The Building Envelope Authority

Guidance Documents

January 2022

GD39 SUSTAINABILITY AND DURABILITY OF METAL ROOFING AND CLADDING SYSTEMS

SECTION 1: INTRODUCTION AND OVERVIEW

1.1 Introduction

Over the past 40 to 50 years there has become an ever-increasing awareness of environmental issues and the need for sustainable development. At an international level, commitments to climate change, reduction of greenhouse gases and keeping global temperature rise this century below 2°C (preferably 1.5°C) above pre-industrial levels have been agreed. National action plans, known as Nationally Determined Contributions (NDC), on how countries will achieve this target were reviewed at the COP26 conference in Glasgow in November 2021. The UK government has made a commitment to reduce greenhouse gas emissions by at least 100% of 1990 levels (Net Zero Carbon) by 2050.

As the construction industry has an important role to play in delivering sustainable development this has led to changes in Building Regulations in relation to conservation of fuel and power with the main emphasis being on the progressive reduction of carbon dioxide (CO_2) emissions from buildings. There are also initiatives such as Zero Avoidable Waste (ZAW) in construction which is aimed at the overall reduction of waste, and the minimisation of waste to landfill to improve material resource efficiency and which can play a significant role in national carbon reduction targets.

Often there will be a desire that the sustainability and environmentally friendliness of a building goes beyond the basic requirements of building regulations. The use of an environmental assessment methodology or rating system (e.g., BREEAM, LEED etc.) can assist in the design and construction of more sustainable buildings which are more energy efficient, climatic responsive, material and resource efficient, have healthier indoor environments for occupants and limit waste emissions and pollution.

To help achieve these targets there is also the need for having buildings built for durability with long design lives and utilising materials, products and systems to construct them that can match the desired design life.

Metal roofing and cladding systems and their associated components can significantly contribute to achieving a sustainable building envelope solution to meet both current and future needs and requirements, thanks to their low maintenance, durability, high recycled content, recyclability and energy efficiency. MCRMA members can offer total sustainable building design solutions thanks to a range of complementary components and systems which include sustainable high performance thermal and acoustic insulation products; high durability fixings, fillers, sealants and membranes; daylight options to maximise the transmission of natural light into buildings; flexible solar PV options and fastening systems; and ‘green’ and ‘brown’ roof options.

Steel and aluminium are the most common materials used in metal building envelopes and offer significant advantages when considering the entire system life cycle. They are produced from materials that have high recycled content from both pre-consumer and post-consumer scrap and can both be reused or recycled repeatedly without losing their qualities as a building material. Percentage wise, recovery rates of metals are in the high 90s.

1.2 Aims, scope and structure of this guidance document

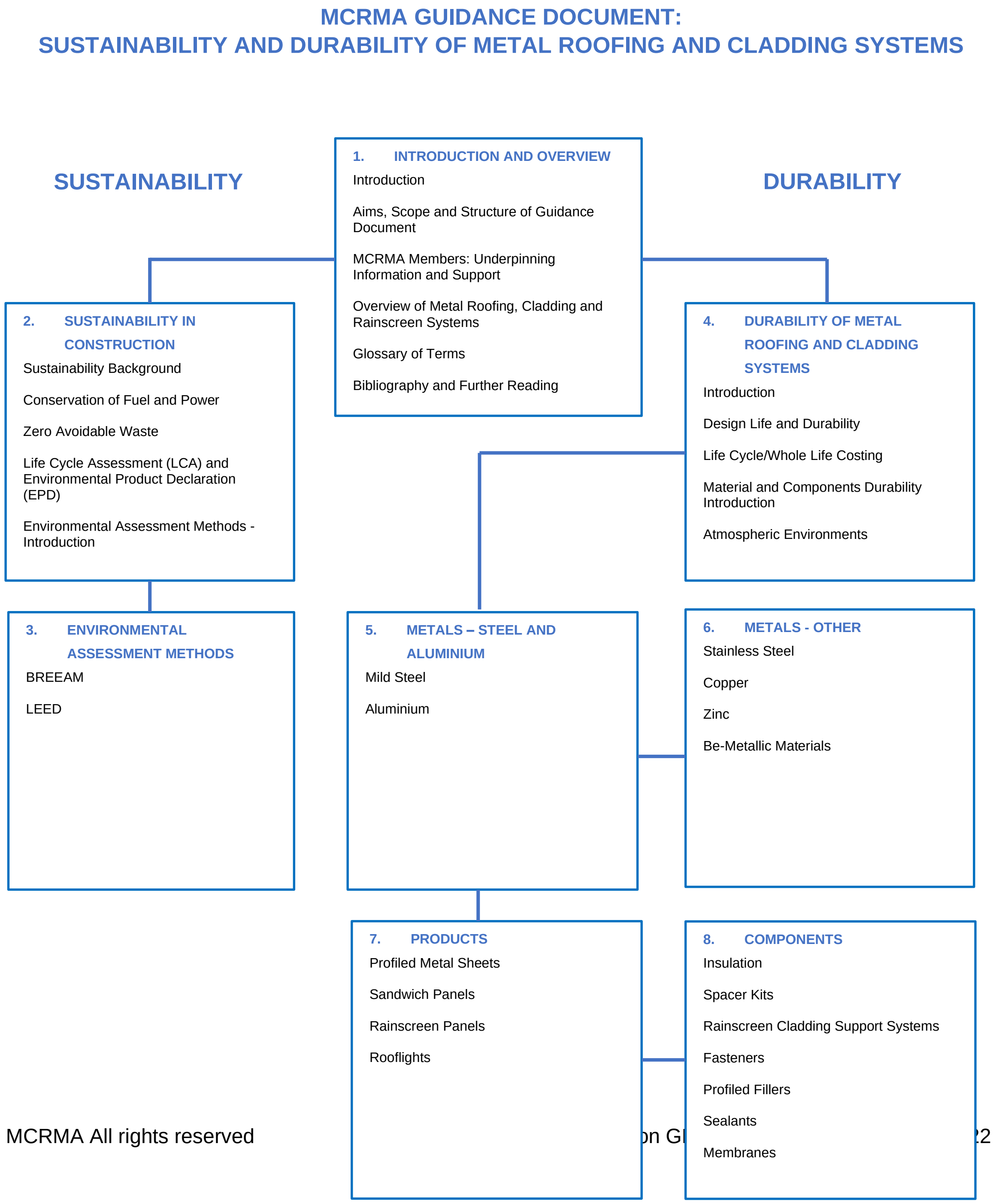
This MCRMA Guidance Document will focus on sustainability from a ‘fabric first’ approach where the metal building envelope provides a long-lasting solution which can be future proofed for potential changes of use of the building. This will include typical materials used in MCRMA members’ products and systems looking at factors such as durability, maintenance, limitations in use (e.g., corrosive influences etc.). There will be an overview of types of products and components and how they are used to form systems for given applications to meet specific project specifications and requirements.

The document will also give a brief overview of the background, external influences and drivers for sustainability e.g., international awareness, client requirements, building regulations and environmental evaluation schemes. Life cycle assessments (LCA) and environmental profiling of products will be covered in greater detail together with some environmental accreditation schemes particularly those credits which can be influenced by metal roofing and cladding systems e.g., BREEAM, LEED etc.

The role that MCRMA member companies and their systems can support, contribute to, and enhance a construction project's sustainability objectives and requirements including the type of information, approval, and certification available that can demonstrate the sustainability credentials of the company itself and their products will also be examined.

As there is a natural split between sustainability and durability topics the MCRMA Guidance Document is published as a suite of eight standalone sections each of which covers specific but interrelated subjects.

