BRANZ

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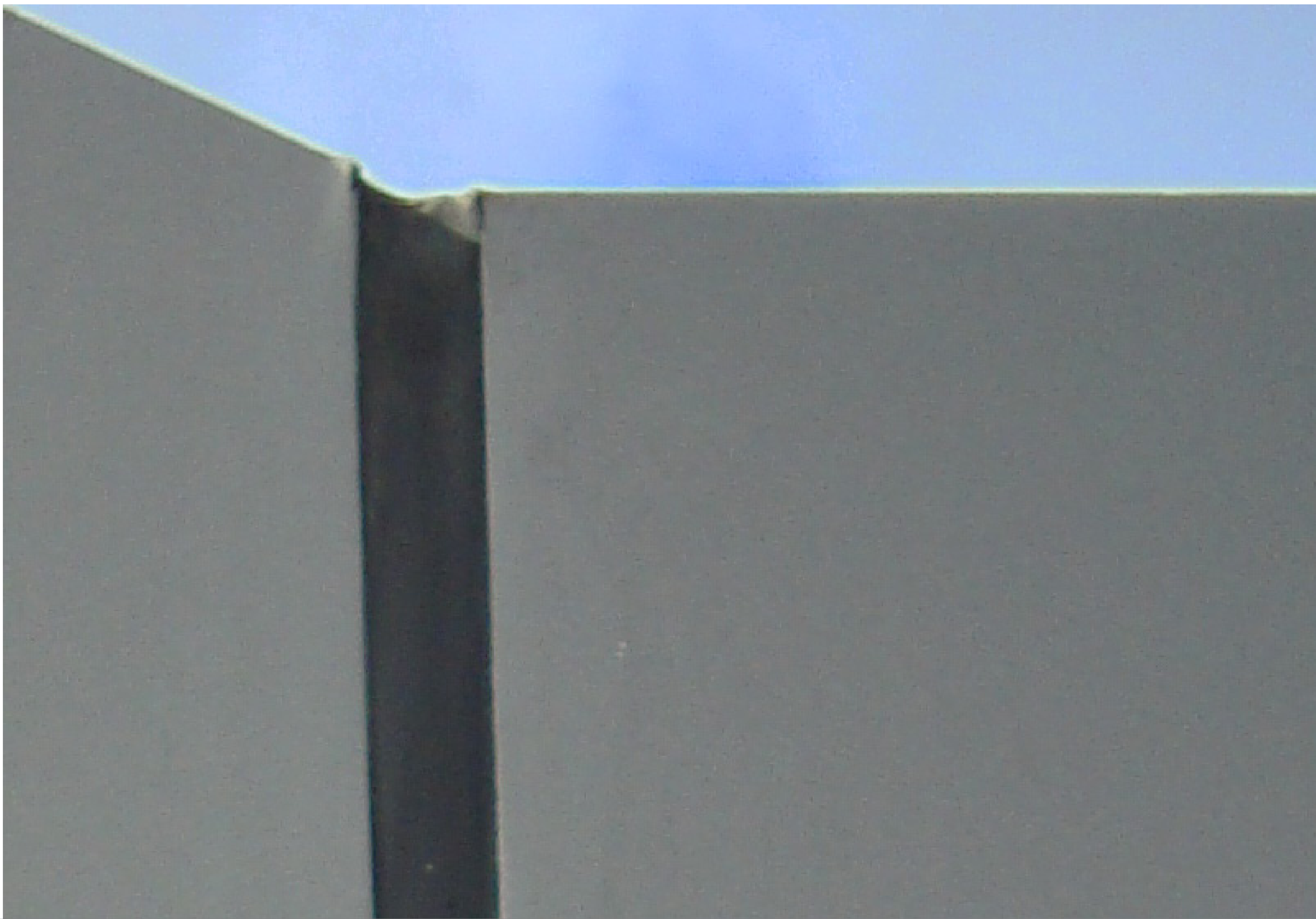


SEALANTS FOR CLADDING JOINTS

August 2016

- Sealants are used to provide weathertight joints or junctions that accommodate movement in a wide range of cladding materials.
- This bulletin examines the factors affecting choice and application of sealant for sealed joints in cladding systems.
- It updates and replaces Bulletin 441 Sealed joints in external claddings – 2: Sealants.

