets are available with integral fibre mesh to reduce the risk of collapse under impact loads.

5.5.4 The maximum permitted load and deflection should be determined in accordance with BS 8219 and be published by the sheet manufacturer. Fibre cement sheets should not be relied on to provide any bracing of supporting purlins or sheeting rails.

NOTE No calculation method exists for predicting the resistance to deflection of profiled fibre cement sheets with uniform or point loading.

5.5.5 Coatings on fibre cement sheets should be in accordance with [7.9.4.3](#).

5.5.6 Foam spray or retrospective coatings should only be applied with the agreement of the manufacturer.

NOTE Fibre cement sheets and their associated factory-applied coatings are vapour permeable, allowing the relatively free transfer of excessive moisture. Any subsequent coating or foam spray application that partially or fully seals the sheeting on one side only after installation of the roof, could be detrimental to this important characteristic and ultimately to the performance of the roof covering.

5.5.7 Fibre cement sheets should be fixed through clearance holes to allow for moisture movement of the material. A clearance of 2 mm greater than the fastener diameter should be allowed, unless installing proprietary self-drilling screws intended for fixing fibre cement with a self-cutting clearance are used.

5.5.8 The four way lap corners of fibre cement sheets should be cut to form mitred corners as recommended by the sheet manufacturer and guides to good practice (see [\[18\]](#)). Butyl strip sealants should be installed in the side- and end laps as required for the intended exposure conditions in accordance with BS 8219.

5.5.9 Flashings for fibre cement roof and walls are available in matching materials, and unlike other profiled materials the building envelope should be designed to use the factory-made standard range of flashing components (see [\[18\]](#)) and not to rely on bespoke shapes and sizes (see [5.11](#)).

5.6 Bitumen fibre

5.6.1 For roofing applications, corrugated bitumen sheets should be category R in accordance with BS EN 534 unless otherwise stated as suitable for use in the relevant climatic conditions in the sheet manufacturer's installation guide.

NOTE Category R or category S sheets can be used on wall cladding.

5.6.2 On heated buildings the corrugated bitumen sheets should be installed over insulation, which should be either self-supporting boards or laid on a supporting liner sheet as recommended in the sheet manufacturer's installation guide.

NOTE The use of corrugated bitumen sheets as an underlay to slate or tile roofs is not covered in this British Standard.

5.6.3 Category R corrugated sheets manufactured in accordance with BS EN 534 should have larger tested values than for category S for bending strength, impact performance and tear strength before and after freeze/thaw cycling.

5.6.4 The maximum permitted load and deflection should be determined by testing and published by the sheet manufacturer in accordance with BS EN 534.

NOTE 1 Bitumen sheets do not provide any bracing of supporting purlins or sheeting rails.

NOTE 2 No calculation method exists for predicting the resistance to deflection of corrugated bitumen sheets with uniform or point loading.

5.6.5 Bitumen sheets should not be installed in contact with materials that deteriorate due to chemical reactions with bitumen; for example, some plasticized polymer membranes.

NOTE Guidance on the expected durability of bitumen sheets is given in [Table 15](#). Durability can be improved by the factory application of a coating to reflect solar UV radiation. Coloured coatings can be factory-applied for aesthetic reasons.

5.6.6 Fasteners should be installed to allow for thermal movement as recommended by the sheet manufacturer's installation guide. The fasteners should have weather sealing washers and should only be of a type recommended in the sheet manufacturer's installation guide.

- 5.6.7** Unless recommended otherwise by the sheet manufacturer's installation guide for the intended application, the end laps of sheets, when unsealed, should be 200 mm long and side laps should be either one or two corrugations, normally unsealed.

5.7 Thermal insulation and moisture vapour control

5.7.1 Thermal insulation materials

COMMENTARY ON 5.7.1

The principal factors affecting the choice of insulating materials are:

- thermal resistance and required thickness;*
- vapour diffusion resistance;*
- strength and rigidity for use in conjunction with particular cladding systems;*
- chemical compatibility with associated cladding and fixing materials;*
- durability in service including condensation risks and exposure to extreme service temperature range;*
- thermal and moisture movement;*
- sound insulation value;*
- effect on fire performance of the cladding assembly; and*
- ease of handling, fixing and installation.*

The thermal resistance of profiled sheeting is small and makes an insignificant contribution to the total insulation value of the cladding system.

Suitable insulating materials for profiled roof and wall cladding systems include foamed plastics and mineral wool or glass fibre in a variety of rigid, semi-rigid and flexible forms; their typical thermal properties should be obtained from BS 5250. The thermal resistance of insulating materials generally reduces with increased moisture content and care should be taken when selecting the thermal resistance value appropriate to the equilibrium or service moisture content of the insulant during design. In addition, the thermal resistance of most types of foamed plastics reduces with age and similar care should be taken in selecting the appropriate long term value.

