This Technical Note is one of a series describing the design and construction of interfaces and joints in building envelopes. The series comprises:

- TN 64 Gaskets
- TN 78 Interfaces and joints – Introduction
- TN 79 Interfaces and joints – Air permeability and water penetration resistance
- TN 80 Interfaces and joints – Thermal performance
- TN 81 Interfaces and joints – Sealant materials
- TN 82 Interfaces and joints – Sealant movement joints
- TN 83 Interfaces and joints – Breathable seals

This Technical Note covers the principles of designing and constructing interfaces and joints in building envelopes.

**Introduction**

An interface occurs between two different forms of construction in the building envelope. An interface may for instance be between:

- Wall and wall
- Wall and roof
- Window and wall

An interface may comprise a single joint but normally has at least an outer and an inner joint.

By comparison a joint occurs where two components meet and may occur within an element of construction or be part of an interface. For instance the joint between IGUs in a glazing screen.

A joint may pass through the full thickness of the construction or may be present in just one layer of the envelope. The performance of a joint in one layer of the envelope is dependent on the performance of joints in all other layers. When designing the joints comprising an interface the performance of all the joints should be considered as part of a holistic approach to design.

This Technical Note gives an introduction to the requirements to be considered in the design and construction of interfaces and joints in the building envelope.

**Interface design and construction**

A single sub contractor may be responsible for the construction on both sides of an interface. However, the different forms of construction are often part of separate cladding packages and the responsibility of different sub-contractors. In the latter case it is essential that:

- The detailing of the interface is agreed by both sub-contractors,
- Responsibility for construction is appropriately assigned to one sub-contractor or the other.

The Main Contractor plays an important role in coordinating design detailing, assigning responsibility for construction and overseeing the QA procedures.

**Purpose of interfaces**

Interfaces are required where:

- Different forms of construction meet,
- Components such as windows or doors are built into the envelope.

**Purpose of joints**

Joints may be required for one or more of the following reasons:
- To facilitate construction. The envelope of the façade is made of components of limited size, small enough to allow manufacturing, transport and handling.

- Allow the use of different material

- Accommodate tolerances

- To allow movement. Joints may be required to allow relative movement of adjacent components. Components in the outer face are prone to the greatest movement resulting from thermal and moisture changes. Joints may also be required to allow movement where a structural frame moves, TN 55.

- To facilitate the construction of an interface.

**Function of an interface**

The primary function of an interface is to provide continuity of envelope performance where two different forms of construction meet.

The two forms of construction may have different levels of performance and the interface is not necessarily required to match the performance of either. For instance permitted air leakage or thermal transmission may be greater at the interface.

The interface should be designed such that taken as a whole the building envelope gives the required performance for:

- Water penetration resistance
- Air permeability
- U-value
- Sound reduction

Additionally the interface may be required to:

- Accommodate tolerances
- Transfer loads
- Allow movement

Interfaces should not contain cold bridges that give rise to harmful condensation forming, TN 80.

**Function of a joint**

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.

A joint may be required to be:

- A water seal
- An air seal
- An air and water seal
- An open joint

Techniques for achieving weathertightness of interfaces and joints are described in greater detail in TN 79.

**Vapour resistance**

A joint may be required to have resistance to the passage of water vapour as part of a vapour control layer.

**Vapour transmission**

A joint may be required to allow the passage of water vapour to allow a cavity to breathe.

**Overall vapour control**

The vapour permeability gradient should be considered and the principle of 'inside tighter than outside' followed in order to allow warmer moist air potentially trapped in the cavity
between an internal and external joint to escape as moisture vapour through a breathable external layer. For example, if two membranes are used, one providing air and vapour control to the inside of the interface and a second providing weather tightness to the outside, the moisture vapour permeability of the internal membrane should be considerably lower than that of the external membrane (ideally by a factor of 10). This applies to climates such as the UK where the external air temperature is predominantly colder than the internal temperature. Alternatively, but in order to still facilitate drying out and escape of trapped moisture, intelligent membranes which have variable ‘sd’ values (moisture and vapour permeability values) can be used.

Sound transmission
Joints may create a path for sound transmission through the building envelope. Generally joints will comprise a small part of the façade and provided that joints do not provide a direct air leakage path the effect on overall sound transmission through the façade will be small. Sound transmission through building envelopes is discussed in greater detail in Technical Note 39.

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. Joints that are concealed from both the inside and outside of the façade may be protected from deterioration but are difficult to maintain if defects do occur. 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 where different components meet and there is a risk that incompatible materials may be used. For example sealants can give rise to staining of stone cladding.

