BRANZ

ISSUE584 BULLETIN

SEALED-JOINT DESIGN – CLADDINGS

June 2015

- Sealant-filled joints are commonly used as a frontline defence against water entry.
- The design of the joint is critical to the performance of the sealant.
- This bulletin outlines the joint design parameters for sealant joints between cladding elements and updates and replaces Bulletin 440 *Sealed joints in external claddings – 1: Joint design.*

1.0 INTRODUCTION

1.0.1 Sealants are commonly used to weatherproof the junctions between building elements. The performance of the sealant is critical to the performance of the building, and the design of the joint is critical to the performance of the sealant.

1.0.2 Sealant joints must accommodate movement, UV and water, without premature failure.

1.0.3 When designing the joint, consider:
- whether there are options other than a sealant joint – for example, an open drained joint or a compression seal
- the joint type – static (non-working) or dynamic (working)
- the properties of the materials being joined – absorbency, composition, colour
- the risk associated should the sealant joint fail
- the expected amount of movement that will occur – thermal, deflection, seismic, settlement
- allowing for construction tolerances – ensuring the joint being sealed will end up being the designed-for width
- the sealant type being specified and its movement characteristics and expected durability
- the level of maintenance likely to be carried out
- accessibility – ensuring the sealant joint can be easily accessed for inspections/replacement
- material thickness.

1.0.4 This bulletin outlines joint design parameters for sealant joints between cladding elements. It updates and replaces Bulletin 440 *Sealed joints in external claddings – 1: Joint design*.

2.0 SEALANT JOINT TYPES

2.0.1 Sealant joints can be classified as working or non-working with respect to movement and as one-stage or two-stage with respect to waterproofing.

2.1 WORKING JOINTS

2.1.1 By definition, working joints are dynamic in that the sealant is required to compress or stretch with the movement of the building elements it is attached to. The sealant within the gap between the elements or materials can change size or shape significantly to accommodate relative movement between component parts.

2.1.2 Working joints can be divided into two types:
- Butt joints (Figure 1a) – commonly used for exterior panel joints, expansion joints and control joints.

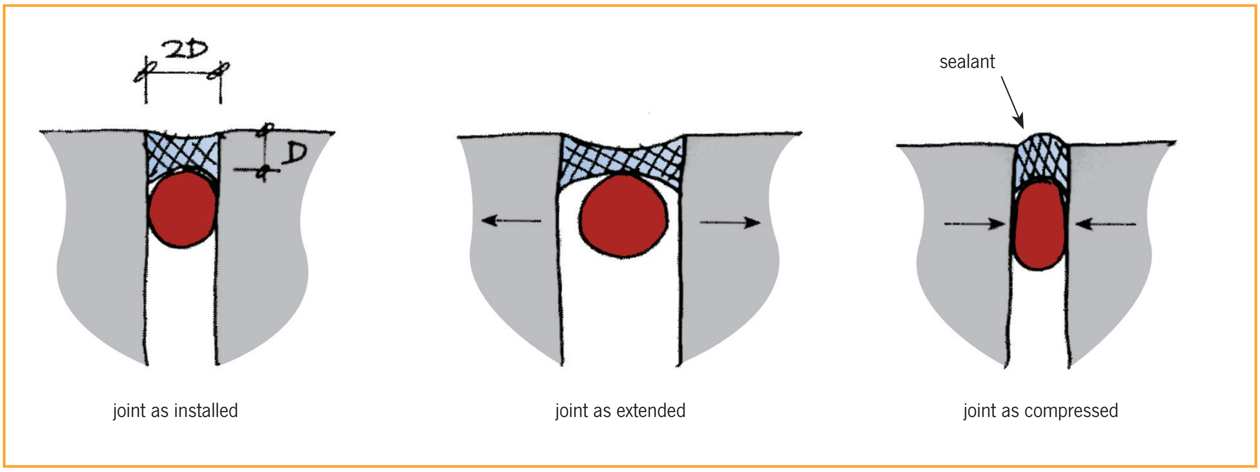


Figure 1a. Working joints: butt joint.

