**Introduction**

Gaskets are widely used to seal joints in the building envelope however lack of watertightness due to poor design, installation or durability of gaskets can arise and may be expensive to put right.

British Standards provide limited guidance on gaskets. BS 4255:Part1 gives requirements for material properties of some specified materials which may be used for gaskets but does not relate these properties to gasket performance. BS 6093 Code of practice for Design of joints and jointing in building construction gives some guidance on the use of gaskets. In general British Standards place limitations on the materials that can be used for gaskets and weatherstrips and as such they both prevent innovation and fail to inform the gasket or joint designer as to the key performance issues.

Technical Note 16 Joints in the Building Envelope gives an introduction to the types of joint in the building envelope and requirements for joint seals. This Technical Note gives further guidance on the properties of gaskets and their use as joint seals.

**Purpose of gaskets**

Gaskets are used to limit the passage of fluids through a joint. However, there are additional functions that a gasket may be required to perform and a more complete list might be:

- Control the passage of fluids (air and water) through the joint,
- Retain one component within another,
- Transmit forces across the joint,
- Enable positional adjustments to be made to overcome induced deviations (manufacturing and erection tolerances),
- Allow relative movement of the joint surfaces.

Some joints must satisfy all of the above criteria; for example, a gasket in the joint between a glass unit and its frame must:

- Prevent water penetration into the frame,
- Should limit air infiltration,
- Retain the glazing in the frame,
- Allow for permissible deviations on frame size and glazing unit thickness,
- Allow thermal movement of the glass without placing excessive forces on the edge of the glass,
- Transfer wind-load on the glazing to the frame and, ultimately, to the building structure.

To achieve all of these functions satisfactorily can be a difficult task for the designer.

**Types of gasket**

Gaskets are made in a range of shapes and sizes as shown in Figure 1 and can be categorised in several ways as follows:

- Type of seal.

  A weatherstrip is a gasket whose primary purpose is to prevent water entering a joint and will normally be located on the exposed side of the joint.

  A draughtstrip is primarily intended to prevent the passage of air through the joint and is normally located at the back of the joint.

- Method of fixing.

  Three methods of locating gaskets are
employed;

Push-in gaskets are designed to be fitted into a groove in the mounting surface, prior to the formation of the joint. It should be possible to remove a push-in gasket by pulling it from the groove.

Slide-in gaskets are designed to slide into a groove on the mounting surface, but must be installed from the end of the groove. A slide-in gasket can usually only be removed by sliding it out from the end of the groove.

Drive-in or wedge gaskets are designed to be forced into the gap between the mounting surface and contact surface, usually as the last stage in sealing the joint. A drive-in gasket can usually be removed by pulling it from the joint, although it may be manufactured with a rigid strip that makes this difficult.

The method of locating the gasket may not appear to be important during design and construction but may affect the ease of subsequent replacement.

- Type of material

Gaskets are generally made from polymer materials including:

Chloroprene (neoprene),
Natural rubber,
EPDM,
Butyl rubber,
Polyurethane,
Silicone.

However, a typical synthetic rubber is a blend of at least ten different chemicals, and small variations in the minor constituents can greatly affect the properties of a generic type of rubber. Simply specifying the generic type of material will not, therefore, guarantee that the gasket will perform as expected.

TPE (thermoplastic elastomer) may be used for gaskets in PVC-U windows and has the advantage that it can be co-extruded with the glazing bead. It is not recommended for

![Figure 1 Types of gasket and terms relating to gaskets.](image-url)
use in curtain walling due to its lack of stability.

- **Principle of operation**

  Most gaskets form a seal as a result of compression of the bulk material but some gaskets form a seal by deflection, either of a cantilevered arm or a hollow tube and others work by wiping with minimal deflection.