1.0 INTRODUCTION

1.0.1 This bulletin examines the factors affecting the choice of sealant for sealed joints in cladding systems, including:

- performance characteristics
- materials the sealants are being applied to
- temperatures the sealants will be exposed to
- sealant types
- joint type
- compatibility issues
- durability and maintenance issues
- preparation and application factors
- cost factors.

1.0.2 Sealants are used to provide a weathertight joint or junction that can accommodate movement in a wide range of cladding materials. These range from heavyweight claddings through to lightweight claddings on both domestic and commercial projects. The most common type of building movement is cyclic thermal expansion and contraction. More recently, seismic design has also been the subject of some focus on joint sealant performance.

1.0.3 While many premature sealant failures are the result of incorrect application, many are also the result of insufficient attention to the system and substrate compatibility. Other important factors are the design of the joint and the movement range, which is often not assessed correctly, and the access for application.

1.0.4 Competent workmanship in joint preparation, priming and sealant installation is critical to achieving best performance.

1.0.5 This bulletin examines the factors affecting the choice and application of sealant for sealed joints in building cladding systems. It updates and replaces Bulletin 441 *Sealed joints in external claddings – 2: Sealants.*

2.0 SEALANT PERFORMANCE

2.0.1 There are two commonly accepted standards in New Zealand for façade joint sealants:

- European-based standard ISO 11600:2002 *Building construction – Jointing products – Classification and requirements for sealants*
- American-based standard ASTM C920–14a. *Standard specification for elastomeric joint sealants.*

2.0.2 The ISO 11600:2002 classification Construction Sealants (F) 25LM specifies +/-25% movement, low modulus.

- +/-25% is a measure of the service movement of the sealant expressed as a percentage of the overall joint width
- LM means low modulus (stiffness) – a low amount of force is required to allow the specified service movement.

2.0.3 American-based ASTM C920–14a specifies +100/-50% movement capacity. Here, the percentage movement capacity is a measure of the service movement expressed in relation to the joint width dimension. Joint sealants designed to this standard are often described as ultra-low modulus.

2.0.4 Sealant performance relies heavily on side adhesion and sealant profile (width to depth ratio) to keep joints closed under repeated cyclic or other types of building movement. Sealants can be a very versatile solution to providing a fully bonded and continuous airtight or weathertight seal. They appear in many different wall applications.

2.0.5 The material that the sealant is applied to can have a significant influence on performance. Often, a joint sealant solution forms part of a system of waterproofing products and is frequently the last line of defence for preventing moisture entering the building envelope through the joint. It is critical that early attention is paid to the joint waterproofing solution. Any other interfacing substrate or waterproofing solution must be complete and compatible with the joint waterproofing solution and the adjacent (sound) materials.

2.0.6 Where a substrate may be considered susceptible to damage as a result of the sealant application, ultra-low-modulus sealants should be considered as they impart less stress on the bond substrate during movement. The same approach should also be taken for lightweight claddings. These typically experience faster and greater temperature variations that result in rapid and large movements creating higher stresses on sealant bond surfaces. As a result, the design, installation and maintenance of sealed joints in lightweight claddings and materials is in many ways more critical than in heavy claddings. This requires sealants with higher rapid movement capability or elasticity.

3.0 SEALANT TYPES

3.0.1 There are a number of sealant technology types with widely differing characteristics. Even sealants of the same basic technology type may have different properties and may require different preparation and priming of the joint to ensure adhesion. The three main technologies used in façade applications are:

- silicone
- MS/hybrid
- polyurethane.

3.0.2 Broadly speaking, silicone offers the best ultraviolet (UV) resistance, and polyurethane offers the best adhesion to porous substrates like concrete. MS/hybrid technology offers a range of performance characteristics and has similarities to both silicone and polyurethane but shares no technology base with silicone.

3.0.3 Silicones are used exclusively for structural glazed applications because of their ability to bond well to smooth or non-porous substrates and their natural UV resistance. They also have some good temperature resistance abilities. They are non-paintable, and some care should be taken when considering their use on concrete and other non-porous substrates. Stain resistance and attention to detail with priming and preparation need to be considered.