A pictorial overview of the structure giving an overview of the content, hierarchy and linkages is shown in figure 1.1.



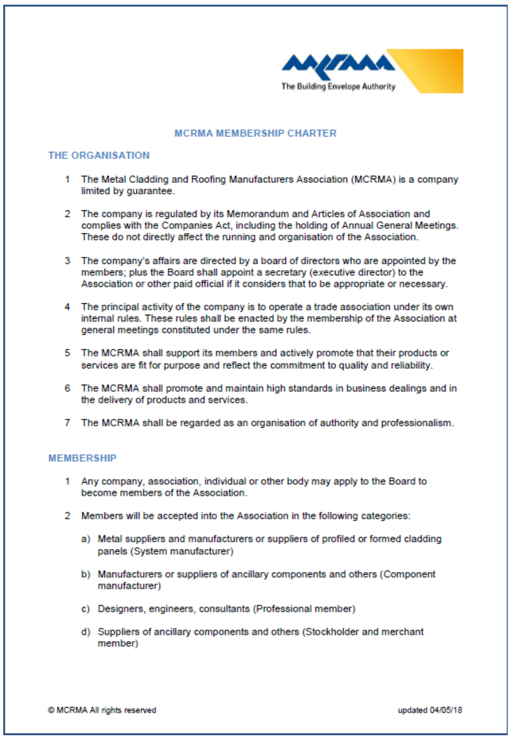
1.3 MCRMA members: Underpinning information and support

This chapter provides a brief overview of the type of information, approval, and certification available from MCRMA member companies that can demonstrate their own environmental and sustainability credentials of the company itself and of their products.

1.3.1 MCRMA members

In the MCRMA membership charter, figure 1.2, there is an environmental ethics section in which the MCRMA undertakes to ensure that:

1. Members have regard for environmental issues during procurement, delivery (including installation implementation) and waste disposal.
2. Members strive to minimise adverse environmental impact in the provision of their products and/or services.



MCRMA MEMBERSHIP CHARTER

THE ORGANISATION

1 The Metal Cladding and Roofing Manufacturers Association (MCRMA) is a company limited by guarantee.

2 The company is regulated by its Memorandum and Articles of Association and complies with the Companies Act, including the holding of Annual General Meetings. These do not directly affect the running and organisation of the Association.

3 The company's affairs are directed by a board of directors who are appointed by the members; plus the Board shall appoint a secretary (executive director) to the Association or other paid official if it considers that to be appropriate or necessary.

4 The principal activity of the company is to operate a trade association under its own internal rules. These rules shall be enacted by the membership of the Association at general meetings constituted under the same rules.

5 The MCRMA shall support its members and actively promote that their products or services are fit for purpose and reflect the commitment to quality and reliability.

6 The MCRMA shall promote and maintain high standards in business dealings and in the delivery of products and services.

7 The MCRMA shall be regarded as an organisation of authority and professionalism.

MEMBERSHIP

1 Any company, association, individual or other body may apply to the Board to become members of the Association.

2 Members will be accepted into the Association in the following categories:

a) Metal suppliers and manufacturers or suppliers of profiled or formed cladding panels (System manufacturer)

b) Manufacturers or suppliers of ancillary components and others (Component manufacturer)

c) Designers, engineers, consultants (Professional member)

d) Suppliers of ancillary components and others (Stockholder and merchant member)

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Figure 1.2 – MCRMA Membership Charter

To this end each manufacturing and supplier member operates their own environmental management system (EMS) which are third party accredited to ISO 14001 and which operates alongside their third-party accredited quality management system (QMS) to ISO 9001.

An overview of a company's EMS objectives will be contained in their environmental policy statement which outlines their company's responsibilities, aims and commitments to operate in an environmentally sound manner; comply with all legal requirements; reduce waste, pollution and environmental impacts; and regularly monitor, review and undertake improvements.

MCRMA manufacturing and supplier members are committed within their own QMS to ensure that all primary materials will be sourced from companies also operating a QMS to ISO 9001 and that there is full traceability of materials or products in relation to a project. They will provide, on request, certificates of origin and product conformity for the primary materials from which the products are manufactured.

Some member companies are also certified to BES 6001 – *BRE Framework Standard for Responsible Sourcing* which is a third part assessed and certified scheme covering the management of responsible sourcing of products and the reduction of environmental impacts throughout the supply chain.

Copies of individual members environmental policy statements, together with their third-party accredited EMS, QMS and other certification are usually made available for viewing on their websites or can be provided by direct contact with the individual member company.

1.3.2 MCRMA members products and systems

MCRMA members can provide third party assessed Life Cycle Assessments (LCAs) and EN 15804 compliant Environmental Product Declarations (EPDs) for their products and systems to assist designers and specifiers to obtain points and credits data to be within environmental rating and certification schemes such as BREEAM and LEED. These are covered in greater detail in Sections 2 and 3 of this Guidance Document.

Several MCRMA members publish their own information sheets of how their products and systems can contribute towards points and credits within the environmental rating and certification schemes.

Products manufactured or supplied by MCRMA member companies comply with the Construction Products Regulations (CPR) and where appropriate are CE Marked in accordance with a recognised assessment procedure or harmonised standard (e.g., BS EN 14782:2006 – *Self-supporting metal sheet for roofing, external cladding and internal lining. Product specification and requirements*). Not all products are required to be CE marked; but products which are covered by a harmonised European standard or a European Assessment Document (EAD), along with an associated European Technical Assessment (ETA), will have specific legislation that requires it.

A CE mark on a building product is a declaration by the manufacturer that their product is compliant with the CPR and shows that the product complies with all the relevant European legislation covering the product's health, safety or environmental requirements. The compliance will be the form of a Declaration of Performance (DoP) and provides information on the performance against the European harmonised standard or for which a European Technical Assessment (ETA) has been issued.

There will be a transition from CE marking to the new United Kingdom Conformity Assessed (UKCA) mark from 1st January 2023. The UKCA (UK Conformity Assessed) marking is a UK product marking that will be used for goods being placed on the market in Great Britain (England, Wales and Scotland). It covers most goods which previously required the CE marking. The UKCA marking alone cannot be used for goods placed on the Northern Ireland market, which requires the CE marking or UK (NI) marking.

Further information on CE Marking and the transition to UKCA marking can be found at https://mcrma.co.uk/ce-marking/

Products and systems not directly covered by British, European and/or International Standards will usually have a third-party approval e.g., British Board of Agrément (BBA), see figure 1.3 for an example. As well as looking at the product/system performance the approval also assesses the manufacturer's production processes and quality management systems.

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Agrément Certificate
19/5671
Product Sheet 1

NVELOPE RAINSCREEN SYSTEMS

NVELOPE RAINSCREEN CLADDING SUPPORT SYSTEMS

This Agrément Certificate Product Sheet [1] relates to Nvelope Rainscreen Cladding Support Systems, for use as a sub-frame to support cladding on the external or internal wall structure of new or existing buildings.

(1) Hereinafter referred to as 'Certificate'.

CERTIFICATION INCLUDES:

- factors relating to compliance with Building Regulations where applicable
- factors relating to additional non-regulatory information where applicable
- independently verified technical specification
- assessment criteria and technical investigations
- design considerations
- installation guidance
- regular surveillance of production
- formal three-yearly review.

KEY FACTORS ASSESSED

Mechanical resistance and stability — the systems can be designed to support the cladding and to transfer the design loads to the substrate wall structure safely (see section 6).

Behaviour in relation to fire — the systems (fixings, brackets, rails, carriers and adaptors) have an A1 reaction to fire classification in accordance with the national Building Regulations (see section 7).