### Design of gaskets

The design of gaskets could be considered to be a ‘black art’. Little information exists as to the best shape for a gasket, and there are many theories as to the need for several line contacts or one or two area contacts between the gasket and the surface against which the seal is to be made. Theories abound about the possibility of water being pumped through a gasket, and whether gaskets should be made of hard or soft rubbers. However, in a study of window performance, Cronshaw notes that water leakage was not observed at the line between glass and gasket, but did occur at gaps between lengths of gasket.

Whatever the gasket profile it is fair to say that air- and water-tightness testing of glazed cladding systems is commonplace, and gaskets designed for a particular cladding system are usually known to work (when carefully and properly installed) before they are used.

Gasket material selection is another area where guidance is often thought to be lacking. However, many facade designers fail to understand that a typical synthetic rubber is a blend of at least ten different chemicals, and that the correct rubber for a particular application can only be determined if the duty of the gasket is properly defined. Unfortunately many facade designers fail to inform the gasket producer, who is in a far better position to understand the limitations of a given material in particular applications (e.g. with respect to service environment, frequency and extent of joint movement).

There are many stories about framing system manufacturers requesting a new gasket design without informing the gasket producer that the end product is destined for use in an extreme climate. Some of the qualities that may be required of a gasket, and about which questions should be asked, are:

- Working temperature range,
- UV stability,
- Impact resistance,
- Abrasion resistance,
- Resistance to set,
- Stiffness.

It is also necessary to identify whether the gasket is for use in a fixed joint (e.g. a glazing gasket) or a working joint (e.g. a door weatherstrip), an exposed location (e.g. a face-sealed cladding system) or a sheltered location (e.g. a centre-seal gasket in a casement window) and in a low, medium or heavy duty application.

British Plastics Federation Specification 345/1 gives a range of tests that can be used to evaluate gaskets.

Lack of communication between facade designer, gasket producer and fabricator/installer is the main reason why gaskets and gasket joints fail in service. Given the lack of communication and the basic problems that arise as a result it is difficult to give guidance on the design of gaskets. A large amount of research has already been carried out on the performance of gaskets, and there are many gaskets that have worked satisfactorily for long periods of time, suggesting that design of the gasket is not as critical as some would believe.

### Gasket Compression

To seal effectively a gasket must remain in compression however the compression of the gasket will cause forces to be exerted on the contact surfaces of the joint. The joint must therefore be designed to ensure that when the joint is at its widest there is sufficient compression in the gasket to create an effective seal. However the gasket must also be capable of being compressed sufficiently to fit when the
The width of a joint can vary considerably due to variations in the manufacturing process of the joint components. The tolerances allowed for in British Standards for the joint between a 20mm double glazing unit and the frame in a PVC-U framed window, are as shown in Figure 2.

BS 7413 gives a tolerance of $f = b = 0.3\text{ mm}$ for the PVC-U sections, BS 3734 gives a tolerance of $t = 0.35\text{ mm}$ for the thickness of the gaskets (nominal un-compressed thickness $T = 6\text{ mm}$), and BS 5713 gives a tolerance of $p = 1.0\text{ mm}$ for the double glazing unit. The worst case cumulative tolerance for the gap into which the pair of gaskets must fit is

$$\delta = f + b + p + 2t = 2.3\text{ mm}$$

If the joint designer has allowed an 8mm gap for the pair of gaskets the joint tolerances mean that the actual joint width is in the range 5.7 to 10.3mm and that a selection of different-sized gaskets will probably be needed to cover all possible joint widths.

So far only the effects of manufacturing and erection tolerances have been considered. The effects of service conditions on the joint also need to be taken into account. Although, in this example, temperature effects are unlikely to be significant, wind loading will affect the compression of the gaskets. For example, a positive pressure on the outside of the glazing will increase the load and hence compression of the inner gasket and relieve load and compression of the outer gasket. This could result in over-stressing the joint components on the inside of the joint or failure of the seal on the outside of the joint.

Manufacture and installation

It does not matter how much effort is expended in designing the perfect joint and the perfect
gasket if it is then installed by an untrained workforce with little appreciation of the performance requirements of a sealed joint.