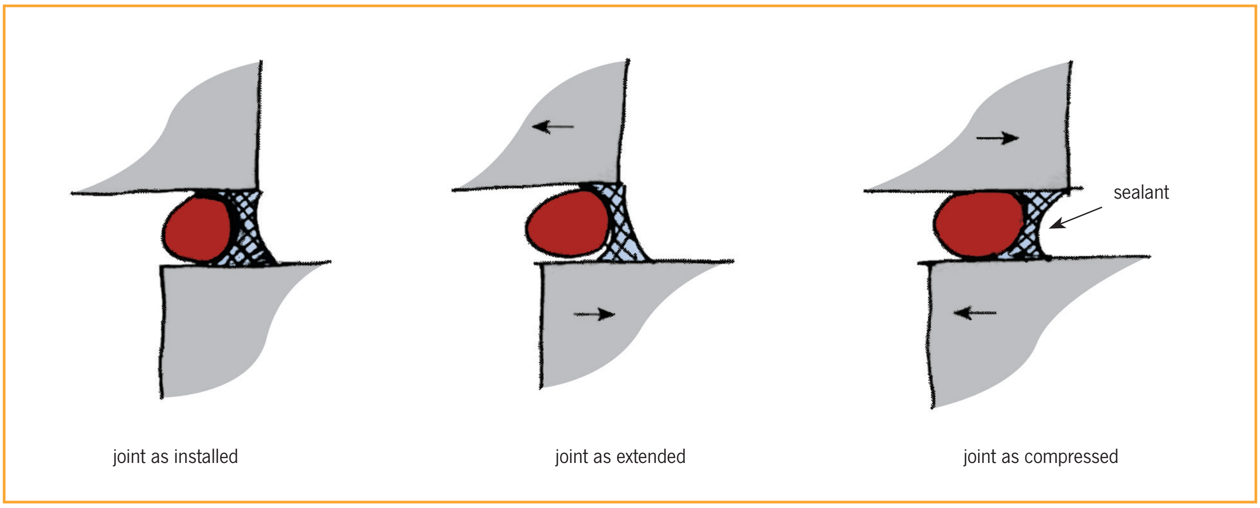


Figure 1b. Working joints: lap joint.

- Lap joints (Figure 1b) – used for exterior panel-mullion joints and panel-sill joints.

2.2 NON-WORKING JOINTS

2.2.1 Non-working joints are static in that movement across the joint is not expected. The design parameters for non-working joints are much less critical than working joints and are not covered in this bulletin.

2.3 ONE-STAGE JOINTS

2.3.1 One-stage or face-sealed joints involve the elimination of all openings that would admit water or air past the outer face of the building. Typical sealant profiles for one-stage joints are shown in Figure 2.

2.3.2 Advantages of one-stage joints:
- The sealant is easy to install.
- Detailing of joint edges is simple.
- Initial cost is low.
- Construction is simpler.

2.3.3 Disadvantages of one-stage joints:
- The sealant is exposed under stress to sunlight, moisture and pollution, which accelerate degradation.
- Sealants exposed to the weather are likely to be less durable (although sealants are available that have proven performance, when correctly installed, of 15–20 years). Durability is likely to be less in adverse conditions, when the sealant is incorrectly specified, when installation is poor and when the movement capability of the selected sealant is exceeded or the width of the joint when constructed is too wide.
- There is no back-up should the sealant fail.
- The sealant will have to be repaired or replaced a number of times during the life of the building.
- The sealant may be vulnerable to vandalism at street level.
- The sealant in horizontal joints may be less durable than that in vertical joints.

2.4 TWO-STAGE JOINTS

2.4.1 Two-stage or open drained joints protect against rain and air as two separate operations. The joint between the components is left open on the face of the building, and the sealant is installed as an air seal at the back of the joint where it is protected from the weather and UV. The sealant should be accessible for checking and maintenance.

2.4.2 Figure 3a shows a horizontal joint, and Figure 3b shows a vertical joint. In vertical joints, the rainscreen is provided by a baffle (typically synthetic rubber or metal) retained in a chamber or slot in the panel edge. Water entering the vertical joint is drained down and out to the exterior at the intersection with the next horizontal joint (Figure 3c).

2.4.3 Detailing of the horizontal-vertical joint intersection requires care to ensure that an effective air seal is maintained. The fixed dimensions of baffles require greater attention to reducing deviations and tolerances in the concrete panel edges.

2.4.4 Two-stage joints have a higher initial cost but have long-term economic advantages because they:
- have fewer leakage and maintenance problems
- require less-frequent replacement because the sealant lasts longer when not exposed to the elements.

