Guidance document GD 27 **July 2016**

INSTALLED TOLERANCES: BEST PRACTICE DESIGN GUIDE

1.0 INTRODUCTION

The Metal Cladding and Roofing Manufacturers Association's guidance documents GD 20 *Guidance document on serviceability states and deflection criteria* and GD 24 *Installation of purlins and side rails* give guidance relating to the installation of purlins and side rails and to the serviceability states and deflection criteria on secondary steelwork installation.

These documents (particularly GD 20) both refer to the importance of complying with tolerance limits and serviceability limits (e.g. deflections) with the secondary steelwork frame, ensuring the ability of the roofing and cladding systems to perform correctly.

The secondary steelwork frame is directly attached to the main steel frame and so any defects in the installation of the various components of the main frame (i.e. columns and rafters) can adversely affect the line and level and attitude (i.e. twist) of the secondary steelwork, which in turn can adversely affect the installation and performance of the cladding.

The purpose of this guidance document is to make the cladding sub-contractor aware of the relevant tolerances that are allowed in the fabrication and erection of the main steel frame and in particular the relevant parts of the British Constructional Steelwork Association Publication No. 52/10 *National Structural Steelwork Specification for Building Construction 5th Edition CE marking version*, the document which covers these tolerances.

This edition GD 27 published 18/07/16

The cladding installer is often left to overcome an out of tolerance structure, compensating for the shortcomings of installation by others, and to deliver a performing and aesthetic cladding.

It is the intention of this guidance document to make the cladding sub-contractor aware of how deviation from these tolerances can affect the performance of not only the cladding system and its fixings but also of associated components such as gutters and flashings and also of any possible contractual issues.

However, it is not the intention of this document to imply that the cladding sub-contractor is responsible for achieving the required tolerances of the structural steelwork or for fully checking the steelwork for any out of tolerances.

Note:

In this document any reference to cladding is intended to include both roof and wall cladding systems.

2.0 CONTRACTUAL REQUIREMENTS

Contract specifications for steelwork contain clauses referring to compliance with the latest edition of the National Structural Steelwork Specification (NSSS) (BCSA Publication 52/10).

They also include specific references to the setting out of the steelwork and permissible deviations and complying with the requirements of the NSSS (section 8.9, BCSA Publication 52/10) requires that when the steelwork has been completed (i.e. installed) the steelwork contractor shall present the employer with a certificate for both parties to sign.

The steelwork contractor signs the certificate to confirm that an inspection has been made and that the steelwork is erected in accordance with the NSSS specification and the specific contract requirements.

The employer signs the certificate to signify acceptance that the structure has been built in accordance with the NSSS specification and the specific contract requirements.

It is **not** the responsibility of the cladding sub-contractor to ensure that these NSSS requirements have been met. However, main contractors in their sub-contract documents often require the cladding sub-contractor to check the secondary steelwork before commencing the cladding and to advise them of any potential problems with the secondary steelwork supports.

If the cladding sub-contractor fails to notify the main contractor of any such problems, possibly due to programme pressures, then the main contractor may hold the cladding sub-contractor responsible for the rectification of any such defects in its work and also for all the damages incurred by the contractor as a result.

The following sections deal with some of the more common tolerances and what some of the problems are and how they can adversely the cladding.

3.0 PRIMARY (STRUCTURAL) STEEWORK: PERMITTTED DEVIATIONS (TOLERANCES)

Structural steelwork is subject to permitted deviations in its fabrication and erection and BCSA Publication No. 52/10 details these as follows:

- Section 7.2: Permitted deviations for rolled components after fabrication. This includes criteria such as deviation from straightness, length and curve.

- Section 7.3: Permitted deviations for elements of fabricated components rolled components. This includes items such as fittings (e.g. welded purlin supports) and their position and alignment, position of holes and flatness of contact surfaces.

- Sections 7.4; 7.5; and 7.6. There are also permitted deviations for fabrication of plate girder sections (section 7.4), box sections (section 7.5) and lattice components (section 7.6).

- Section 9: Permitted deviations in erection of steelwork, in particular section 9.6 for erected components such as columns, beams and rafters.

4.0 SECONDARY (LIGHT GAUGE) STEELWORK: PERMITTED DEVIATIONS (TOLERANCES)

Guidance on manufacture and installation tolerances for secondary/light gauge steel sections can be found in MCRMA document GD24 and SCI document SCI P346 – *Best practice for the specification and installation of metal cladding and secondary steelwork*.

5.0 PROBLEMS CAUSED BY OUT OF TOLERANCE STEELWORK AND CLADDING AND THE EFFECTS ON CLADDING

The secondary cladding supports are also subject to tolerances, albeit there is very little available guidance on specific erection tolerances in the UK, but guidance is given in MCRMA GD 24, and because the secondary supports are connected directly to the main steel frame any out of tolerance within the structure will be transmitted to the secondary supports, and in turn, to the cladding and its fixings, which are fixed directly to the secondary supports and are not packed off them to achieve line and level.

There are many reasons why packing is not installed, for example, time, cost and structural problems with restraint of the supports.