Foam spray or retrospective coatings should only be applied with the agreement of the manufacturer in accordance with [5.5.6](#).

Insulating material should be secured in place against downward slippage and gapping in steep roofs and walls, and wind dislodgement in ventilated cavities, to avoid local reductions of thermal insulation values in the roof or wall cladding system.

Thermal insulation materials should conform to the appropriate British Standards listed in [Table 2](#).

Table 2 — Common insulating materials for use with profiled roofing and wall cladding

Insulating product	Other common name	Harmonized standard
For use in built-up profiled systems		
Mineral fibre	Fibres of glass, rock or slag	BS EN 13162
Polyisocyanurate board	PIR board	BS EN 13165
For use in sandwich panels		
Mineral fibre	Fibres of glass, rock or slag	BS EN 14509
Polyisocyanurate insulation	PIR insulations	BS EN 14509 A1

5.7.2 Thermal transmittance

For a multi-layer cladding, the thermal transmittance U should be calculated in accordance with BS EN ISO 6946.

For sandwich panels the thermal transmittance U should be calculated in accordance with BS EN 14509.

Thermal transmittance U value of systems should be calculated including regular repeating thermal bridging by metal or other good conductors of the insulation layers, which includes fixings through insulated sandwich panels and spacers in built-up systems.

NOTE 1 BS EN ISO 10211 provides a calculation method using finite element analysis for calculating these effects where these effects are not covered by the method in BS EN ISO 6946.

NOTE 2 Guidance on assessing the effects of thermal bridging at junctions and around openings in the external elements of buildings and how to assess their overall heat loss is given in [19] using numerical analysis to the method of BS EN ISO 10211.

NOTE 3 BS 5250 gives data on the thermal resistance of air spaces and thermal conductivity of various cladding and insulating materials which can be applied to the thermal design of cladding.

NOTE 4 Attention is drawn to the relevant Building Regulations [3], [4], [5] and [6] and consideration of thermal comfort, conditions of use of the building and control of condensation.

5.8 Spacers

5.8.1 General

COMMENTARY ON 5.8.1

Spacer kits are used within built-up insulated roof and wall cladding systems to provide a cavity of a specified depth. The cavity is occupied by thermal insulation material and might also accommodate acoustic insulation. The spacer kit provides for the mechanical fastening of the external weather sheet and the transfer of imposed loads (including wind and snow loads) to the supporting structure.