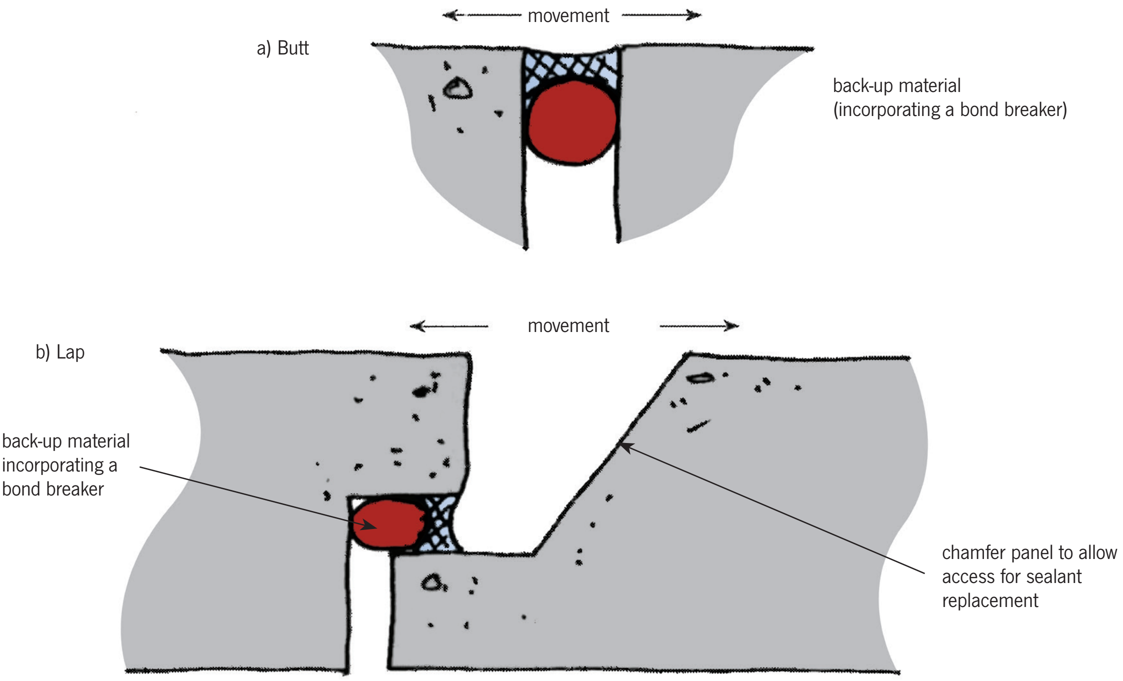


Figure 2. Typical one-stage joints.

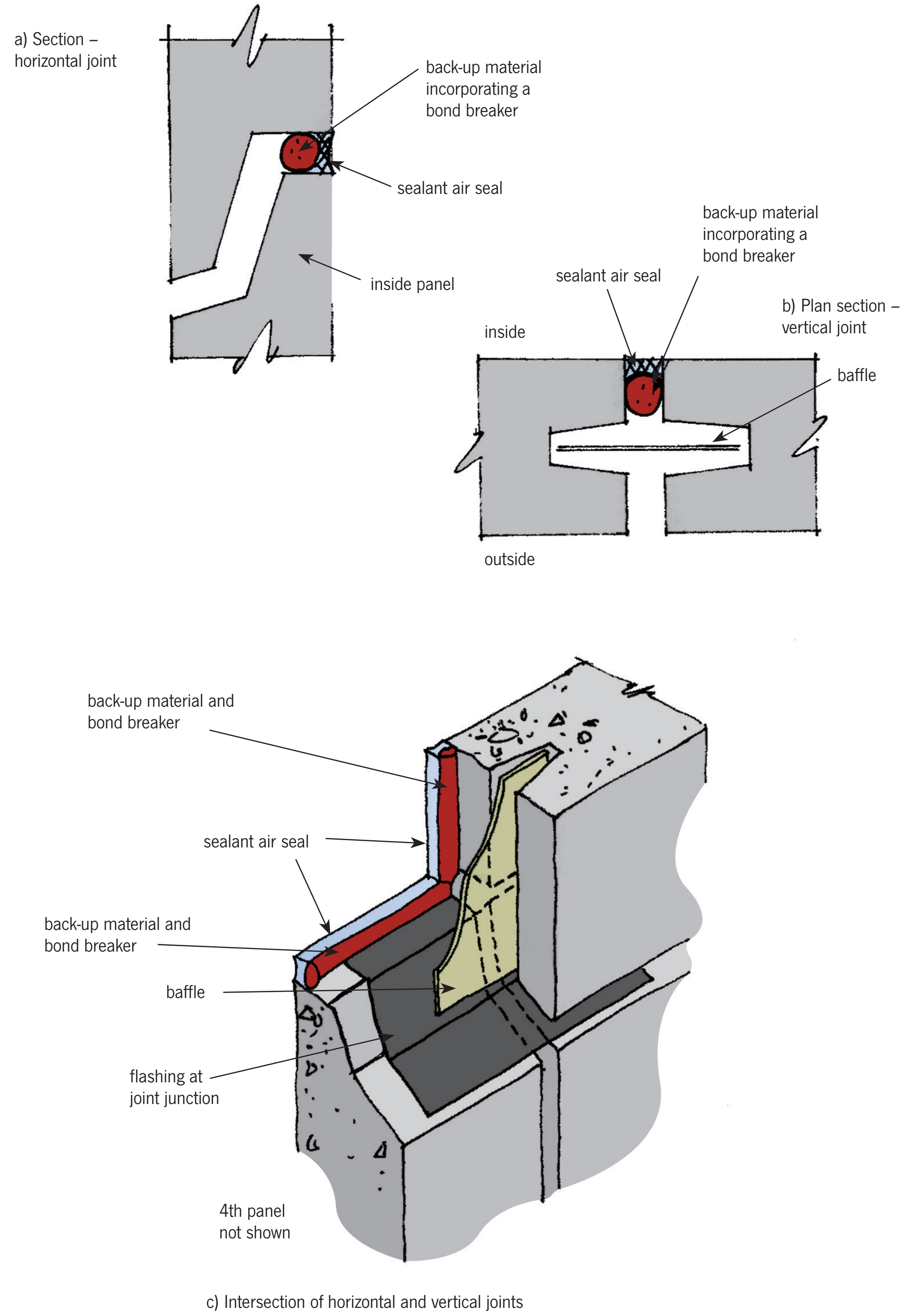


Figure 3. Typical two-stage joints.

