STEEL INDUSTRY GUIDANCE NOTES

Achieving airtightness with metal cladding systems

The airtightness of buildings has become increasingly important in recent years as the regulatory authorities attempt to reduce energy consumption and the associated greenhouse gas emissions. Building Regulations Part L 2006 will continue this trend, by requiring an improvement in energy efficiency compared with the requirements of the 2002 Regulations of between 23.5% and 28%. Although building designers may choose between a variety of means to achieve this improvement, it is likely that airtightness will play a central role in ensuring compliance with the new regulations. Moreover, air leakage tests will be compulsory for all buildings larger than 500m².

There are many potential sources of air leakage in a building, for example poorly-fitting window frames or badly-detailed service penetrations, but there is little doubt that significant improvements in airtightness may be achieved by the correct specification and installation of the cladding and its supporting steelwork. This guidance note highlights the key issues.

1. Sizing the purlins and side rails

Purlins and side rails are normally selected from the manufacturer's load/span tables taking into account the anticipated gravity and wind uplift loads and the maximum permissible deflection of the member and the cladding it supports. This last point is crucial, as excessive purlin / side rail deflection can cause failure of the cladding leading to air leakage and a loss of weathertightness. Specifiers should note that some cladding systems are more tolerant of deflections than others and most manufacturers give guidance on this issue.

In using the load/span tables, specifiers automatically accept the assumptions made by the purlin and side rail manufacturers regarding the level of restraint provided by the cladding to the supporting steelwork. There is little doubt that the assumption of full restraint under gravity loading (or positive wind pressure in the case of a wall) is valid for insulated panels and the liners of built-up systems. However, the wind uplift or negative pressure situation is less straightforward as the ability to provide restraint depends on the flexural stiffness of the cladding sheet or panel. The matter is further complicated by the fact that varying degrees of restraint are assumed by the different purlin / rail manufacturers in their load/span tables. If in doubt, advice should be sought from the manufacturers. Specifiers might also consider the use of anti-sag bars in order to increase the capacity of the otherwise unrestrained purlins. Their use might also be considered where particularly tight tolerances are required, for example when using standing seam roofs.

2. Choice of cladding system

The choice of cladding system is usually a matter for the architect and is often governed by aesthetics. However, there are also important structural issues to consider and implications for airtightness as listed below:

- Tolerance requirements for the supporting steelwork, i.e. how accurate the purlins or rails have to be positioned to support the chosen cladding.
- The ability of the chosen cladding system to provide restraint to the purlins or side rails.
- The need for maintenance and inspection – this has important Health and Safety implications.
- The ability of the cladding to support foot traffic without damage.
- The ease with which airtight seals can be obtained between panels.

Where built-up systems are used, the ability of the cladding to perform as required is dependent not only on the characteristics of the individual components (liner, spacer system, weather sheet and fasteners), but also on the interaction between them. It is essential, therefore, that specifiers choose recommended combinations of components, rather than specifying each in isolation.

3. Good site practice - purlins

A potentially significant source of air leakage through the building envelope is inaccurate positioning of the supporting purlins or side rails, either due to poor fabrication and erection or due to sagging under the weight of men and materials. Whatever the cause, a poorly positioned purlin will be difficult to fix to and could, if the problem is

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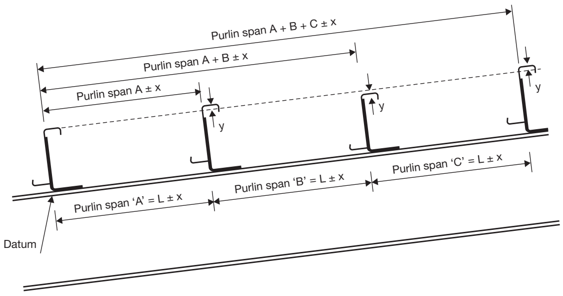
sufficiently severe, result in the panels or sheets having insufficient bearing support or fasteners being incorrectly installed (e.g. at an angle to the purlin flange) or missed out altogether.

With regard to fabrication, the most important issue is the correct positioning of the purlin cleats on the rafters (or side rail cleats on the columns). In respect of the cladding installation, there are two criteria to consider:

1. The location of the cleat relative to a datum (e.g. the eaves) and relative to the neighbouring cleats – see Figure 1.
2. The orientation of the cleat in the plane of the supporting steelwork.

Tolerances on purlin location



The required degree of accuracy is dependent on the type of cladding that the purlins are intended to support. For example, built-up cladding systems are able to accept greater tolerances than standing seam systems. Recommended tolerances for cleat location (dimension x in Figure 1) and orientation are given in SCI-P-346 due for publication in summer 2006 and will also be included in the next edition of the National Structural Steelwork Specification. However, specifiers are advised to contact the cladding manufacturers to ascertain whether tighter tolerances are required for the chosen cladding system and, where appropriate, to inform the steelwork contractor of this fact. The level of the top flange of a purlin relative to those on either side (dimension y in Figure 1) might also be important for certain types of cladding (e.g. insulated panels).

4. Good site practice - cladding

The ability to correctly fix the cladding to the purlins (or side rails) depends not only on the position and orientation of the cleats, but also on the deflection of the purlin within its span. While there this clearly a responsibility on the purlin specifier to ensure that the chosen purlin has sufficient stiffness not to sag excessively during construction, anecdotal evidence suggests that a significant number of reported problems could have been prevented by good site practice and better communication between the specifiers and contractors.

It is common practice to specify purlins on the assumption that they will be fully restrained in the gravity load case. However, in practice, purlins are often required to support the weight of operatives and materials during construction before the cladding has been fixed in place and such loading can cause considerable damage if the necessary precautions are not taken. Therefore, the main contractor and any sub-contractors who require access to the unfinished roof should be made aware of the limitations of the unrestrained purlins and devise their methods of working with these limitations in mind. It is strongly recommended that packs of cladding and other materials are loaded over the rafter backs and that all cladding operations proceed from the rafter into the span of the purlins, with the cladding panels (or liner sheets) fastened in place as they are laid.

Key Points

1. The airtightness of buildings is becoming increasingly important and Building Regulations Part L will continue this trend.
2. The cladding is an integral part of any building and should not be specified in isolation.
3. Airtightness of the building envelope requires that all component to fit properly together, are correctly sealed and do not move apart under load.
4. The positional tolerances of the supporting steelwork are of paramount importance in achieving airtightness.
5. When specifying the purlins and side rails, the specifiers should ensure that the deflections under permanent and construction loads do not exceed the limits for the chosen cladding type.
6. Efficient structural design requires good interaction between all components of the cladding system and supporting steelwork, e.g. restraint of the purlins by the cladding.
7. Specifiers should consider the use of anti-sag systems to provide additional restraint to the purlins / side rails and to limit deflections.
8. Assumptions made during the specification of the purlins should be communicated to the main contractor and sub-contractors to ensure that suitable methods of working are devised for operations on the unfinished roof.
9. Care must be taken not to cause excessive sag due to inappropriate positioning of construction loads. All materials should be loaded onto the rafter backs and unrestrained purlins should not be used to provide access.

Further sources of Information

National Structural Steelwork Specification 5th Edition (due January 2007)
SCI-P-346 Good practice for cladding of industrial buildings (due summer 2006)