IGMA INSULATING GLASS MANUFACTURERS ALLIANCE

GANA GLASS ASSOCIATION OF NORTH AMERICA

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Unsupported Edge Conditions of Insulating Glass Units

TECHNICAL BULLETIN

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1.0 Scope & Introduction

1.1 Scope:

1.1.1 This technical bulletin addresses concerns regarding the structural and durability performance of unsupported insulating glass unit edges subject to uniform load including glass stresses, practical glass deflections, sealant strength capabilities, spacer stress and deformation limits, load durations, dead load support and setting block location and other variables that influence the unsupported edge condition for insulating glass units.

1.1.2 This bulletin seeks to explain these and other technical issues so that the designers can understand the abilities and / or limitations of the glazing industry, primarily represented by the IGU fabricators, to respond to this design intent.

1.1.3 Point-supported systems are not addressed in this document.

1.1.4 This bulletin does not address approval or warranty of IGUs in unsupported edge conditions, and the discussion herein does not imply approval of use or warranty by IGU fabricators. Users and specifiers of unsupported IGUs should consult directly with IGU fabricators for any recommended limits on design, use and warranty of IGUs in unsupported edge conditions.

1.2 Introduction

1.2.1 One of the more technically challenging situations facing glazing contractors, glass fabricators, and framing suppliers being posed by the design community is to support insulating glass units along two edges only, with the other two edges not having any framing support at the edge of the glass unit(s). The designers have sought to give the perception of more "openness" to a wall or window as well as permitting additional daylighting to reach further into the building interior by eliminating framing members.

1.2.2 Monolithic and laminated glass lites have been primarily used to achieve this aesthetic. But because they offer better overall energy performance, architects and designers are now seeking to use insulating glass units (IGU) in these designs in lieu of monolithic or laminated glass solutions.

1.2.3 To date, it has been standard glazing industry practice not to allow the use of IGU's in such construction. There are several concerns that must be resolved:

1.2.3.1 There has not been sufficient data or testing to confirm how such glazing would resist wind loading. Therefore, standards such as ASTM E 1300 do not currently allow calculations of wind load capability for unsupported edges. Nor is there any empirical data on edge deflection of IGUs with unsupported edges. The result being there's no supporting data to set the deflection limit for unsupported IGU glass edges as an industry standard.

1.2.3.2 Unsupported IGU edges may impact the durability or service life of the edge seal of the IGU due to edge deflection.

1.2.3.3 The location of glass setting blocks to support the dead load weight of the glass must be addressed where horizontal framing members are not present, thus eliminating the recommended means of supporting the weight of the individual glass lite(s).

1.2.4 The intended or designated glass fabricator or supplier should review the design for its technical feasibility before the design team proceeds to the point where unsupported IGU edges are included in schematic, design development or any contract documents. If the glass application is approved by the intended fabricator, the frame manufacturers can generally develop the system details to meet the design intent. However, the frame supplier only knows one side of the two-part issue, and theirs is the lesser of the two as far as meeting all technical aspects of a given design. The glass supplier or fabricator may have the overriding say as to whether or not the design can be built with the appropriate warranties the design team requires for the glass as well as the support system.

1.3 ASTM E 1300 applies only to monolithic or laminated glass constructions of rectangular shape with continuous lateral support along one, two, three or four edges. The practice assumes that:

1.3.1 The supported glass edges for two, three and four-sided support conditions are simply supported and free to slip in plane.

1.3.2 Glass supported on two sides acts as a simply supported beam

1.3.3 Glass supported on one side acts as a cantilever.

1.3.4 For insulating glass units, this practice applies to IG units with four-sided edge support only.

1.4 It is necessary to pint out that many, if not most, insulating glass fabricators will not approve and will not warrant their glass in framing designs that do not firmly support all edges of the insulating glass unit.

2 Uniform Load Including Glass Stresses

2.1 The loading criteria for insulating glass units with unsupported edges is normally provided by the engineer or architect responsible for the project design to meet the project requirements as indicated in the specifications and/or building code that applies to the building location. The uniform load for the glass is provided in units of pounds per square foot (psf) or kilopascals (kPa). A method for analyzing single glass (as defined in ASTM E 1300) with unsupported edges is presented in the ASTM standard E1300 *Standard Practice for Determining Load Resistance of Glass in Buildings*. The E1300 standard provides non-factored load charts and deflection charts for monolithic glass subjected to uniform loads for various glass thicknesses used in building design. This information can be used background for understanding insulating glass units.

2.2 When analyzing insulating glass with unsupported edges the stresses of importance will be the edge and surface stresses. The method used to determine the values of stress are based on the method used to evaluate the insulating glass under the uniform loading condition whether it be a classical plate theory technique, finite element analysis, testing or other method. The ASTM E1300 standard provides in the Annex sections X6- "Approximate maximum surface stress to be used with independent stress analysis" and X7- "Approximate maximum edge stress for glass". These two sections of the standard are appropriate for the engineer to use conservative allowable stresses to evaluate glass. The standard provides allowable edge and surface stresses for annealed, heat-strengthened and tempered glass.

3 Glass Edge Deflections

3.1 As noted in Section 2403.3 of the International Building Code (IBC) 2015 of the ICC:

> "the framing members for each individual pane of glass shall be designed so the deflection of the edge of the glass perpendicular to the glass pane shall not exceed L/ 175 of the glass edge length or 3/4 inch (19.1 mm), whichever is less, when subjected to the larger of the positive or negative load where loads are combined as specified in Section 1605."

