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CHOOSING THE RIGHT SEALANT

Sealants—their properties and performance

by Michael G. Kasperski and Jerome M. Klosowski

THE VARIETY of caulks and sealants available may seem almost limitless—acrylics, butyl, oil-based polysulfide, polyurethane, silicone; one-part, two-part, low-modulus and so forth. Each sealant has characteristics that make it suitable for some applications, but no one material is best for all uses.

Caulks and sealants are used to fill and seal joints-to weatherproof by preventing drafts and the intrusion of wind-driven rain and dust. Energy conservation mandates that buildings be sealed to prevent drafts and reduce the energy requirements for heating and air conditioning. The penetration of water through joints can cause structural damage and almost always results in unsightly water staining. While the initial cost of the sealant and its installation may comprise only a small fraction of the total building cost, failure of the sealant may result in disproportionately high bills to repair structural and aesthetic damage. Energy costs will be greater than needed, too.

Specific applications for construction sealants are as varied as the sealants available, and selections of the "best" sealant can come only after careful matching of the sealant properties with the application requirement. "Best" means the product of lowest cost that will do the intended job.

While applications vary greatly, functionally there are only two types of joints—working joints and nonworking joints. The essential difference between these joints is the degree of movement. While a few special applications may require special sealant properties, the first The increasingly wide selection of sealants available to specifiers today offers rewarding design flexibility and sureness of construction. However, no single sealant is ideal for every application and it is important to understand the sealant of your choice.

Here is the first of a two-part Specification Associate feature on sealants—compiled specially by research experts with Dow Corning Canada Ltd. We are indebted to the authors for their thorough treatment of the subject, and its consequent value to our readers.

consideration in selection of a sealant for any joint must be the amount of joint movement.

Non-Working Joints

These are joints in which there is little or no movement of the joined parts. Movement may be restricted because the parts are connected with mechanical fasteners; the size of the unit is small; or the joint is in a relatively constant environment. Maximum movement is typically limited to 5 percent of total joint width. Some examples of nonworking joints are:

Interior heel beads in glazing Glazing of small and individual window lights

Copings and gravel stops

Reglet joints

- Stabilized settlement cracks in
- masonry walls Residential perimeter glazing.

Sealing materials in these applications function primarily as "fillers" since there is little or no stress on the material. Because the primary function is filling holes and cracks, almost any sealing material will work and material cost becomes the deciding factor. The major part of any sealing job is labor, so installation must also be easy. Extensive joint cleaning or preparation adds significantly to the cost of the sealing project. Special handling requirements, such as heating or mixing of a 2-package sealant, must be considered from the viewpoint of added time, added equipment, and added chance of applicator errors.

The sealing materials must bond to the substrates and must be able to accommodate the limited degree of joint movement that occurs in these joints. It should not take a permanent set when held in extension or compression. Within the temperature range expected in this application, the sealant should not become brittle at low temperatures or soften and flow when hot. It should not dry, harden, or crack over its needed life time.

It is important to know the life needed on the job to match to the stated life of various sealants. Other factors may also be important, such as ability to withstand sunshine and weathering when the application is exterior, resistance to traffic for floor joints, resistance to chemicals and resistance to color change or staining with age. These factors should be considered when selecting a sealant:

- 1) Cost
- 2) Ease of installation
- Amount of joint preparation required

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DISPONIBLE UN DEVIS DIRECTEUR

Depuis quelques années, notre administration fédérale a travaillé à ce que nous savons, personnellement en tant que rédacteurs de devis, et en tant qu'association, être nécessaire pour que nous soyons plus efficaces et productifs dans notre métier. Lentement et sûrement, d'abord dans un certain nombre de ministères séparés, et maintenant en collaboration, ceux qui, dans l'administration, préparent ou font préparer la documentation des contrats (instructions à ceux qui construisent des immeubles à l'intention du governement) ont réuni un devis directeur, connu sous le nom de Devis directeur du gouvernement.

