TESTING RESULTS

Building Code Requirements

The International Building Code (IBC) and International Residential Code (IRC) are “model codes” created by the International Code Council, intended to be used by states and municipalities as they publish their own building codes. Section 1607.8 of the IBC requires that “handrails and guards shall be designed to resist a linear load of 50 plf.” It also requires the system to resist a 200# concentrated load that produces the “maximum load effect” on any element within the system. The 2018 IRC Table R201.5 extends this requirement into residential construction. It is understood within the building design industry that loads applied to the top of the panel create the maximum load effect; structural design assumes this loading condition.

Section 1607.8 of the IBC also refers to IBC section 2407 that adds a requirement for all-glass handrails and guards to “be laminated glass constructed of fully tempered or heat-strengthened glass”; this requirement was added in the 2015 IBC code cycle. Section 2407.1.1 adds the significant requirement: “a design factor of four shall be used for safety”. This addition bumps up the linear load to 200 plf and the concentrated load to 800#. Presumably, this is intended to prevent the glass from shattering and injuring people below.

Exterior glass guardrail panels are designed to resist two load types: wind loads, and “live” loads such as a person or object pushing on or striking the panel from the side or from above. Wind loading on a panel can vary greatly based on location, terrain (wooded vs open) and elevation above ground; these are governed by publication ASCE 7 (American Society of Civil Engineers Minimum Design Loads for Buildings and Other Structures). Wind speeds of 115 psf are used to calculate wind pressures against the glass, which generally vary from 17 psf (2nd story in wooded area) to 35 psf (30 stories tall in open terrain). The wind speeds required to match the stresses created by the 800# point load are 192 mph for the 42” tall panel and 215 mph for the 36” tall panel; these are only seen in a Category 5 hurricane or a tornado. Therefore, the 800# horizontal point load is the worst-case scenario for the panels. Note: panel design in “high wind” regions such as the coastal Southeast US are designed to resist flying debris and are subject to different loading requirements. Calculation methods to arrive at these values include computer modeling using finite element analysis; criteria specific to Clear View’s panels and support configuration were used.

Hercules Glass Testing

Testing was performed on the Hercules Glass panel by Clear View’s glass supplier, to simulate the forces created by 800# horizontal and vertical point loads on the panel (loads are not required to be simultaneous). The vertical load test is fairly straightforward and is shown in photo 1. Note: the intent was to load the panel to failure; however, the testers ran out of sandbags at 2,520 pounds, without failure. Given the difficulty of pushing an 800# load horizontally against the panel, a test rig was set up that supports the panel on its side and places sandbags vertically on the panel. The panel is supported 28” from the top of panel (creating a 28” cantilever), with a heavy counterweight holding down the bottom of the panel mounted in its spigots. Sandbags were placed at the top edge of the panel until failure. See Diagram 1 and photo 2. The panel failed after one minute with 820 pounds loaded on its edge. Due to the laminate construction of the panels (similar to a vehicle windshield), the panel broke into small pieces that were retained within the panel, preventing dangerous flying glass debris. See photo 3. This test shows that the panel meets the intent to create a strong and safe barrier that can withstand reasonable loading, and does not explode with dangerous glass shards during excessive loading.

Photo 1: Panel loaded vertically with 2,520 pounds.

Photo 2: Loading of panel with sandbags, simulating horizontal force

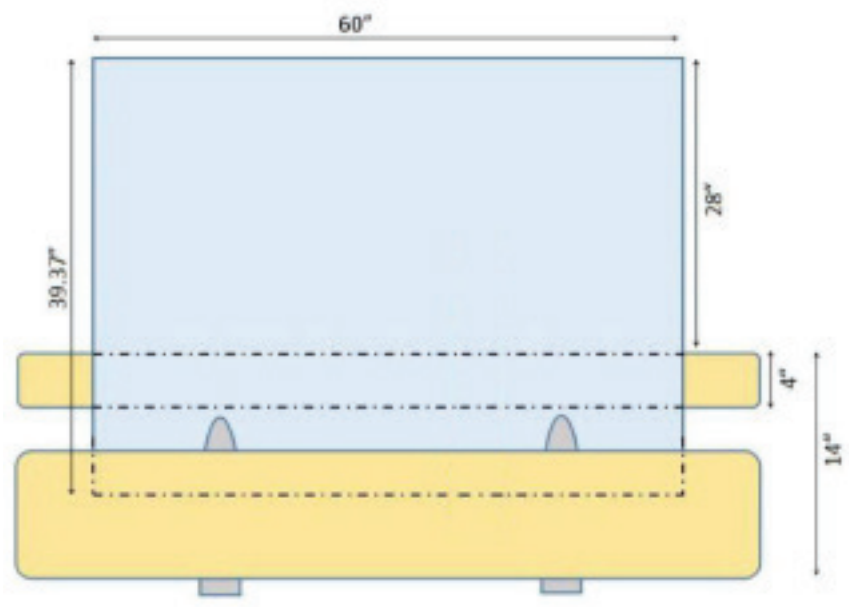

Diagram 1: Test rig lying on its side, looking from above, showing panel supported at 28" and at bottom of panel

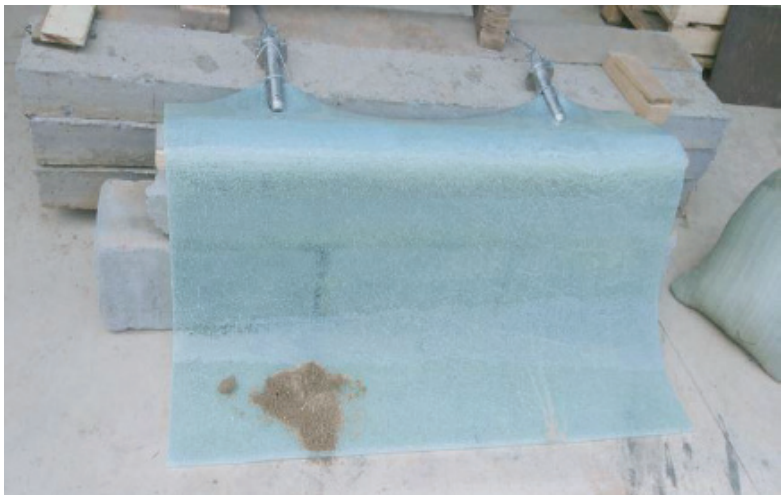

Photo 3: Panel after failure, showing all glass intact within laminate structure.