SYNERGi

Don’t let glass railing code changes derail your project

WHITE PAPER

Laminated Glass and the **2015 International Building Code**

August 2016

Roosevelt Field Mall - Synergi Project 2015

Glass looks great, but needs to be safe.

Glass has long been prized as an architectural element for railing and guard systems to enhance the appearance of shopping malls, arenas, museums, condos and many other types of buildings - while also providing safety for occupants and visitors. Glass not only looks very clean and minimalist, it allows the greatest line of sight from many different vantage points.

Unfortunately, in recent years, several high profile incidents of glass breakage, which resulted in glass fallout, have sparked concern over the safety of glass railings and guard systems. If the elements designed to protect people are actually potentially harming them, then there is definitely a problem.

"Design trends are definitely toward cantilevered designs. Because of sight lines to stores, minimally supported designs are very important to retailers. The ability to take out posts and minimize rails improves those sight lines."

Bernard Lax, Pulp Studio.

In order to address the issue of glass breakage, the 2015 International Building Code (IBC) calls for the use of laminated glass in most railing applications. This represents a major change to the monolithic glazed glass that is currently used for most railing and guard systems.

By requiring heat strengthened or tempered laminated glass in railing systems, the 2015 IBC model code has taken a major step forward in terms of improved safety. On the other hand, this change represents a major adjustment for owners, designers, architects and general contractors, as you consider current or future renovations and new development.

Read on to find out what you need to know about the code change and what you can do to better prepare for your glass project.

From monolithic to laminated glass - the new code is here

" Many commercial and retail properties across North America that were built over 15 years ago have railing systems that no longer comply with current international building codes. The current code changes have significant impacts to owners in terms of costs and scheduling risks."

Walter Bowie, Glass Railing Consultant, Synergi

Driven by safety concerns and improved production techniques, laminated glass has been used in guardrail systems in Europe for years. Now, several U.S.-based fabricators have adopted similar production processes, and more and more states and local jurisdictions in the U.S. have adopted and are enforcing IBC 2015 building code. See where your state is on the adoption curve.

What exactly is the new code?

The revised model code (Section 2407.1) now states, *"handrail, guardrail, or a guard section shall be laminated glass constructed of fully tempered or heat strengthened glass and shall comply with Category II or CPSC 16 CFR Part 1201 or Class A of ANSI Z97.1. Glazing in railing in-fill panels shall be of an approved safety glazing material that conforms to the provisions of Section 2406.1.1. For all glazing types, the minimum nominal thickness must be 1/4 inch (6.4 mm)."*

Section 2403.4 states *"where interior glazing is installed adjacent to a walking surface, the differential deflection of two adjacent unsupported edges shall not be greater than the thickness of the panels when a force of 50 pounds per linear foot (plf) (730 N/m) is applied horizontally to one panel at any point up to 42 inches (1067 mm) above the walking surface."*

Section 2403.4 was added to mitigate against "pinching hazard" which can occur in interior applications when an individual may contact the glass panels (inadvertently or otherwise) with an impact force that exceeds the differential deflection minimum. Mullions prevent this from happening in exterior applications.

There are exceptions noted in the model code that permit monolithic tempered glass in railing systems:

- For applications (such as on ground floor) based on the absence of a walking surface beneath the railing or the permanent protection of the walking surface from the risk of falling glass.

- Infill panels that do not support the railing (such as in post mounted systems) also have less stringent requirements and may be satisfactory to the local jurisdiction with tempered monolithic glass. Here's a quick snapshot of the changes:

Railings with infill panels not supporting the top railing	Glass baluster or infill panels supporting the top rail
Interior Applications - tempered monolithic	Interior Applications - laminated required, unless at ground level where glass cannot fall on someone below
Exterior Applications - laminated required (2407.1.4.1)	Exterior Applications - laminated required, unless at ground level where glass cannot fall on someone below

"By requiring heat strengthened or tempered laminated glass in railing systems, the 2015 IBC model code has taken a major step forward in terms of improved safety."

Mark Jacobson, chair of the GANA Laminated Glass Railing Code Task Group.

The transparent truth: Why a new code now?

W Hotel in Austin, TX.
…"the problems began on the pool deck. On June 10, two lites of glass fell from the balconies of south-facing condos on floors 24 and 25, crashing down and injuring four people on the pool deck below. Weeks later, three more lites fell."

Murano Condominiums, Toronto, Canada:
…"after a fifth lite of glass from a condominium balcony fell - this time from 29 stories up and hitting a pedestrian below."

(Source: US Glass Magazine, October 2011)

Historically, tempered glass typically has been specified over laminated glass for two reasons, lower cost and aesthetics, as many designers do not want to have an "unsightly" laminated edge showing.