Drainage and ventilation — provided correct details are adopted, the systems can provide adequate drainage and ventilation behind the cladding (see section 8).

Durability — the systems will have a service life in excess of 35 years (see section 10).

The BBA has awarded this Certificate to the company named above for the systems described herein. These systems have been assessed by the BBA as being fit for their intended use provided they are installed, used and maintained as set out in this Certificate.

On behalf of the British Board of Agrément

Date of First issue: 24 June 2019

Paul Valentine
Technical Excellence Director

Claire Curtis-Thomas
Chief Executive

The BBA is a UKAS accredited certification body – Number 113.
The schedule of the current scope of accreditation for product certification is available in pdf format via the UKAS link on the BBA website at www.bbacerts.co.uk
Readers are advised to check the validity and latest issue number of this Agrément Certificate by either referring to the BBA website or contacting the BBA direct.
Any photographs are for illustrative purposes only, do not constitute advice and should not be relied upon.

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Page 1 of 16

Figure 1.3 – Example of BBA Certificate

Typical examples of products/systems which have BBA approvals (or other third-party approval scheme) are metal profiled secret-fix and standing seam systems, rainscreen panel systems, rainscreen cladding support systems, coil coated finishes, breather membranes, vapour control layers etc. The third-party approval typically gives advice on compliance with building regulations, use, installation, performance (e.g., structural and hygrothermal), maintenance, durability and recyclability.

Copies of EPDs, DoPs, approval certification etc. are usually provided by direct contact with the individual member company although some may be made available for viewing on their websites.

1.4 Metal roofing, cladding and rainscreen systems

Metal roofing, wall cladding and rainscreen panels and their associated components are used to form systems for given applications to meet specific project specifications and requirements and can significantly contribute to achieving a sustainable building envelope solution to meet both current and future needs and requirements.

The following looks at some of the main forms that these systems take and how built-up systems, in particular, can be enhanced thermally and acoustically to provide long lasting building envelope solutions which can be future proofed for potential changes of use of the building and potential energy efficiency requirements.

Other sustainability enhancements, such as incorporation of photovoltaic (PV) panels, green roofs and cool roofs are also commented on.

1.4.1 Sandwich panel systems

Sandwich panels, also known as composite panels, are factory produced assemblies consisting of an inner and outer sheet of metal bonded to an insulation core. They are installed basically as a single product which can enable speed of installation. They can be used for roofing, see figure 1.4, or wall cladding. In roofing applications, they are used on pitched roofs and large radius curved barrel roofs.

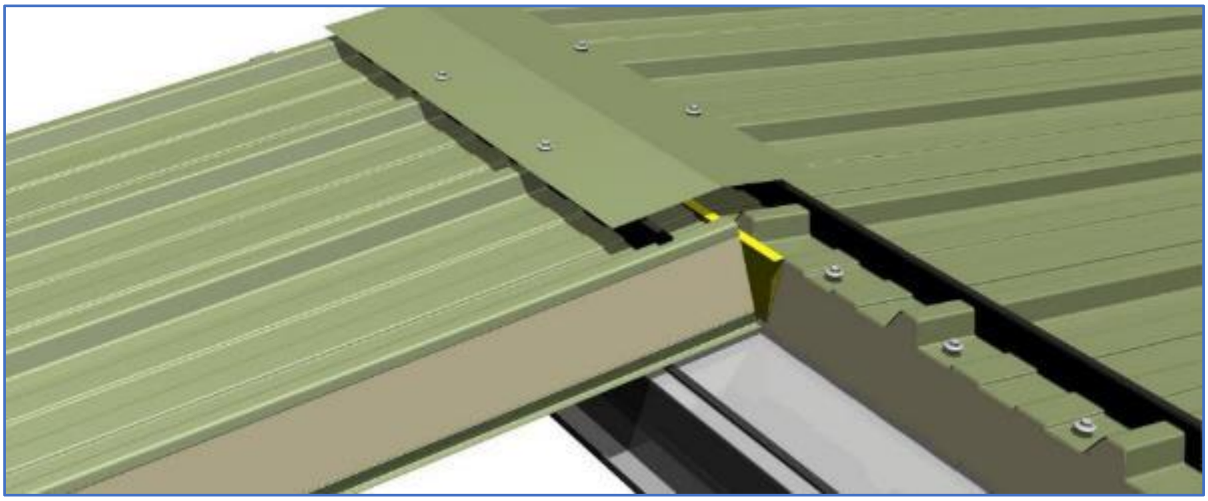


Figure 1.4 – Insulated sandwich panel installed in pitched roof application

The insulation core is predominantly polyisocyanurate (PIR) although when a wall cladding requires a higher level of fire performance mineral fibre cored panels are available. Sandwich panels are available in a variety of depths each offering varying levels of thermal performance. U-values as low as 0.14 W/m^{2}K can be achieved with PIR insulated panels of approximately 150 mm deep (core depth, not including profiled ribs).

As metal sandwich panels are relatively lightweight and rigid, their ability to reduce sound transmission and provide sound absorption properties can be limited. The acoustic properties could be increased by incorporating an additional profiled perforated metal sheet with mineral wool insulation on the inner face of the panel or supporting steelwork.

In-plane factory assembled insulating rooflights (FAIRs) can be incorporated into sandwich panel roofs to provide daylighting requirements making efficient use of natural light and reducing the reliance on artificial lighting, see figure 1.5. Materials such as GRP act as a diffuser giving a more even spread of light and reducing glare and localised heat build-up.

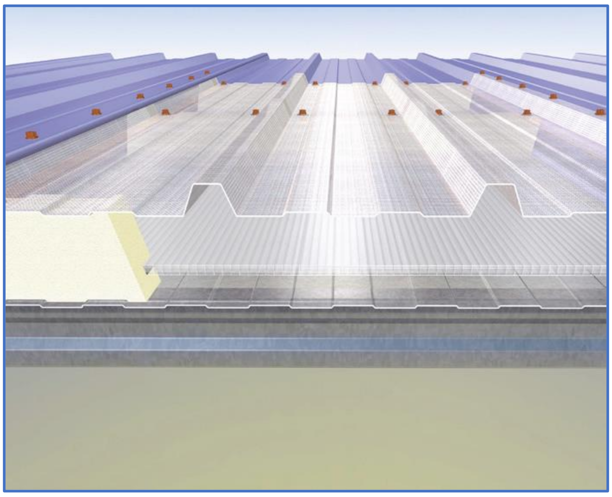


Figure 1.5 – FAIR incorporated into sandwich panel roof

FAIRs are designed to match a specific proprietary system and overall depth of sandwich panel. They are supplied with intermediate layers to make triple or quadruple skinned systems or can incorporate translucent insulation for increased thermal performance.

Sandwich panels can also be used as a structural roof liner to support other metal outer roofing sheets or as a backing wall to support rainscreen panels.

1.4.2 Metal single-skin sheet systems

Profiled metal roofing and cladding sheets can be used as a single skin fixed to the supporting structure in unheated buildings where there is no requirement for insulation such as stadia and some warehouses. In roofs the structural support for the sheet will generally be purlins spanning between rafters and in walls, wall-rails spanning between columns.

Daylighting can also be incorporated using matching profiled rooflight sheets.

Single skin systems are also used in refurbishment, e.g., re-cladding existing pitched roofs or over-roofing existing flat-roofs (flat-to-pitch roof conversion) or are applied over a substrate such as a metal sandwich panel (see above), structural insulated panels (SIPs), plywood, timber boarding etc.

1.4.3 Metal built-up roofing and cladding systems

Metal built-up roofing and cladding systems offer a high degree of design flexibility to meet project specific requirements. They are site assembled using many of the products and components described in Sections 7 and 8 to form an insulated double skin construction which can be configured to meet specific thermal, acoustic and fire performance requirements.