3.0 JOINT DESIGN

3.1 LARGE JOINTS

3.1.1 The design of working joints requires the designer to do the following:

- For thin material joints, ensure the joint depth is sufficient to allow the creation of the correct sealant profile within the joint. Where the joint depth is more than 12 mm, control the sealant depth and profile by inserting a PEF back-up rod. For joints 12–18 mm wide, sealant depth should be one-half the joint width and never more than 12 mm.
- Establish essential joint locations, such as junctions between different materials.
- Calculate panel dimensions to achieve joint dimensions that are appropriate for the panel's size, expected movement and sealant specification.
- Recognise that constructional variations exist, establish their range and consider how to deal with dimensional tolerances.
- Establish movement range for the joint – a minimum joint width of 6 mm is typically recommended.
- Establish the environmental conditions under which

the joints are expected to perform and allow for the variations that can occur.
- Establish the adhesion properties of the sealant to the substrates being sealed.
- Specify a sealant to cope with the upper and lower limits.
- Specify sealant colour.
- Ensure the joint is accessible for future maintenance of the sealant.

3.1.2 It is important that the joints are not located where intersections are complex, as this can result in extraordinary stresses on the sealant. The flow chart in Figure 4 outlines the design process for sealant joints.

3.2 THIN MATERIAL JOINTS

3.2.1 Where a sealant joint is being used with a ‘thin’ material – for example, a joint within a 6–12 mm sheet product such as a fibre-cement sheet – where the joint depth does not allow the creation of the sealant profile described in 3.1.1 above, the requirements are:

- ensure a bond-breaker is installed at the back of the joint – it is important that the sealant adheres only to the side of the joint so that it can flex with the expected movement
- limit joint depth to around 12 mm.