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 continuity of earthing.

Security
The joint should not form a weak point for intruders.

Joint and interface components

Joints and interfaces will require all or some of the following components:
- Fixings,
- Baffles,
- Seals,
- Membranes,
- Flashings,
- Insulation.

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 joints to prevent water being blown through open joints. The baffle may be a separate strip of metal or plastic, or may be formed as part of a cladding panel. A common application is in joints between pre-cast concrete panels where the baffle can be supported by grooves in the edges of the panel.

### 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. They rely on compression to form a seal although some adhesion to a joint face may take place which helps to retain the strip in the joint. Sealing strips and tapes take one of the following forms:

- Mastic strips, usually manufactured from relatively soft, tacky synthetic rubber to which an easily removed backing paper is applied;
- Impregnated foams, open cell foams impregnated with resins or waxes to prevent the passage of water. They may allow the passage of water vapour depending on the degree of compression.

### 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.

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.

Gaskets are described in greater detail in TN 64.

### 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.

TN 81 and TN 82 give further guidance on the selection of sealant materials and the design of sealant joints.

### Membranes
Membranes may be made of:

- Impregnated fabric
- Coated fabric
- Rubber or plastic

Membranes are used at interfaces to provide an air or water seal. They are available with different (or even variable) levels of moisture vapour permeability and care should be taken to select the most appropriate type for the required performance and function. They are particularly good at accommodating tolerances and allowing movement.

Membranes are attached to the other envelope components by either:
• Insertion in a race or groove in a similar manner to a gasket,
• Clamping, normally with a strip of metal screwed to the substrate,
• Bonding, commonly with a double sided adhesive and peel off strip applied in the factory or with site applied contact or paste type adhesive.

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

Insulation
Insulation either as solid material or spray applied foam may be used in interfaces to reduce heat loss. Use of such materials must avoid blocking drainage and ventilation paths.

Joint design
There are several issues that need to be addressed, when selecting and designing joints whether as part of an interface or as stand-alone joints. They are:

Jointing materials
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 or a nib that can engage in a groove in the gasket 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 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. Impregnated foam tapes which do not rely on chemical adhesion or careful tooling to achieve the required aesthetic finish can be installed in adverse weather.

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.

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.

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.

Examples of interfaces and joints
Interfaces and 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) Joint in a bolted glazing system

The IGUs in this bolted glass screen are sealed externally and internally with a wet applied sealant. The system does not rely totally on the outer joint to prevent water penetration into the building. However, water ingress past the outer seal may lead to deterioration of the IGU edge seals.

c) Vertical and horizontal joints in a rainscreen 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. Drainage of the cavity behind the joint must be provided to remove water passing through the joint and airtightness is provided by a continuous back wall.

d) Window into wall

Multiple joints are required to control air leakage at the sill, jambs and head of the window. For instance between:

- Window frame and sill
- Sill and window board
- Window board and lining
- Window jamb and lining
- Window head and lining

Mounting an opening vent in a stick curtain wall will create a joint between the curtain wall framing and the window frame. However, if the curtain wall profiles and the window profiles are made by different suppliers then it is better to regard this as an interface as:

- Air seals may not be coordinated
- Drainage paths may not be coordinated

Flashings are required at the head and jambs of the window to prevent cavity drainage water entering the building.

Water seals may be required to prevent excessive water entering the wall cavity.

e) Dual-sealed joint in a stick-system curtain wall.
f) Curtain wall to rainscreen wall

The inner membrane (shown as a solid line) forms an air and vapour seal between the curtain wall and the back wall of the rainscreen. The outer membrane (shown dotted) provides a water seal to prevent water penetration but is vapour permeable to allow water vapour to escape from the wall assuming that the cavity behind the rainscreen is ventilated.

Summary

Joints in the building envelope are required to facilitate construction and may also be introduced to allow for movement and accommodate tolerances. Interfaces occur where different forms of construction meet and will generally require a series of joints through the thickness of the building envelope.

The performance requirements for joints depend on the purpose and location and may include:

- Transmission of forces,
- Accommodation of movement,
- Allowance 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


CWCT TN 39 Sound transmission through building envelopes

CWCT TN 55 Movement accommodation in building envelopes

CWCT TN 64 Gaskets

CWCT TN 79 Interfaces and joints – Air permeability and water penetration resistance

CWCT TN 80 Interfaces and joints – Thermal performance

CWCT TN 81 Interfaces and joints – Sealant materials

CWCT TN 82 Interfaces and joints – Sealant movement joints

CWCT TN 83 Interfaces and joints – Breathable seals