Technical Note No. 16
JOINTS IN THE BUILDING ENVELOPE

Introduction

A joint may be defined as a discontinuity in the fabric located in a predetermined position between either similar or dissimilar materials. A joint may pass through the full thickness of the building envelope or may only be present in one layer or component of the envelope. However, the performance of a joint in one layer of the envelope may be affected by the properties of the remaining layers and the interaction of the various layers of the construction must be considered in the design of a joint.

This Technical Note gives an introduction to the requirements to be considered in the design of joints and the types of joint that can be employed. More detailed guidance on joints in general is given in BS 6093.

Purpose of joints

Joints may be required for one or more of the following reasons:

- To facilitate construction. The façade of a building is normally composed of a number of components made of different materials and there will be joints where the different materials meet. Even where the same material is used for a large area, the material will have to be supplied in sections, which are small enough to handle, and joints will often be required.

- To allow movement. Two types of movement must be considered. The outer layer of the façade, which is exposed to the weather, will normally be subject to greater variations in environmental conditions than the inner layers and the structural frame. It will therefore be subject to greater movements and joints will normally be required to allow these movements to occur without inducing stresses in the fabric. Where a large building is involved there may also be movement joints in the structural frame. Where these occur it is necessary to ensure that joints are also provided in the cladding.

- To provide separation. There are some situations where it is necessary to provide a break in some property of an element in the façade. The most common situations are the use of thermal breaks in aluminium window frames and curtain walling and the provision of dpcs or cavities in masonry construction.

Properties of joints

Joints may be required to have some or all of the following properties:

- Transmission of forces. A joint may be required to transfer load in one or more directions and in some cases will also be required to transmit moments.

- Accommodation of movement. Joints will often be required to allow movement in one or more directions but may be required to prevent movement or even transmit loads in other directions. For example the joint between a glazing unit and frame will be required to allow movements due to expansion or contraction of the unit but will be required to transmit the wind loads to the frame.

- Allowance for induced deviations. Induced deviations are the variations in the actual size of components relative to the specified size resulting from inaccuracies in manufacture and construction. Joints provide the only means of accommodating these deviations and failure to make adequate allowance may compromise other aspects of the joint’s performance, such as the ability to accommodate movement.

- Weathertightness. Weathertightness includes resistance to both air and water penetration. Although the overall thickness of the building envelope will invariably be required to be weathertight, the requirement for a joint in a particular element of the wall will depend on the way the cladding components have been designed.

Weathertightness is achieved in a number of
ways. Generally there must be a line of defence against water penetration and a line of defence against air infiltration. Although both defences may be provided by a single seal, a two stage approach may be used. In this case the joint in the outer surface of the façade is not sealed against air penetration but limits water penetration using baffles or a complex geometry and an air seal at the back of the wall in conjunction with drainage of the cavity prevents water penetration of the overall façade. Techniques for achieving weather tightness are described in greater detail in Technical Note 17 Weathertightness and drainage.

- Buildability. It must be possible to construct the joint as intended. If the joint is difficult to construct, poor workmanship is more likely and this may lead to inadequate performance in service.

- Maintainability. Two aspects of maintenance need to be considered. Clearly it must be possible to rectify any defects in the joint and this is likely to be easier where access can be gained from inside the building. However it may also be necessary to dismantle the joint to rectify faults in other components. For example glazing beads will have to be removed to replace failed glazing units.

- Fire resistance. Some joints may be required to resist fire. The requirement may be to maintain the ability to carry load or to prevent the spread of flame and smoke. For example the joint between intumescent glazing and the frame will be required to hold the glass in place and prevent combustion products escaping.

- Resistance to birds, animals and insects. Joint seals can be attacked by birds and gaps in the building fabric may provide a means of entry for small animals and birds. Infestation by insects is at best a nuisance and can lead to deterioration for example wood boring beetles.

- Durability. Deterioration is more likely to occur at joints as there may be breaks in the normal protection systems to the cladding materials, they will often be subject to more aggressive conditions due to movements and increased water loading and the joint components such as gaskets and sealants may be prone to deterioration. Joints often occur at the interface between different components and there is a risk that incompatible materials may be used. For example steel or brass screws may be used to fix an aluminium window frame and may need isolating.

- Appearance. Where joints are exposed on the face of the building they will affect the appearance. A larger number of small joints may look better than a few wide ones and the colour of joint seals may affect the perceived colour of the cladding.

