MARK YOUR CALENDAR FOR THESE OTHER UPCOMING EVENTS!

Annual Conference
Jan. 22-24, 2019
Naples Grande Resort | Naples, FL

Building Envelope Contractors (BEC) Conference
Mar. 3-5, 2019
Caesars Palace | Las Vegas, NV

Glass Processing Automation Days - GPAD (co-sponsored by NGA)
March 26-28, 2019
San Antonio, Texas

Fall Conference
August 12-14, 2019
Toledo, OH

GlassBuild America
September 17 - 19, 2019
Georgia World Congress Center | Atlanta, Georgia
GLASS RAILING
INTRODUCTION

Transparency and safety are essential for every unique stadium or shopping mall experience. All-glass railings and partition walls made of laminated safety glass are important parts of this concept.

Balconies are considered as social connectors in design of modern high-rise buildings. It’s important to make the railings neither a fence nor a barrier. Transparent all-glass railings help connecting with the outdoor and the neighborhood.

Daylight Autonomy is an important criteria in the evaluation process of LEED certified buildings. Frameless all-glass railings help improving daylight gains of modern facades as well as safety and comfort of balconies at the same time.

GLASS RAILING
TECHNICAL STANDARDS & GUIDELINES

GUARDRAIL: According to ASTM E2353 Section 3.2.3, a protective railing system around the outer edges of locations of an accessible roof, balcony, landing, platform or ramp designed to minimize the probability of an accidental fall from the walking.

GUARD: According to the 2015 IBC and 2018 IBC, a building component or system of building components located at or near the open sides of elevated walking surfaces that minimizes the possibility of a fall from the walking surface to a lower level.
GLASS RAILING
TECHNICAL STANDARDS & GUIDELINES

ASTM E2358
Standard Specification for the Performance of Glass in Permanent Glass Railing Systems, Guards, and Balustrades

ASTM E2353
Standard Test Methods for the Performance of Glass in Permanent Glass Railing Systems, Guards, and Balustrades

ASTM C1172
Standard Specification for Laminated Architectural Flat Glass

ASTM C1048
Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass

2015 IBC & 2018 IBC
2015 and 2018 International Building Code represents a major change in the use of glass in railing systems. It makes specific reference to glass railings in Section 2407.

GLASS RAILING
INCREASED SAFETY DEMANDS

RELEVANT POINTS OF SECTION 2407 OF THE 2015 IBC

- Laminated glass must be used in handrails, guardrails or guards.
- Glass types must be fully tempered laminated or heat-strengthened laminated.
- Laminate must comply with CPSC 16 CFR 1201 Cat II or ANSI Z97.1-2015 Class A
  - (for more information look at Glass Informational Bulletin –Differences Between Safety Glazing Standards - NGA/GANA FB 08-06 (2009))
- Minimum nominal thickness must be 1/4 in.
- The panels and their support systems should be designed to withstand the loads as specified by the code. A design factor of 4 must be used in designing the glass.
- Top rail is not required if the laminated glass is comprised of two or more glass lites having equal thickness and only then if the system receives approval from the building official.
- In windborne debris regions, in-fill glass and glass balusters must be laminated and comply with safety glazing standards.
GLASS RAILING
COMPATIBILITY WITH LAMINATED GLASS

USE OF LAMINATED GLASS IN GLASS RAILING SYSTEMS GIB
NGA/GANA FB 33-11 (2017)

Glazing System Considerations
When a system is wet glazed, it is important to verify compatibility of the caulk, grout, blocks, and sealant used in contact with the laminate interlayer. This is especially important in exterior applications where moisture and expansion rates can impact the system.

Traditional methods of setting monolithic glass in railings such as cement-based grouts may be incompatible with laminated glass.

Bolted or clamped systems must be designed and installed properly to avoid over-stressing the glass around the points of contact.

Consult with the fabricator and component suppliers (i.e. interlayer manufacturers, sealant suppliers, etc.) for questions surrounding compatibility.
GLASS EMBEDDING

INTRODUCTION

Growing importance of frameless total vision glazing and glass railing.

Postless design - Embedding the bottom edge of glass units into the base shoe fixed to the building structure.

Flat, bent, rectangular, trapezoidal, horizontal, inclined

Common installation methods:
- dry glazing
- wet glazing

GLASS EMBEDDING

TRADITIONAL SYSTEMS

MECHANICAL FIXATION
- Popular technique
- Customer must use a specific channel system
- Water accumulation → Drainage needed
- Concentrated pressure on glass and interlayer

EMBEDDING WITH CEMENTITIOUS GROUT
- Customer-made channel possible
- Incompatibility with glass interlayers
- Alkaline attack on glass → glass corrosion
- Glass breakage as cementitious grout is too rigid (peak stress, constraint forces)
GLASS EMBEDDING
TRADITIONAL SYSTEMS

INCONSISTENT FIXING
- Mechanical means or rigid materials cause significant stress peaks
- Concentrated stress requires more sophisticated analyses and increase of glass resistance
- Increased risk of glass breakage
- Local relaxation of the interlayer

RIGID GROUTS
- Installed at outdoor summer conditions with epoxy-based grout
- Glass breakage during first winter
- Range of temperature: -20 to +120 F [-30 to +50°C]
- Thermal expansion of glass vs. aluminum?
- Extreme high hardness of the grout?
- Strong adhesion of the grout?
- Inconsistent filling?
- Collected water → expanding ice?
GLASS EMBEDDING
TRADITIONAL SYSTEMS

CEMENTITIOUS GROUTS

- Cementitious grout has been very common in many projects (easy handling, availability)
- BUT: Significant interaction with the interlayer and visible reactions have been observed in most of the outdoor projects!