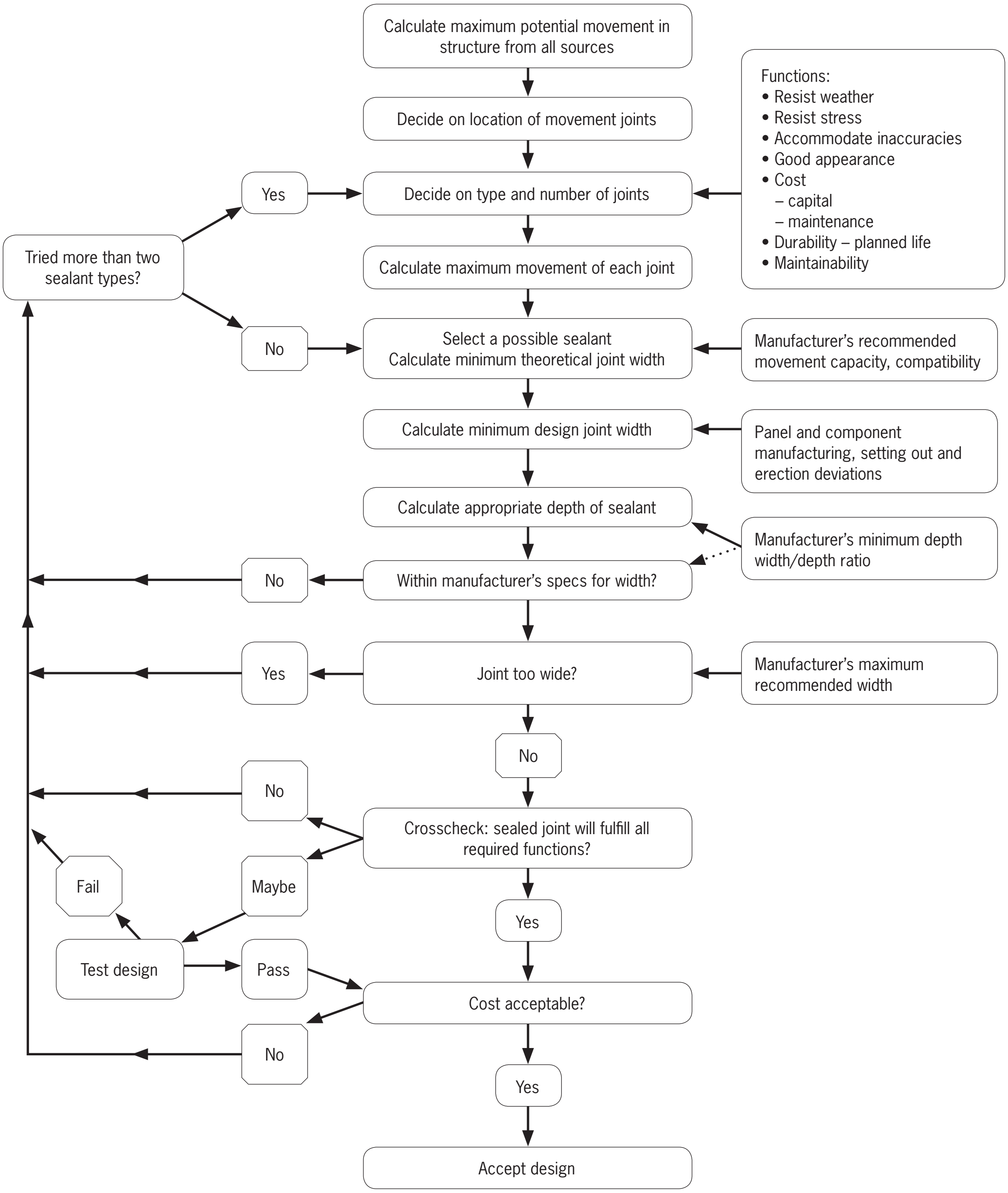


Figure 4. Checklist for sealed-joint design.

4.0 WEATHERPROOFING PERFORMANCE

4.0.1 As the minimum life of a building is normally at least 50 years and the life of a sealant exposed to the weather is between 15 and 25 years, the sealant will have to be replaced during the life of a building. To improve the durability of sealants, joint design should:

- minimise exposure of the sealant to the weather (see 2.4) or consider a different jointing option
- minimise the risk of damage to the building fabric should joint failure occur
- allow for sealant to be easily and regularly inspected and, when necessary, repaired or replaced
- ensure the expected movement the sealant is exposed to (stretching/compression) is within the manufacturer's specified limits.

4.0.2 Poor joint design and an inappropriate choice of sealant will lessen the life of the joint and increase frequency of replacements.

5.0 OTHER DESIGN FACTORS

5.1 ENVIRONMENTAL ISSUES

5.1.1 Temperature variations are a major factor to be considered for overall design but are also important in relation to the conditions that apply when the sealant is installed. To avoid stress failures, install sealant at a temperature around the midpoint of the range expected in service. Sealants are often installed in the hottest part of the day when thermal expansion is greatest and joint width least. This creates a situation where the sealant has to deal with twice the extension that it would do if it had been installed at the midpoint of its working temperature range (Figure 5).

5.1.2 In hot dry conditions, concrete and fibre-reinforced cement sheets remain neutral as shrinkage from low moisture is counteracted by expansion from high temperature.

5.1.3 Moisture variations cause most of the movement for ceramic, timber and wood-based products.

5.1.4 Long-term movements caused by settlement, deflection and shrinkage are likely to be a complicating factor with products that take a long time to fully cure, such as concrete.

5.1.5 For textured panels and exposed aggregate panels, it is better to recess the sealant as shown in Figure 6d, or to form clean smooth panel margins adjacent to the joint to aid correct sealant application (Figures 6a–6c).

5.2 IRREVERSIBLE SHRINKAGE

5.2.1 Table 1 outlines materials in which irreversible shrinkage or creep can be expected as the material conditions or cures over time (up to two years).

TABLE 1. IRREVERSIBLE (SHRINKAGE) MOVEMENT

Material	% of length change (wet to oven dry)
cement mortar	00.4–0.10
concrete	0.03–0.08
GRC	0.07
concrete block	0.02–0.06

5.3 INACCURACIES ARISING FROM MANUFACTURE AND CONSTRUCTION

5.3.1 At the planning stage, the building is usually drawn up within a grid, and the various components, including cladding panels, are dimensioned from this, allowing for manufacturing tolerances, assessed movement and construction tolerances, together with an allowance for properly sized joints (Figure 7).

5.3.2 Designing for good fit by incorporating the smallest possible tolerances is often attempted, but in practice, tolerances that are too tight are unrealistic and expensive. Conversely, unnecessarily wide joints use lots of sealant and don't look good.

5.3.3 Appropriate design depends on an accurate assessment of factors including:

- optimising the number of joints in an assembly
- ensuring that joints are not made subservient to other design parameters (for example, structural)
- consideration of the environmental conditions likely to prevail at installation time.

5.4 FIT PROBLEMS

5.4.1 Joint design and therefore sealant performance depends on ensuring that, once cladding or sheet materials are installed, the joint is the correct width. It is common for joint and sealant performance to be compromised where:

- the joint width is too large
- the joint width is too small
- the constructed joint is outside the specified tolerances to allow for expansion and/or contraction.

5.5 SEALANT WIDTH-TO-DEPTH RATIO

5.5.1 To minimise stress, the ideal width-to-depth ratio is 2:1, calculated at the neutral position. However, a sealant depth or width of less than 6 mm is not recommended, resulting in a minimum width of 12 mm. At the other extreme, moisture-curing one-part sealants have a practical maximum depth limit of about 15–20 mm. Therefore, at 2:1, they have a maximum joint width of about 40 mm (Figure 8).

5.5.2 Inadequate sealant width or depth is a major cause of sealant overstress and failure. Before committing to a joint outside these general guidelines, consult the sealant manufacturer.

