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CPD APPROVED

GD35 AESTHETICS: ASSESSMENT AND EVALUATION OF COSMETIC IMPERFECTIONS OR DAMAGE

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1.0 INTRODUCTION

'Aesthetics' within the context of building is used to describe the positive appearance of colour, form and details used within the area of the roof and façade. However, it can also be used in a negative way to describe small or large imperfections in materials, junctions, details or finishes on a product or systems which may be visibly unacceptable.

This guidance document provides advice about how to assess and evaluate an aesthetic or cosmetic imperfection or practical concerns, which may become apparent within the profiled wall cladding or panelling of a metal clad building. Equally some of the advice is applicable to profiled roof sheeting, components and flashing and fabrications details. It explains possible reasons for the imperfection or perceived imperfection and offers advice about how, or if, the imperfection can be resolved or rectified via the supply chain.

In all cases, there is a need to highlight any aesthetic imperfections, which may have been identified as early as possible to all parties involved in the manufacturing, supply and installation process. It is vital to document concerns and provide dated visual evidence of aesthetic imperfections and involve those who can provide expert advice and offer a solution

2.0 EVALUATION AND ASSESSMENT

Evaluating surface defects such as scuffs and scratches, dents and other visible surface defects can be quite subjective. An imperfection that few building users would ever notice without close inspection may be judged as unacceptable by others involved in the construction, acquisition and use of a building. Surface defects and imperfections may become apparent on roof profiles of a metal clad building or on the façade of the building during inspection.

The extent of the defect may have implications relating to aesthetics, practicalities or durability of the roof or wall cladding, component, fabrication, flashing or panel. A further complication is the type of façade being viewed. What is acceptable on a profiled metal industrial building may not be acceptable on an ‘aesthetic flat panel or rain screen cladding system’ or on highly visible parts of a building such as a main reception entrance.

National and European building codes do not make any mention of standards for visual acceptability of what may be described as minor surface imperfections. However, the identification of surface imperfections on flashings, fabrications, roof and wall cladding sheets and wall panels is dealt with in several voluntary industry standards widely adopted in America.

Historically, the advice and recommendations from America have been widely regarded by manufacturers and industry professionals as appropriate and prescriptive for the UK market place and international locations. A number of voluntary industry standards exist and these have been adapted to provide the following guidelines.

One of the key factors when assessing a building for either aesthetics or other imperfections is the viewing distance. The following are regarded across the industry as normal and appropriate for each situation:

- For standard profiled wall cladding, the element should be viewed at a distance of not less than 3m away. However, for specific surface coatings reference should be made to BS 3987:1991 *Specification for anodic oxidation coatings on wrought aluminium for external architectural applications* which states viewing distance as 5m externally and 3m internally.
- For standard profiled roof sheeting, the element should be viewed from a standing position
- For rainscreen cladding and highly visible elements the viewing distance should be not less than 1m away.
- For flashings, interfaces and junctions, the element should be viewed at a distance relating to its position on the building (ridge, eaves, window and door reveals, corners and drip details etc.) and referenced to the distances suggested above.

The standards describe a visual inspection procedure that involves walking away from the imperfection for a distance indicated above for a wall or a standing position for the roof, turning and inspecting for imperfections while looking at a perpendicular (90°) angle to the surface of the building under natural exterior lighting conditions. This procedure avoids the over-emphasis of normal surface variations due to a very detailed inspection or lighting angle.

If the inspection does not highlight surface imperfections during the process and under normal lighting conditions (not under the glancing light that might be encountered at sunrise or sunset, for example) the roof or wall cladding and building façade panel are considered to be within normal manufacturing and installation specifications. However, if imperfections can be seen under these conditions and the project team deems them unacceptable, there may be grounds to request rectification or replacement of the item in question.

Fig 1 Reflected sun light producing highlights and shadows across a façade

It should be noted that natural external lighting conditions will vary according to

- Weather conditions
- Time of day
- Time of year
- Orientation of the roof
- Façade elevation (North/South/East/West)

It is therefore possible that inspection under one set of conditions, may highlight defects which are not visible under different conditions. Reflections and shading should also be taken into account as this can influence visual perception.