Metal built-up roofing and cladding systems are site assembled using many of the products and components described in Sections 7 and 8 to form an Insulated double skin construction. They are primarily used for new build, although they can be used for refurbishment usually where the existing roofing and/or system has been completely removed. Although the support for the system can take many forms it will generally be either purlin/wall rail based, or rafter/column based.

The former has the outer sheet and the internal liner sheet laid in the same direction across the purlins/wall rails. Typical centres would be approximately 1.0 to 2.4 m. In the wall cladding application, the outer weathering sheet can be laid horizontally as well as vertically.

The other common method has the outer roofing sheet running transverse to an inner structural deck or structural liner tray which spans between the primary support rafters. Typical rafter/column centres would be approximately 3 to 10 m. Again, in the wall cladding application the outer weathering sheet can be laid horizontally as well as vertically.

The cavity for the mineral wool insulation between the outer weathering sheet and the inner liner/decking sheet is created by the use of a spacer kit, the type of which is dependent upon the type of outer sheet used and the insulation depth, see figure 1.6.

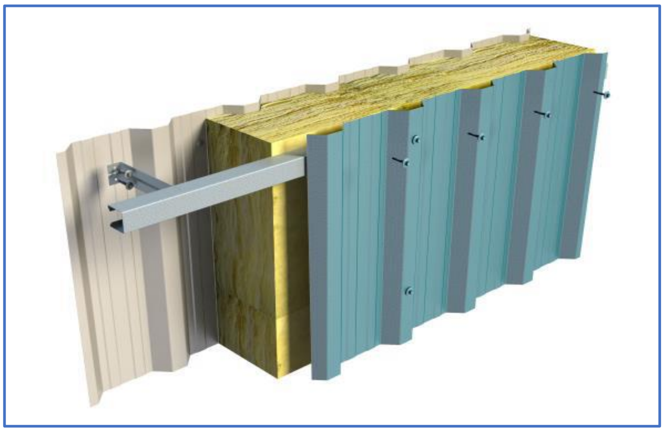


Figure 1.6 – Typical trapezoidal twin-skin built-up wall cladding system.

In-plane site assembled insulating rooflights or barrel vault rooflights can be incorporated into metal built-up roof systems to provide daylighting requirements making efficient use of natural light and reducing the reliance on artificial lighting. Materials such as GRP act as a diffuser giving a more even spread of light and reducing glare and localised heat build-up.

For through-fix profiled sheeting supported on purlins the common form of rooflight consists of separate profiled translucent sheets matching the profiled metal outer and liner sheet and a separate intermediate layer to make a triple or quadruple skinned systems for increased thermal performance, see figure 1.7. Similar forms of rooflight may be used on secret fix or standing seam systems although barrel-vault rooflights are more common with this type of outer sheet especially on low roof pitches.

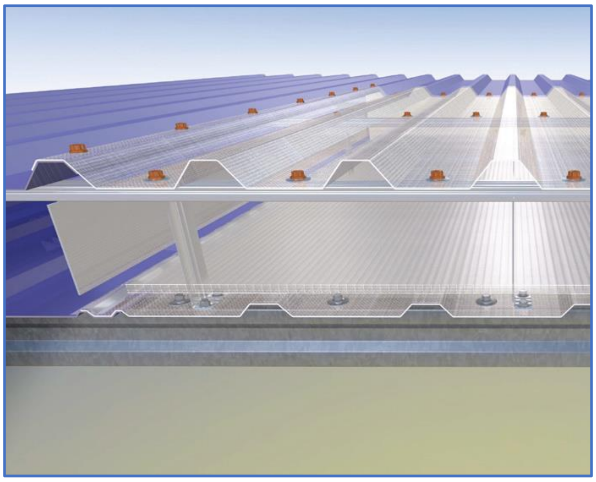


Figure 1.7 – Multi-layered rooflight incorporated into built up roof system

Incorporating daylighting into metal built-up systems supported on structural decking and liner tray systems is more complex as the inner decking/tray forms part of the structural support system and large openings cannot be formed in them. It is feasible to install small modular rooflights with structural decking/tray systems, but this would usually involve the use of additional framing members to support the decking/tray at the opening. Other options would include using a continuous barrel-vault rooflight running along the ridge rather than downslope and structurally framed glazing systems taking their support from the rafters.

1.4.3.1 Thermal performance enhancement

MCRMA Guidance Document GD21 *Thermal performance of buildings: non-domestic construction* provides information on the typical U-value requirements for roof and wall systems for notional buildings together with the maximum back-stop U-values indicated in the various support documents of UK Building Regulations.

The flexibility of built-up metal cladding and roofing systems allows the thermal performance of the system to be enhanced to achieve lower U-values than current requirements and enables a building envelope solution that can be future proofed for potential changes of use of the building and potential energy efficiency requirements.

Bracket and bar spacer kits are available in a wide range of standard bracket heights with the more structural versions being typically up to 400 mm allowing large cavities for the mineral wool insulation to be created.

Bracket and bar spacer kits can also be used in combination with other forms of spacer kit, such as halters with standing seam systems and top-hat sub-purlins on structural decking sheets and in acoustic systems. U-values as low as 0.09 W/m^{2}K are not uncommon with these thermally enhanced built-up systems.

1.4.3.2 Acoustic enhancement

The flexibility of built-up metal cladding and roofing systems can greatly assist the building designer/specifier in enhancing the acoustic properties of the building envelope to provide a solution to meet both the building's acoustic requirement and one that can be future proofed for potential changes to the use of the building. There are acoustic products that can be incorporated within the systems that will enhance the systems acoustic performance including perforated liner and decking profiles, various densities of insulation, acoustic boards, acoustic membranes, anti-drumming membranes etc.

The sound reduction performance of a built-up metal roofing and cladding system can generally be increased by adding mass into the system. This can be achieved by including higher densities of mineral fibre insulation. High density boards e.g., cement particle, gypsum etc. and acoustic membranes e.g., rubberised polyethylene, can also be incorporated into a built-up system to further increase the mass whilst keeping the increase in its depth to a minimum.

The inner liner/decking layer of standard metal built-up systems are hard and smooth surfaces which are natural reflectors of sound. Perforated liner and decking sheets can be specified to utilise the sound absorption properties of mineral wool insulation to provide sound absorption properties to the built-up system to help reduce the reverberation time in an enclosed space such as sports arenas, classrooms etc.

A flexible mineral wool slab, typically 30 mm thick, is positioned as the first layer above the perforated liner/decking sheet to provide the sound absorption properties of the system. This layer of insulation is overlaid with a vapour control layer (VCL) membrane. A top hat profiled sub-purlin spacer kit of the same depth as the flexible provides the support for the remainder of the spacer kit (e.g., bracket and rail and/or halters) above the VCL.

The built-up system may also include higher densities of insulation, high density boards and/or acoustic membranes above the VCL to enhance its sound reduction properties as well. Trapezoidal shaped mineral wool lags positioned in the profiles of the perforated liner/decking sheet can also be used either in combination with the flexible mineral wool slab or on their own, see figure 1.8.

