NATIONAL GLASS ASSOCIATION with GANA

Glass Technical Paper **FB05-04 (2023)**

Emergency Egress through Laminated Glazing Materials

Building codes often require, and/or modern architectural designs specify, glazing materials that provide enhanced performance levels of security and safety. These performance properties include resistance to ballistics, blast, hurricane/cyclic wind pressures and physical attack. Glazing applications may also specify such properties as sound reduction, fade resistance, and solar and thermal control. Because laminated glazing materials are able to meet such requirements and design criteria, they are finding application in a broader range of installations than ever before. The use of laminated glazing in residential and commercial installations has led to inquiries by design professionals and specifiers regarding the reaction of public safety officials to these products. This Glass Technical Paper is intended to inform building owners, design professionals, and specifiers about emergency ingress and egress considerations when using these products.

Laminated Glazing Fabrication

Laminated glazing materials consist of multiple layers of glass, interlayers, resins and/or plastic glazing materials which are often complex in nature. The interlayers can be any one of several thermoplastic layers such as polyvinyl butyral (PVB), polyurethane (PU), ethylene vinyl acetate (EVA), ionomer interlayers or other individual or combinations of thermoplastic polymers. These layers are usually bonded to the glazing system base (glass, acrylic, polycarbonate, etc.) using heat and/or pressure systems that create a laminated glazing lite. Laminated glazing can also be fabricated using cured resins between the layers of glass. In each construction, the resulting glazing product is designed to provide the specified level of performance for the required application.

Performance Characteristics

Laminated glazing materials have performance properties that add value to architectural structures, automobiles, and aircraft. In addition to effectively reducing solar heat gain for energy control and sound transmittance in acoustically engineered structures, a beneficial property of laminated glass is that it provides a barrier to penetration. This transparent yet resistant glazing system helps protect against a range of manmade and naturally occurring situations that would cause the structural envelope to be breached if laminated glass were not used. Such situations include security requirements to protect against forced entry, ballistic, or even blast attack. Laminated glazing provides protection and safety in such naturally occurring situations as earthquakes, windstorms, or hurricanes. In such situations laminated glazing tends to remain in place if broken, thereby reducing the likelihood of glass-related injury. Requirements that glass remain in the window opening during and following these events make laminated architectural glazing attractive for use in hurricane zones, earthquake-prone areas and those buildings potentially subject to the threat of a blast.

Emergency Egress

An often asked question regarding the installation of laminated glazing systems is how the glazing will affect the ability of an occupant to use the window as an emergency egress. In residential applications, doors are utilized for emergency egress, and in those instances where windows are used for egress, the windows can be opened using the standard locking / latching mechanism prior to egress. If a resident must leave a burning building through a window, typically they open the window to escape. "Normally, it is not somebody's first response to break a window," said Mike Forgy of the International Association of Fire Chiefs.

In office buildings, the installation of laminated glazing in non-operable windows would not affect their use for points of egress since these windows are usually installed in multi-level (high rise) buildings where such windows are not the designated point of egress. According to Reginald Penny, president of the Fire Marshall's Association of North America and Chief and District Commander for the Palm Beach County Fire Department, "Windows are only to be used as a secondary means of escape according to standard building code requirements."

Emergency Ingress

Often of greater concern than the issue of emergency egress is the perceived deterrence that laminated glazing poses to fire and rescue personnel attempting to enter a building. "We really don't like to break windows because the sharp glass shards that remain can cause injury and cut through fire hoses," Penny said. "Windows are removed as a last resort because there is too much room for error and injury." According to Mr. Penny, the ability of laminated glazing to resist penetration does not pose a significant risk to inhabitants during a fire. "We use windows as a last resort in rescue operations because open windows feed oxygen to a fire and often times when utilized, windows do more harm than good because they have a tendency to blow out when punctured under pressure." said Mr. Penny.

In some severe cases it may be necessary for a firefighter to enter through a window. With the implementation of building codes that have made laminated glazing more prevalent, fire and rescue personnel are being targeted for awareness of, and response training toward, these products. NGA is aware of several training programs which instruct fire and rescue personnel to quickly identify the presence of, and respond to, penetration deterrent glazing. Fire and rescue personnel are equipped to penetrate these glazings with the available tools they bring with them in an emergency. These tools vary from a common fire ax or fire hook to saws and other cutting devices. Mr. Penny feels that "If firefighters can cut a car in half to rescue its occupants, then they can cut through a piece of glass without a problem."