When observing a building consider also for other visual effects such as:

- Material flatness/shape/oil canning
- Colour consistency
- Sheet/panel alignment and consistency of joint details
- Overall façade flatness
- 'Pulling' of the profile or panel on the roof or wall to meet misaligned steelwork

It is suggested that the building should be viewed from a greater distance and a range of viewing angles (up to +/- 60°) from perpendicular to the surface of the building under natural exterior lighting conditions to get a more overall conclusion.

3.0 DIMENSIONAL TOLERANCES

3.1 Roof and wall profiles

MCRMA members profile self-supporting roof and wall cladding panels in accordance with the harmonised European Standard BS EN 14782:2006 *Self-supporting metal sheet for roofing, external cladding and internal lining. Product specification and requirements* and BS EN 508 *Roofing and cladding products from metal sheet* series product standards. Profile shape and dimensional tolerances associated with roll formed or fabricated roof and wall cladding can influence the in-service functionality and aesthetics of the product or system. The subject is beyond the scope of this document but is dealt with in detail in GD 29 *Manufacturing tolerances for profiled metal roof and wall cladding*.

3.2 Rainscreen panels

Flatness tolerance for rainscreen panels is dependent upon the type of material, thickness or gauge, physical properties, the actual size of the sheet or panel in question, manufacturing route and detailed reference to national or international standards. Flatness of individual panels is generally expressed in terms of width/300 and height/300. Material manufacturers and suppliers should be consulted about dimensional size and tolerances for the product in question at the design and manufacturing stage.

3.3 Sandwich panels

Dimensional tolerances for sandwich panels are detailed in Table 4 - Dimensional tolerances for panels within BS EN 14509:2013 *Self-supporting double skin metal faced insulating panels. Factory made products. Specifications*. For narrow plank profiles sometimes called 'weatherboarding' where the total product width may be 150mm or less it can sometimes be difficult to accurately determine dimensional tolerance.

3.4 Overall façade flatness

Structure tolerances can affect flatness of installed profiled roofing and cladding products and systems and the installed flatness of façade and rainscreen systems. If façade flatness is a key objective an adjustable sub frame should be specified (typically rainscreen carrier systems incorporating 'helping hand brackets') at the design and installation phases. The design specification should also specify flatness/ aesthetic limits required within the contract documentation. Overall horizontal and vertical façade flatness is generally expressed in +/- mm/10m.

Fig 2 Demonstration of how the aesthetics can alter with incident light and orientation

4.0 RAINSCREEN PANEL ALIGNMENT AND TOLERANCE AT JOINTS

Alignment of adjacent panels and maintaining a consistent width of joint between adjacent panels across a façade can have a marked effect on the visual appearance and aesthetics.

The manufacturing tolerances and the overall length and width of individual panels will also impact on alignment and the tolerance of joints. These factors need to be agreed at the design and specification stage and documented in the contractual arrangement.

It is also imperative to ensure that the importance of alignment and joint tolerance is conveyed to the installation contractor before work commences and the items are checked on a regular basis during the installation process. The panel carrier system must be capable of accommodating an allowance for site tolerance in aligning and adjusting joints on rainscreen flat panels.

Narrow joints between panels further enhance the difficulty and a 20mm gap is generally acceptable with 15mm as the minimum. Joints of this size will allow 1 to 2mm adjustment on each panel without being particularly visible. Attention to detail and early correction of any deviation should be noted and rectified as soon as possible.

The following MCRMA guidance documents provide more detailed information and guidance about acceptable primary and secondary steelwork tolerances and deflection criteria, rainscreen support systems, acceptable primary and secondary steelwork tolerances and deflection criteria:

GD08 *An introductory guide to rainscreen support systems*
GD20 *Serviceability states and deflection criteria*
GD24 *Installation of purlins and side rails*
GD27 *Installed tolerances: best practice design guide*

5.0 COLOUR CONSISTENCY

Building codes do not address finish colours and performance, although these are normally detailed in project specifications. Test methods for the durability and performance of coatings for pre-painted and metallic finishes are defined in normative references contained within National and European standards. The MCRMA web site provides lists of relevant standards for the material used in roofing and cladding applications. (See www.mcrma.co.uk/industry-standards/)

The visual appearance of colours can vary for a variety of reasons:

- Batch to batch colour variations
- Grain directionality of metallic or mica-based coatings
- Degradation of colours due to sun exposure and weathering
- Cleaning procedures

Because of the wide range of available panel finishes and performance variability due to colour choice, application, geography, sun exposure and other factors, colour performance should be specified in the warranty for the specific project.