Des employés et des conseillers de l'administration fédérale, dont plusieurs ont été, ou sont toujours, membres de notre association, ont réalisé ce travail qui, en général, est conforme aux principes et aux pratiques mis de l'avant conjointement par Devis de Construction Canada et le Construction Specification Institute des Etats-Unis.

Devis de Construction Canada a passé une entente avec l'Administration fédérale pour la diffusion dans le secteur privé du Devis directeur du gouvernement. Vous trouverez au verso un bulletin de commande, pour permettre à ceux qui le désierent, de se procurer, en tout ou en partie, le devis directeur, ou, s'ils le possèdent déjà, de le mettre à jour.

Ce "Devis directeur du gouvernement" est rédigé en fonction des projets du gouvernement, et, par conséquent, il contient certains articles qui ne s'appliquent qu'aux contrats du gouvernement, alors que d'autres articles, qui seraient nécessaires pour les contrats du secteur privé, n'y apparaissent pas. Toutefois, un devis directeur n'est qu'un instrument, et il doit être adapté par un rédacteur de devis compétent, qui modifie, supprime ou ajoute des articles.

Devis de Construction Canada, à la suite d'une série d'entretiens et de négociations, a réussi à convaincre ses propres membres, au moyen de représentations faites auprès du Conseil national de direction, aussi bien que l'administration fédérale, que cette association, qui représente le secteur privé de l'industrie de la construction, devrait revoir le DDG. et, par la modification de ses textes, élaborer, à partir d'un document à orientation gouvernementale, un texte qui pourrait servir toute l'industrie de la construction et tous les Canadiens qui désirent ou doivent construire. Il s'agit là d'un processus graduel, qui doit s'étendre sur cinq ans (une année vient déjà de s'écouler), et, à mesure que les modifications seront faites, ce document va devenir, section par section, le Devis directeur national de la construction canadienne (DDN en bref).

Les prix qui apparaissent au verso, pour le devis directeur, permettent d'acheter le document dans sa version actuelle, qui a déjà subi une première révision, en plus de tout document mis à jour qui deviendra disponible au cours de la deuxième moitié de 1978 devant être publié d'ici la fin de l'année.

Des abonnements de mise à jour sont aussi disponibles pour chaque année supplémentaire, tel qu'indiqué sur la liste de prix des mises à jour.

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- 4) Adhesive and cohesive strength
- Dynamic movement capability
 - Stability—not embrittle when cold or soften when hot
 - 7) Weatherability
- 8) Intrusion resistance
- 9) Chemical resistance
- 10) No staining or discoloration

What types of materials meet these requirements? All but the cheapest mastics have some area of practical use, and any "good" sealant satisfies to some degree most of these areas. The high performance sealants satisfy to some degree all of these areas except initial low cost.

The high performance sealants designed for use in working joints generally offer only improved extension and compression capabilities, improved weatherability and somewhat extended useful temperature range.

For most nonworking joints, some of these properties are required. If the sealing material is used only as a filler with no movement intended, and the life required is no more than two to five years, then the oil and bituminous-based caulks and mastics and vinyl latex systems are probably satisfactory. These materials are referred to as low range caulks.

If the joint will be moving (but is still nonworking) or if a longer service life is required, a medium range sealant is desireable. These materials include the butyls, acrylic latex systems, cholorosulfonated polyethylenes and chloroprenes. These sealants can provide satisfactory service for up to 10 years when properly installed.

These low range caulks and medium range sealants are generally the right sealant for nonworking joints because they do provide adequate performance and are lower in initial cost than high performance sealants and premium quality silicones. In some cases, even in nonworking joints, a premium silicone sealant may be more appropriate because of its ability to withstand long term exposure to water, sunlight, and weather. Long life, easy cleaning, and appearance considerations may be reasons for choosing a premium quality silicone sealant. Residential exterior applications and sealing around bathtubs and showers are examples.