Basic good practice includes careful handling of the gaskets to avoid damage and cleaning of joint surfaces including removal of swarf. Lubricants may be used to ease fitting of gaskets but must be compatible with the gaskets and adjacent materials. Leaving gaskets unpacked in a warm environment to relax and recover their natural shape prior to installation is also recommended although this may leave the gaskets prone to damage.

Temperature may affect the flexibility of the gasket and width of the joint. Generally it is not recommended that gaskets are installed at temperatures below 5°C and even at this temperature the joint may have opened up due to thermal contraction of the components, leading to the risk of crushing the seal at higher summertime temperatures.

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.

An important issue with gaskets is the method by which corners and other joints are produced. The main manufacturing process for gaskets is extrusion, in which a continuous length of gasket is produced. Corners and joints are then produced either by:

- Cutting square ends on lengths of gasket and forming a butt joint (an appropriate sealant may be applied to ‘butter’ over the joint).
- Cutting mitred ends on lengths of gasket and forming a butt joint (sealant may be used).
- Either of the above methods but with an adhesive bond formed at the joint.
- Folding a linear piece of gasket around the corners and forming a joint midway along one of the sides - this method may require part of the gasket to be cut away at the corners. The joint should be placed at the centre of the top of the glass to minimise leakage.
- Forming injection-moulded corners and using a butt joint to attach linear pieces of gasket to the corners (either adhesive or a sealant may be used).
- Forming injection-moulded corners directly onto the linear pieces of gasket to form a one-piece ‘picture frame’ gasket.

Only the last method reliably produces a continuous seal, and is the method specified for all internal gaskets in Standard for Curtain Walling (CWCT, 1996). The corner can also be designed to be more flexible than would be the case if the gasket were folded around the corners, or glued together. Where a section of gasket is notched to feed around a corner then the notch may produce a stress concentration and cause the rubber to tear over a period of time. Adhesives or sealants used to form the joint must be compatible with the gasket and joint materials, and adhesives must be allowed sufficient time to cure before the gasket is compressed into place. Proper cleaning of the joint is also essential.

A significant problem with installing gaskets as joined-together linear pieces of extruded rubber is that if the lengths of rubber are stretched as they are installed they may initially meet, but over a period of time the rubber returns to its original length and gaps subsequently appear at the corners. This is frequently observed in newly installed cladding, if gaskets are inspected a few months after installation. To prevent this, lengths of gasket should be cut over long when in the free state and installed by inserting the ends in the gap first before moving towards the centre of the panel. Another way to ensure that the gasket is not stretched into place is to incorporate an anti-stretch feature in the gasket during the extrusion process. This usually comprises a cord or strip of some more rigid material that is co-extruded with the gasket. The
Gaskets

...should still be cut over-long and compressed into place.

This does not preclude the use of simple joints between lengths of gasket - some curtain walling producers use dry joints (‘cut and butt’) with some success. However, the assembly process is carefully controlled, and emphasis is given to cutting each linear piece of gasket longer than the joint, so that the gasket must be compressed into place.

Summary

Gaskets are widely used to seal joints in the building envelope however in addition to preventing ingress of air and water they are required to be durable, transmit forces, accommodate tolerances during construction and allow movements in service.

Satisfactory performance of gaskets requires good joint design, selection of appropriate gasket material and profile and installation by a trained workforce.

References


CWCT, 1996, Standard for Curtain Walling, Centre for Window and Cladding Technology Bath.


BS 5713, 1994, Specification for hermetically sealed flat double glazing units, British Standards Institution.


© CWCT 2000

CWCT Technical Notes 1 – 30 have been part-funded by the DETR under research contract 39/3/338 (CI 1354)

CWCT
The Studio, Entry Hill, Bath, BA2 5LY

T: +44 (0) 1225 330945
cwct@cwct.co.uk
www.cwct.co.uk