CWCT
CURTAIN WALL
INSTALLATION
HANDBOOK

Chapter 2 Principles of weathertightness

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This handbook was written by the Centre for Window and Cladding Technology (CWCT) as part of its training programme to improve the standard of curtain wall installation.

It will be of benefit to all those installing, or supervising, the installation of curtain walling and other glazed building elements.

This is one of eight chapters from the CWCT Installers' handbook.

Introduction

The installation of facades and façade elements is one of the more complex operations on a construction site. It requires a range of skills and knowledge yet has not been recognised as a particular skill or trade. Façade failure, particularly water leakage, is the most common cause of failure in new buildings.

This handbook brings together advice on installation of curtain walling including all the major components: frames, gaskets, sealants, finishes, glass and fixings. It is based on experience gained by CWCT in setting up training centres for installers and in training main contractors' site supervisors.

The book explains why things should be done and highlights those things that are most critical to the success of curtain wall and window installation.

This Handbook is a guide to achieving better curtain wall installation. However, it is not a substitute for care and diligence, nor should it be a substitute for proper training. Full details of CWCT's training programme are available at http://www.cwct.co.uk/installers.

2 Principles of weathertightness

- **Water and air tightness**

It is important that a facade keeps out the rain and the wind. Walls are designed to resist wind loading appropriate to the site and to provide water penetration resistance corresponding to that wind exposure.

Walls are designed to achieve the required low levels of air leakage. The allowable leakage is determined by the specifier and will depend on the use for which the building is designed, whether or not it is air-conditioned and the assumptions made when designing the heating systems. Excess air leakage gives rise to increased heating costs and possibly an inability to heat the building fully.

- **Water penetration**

Water should not penetrate the wall and reach the inner surface of the wall. It is also unacceptable for water to penetrate partly through the wall if it causes damage (rot or corrosion) to the wall or reduces its performance (reduction of thermal insulation).

A wall may be designed and constructed so that water can enter into the wall but is then drained safely to the outside. Water management rather than watertightness is the secret to constructing a good wall.

Water will penetrate the wall wherever there is an opening, water and a mechanism to take the water through the opening.

- **How water penetrates a wall**

Water may penetrate a wall or component in one of six basic ways:

- Gravity
- Wind pressure
- Air borne
- Kinetic energy
- Surface tension
- Capillary action

These are illustrated in Figure 2.1. Very often it is a combination of factors that causes leakage.

Incorrect installation can allow water to enter by any of these mechanisms even if the wall is designed to prevent water penetration.

Failure to lap components such as flashings, wrongly fitted gaskets and poor sealant joints will all create openings that allow water to flow into the wall under gravity. If drainage paths are blocked water will pond and overflow (often into the wall) under the effect of gravity.

Failure to seal openings that should be sealed and the incorrect fitting of gaskets leaves openings through which the wind can force water.

Failure to install air seals correctly allows air to pass through the wall and this may carry water into the wall.

Removal of drips and nibs from the underside of components can allow water to remain attached to the surfaces and run into the wall as a result of surface tension.

- **Leakage points**

Gravity is the most serious cause of water leakage followed by the effects of wind pressure. Both can allow large volumes of water to flow continuously. The other causes of leakage allow only intermittent flow or small flows.

The risk of leakage is greater at places on the wall where there is most water or greatest pressure. The points at which water leakage is mostly likely to occur are shown in Figure 2.2. Water is driven across the facade by the wind. It gathers at the mullions and runs down to the corner of each frame bay.

Wind passing a building moves around and over the building. This movement of the wind deposits more intense rain on the edges of the facade. Wind moving upwards on the wall can drive rain up the wall, particularly on the upper levels of medium and high rise buildings. Drainage openings can be designed to cope with this. Water may leak past gaskets and seals at the head of a frame if the joints are not correctly made.

It should never be assumed that a joint is in a protected position and that it is not an important joint.

The use of picture frame gaskets avoids the need to make mitre or butt joints of gaskets on site.

- **Forms of construction**

Walls have to be sealed against air leakage and water has to be prevented from penetrating the wall. In many walls and components the air seal is separate from the water barrier.

The outer water barrier, or rainscreen, prevents large amounts of water entering the wall or component. A cavity in the wall or component frame intercepts the small amount of water that passes the water barrier. An inner air barrier or air seal is provided behind the cavity to give the required low level of air leakage.

The water barrier is designed to prevent water leakage. It is the primary defence against water leakage and should be constructed with this in mind. Any small amounts of water that enter the cavity have to be drained to the outer face of the wall.