Material for the entire façade elevation should be sourced from the same batch and installed in a consistent direction of lay. This is particularly important for metallic finishes where heavy duty directional protective film should be specified at the design stage and retained on the material while the sheets or panels are temporarily fixed to ensure constant directionality – film must be removed within 6/8 weeks of installation as the film will bond to the panels and will prove difficult to remove.

Flashings should be sourced from the same supplier, coating specification and batch as the sheeting where a colour match is required.

Fig 3 Showing consistent colour match between the panel and the flashing

It should be noted that if a building is being extended, the new extension may show a slight colour variation from the original as it will be from a different manufacturing batch and production run and the original cladding will have weathered.

If doors, window frames etc. are post powder painted to match the façade, there may be a slight variation in colour due to the degree of colour matching and the local profile/lighting effects. These elements will also weather differently to the cladding.

6.0 FASTENERS

In addition to comments in section 7.3 Surface dents and dishing, there are a wide number of fastener types including

- Standard hex head carbon and ‘stainless’ steel fasteners
- Painted hex head carbon and ‘stainless’ steel fasteners with colour matched finish
- Moulded plastic head carbon and ‘stainless’ steel fasteners with colour matched finish
- Low profile carbon and ‘stainless’ steel fasteners with/without colour matched finish
- Rivets with/without colour matched finish
- Push fit site-applied (plastic) caps should not be used for colour matching as an alternative to factory coloured heads as noted above

Fig 4 Examples of different colour head and fasteners

Coloured matched fastener heads can sometimes appear slightly different in colour to the metal sheet, due to their surface profile being at a different angle to the metal, and being made from different materials such as nylon, or painted/coated in a separate process from the metal sheet. Also, degradation of the pigments in the fastener head colouring may differ from that in the cladding surface over a period of time.

Powder coating tends to offer greater colour stability against fading compared to plastic/nylon moulding. Poppy Red fasteners as specified for health and safety reasons on many in-plane rooflight systems is a particular example.

Some panels which naturally weather, such as Corten steel, have a variable colour finish which is produced via an oxidised process that is dependent upon the local environment and natural aging. In these situations, specifiers should consult the fastener supplier for guidance about a suitable colour for the pre-coated head on the fastener.

On an ‘aesthetic flat panel or rain screen cladding system’ or on highly visible parts of a building such as a main reception entrance, it is common practice to select fasteners with a low-profile head design.

Fastener selection should be as per the cladding specification, including location and number for structural requirements. The choice should be in keeping with the overall façade appearance.

For safety reasons in roofing applications, it is an industry recommendation to define a demarcation zone around the perimeter of and within in-plane rooflights to use fasteners of a highly visible bright red colour.

For achieving consistency in the installation of fasteners further reference may be made to *GD32 Self-drilling fastener installation tools* and *GD33 Fasteners for metal roof and wall cladding: design, detailing and installation guide*

7.0 SURFACE IMPERFECTIONS AND SOLUTIONS

The following paragraphs explain how different imperfections can be identified, quantified and assessed. In addition, solutions are offered which may be considered to be appropriate to rectify the imperfection if it is deemed necessary to take remedial action.

7.1 Oil canning

Local oil canning and general distortion in metal is detected as waviness across the flat areas of sheet metal panels or fabrications. In some cases, the effect is used as a design feature to enhance aesthetics across large areas of facades. However, oil canning is usually seen as a weakness of the chosen system; something which was not acknowledged at the design stage, was not allowed for during the material specification stage and therefore only becomes apparent as an issue at the post installation stage. Oil canning is not grounds for profile or panel rejection although it may be considered as aesthetically unacceptable.