- Electrical isolation. Where a joint occurs between components made of different metals, it may be necessary to prevent electrical contact between the different metals in order to reduce the risk of corrosion.

- Electrical continuity. Electrical continuity across a joint may be required, for example to ensure the effectiveness of a lightning conductor or cathodic protection system.

### Joint components

Joints will require all or some of the following components:

- Fixings,
- Baffles,
- Seals,
- Flashings.

### Fixings

A joint will require fixings for the materials either side of the joint. The fixing may be a direct fixing crossing the joint as in a screw fastening of overlapping sheets of cladding or indirect as in the case of rainscreen cladding panels which are not directly connected but independently fixed to a continuous background wall.

The design of the fixings will need to take account of requirements for load transfer or freedom of movement across the joint. Types of
fixing which allow a degree of movement include the following:

- Bolts in slotted holes, possibly using PTFE washers to reduce resistance to sliding,
- Dowel joints, generally with an additional fixing to a supporting structure on one side of the joint,
- Tongue and groove joints, generally with an additional fixing to a supporting structure on one side of the joint,
- Channel fixings,
- Gasket and pressure plate.

**Baffles**

Baffles are used in some unsealed joints to prevent water being blown through the joint. The most common application is in joints between precast concrete panels where the baffle can be supported by grooves in the edges of the panel.

Baffles may consist of strips of metal or rubber, brushes or open cell polymer foam impregnated with sealant.

**Seals**

The selection of joint seals has always been a difficult decision for the facade designer, although the process is sometimes dictated by the choice of cladding system. There are three options:

- Sealing strips or tapes.
  
  Sealing strips are flexible materials which are pre-formed in a range of sizes and sections which 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.

- Gaskets.

Gaskets are pre-formed seals made from flexible materials, which must remain in compression to function effectively. They can be of solid or hollow section and may be formed from either cellular or non-cellular materials. They are generally made from rubber or plastic by extrusion or moulding. The material should have a good elastic memory and not suffer ‘compression set’.

Pre-formed gaskets offer some advantages over sealants, particularly in terms of ease of removal. However they have their own set of problems regarding correct installation, require careful control of the joint width if they are to work properly and still pose a risk with material compatibility.

Like sealants, gaskets are a target for cost cutting; a fabricator will buy cheaper gaskets from another supplier just to save a few pence on the cost of each metre length, without any form of guarantee that the new gaskets will perform satisfactorily. The cost of even a small amount of water leakage, in terms of problem rectification/damage repair never justifies the capital cost saving, but the capital cost saving is made by the fabricator, who rarely sees the clients’ costs of repair.

Gaskets are described in greater detail in Technical Note 18 *Gaskets*.

- Sealants.

Sealants are wet applied materials formulated to both solidify in situ and adhere to the joint surfaces in a controlled manner. The sealants used for joints in the building envelope are cold-applied, non-cellular materials that are based on synthetic polymers. In the solid form they are able to accommodate movement by elastic or plastic deformation.

Sealants must always be treated as a system, as additional products are essential for effective performance - back-up materials, bond breakers, and where recommended primers or surface conditioners.

A properly applied sealant, in a well-
designed and constructed joint, offers a durable and effective seal against water penetration and air leakage. However, sealants are frequently the target for poor application, cost cutting by using a lower specification material, and a complete failure on the part of the installer to understand the need for proper joint preparation, or a uniform depth and width of the sealant bead. Backing materials are rarely used (the sale of sealant backing materials is much less than expected from the volume of sealant sales) and the sealant may not be properly tooled, trapping within the body of the sealant pockets of air which attract moisture or expand breaking the seal. Furthermore, the need for access to install sealants generally means that they are located in exposed joints, where they are subject to the greatest environmental exposure and most likely to be damaged during cleaning operations.

Technical Note 19 Selection and use of sealants and Technical Note 20 Design of sealant joints give further guidance on sealants.

There are several issues that need to be addressed, when selecting and designing gasket seals or wet-applied sealants:

- **Durability**
  Rubber and sealant materials are a blend of many chemicals - they are affected by ultraviolet radiation, ozone and atmospheric pollutants, and may react with adjacent materials or run-off water contaminated with copper or alkalis leached from concrete.

- **Joint design**
  A compression gasket usually requires an accurately constructed joint, with little variation in width, and flat joint surfaces. Selection of gaskets must consider the means of their retention within the joint as compression alone is not generally sufficient. A positive receptor keyway into which part of the gasket can locate is needed.

