CWCT CURTAIN WALL INSTALLATION HANDBOOK

Chapter 5 Sealants

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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.

5 Sealants

- **Function**

Sealants are used to make water seals, air seals, combined seals or to protect an internal seal. They have to adhere to the materials they connect, resist tearing and be durable. In movement joints they should not stress adjacent materials.

Many sealants are likely to have a shorter useful life than the design life of the building unless they are protected and provision should be made for replacing the sealants within the joints, or oversealing.

- **Sealant systems**

Sealants used in modern façade construction are wet applied materials based on synthetic polymers which cure to form flexible solids. Oil based mastics which gradually harden with time are not generally suitable for use in these applications.

Sealants should be used as part of a system comprising: sealant, cleaner, primer and backer rod.

Sealant
There is a large range of wet applied sealants. Supplied in tubes or tins, they are either one or two part materials. One part materials avoid the need for site mixing but generally take longer to cure as they cure from the surface.

Cleaners
Cleaners are used to prepare surfaces before a primer or sealant is used. They are used to degrease the surface and are normally solvent based.

Some cleaners are not suitable for use with all materials, particularly plastics. Cleaners should be chosen to be compatible with both the sealant material and the substrate. Cleaners should be tested on a small area of substrate before being used more widely.

Primers
Primers are used to prepare the surfaces the sealant has to bond to. They may seal the surface to prevent penetration of the sealant and improve bond or they may promote a chemical bond between the sealant and substrate material.

Primers used to seal porous materials serve to reduce seepage of the sealant into the substrate and possible staining of surfaces adjacent to the joint.

Backer rods
Backer rods are used with wet applied sealants to control the joint shape and to limit the waste of sealant material in joints that are too deep.

Sealing strips
An alternative to wet applied sealants is to use sealing strips. Sealing strips are flexible materials which are pre-formed in a range of sizes and sections and mainly rely on compression although some adhesion to a joint face may take place. They may be considered as a special type of gasket and are of two basic types:

Mastic strips, usually manufactured from relatively soft, tacky synthetic rubber to which an easily removed backing paper is applied; and,

Cellular strips, usually based on a synthetic polymer, which may also be edge-coated with an adhesive layer. They may be composed of closed cell material or open cell material impregnated with a sealant. They are supplied precompressed to about 20% of their normal thickness and expand after placing. They can either be inserted in a preformed joint or fixed to one side of the joint before placing the component forming the other side of the joint.

• Types of joint

Joints are made to join together elements of the building and may be used for two purposes:

Fixed joints
These occur where materials are joined because maximum panel or unit size requires the use of more than one element. Joints also occur where different materials or components meet.

At a fixed joint the adjacent components are fastened together to prevent movement between them. The joint then has a constant size and shape and the sealant does not have to move.

For fixed joints the materials used are selected to be durable, Figure 5.1 and to bond to the substrates.

Movement joints
These joints are provided to allow the building and the cladding to move. Movement occurs because of temperature change, wind loading and imposed loading amongst other things. Movement joints are made at the natural joints in the building where there would otherwise be fixed joints.

The shape and size of a movement joint will change daily and over longer periods of time. A sealant that can move in the required way is chosen for a movement joint and there is a wide range of performance available Figure 5.2. Sealants also have to be durable and bond to the substrates.

In a movement joint the stretching of the sealant will make greater demand on the bond to the substrate.

Joint size
The exact size of a movement joint gap, Figure 5.3 is important to its short and long term performance. If the width of a movement joint is made only half of the intended size then the forces within it will be double those intended and failure is almost inevitable. All joint designs should specify a minimum joint gap size to be achieved on site.

• Joint shape

There are three basic shapes of sealant joint:

Butt joint
This shape of joint occurs when two thick panels are joined edge to edge or where thinner panels are required to have a flush face Figure 5.4.

Thin panels should be formed with a return that gives an adequate bond area for the sealant.

It is important, particularly for a movement joint, that the sealant material can stretch across its full width. A backer rod or release tape is used at the back of the joint to prevent adhesion of the sealant at the back of the joint. If the sealant is not free to move then it will tear early in its life Figure 5.5.

It is important to control the depth of sealant within the joint. Too deep a sealant will cause high stresses and tear the sealant or adjacent material. It will also be wasteful of material. Too little sealant will not create a robust joint.

Lap joint
This shape of joint is most commonly used for fixed joints although it can be designed to move.

It is important that the gap achieved on site is not less than that intended, particularly for a movement joint. Otherwise the sealant will be overstressed leading to tearing or debonding.

Backer rods should be used to control the size of the sealant bead within the joint to avoid the wasteful use of material and to provide a robust joint Figure 5.6.

Fillet joint
This shape of joint is frequently used when components are neither lapped or positioned to give a flush face. This is the joint commonly used to seal windows recessed in openings.

