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Designation: C1249 – 06a (Reapproved 2010)

Standard Guide for Secondary Seal for Sealed Insulating Glass Units for Structural Sealant Glazing Applications[1]

This standard is issued under the fixed designation C1249; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide covers design and fabrication considerations for the edge seal of conventionally sealed insulating glass units, herein referred to as IG units. The IG units described are used in structural silicone sealant glazing systems, herein referred to as SSG systems. SSG systems typically are either two or four sided, glazed with a structural sealant. Other conditions such as one, three, five, six sided may be used.

1.2 This guides does not cover the IG units of other than conventional edge seal design (Fig. 1); however, the information contained herein may be of benefit to the designers of such IG units.

1.3 In an SSG system, IG units are retained to a metal framing system by a structural seal (Fig. 2). The size and shape of that seal, as well as numerous other SSG system design considerations, are not addressed in this guide.

1.4 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.5 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

1.6 The committee with jurisdiction for this standard is not aware of any comparable standard guides published by other organizations.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C639 Test Method for Rheological (Flow) Properties of Elastomeric Sealants

C679 Test Method for Tack-Free Time of Elastomeric Sealants

C717 Terminology of Building Seals and Sealants

C794 Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants

C1087 Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems

C1135 Test Method for Determining Tensile Adhesion Properties of Structural Sealants

C1184 Specification for Structural Silicone Sealants

E631 Terminology of Building Constructions

E773 Test Method for Accelerated Weathering of Sealed Insulating Glass Units (Withdrawn 2010)[3]

E774 Specification for the Classification of the Durability of Sealed Insulating Glass Units (Withdrawn 2006)[3]

E2188 Test Method for Insulating Glass Unit Performance

E2189 Test Method for Testing Resistance to Fogging in Insulating Glass Units

E2190 Specification for Insulating Glass Unit Performance and Evaluation

2.2 *Other Standards:*

Igma 73-8-2B Test Methods for Chemical Effects of Glazing Compounds on Elastomeric Edge Seals[4]

3. Terminology

3.1 *Definitions:*

3.1.1 Refer to Terminology C717 for definitions of the following terms used in this guide: adhesive failure, bead, cohesive failure, compatibility, cure, elongation, gasket, glazing, joint, lite, modulus, non-sag sealant, seal, sealant, sealant backing, setting block, shelf-life, silicone sealant, spacer, structural sealant, substrate, tooling, and working life. Refer to Terminology E631 for the definition of sealed insulating glass as used in this guide.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *desiccant*—a hygroscopic material that adsorbs water or may adsorb solvent vapors, or both (see Fig. 1).

[1] This guide is under the jurisdiction of ASTM Committee C24 on Building Seals and Sealants and is the direct responsibility of Subcommittee C24.10 on Specifications, Guides and Practices.

Current edition approved June 1, 2010. Published July 2010. Originally approved in 1993. Last previous edition approved in 2006 as C1249–06a. DOI: 10.1520/C1249-06AR10.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The last approved version of this historical standard is referenced on www.astm.org.

[4] Available from IGMA, 111 E. Wacker Dr., Ste. 600, Chicago, IL 60601.

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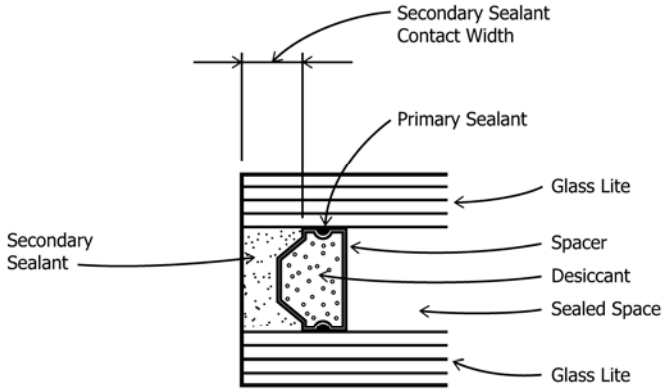

FIG. 1 Sealed IG Edge Seal: Basic Components

3.2.1.1 *Discussion*—The desiccant maintains a low relative humidity in sealed insulating glass.

