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GD39 SUSTAINABILITY AND DURABILITY OF METAL ROOFING AND CLADDING SYSTEMS

SECTION 4: DURABILITY OF METAL ROOFING AND CLADDING SYSTEMS

4.1 Introduction

As the aim of current UK government policy is the reduction of emissions by at least 100% of 1990 levels (net zero) by 2050 one way that can assist in this is through 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.

To ensure value for money over the life of a building Whole Life Costing (WLC) or Life Cycle Costing (LLC) can be used to consider all relevant costs e.g., construction costs, operation and occupancy costs, maintenance costs, renewal costs, and end of life costs as well as any environmental costs.

The design life of a building can only be fully realised if external building envelope materials along with their component products have the durability that can achieve that desired design life. Sections 5 to 8 of this guidance document looks at the durability of the metals used for manufacturing profiled roofing and cladding sheets, sandwich panels and rainscreen panels and the components, such as rooflights, insulation, support systems, fasteners etc. which are used to form complete building envelope systems. Factors which may impact on the required durability are also commented on such as location and atmospheric environment, cleaning, maintenance, etc. as well as any potential limitations in use.

4.2 Design life and durability

A 60-year life expectancy is generally taken as a typical life expectancy of a building, e.g., in life cycle assessments (LCAs) etc. The actual design life for a building though can be different to this and would be dependent upon several factors including location, the type of building, its use, method of construction, materials used etc.

BS EN 1990 (Eurocode 0) and the UK National Annex give indicative design working lives for design purposes for various building types and structures in the UK as follows:

- Category 1 - Temporary structures, not including structures or parts of structures that can be dismantled with a view to being re-used – 10 years
- Category 2 – Replaceable structural parts, e.g., gantry girders, bearings – 10 to 30 years
- Category 3 – Agricultural and similar buildings – 15 to 25 years
- Category 4 – Building structures and other common structures – 50 years
- Category 5 – Monumental building structures, bridges and other civil engineering structures – 120 years

The indicative design life of any building can only be fully realised if materials, products and systems for the external building envelope are specified which have the durability in the given use, location and surrounding environment that can achieve the desired life and that all necessary cleaning, maintenance, repairs etc. is undertaken.

BS 7543 *Guide to durability of buildings and building elements, products and components* can be used to provide guidance on design service life planning and the means of communication of information on materials (including metals) durability for all members of the construction and facilities management teams. The standard also gives guidance on climatic agents that can affect durability of materials.

Table 4.1taken from BS 7543 gives design life categories for various building component types in relation to the design life of the building.

Category description	Life	Typical examples
Short-term	Shorter life than the building and readily replaceable	Door actuators and motors, taps
Replaceable	Shorter life than the building and replacement can be envisaged at design stage	Most floor finishes and services installation components
Maintainable	Lasts, with periodic treatment, for the life of the building	Most external cladding, doors and windows
Lifelong	Lasts for the life of the building	Foundation and main structural elements

Table 4.1 – Categories of design life (BS 7543)

Metal roofing and cladding systems offer a very durable building envelope solution and are generally classed as 'maintainable' and can meet the life of the building with the appropriate material and component specification and maintenance regime. Some components of the system, such as flashings, rooflights, profiled fillers etc. may be classified as 'replaceable' on buildings with long life expectancies and where the component is easily accessible to undertake the replacement. Other components, such as fasteners, are not easily accessible for maintenance or replacement and would be classified as being 'lifelong' to the design life of the material or system within which they are used. This will be covered in greater detail in the relevant material and component in sections 5 to 8 of this guidance document.

4.3 Life cycle/whole life costing

The requirements for a building with long design life can vary from one project to another depending upon various factors as indicated above. Long life and durable forms of construction (e.g., metal building envelope system) could sometimes be seen to be more expensive than other cheaper forms of construction which may not necessarily meet the intended design life of the building. Choosing the more durable form of construction is likely to increase the initial cost of a project but could offer considerable savings over the life cycle of the building.

The terms life cycle costing (LCC) and whole life costing (WLC) are often seen as being interchangeable but differ slightly in what they cover. LCC will consider all relevant costs over the defined life of the building covering construction costs, operation and occupancy costs, maintenance costs, renewal costs, and end of life costs as well as any environmental costs. WLC will cover all these costs as well as non-construction costs and incomes.