  A sealant joint can tolerate some variation in joint width but variations in width caused by steps in the joint faces can lead to stress concentrations under joint movement, which can cause the material to crush or tear.

  Sealants must always have an adequate bearing surface. Sealants applied to thin edges of sheet metal never work. Joints will often be required in the jointing materials and these joints will require careful design to avoid problems.

- **Installation**
  Wet-applied sealants require cleaning, sealing (of porous materials) and priming of joint surfaces prior to sealant application, and provision of back-up material to limit the depth of the sealant bead. Gaskets may require a groove or race to assist retention and might be stretched during installation, leading to subsequent problems as the material returns to its original length. Adverse weather conditions during installation are likely to have a greater effect on the performance of sealants;

- **Removal**
  Sealants (and some gaskets after a long period of time) adhere to the joint surfaces, and special tools or chemicals may be needed for complete removal prior to replacement.

The facade designer should always think beyond the simple question of how to prevent immediate air and water penetration, and must consider the long-term implications of any design decision.

Failed air seals, which cannot readily be replaced lead to greater expense through a reduction in energy efficiency. The majority of facade systems are still installed and glazed from the outside of the building. The joint seals are therefore also applied from the outside of the building, and so must be removed and replaced externally. This is particularly true of wet-applied sealants, which require some form of back-up to control the depth of the sealant bead. Sealants required on the outside of a building can only be applied from the outside. Whilst this may not be a problem during construction, subsequent replacement of sealant may prove impossible without the use of expensive access equipment.

Gaskets, on the other hand, can be installed internally, but they require a much higher degree of control on the construction of the joint - a typical compression gasket does not adhere to the joint surfaces, relying instead on a precisely constructed joint to compress the gasket against
Joints in the building envelope

The joint surface. Furthermore, a gasket cannot be expected to accommodate local fluctuations in the width of the joint, and so the joint faces must be reasonably smooth and parallel with a uniform gap.

The use of open, baffled, joints between cladding panels would eliminate the need for an external gasket and encourage the facade designer to consider proper drainage. The internal seal (or seals) can then be either a gasket, or a wet-applied sealant. The former case is appropriate for the glazing system, the latter for joints between irregular panel edges or moderately non-uniformly aligned panels. Note that locating the principal joint seal on the internal side of the joint also protects the seal from extremes of temperature, solar radiation and atmospheric pollution, thereby reducing the risk of seal failure. Regular inspection is also easier, and replacement of damaged or defective seals straightforward.

**Flashings**

Flashings and dpcs may be required at joints to direct water, which has penetrated the outer layer of the façade, back to the outside.

**Examples of joint types**

Joints take many forms as illustrated by the following examples:

a) Face sealed cladding panels

This system relies on the outer seal to prevent both air and water penetration.
b) Vertical and horizontal joints in a concrete panel cladding system

The vertical joint is left open, and relies on a baffle to prevent direct water penetration. The horizontal joint relies on the slope-and-step to keep water out. The cavity behind the panel is pressure-moderated and relies on the air-tightness of the backing wall to prevent significant air movement and water penetration.

c) Joint between mullion and transom of curtain wall

The joint shown has a butt joint between the end of the transom and the mullion, which is vulnerable to leakage. More complicated joint arrangements with overlapping components are more satisfactory.

d) Dual-sealed joint in a stick-system curtain wall

The outer gasket is intended to limit water penetration, but is backed up by a good drainage system. The inner gasket is to prevent air infiltration, and may be formed in one piece with integral moulded corners.

e) Joint in a structural sealant glazing system

The glass is bonded to an aluminium carrier-frame with a structural silicone sealant, which is then fitted into a stick-system curtain wall grid. The outermost joint is weather-sealed with a compatible sealant. If insulated glazing units are used it would be necessary to provide a mechanical support to take the dead load.
Summary

Joints in the building envelope may be required to facilitate construction, allow movement of one component relative to another or to provide a break in the properties of the structure for example to prevent transmission of heat or water.

The performance requirements for a joint depend on its purpose and location and may include:

- Transmission of forces,
- Allowing movement,
- Allowing for tolerances during construction,
- Weathertightness,
- Buildability,
- Maintainability,
- Fire resistance,
- Resistance to pests and environmental conditions.

Joints can be constructed using different combinations of fixings, baffles, seals and flashings that allow these requirements to be achieved.

References