Technical Note No. 77

Assessment and certification of rainscreen systems

Rainscreen walls are commonly used in modern buildings. Weathertightness of walls is commonly specified by performance requirements for air leakage, water penetration and wind resistance. Rainscreens may also require testing to assess impact resistance. This Technical Note explains how these aspects of performance can be assessed and certified.

Introduction

The CWCT Standard for systemised building envelopes sets out a performance standard for weathertightness of building envelopes based on testing.

Testing and certification of curtain wall systems has been carried out for many years.

Rainscreen suppliers are often required to provide certificates for their systems to gain acceptance from the specifier or a warranty supplier. A rainscreen wall consists of a back wall and a rainscreen. It will usually have windows as well. The rainscreen, the back wall and the windows are often supplied by different companies and the combination of components will vary from project to project however the performance of the wall depends both on the performance of individual components and on their interaction. Testing of individual components does not therefore give a complete assessment of performance in a wall.

A further complication arises from the fact that a rainscreen does not present a complete barrier to the passage of water and watertightness of the complete wall depends on removal of water passing the rainscreen. Any testing of a rainscreen for watertightness requires a judgement on the acceptability of the amount of water passing the rainscreen and its effect on the components of the wall.

This Technical Note describes the procedures that may be used to demonstrate that a rainscreen system meets the requirements of the CWCT Standard for systemised building envelopes.

Requirements of CWCT Standard

Airtightness

Walls are required to be airtight to maintain a comfortable internal environment and to limit heat loss.

The CWCT Standard describes procedures for testing the airtightness of building envelopes. This is appropriate for curtain walling where the main concern is air leakage through gasket joints which can be reproduced on a test sample.

In a rainscreen wall, airtightness depends on the performance of the back wall, the windows and the interface between the windows and the back wall. In many cases the back wall is constructed as infill between the floors and the seal between the back wall and the floors will also be important. The rainscreen does not contribute to airtightness of the wall.

In the design of a rainscreen wall, the air barrier needs to be identified and the barrier needs to be made continuous at interfaces between different forms of construction. For a masonry wall, the air barrier will normally be the plaster or dry lining on the inside face of the wall. For a stud wall, the air barrier may be sheathing boards on the inside or cavity face of the studs. In this case the joints between the boards must be sealed. The air barrier will be subject to wind load in both positive and negative directions and the air barrier needs to be supported so that it can resist the resulting forces.

Testing for airtightness on a laboratory specimen only has value on a project basis when all the relevant construction details are known. Even in this case, airtightness may be more dependent on workmanship than the design of the sealing system making laboratory testing of limited value.

Watertightness

Watertightness of a rainscreen wall may be achieved in different ways. In some cases the back wall is fully watertight and in such cases the back wall can be tested for watertightness without the presence of the rainscreen. Any fixings for the rainscreen that might compromise the watertightness of the back wall should be present.

In other walls, watertightness is achieved by the rainscreen limiting the amount of water that enters the wall and by effective removal of this water by drainage and ventilation. The wall construction may not have a fully watertight layer provided that water can be removed to the outside before it penetrates to the inside. It is however common practice to have a water resisting membrane in the wall. Most commonly this takes the form of:

- Aluminium foil facing to the cavity face of insulation boards with foil tape over the board joints and around rainscreen fixing brackets. This method has the disadvantage that it is time consuming to install as all the penetrations at brackets have to be sealed. Any water that gets behind the foil is likely to be trapped within the wall.

- A breather membrane, normally located between the back wall and the insulation. If the membrane is behind the insulation it will be subject to less water than on the face of the insulation. As the membrane is vapour permeable any water that does penetrate the membrane, for example at penetrations for fixings may be able to escape.

- A waterproof membrane, commonly epdm, between the back wall and the insulation. If the membrane is not vapour permeable there is a greater risk of water being trapped within the wall if it penetrates, for example, at fixing locations.

Testing a rainscreen wall for watertightness under a static air pressure difference is unlikely to be realistic as it will not generate significant air movement through the joints in the rainscreen. The CWCT Standard for systemised building envelopes requires watertightness testing of a rainscreen wall to be carried out on a large scale test specimen using the dynamic aero-engine test.

With most rainscreen walls some water will be blown across the rainscreen cavity and will wet the face of any material at the back of the cavity. Generally the greater the height of the cavity the greater the degree of wetting.

The extent of water penetration may depend on the width of the air gap, thickness of insulation, presence of cavity barriers, fixings used for the insulation, presence and method of retaining water resistant layers. For a project test these details are known and should be replicated in the test specimen. For a system test these details will not be known and the test specimen should replicate the worst arrangement likely to be used. This will generally be

- Minimum width of air gap
- Minimum thickness of insulation
- Inclusion of horizontal fire barrier.

To enable the extent of water penetration to be assessed, viewing ports are normally provided in the back wall. At the end of the test it is necessary to dismantle sections of the wall to assess the extent of water penetration. This will include removal of sections of any water resisting membranes.

Prior to testing a rainscreen wall for watertightness, the permissible extent of water penetration through the wall should be established. Water should not penetrate to the inside face of the wall. The presence of water within the rainscreen cavity is acceptable provided that it is adequately drained. Whether other materials in the wall are allowed to be wetted will depend on the nature of the materials used and should be established for a particular wall prior to test.

The most vulnerable details for water entry into the building are at window interfaces and similar details where water must be drained from the cavity. These details tend to be

project specific and cannot be replicated in a typical test panel for a rainscreen system alone.