However, after a number of highly publicized incidents involving window and balcony glass breaking spontaneously and falling from high-rise buildings, the Glazing Industry Code Committee (GICC) proposed the changes.

It doesn't take an earthquake or violent impact for tempered glass to break. On a day-to-day basis, glass railings are exposed to potential incidents that could cause breakage, such as strollers, delivery carts, or even workers unintentionally bumping into them with floor cleaning machines. However, the most common causes for breakage are not related to impact. The most common causes are:

- Poor edge quality: The most common is damage to the edges of glass as it is being pre-cut into panels, or nicks or chips to the edges that occur when the glass is being packaged, shipped, or installed onsite.
- Frame-related breakage: Expansion and contraction of glass framing members may also lead to frame-related breakage
- Thermal stress: Thermally induced stresses in glass are caused by a positive temperature difference between the center and edge of the glass lite, meaning the former is hotter than the latter.
- Nickel-sulfide inclusions: Small nickel-sulfide stones can form randomly in the production of float glass.

Most North American glass makers have controls that greatly reduce the likelihood of nickel sulfide formation. However, offshore tempered glass quality can be substandard, especially glass that is produced in China. In addition, North American glass manufacturers do not use nickel in batch formulations for primary glass and go to great lengths to avoid nickel-bearing components in their glass-melting processes. Despite rigorous quality controls and procedures aimed at reducing the likelihood of nickel-sulfide stones, there is no technology to completely eliminate their formation in today's float glass.

Factor in litigation and liability costs

As a result of these accidents, a number of class actions lawsuits have been filed around the country as a result of shattered glass panels. For example, as reported by US Glass Magazine, "The plaintiffs are alleging breach of contract by the developers of the three properties because of the time they were barred from their balconies following the displaced glass panels that fell from their homes onto the streets below, as well as diminished property values as a result of the highly-publicized incidents."

Bernard Lax puts this in perspective. "In the past many developers see the line item costing of the laminated glass selection versus monolithic glass and balk at the idea of its use. When you factor in the litigation and liability costs associated with the multitude of legal actions the delta of the selection of laminated glass can seem like a bargain."

Spontaneous glass breakage

Laminated glass: A quick overview

Laminated glass features two pieces of glass “sandwiching” a plastic interlayer, which provides an added level of safety. If breakage does occur, the glass does not typically fall away, as it is held in place by the plastic interlayer.

With durability requirements in building applications increasing over the past two decades, the composition of the interlayers has been improving to meet these requirements. Today there are different types available, with basically two families of structural interlayers to choose from:

- Ionoplast interlayers (such as SentryGlas® Interlayer)
- Stiff Polyvinyl Butyral PVB (low plasticizer)

These interlayers feature a much higher shear and elastic modulus than tempered glass, increasing the strength of the laminate and enhancing the coupling between the glass panes. Stress and deflection are reduced, which will allow the use of lower laminated glass thickness and/or increased glass spans.

The extra stiffness of the interlayer also enhances post breakage performance, and is particularly well suited for structural applications such as:

- Minimally supported glass construction
- Overhead glazing
- Structural balustrade systems

Standard PVB interlayer (originally developed for windshield glass shard retention and later on impact performance) is still used in special glazing applications but is getting increasingly replaced by higher performance structural interlayers. (i.e. SentryGlas®)

With the different types of interlayers, there are differences in performance, especially with regard to the sensitivity to develop defects at the edges. Interlayer suppliers should be consulted to understand these differences and select the right interlayer for the specific application.

The laminated glass sandwich. Two glass lites and a plastic interlayer.

Three key insights for meeting the laminated glass code

1. It's going to cost more. Changing from tempered glass to laminated glass increases overall guardrail cost by 20-30%

The complexity of the lamination process and extra materials naturally means that laminated glass is going to cost more than standard tempered glass. Understanding that there is a significant cost differential will help you prepare ahead of time for increasing budgets or cutting costs in other areas to offset the increase.

While the increased cost cannot be avoided, you can reduce the risk of budget overruns by understanding the differences between laminated glass and tempered glass and how the code change will affect the design and renovation process.

In addition, working with a specialist who provides design input and warranties on materials and workmanship helps you ensure quality. One who has industry experience designing and installing railings and guards using the laminated glass will help ensure that you do not spend more than is necessary.

2. It's going to take longer to get the glass. Laminated glass can take up to 50% longer to fabricate.

The additional steps needed to manufacture laminated glass are complicated and increase the lead time. So plan accordingly.