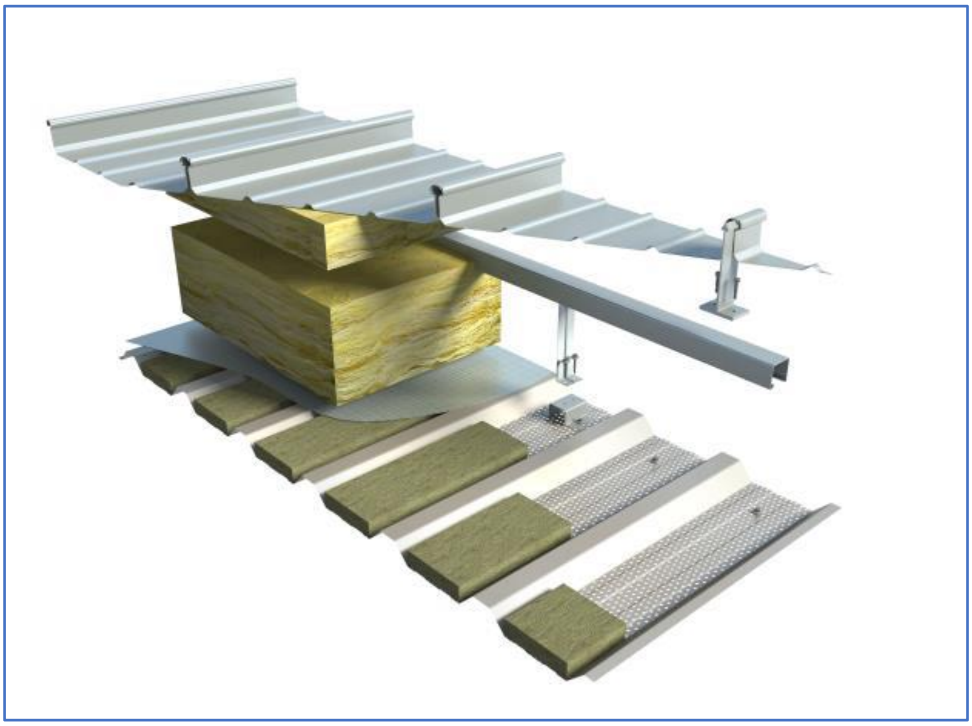


Figure 1.8 – Trapezoidal shaped insulation lags in profiles of perforated liner sheet

The above adaptive acoustic measures will also have a benefit in roof systems where impact noise from rainfall needs to be reduced. The reduction in the impact noise due to rainfall is particularly important in the acoustic design of schools and colleges and may also be a requirement in other buildings such as offices, arenas, cinemas etc. Another measure that could be considered, especially in built-up roof systems which do not have any other acoustic enhancements, is the use of damping materials, such as anti-drumming membranes applied to the underside of the outer weathering profiled sheet which acts to reduce vibration in the metal sheet caused by rainfall and reduces the level of radiated noise.

Advice should be sought from the metal build-up system manufacturer or supplier as to the best way to achieve a specific acoustic performance requirement for their systems. An indication as to the acoustic performance of specific systems can normally be backed up by an extensive range of existing acoustic test data from various MCRMA members and/or the use of MCRMA's SRI (Sound Reduction Index) prediction software.

1.4.3.3 Fire wall systems

Metal built-up wall systems, especially those with steel outer weathering and liner sheets are available as a fire wall system offering various degrees of fire resistance. Fire wall systems are typically tested and certified to BS 476-22:1987 – *Fire tests on building materials and structures. Part 22: Method for determination of the fire resistance of non-loadbearing elements of construction.*

The specification, design and installation of a fire wall built-up cladding system should be carried out using all the same components and fixing methods used in the test and contained within the test certificate.

Fire wall systems will usually be insulated with glass or rock mineral wool insulation products both of which can achieve a European Reaction to Fire Rating Classification of A1 (equivalent to non-combustible) as defined in BS EN 13501–1. Insulation will usually be compressed within the cavity, installed in layers with all joints staggered. The positioning of the spacer kit bracketry is critical, and the support centres should be no more than the width of the insulation strips with at least one bracket per wall rail support penetrating each strip of insulation to prevent it from dropping down in the cavity during a fire. There may also be a requirement for either or both outer and liner profiled to be stitched with fasteners at side-laps. There may also be a requirement as to the type of and the fixing to the supporting structure, e.g., wall rails, eaves, beams etc.

Test certificates of the fire resistance performance of a fire wall will be given as integrity (i.e., the ability of the system to resist flame) and insulation (i.e., the ability of the system to limit the transfer of heat from one side to the other) e.g., 240 minutes integrity/30 minutes insulation. The direction of the fire will also be given e.g., internal to external.

The position of a specific fire wall in relation to a boundary (e.g., relevant boundary as described in Approved Document B Volume 2 – *Buildings other than dwellinghouses – Fire Safety)* is important.

As an example, a specific fire wall system would be suitable for use 1 metre or greater than a boundary but may not be suitable for use less than 1 metre from a boundary due to the possible need for a longer insulation fire resistance and direction of fire.

Advice should be sought from the metal build-up system manufacturer or supplier as to which certified fire wall system(s) is/are best suited for a given location and fire performance requirement.

1.4.4 Metal built-up rainscreen systems

The outer layer of a metal built-up rainscreen system is a rainscreen panel fabricated from a wide variety of metals in their natural uncoated condition or with a pre-coated finish. They can also be fabricated from aluminium composite materials (ACMs). The panels are supported by a rainscreen cladding support system that connects them to the structural backwall, either an existing façade as in the case of refurbishment or a new structural wall as in the case of new build construction, see figure 1.9. The size of the of the bracket projecting from the wall will depend on the thickness of insulation and cavity size.

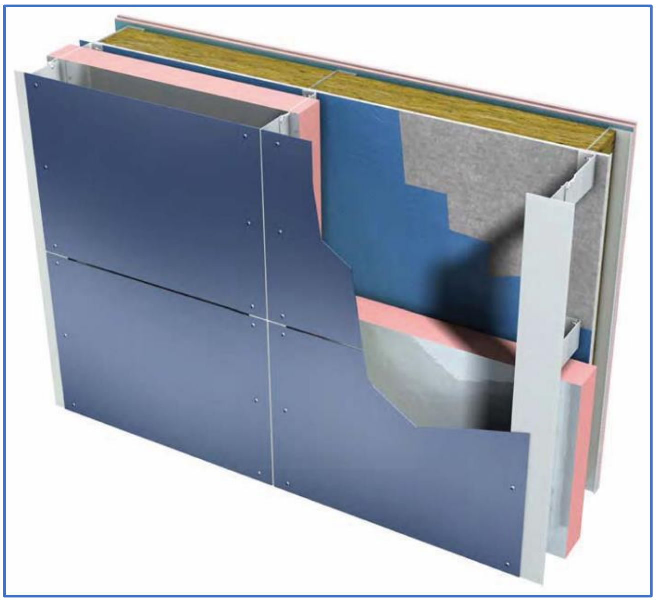


Figure 1.9 – Typical metal built-up rainscreen cladding system

The structural backing wall can take a number of forms including solid masonry, steel or timber frame with insulation and sheathing boards or a panel system such as a metal-faced insulated sandwich panel. The structural backing wall will usually be designed to provide the air barrier for the built-up wall and any fire resistance requirement. Dependent upon the type of wall and position of the insulation the backing wall may also form the vapour control layer (VCL).

Although they can be installed as part of a fully sealed system, rainscreen panels are predominantly installed with open joints with a ventilated cavity behind. Rainscreen panels, as the name implies, are designed to shed water from the outer surface and are not intended to be fully watertight.

The ventilated cavity allows any water that enters through the rainscreen joints to be drained to the outside of the building envelope. The ventilated cavity can also help dry out any excessive water in the cavity. To prevent the spread of flame/smoke within this ventilated cavity, horizontal and vertical fire barriers may need to be installed.