Government and Industry Research

Federal and local governments have reacted to concerns about emergency access through laminated glazing materials. The U.S. General Services Administration (GSA) in conjunction with the Office of Homeland Security commissioned a study by Hinman Consulting Engineers in May, 2003, that tested emergency personnel access through penetration deterrent windows (such as those specified for blast resistant glazing in GSA facilities).

Working with the San Jose (CA) Fire Department and the Protective Glazing Council, twenty-seven different protective glazing constructions with ¼" glass were studied, ranging from standard annealed glass to blast resistant glazing. The study included:

- laminated glass with 0.030-inch and 0.060-inch interlayers.
- tempered glass with 7 mil (0.007 inch) thick surface-applied film, with variations including daylight only and with mechanical attachment on two and four sides.
- insulating glazing units with inner pane laminated with 0.030-inch, 0.060-inch and 0.090-inch interlayers.

Fire and rescue personnel utilized the standard forcible entry tools and operating procedures of the San Jose Fire Department and the International Fire Service Training Association. As stated in the report's conclusions, "The Firefighters were able to enter all of the window mock-ups with conventional firefighting tools such as axes, hooligans' tools, and pike poles" (see Figures 1, 2 and 3 for examples of these tools).

Figure 1: Pickhead axe

Figure 2: Hooligan tool

Figure 3: Pike pole

Though conventional tools were equal to the job, updated techniques were required to efficiently break and clear the windows."

- For example, the most effective method of clearing the filmed glass with mechanical attachment was to chop around the perimeter beginning with clearing the top, then halfway down the sides, then the bottom, then completing by clearing the remainder of the sides.
- In contrast for laminated glass, the firefighter was able to use the weight of the tool to push the entire broken unit out of the frame rather than chopping around the window perimeter. This technique was also effective for insulating glazing units with inner laminated pane. The firefighter first ensured the non-laminated panes were fully broken, then used the weight of the tool to push the broken laminated pane out of the framing system.

The complete study, along with videos of the entry tests can be found at the internet site of the National Institute of Building Sciences (NIBS): https://www.wbdg.org/ffc/gsa/criteria/forcible-entry-demos-air-blast-resistant-window-systems

Additional comments from this report are:

"All tools used in the tests are commonly carried on fire apparatus or by firefighters throughout the United States. Entry was restricted to gaining access through the glass itself and not by prying the window framing from the wall. If the firefighters did not gain access with these limitations, provisions were made for the use of more sophisticated tools. In this set of demonstrations, more sophisticated tools were not required."

"Films and lamination tend to hold glass shards together, which can allow firefighters to more easily move the glass away from the operational area and may decrease the likelihood of injuries associated with stepping on glass shards (slip, trip, and fall type injuries). It can also reduce the hazard from falling glass to those working outside the building."

Like the U.S. Government, private industry is also working to inform and educate emergency rescue personnel. Manufacturers of penetration deterrent windows have conducted training demonstrations and produced educational videotapes which they make available to fire and rescue personnel.

Visit www.glass.org/store for a complete list of Glass Technical Papers, as well as other glass building products and glazing industry reference materials.

The Technical Services Division of the National Glass Association (NGA) has produced this Glass Technical Paper solely for informational purposes. NGA makes no representations or warranties, express or implied, with respect to the information provided in this Paper or to its use. This Paper makes no attempt to provide all information or considerations for the topic area covered within this Paper. NGA disclaims any responsibility for any specific results related to the use of this Paper, for any errors or omissions contained in the Paper, and for any liability for injury, loss or damage of any kind arising out of the use of this Paper. This Paper is a "living document," and NGA reserves the right, in its sole discretion, to update, revise, and amend the Paper from time to time as it sees fit and to do so without notice to prior recipients or current users of this Paper.

This Paper was developed by dedicated member volunteers and subject matter experts. The original version of this document was approved and published in 2004. This version of the document was updated and published in December 2023.