The joint should be constructed to give an adequate contact area between the sealant and the substrates. This should be not less than 6mm onto a non-porous surface and 10mm onto a porous surface. A fillet joint made in front of two components that are very close together will tear Figure 5.7 and a minimum gap of 5mm should be allowed.

Joints between windows and walls are not designed as movement joints but are not perfectly fixed and so some movement will occur.

Backer rods should be used to prevent the wasteful use of material and so that the joint can be properly tooled to form a good bond.

• Materials

Sealants are commonly classified by their base materials:

- Silicones
- Polysulfides
- Polyurethanes
- Acrylics

However the performance of a sealant is not only governed by the base material but also by additives such as plasticisers, retarders and fillers. The preferred practice adopted by recent British Standards is to specify sealants by performance.

The following classification system is given in BS ISO 11600:

Sealant type
Sealants may be classed as type G which are suitable for use in glazing and type F which are suitable for use in building joints other than glazing.

Sealant class
Four classes are given relating to the amount of movement the sealant can accommodate. The classes are 7.5, 12.5, 20 and 25 which give the allowable movement as a percentage of the unstressed width. Sealants can accept this movement in both compression and tension. Although a class 25 sealant can accommodate more movement than a lower class sealant it would only be suitable for use in place of a lower class sealant if all the other properties of the sealant are also acceptable.

Some sealant specifications give movement accommodation as the total movement expressed as a percentage of the minimum joint width (the joint width when the sealant is fully compressed). This will give values about twice those given using the BS ISO 11600 definition. When selecting sealants for movement joints it is important to check the basis on which the movement characteristics sealant are given.

Sub-classes
Sub-classes relate to the elastic properties of the sealant.
Class 20 and 25 sealants are elastic and may be designated LM for low modulus or HM for high modulus.
Class 7.5 sealants are plastic
Class 12.5 sealants may be designated P for plastic or E for elastic

Test criteria are given in British Standards to establish compliance of the sealants with this classification system. This classification system gives a starting point for the specification and selection of sealants however other properties which must be considered include:
- Life expectancy
- Colour

- Compatibility with substrate
- Adhesion to substrate
- Stress relaxation

It follows that sealants should not be casually chosen or substituted at site. It will always be possible to buy a cheaper sealant but it will probably not be suitable.

• Storage and use

A successful sealant joint requires correct installation procedures.

All materials making up the sealant system must be compatible and should preferably come from the same supplier. The materials making up the sealant system must also be compatible with the substrate.

Materials must be used in accordance with the manufacturer's instructions. The provision of detailed site specific method statements ensures that the applicator is aware of the correct procedures and allows co-ordination of sealant application with other work on site. Aspects to be included in the method statement are described below.

Storage

Sealants and associated materials including primers and cleaners may contain hazardous materials and require appropriate storage conditions. Materials may also require protection against frost and excessive heat or humidity during storage. Storage procedures should also ensure that materials are used before their expiry dates.

Inspection

Before sealant application commences joints should be inspected to ensure that their dimensions are within permitted limits and that the adjacent materials are of suitable quality. The inspections should be carried out in sufficient time to allow remedial work to be carried out where necessary.

Weather

Temperature will affect the properties of the sealant and the opening of joints. In cold conditions the sealant will be more viscous and take longer to cure whereas in hot conditions it will be less viscous and have a shorter working life.

Sealant application is normally limited to temperatures between 5°C and 40°C. These temperatures apply to the surfaces to be sealed not the ambient air temperature.

Frost may persist on shaded surfaces after the air temperature has risen to 5°C and surfaces subject to direct sunlight may reach temperatures as high as 80°C.

It is also necessary to consider likely temperature changes during the curing period of the sealant as excessive movement during this period may cause the joint to move while it is curing and pucker the cured surface of the joint.

Sealants should be applied in dry conditions although some primers are tolerant of damp surfaces. Wet surfaces can arise due to condensation in cold weather as well as rain. For this reason sealants should only be applied when surface temperatures are at least 5°C and rising.

Cleaning

Cleaning of the joint surfaces is always necessary. The cleaning methods to be used vary according to the type and condition of the surfaces.

Physical removal of dirt may require use of a dry brush, compressed air, wire brush or abrasive pads. The method chosen must ensure that the surface is not damaged.

Removal of grease may require use of a solvent. The solvent must be compatible with the substrate, primer and sealant and must be clean. Cloths used for application should also be clean and lint free:

use of white or light coloured cloths is preferable so that soiling is evident. One cloth should be used to apply the cleaner and a second to wipe off.

Masking

Masking tape is useful on substrate surfaces where removal of excess sealant is difficult and may also be used to improve the appearance of the finished joint by giving a clean edge. Tape should be applied prior to application of primer and the tape should not touch surfaces cleaned for sealant application. Tape must be removed immediately after sealant application and tooling.