Depending on the type of backing wall and degree of insulation within it, a layer of insulation can be installed in the cavity which can offer an increased level of thermal performance to the system. Glass and rock mineral wool products can provide a non-combustible insulation layer. A breather membrane is usually positioned within the ventilated cavity on the outside of the insulation and its general purpose is to protect the outer surface of the mineral wool insulation layer from water penetration whilst allowing any water vapour from inside the construction to pass through it.

There may also be the need for a separate VCL membrane to be installed on the warm side of the insulation. A condensation risk analysis through the construction should be carried out to determine its position and ensure that the dew point does not occur within the construction on the cold side of the VCL.

Metal built-up wall cladding systems with an outer layer of standing seam sheets are also increasingly being used as a weathering layer and support for rainscreen panels, which are supported on rails fixed to proprietary clamping devices which are clamped to the seams of the standing seam sheet without penetrating the sheet itself.

1.4.5 Other sustainable system variations

Metal roofs systems can be further enhanced with other sustainable features, the following gives a brief overview of a few of the more common ones.

1.4.5.1 Photovoltaic (PV) systems

MCRMA members offer several forms of flexible solar PV options that can assist in providing a renewable source of energy which can help safeguard against rising energy costs and reduce overall carbon emissions. These would include fully PV integrated roofing sheets, fabricated panels with flexible PV membrane for over-cladding roofing sheets and fastening systems for attaching PV modules to the roof sheets.

Profiled metal roof sheets which have wide flat troughs, such as standing seam sheets, can be supplied with a flexible lightweight thin film photovoltaic strip factory bonded to the surface of the sheet to create a building-integrated photovoltaic (BIPV) solution for new-build constructions, see figure 1.10. The sheets with PV strips attached can also have junction boxes fitted to the underside so that all cables and connectors are concealed within the built-up roof system. This approach offers a means of protecting the cabling and connectors from the weather whilst also offering a better visible appearance.

Figure 1.10 – Standing seam system with BIPV in curved roof application.

The flexibility of the PV film allows the roofing sheeting to be supplied in curved forms as well as standard straight sheets. The films are lightweight, typically only adding approximately 3 to 4 kg/m^2 to the overall weight of the roof system.

The same thin film PV strips can also be bonded to fabricated panels for use as a retrofit solution for connection to existing roof sheets or installed at the same time on to narrow trough profiled sheets (e.g., through fix trapezoidal sheets) on new build constructions. The attachment method will be dependent upon the type of roof profiles that the PV fabricated panels are to be fixed to and advice should be sought from the roof system manufacturer/supplier.

The weight of the PV fabricated panels will vary based on the metal that the PV film has been bonded to but as an example the overall additional weight if bonded to an aluminium panel would be approximately 7 to 8 kg/m^2. The overall weight of the PV fabricated panels and connection will need to be considered when evaluating the suitability of an existing roofing system and its support structure to accommodate the additional dead load.

Heavyweight PV panels, e.g., framed and glazed monocrystalline or polycrystalline PV cells, are often installed as a retrofit on existing roofs but occasionally are installed as part of a new-build roof system installation. The PV panels may be installed parallel to the roof surface but are often mounted on frames to create the pitch and orientation to maximise the PV panel's efficiency. i.e., south facing and pitched at between 30 to 40°. See figure 1.11.

Figure 1.11 – PV panels installed on pitched frame connected to roof sheets

The panels and frames should be connected in a manner which does not comprise the integrity of the roof system and there are a number of proprietary PV frame and/or connection systems available for various types of metal profiled roofs e.g., clamping devices which are clamped to the seams of standing seam sheets without penetrating the sheet itself.

These type of PV panels, frames and connections can add between 10 to 30 kg/m^2 weight to the roof system and may not be suitable for some existing roofs. The weight of the PV configuration will need to be considered when evaluating the suitability of an existing roofing system and its support structure to accommodate the additional dead load as well as the impact that wind uplift may have on the PV panels and roof connections. Advice should be sought from the roof system manufacturer/supplier.

The surface of a metal roofing system below a framed PV system may not be subject to natural washing by rain and may lead to an increased risk of corrosion and degradation of the material and/or its coating. This may negate any material/coating guarantee, and it is advised that written approval and any further maintenance requirement is sought from the roof system manufacturer/supplier prior to specification and installation of the PV system.

Further information on installing PV panels to roof systems can be found in MCRMA Guidance Document GD22 *Installing renewables on metal roofs: A checklist,* MCRMA article *The factors to consider when installing PV panels* and BRE Digest 489 *Wind loads on roof-based photovoltaic systems*.

1.4.5.2 Green and brown roof systems

Metal secret fix and standing seam roof systems can be designed as a 'green' or 'brown' roof system which can offer further sustainability and ecological benefits. The use of a green/brown roof can assist in reducing rainwater run-off and the impact of storm water by retaining water and slowly releasing into the drainage system preventing flooding. They also complement, support and provide habitat for a range of species including plant, invertebrate and bird species. Green/brown roofs reduce urban heat island effect leading to less energy usage and they also provide an improved sound reduction performance.

Green roof systems can be broken down into several generic types such as intensive, extensive and biodiverse (also known as brown roofs) some of which are suitable for installing on metal roof systems.

Intensive green roofs are a deep soil/substrate system capable of being planted with a variety of vegetation including grasses, plants, bushes and small trees and can also incorporate hard landscaping and water features. They are typically designed to replicate a ground level garden space in urban settings with access for people to use the space and also maintain the vegetation and other features. As the name suggests intensive roofs have high maintenance requirements and require regular irrigation. They add a considerable amount of weight to the roof dependent upon the soil/substrate depth but can be over a tonne/m^2 for deep systems. This type of green roof is not suitable for installing on metal roof system and is usually installed over a concrete deck.

Extensive green roofs on the other hand are a shallow soil/system (75 to 100 mm) with relatively low weight (70 to 100 kg/m^2) and planted with drought tolerant vegetation e.g., succulents, meadow flowers etc in either individual plant plugs or pre-grown mat. Extensive green roofs require minimal maintenance and no irrigation and are suitable for being installed on metal secret fix and standing seam roof systems.

Bio-diverse or brown roofs are basically substrate based extensive green roofs designed to allow local, naturally occurring plant species to flourish to reinstate the pre-development ecology that is often only present on brownfield sites. Brown roofs require little or no maintenance but can take a length of time to become fully established.

For both the extensive green and brown roofs the metal secret fix and standing seam roof acts as the waterproofing and root barrier layer for the system. The metal sheet is typically overlaid with a drainage mat and filter fleece often as a combined component, which allows fine particles to be retained within the substrate but allows excess rainwater to slowly drain away. This layer is then overlaid with the soil/substrate and the vegetation layer (in the green roof variant), see figure 1.12.

Figure 1.12 – Typical extensive green roof system on standing seam roof system

Although extensive green and brown roofs on metal secret fix and standing seam roof systems are generally laid to a near flat low roof pitch (i.e., 1.5°), they can also be laid on steeper roof pitches and barrel vault roofs where retaining battens need to be installed to prevent slippage of the substrate.

The weight of the extensive green or brown roof system will need to be considered when designing the metal secret fix and standing seam roof and its structural support and advice should be sought from the roof system manufacturer/supplier.

1.4.5.3 Cool roofs

In cities and in other urban areas building and air temperature can be much higher than in rural and less developed areas. Known as the urban heat island effect, it is attributed to the lack of reflective or suitable absorbing surfaces such as vegetation and open ground which are found in rural areas. Although not having much impact on global climate change it does have a big impact on the local micro-climate and air quality and can lead to an increased cooling demand for buildings and the subsequent energy usage increase.