5.6 BACK-UP MATERIALS AND BOND BREAKERS

5.6.1 Compressible back-up materials such as filler boards, closed-cell foam, polyethylene rods or rubber tubes are used to regulate the depth of the joint. Using

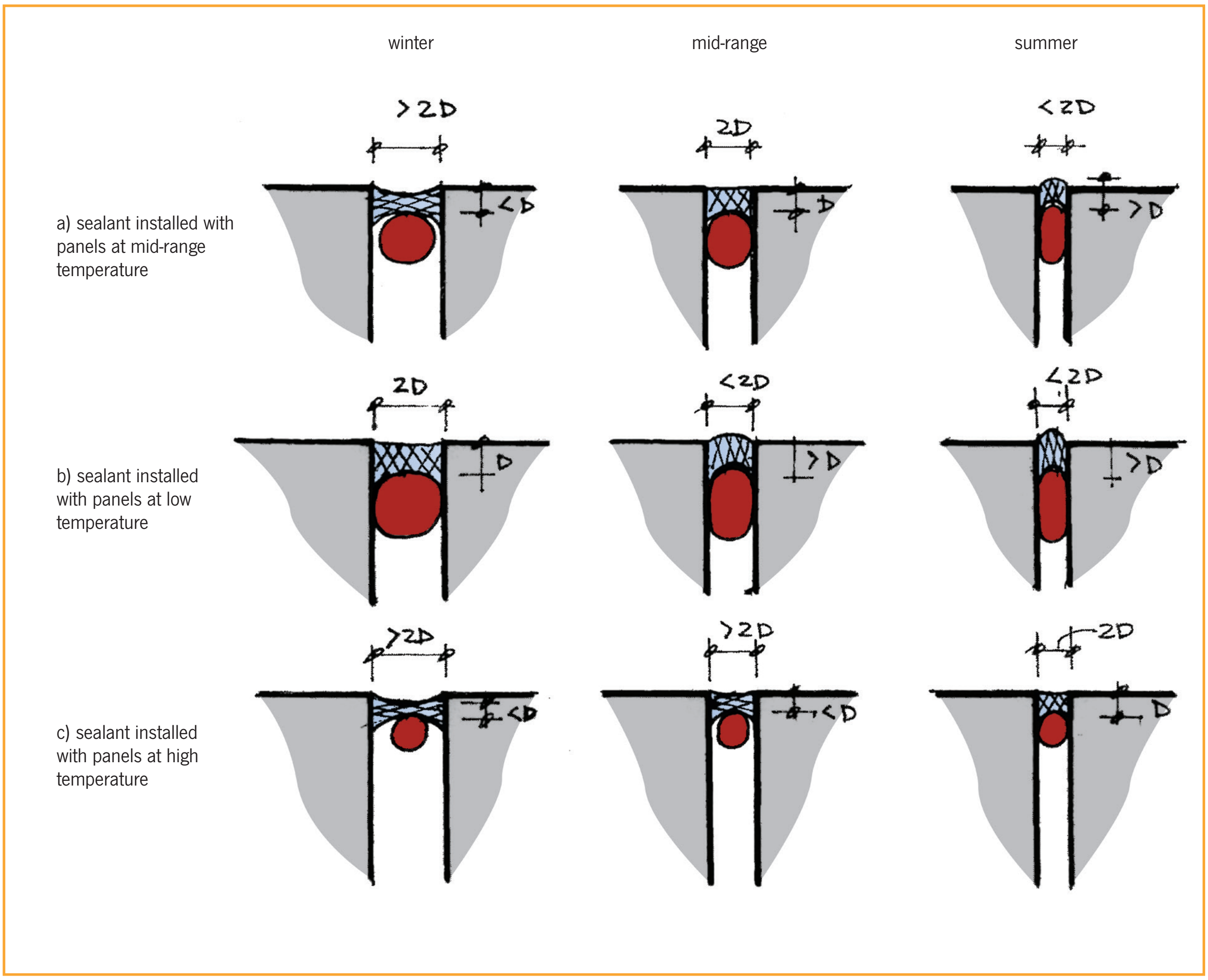
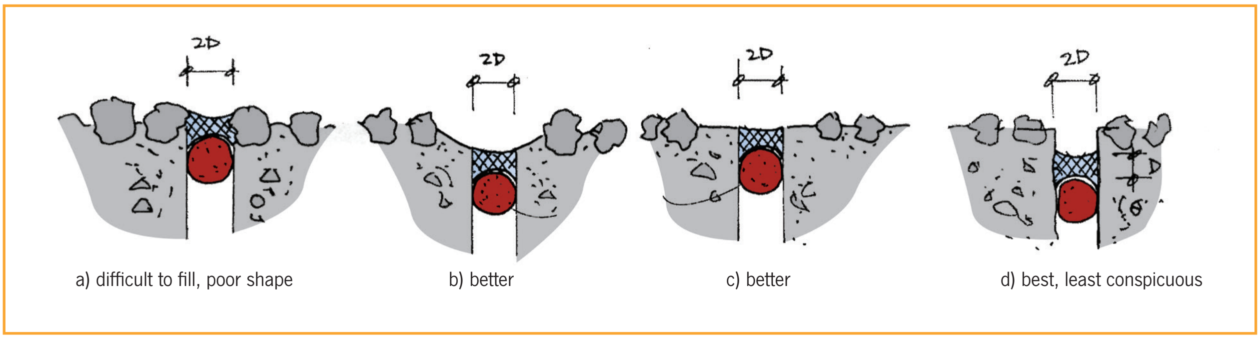


Figure 5. Potential effects of temperature conditions at time of application.



a) difficult to fill, poor shape

b) better

c) better

d) best, least conspicuous

Figure 6. Joints between high-profile panels – panel edge design.

a circular section back-up material increases sealant edge contact area and reduces thickness at the centre. This, in turn, creates lower stresses on the sealant bond at the edges.