Priming

The need for a primer will depend on the substrate and sealant to be used. Non-porous surfaces usually use a silane type primer which must be applied sparingly using a cloth. Resin type primers are normally used for porous surfaces and may be applied by brush or cloth.

Primer should only be applied to the sides of the joint to which the sealant is required to adhere.

Care should be taken to avoid contamination of the primer both before application and between application of primer and sealant.

The primer must normally dry or cure before application of the sealant but if left too long may cease to be effective.

Back up material

Closed cell polyethylene or polyurethane foams supplied in rods, hoses or flat sheet, which may be cut to form rectangular sections, are commonly used as back up materials to control the depth of the joint. The back up material may have a surface skin which prevents adhesion of the sealant. If this is only present on one surface care is required to ensure that the material is inserted the right way round. If the back up material does not have a surface skin a bond breaker tape is required. Polyethylene and PTFE are commonly used for bond breaker tape.

The back up material may be applied before or after priming. In the former case care is required to ensure the primer is not removed or damaged during installation of the back up material and in the latter care is required to avoid application of the primer to the back up material.

Foam back up material should be compressed by 25 to 50 % when installed to ensure that it is held securely in place during sealant application. The backer rod must be placed carefully to avoid distortion or twisting and it must be at the correct depth as it controls the depth of the sealant.

If the backer rod is damaged during installation gases can be released and as a precaution a period of 30 minutes should be left between installation of the backer rod and application of sealant to allow gasses to disperse. If severe damage to the backer rod occurs replacement is necessary.

Mixing

Two part sealants require mixing. Mixing is normally carried out using a paddle in a low speed drill.

Mixing needs to be thorough, indicated by a uniform colour, but if too vigorous air can be trapped in the sealant.

Curing of the sealant will commence as soon as it is mixed hence it should be mixed in quantities which can be used within the pot life.

Sealant application

Sealant is normally applied from a hand operated gun.

The nozzle should suit the width of joint and the rate of extrusion and movement of the gun should be such that the joint is filled with sealant in a single pass Figure 5.8.

For very wide joints it may be necessary to use several passes of the sealant gun building up from the back corners of the joint.

Tooling

Tooling removes voids, improves adhesion by compacting the sealant against the sides of the joint and gives a neat finish. A slightly concave surface reduces movement stresses but overtooling can leave the sealant too thin at the centre.

Tooling must be carried out before the surface forms a skin which may be damaged. The available time for tooling varies from a few minutes to several hours depending on the type of sealant and ambient conditions.

Tooling is usually carried out using a wooden or metal spatula which may be wetted with water or a dilute detergent solution. Water should be used sparingly and applied to the tool rather than the joint. Excess water should be shaken from the tool.

Protection

During the curing cycle dirt may adhere to the tacky surface of the sealant and become embedded. The sealant should therefore be protected from dirt and debris. The sealant may also require protection against inclement weather. However sealants may require the presence of air, moisture or UV to aid curing and protection should not interfere with the curing process.

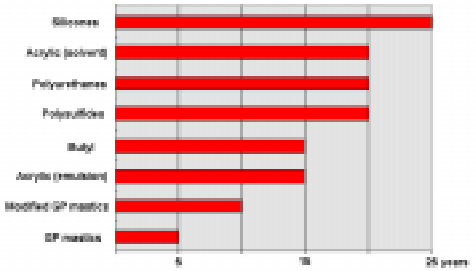

Figure 5.1 Durability of sealants

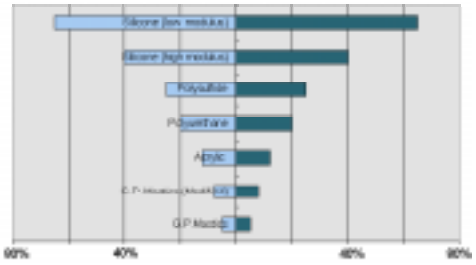

Figure 5.2 Movement accommodation of sealants

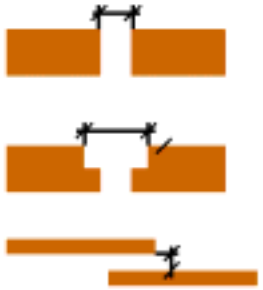

Figure 5.3 Joint width

Figure 5.4 Joints between thin panels

Figure 5.5 Use of release tape

Figure 5.6 Use of backer rod

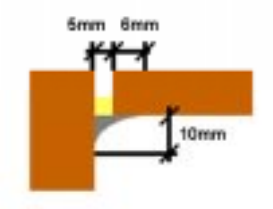

Figure 5.7 Fillet joint minimum dimensions

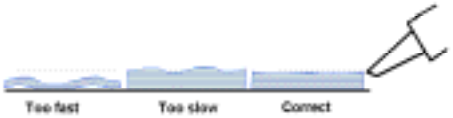

Figure 5.8 Use of sealant gun