Visible rippling, oil canning and distortion on profiled wall sheets is typically caused by excess stress being applied at the installation stage resulting in a deformation of the profile. It is commonly caused by a misalignment of the underlying steelwork adding uneven pressure to the profile. Steel work alignment tolerances should be included in the NBS H31 spec at design stage.

Fig 5 An example of oil canning due to radius of standing seam aluminium.

The alignment of the support structure should be checked prior to installation of the profiles and any discrepancies rectified before installation. Reference should be made to MCRMA guidance documents *GD 24 Installation of purlins and side rails* and *GD 27 Installed tolerances: best practice design guide* for more information on this topic.

Fig 6 Oil canning on a trapezoidal profile.

In addition, astute designers should avoid the use of thin gauge metal for large flat areas where the effects of distortion would not be acceptable, such as in fascias, fabrications and trim bands. Designers should however, understand the phenomenon and specify systems and components which are manufactured from thicker gauge material, include additional bends or folds to provide stiffness or include additional bonded stiffeners. Ultimately the system should be supplied by a reputable and experienced manufacturer who can provide detailed guidance at the specification and contractual stage.

Glass is often considered to be optically flat but toughening bands often lead to visual distortion similar to oil canning. The occurrence of oil canning and distortion within a metal fabrication is solely aesthetic and can only be minimised through proper design, manufacture, handling, fabrication and installation. The effect may also be caused by thermal movement due to a change of surface temperature and localised environmental conditions.

In some cases, distortion can be minimised or removed by releasing the fasteners retaining the sheet, panel or component in question and re-fixing to alleviate potential induced stresses.

A surface texture or the specification of a lightly profiled section can also help to reduce the appearance of oil canning and distortion or alleviate other local or general aesthetic imperfections. However, wide flat profiles, fabrications and flashings may show pockets of shape (oil canning) and this can be caused and highlighted by a number of factors:

- General misalignment of the secondary steelwork/substructure (see GD24, GD27 and SCI P346 *Best practice for the specification and installation of metal cladding and secondary steelwork*)
- Higher gloss finishes highlighting effects which might not be seen in matt finishes
- Wider profiles/pan widths
- Longer sheet lengths and or viewing lengths **NOTE:** Standing seam and concealed fix systems are available in longer lengths
- Longer sheet spans
- Horizontal cladding. Use of 0.7mm gauge for steel material is recommended to reduce this effect. Additionally, a profile ‘gauging template’ may be utilised during the installation phase as this will reduce the concertina effect.
- Fixing pattern and tightness, particularly at sheet end laps

- Wide flashings without stiffening ribs or backing support. Flashings should be fabricated from minimum 0.7mm gauge for steel material and minimum 0.9mm gauge for aluminium material. Increasing flashing leg lengths beyond 150mm significantly increases the risk of oil canning. Use of a stiffening edge fold/welt will also reduce shape issues
- Aluminium fabrications are defined as sections with a material thickness of 1mm or more. These tend to be regarded as aesthetic; items such as bullnose and fascia etc. A fabrication should be attached to a robust structural sub-structure to minimise thermal and dimensional distortion. This subject is beyond the scope of this document but is dealt with in detail in GD26 *Aluminium fabrications: a guide to good practice*.

7.2 Surface dents

If minor surface dents and dishing have been identified during the inspection process (note viewing distances and angles) and it has been shown that the paint or surface layer has not been breached then it may be best not to intervene or carry out any remedial action on the imperfection. However, if the dents are considered to be more severe or are highly visible then there are two options:

1 Repair the dent using a good quality body filler and then overspray the repaired panel to the nearest joint line. It must be noted that this type of repair may result in a slightly different hue or surface texture to that of the original or surrounding panels.

2 Replace the sheet or panel. While this may appear the most satisfactory solution, it must be taken into account that it can be very difficult to remove panels from a façade, without causing further damage and may compromise the cladding performance. It must be noted that the new panel may show colour batch variations and this may be more apparent if weathering has taken place of the original facade.

NOTE Prior to carrying out any repair, the cladding system manufacturer and material manufacturer should be consulted and their guidelines followed.