A problem can arise where both structural restraint and packing are required, and with packing, is where the lateral stability of for example, a purlin depends upon the liner panel being in contact with and being fixed directly to the top flange of the purlin. This is not to be confused with purlin sag down the slope (where, if excessive, fixings from items such as liner panels and spacer brackets in built up roof systems, or composite panels, may miss the purlin flange).

As referred to above, there are different types of cladding systems, for example built-up twin skin insulated cladding systems, some with intermediate end laps and some with full length sheets, composite panels and standing seam systems.

Some of these systems such as standing seams can be more affected by out of tolerance than other systems, where, for example, any excessive undulations in adjacent purlin levels can affect the nesting and hence structural integrity and weathering of the system.

The importance of ensuring that bolt-on purlin cleats are installed within acceptable tolerance and how failure to do so can cause a rotation of purlin flanges and the consequences of unacceptable twist on cladding are dealt with in section 4.5 of MCRMA GD 24, similarly with welded cleats and the tolerance is approximately 1° from vertical which is the recommended rotation tolerance.

Another potential problem of purlin cleats not being within permitted tolerance along a rafter, where up to ± 5mm of tolerance is permitted with regards to the cleat position on the rafter, is that many composite panels require a minimum end bearing of 10mm onto a purlin and this out of tolerance combined with sag of the purlin down the slope can adversely affect end laps and bearing of the panels onto the purlin.

Other items associated with cladding such as gutters and flashings can also be adversely affected by a combination out of tolerance.

Gutters are always fixed either directly or indirectly (via brackets) to the purlins, which in themselves are allowed a certain acceptable amount of deflection (see MCRMA GD 20), which can result in ponding water in the gutter, and this can be exacerbated say in the case of a valley gutter if a column is out of inclination tolerance affecting rotation of adjacent rafters and, hence eaves purlins (see section 9.6.3.3 of BCSA 52/10).

Verge rafters are connected to perimeter columns which are permitted (see section 9.6.8.4 of BCSA 52/10) to be out of alignment one to the other by 100mm. Because the purlins are supported by this rafter and the cladding by the columns, more than this permitted deviation can cause problems not only with the line of the cladding but also with the verge flashings.

Excessive deviations in steelwork tolerance can also adversely affect the ability of the cladding to provide the necessary degree of airtightness.

6.0 RECOMMENDATIONS FOR CHECKING

It is recommended that the cladding sub-contractor should ask to see that the certificate (referred to in section 2.0 above) has been signed.

Very often, due to programming constraints, the cladding sub-contractor has to order materials from steelwork drawings, which are subject to change. In this instance, the cladding sub-contractor should ensure that they have the latest drawings when they place the order and make it clear to the main contractor that this is the situation.

The cladding sub-contractor should only work from the latest construction issue drawings and should refer to these on their own drawings and also be aware of any changes made to the drawings as this may, for example adversely affect lengths of members and hence sheet lengths and laps.

The sub-contractor should also request that they have reasonable notice and access to site prior to them commencing so that they can carry out a visual inspection, photographing and recording any obvious defects (such as missing anti-sag rods or excessive out of alignment of purlins) and also checking critical dimensions, such as length and width given that the permitted deviations in the length (width) of a building can be as much as 75mm for buildings up to a dimension of 250m (see section 9.6.8.1, BSCA publication 52/10). This might only affect flashing sizes but can lead to problems with delay (which may well be construed as a part of the damages that are incurred by the contractor).

It is often not practicable for a complete survey of the structure and secondary steelwork to be carried out prior to installation of cladding and it is only when cladding commences that problems may be encountered. In this instance, the sub-contractor should try and identify any problems as soon as is practicable and inform the main contractor.

Situations sometimes arise on site where there are missed or loose bolts on structural members and if these are installed/tightened for example, after a liner panel has been installed in a built up roof system this may create problems with seals on the liner panel. Vigilance on behalf of the cladding sub-contractor may prevent such situations from arising.

The cladding sub-contractor may also wish to consider having any adversely worded sub-contract documents suitably amended with regards to the sub-contractor's checking of the structure.

7.0 CONCLUSIONS

It is important that the installation and deflection criteria are set at the design stage and implemented at the construction stage to 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 will be compromised. Follow-on trades which are contractually responsible for accepting the condition of the earlier works prior to commencing the installation of subsequent components must ensure that the serviceability states and deflection criteria meet the design parameters for their products before proceeding.

Adoption by industry of the guidelines outlined in this document will lead to better and more consistent standards of metal roofing and cladding construction.

MCRMA member companies can advise on the suitability and performance of materials, systems and assemblies to ensure that the installation and 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

REFERENCES

British Constructional Steelwork Association Publication No. 52/10 – *National Structural Steelwork Specification for Building Construction 5th Edition CE marking version*
http://www.steelconstruction.info/Steelwork_specification

MCRMA guidance document GD 20 *Guidance document on serviceability states and deflection criteria*
http://mcrma.co.uk/wp-content/uploads/2016/01/GD20-MCRMA-deflections-document.pdf

MCRMA guidance document GD 24 *Installation of purlins and side rails*
http://mcrma.co.uk/wp-content/uploads/2016/01/GD24-MCRMA-purlins-document.pdf

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

DISCLAIMER

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Published 18/07/16