In extremes of direct sunlight surface temperatures of materials can be much higher than the air temperature due to solar overheating. Light coated surfaces have high thermal reflectance and will absorb less solar energy. They also have high thermal emittance so will re-radiate energy from the surface.

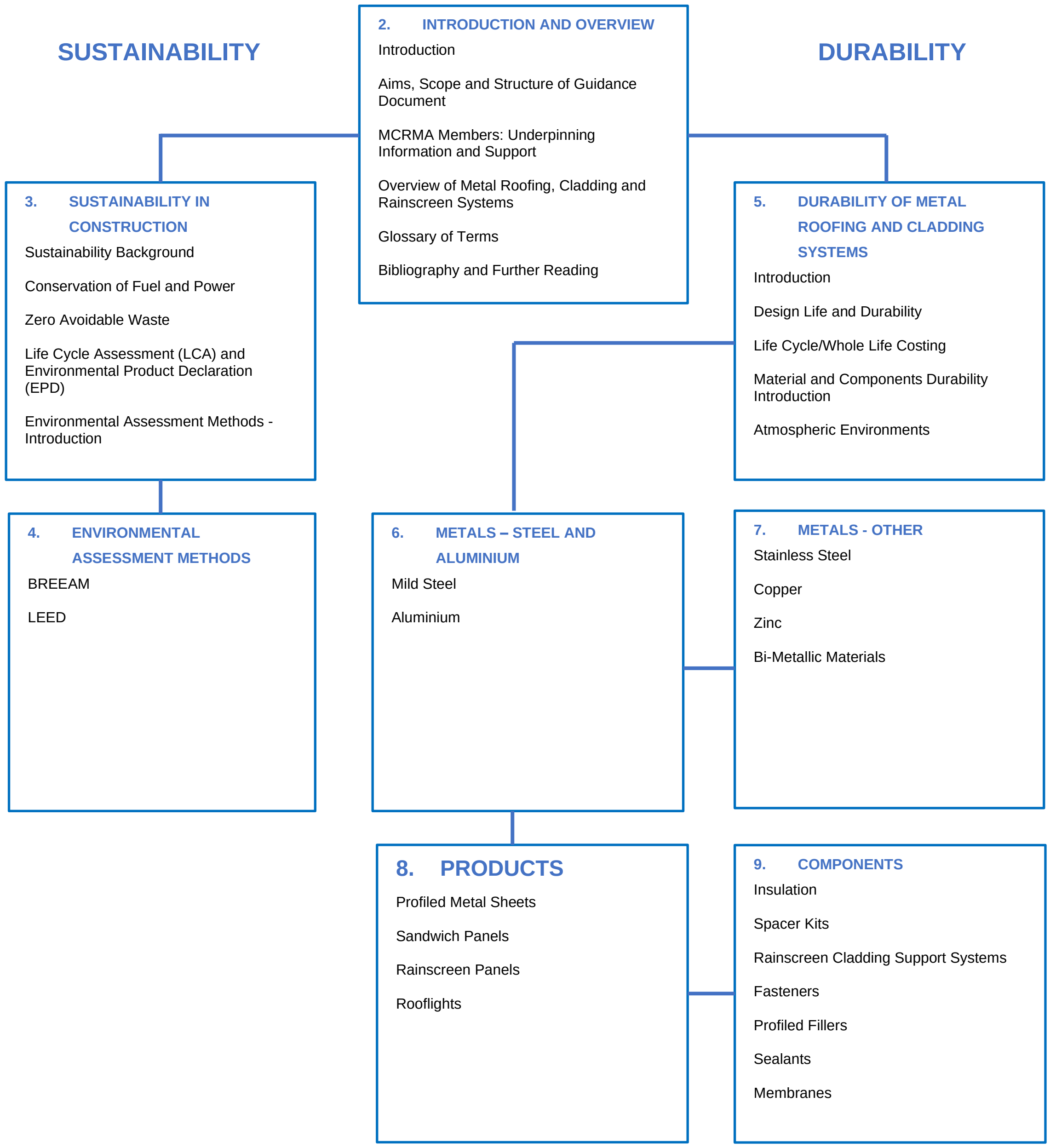
Dark coated surfaces although having high emittance values have relatively low reflectance values so will invariably attain much higher surface temperatures than light coated surfaces. The combination of reflectance and emittance gives a material's solar reflectance index (SRI), the higher the SRI the better it is for reducing solar gain and keeping the surface temperature relatively cool. Roofs with high SRI values are often referred to as 'cool roofs'.

With the advent of environmental rating and certification schemes having a greater influence in environmental design of buildings globally, the availability of SRI values for specific materials, finishes and colours is becoming more widely available. This enables designers and specifiers to obtain scheme credits for the reduction of the urban heat island effect of a roof where the use of materials and finishes with a high SRI is encouraged.

Metal roofing sheets can be supplied with innovative cool roof coatings with high SRI values over a wide range of colours. Developed by paint manufacturers and coil coating specialists, they have moderate to highly reflective surfaces and are engineered to have increased emissivity.

Further information on cool roofs can be found in BRE Information Paper IP 13/10 – *Cool roofs and their application in the UK.*

1.5 STRUCTURE OF GD 39



Pictorial overview of MCRMA guidance document GD39: Sustainability and durability of metal roofing and cladding systems

1.6 GLOSSARY OF TERMS

BRE Green Guide to Specification Generic product LCAs and EPDs form the basis of the BRE (Building Research Establishment) Green Guide to Specification (Green Guide). Initially published as a simple to use 'green guide' to the environmental impacts of common building materials and products. It has undergone regular updates and expansion as an online version which provides guidance for specifiers, designers and their clients on the relative environmental impacts of many elemental specifications for roofs, walls, floors etc.

BREEAM (Building Research Establishment Environmental Assessment Method) A voluntary scheme which can be used to assess the environmental performance of most types of building (new and existing). Developed by BRE (Building Research Establishment) it is the world's longest established environmental assessment system and is used internationally as well as in the UK.

COP (Conference of the Parties) 26 The 26th Meeting of the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC). The COP26 conference was held in Glasgow in November 2021 hosted in partnership by UK and Italy. Previous notable COP conferences took place at Kyoto (COP3) in 1997 and Paris (COP21) in 2015. These and other conferences have led to commitments to climate change, reduction of greenhouse gases and keeping global temperature rise this century below 2°C (preferably 1.5°C) above pre-industrial levels have been agreed.

CSR (Corporate Social Responsibility) The self-regulated responsibility of companies to society in areas such as the environment, the economy, employee well-being etc. Most companies, especially larger ones, now report on their CSR, a major element of which is the carbon footprint of a company's activities and their efforts to reduce it.

Environmental assessment method/rating system A methodology and/or rating system where various environmental impact factors are assessed against given criteria and points/credits are awarded. The total number of points/credits obtained will provide an indication of the environmental friendliness of a building design and its operation. The use of environmental assessment methods and rating systems can help encourage clients, developers and design teams to design and construct more sustainable buildings which are more energy efficient, climatic responsive, material and resource efficient, have healthier indoor environments for occupants and limit waste emissions and pollution.

EPD (Environment Profile Declaration) The results of an LCA are published in an EPD which is developed to a common format e.g., to the principles and procedures given in ISO 14025. The overall goal of an EPD is to communicate verifiable and accurate information on the environmental aspects of products that are not misleading. An EPD also provides the basis of a fair comparison of the environmental performance of products.

Greenhouse Gases Greenhouse gas emissions from human activities strengthen the greenhouse effect, causing climate change. Some of the gases occur naturally in the atmosphere, while others result from human activities. The seven greenhouse gases which contribute directly to climate change are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6) and nitrogen trifluoride (NF_3). The largest contributor to global warming is carbon dioxide (CO_2) which makes it the focus of many climate change initiatives.