Wind resistance

A typical rainscreen system will have rainscreen panels, support rails and brackets to fix the support rails to the back wall. There will also be fixings to connect the panels to the rails, the rails to the brackets and the brackets to the wall.

Many systems have vertical rails which support the panels directly but some have horizontal rails in addition to vertical rails with the panels hooked onto the horizontal rails.

When a rainscreen wall is subject to wind load, the windload may act on the rainscreen panels or the backing wall. Windload acting on the rainscreen is often transferred to the structure through the backing wall but can be applied directly to the structural frame if the cladding rails are sufficiently robust to span between floors.

The CWCT Standard requires the backing wall to be designed to carry the difference between the external wind pressure and the internal wind pressure. The rainscreen is required to be designed to carry the external wind pressure only. If the rainscreen is pressure equalised, the rainscreen is only required to carry two thirds of the external wind pressure.

For a curtain wall, resistance to windload is normally assessed by a combination of testing and calculation. Testing is required to show that the air permeability and watertightness are not affected by application of wind load. Calculation is required to demonstrate that stresses and deflections are acceptable for arrangements of the curtain wall that have not been tested.

For rainscreen walls, deflection of the wall under wind load is unlikely to affect air or water penetration through the wall and wind resistance of both the backing wall and the rainscreen can be established by calculation in accordance with codes of practice.

For standard components of the rainscreen it may be economic to assess performance by small scale tests.

Where a large scale specimen has been constructed for assessment of airtightness and watertightness it is a simple matter to test the back wall for wind resistance. Testing the rainscreen requires the joints between the rainscreen panels to be sealed and an opening to be made in the back wall to allow the pressure in the test chamber to act on the rainscreen.

Testing of a large scale rainscreen specimen can be valuable to confirm the validity of assumptions made in calculations but is unlikely to be sufficient on its own to fully assess the performance of a system. It therefore needs to be supplemented by calculations and/or component tests in the following cases

- Some components of the system particularly fixings may require higher factors of safety than can be used for testing the large specimen which contains other components designed to lower factors of safety

- Full scale testing cannot replicate all the variations of panel size and framing member span

If testing for resistance to wind load is carried out, acceptable limits on deflections must be established.

Deflection of the back wall will generally be governed by the need to support internal linings and may be limited to span/360.

Deflection limits for rainscreen panels are given in the CWCT Standard as 1/90 of the span between points of attachment for aluminium, glass and steel and 1/360 of the span or 3mm for stone and similar brittle materials. For a panel supported at the corners, deflection along the edge can be related to the length of that edge and deflection at the centre of the panel can be related to the diagonal dimension of the panel.

Deflection limits for rails supporting rainscreen panels are not clearly defined. Rainscreen support rails are often fairly lightweight with support brackets at less than 1m centres.

There are support rail systems that are widely used for rainscreen panels. These may be

validated by manufacturers' safe load tables, they may be designed following design codes or they may be tested on a project basis.

The ability of the wall to stand up to the 'wind' generated by the aeroengine in the dynamic watertightness test gives additional confidence that the wall can resist the dynamic effects of the wind.

Testing is also necessary for systems that may be affected by fatigue. Fatigue tests would normally be carried out on small assemblies where load can be applied by computer controlled jacks.

Impact

Rainscreen panels are generally lightweight and vulnerable to impact damage. Guidance on specification and testing for impact resistance is given in CWCT Technical Notes 75 and 76.

Performance of rainscreen panels in an impact test will be affected by the properties of the panel and the support conditions. Where a project weathertightness test is carried out, the test sample will normally be suitable for impact testing. However it may be necessary to replace damaged panels to allow sufficient tests to be carried out.

For a standard rainscreen system the stiffness of the backing wall needs to be considered. Generally a more rigid backing wall will increase the severity of impacts on the rainscreen panels. Impact tests carried out on a weathertightness specimen with a framed back wall may not represent the performance when the rainscreen is supported on a more rigid backing wall. It may therefore be more appropriate to carry out impact tests on a separate sample of the rainscreen supported on a concrete backing wall. For a rainscreen system that can be used with different sizes and shapes of panel it will be necessary to carry out tests on sufficient number of different sizes and shapes to cover the range.

Conclusion

Testing to demonstrate the weathertightness of rainscreen walls can be carried out in accordance with the CWCT Standard for systemised building envelopes.

Testing of a rainscreen system on a standard back wall will give an indication of its likely performance but watertightness of a wall constructed using the rainscreen system will be influenced by the full make up of the wall construction, particularly the effect of any membranes incorporated into the wall and the detailing of interfaces around windows. Air tightness will be entirely dependent on the backing wall.

To demonstrate adequate wind resistance of a rainscreen system, calculations for the actual layout of panels, rails and brackets will generally be required.

Impact resistance of rainscreen panels may be affected by the rigidity of the back wall. Tests carried out with rainscreen panels supported on a rigid structure will have the widest application.

For project tests where the full details of the wall construction are known, testing for weathertightness and impact can demonstrate the likely performance of the proposed wall construction.

References

CWCT Standard for systemised building envelopes, CWCT, 2006, ISBN 1 874003 20 3.

CWCT Standard test methods for building envelopes, CWCT, 2006, ISBN 1 874003 20 3.

CWCT Technical Note No 75 Impact performance of building envelopes -guidance on specification.

CWCT Technical Note No 76 Impact performance of building envelopes –method of impact testing cladding panels.

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