3.2.2 *primary seal*—A joint seal of which the sealant resists moisture vapor permeation into the desiccated space of sealed insulating glass (see Fig. 1).

3.2.2.1 *Discussion*—It also resists inert gas permeation (for example, argon) from the IG unit sealed space if the intent is to use an inert gas.

3.2.3 *secondary seal*—a joint seal of which the sealant structurally unites the two glass lites and spacer of sealed insulating glass (see Fig. 1).

3.2.4 *spacer*—a fabricated shape that creates an appropriate distance between two lites of glass in sealed insulating glass (see Fig. 1).

3.2.4.1 *Discussion*—As a component of the edge seal system, the spacer also resists vapor migration into sealed insulating glass and provides a container for a desiccant.

3.2.5 *structural seal*—a joint seal of which the sealant structurally adheres an IG unit to a metal framing system (see Fig. 2).

3.2.5.1 *Discussion*—The structural seal transfers applied loads to the framing system as well as accommodates differential movements between the IG unit and the framing system.

3.3 *Symbols:*

3.3.1 A = area, m^2 ($in.^2$).

3.3.2 C_s = sealant contact width, shear, mm (in.).

3.3.3 C_t = sealant contact width, tension, mm (in.).

3.3.4 D = design factor, dimensionless.

3.3.5 F_s = allowable shear stress, Pa (psi).

3.3.6 F_t = allowable tensile stress, Pa (psi).

3.3.7 F_y = yield stress, Pa (psi).

3.3.8 H = height, m (ft).

3.3.9 L = perimeter length, m (ft).

3.3.10 M = mass per unit area, N/m^2 (lb/ft^2).

3.3.11 P = applied load, Pa (lbf/ft^2).

3.3.12 W = width, m (ft).

4. Significance and Use

4.1 It should be realized that the design of an IG unit edge seal for use in SSG systems is a collaborative effort of at least the IG unit fabricator, sealant manufacturer, and design professional, among others.

4.2 This guide provides information on silicone sealants that are used for the secondary seal of IG units that are glazed into SSG systems.

4.3 Information is also provided on the other major components of the IG unit edge seal, compatibility of components, durability, and quality assurance (QA).

5. Insulating Glass Unit

5.1 *Insulating Glass Unit Components*—The edge seal of an SSG system IG unit consists of the two lites of glass, spacer, desiccant, primary sealant, and secondary sealant (Fig. 1) (**1**).[5] This type of IG unit is referred to commonly as a dual-seal unit in that it has separate primary and secondary seals. A single-seal IG unit is inappropriate at this time for SSG systems and should not be used. The following sections describe the components of a dual-seal IG unit briefly.

5.2 *Glass and Architectural Coatings:*

5.2.1 *Glass*—All types of glass have been used in the fabrication of IG units, including monolithic, laminated, tempered, heat-strengthened, tinted, heat-absorbing, light reducing, patterned, and wired. Almost all glass is produced by the float manufacturing process, in which the glass ribbon that emerges from the furnace is floated on a bath of molten tin, allowing gravity to produce essentially flat parallel surfaces.

5.2.2 *Architectural Coatings*—These coatings, which are applied to the surface of the glass prior to IG unit fabrication, are generally grouped into one of two categories: low-emissivity or reflective. They are both metallic or metallic oxide materials and in some cases are in multi-layers, deposited onto or into a glass surface. The coatings are deposited primarily by two methods: magnetic sputtering onto the glass surface and pyrolitic deposition into the glass surface. Low-emissivity coatings are visually transparent and reflect long-wave infrared radiation, thereby improving the thermal transmittance of the glass. In general, they also decrease but to a lesser extent than reflective coatings, visible light transmission, and transmitted solar radiant energy. Depending on lighting conditions, reflective coatings are generally considerably less transparent than low-emissivity coatings. These coatings provide a reduction in transmitted solar radiant energy, conductive heat energy, and visible light into the building interior. Ceramic enamel, silicone, and pressure-sensitive vinyl and polyester film are applied to the surface of glass to make spandrel glass.