3.0.4 Polyurethane technologies have very good adhesion to porous substrates and are compatible with a wide variety of paint and other façade waterproofing technologies. There is also a wide variety of UV resistance performance, with quality usually reflected in the price.

3.0.5 MS/hybrid technologies in general offer good adhesion to both porous and non-porous substrates, which makes them well suited to window installation airseal and weatherseal applications. They are also paintable and, like polyurethane, offer a wide variety of UV-resistant performance.

3.0.6 All three technologies offer a range of features and benefits that make them more or less suitable for a particular project or façade application. In all cases, the manufacturer's advice on application and installation should be followed to gain the best possible result.

4.0 SEALANT FUNCTION

4.0.1 Sealants can be used alone or in conjunction with other techniques as a means of preventing weather penetration in joints between cladding panels and in glazing. Refer to Bulletin 584 *Sealed joint design – claddings*.

4.0.2 The sealant selected must withstand the external environmental effects (typically heat, cold, UV radiation, water and thermal and moisture movement) throughout its life.

4.0.3 To be effective, the sealant must:

- completely fill the joint to the required depth
- be fully and permanently in contact with the side of the joint for the full sealant depth
- not adhere to the back of the joint
- have no entrapped air within the sealant.

5.0 SEALANT FORMS

5.0.1 Sealants are supplied as thick pastes, for cartridge or sausage gun application, and as thixotropic liquid (thick liquid that becomes more viscous when shaken) for pouring self-levelling applications. They may be one-part (ready to apply) or, less commonly now, two-part (two components that must be mixed before application). The most commonly used façade sealant technologies are single-component moisture-reactive compounds that have up to a 98% solids content. They cure with very minor shrinkage by reaction with airborne moisture to an inert (not chemically reactive) elastomeric compound.

5.0.2 The sealant is extruded by use of a hand-operated cartridge or sausage gun into the joint onto correctly prepared and primed, sound bond surfaces. The joint depth is controlled by a tight-fitting round closed-cell polyethylene foam (PEF) rod. This rod also acts as a bond breaker at the base of the joint to prevent three-sided adhesion, which will severely limit the ability of the joint sealant to accommodate movement. The sealant then cures to a fully bonded continuous, permanently elastomeric waterproof compound.

6.0 SEALANT SELECTION

6.1 SELECTION FACTORS

6.1.1 Sealants for façade applications are usually classified by movement type. Once the desired movement capacity has been established, a series of other selection criteria should be considered such as:

- suitability – for example, compatibility with substrate(s)
- temperatures the sealant will be exposed to – for example, modulus of a sealant can reduce at higher temperatures
- amount of joint preparation required
- need to prime
- movement capability
- joint orientation – vertical or horizontal
- joint width
- resistance to UV and weathering – durability or service life
- ease of installation
- ability to perform if there is exposure to moisture, chemicals, fuels or solvents
- cost.

6.1.2 Sealant classification by chemical and movement type, joint preparation, primers, mixing and sealant application is described below. A sealant selection guide is provided in Table 1.

6.1.3 Selection solely by technology or movement type is unreliable as sealants seemingly of the same type may vary widely between manufacturers in terms of formulation and, consequently, performance.

6.2 SEALANT COSTS

6.2.1 It has been estimated that sealants account for up to 1% of the cost of a building, and the filled joints cause 10% of the cost of subsequent problems. Of the 1%, about a quarter is material cost. There is little point (and great risk) in skimping on the cost of material to save money.

6.3 SEALANT DURABILITY

6.3.1 Typical sealant service life is between 10 and 20 years, which is about one-quarter to one-third of the economic life of a building. The owner of a building must be prepared (and have access) to repair or replace the sealant two or three times during the estimated 50-year life of the building.

6.4 MODULUS AND ELASTICITY/PLASTICITY

6.4.1 Modulus is a measure of the stiffness of a sealant – a high-modulus sealant is stiffer than a low-modulus sealant and requires a greater force to extend it. As a result, stresses within a sealant and at the junction with the sealed material will be higher for a high-modulus sealant. Where materials being sealed are weak or friable, a low-modulus sealant is preferred to minimise stresses on the sealant and the adjacent materials. This is an important performance feature of façade joint sealants as they are specifically designed to protect the façade panels from fracturing during excessive movement. It is quicker and less expensive to repair a joint sealant that has failed cohesively than to repair a façade panel.