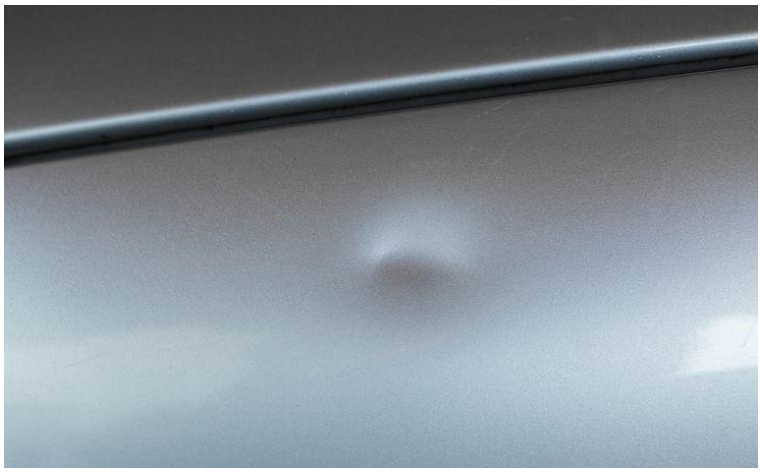

Fig 7 Showing a dent in the surface of a flat fabricated rainscreen panel

In some cases where the surface coating of the panel has not been broken or compromised distortions can be carefully dressed if replacement is not practicable.

The identification of a major dent in the panel or profile may compromise the panel's aesthetics and, in extreme cases, the structural integrity and functional long-term performance, in which case the panel or sheet should be replaced.
The depth (d) of a local dent should not exceed the radius (r) divided by 30 i.e. $d < r/30$.
During the replacement process care should be taken not to compromise the structural or performance integrity of adjacent sheets or panels.

7.3 Dishing

In contrast, dishing is often evident around the local area of a fastener. In many cases the dishing may have been caused by overtightening of the fastener at the installation stage. Dishing around fasteners may be apparent where, during the installation process, cladding sheets and panels have been pulled back to poorly misaligned steelwork and sub structure. (Refer to SCI P346, GD 24 and GD 27 for more information on this topic). Dishing is also often apparent on through-fixed sandwich panels and façade systems if an appropriate fastening method and technique has not been used.

Dishing may however, also occur on twin skin weather sheets particularly where a quilt insulation layer has been compressed OVER the spacer rail. This is NOT recommended good practice particularly on roofing due to longer term weather tightness risks as well as for aesthetic considerations.

On walls the greater consideration is aesthetics. However, some current tested and certified firewall twin skin systems include a quilt insulation layer (or additional layer) compressed OVER the spacer rail.

Fig 8 Example of an over tightened fastener

Consult the firewall system supplier for their tested and certified specification to include sheet gauge/profile, insulation layer(s) and positioning and fastener type and spacing.

In sandwich panel systems and twin skin systems for both roof and wall applications, the extent of dimpling at fasteners is dependent on a number of factors i.e. sheet gauge, sheet profile, valley fix width, crown fix, sealed end laps as well as fastener washer diameters and softness of the sealing element (e.g. EPDM) to adequately compress to seal without excessively dimpling the panel/sheet.

Whereas minor dimpling around the fastener may not affect the weather tightness of the connection it may be reduced to acceptable aesthetic levels by slightly releasing the fastener providing the washer is still under compression.

The contractor, system supplier and fastener supplier/manufacturer should be contacted for specific advice and guidance. For achieving consistency in the installation of fasteners further reference may be made to GD32 *Self-drilling fastener installation tools.*

7.4 Repair of scuffs and scratches

NOTE Prior to carrying out any repairs, the cladding system manufacturer and material manufacturer should be consulted and their guidelines followed. It should also be noted that while a defect may not create an aesthetic issue, it may require remedial action for performance requirements.

Repair options include but are not limited to the following:

- Minor surface scratch which does not fully penetrate through the paint layer:
  Unless the scratch is in a highly visible part of the façade and is easily replaceable, it is generally best to accept the situation.
- Surface scratch which penetrates through to the base metal layer:
  Unless the scratch is in a highly visible part of the façade and is easily replaceable, it is generally best, to carefully touch-up the scratch using a recommended touch-up paint and an artist's fine paint brush.