5.3 *Spacer*—Spacers are fabricated primarily from roll-formed hollow metal shapes and are available in numerous profiles, depending on the application. Metals typically used are aluminum, both mill finish and anodized, galvanized steel, and stainless steel, with aluminum used predominately. The spacer establishes the size of the sealed space, provides surfaces for installation of the primary sealant, is hollow for desiccant installation, and forms the third surface of the cavity created at the edge of the glass lites for installation of the secondary sealant.

[5] The boldface numbers in parentheses refer to the list of references at the end of this guide.

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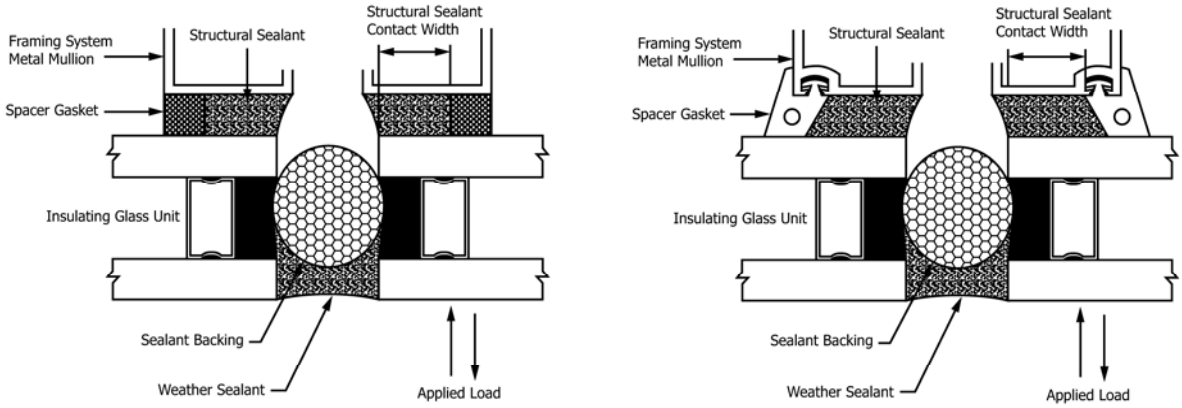

FIG. 2 Typical A-Side SSG System Mullion: Horizontal Section (Vertical Joint)

5.4 *Desiccant*—These substances are hydrophilic crystalline materials that are installed into the hollow of the spacer, usually on at least two sides of the IG unit. Commonly used desiccants are molecular sieves or a blend of silica gel with molecular sieves. Their purpose is to adsorb residual water and solvent vapor in the sealed space immediately after fabrication of the IG units. They also maintain a low relative humidity in the sealed space for the life of the IG unit by absorbing infiltrating moisture vapor.

5.5 *Primary Sealant*—This sealant provides a high level of moisture vapor migration resistance and controls and minimizes gas and solvent migration into the IG unit sealed space. The sealant also acts as a barrier to the permeation of inert gases (for example, argon) when these gases are used in the sealed space of the IG unit. The sealant is designed to fill the space between the sides of the spacer and the faces of the two glass lites and to develop adequate adhesion to the surfaces of both materials. The primary sealant must also have sufficient movement capability to not fail due to limited differential movement that may occur between the spacer and the glass lites. Polyisobutylene-based materials have been found to be very suitable for this purpose. The primary sealant contributes little to the structural function of transferring lateral loads and holding the IG unit edge assembly together. These functions are fulfilled by the secondary sealant.