6.4.2 Sealants may generally be classified by their elasticity or plasticity – in effect, their ability to return to their original width (elastic recovery):

- Elastic sealants (silicone, polyurethane and MS/hybrid) should recover to a specified width and profile after being subjected to a specified amount of extension. They are more suitable for joints that are subject to reversible movement.
- Plastic sealants (acrylic and bitumen) are those that do not meet a specified elastic recovery criteria. They are more suitable for joints where movement is irreversible.

6.5 TEMPERATURE

6.5.1 Temperature of the sealant and/or materials the sealant is applied to can have a significant impact on sealant performance. As temperatures increase, modulus can decrease, increasing the risk of mechanical damage. The temperature at which this occurs will tend to rise as the sealant ages. As temperatures decrease, modulus can increase.

6.5.2 Where sealants will be exposed to sub-zero temperatures, sealant suitability should be verified with the respective supplier.

6.6 MOVEMENT

6.6.1 The amount of movement a sealant must accommodate is a factor of:

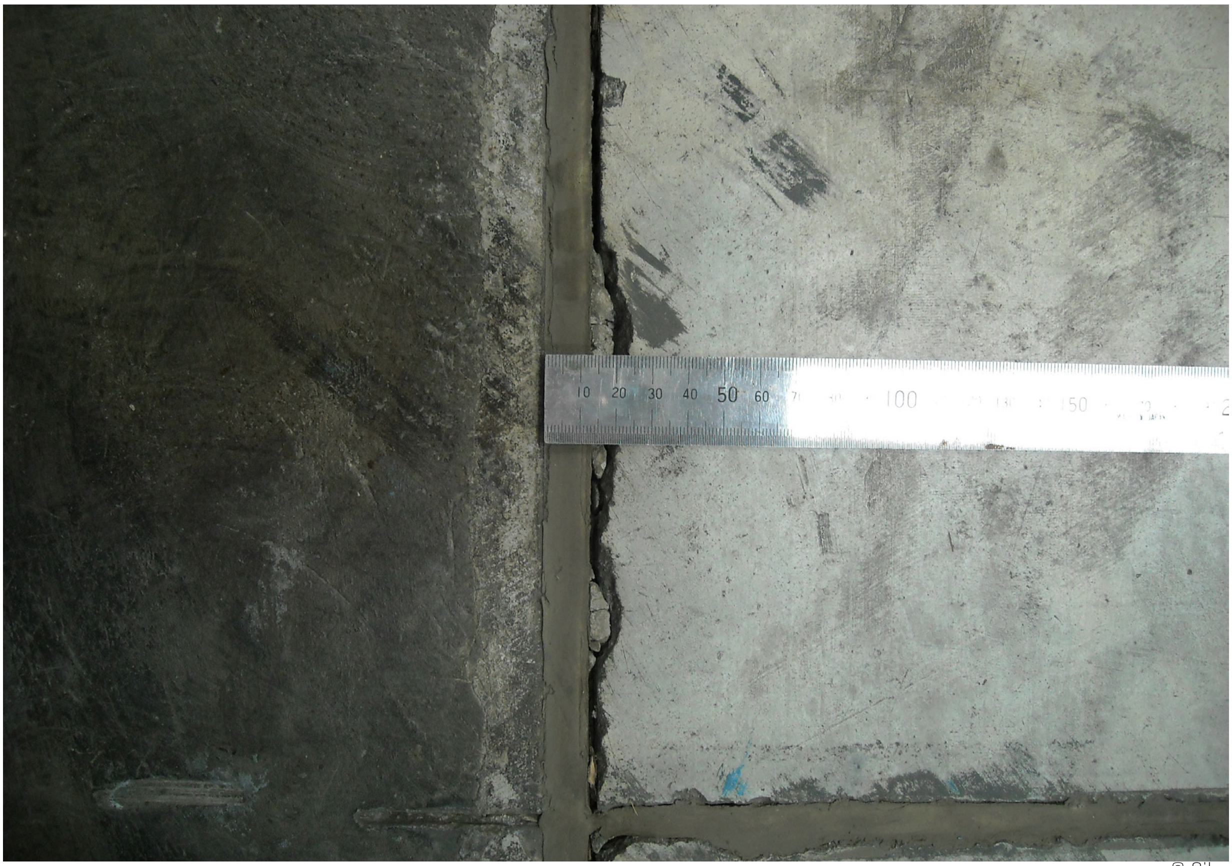
- joint width
- material being sealed
- air and material temperature at time of sealant application.