5.6.2 For a moving joint to perform properly, it is essential that the sealant adheres only to the joint sides and not to the joint back or the back-up material. In many cases, the back-up material acts as a satisfactory bond breaker, but a suitable polyethylene tape or coating may be used as a bond breaker between the sealant and the back of the joint. In order to avoid possible discoloration or poor adhesion, back-up and bond breaker materials must not contaminate the sealant or the side contact surfaces (Figure 9).

5.7 INSTALLATION

5.7.1 The final part of the sealant performance equation is the installation on site. Joints must be:

- clean
- primed when specified
- free of loose material that will compromise sealant adhesion, particularly to porous substrates.

5.7.2 Sealant must be:

- compatible with the material being sealed
- applied in the correct direction
- within its use-by date
- tooled off to give a smooth surface to the correct profile
- installed when the environmental conditions are within the manufacturer's limits.

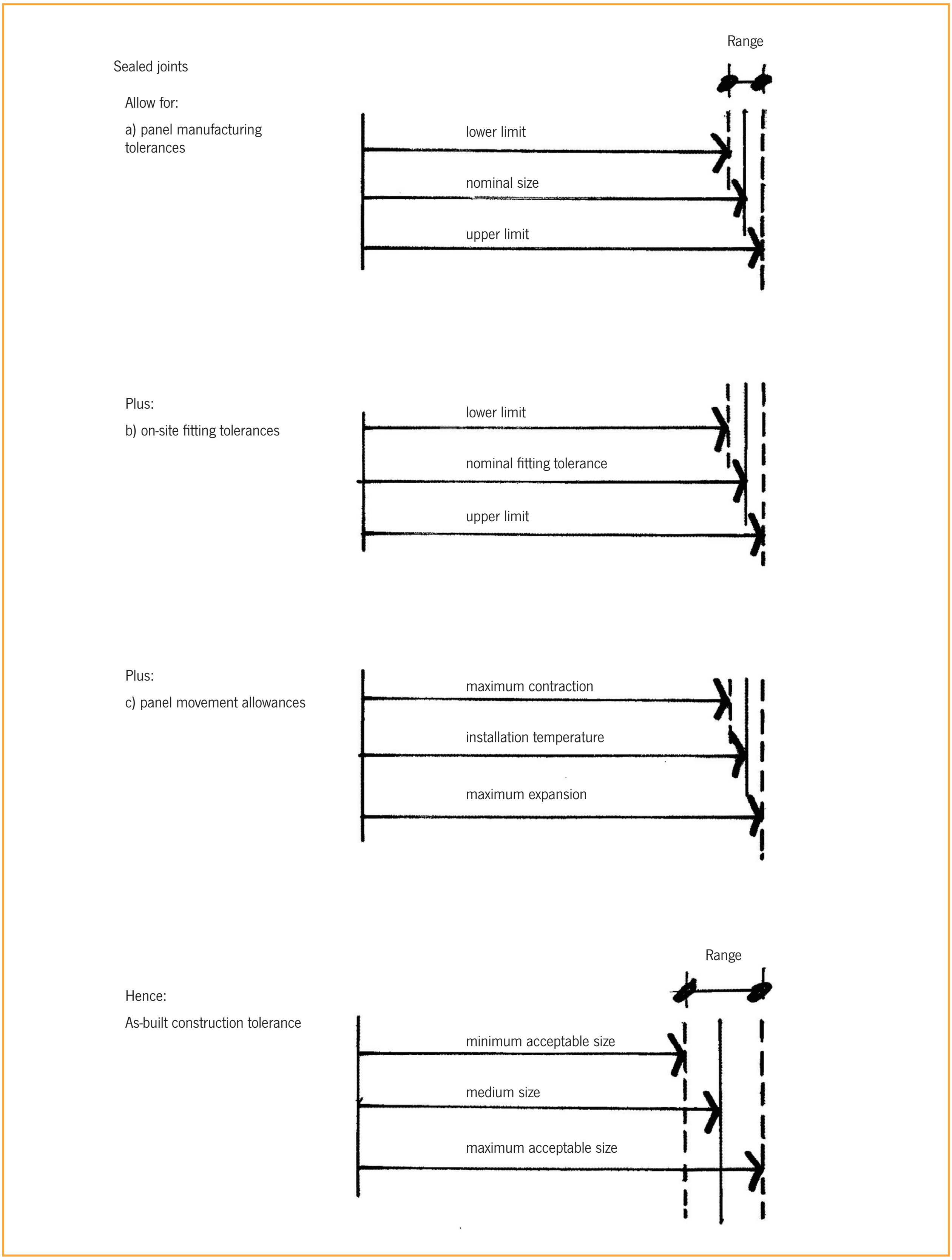


Figure 7. Allowances to be accommodated in cladding panel design.