5.6 *Secondary Sealant:*

5.6.1 This sealant transfers negative lateral loads, occurring on the exterior lite of glass, to the interior lite of glass, which then transfers the load to the structural sealant that adheres the IG unit to the metal framing system. It also functions as the adhesive that unites the two glass lites and spacer together as a unit and prevents excessive movement from occurring in the primary seal (**2**). The secondary sealant must maintain adequate adhesion to the glass lites and spacer and also maintain other performance properties, such as strength and flexibility after prolonged environmental exposure. Failure of the secondary seal to do so could result in excessive movement in the primary seal and fogging of the IG unit or adhesive or cohesive failure of the secondary seal and catastrophic failure of the IG unit.

5.6.2 Four generic classes of sealants are used presently for a conventional IG unit edge seal system (non-structural sealant). These sealants are polysulfides, polyurethanes, hot-melt butyls, and silicones. For SSG systems, only IG units with a dual-seal (polyisobutylene primary seal and silicone secondary seal) have the required durability for the application and are the only sealants permitted for SSG systems.

5.7 *Enclosed Gas*—The IG unit sealed space encloses a gas such as air, argon, krypton, or sulfur hexafloride. Air is normally used if conventional thermal resistance properties are required. Argon and krypton are used to increase the IG unit thermal resistance. Sulfur hexafloride is used in applications in which increased resistance to sound transmission is necessary. When using gases other than air, the IG unit edge seal system must be capable of retaining a substantial percent of the gas for the life of the IG unit; otherwise, thermal or sound transmission performance will decrease to an unacceptable level.

5.8 *Breather and Capillary Tubes:*

5.8.1 *Breather Tube*—A breather tube is a small tube or hole that is factory-placed through the spacer of the IG unit to accommodate an increase in sealed air space pressure when an IG unit is shipped to a higher elevation than where fabricated. The breather tube allows the sealed air space pressure to equalize to the atmospheric pressure at the installation site. The breather tube is sealed prior to the IG unit installation. Special sealed space gases (see 5.7) cannot be used in IG units that have breather tubes.

5.8.2 *Capillary Tube*—A capillary tube is a very thin bore tube of specific length and inside diameter that is factory-placed through the spacer of the IG unit. A capillary tube fulfills the same function as a breather tube and, in addition, is left open during transportation to permit the sealed space of the IG unit to continue to pressure equalize with fluctuating ambient air pressure. Capillary tubes should be sealed with a high performance sealant specified by the IG fabricator at the final destination immediately before installation. Special sealed space gases (see 5.7) cannot be used in IG units that have capillary tubes.

SECONDARY SEALANT DESIGN CONSIDERATIONS

6. Structural Properties

6.1 *General:*

6.1.1 The design of an IG unit edge seal parallels the methodology used for the design of the SSG system structural joint that adheres an IG unit to a framing system. SSG system structural sealants must meet the requirements of Specification C1184. Presently, there is no comparable specification for sealants used for the secondary sealant of IG units; however, sealants should meet the requirements of Specification C1184 (as a minimum) in the absence of another applicable specification.

6.1.2 The following sections provide the design professional with information on the design of the IG unit edge seal secondary sealant regarding the following: allowable tensile strength; modulus properties; appropriate design factors; and design of the secondary sealant for the effects of shear stress, tensile stress, and combined stresses.

6.2 *Sealant Yield Stress*—The minimum sealant yield stress (F_u) (or tensile adhesion value) is determined by Test Method C1135 by pulling to failure small laboratory specimens of sealant having a cross-section similar (but not necessarily identical) to that used in a structural seal. Sealant manufacturers usually report this value in a table of performance criteria for a particular sealant. An example of a sealant manufacturer's reported value for F_u would be 896 kPa (130 psi) for a two-part high-modulus sealant.