6.6.2 Consideration should also be given to the sealant curing time and the potential for exposure to movement before the sealant has fully cured. Stressing a sealant that has not fully cured is likely to damage it.

6.7 JOINT WIDTH

6.7.1 Sealant joints require accurate set-out on site as joints that are too narrow or too wide can result in poor sealant performance.

6.7.2 It can be difficult to clean, prime and apply the sealant to joints that are too narrow. Joints that are too wide may have issues with sealant slump, excessive material use and extended curing times.



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Adhesive sealant failure (loss of edge bond).


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Cohesive sealant failure - sealant fracture.

6.8 SUBSTRATE CONSIDERATIONS

6.8.1 Sealant performance is also influenced by the materials being sealed. Considerations include:
- surface finishes
- porosity of the material – there may be a likelihood of the material being stained
- the degree of chemical reactiveness – some alkaline materials may react with the sealant
- substrate strength
- surface dryness – if the surface is damp, the sealant may not be suitable for application
- potential influences on sealant performance.

7.0 CLASSIFICATION BY CHEMICAL TYPE

7.1 ACRYLIC SEALANTS

7.1.1 Latex-based acrylic sealants:
- cure by evaporation of their water content, which causes partial chemical cure, imparting some water resistance
- are not recommended for use in exterior moving joints
- should be painted for better durability and to prevent dirt pickup
- are suitable for use as interior and exterior gap fillers, particularly when protected with a paint system.

7.2 POLYURETHANE SEALANTS

7.2.1 Polyurethane sealants are typically one-part formulations that:
- have good resistance to puncture
- are less likely to harden with age, but this does depend on the specific product formulation
- provide good tear resistance
- have a low modulus
- do not cause staining in natural stones
- are sensitive to moisture during cure (substrates must be completely dry during application)
- have poor performance when immersed in chlorinated water
- have widely varying cure speeds – slow-curing formulations are vulnerable to damage during the curing phase
- are non-slumping
- provide reasonable adhesion to a variety of substrates without a primer
- will yellow with exposure to UV
- have moderate abrasion resistance but specific performance depends on their hardness
- are paintable.

7.3 SILICONE SEALANTS

7.3.1 Silicone sealants:
- have good weather resistance
- can be formulated to perform in high and low temperatures
- equire careful surface preparation and priming for optimum performance, mainly on porous substrates
- have low tear resistance in some formulations, and because of the diversity of types, care is required in their specification
- cannot usually be painted, and paint may not adhere well to previously cured silicone

TABLE 1 SEALANT SELECTION GUIDE

	Polyurethane	Modified silane (MS)	Polyurethane hybrid (AT)	Silicone	Acrylic
Mechanical strength	Highest performance	Acceptable performance	Highest performance	Low or no performance	Low or no performance
Tear resistance	Highest performance	Acceptable performance	Highest performance	Low or no performance	Low or no performance
UV resistance	Acceptable performance	Acceptable performance	Acceptable performance	Highest performance	Acceptable performance
Chemical/temperature resistance	Acceptable performance	Acceptable performance	Acceptable performance	Highest performance	Low or no performance
Non-staining	Highest performance	Highest performance	Highest performance	Low or no performance	Highest performance
Paintability	Acceptable performance	Acceptable performance	Acceptable performance	Low or no performance	Highest performance
Surface tack – dirt pick-up	Highest performance	Acceptable performance	Highest performance	Acceptable performance	Highest performance
Green rating	Highest performance	Highest performance	Highest performance	Highest performance	Highest performance
Porous substrate adhesion	Highest performance	Highest performance	Highest performance	Low or no performance	Highest performance
Non-porous substrate adhesion	Acceptable performance	Highest performance	Highest performance	Highest performance	Highest performance
Compatibility with other repair systems	Highest performance	Highest performance	Highest performance	Low or no performance	Highest performance
Compatibility with bitumen and rubber	Low or no performance	Low or no performance	Low or no performance	Low or no performance	Low or no performance
Repairability	Highest performance	Acceptable performance	Highest performance	Low or no performance	Low or no performance

Highest performance Acceptable performance Low or no performance

- have a low modulus
- are sensitive to moisture during cure (substrates must be completely dry during application)
- are available as specifically formulated silicones to resist fungal attack and surface discolouration, which was a problem with earlier materials.