LCA (Life Cycle Assessment) An assessment of the environment impacts of a product over its life cycle to a given methodology e.g., compliance with ISO 21930, considering several environmental issues. This life cycle of the product is often referred to as '*cradle to grave'*, where the *'cradle'* is the extraction of raw materials and the *'grave'* is the product's disposal and will consider the product's use over the building's life expectancy. A variation is a '*cradle to cradle'* life cycle where the disposal stage is replaced with a recycling process that produces material suitable for manufacturing a new product. LCAs are often broken down further into '*cradle to gate*' and '*gate to gate*' life cycles which can be useful for a manufacturer as a means of identifying internal processes for environmental improvements.

LCC (Life Cycle Costing) An LCC will consider all relevant costs over the defined life of a building covering construction costs, operation and occupancy costs, maintenance costs, renewal costs, and end of life costs as well as any environmental costs.

LEED (Leadership in Energy and Environmental Design) Green Building Rating System A voluntary, standard for developing high-performance, sustainable buildings developed by the US Green Building Council (USGBC). Although developed in and for the USA it is used internationally including the UK.

NDC – Nationally Determined Contributions National action plans on how countries will meet their commitments to climate change, reduction of greenhouse gases and rise in global temperature.

Net Zero Carbon/Net Zero Total greenhouse gas emissions going into the atmosphere e.g., from a particular process are equal to (or less) than the removal of greenhouse gases out of the atmosphere.

WLC (Whole Life Costing) A WLC will cover all the costs in an LCC as well as non-construction costs and incomes.

ZAW (Zero Avoidable Waste) The prevention of waste being generated at every stage of a project's lifecycle, from the manufacture of materials and products, the design, specification, procurement and assembly of buildings and infrastructure through to deconstruction. At the end of life, products, components and materials should be recovered at the highest possible level of the waste hierarchy, whilst ensuring minimal environmental impact.

1.7 BIBLIOGRAPHY AND FURTHER READING

The following is a list of support documents and publications that were used in the development of this guidance document, and which will provide further reading on the subject.

Approved Document B Volume 2 – *Buildings other than dwellinghouses – Fire Safety (for use in England)*

Aurubis – *Copper Book for Architecture*

BES 6001 – *BRE Framework Standard for Responsible Sourcing*

BRE BR502 – *Sustainability in the built environment: An introduction to its definition and measurement*

BRE Digest 489 – *Wind loads on roof-based photovoltaic systems*

BRE Information Paper IP 13/10 – *Cool roofs and their application in the UK*

BREEAM – *BREEAM UK New Construction – Non-domestic Building (United Kingdom) – Technical Manual – 2014*

BREEAM – *BREEAM UK New Construction – Non-domestic Building (United Kingdom) – Technical Manual - 2018*

BS ISO 15686-5:2017 – *Buildings and constructed assets. Service life planning. Life-cycle costing*

BS 7543:2015: *Guide to durability of buildings and building elements, products and components*

BS EN 1990: 2002+A1: 2005 (incorporating corrigenda December 2008 and April 2010) – *Eurocode – Basis of structural design*

NA to BS EN 1990: 2002+A1: 2005 (Incorporating National Amendments No.1) – *UK National Annex for Eurocode – Basis of structural design*

BS EN 15804: 2012+A2:2019 (incorporating corrigenda February 2014 and July 2020) – *Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products*

BS EN ISO 14001:2015 – *Environmental management systems. Requirements with guidance for use*

BS EN ISO 9001:2015 – *Quality management systems. Requirements*

BS EN 14782:2006 – *Self-supporting metal sheet for roofing, external cladding and internal lining. Product specification and requirements*

BS 5427:2016+A1:2017: *Code of practice for the use of profiled sheet for roof and wall cladding on buildings*

BS EN ISO 12944-2 *Paints and varnishes. Corrosion protection of steel structures by protective paint systems. Classification of environments*

BS 476-22:1987 – *Fire tests on building materials and structures. Part 22: Method for determination of the fire resistance of non-loadbearing elements of construction*

BS EN 506:2008 – *Roofing products of metal sheet. Specification for self-supporting products of copper or zinc sheet*

BS EN 1172:2011 – *Copper and copper alloys. Sheet and strip for building purposes*

BS EN 988:1997 – *Zinc and zinc alloys. Specification for rolled flat products for building*

BRE – *BRE Building Elements: Roofs and roofing: Performance, diagnosis, maintenance, repair and the avoidance of defects - Third Edition*

BSSA – *Stainless Steel and Sustainable Construction*

CAB – *Aluminium & sustainability: a ‘cradle to cradle’ approach*

CLC/GBC – *Zero Avoidable Waste in Construction*

CLC/GBC – *The Routemap for Zero Avoidable Waste in Construction*

Constructing Excellence – *Sustainable Construction: An Introduction*

Constructing Excellence – *Whole Life Costing*

CP 143-5:1964 – *Code of practice for sheet roof and wall coverings. Code of practice for sheet roof and wall coverings. Zinc*

CPA – *COP26 – An Introduction*

CPA – *Net Zero Carbon – What on Earth does it mean?*

CPA - *A guide to understanding the embodied impacts of construction products*

CWCT Technical Note 33 - *Breather membranes and vapour control layers in walls*
CWCT – *Guidance on built-up walls*
Euro-Inox – *Technical Guide to Stainless Steel Roofing*
Euro-Inox – *Cleaning Architectural Stainless Steel*
Hydro – *Circular economy – the design perspective. From theory to implementation*
International Molybdenum Association (IMOA) – Which *stainless steel should be specified for exterior applications?*
ISO 21930:2017 - *Sustainability in buildings and civil engineering works — Core rules for environmental product declarations of construction products and services*
ISO 14025:2006 - *Environmental labels and declarations — Type III environmental declarations — Principles and procedures*
MCRMA Article – The factors to consider when installing PV panels
MCRMA Membership Charter
MCRMA Guidance Document GD01 – *Built up systems and spacer stability*
MCRMA Guidance Document GD08 – *An introductory guide to rainscreen support systems*
MCRMA Guidance Document GD11 – *Fixings and fastenings for rainscreen systems*
MCRMA Guidance Document GD12 - *Composite flooring systems: Sustainable construction solutions*
MCRMA Guidance Document GD17 – *A guide to site installation of insulated roof panels*
MCRMA Guidance Document GD19 – *Effective sealing of end laps in metal roofing constructions*
MCRMA Guidance Document GD21- *Thermal performance of buildings: non-domestic construction*
MCRMA Guidance Document GD22 – *Installing renewables on metal roofs: A checklist*
MCRMA Guidance Document GD28 – *Mineral wool insulation installation: Best practice guide*
MCRMA Guidance Document GD 33 – *Fasteners for metal roofing and wall cladding: design, detailing and installation guide*
MCRMA Guidance Document GD 34 – *The definition of cladding within the construction sector*
NARM Technical Document NTD09 2014 - *Rooflights: glass, polycarbonate or GRP?*
NARM Technical Document NTD15 2018 - *A guide to rooflights for profiled sheeted roofs*
NFRC – *Profiled sheet roofing and cladding – The NFRC guide to design and best practice (Blue Book)*
NFRC Technical Bulletin 36 – *Performance standards of building strip sealants in metal clad buildings*

RICS NMM3 - *New rules of measurement: Order of cost estimating and cost planning for building maintenance works*

RICS Guidance Note – *Life cycle costing*

UK Government – *COP26 Explained*

USGBC – *LEED v4 for Building Design and Construction*

USGBC – *LEED v4.1 for Building Design and Construction*

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