Working Joints

The second functional type of joint is the working joint, designed to accommodate movement. Examples are:

Isolation joints (expansion joints)

Curtain wall joints ... panel to panel, panel to mullion Masonry control joints Perimeter glazing Structural glazing Pools, reservoirs, canals Highway joints Joints between dissimilar materials Lap joints in corrugated metal sheets

for roofs and walls Skylights

Working joints may be of several designs—butt joints, lap joints or a surround joint. In a butt joint, the panels being joined abut each other and the sealant is subjected to alternating tensile and compressive forces. In a lap joint, the panels over-ride each other in a sliding type of movement, which results in shearing stresses on the sealing material. The "surround joint" is a combination of butt and lap joints. In this joint the sealant may be subjected simultaneously, or separately, to these forces.

The amount of stress the sealant must withstand depends then on how much the joint moves, the configuration of the joint and size of



Solar panels call for sealants withstanding high stagnation temperatures.

the joint. How much a joint moves depends on a variety of factors.

Temperature is very important. In a 1970 publication, K. K. Karpati and E. V. Gibbons of the Division of Building Research, National Research Council of Canada, reported a high correlation between daily temperature changes and expansion joint movement. Statistical analysis of the daily data indicated it could be extrapolated to annual movement. This was confirmed by actual measurements.

Data for this study was obtained by

measurement of movement in expansion joints in two different buildings while constantly monitoring temperature. Results of the study showed that while temperature may not be the sole cause of joint movement, calculations based only or expected temperature changes can give a good estimate of the movemen that will occur.

Temperature is also important in the the substrate temperature at the time of sealant installation will determine the type of stress on the sealant. If a sealant is installed in a butt joint on a hot summer day, panels will be near their maximum size, joints near their minimum, and the sealant will primaril undergo extension stresses. If installation is done in midwinter when panels are at a lower temperature and joints are wider, the sealant will undergo primarily compression. Installation at temperatures between the extremes will result in some extension and some compression.

The effect of temperature changes on joint movement of various substrate materials is another factor to consider All materials expand and contract, but they do not expand and contract at the same rate. A 10-ft. section of plate glass, for example, will expand or contract less than 0.1 in. over a temperature change of 150 degrees F The same size precast concrete pane will change slightly more than 0.1 in., and some plastlcs may expand or contract a full inch.

Wind can contribute to joint movement. For example, a 10 ft. \times 8 ft. \times % in. plate glass light in a curtai wall frame will have a deflection of more than 1 in. at its centre in a 120 mph wind. This causes compression and extension forces on the sealed joint. Besides the positive windward and negative leeward forces, the wind causes actual deflection of tall buildings, increasing stresses even more.

Joint movement can also be caused by changes in the relative humidity, especially with wood products. Other forces that cause joint movement are vibration and settling, but these are generally unpredictable. Calculations to estimate joint movement are relatively simple. If the panel material, the panel size and desired joint size are known, the architect can determine the expected temperature range of exposure and

estimate the installation temperature. Only after the amount of joint movement has been determined can the sealant be selected. Sealants are classified by federal specification according to the amount of movement

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Example	
Material	Precast Concrete
Coefficient of Expansion	6.5 × 10 ⁻⁶ in/in/°F
Panel Size	30 ft.
Joint width	1/2 in.
Installation Temperature Expected Temperature	70 F
Range	- 30 F to
	130 F
of expansion) (temperature Maximum Expansion	re range)
= (30')(12 in/ft)	
(6.5 × 10 ⁻⁶ in/in/ ⁶ = .234 in. = 47 percent Maximum Compression	°F) (100 F)
(6.5 × 10 ⁻⁶ in/in/ ⁶ = .234 in. = 47 percent Maximum Compression = (30') (12 in/ft) (6.5 in/in/°F) (60 F)	°F) (100 F) × 10 ⁻⁶
(6.5 × 10 ⁻⁶ in/in/ ⁶ = .234 in. = 47 percent Maximum Compression = (30') (12 in/ft) (6.5 in/in/°F) (60 F) = .141 in.	°F) (100 F) × 10 ⁻⁶

they can tolerate, and in working joints, the most important sealant property is the ability to withstand (as a minimum) the designed amount of movement. To do this the sealant must maintain adhesion to the joint surface without developing so much internal stress that it fails cohesively. Ability to withstand "designed movement" is a minimum requirement because tolerances in panel dimensions and erection procedures will result in some variations from the designed joint width. Thus, the sealant must have a safety factor in the degree of movement it can accommodate.