7.3.2 Care must be taken during application because silicone-contaminated surfaces are hard to clean, and silicone may cause staining that will discolour natural stone.

7.3.3 Silicone sealants are normally one-part systems cured by the absorption of atmospheric moisture. They are usually not as slow curing as one-part polyurethanes or polysulphides. Several curing systems are used, and these are generally denoted as acid cured and neutral cured. This classification is complicated by reference to silicone sealants as being high, medium or low modulus.

7.3.4 Acid-cure silicone sealants:
- release acetic acid during cure
- are usually high modulus
- can be used on non-alkaline, non-porous substrates in fast-moving joints where the high elastic modulus ensures good shape recovery after deformation
- will withstand water immersion with the use of correct substrate preparation and priming
- are not recommended for alkaline substrates (concrete, fibre-cement sheet or glass fibre reinforced concrete)
- can affect coil-coated steel, galvanised steel, zinc, lead, copper and brass due to the acetic acid release
- for high-modulus silicones, high stress may be imposed on the substrate, but they are particularly suited to joining high-strength materials, such as glass to glass and glass to metal.

7.3.5 Neutral-cure silicone sealants:
- provide sufficient tensile strength to be used in many of the acid-cured silicone sealant applications
- are general purpose construction sealants that can be used on almost all substrates
- are not satisfactory for high-movement applications
- generally will not withstand water immersion, such as in a fish tank.

7.4 MS SEALANTS

7.4.1 MS sealants, based on modified polymers:
- are neutral cure
- are a one-part formulation

- have a low modulus
- are non-yellowing
- can be painted
- adhere well to a wide range of materials
- provide excellent weathering resistance with a life expectancy of up 20 years
- are sensitive to moisture during cure (substrates must be completely dry during application)
- are moisture tolerant.

7.4.2 The versatility of MS sealants makes them a good-value general-purpose option for many junctions between different materials.

8.0 JOINT PREPARATION

8.0.1 Substrates such as brick or concrete masonry, cement-based sheet materials and concrete surfaces should be free of dust or laitance and any loose or crumbly material. Contaminants such as oil or grease must be removed, preferably mechanically, since solvents may carry the contaminant deeper into the substrate. Concrete curing compounds or surface sealers should be avoided or their compatibility checked with the sealant supplier. Badly damaged joint edges should be made good with durable compatible patching compounds to ensure a regular sealant profile. Drastic deviations impose additional stresses that may lead to sealant or substrate failure. Wooden substrates must be dust and defect free.

8.0.2 Non-porous substrates such as metals, glass, glazed tiles and plastics should be clean and degreased. The joint must be dry during sealant application.

8.1 PRIMING

8.1.1 Primers are usually necessary on most substrates to promote adhesion and therefore a long-term durable bond. This is especially important for:
- high-movement joints
- joints frequently exposed to high amounts of weathering or moisture
- applications that are difficult or expensive to access.

8.1.2 Primers are normally of much lower viscosity than sealants and readily wet out and penetrate porous substrates. They prevent penetration of moisture from the substrate to the sealant, which could cause loss of adhesion, and they also prevent staining of the substrate by the sealant.

8.1.3 Primers can be specifically formulated so that they chemically bond to the substrate as well as the sealant. Different primer types are recommended for different substrates. It is important to strictly follow the manufacturer's instructions regarding primer type and application.

8.1.4 Primers are generally formulated from chlorinated rubber, modified epoxy resins, polyurethanes, acrylics, silanes or isocyanates. Although many modern sealants are formulated to be used without primers, all sealants will perform better if the substrate is primed first.

8.1.5 When applying primers:
- ensure the joint and surfaces to be primed are clean
- follow the manufacturer's instructions
- mask the surfaces on both sides of the joint to prevent staining by the primer and the sealant
- do not leave primed surfaces exposed for longer than the time recommended by the manufacturer – where the primer has been exposed for too long, joint surfaces will need to be reprimed.