Fig 9 A series of scratches and small dents on a lightly profiled panel which detracts from the aesthetics and could impact on the remediation process and subsequent guarantee

7.5 Implications of paint touch up and overpainting

The building owner should check the condition clauses within the guarantee with the material provider, system manufacturer and cladding contractor as different manufacturers and suppliers will have different terms and conditions which may have an impact on the long-term status of the guarantee.

Where the defect in the panel or roofing or cladding profile is due to a factory painting defect, the material provider may propose an overpainting option, however if this is done at their request, then the guarantee should remain unaffected. It must be noted that an over-painting option may result in a different surface texture than the original coating.

Where the defect in the panel or roofing or cladding profile is due to an installation defect, the onus to maintain the guarantee needs to be clarified between the owner, installation contractor and the repair contractor.

In all cases where a repair or rectification has been carried out which may have an influence on the original guarantee, written confirmation must be obtained from the manufacturer of the panel or system and should make reference to the advice from the material supplier. The guidance should be retained for future reference by the building owner.

MCRMA member companies provide a wide range of building envelope solutions for metal-based roofing and cladding products and services and they can advise on the suitability and performance of materials, systems and assemblies. In addition, design information can be obtained from any of the independent roofing and cladding inspectors featured on the MCRMA web site at www.mcrma.co.uk

MCRMA ONLINE CPD PROGRAMME

This guidance document is available as an online CPD and is accredited by the CPD Certification Service. The MCRMA 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.

MCRMA provides informative self-study training, delivering good learning value with an online assessment to check knowledge. The course material is an informative self-study with an online evaluation to test knowledge.

To take the CPD associated with this document, go to GD35 CPD Test.

8.0 REFERENCES

Standards

BS EN 508-1:2014 *Roofing and cladding products from metal sheet. Specification for self-supporting of steel, aluminium or stainless steel sheet. Steel*

BS EN 508-2:2019 *BS EN 508-2:2019. Roofing and cladding products from metal sheet. Specification for self-supporting products of steel, aluminium or stainless steel sheet. Aluminium*

BS EN 508-3:2008 *BS EN 508-3:2008. Roofing products from metal sheet. Specification for self-supporting products of steel, aluminium or stainless steel sheet. Stainless steel*

BS 3987:1991 *Specification for anodic oxidation coatings on wrought aluminium for external architectural applications*

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

BS EN 14509:2013 *Self-supporting double skin metal faced insulating panels. Factory made products. Specifications*

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

MCRMA Guidance Documents

GD08 *An introductory guide to rainscreen support systems*

GD20 *Serviceability states and deflection criteria*

GD24 *Installation of purlins and side rails*

GD26 *Aluminium Fabrications: a guide to good practice*

GD27 *Installed Tolerances: best practice design guide*

GD29 *Manufacturing tolerances for profiled metal roof and wall cladding*

GD32 *Self-drilling fastener installation tools*

GD33 *Fasteners for metal roof and wall cladding: design, detailing and installation guide*

SCI P346 *Best practice for the specification and installation of metal cladding and secondary steelwork*

All the above documents are available for download from the MCRMA web site at www.mcrma.co.uk

Articles

http://www.alpolic-americas.com/understanding-visual-acceptance-standards/
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Useful links

American Architectural Manufacturers Association
http://www.aamanet.org/

Centre for Window and Cladding Technology
http://www.cwct.co.uk

Metal Construction Association
http://www.metalconstruction.org/

Ruukki
https://www.ruukki.com/

Tolerances of product dimensions - rainscreen panels
http://cdn.ruukki.com/docs/default-source/b2b-documents/facades/rainscreen-panels/rainscreen-panel-product-tolerances-24-11-2015.pdf?sfvrsn=2

Installation tolerances
https://cdn.ruukki.com/docs/default-source/b2b-documents/facades/joint-folder/facade-cladding-installation-and-base-tolerances_24_11_2016.pdf?sfvrsn=10c1dd84_10

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