The outer layer may be impermeable such as an aluminium or glass panel or it may be porous such as brick or terracotta.

- **Drained facades**

With the exception of front sealed construction, all framing members and cavities behind rainscreen panels should be designed to be drained. This means that water passing the outer seal has to drain out through drainage openings to the outer face.

Drainage may occur at open joints between panels or through drainage paths in the framing members.

Window frames are normally drained through holes in the outer face of the frame. An opening sash may have drainage holes in its lower edge. These drain water from the glazing cavity into the cavity below. This in turn has to be drained to the outer face, Figure 2.3.

Stick curtain walling systems may be drained in the same way as windows. Each glazing rebate is drained to the outer face with holes in the front face of the lower framing member, Figure 2.4. Alternatively systems may be designed to drain water along the transom to the mullions, Figure 2.5. The drainage capacity of these systems is limited and water should be drained from the mullion at every third floor.

It is important that drainage channels are not blocked as the wall is installed. Badly placed glazing blocks, use of sealants in the wrong place, debris left in the glazing rebate or inadequate or missing drainage holes can all block the intended drainage paths.

Water will not drain freely from very small openings due to the effect of surface tension. Drainage holes should be at least 8mm diameter or 25mm x 6mm. Holes that are partially blocked or not properly deburred will not allow water to drain. Glazing blocks should bridge the drainage channel in the glazing rebate unless drainage holes are provided between all glazing blocks. Water will not drain for long distances along horizontal frames, particularly if they deflect under load. Many designs set a maximum distance between drainage holes.

- **Drained and ventilated facades**

Drained rainscreen and glazing frames have drainage holes at the bottom of each cavity to allow water out. Holes may also be provided at the top of the cavity to provide ventilation of the cavity. This allows air to pass through the cavity or frame to remove excess water vapour.

Holes for ventilation may be smaller than drainage holes. They are normally made the same size as drainage holes and placed in symmetrical positions so that transoms cannot be installed upside down. If transoms have holes for only one glazing rebate it should be assumed that they are drainage holes. The transom should be placed with the drainage holes uppermost so that they are at the lowest point of the glazing rebate they drain.

- **Pressure equalised facades**

Pressure equalised windows and walls are designed with openings large enough to allow the air pressure in the cavities to nearly balance that of the wind on the outside. This helps to prevent water from entering the cavity.

For a rainscreen the drainage and ventilation holes may be larger than for a simply drained and ventilated system. Pressure equalised window frames do not always need larger holes. It is not obvious on site whether a window is pressure equalised or only drained and ventilated.

Unless a seal is shown it should be assumed that all holes, including ventilation holes, are necessary to prevent water penetration into the wall.

If a glazing rebate is vented into the cavity between an opening frame and a fixed frame then the outermost vent or drain holes will be larger than the inner ones. This is because they have to allow pressurisation of the two cavities, Figure 2.6.

- **Windows**

Windows are tested to BS5368 Pt 1 for watertightness and BS5368 Pt 2 for airtightness. The test only proves the effectiveness of the window and its internal seals. The joint between the window and the surrounding wall is equally important if the wall is to function correctly.

The window should be sealed to the surrounding wall using either a wet applied sealant, a sealant impregnated sponge or, in the case of a window in a curtain wall, a gasket. The same principles apply to these seals as to all the other seals of the window:

- The seals should be well made.
- It should always be assumed that some water may leak past the outer seal and provision should be made to drain this to the outer face.
- An effective air seal should be made at the inner face, Figure 2.7.
- The sill should be sealed to both the surrounding wall and the window taking care not to restrict any drainage channels.

Particular attention should be paid to the sill detail. Sub sills are not tested as part of BS5368 and in any case are frequently made to suit a particular contract.

• Curtain wall

Curtain wall is tested to the CWCT 'Standard and Guide to Good Practice for Curtain Walling'. A representative sample of the wall is tested and for a custom wall the test will have included the flashings and typical interface with adjacent elements of the building envelope.

Flashings and interfaces must be constructed in accordance with the drawings as approved after test.

For proprietary systems it is normal to test the system once only. In this case the flashings and other interface details may not have been tested. It is important that these details are built according to the drawings.

The installer should be alert to any possible leakage paths as this is often the first time that complex details have been seen full size in three dimensions. If there is doubt about the detailing of the interfaces the designer should be consulted before work continues.

If a wall has been tested the design may have been modified as a result of early tests.