8.2 BACKING RODS

8.2.1 An essential performance aspect of sealed joints is to ensure that:
- sealant adheres to the sides of the joint only
- the correct sealant profile is achieved.

8.2.2 The above requirements are met by the installation of either a bond breaker (tape) to small joints in thin claddings or a PEF rod to larger joints to control depth, sealant profile and ensure only side adhesion occurs

9.0 APPLICATION

9.0.1 To prevent contamination of the adjacent surfaces, mask joint edges. Remove masking tape immediately after tooling. The sealant must be applied to the joint within the time constraint noted on the primer container to ensure optimum performance.

9.0.2 It is essential to ensure the sealant completely fills the joint to the required depth, is in good contact with the full depth of the sides and no air is trapped in the joint. When applying sealants by gun, pulling the gun along will leave a good looking job without tooling, but it is very likely to leave voids and trapped air beneath the surface. The best method is to push the gun in the direction in which the sealant is being applied, as shown in Figures 1 and 2, forcing the sealant into the joint, then tool the joint to produce a smooth finish.

9.0.3 Tooling also forces the sealant into the joint, ensures that the sealant wets the side of the joints, brings any trapped air to the surface and gives it the correct contour.

9.0.4 Use the manufacturer's recommended compound or solution to lubricate the tool in this operation and prevent the sealant sticking to it. However, careless use of the solvent can contaminate the joint and reduce adhesion. Water or water-based solutions should not be used as the sealant is moisture reactive.

9.0.5 The manufacturer's instructions regarding the temperature at the time of application must also be strictly observed. The application temperature of most modern sealants is between 5°C and 40°C ambient temperature. Application of any liquid-applied waterproofing product should be conducted in falling temperature to avoid excess heating and formation of voids or bubbles. For best results, joint sealant should be applied at lower temperatures when the joint substrates are contracted and the joint is open at its widest. This is especially important for aluminium composite panels where joint movement under temperature change can be considerable.

9.0.6 Although the application of these products is simple in theory, many building weathertightness problems have been associated with joint sealants. In reality, most problems are a result of lack of substrate preparation and priming and insufficient joint depth. For critical weathertight applications, a trained and experienced contractor must be engaged to apply these products. The application should be supported by a rigorous quality assurance process that details the product type, manufacturer, batch number and expiry date of the selected product.

10.0 CURING

10.0.1 All sealants require time to cure. Curing will be slower when temperatures are cooler and, for moisture-cure sealants, when the air is dry.

10.0.2 Temporary protection may be required to keep the panels and joint dry and at an even temperature until the sealant is cured.

11.0 MAINTENANCE

11.0.1 Minor defects should be made good, using the same type and brand of sealant, by cutting out and replacing defective areas. Fault-finding inspections of all sealed joints should be made annually.

11.0.2 Because the sealant life can be less than that of most buildings, provision for replacing the sealant should be made at the design stage. Replacement should involve removing any defective sealant, usually by cutting it out and cleaning the joint faces with a wire brush or grinding disk and repriming as required.

11.0.3 Solvents should not be used on porous surfaces, and care must be taken to ensure no broken wires or other contaminants remain. Also, consider the likely compatibility issues between old and new sealant.

11.0.4 Painting over sealants is possible in the case of polyurethane and MS/hybrid. However, it is difficult to ensure compatibility between the paint system. In general, most commonly available widely known brands of acrylic-based paints can be used to overcoat these two sealant technologies. Some advantage for weathering resistance can be gained with a painted joint. Do not overcoat with solvent or oil-based paints. The risk with painting movement joints is restriction of movement causing unsightly cracks in the paint film and possible early failure of the joint sealant. In specific cases, compatibility between paint and sealant has been obtained by close cooperation