6.3 *Sealant Tensile Stress:*

6.3.1 The allowable sealant tensile stress (F_t) for SSG system structural seals is determined by dividing the ultimate stress (F_u) by an appropriate design factor (D) ((Eq 1)).

$$F_t = F_u/D \tag{1}$$

6.3.2 For example, using a manufacturer's published ultimate stress (F_y) for a sealant of 559 kPa (80 psi), with a design factor (D) of 4.0, and substituting these values into (Eq 1), results in the following:

$$F_t = 559/4.0 = 138 \text{ kPa} \tag{2}$$

or

$$F_t = 80/4.0 = 20 \text{ psi} \tag{3}$$

6.3.3 Current industry practice for the structural seal of an SSG system, which was determined empirically, is to limit the value of F_t to 138 kPa (20 psi). The SSG system structural seal contact width (Fig. 2) is usually established using the applied lateral load, acting in tension, in conjunction with the 138 kPa (20 psi) tensile stress. Additional contributory stresses from, for example, thermal movement, dead load (see 6.6), sealant cross-section dimension, non-linear glass deflection under load, internal sealant stress due to cure shrinkage, prestress in sealant due to differential building component movement, and variation in sealant physical properties can also influence this value. If these additional factors are a significant concern, an allowable tensile stress (F_t) of below 138 kPa (20 psi) may be appropriate for the SSG system structural seal sealant.

6.3.4 Regarding the secondary sealant for IG units, some IG unit fabricators recommend using values for F_t such as 207 kPa (30 psi) in lieu of the more conservative 138 kPa (20 psi) value used for the SSG system structural seal. The rationale for using higher values for F_t is the already high quality of the fabricator's QA program for fabricating the IG unit edge seal. Better QA results in more consistent adhesion of the secondary sealant, and higher values for F_t can therefore be maintained reliably. In addition, the cladding design load is usually chosen as the maximum to occur in a 50 or sometimes 100-year return period. Because of this, the actual tensile stress on the secondary sealant is typically a lower value and in some areas a relatively small percentage of the F_u value. If a value of F_t in excess of 138 kPa (20 psi) is proposed, it must be evaluated carefully. This careful evaluation is especially significant since F_t does not give significance to the additional stress factors discussed in 6.3.3.

6.3.5 Presently, for the IG unit secondary sealant, the stress in the secondary sealant is usually limited to 138 kPa (20 psi). The applied lateral load, which is shared between the two lites of glass of the IG unit, in conjunction with the 138 kPa (20 psi) limit, is used to calculate the secondary sealant contact width required to resist the applied lateral load (see 6.7). This equal load sharing is applied only when the two lites are of equal thickness.

6.3.6 It is not within the scope of this guide to specify a particular tensile stress (F_t) for the IG unit secondary sealant. This should be an informed decision made by the design professional, in conjunction with the structural sealant manufacturer and IG unit fabricator, considering, among other factors: building code requirements, degree of risk, and the particular SSG system and IG unit requirements.

6.4 *Design Factor:*

6.4.1 For SSG system structural seals, a factor ranging from 4 to 12 was originally selected for the structural sealant during the beginnings of SSG technology. This range recognized the many variables and unknowns, such as determining applied loads and load distribution accurately, the relatively poor tear strength if three-sided adhesion occurred, and the difficulty of determining the actual sealant stress. This approach is consistent with traditional engineering practice, in which uncertainty and unknowns are mitigated to a certain extent by using a design factor, sometimes referred to as a safety factor. The design factor can be determined by using (Eq 1) and solving for D. It should be noted, however, that higher-strength sealants do not improve the probability of attaining and maintaining long-term sealant adhesion. Adhesion concerns are decreased by lower design stress (f_t). Since adhesion is one of the primary concerns in every aspect of structural glazing, a higher design factor is best achieved by using smaller design stresses (F_t).

6.4.2 For example, for a sealant in which F_u = 896 kPa (130 psi), with a value of F_t = 138 kPa (20 psi), the value of D will be 6.5. If a different sealant, in which F_u is 345 kPa (50 psi), is used with a value of 2.5 for D, F_t will be 138 kPa (20 psi). Presently, a lower-limit design factor (D) of 2.5 is being used for SSG system structural sealants. This lower limit is based on the following: the successful performance of SSG system structural sealants since approximately 1972, advances that have occurred in adhesion technology, and the implementation of QA programs. Higher design factors are not to be construed as rationale to change the design stress (f_t) to values above 138 kPa (20 psi).