How the sealant accommodates the movement and what happens when the stress is removed are also important. A good working joint sealant should be able to be deformed without putting excessive stress on the adhesive bond. Modulus is the measurement of this stress. With rubbers and elastomers, modulus is not a constant but is the stress required to produce a specific degree of deformation. Low modulus sealants are more easily deformed; that is less force is required to cause a specific deformation than with a high modulus sealant.

Low modulus is an advantage because it results in less strain on the adhesive bond and the substrate. This is important if adhesion is marginal or if cementatious substrates are involved. (A high modulus sealant with good adhesion can put enough stress on a concrete surface to cause failure by rupture of the concrete near the surface. The concrete surface looks like it has spalled.)

Recovery from deformation is



Sealants facilitated glazing concepts at Toronto Hydro.

another important sealant property. While 100 percent recovery is not essential, a high degree of stress relaxation or compression set will rapidly result in sealant failure. If the sealant fails to recover form extension, it will be pumped from the joint during compression, putting a large stress on the bond and sealant, and will eventually fail. If the sealant has a high compression set, compression will result in a permanently reduced sealant bead width. Once this occurs, any subsequent extension may exceed the strength of the material resulting in cohesive or adhesive failure.

Finally, sealants used in working joints must retain these critical properties over the service temperature range expected and on prolonged exposure to weathering. The sealant that becomes brittle as temperature decreases loses its ability to withstand extension at the very time that extensibility is most needed. Good weatherability is dependent upon the sealant's ability to withstand ultraviolet radiation, ozone and other atmospheric conditions, all of which can cause severe degradation.

Other properties that should be considered when selecting a sealant for a working joint are requirements for joint preparation, primer needs, and ease of installation. Unfortunately, only the initial cost and not the life cycle cost is usually

considered. As already mentioned,

installation costs constitute the major expense in any sealing application. The cost involved in replacement of a "bargain" sealant will rapidly exceed the initially higher cost of a premium quality sealant. As with sealants used in nonworking

As with sealants used in nonworking joints, some applications may require special properties such as resistance to abrasion or penetration, chemical or oil swell resistance.

In summary, the properties required of sealants to be used in working joints are:

- Ability to withstand significant dynamic movement
- 2) High recovery
- Good weatherability for a long service life
- 4) Low "life cycle cost"
- Special properties, such as abrasion resistance, chemical resistance, oil swell resistance.

Sealants with properties required to perform in working joints are classified as "high performance" sealants. These include solvent-type acrylics, polysulfides, polyurethanes and silicones. All these have higher joint movement capability and better weatherability than the low range caulks and medium range sealant but each class also has its own characteristics.

The concluding part of this article will appear in our next issue.

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Silicone lurethane roofing and tank insulation. High-heat silicone sealant protects solar collectors.

superior to polysulfides (about 80 to 90 percent), and weatherability and ultraviolet resistance are comparable. Depending on the brand and its use in relation to sun and weather, a 10 to 20 year life is expected. Joint movement capability for polyurethanes is usually ±25 percent, and in a pure extension cycle some modified urethanes are capable of up to 40 percent movement.

Adhesion of polyurethanes is normally quite good though priming is sometimes required. Water immersion resistance is not as good as polysulfide and can result in adhesion failure. Presence of excess moisture during cure can impair adhesion.

The cure of one-part materials is slow, sometimes requiring several days to become tack-free. Cure rate for the two-part materials is not significantly faster and very thorough mixing is required. Working life is one to four hours. The working temperature range is adequate for most construction applications and is comparable to the polysulfides.

Urethanes are used in many of the same construction applications as polysulfides, such as curtain wall sealing, perimeter glazing, expansion joints and precast concrete joints. Use in insulating glass is just being developed. The foot traffic and high abrasion areas are really their special niche.

