



This stained-glass window in the West Los Angeles Cathedral in Los Angeles, CA, features ½-in. tempered laminated glass, a method that is approved for earthquake and hurricane codes.

on steel); this window has a problem. If your window frames are wood, check for rot; if steel, check for rust; if stone, check for spalling. From the interior, check the stained-glass window for sagging, bulging and cracks in the stained-glass panes and the glass pulling out of the flanges of the lead came in these areas.

## Venting Systems

For the past decade, venting in protective covering for stained-glass windows has largely been achieved by making holes in the single-glazed protective covering and adding louvered and/or screened vent plugs with a rain-guard feature. This approach always bothered me though. I felt it was not aesthetic and in glass it adds a structurally weak point to the glazing. Over time, working with our engineers and our experienced field staff, we came up with solid designs with a venting system built into the frames that prevents water and insect infiltration. We refined our designs and arrived at our Precision Flow ventilation system designed for the conservation of stained-glass windows. We received our official Patent Pending status in November 2003 for our system and are hoping to receive our final patent approvals at any time. We install our Precision Flow ventilation system into all of our frames, protective covering, double glazed and thermal barrier aluminum frames, as well as into our wood frames.

Precision Flow venting in our frames is designed to hold both stained glass and exterior glazing, whether in a single-glazed protective covering system or insulated-glass exterior glazing system. It is designed to the guidelines of 1 sq.in. of ventilation to 16 sq.ft. of stained glass in the bottom and top of the unit, with a gravity flow system. Hot air rises, causing the heat buildup and condensation to escape at the top of the unit.

This craftsman at Bovard Studios is fabricating a ventilation system in a mahogany wood frame for the St. Cecilia Chapel, Dominican Sisters Motherhouse in Nashville, TN.



Holes randomly placed in the framing system without a gravity air-flow system will not be as effective for the conservation of stained-glass windows. On exterior venting, we incorporated a water-guard system into our frame design to prevent wind-driven rainwater from entering the system. Perforated-aluminum screens are incorporated into the vents of the frame to keep insects out and are placed flush with the exterior surface area so no indentations or hooded areas exist for bugs to nest in, which would block the air flow and cause the ventilation system to fail.

Working with our clients' local architects and our engineers, we fabricate framing and glazing systems for stained-glass windows that meet Florida's hurricane codes and California's earthquake codes. Our new framing systems survived Florida's 2004 quadruple hurricane onslaughts without failure or leakage. Of course, the forces of nature are unpredictable and manmade structures cannot resist all of nature's forces. Nothing made by man can stand against the strongest forces of nature.

## Materials

There are several types of glazing materials available for protective glazing systems for stained-glass windows: modern float glass, laminated glass, tempered glass, tempered laminated glass, polycarbonate (Lexan is a brand name of polycarbonate), acrylic (Plexiglass is a brand name of acrylic) and extended-life polycarbonate (polycarbonate with a coating of acrylic).

The advantage of plain float glass is that it stays clear and is less expensive than the other materials. Its disadvantage is its lack of strength and, when broken, the shards are a safety hazard, especially in storms and earthquakes.

Laminated glass is no stronger but holds together when broken. This is an important safety feature in a storm or in earthquake zones. Tempered glass maintains all of the attributes of float glass plus is up to 10 times more resistant to breakage from impact than annealed float glass.

Non-laminated tempered glass cannot be used in areas with hurricane codes because once it breaks, it shatters into countless small razor sharp shards that can cause fatalities when blowing through the air at high velocity.

Laminated glass, like that used in a car windshield, will hold together when broken and will continue to protect the window from most hurled projectiles.

Tempered laminated glass combines all of the clarity and beauty of float glass with the strength of tempered glass and the safety of laminated glass. The only drawback is its high cost.

Plastic polycarbonate and acrylic protective glazing are much stronger. Polycarbonate is virtually shatterproof and acrylic is shatter resistant. Polycarbonate and acrylic haze from wind-blown dust. Both have relatively large coefficients of expansion that must be handled in a framing system designed for their expansion and contraction cycles. These

plastics flex during these cycles causing a glare that is unattractive as light reflects off of the concave or convex surfaces. I recommend a minimum of ¼ in. thickness to give the plastic materials enough rigidity to minimize this unattractive effect.

Polycarbonate yellows in a few years when exposed to ultraviolet light. By coating the polycarbonate with acrylic, manufacturers have developed a product with a significantly increased life expectancy. Acrylic is harder than the much stronger polycarbonate. The acrylic coating provides more resistance to scratching, and blocks the UV light that causes the yellowing in polycarbonate, thus extending the useful life of polycarbonate.