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6.4.3 It is not within the scope of this guide to specify a particular design factor for the IG unit secondary sealant. This should be an informed decision made by the design professional, in conjunction with the structural sealant manufacturer and IG unit fabricator, considering, among other factors: building code requirements, degree of risk, and the particular SSG system and IG unit requirements.

6.5 *Sealant Modulus and Joint Stiffness:*

6.5.1 The design of the structural seal in SSG systems should consider the relationships of joint shape, joint stiffness, and sealant modulus so that the outward movement of the peripheral edge of the IG unit, by an applied lateral load, is no more than 1.6 mm (1⁄16 in.) for a glass lite nominal thickness of 6 mm (¼ in.). Test Method C1135 can be used to determine that the elongation of the structural sealant at 138 kPa (20 psi) is less than 1.6 mm (1⁄16 in.). The 1.6-mm (1⁄16-in.) movement or sealant elongation is related to the position and support provided to the outer lite of the IG unit by setting blocks that are recessed from its outer face, usually by one-half the nominal glass thickness. If outward movement is excessive and the IG unit outer lite drops off the setting blocks, it could cause a failure of the IG unit edge seal.

6.5.2 From the above discussion, it should also be apparent that the outward, and in some cases downward (see 6.6), movement of the outer glass lite of an IG unit relative to the inner lite, under the influence of the applied lateral load, must also be limited. Detrimental movement or change in the secondary seal shape (**3**) could cause a seal failure in the primary sealant, resulting in fogging of the enclosed space. The modulus of the secondary sealant, as well as the shape and size of the secondary seal, should be evaluated.

6.6 *Sealant Contact Width for Shear Stress:*

6.6.1 Good glazing practices require that glass, including IG units, be supported by two setting blocks located at approximately the ¼ points of the glass width. See the Glass Association of North America (GANA) Glazing Manual,[6] page 52, for a typical detail. Although not generally recommended, installations are occasionally designed in which the glass or IG unit is not supported by setting blocks (Fig. 3). Contact the sealant and IG manufacturer for specific recommendations. The dead load of the IG unit is supported by the SSG system structural seal with such installations. This will result in a constant dead load shear (Fig. 3) stress (F_s) on the sealant and the potential of a downward movement of the IG unit under the influence of gravity (**4**). Because of special considerations, in some unusual situations some sealant and IG manufacturers have approved specific installations with no setting blocks. If this is ever done, the sealant and glass manufacturer and design professional must review the design and details, and the dead load shear stress (F_s) on the SSG system structural sealant is limited to no more than 6895 Pa (1 psi) and often considerably less (for example, 3400 Pa or 0.5 psi).

6.6.2 With such installations, the secondary seal of the IG unit must also be designed to resist shearing stress and potential movement induced by the dead load of the outer lite of glass. Unacceptable differential movement of the two lites could cause a seal failure in the primary sealant, resulting in fogging of the enclosed space. The minimum sealant contact width required due to dead load shear stress, assuming no contribution from the primary seal, can be determined using (Eq 4).

$$C_s = (M*A)/(F_s*L) \quad (4)$$

6.6.3 For example (Fig. 4), for an IG unit with W = 1.219 m (4 ft), H = 1.829 m (6 ft), M = 311.22 N/m^2 (6.5 lb/ft^2), L = 6.096 m (20 ft), and F_s = 6895 Pa (1 psi), the contact width for the secondary sealant would be determined as follows. Only the weight of the exterior lite of glass will cause a