Silicone Sealants

Silicone sealants used in construction are one-part materials that cure by reacting with atmospheric moisture. They are available in three basic types (low, medium and high modulus) with a range of properties. All utilize the same basic polymer, but differ in cure and the modulus of the cured material.

If the solvent acrylics, polysulfides and polyurethanes are considered high performance sealants than the silicones should be classed as "super high performance" because in several important properties they outperform all other materials. The silicones can be applied over a wider temperature range than other materials, from - 35 to 140 degrees F. They also have a wider service temperature range (-65 F to 350 F) and recovery from deformation is superior to all other materials, approaching 100 percent.

Weatherability is also superior because silicones are not affected by ultraviolet radiation or by typical ozone or oxidation conditions, and they possess excellent high and low temperature stability. After 1,000 hour tests in a weathering machine, polysulfides develop surface crazing and harden. Silicones exposed to the same conditions for more than 6,000 hours exhibit no increase in hardness or surface crazing. Silicones also do not lose adhesion on ultraviolet exposure as do polysulfides.

Because of excellent weatherability, silicones are used extensively in many exterior sealing applications. While initial cost of the sealant is relatively high, silicones are found to be more than competitive when "life cycle" costs are calculated.

Some caution is warranted against overestimating the cost of a silicone. Silicones should be generally applied in a 2/1 width to depth ratio (1/2 in. wide, 1/2 in. deep) while the recommended practice for many other high performance sealants is a 1 to 1 ratio (1/2 in. wide, 1/2 in. deep). Some joint preparation is always required and priming is sometimes required. This depends upon the type of silicone and the application. Most silicones manufactured today are rather soft and are not recommended for foot traffic areas. High modulus sealants are used to seal aquariums while most of the low modulus products are not recommended for below grade applications.

High Modulus Silicones

The original silicone sealant (and the most familiar) is the acid cure type, the material that evolves the familiar vinegar odor during cure. Acid cure



silicones in Canada have a high modulus and excellent adhesion to many substrates. This had led to use in a myriad of adhesive and sealing applications ranging from affixing information signs and lettering to structural glazing.

The high modulus silicone sealants are the only materials that have the necessary adhesive and cohesive strength, durability and weatherability to perform in structural glazing applications. The silicone sealant is used for the weather seal and the transfer of applied loads from the glass panel to its perimeter support.

Another major application for this sealant is in dual seal insulated glass units. It is the structural seal with a hot melt butyl sealant being used as a vapor barrier. The silicone gives the units strength along with exceptional ultraviolet and aging resistance. These silicones have a high moisture vapor transmission rate and cannot be used in an insulated glass as the only sealant of a single seal unit.

These sealants are also used to seal curtain walls where movement is within the material capability of ±25 percent. It should not be used on masonry substrates because the acid released during cure weakens the concrete strate and adhesion is ruined.

These sealants cure very fast and are tack-free in less than 30 minutes. This is a mixed blessing in that it reduces dirt entrapment but it also requires tooling very soon after application, ideally within 5 minutes.

Low Modulus Silicones

A second type of silicone is a very low modulus sealant with a neutral cure. The most common is a one-package material that gives off an amide during cure. This material has excellent adhesion to a variety of substrates including masonry and is especially suited for applications where a high degree of movement is expected.

The low modulus characteristics of

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Member: An individual concerned professionally with preparation, interpretation and enforcement of specifications and documents used in connection with the design, construction, maintenance and equipment for construction projects OR An individual who uses specifications for construction, manufacturing, processing, or procuring construction materials and equipment for a building or engineering construction project, or who represents an Association related	school of architecture, engineering or technology for the period of the training. Individuals undergoing training in an office of an Architect or Engineer or an industrial organization, shall qualify for "Student" membership for one year. Contact CSC office for exception when taking correspondence courses. Membership in Construction Specifications Canada is personal and not transferable. Dues must accompany this application. Annual dues are \$60
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	Signature of Applicant

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This article concludes an exclusive two-part study of construction sealants prepared for Specification Associate by Dow Corning Canada Ltd. The authors are acknowledged experts working for the company in research and development, and we congratulate them on such a comprehensive work. The first article was published in our September-October issue, and focussed on factors to be taken into account when selecting a sealant: such as determining joint movement, temperature changes, possible deformation and recovery. This concluding section examines the characteristics of the many sealants available to us today.