6.0 CALCULATION OF JOINT WIDTH

6.0.1 Joint width calculation is normally done to establish the plus and minus movement based on mid-point conditions. It is often assumed that sealant installation is also done at the mid-point of the element's movement range. However, most sealant application is done during the day when temperatures are more likely to be at their highest and the joint probably at its narrowest. Therefore, an appropriate allowance must be made at the design stage for the sealant to be able to cope with twice the calculated mid-point movement capacity (extension).

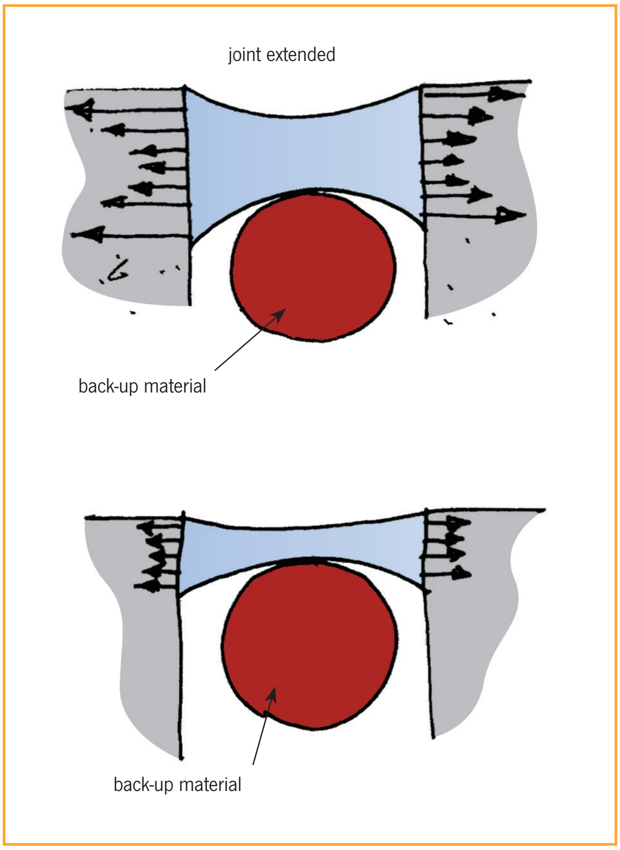


Figure 8. Stress in extended joint with different sealant depths – longer arrow means greater stress.

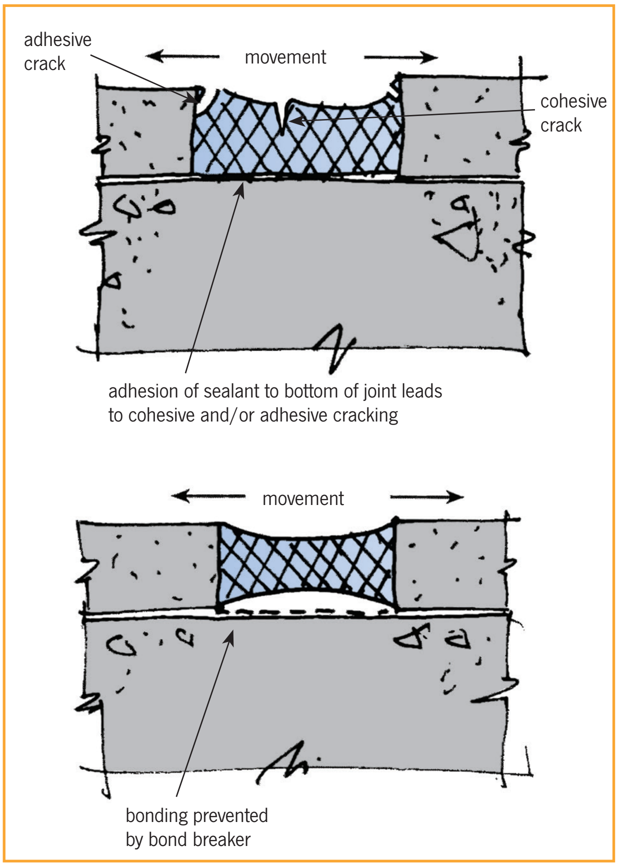


Figure 9. Use of bond breaker.

6.0.2 Maximum joint width may also be controlled by the resistance of the sealant to slumping in vertical joints.

7.0 STANDARDS

British Standards Institution
BS 6954:1988 *Tolerances for building*
BS 5606:1990 *Guide to accuracy in building*
BS 6093:2006+A1:2013 *Design of joints and jointing in building construction. Guide*
BS 6213:2000+A1:2010 *Selection of construction sealants. Guide*

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