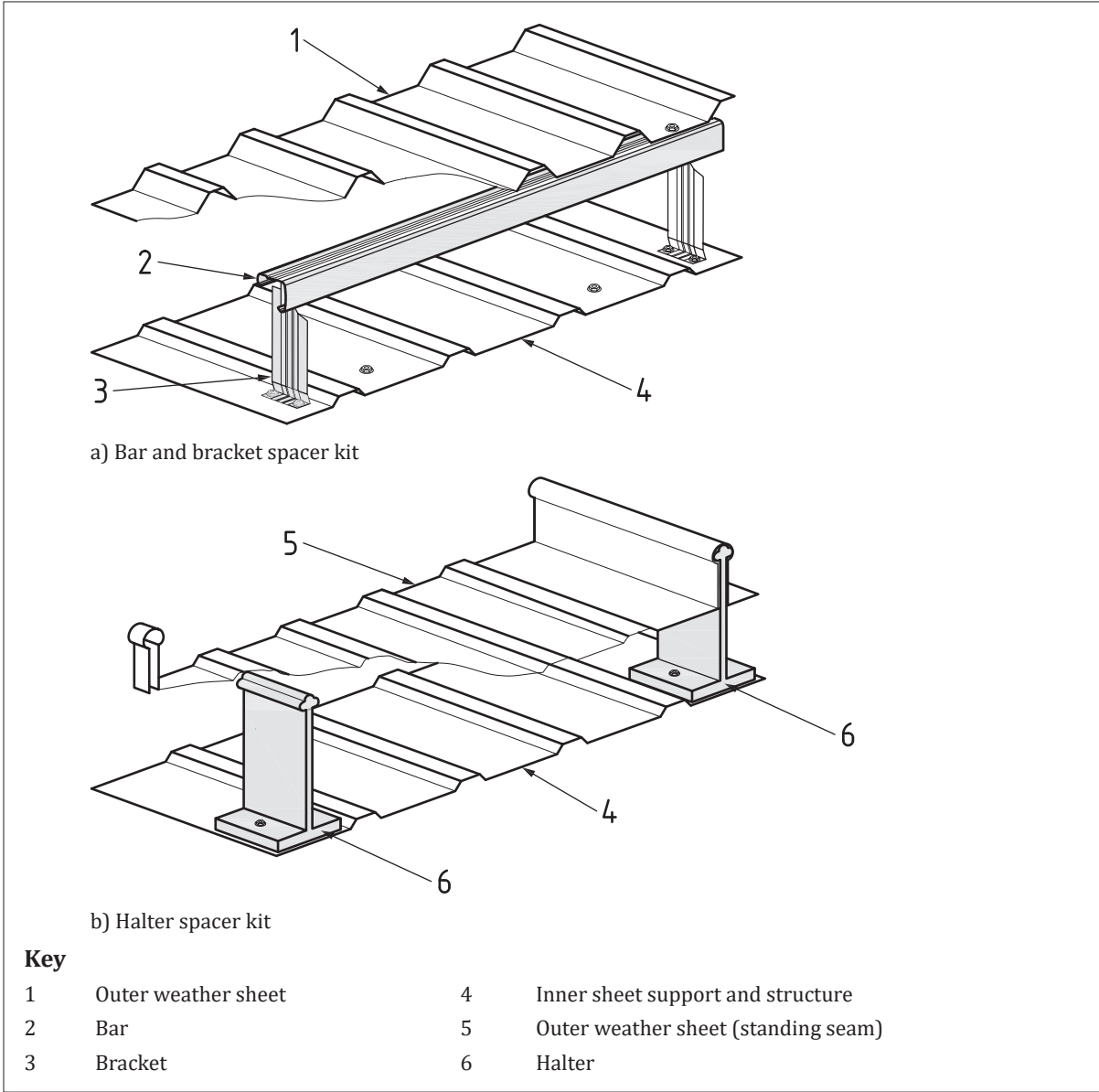
Various forms of spacer kit are available, but in all cases, their primary function is to hold the liner and outer sheets of the cladding system at a specified distance apart in order to create a void for the insulation material. Spacer kits are manufactured from a range of materials. A typical kit includes one or more of the following components: light gauge metallic brackets, bars, halters, sub-purlins and fasteners, and non-metallic components such as plastic blocks, knuckles and pads.

Spacer kits can generally be categorized as either bar and bracket or halter systems, as shown in [Figure 3](#), although other types also exist.

Spacer kits can be used to fulfil the following functions:

- connect the outer profiled cladding (weather) sheet to the supporting building structure underneath;
- provide a predefined cavity depth between the outer cladding sheet and the inner liner to accommodate the manufacturer's required thickness(s) of insulation. The cavity depth might also be needed to accommodate other materials in addition to thermal insulation, e.g. acoustic layers;
- transfer forces acting on the outer cladding sheet to the supporting building structure without excessive deformation or instability; and
- minimize thermal bridging to provide an effective thermal barrier between the outer sheet and the internal surface of the envelope.

Figure 3 — Bar and bracket and halter spacer kits



Spacer systems form repeating thermal bridges which should be included when calculating the thermal performance of cladding.

Spacers are located in the cladding system in a position exposed to interstitial condensation risk; spacers and associated fasteners should therefore be moisture and corrosion resistant, and components should be made of compatible materials.

Timber spacers should not be used with metal and polycarbonate profiles. Where used with fibre cement and/or bitumen fibre, timber spacers should be preservative-treated and dried before installation to avoid excessive shrinkage in service. Preservative treatment to timber spacers should be compatible with the sheet and associated materials (see also 7.10 for recommendations on the compatibility of materials).

5.8.2 Spacer performance

The performance of spacer assemblies should be tested or calculated in accordance with Annex E and for information on safety factors in accordance with Annex C.

NOTE 1 Users of this British Standard are advised to refer to accreditation certificates and manufacturers' technical data relevant to the conditions of use in the UK.

NOTE 2 The local environment in the cavity is usually non-corrosive for normal building applications, since the components of the spacer kit are protected from the external environment by the weather sheet and from the inner environment of the building by the liner. A vapour barrier may be included within the envelope if appropriate for the site conditions and building use.

Where corrosive conditions are expected in the cavity around the spacer, spacer and fastener materials should be selected that are resistant to the corrosion for the intended life of the building envelope.

Spacer rails should provide a support flange of adequate width, thickness and tensile strength to accommodate the designated fixings and provide a stable bearing surface to the underside of the weathering sheet. The bearing surface should provide support to the underside of the weather sheet sufficient to avoid local deformation of the weather sheet across the spacer rail under the design positive (downward) loading conditions. The rail should be sufficiently wide to accommodate the alignment of weather sheet fasteners.