As stated in our first article, the range of caulks and sealants available today may seem virtually limitless—acrylics, butyl, oil-based polysulfide, polyurethane, silicone; one-part, two-part, low-modulus etc. The characteristics of each sealant will make it suitable for certain applications, but no one sealant can prove ideal for all purposes. In selecting a sealant, we should assess its individual properties as follows.

Solvent-Type Acrylics

Solvent-type acrylics are normally classed as high performance materials because of their good weatherability and ultraviolet resistance. If rated strictly on movement capability, they would be only medium range. These materials cure by solvent evaporation, not a chemical reaction, and curing is slow. An unpleasant odor is noticeable during cure, and the surface remains tacky for several days. Solvent-type acrylics have poor recovery, approximately 25 percent, so their use is limited to joints with a maximum movement of ±10 percent.

A disadvantage of acrylics in cool weather is that they must be heated to 70 degrees F to obtain a gunnable consistency. Advantages are that they come in a wide range of colors and offer good adhesion with little joint preparation and no priming.

Solvent-type acrylics are used for panel to panel sealing and caulking of precast joints and perimeter joints where movement is within sealant capabilities. In glazing, they are used over tapes and for heel beads and back bedding. Solvent acrylics are not recommended for traffic-bearing joints, underwater uses or interior uses where food contact may occur.

Polysulfides

Polysulfides were the first elastomeric joint sealants to be used in construction and they still occupy a large segment of this market. They are available as both one- and two-part sealants in a wide range of mechanical properties. Maximum joint movement capability is ±25 percent. Recovery is somewhat better than the solvent acrylic, about 60 to 80 percent, but failure can occur if movement is great. The polysulfides have good resistance to deterioration when immersed in water and are often used in sealing swimming pools, reservoirs and culverts. Solvent resistance is also good.

The one-part polysulfide materials are slow to cure, especially at low temperatures. The two-part materials cure much faster, but thorough mixing is required and working time, when mixed is short. Primers are required to obtain good adhesion to masonry and many other substrates, and both oneand two-part materials have a characteristic odor.

Weatherability and ultraviolet resistance of the polysulfides is satisfactory for applications where direct long term exposure to weather is not encountered and long-term ultraviolet resistance is not required. Performance is usually good for 10 to 15 years although some surface changes may occur during this time.

One of the major uses of polysulfide sealants is in the fabrication of insulated glass, but they are being gradually replaced by sealants that have better aging characteristics. Polysulfides are also used in expansion joints, curtain wall sealing and sealing of corrugated roofing. They are not recommended for insulated glass sealing if the insulated unit will be used in a flush glazing system for the same reason.

Polyurethanes

Polyurethanes are among the most versatile polymers used in sealant formulation. Some urethanes are combined with other organic polymers to provide an even greater range of properties. Polyurethanes and the modified urethanes are available as one- and two-part materials. They have good elongation and excellent abrasion resistance and tear strength. Because of their toughness, they are often used in floor joints for buildings, patios, decks and parking garages.

Recovery from deformation is

Modulus	Application	Precaution
High	• glazing	Joint not to move
	 structural glazing 	> ± 25 percent.
	 adhesive 	Never against con-
	 perimeter seals (limited use) 	crete and cementa- tious materials.
	 can be used under water against some substrates (glass) 	
Medium	 glazing 	Joint not to move
	adhesive	$> \pm$ 40 percent.
	 perimeter seals (limited use) 	Not for below grade.
	 against any substrate 	
Low	 expansion joints non-structural glazing perimeter seals highway seals against any substrate 	Too pliable to be an adhesive. Not for structural glazing. Not for below grade. Not
		for foot traffic.
Modulus defin	ed as:	
High Modulus	100-150 psi tensile @ 150 percent elongation	

Medium Modulus Low Modulus

this material is important because it reduces the stress at the bond/substrate interface. In a tensile bar configuration (as described in ASTM-D412) a force of 20 to 40 psi is required to extend the low modulus sealant by 150 percent. The high modulus acid cure sealant typically requires a force of 110 psi.