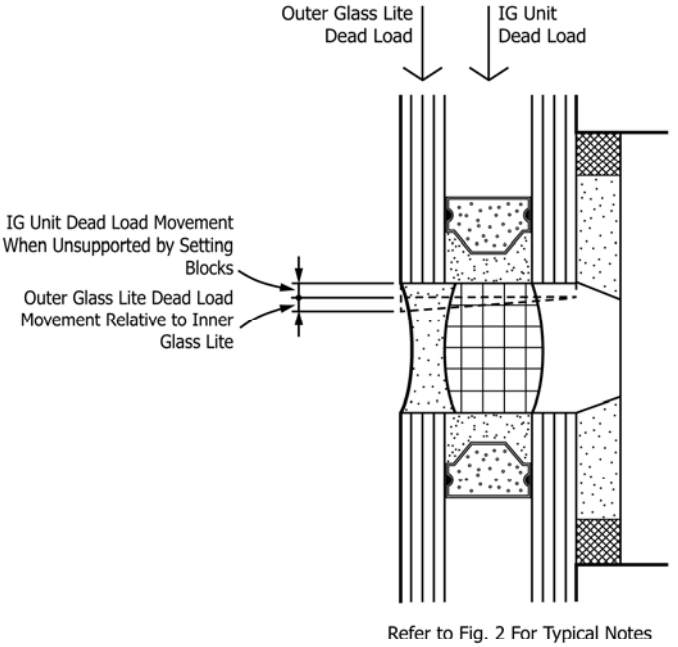

FIG. 3 Dead Load Movement of IG Unit: Vertical Section (Horizontal Joint)

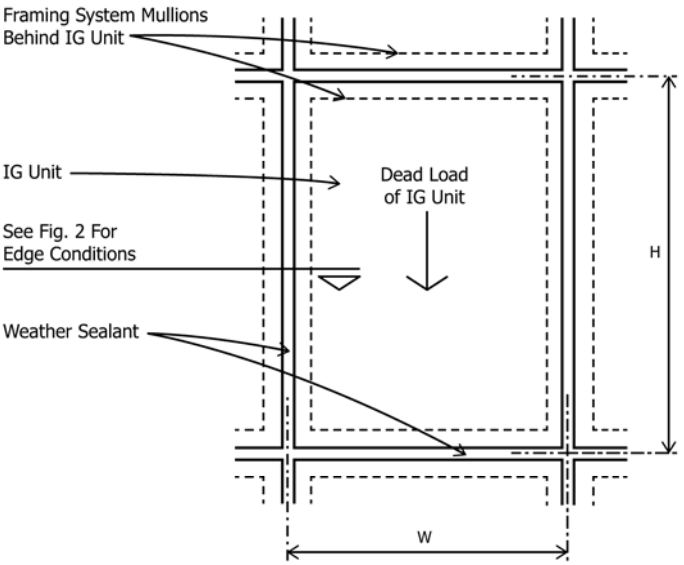

FIG. 4 Elevation of a Four-Sided Structural Sealant Glazed IG Unit

[6] Available from Glass Association of North America (GANA), 777 East Eisenhower Parkway, Ann Arbor, MI 48108.

shearing stress in the secondary sealant, so one-half of the weight of the IG unit is used in the calculation. Substituting into (Eq 4) results in the following:

$$C_s = (155.61*2.2296)/(6895*6.096) = 8.25 \text{ mm} \quad (5)$$

or

$$C_s = (3.25*24)/(1*20*12) = 0.325 \text{ in.} \quad (6)$$

6.7 *Sealant Contact Width for Tensile Stress:*

6.7.1 The minimum secondary sealant contact width (C_t) required to resist the applied lateral tensile load can be determined using (Eq 7), which is based on trapezoidal load distribution theory. Other load distribution theories may be applicable, depending on, among other factors, IG unit shape and size (**5**). Any influence from the primary seal is not considered.

$$C_t = (P*W/2)/F_t \quad (7)$$

6.7.2 For example (Fig. 4), for an IG unit with W = 1.219 m (4 ft), H = 1.829 m (6 ft), P = 1436 Pa (30 lbf/ft^2), and F_t = 138 kPa (20 psi), the contact width for the secondary sealant would be determined as follows. With a sealed IG unit, there is load sharing between the two lites of glass. If both lites are of the same thickness, the lateral load (P) is shared almost equally; and, if of unequal thickness, the load shared by each lite will vary, depending on the difference in thicknesses (**6**). For the following example, both lites are the same thickness, and the secondary seal therefore experiences approximately one-half the applied load. Substituting into (Eq 7), using the least dimension, which is the width (W) of the IG unit, results in the following:

$$C_t = (718*0.6096)/138 = 3.2 \text{ mm} \quad (8)$$

or

$$C_t = (15*2)/(20*12) = 0.125 \text{ in.} \quad (9)$$

If the lites are of unequal thickness, equal load sharing cannot be employed, and appropriately higher values are to be used.