GLASS EMBEDDING
PROBLEM SOLVING

CHALLENGES

- New standard requirements
- Higher demands on structural and post-breakage performance
- Material compatibility
- Durability under various conditions
- Fast setting and easy repair
- Freedom of design
GLASS EMBEDDING
STRONG TECHNOLOGY WITH CONTROLLED FLEXIBILITY

1C Polyurethane adhesives
1C Sealants (PUR, MS, STP, Silicones)

2C Polyurethane adhesives

Epoxy adhesives

Elongation at break [%] vs. Modulus [MPa]

semi-structural
elastic
rigid

15

GLASS EMBEDDING
INNOVATIVE SOLUTION

Glass unit

Weather Sealant
2-part, self-leveling, strong material with appropriate flexibility

Base shoe

- Self-leveling, polymer-based technology
- Appropriate hardness and flexibility
- 2-component system: uniform and controlled curing

NGA
GLASS EMBEDDING
COMPATIBLE PRODUCTS

<table>
<thead>
<tr>
<th>Product</th>
<th>Base</th>
<th>Open time</th>
<th>Shore Hardness</th>
<th>Viscosity mixed</th>
</tr>
</thead>
<tbody>
<tr>
<td>SikaGlaze™ GG-735</td>
<td>Two-component polymer-based grout</td>
<td>35 min</td>
<td>80 (Shore D)</td>
<td>10 Pas for horizontal application</td>
</tr>
<tr>
<td>SikaForce™-7722 L45</td>
<td>Two-component polymer-based grout</td>
<td>45 min</td>
<td>80 (Shore D)</td>
<td>140 Pas for inclined glass railings</td>
</tr>
<tr>
<td>SikaForce™-7780 L05</td>
<td>Two component polymer-based grout</td>
<td>5 min</td>
<td>80 (Shore A)</td>
<td>140 Pas for smaller applications, horizontal and inclined, repair</td>
</tr>
</tbody>
</table>

Compatible with laminated glass: Tested

Packaging:
- Component A: Pail 25 kg
- Component B: Can 5 kg

Tested compatible whether sealants and for the cap joints:
- Sikasil® WS-305 CN
- Sikasil® WS-295

GLASS EMBEDDING
APPROPRIATE DESIGN

DESIGN CONSIDERATIONS
- Recommend minimum clearance between base shoe and glass unit: 3/8 in
- Recommend minimum covered glass bite at the bottom edge: h/10 not less than 3 in
- Recommend depth of the silicone top finish: 1/4 - 3/8 in
- Details can be optimized and customized if verified in a mock-up application and performance testing

COMPATIBLE PRODUCTS
- **Cycles of 21 weeks in a climatic chamber**
- Temperature range -20 to +140 F [-30 to +60°C]
- High humidity / condensation
- Laminated glass in full contact with grouts and sealants
- **Thermal expansion tests** over 1 year
- Good compatibility with common interlayers
- Waterproof embedding system
- Compatible weather sealing recommended for outdoor applications
GLASS EMBEDDING
METERING & DISPENSING EQUIPMENT

MIX MASTER 66

APPLICATIONS
• GROUTING OF GLAZING CHANNELS
• LARGE JOINT SEALING

MATERIALS
• DESIGNED FOR SikaGlaze GG-735

GLASS EMBEDDING
PRODUCTIVITY

CASE STUDY
- Installation of 1600 LF glass railing, incl. glass planting, grouting, cap joints
- 3 man crew

<table>
<thead>
<tr>
<th>Grouting method</th>
<th>Total completion of 1600 LF</th>
<th>Productivity of 3 man crew</th>
<th>Advantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional cementitious grouts, manually mixed and applied</td>
<td>20 workdays</td>
<td>80 LF per day</td>
<td></td>
</tr>
<tr>
<td>Polymer-based grout, manually mixed and applied</td>
<td>8 workdays</td>
<td>200 LF per day</td>
<td>Easy to mix</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Self-leveling</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Applied from one side</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Fully cured after 24 hours</td>
</tr>
<tr>
<td>Polymer-based grout, machine mixed and dispensed</td>
<td>4 workdays</td>
<td>400 – 500 LF per day + 60% less waste</td>
<td>Pump supported mixing and dispensing</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Reduced material waste and cleaning effort</td>
</tr>
</tbody>
</table>
Glass Bonding is our Passion