In addition to the low modulus, this sealant is also capable of very high extension. In the same ASTM configuration, low modulus silicones can be extended more than 1500 percent before failure occurs. In an actual simulated concrete joint, the sealants are capable of more than 650 percent extension—far beyond any normal requirements. This provides a significant safety factor.

Low modulus sealants also have the good recovery typical of silicone sealants and so they withstand repeated extension and compression. The cylic movement capability of this material is rated at greater than ± 50 percent.

The high movement capability of the low modulus sealants make them ideal for such applications as expansion joints and curtain wall sealing. They are also finding increased use in highway joint sealing. Use on highways requires installation slightly below the joint surface to prevent damage from traffic.

Because the movement capability of low modulus silicones is great, they are not considered as having sufficient strength to be used in applications like structural glazing. They are considered too soft and pliable. Medium Modulus Sealants

80-100 psi tensile @ 150 percent elongation

20-40 psi tensile @ 150 percent elongation

The third type of silicone sealant for construction uses is also a neutral cure sealant. It is a medium modulus material that has sufficient strength to be used in many of the acid cure applications (95 psi at 150 percent elongation) and enough movement capability (\pm 40 percent in dynamic ASTM tests) for many of the low modulus applications. As with any relative term like "medium modulus", one should look at the fine print for a definition. Some sealant manufacturers define \pm 40 percent as low modulus while others define it as medium.

In general, a medium modulus sealant is a good general purpose construction sealant and can be used in many applications but it is still not ideal for all uses. It does not provide the insurance factor of the truly low modulus silicones in problem joint applications. It is not as high strength as the high modulus to give the insurance factor in the structural glazing applications. These sealants are satisfactory for normal, nonstructural glazing and for most perimeter seals which are designed to have less than ±40 percent joint movement. They can be characterized as high performance, general purpose sealants possessing all of the typical silicone properties (long life, weatherability, and good recovery).

All neutral-cure silicones, low and medium modulus, offer good adhesion to a broad variety of substrates, broader than the other silicones—and in most cases, no primer is required. Their cure rate is almost ideal for exterior construction, allowing 15 to 45 minutes after application for tooling and become tack free in two to four hours.

The neutral cure products, low and medium modulus silicones are not recommended for use in foot traffic joints nor under conditions of total immersion. This detail is important in understanding silicone sealants because most people will only say silicone when specifying a silicone sealant. They should consider the substrates involved, the other application requirements and specify by sealant modulus.

The ability of a sealant to elongate without rupture is another key property to consider. The elongation capabilities of the various classes of sealants listed above is indicated here (elongation measured in an ASTM tensile bar configuration):

High Modulus 300-500 percent Medium Modulus 450-700 percent Low Modulus > 1000 percent (typical 1500 percent)

Sealant Summary

After reviewing these high performance materials, it should be apparent that no one sealant is ideal for all applications. We have found that solvent acrylics have good ultraviolet resistance and weatherability, but only limited movement capability. Polysulfides offer greater movement capability and water immersion resistance than the solvent acrylics, but ultraviolet resistance is inferior. Polyurethanes are generally "tough" materials that are extensively used in traffic joints, especially foot traffic areas. They have good, but limited, weatherability, and recovery. They have a broader application and service temperature range and a fast cure but generally are not recommended for foot traffic joint applications. Those that can be used against concrete are not recommended for continuous immersion.

Finally, silicones—with their unsurpassed aging, weatherability, and useful temperature range—are the sealants of choice in many different applications. These uses range from structural glazing and solar collectors to difficult joints in highway seals, depending on which silicone you choose.

With any application, careful selection of the sealant is essential to good performance. Know what you want and pick the sealant accordingly.