The wall should be constructed on site to exactly match the wall tested. The installer should be notified of any modifications or non-standard details. Even proprietary systems are modified from contract to contract and the installer should not assume familiarity with a system.

• Rainscreen

Rainscreen performance depends on the rainscreen panels and all components in the cavity. Design drawings and test reports should show details of the framing members, number and location of fixings, size and position of all openings, dimensions of all cavities, internal flashings and gutters, cavity closers and fire barriers.

Excess water may pass the rainscreen if:
- drainage and ventilation openings are the wrong size
- cavity closers are omitted or wrongly constructed
- baffles are omitted from joints
- the cavity is too wide

Water will fail to drain from the cavity if:
- drainage holes are too small
- drainage paths are blocked with debris
- the cavity is blocked with insulation material
- internal flashings and gutters are incorrectly fitted or missing
- drainage of components (windows and doors) is not linked with drainage of the rainscreen

• Site testing

Site testing may be carried out during construction to check for good workmanship and consistent performance. Testing may also be carried out after construction to identify the cause of water leakage.

The hose pipe test is used for routine site testing for water penetration. The test is described in CWCT 'Standard and guide to good practice for curtain walls'. A full description of site testing is given in CWCT TN10 'Site testing for watertightness'. Testing should be conducted using a standard nozzle, standard water pressure and motion of the nozzle.

The test was developed for use on sealed joints but it may be modified for use on opening joints. In this case it is good practice to vary the nozzle pressure and not the motion of the nozzle.

• Air leakage

Air leakage can lead to excessive heating bills, an inability to heat a building and uncomfortable draughts.

Allowable air leakage rates are given in Part L of the Building Regulations.

High rates of air leakage are symptomatic of poor installation. Walls that leak too much air are also likely to leak water as poor air seals impair the pressure equalisation of many walls and components.

High rates of air leakage are associated with unintentional openings in the air barrier. These openings will impair the acoustic properties of the wall and allow more sound into the building.

The main causes of unintentional air leakage are:
- incorrectly fitted air seal gaskets
- failure to seal windows and other elements to the air barrier of the surrounding wall
- Opening windows and doors that are not correctly adjusted and do not seat correctly

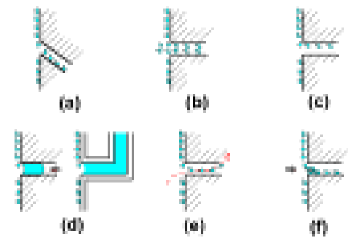

Figure 2.1 a) Gravity d) Capillary action
b) Kinetic e) Air driven
c) Surface tension f) Pressure difference

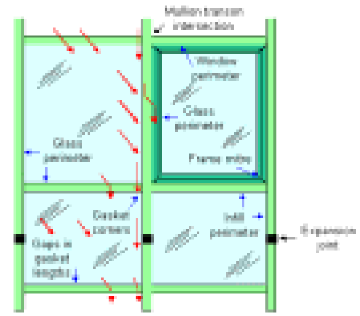

Figure 2.2 **Potential leakage sites**

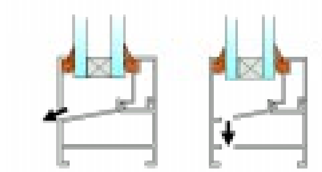

Figure 2.3 Drainage of window frames

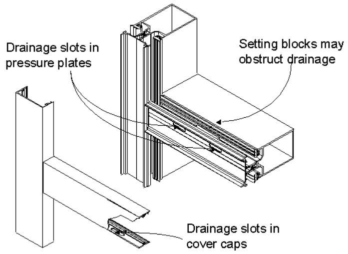

Figure 2.4 Transom drained curtain wall

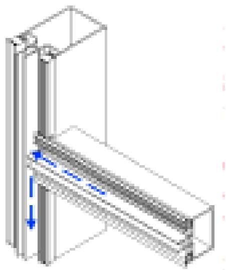

Figure 2.5 Mullion drained curtain wall

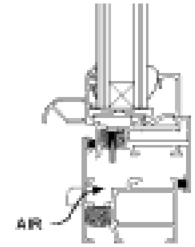

Figure 2.6 Pressure equalised frame

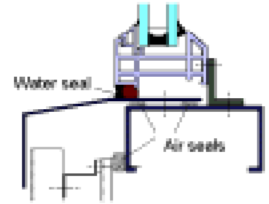

Figure 2.7 Air sealing of window to wall