RICS NMM3 (new means of measurement) defines these as follows:

- Life cycle costing (LCC) – "*a methodology for the systematic economic evaluation of life cycle costs over a period of analysis, as defined in the agreed scope of assessment*".
- Whole life costing (WLC) – "*a methodology for the systematic economic evaluation used to establish the total cost of ownership, or the whole life costing of option appraisals. It is a structured approach addressing all costs in connection with a building or facility (including construction, maintenance, renewals, operation, occupancy, environmental and end of life). It can be used to produce expenditure profiles of a building or facility over its anticipated life span or defined period of analysis*".

As well as carrying out an LCC/WLC analysis at the whole building level the methodologies can also be utilised at element level (e.g., building envelope) where the results can be used to assist in the decision-making process when there is a choice of product/system.

This type of analysis provides the opportunity to optimise the allocation of benefits and costs to achieve 'best value' over the building design life. For convenience, these costs would usually be considered under the headings of:

- Initial cost
    - Material/product and labour cost required to purchase and install a system.
- Operational costs
    - Cleaning and maintenance costs, material/product and labour costs to purchase and install any replacement study during the building's design life
- Disposal costs (if applicable)
    - Disposal cost of the system components at the end of their lives, considering possible benefits of the recyclability of the materials/components.

An example of this would be considering the lifetime costs associated with a low pitch uncoated aluminium standing seam built-up insulated roof system against a single ply membrane built-up insulated roof system taken over a 60-year design life.

The BRE Green Guide summary ratings for these forms of system are the same with an A+ rating, but their overall equivalent kg of CO_2 emissions over the 60-year period will differ with the aluminium standing seam system being 68, whilst the single ply membrane system would be higher and be dependent upon the membrane used; EPDM – 72; TPO – 75; PVC – 77.

Both systems would be capable of being designed to meet the functional requirements of the building e.g., thermal and acoustic performance but would have different levels of durability and ease of recyclability.

The initial cost would not be too dissimilar as the overall roof system would be near identical, e.g., coated steel liner, insulation etc., but the aluminium roof system would be expected to be slightly more expensive than the membrane roof system.

The uncoated aluminium standing seam outer sheet would be more expensive than the single ply membrane but the insulation to support the single ply membrane would be more expensive due to its higher density and rigidity requirement than the lower density and softer insulation which acts as an infill for the uncoated aluminium standing seam system.

However, over the 60-year design life of the building the aluminium roof system would prove to perform better economically and offer greater value for money due to its greater durability over the operational cost period. The uncoated aluminium roof system would be deemed to last the 60-year design life of the building with ongoing maintenance whereas the single ply membrane would likely need replacing at least once over the 60-year design life period due to its lower service life expectancy.

The aluminium roof system option would also prove to offer better value for money at the disposal period and offer a more environmentally friendly roof solution. Aluminium can be widely and fully recycled without loss of quality for future use; it also has a high intrinsic scrap value which would be used to offset costs at this phase and other phases of the LLC/WLC analysis.

Although it is feasible to recycle some single ply membrane materials (e.g., TPO, PVC); its re-use quality for future use is much lower than the original material; recycling is not that widespread and usually relies on manufacturer recycling schemes; and there is also little intrinsic value and will have an on-cost to enable recycling. Membranes if not recyclable or if not entering a manufacturer’s recycling scheme would invariably be disposed of in landfill which has its associated costs as well as having an impact on the environment.

Other components used in both systems would be recycled and disposed of accordingly. The steel liner in both systems is widely and fully recyclable and like aluminium, without loss of quality for future use.

4.4 Materials and components durability introduction

As indicated earlier the design life of a building can only be fully realised if external building envelope materials, products and systems have the durability that can achieve the desired life. The durability of the materials used in the roll forming and fabrication of roofing and cladding products and the components which are used to form building envelope systems will be looked at in detail in sections 5 to 8 of this guidance document.

Factors which may impact on the required durability will also be commented on such as location and atmospheric environment, cleaning, maintenance, etc. as well as any potential limitations in use.