Different vendors design to different specifications. And the durability of laminated glass will depend of a number of design and manufacturing factors. Some things to discuss with your vendor:

- Quality of the lamination process.
- Quality of the glass.
- Edge quality (alignment and smoothness)
- Procedure and quality of the glass installation.
- Glass fixation system.
- Interlayer selection: Type and thickness.

3. The laminated glass will affect your design. Make sure you understand how.

It's important to understand the exposure of the glass edges to moisture, temperature, and sealants, and how those factors might degrade performance over time.

"First you cut two pieces of glass, then polish the edges. They have to be virtually the same size. Then they put it through a tempering oven, heating and cooling. When you laminate you have to make sure everything is aligned through the rollers, and finally, you place it into an autoclave. So a lot of opportunities for misalignment to occur with all of these processes."

Mark Jacobson Kuraray America and the chair of the GANA Laminated Glass Railing Code Task Group., explaining the complexity of the process

Remember these numbers:

Cost – Changing from tempered glass to laminated glass increases glass railing overall cost 20-30%

Schedule – The fabrication of laminated takes approximately 50% longer. 4-6 weeks for tempered. 6-8 weeks for laminated.

Edge Conditions

Edge quality is of paramount importance for structural integrity as well as appearance. The standard tolerance for laminated glass edge mismatch according to ASTM C1172, Section 8.5.1 can be up to ¼ inch. A mismatch of this magnitude may, however, create issues with the performance of the glass, particularly when a load on the edge is concentrated on one lite. The exposed edge is easier to bump into and is the weakest link when it comes to breakage.

To add in a higher degree of safety, designers can specify tighter tolerances, per ASTM C1172, Section 8.5.3, but it will increase the cost. Treatments such as top channels/caps can also be used to mask any deficiencies in the edge matching. Though some designers resist this option, a continuous top channel eliminates the need for a handrail as the top channel doubles as a structural element.

Moisture, Environmental Exposure and Laminate Erosion

With laminated glass, it is important to consider compatibility of the glass and interlayer with any sealant, grout or cement that may come in contact with the glass and interlayer. Since the interlayer will come in contact with the other components (such as water), it is critical to make sure they are compatible chemically and that no interaction will occur with long-term contact.

In general, epoxy or polyurethane based grouts have superior performance characteristics compared to Portland based cement, which is highly alkaline and may attack the laminate structure. In shoe mounted or cantilevered systems, this delamination occurs below the line of sight so it may be difficult to detect until the glass has been seriously weakened.

Ionoplast interlayers tend to stand up to the elements (or frequent glass washing on interior applications) better than standard PVB. Ionoplast interlayers will have better structural properties than stiff PVB interlayers at temperatures above 30C (86F)

With post mounted systems there is no chance of interaction with grout, since instead of a glass panel being captured at bottom, it is bolted to the post. However, those bolt holes weaken the laminate, creating stress and potential for de-lamination at those points, unless a structural interlayer (ionoplast or stiff PVB) is used.

Sources:

constructionspecifier.com “Spontaneous glass breakage. Why it happens and what to do about it” 10/11

architectmagazine.com “Falling Glass Closes New W Hotel in Austin, Texas” 09/11

Bernard Lax CEO of Pulp Studio

GANA Perspectives “ Guiding the Rails”, Mark Jacobson 09/15

Glass Performance Days 201 Tampere, Finland. “Which interlayer for which glazing application?“ Björn Sandén Kuraray Europe GmbH 06/15

USGlass, Metal & Glazing “Tale of Three Cities - and lots of broken glass” 10/11

Summary

Yes, it's going to cost more money and require you to adjust your designs and timelines. So make sure to consult with industry experts and retain glass railing specialists who are knowledgeable and reputable when it comes to making recommendations that follow the new code.

The key is to be knowledgeable of the changes and to partner with industry experts to mitigate the exposure and potential risks to the owners, designers, architects and general contractors as you consider current or future renovations and developments.

About Synergi

Synergi is excited to be included among Glass Magazine's 2016 Top 50 Glaziers List. Synergi builds your brand by transforming high impact decorative elements. As turnkey specialists in handrails and decorative glass, we advise developers, designers, architects and contractors on how best to accomplish strategic projects

Call 800.784.5201 and let us help you understand how the new IBC 2015 Code changes will affect your renovation, expansion or development projects.

SYNERGi

SYNERGi

Washington, DC
7477 New Ridge Road • Hanover, MD • USA 21076 • T 800.784.5201

San Francisco
2364 Baumann Avenue • San Lorenzo, CA • USA 94580 • T 800.784.5201

Montreal
106 Avenue Gun • Pointe-Claire, Quebec • Canada H9R 3X3 • T 800.784.5201

synergi-global.com

info@synergi-global.com