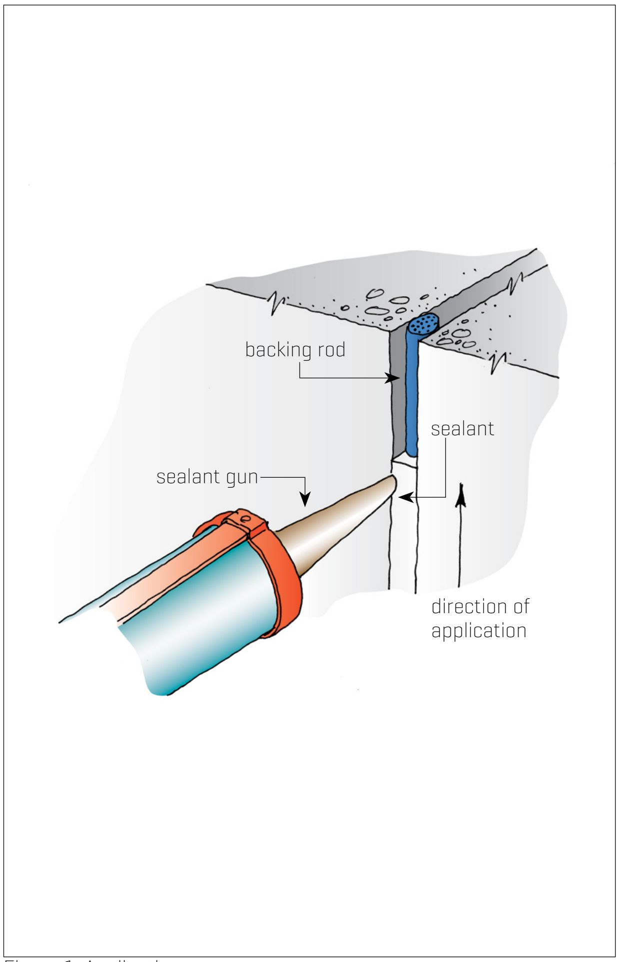

Figure 1: Application.

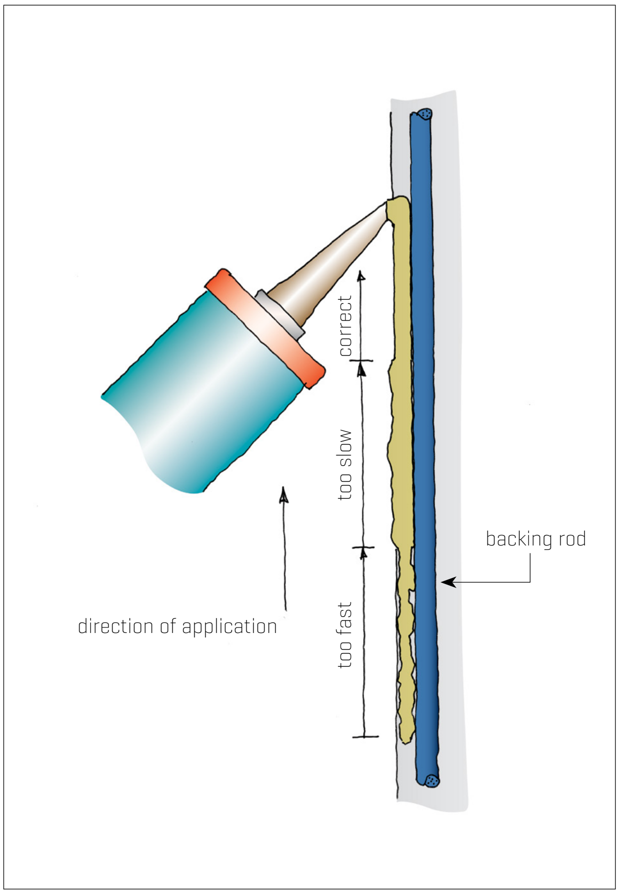

Figure 2: Effect of application rate.

between manufacturers. In most cases, a limited site trial is all that is needed to gain an indication of compatibility. However, decide at the design stage if the sealant is to be painted and select a compatible sealant-paint system.

11.0.5 Mould growth on sealants should be removed by brushing with a dilute neutral detergent solution. Do not use solvents, bleaches or abrasives.

12.0 STANDARDS

ISO 11600:2002 *Building construction – Jointing products – Classification and requirements for sealants.*

ASTM C920–14a. *Standard specification for elastomeric joint sealants*

13.0 FURTHER READING

BRANZ Bulletin 584 *Sealed-joint design – Claddings*

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BRANZ would like to thank Sika for providing the photos used in this bulletin and the information in Table 1.

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