Information on assessing the durability of materials for metal roofing and cladding systems are given in several sources such as British Standards (i.e. BS 5427:2016+A1:2017 *Code of practice for the use of profiled sheet for roof and wall cladding on buildings*, and BS 7543:2015: *Guide to durability of buildings and building elements, products and components*) and specific coating and system British Board of Agrément (BBA) Certificates as well as industry and individual manufacturers publications.

BS 5427 indicates that "*the durability of profiled sheeting is a measure of the ability of the material, and its finishes and fixings to retain satisfactory appearance and performance in various conditions of exposure over a certain period. Deterioration can occur on both faces of the sheeting and can be more pronounced at fixings, laps, edges and abrupt changes in profile".*

Regular inspections and necessary cleaning and maintenance should be carried for all types of metals, finishes and rooflights.

4.4.1 Atmospheric environments

Defining an atmospheric environment can appear confusing at times and different sources use slightly different terminology and descriptions.

BBA approval certificates for products and systems generally indicate external environments as coastal, industrial (normal and severe), suburban/urban and rural.

BS 5427 indicates the following external environments where differing precautions towards durability may need to be taken: coastal, inland, polluted, high UV. BS 5427 also includes a table, see table 4.2, which gives guidance on atmospheric-corrosivity categories for both internal and external environments which can be used for assessing the expected durability of roofing and cladding sheets. This table is based on and in accordance with BS EN ISO 12944-2 *Paints and varnishes. Corrosion protection of steel structures by protective paint systems. Classification of environments.*

Corrosion Category	**Examples of typical environments in a temperate climate**	
	Exterior	**Interior**
C1 Very low	–	Heated buildings with clean atmospheres e.g., offices, shops, schools, hotels.
C2 Low	Atmospheres with low level of pollution. Mostly rural areas.	Unheated buildings where condensation can occur e.g., depots, sports halls.
C3 Medium	Urban and industrial atmospheres, moderate sulphur dioxide pollution. Coastal area with low salinity.	Production rooms with high humidity and some air pollution, e.g. food-processing plants, laundries, breweries, dairies.
C4 High	Industrial areas and coastal areas with moderate salinity.	Chemical plants, swimming pools, coastal ships and boatyards.
C5-I Very high (industrial)	Industrial areas with high humidity and aggressive atmosphere.	Buildings or areas with almost permanent condensation and with high pollution.
C5-M Very High (marine)	Coastal and offshore areas with high salinity.	Buildings or areas with almost permanent condensation and with high pollution.

Table 4.2 – Corrosion categories for assessing the expected durability of profiles

Coastal/marine environments can have a detrimental effect on durability of materials due to the salt atmosphere, this is especially so for materials with protective coatings where wind borne salt and high UV can cause erosion of the coating and reduce their aesthetic appearance. High UV can cause colour changes and chalking of coatings.

Industrial environments can lead to corrosion of materials and degradation of coatings due to attack from sulphur dioxide and from other chemical pollution dependent upon the type of industry in a project location.

The extent that coastal /marine environments extend inland would be dependent upon several factors including, geographical features (e.g., estuaries, peninsulas etc), topography and prevailing wind.

The International Molybdenum Association (IMOA) publication *Which stainless steel should be specified for exterior applications?* indicates that locations up to 8-16 km inland could be considered coastal.

MCRMA Guidance Document GD 33 *Fasteners for metal roofing and wall cladding: Design, detailing and installation guide* advises that from a fastener perspective, it may be prudent to consider a coastal zone extending 10 kilometres from the high tide mark along the coastline and five kilometres from tidal rivers where the tidal reach from the coastline/river mouth exceeds the 10 kilometres as above.

Manufacturers often offer guarantees for their materials and products with periods of guaranteed life dependent upon location and atmospheric environment. Different manufacturers though may use different definitions, for example ‘coastal’ or ‘marine’ which may or may not be the same thing and may differ in how far inland from the sea that atmospheric environment extends.

Some manufacturers may give a distance zone, e.g., within 1 or 2 km of the sea, others may require a more specific location. It is therefore advisable that the manufacturer is consulted as to what definition and inland extent they are using when considering the expected durability of their product or material and any associated guarantee. Often it will be necessary to complete a location/environmental questionnaire when applying for a guarantee.

MCRMA ONLINE CPD PROGRAMME

This guidance document is available as an online CPD and is accredited by the CPD Certification Service. MCRMA's online CPD programme is open to anyone seeking to develop their knowledge and skills within the metal building envelope sector. Each module also offers members of professional institutions an opportunity to earn credit toward their annual CPD requirement.

