GUIDANCE ON SERVICEABILITY STATES AND DEFLECTION CRITERIA

Introduction

The Metal Cladding and Manufacturers Association (MCRMA) had noticed a gap in the published Standards relating to the serviceability states for design. This has now been addressed in a new MCRMA publication which also gives guidance on secondary steelwork installation tolerances.

In structural engineering, serviceability refers to the conditions under which a building is still considered useful. Should these limit states be exceeded, a construction that may still be structurally sound would nevertheless be considered unfit. It also includes conditions other than the building strength that might render a building unusable; such as durability, overall stability, fire resistance, deflection, cracking and excessive vibration.

MCRMA recommends that appropriate and workable serviceability states and deflection criteria should be agreed at the outset. When applied to the primary structure, secondary structure and the building envelope, it will ensure that all elements of the construction perform as expected and also that the interface, interaction and fit between components and systems meet with expectations.

Without these criteria the building will not perform correctly and the installation and attachment of component parts by follow-on trades might be compromised. Follow-on trades which are contractually responsible for accepting the condition of the earlier works prior to the installation of subsequent components must ensure that the serviceability states and deflection criteria meet the design parameters for their products before proceeding.

In the design of light gauge steel sheeting and purlins, British Standards define load factors and load combinations for ultimate limit state (ULS) design, i.e. resistance to collapse but do not give guidance on serviceability limit states (SLS), i.e. stiffness and limiting deflections.

Why serviceability limits?

Serviceability limits states concern the functioning of the structure under normal use, the comfort of building users and the appearance of the structure. These may be irreversible or reversible; with metal roofing and cladding the SLS are normally reversible (when none of the consequences remain after the actions have been removed).

Criteria that might be considered during SLS design checks are:

- Deflections that affect the appearance of the structure, comfort of its users and its functionality (cracking, movement, air tightness, water tightness, drainage, etc.)
- Vibrations that may cause discomfort to users of the structure and restrict the functionality (noise etc.)
- Damage that may affect appearance or durability (distress to fixings and sealants, ceilings, fittings, ponding etc.)

The deflections of a profiled sheet under serviceability loads should not impair the strength or efficiency of the sheeting or of its fixings, or cause damage to flashings, insulation or waterproofing.

The dead load (permanent) should reflect the actual load acting on the structure and the imposed load (snow and foot traffic) should reflect any temporary or transient load at the location. Wind loading should normally be assumed to be uniform on all spans of multi-span sheeting.

Structural element (fittings = ceilings/services etc)	Purlins and structural deck (fittings = plasterboard/ fragile types)	Purlins and structural deck (fittings = non-fragile types)	Purlins and structural deck (fittings = n/a)	Profiled metal roof sheeting (fittings = n/a	Sheeting rails (fittings = n/a)	Profiled metal wall cladding (fittings = n/a)
Deflection limit- Dead (permanent) loads	L/500	L/500	L/500	L/500	n/a	n/a
Deflection limit- Dead + Live (permanent and variable) loads	L/360	L/250	L/200	L/200	n/a	n/a
Deflection limit- Dead + Wind/Snow drift loads (permanent and variable, as applicable)	L/150	L/150	L/150	L/90	L/90	L/90

Table 1 Deflection limits: MCRMA recommendations.
Note: Manufacturer's published guidance takes preference if different

Installation tolerances

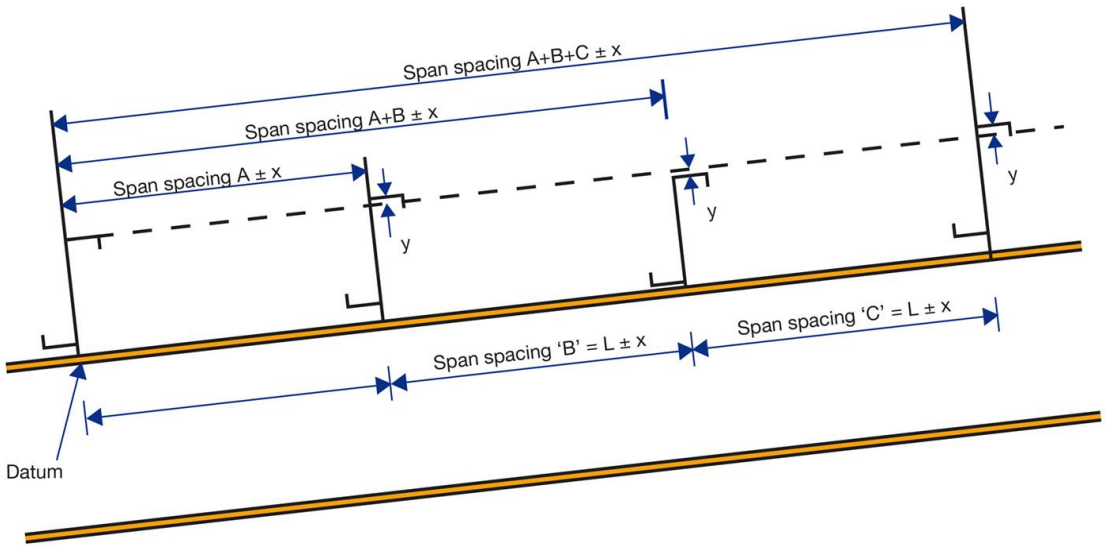
As already mentioned, installation tolerances are also an important consideration at the design stage and it is vital that the agreed tolerances are maintained during the erection and installation period. Historically, there has been little guidance available for the installed position and tolerance of secondary steelwork - light gauge steel purlins and sheeting rails.

The absence of standards leaves setting and accepting them open to commercial and programme pressures, resulting in lower quality and impaired performance and durability.

Installation tolerances for purlins and rails supporting profile metal roof sheeting and wall cladding must be agreed and set for practical reasons and to give the installer the best chance of locating the purlin or rail and installing fasteners consistently. Misalignment of a purlin can be due to rotation under self-weight or following loading out, general deflection and sag or excessive installation tolerances.

If the purlin is not close to the intended position, fasteners may unknowingly miss the purlin risking attachment failure and end laps could miss purlins and both air tightness and water tightness could be compromised.

The recommended tolerances for x and y, downslope and vertical deviations from the intended positions are shown in the diagram below and table overleaf:



	Built up metal twin skin system	Standing seam twin skin system	Factory insulated panels
X mm, down slope	20mm	20mm	10mm
Y mm, 90° to slope (L=purlin spacing, mm)	+/-L/100 (typically +/- 15mm at 1.5m purlin spacings)	+/-L/200 (typically +/- 7.5mm at 1.5m purlin spacings)	+/-L/300 (typically +/- 5.0mm at 1.5m purlin spacings)

Table 2 Purlin position tolerances for metal roofing.
Note: Manufacturer's published guidance takes preference if different

This subject is covered in the latest MCRMA publication, *Guidance document on serviceability states and deflection criteria*, which includes guidance on installation tolerances for purlins and rails supporting profile metal roof sheeting and wall cladding and examines structure positioning from the point of view of the practicalities of installing a roof or wall covering. The document can be downloaded from the MCRMA web site.

MCRMA member companies can advise on the suitability and performance of materials, systems and assemblies to ensure that the deflection criteria are calculated properly and that the cladding and components are specified accordingly. 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

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This article was written for MCRMA by David Lowe, chairman of MCRMA

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