6.7.3 If it has been determined that an unsupported IG unit is allowable in a given situation and both the deal load and wind load calculations are performed, the largest of the calculated contact widths must be used.

6.8 *Combined Stresses:*

6.8.1 Depending on, among other factors, loading conditions (that is, tensile and shear loads), IG unit shape and size, secondary sealant, and secondary seal shape and size, the effects of combined stresses on the secondary sealant may require consideration (**7**).

6.8.2 It should also be realized that the final secondary sealant contact width may have to be greater than as determined by calculation. Other factors, such as spacer geometry (**8**), fabrication procedures, and fabrication tolerances, may have to be considered to determine a minimum acceptable secondary sealant contact width.

7. Adhesion

7.1 *General:*

7.1.1 Adhesion of the secondary seal to the IG unit edge seal components is one of the most critical functions of the sealant. The secondary sealant adheres the glass, with or without a glass coating, and spacer into a rigid yet flexible system, and, in addition, transfers applied lateral loads from the outer lite to the inner lite of the IG unit. Poor sealant adhesion to any of the IG unit edge seal components can have adverse effects on IG unit performance.

7.1.2 Time, temperature, water and water vapor, ultra-violet radiation, and foreign chemicals can affect the adhesion and performance of the secondary seal. The following sections address adhesion issues related to glass, glass coatings, and spacers, among other factors, that commonly occur with IG units.

7.2 *Glass and Architectural Coatings:*

7.2.1 *Glass*—Adhesion of a silicone secondary sealant to a properly prepared, uncoated glass surface has proven to be tenacious. To develop adequate adhesion, the glass surface must be properly cleaned (see 7.4) immediately prior to sealant application.

7.2.2 *Architectural Coatings*—A wide variety of glass coatings are currently available for architectural glass. Adhesion of the sealant to these coatings depends on the type of architectural coating and its particular type of top coat, such as titanium dioxide or silicon dioxide, among other types, and the coating application technique, such as a pyrolitic or magnetic sputtering process. No generalized statement can be made regarding sealant adhesion to the many available architectural coatings, since variations may occur even for a given type of coating and application process due to process conditions. The adhesion of the sealant to an architectural coating on glass must be verified on samples of actual manufactured specimens for each job by the sealant manufacturer. The adhesion of some architectural coatings to glass may degrade with time, and coating deletion (removal) may be required.

7.2.3 *Coating Deletion*—This is usually performed by abrasion, with an abrasive wheel, or by burning the coating off with a high-temperature flame. Any coating deletion technique will result in a glass surface that is chemically and physically different from a normal glass surface. Adequate adhesion of the sealant to this glass surface should be verified. A representative sample should be submitted to the sealant manufacturer. Statements regarding the durability and adhesion of the architectural coating to a glass surface can be made only by the insulating glass fabricator or coating applicator.

7.3 *Spacer*—Adhesion of the secondary sealant to the spacer is required to prevent "walking" or displacement of the spacer into the vision area of the IG unit and potential edge seal failure and fogging. Different secondary seal sealants will develop various levels of adhesion to the vast array of available spacer materials. For example, some sealants may develop excellent long-term adhesion to an anodized spacer, whereas others may not. Long-term adhesion can be verified by many different standard test methods. The sealant manufacturer can suggest and perform various tests, such as those found in Test Methods C794, E773, and C1135, to predict the long-term adhesion of the secondary seal to the spacer under various physical and environmental conditions.

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