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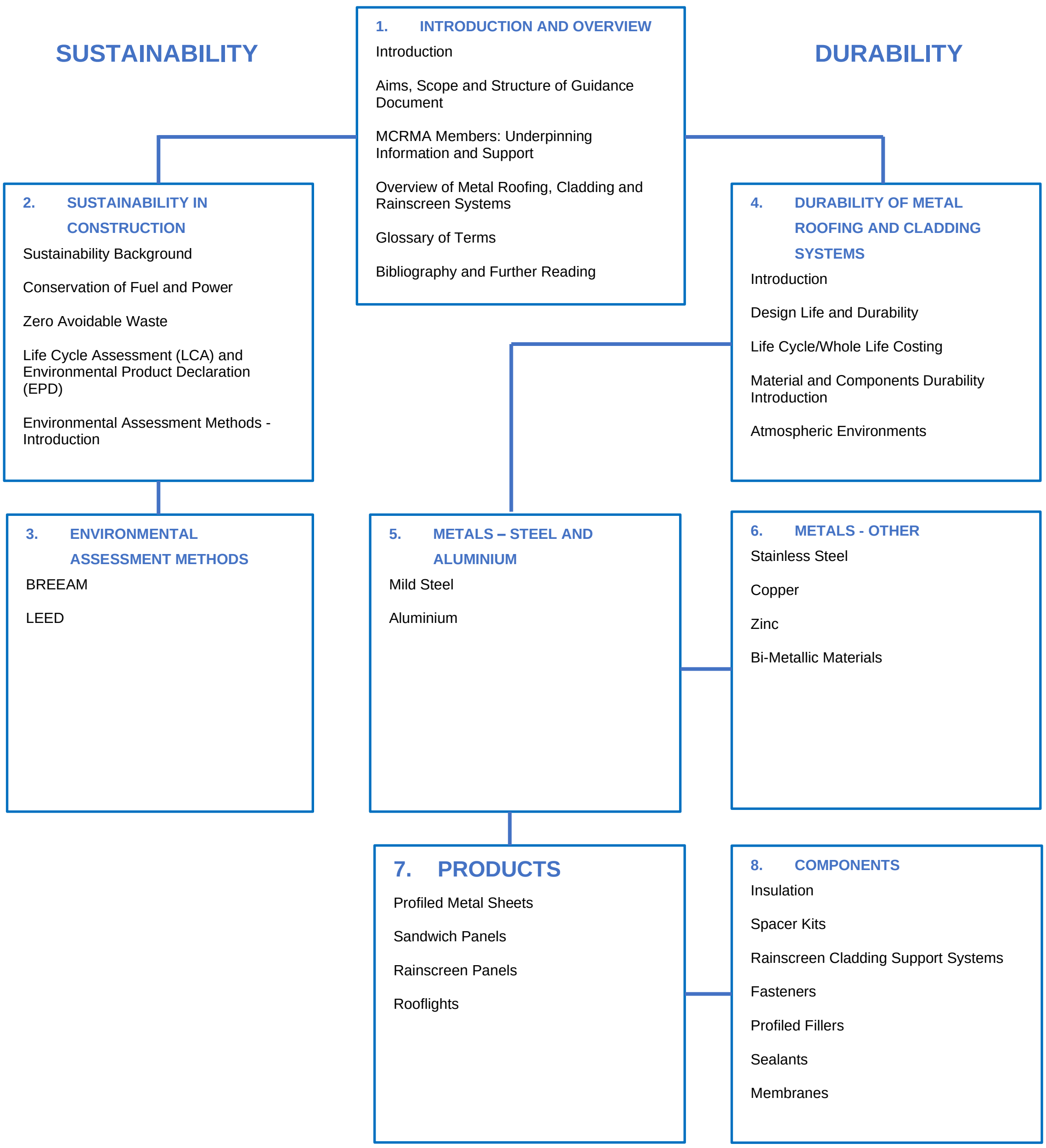
This module has an anticipated CPD value of 60 minutes or equivalent.

You can take the module at https://mcrma.co.uk/online-cpds/

4.5 STRUCTURE OF GD 39



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

4.6 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.

4.7 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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