3.2 The L/175 edge deflection limit is a reasonable method to be employed to limit the edge stress on glass and give the designer of the framing system proper guidance so that the glass is properly supported in an effort to utilize the appropriate glass load resistance based on testing and analytical methods for determining stresses and deflections of glass. The limit assures that there is edge support around the perimeter of the supported edges of glass. The edge deflection should not be confused with the center of glass deflection. The center of glass deflection will be analyzed based on aesthetic conditions, edge pullout characteristics, effect on gaskets and sealants, and possible contact with other building materials to name a few items that may cause the designer to limit center deflection. Glass strength and resistance to breakage is the primary issue with center deflection as an item that should be thoroughly reviewed and if need be limited by the designer.

3.3 The L/175 and / or 19.1 mm (¾") maximum limit mentioned has been used by the glass and glazing industry for many years and has proven to be a safe limit for insulating glass deflection limits as well as general edge of glass limits for most window designs that are subjected to wind and snow loads. To date there have not been any reported failures when the edge deflection limit of L/175 or 19.1 mm (¾"), whichever is less, is used for insulating glass edge seal designs.

3.4 There are various other references to the L/175 edge deflection limit. The following sources are noted:

North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use, IGMA TM-3000-90(16), Section 3.1

Standard Practice for Determining Load Resistance of Glass in Buildings, ASTM E 1300-12a$^{\varepsilon 1}$, Section 5.2.4, pg. 3

GANA Glazing Manual, Glass Association of North America, 50th Anniversary Edition, pg. 91

Structural Properties of Glass, AAMA Aluminum Curtain Series No. 12, 1984, pg. 17

3.5 For those special cases when the edge of an insulating glass unit is not supported it is recommended to limit the deflection along that edge to the L/175 or 19.1 mm (¾") whichever is less criteria. Extra attention for special cases can be dealt with on an individual basis for those conditions which exceed this limit. One option to limit deflection is to use thicker glass.

3.6 The present ASTM E 1300 and CAN/CGSB 12.20-M89, *Structural Design of Glass for Buildings,* standards do not address unsupported edges in insulating glass units and due to the number of variables that exist in the fabrication of insulating glass there is not a common method that will address all cases.

4 Edge Seal System Strength Capabilities

4.1 The primary seal Polyisobutylene (PIB) offers no structural support to the insulating glass unit. It acts specifically as a barrier for moisture ingress and means of insulating gas retention.

4.2 If an Insulating Glass Unit (IGU) is structurally glazed, any secondary sealants must meet ASTM C1369: *Standard Specification for Secondary Edge Sealants for Structurally Glazed Insulating Glass Units*. The secondary sealant of the IGU should always meet the minimum sealant contact width requirement as determined by the IGU manufacturer and / or designer based on the allowable design strength of the sealant and recommendation of the sealant supplier. Both dynamic (wind load) and static (dead load) loads must always be considered to determine the correct secondary sealant contact width for long term durability of the insulating glass unit.

4.3 ASTM C1249 *Standard Guide for Secondary Seal in Insulating Glass Units*, IGMA TM-3000-90 *North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use* and the *GANA Glazing Manual* should be considered in helping to choose the right components and design the right IGU for the desired application.

4.4 Several considerations need to be given when choosing a sealant if a butt glaze will be used between two unsupported IGU's. The butt joint sealant

must be compatible with the components of the IGU's (primary and secondary sealant, spacer etc.) to ensure it will not affect performance or create aesthetic problems. The same consideration must be given If laminated glass or Low-e glass is used in the IGU construction. Additionally, the butt joint sealant needs to be compatible with the secondary IGU sealant to prevent adhesion loss or discoloration. Contact the sealant and component suppliers for appropriate compatibility and adhesion testing.

5 Dead Load Support and Setting Block Location

5.1 The setting block locations for the supported edge of the insulating glass units will follow the guidelines outlined in the IGMA and GANA glazing guidelines referenced in this document (See section 6.0).

5.2 When a wall system design eliminates horizontal framing members, the issue of how to support the dead load weight of individual lites must be addressed. Stacking lites on each other with hard rubber blocks placed in the joints between lites is generally not permitted by the glass fabricators. Typically, setting blocks are located at or near the lower corners of the insulating glass unit with the framing system providing a shelf of some type to receive the blocks and the weight of the glass. Locating the setting blocks in close proximity to the IGU's corners increases the stress in the glass at one of the IGU's weakest points. Doing so may require the individual lites making up the IGU be increased in thickness and / or heat treatment, or both. The glass fabricators can address specifically how the IGU makeup responds to these types of conditions.

6.0 References

ASTM C 1249, Standard Guide for Secondary Seal for Sealed Insulating Glass Units for Structural Sealant Glazing Applications

ASTM C 1369, Standard Specification for Secondary Edge Sealants for Structurally Glazed Insulating Glass Units

ASTM E 1300, Standard Practice for Determining Load Resistance of Glass in Buildings

GANA Glazing Manual, Glass Association of North America, 50th Anniversary Edition, pg. 91

International Building Code (IBC) 2015 of the ICC Section 2403.3.

North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use, IGMA TM-3000-90(16), Section 3.1

Structural Properties of Glass, AAMA Aluminum Curtain Series No. 12, 1984, pg. 17

Consult the Publications page of the Insulating Glass Manufacturers Alliance (www.igmaonline.org) or the *Tech Center* section of the Glass Association of North

America (GANA) website (www.glasswebsite.com) for additional information and glass industry reference resources.