In practice, a minimum bearing width of 40 mm is satisfactory for use with steel sheeting, although this should be increased to 50 mm when used with some aluminium materials.

The thickness and material grade of spacer rails should be sufficient to safely resist the pull-out action of the weather sheet fastener under negative wind loading conditions.

NOTE 3 The pull-out resistance is directly related to the tensile strength of the rail material and its thickness.

Advice on performance should be obtained from the supplier of the fastener or rail components.

NOTE 4 A minimum thickness of 1.5 mm is satisfactory for steel of Z22 quality, conforming to BS EN 10147, and a minimum thickness of 2 mm is satisfactory for aluminium with a minimum 0.2% proof stress of 180 N/mm².

NOTE 5 Various forms of spacer kit are available and are described in [Annex D](#) and [Figure 3](#).

5.9 Fixings and fasteners

5.9.1 General

Primary and secondary fixings should be selected and positioned so that they can secure the cladding system against dead, imposed and wind loads in service, maintain watertightness, are durable for the service life of the cladding and, in certain types, accommodate some thermal movement of the cladding.

The design load of the fixings should not be less than:

- a) the characteristic strength derived from [C.5.6.3](#), [Annex E \(E.6\)](#), with safety factors in accordance with those in [Annex C](#); and
- b) level of deformation at which there would be a risk of leakage.

NOTE 1 The strength of fixings can be determined by the method of test and acceptance levels as specified in [Annex E](#).

NOTE 2 The strength of a fixing is influenced by the combined behaviour under load of the fastener, washer and connected materials, and not merely by the strength of the fastener alone.

In the case of fasteners of the self-tapping or self-drilling type the thickness and strength of the material in which the screw thread is formed should be suitable for the particular fastener and be in accordance with the fastener manufacturer's recommendations for use under practical site conditions.

NOTE 3 Fastener manufacturers define the range of types, thicknesses and material strengths that each of their selfdrillers is suitable for and also, for selftappers, the required predrill hole diameter.

For a given fastener size and type applied to flexible sheeting (e.g. metal or plastics), the strength of crown fixings is usually less than trough fixings, due to limited buckling resistance of the profiled

sheeting under uplift load; large washers or saddle washers of adequate size and stiffness or sheet to support fasteners should be used to improve the strength of such fixings if required.

Exposed fixings should remain watertight under all maximum and various loading conditions. Therefore the sealing washers should be of adequate diameter, thickness, softness and strength to accommodate these loading conditions and, additionally, where thermal movement is a potential condition, they should maintain a seal over any oversize holes or potential localized slotting or distortions.

NOTE 4 Fixings on the sheeting can affect the external appearances of the building.

The size, shape, colour, numbers and positioning of cladding fasteners and washers in relation to the type of profiled sheeting might significantly affect the performance and external overall appearance of the building, particularly walls and steeply pitched roofs, and should be included in the design.

To avoid unsightly inward dimpling of flexible sheeting around fasteners, firm backing support to the sheeting at the fixing positions should be provided.

5.9.2 Fasteners

COMMENTARY ON 5.9.2

Proprietary fasteners have been developed, particularly self-drilling screws, rivets, washers and colour heads, to meet the fixing requirements of single layer and multi-layer cladding systems incorporating components which might include a combination of thermal and acoustic insulation, condensation and air control layers, spacing systems and internal linings.

When correctly installed, self-tapping screws and self-drilling screws should have hardness to form threads and, in the case of self-drilling screws, drill through the material and thicknesses of the profiled sheeting and structural element to be connected without stripping the threads in the fasteners or connected element.

Fastener and cladding manufacturers should be consulted on the choice of fasteners for the cladding design and the suitability of fasteners should be evaluated by examining the available performance data.

NOTE 1 In general, fasteners cannot be replaced during the life of the building as part of any routine maintenance.

NOTE 2 Examples of fasteners are illustrated in [Figure 4](#). [Annex E](#) gives methods for determining the strength of fasteners and fixings.

The fastener material should be able to resist corrosion for a period comparable to the functional life of the sheeting, including any over-painting in the intended environment of use.

NOTE 3 Fasteners are available in a range of materials including coated carbon steel, various grades of stainless steel and aluminium.

NOTE 4 BS EN ISO 6988 specifies a method of test on the appearance of rust after exposure to an alternating atmosphere containing sulfur dioxide, and BS EN ISO 9227 for an atmosphere combining salt spray. These are used for evaluating the corrosion resistance of fasteners.