

## "Transparent box" to house new Philadelphia landmark

A soaring, 50 metre-high, barrel vault-shaped atrium roof of laminated glass with DuPont™ Butacite® PVB houses The Kimmel Center for the Performing Arts, Philadelphia's newest landmark (completion: December 2001), protecting what architect Rafael Vinoly calls "two jewels floating in a transparent box": the 2,500-seat Verizon Hall and the 650-seat Perelman Theater. The barrel vault ends

varied aesthetic since it appears to float above the two transparent end walls. Project Architect at Rafael Vinoly Architects, Charles Blomberg, told LGN: "We were inspired by the great winter garden or greenhouse architectural structures of the nineteenth century, like Crystal Palace in London. The lobby is important at the Kimmel Centre; it is a place where people can gather all day and into

against each other at an angle of 45 degrees. The membrane of the arch therefore resembles a folded plate structure when seen close up and achieves the structural rigidity we needed; it's like window mullions holding up the building! The result is a pure, gravity-loaded arch of laminated glass that can bear snow- and wind-loads."

factor we needed into the glass construction. Without the Low-E coating, the solar gain would have been prohibitive. The roof has a massive surface area and its length extends for the equivalent of a whole

should use two layers of 6 mm Starphire low iron tempered glass laminated with 1.52 mm clear DuPont™ Butacite® PVB. The panes of glass we used are pretty big (135 cm x 170 cm) and laminated glass gives the best protection



The atrium and end walls of laminated glass give an outdoor feel to the lobby.

on both sides in two colossal glass arches; both 'end walls' are also made of laminated glass with Butacite®.

### "A PURE, GRAVITY-LOADED ARCH OF LAMINATED GLASS"

The self-supporting barrel vault of laminated glass is unique for its huge size (radius: 26.5 m; span: 53 m; total area: 12,000 m<sup>2</sup>) and for its striking and

the night in all weathers, year-round."

The Kimmel Center's roof is based on a column-free, self-supporting, 53 metre Vierendeel truss to arch across the span, and on folded glass plate action to create longitudinal stiffness. Blomberg explained: "There are no square or triangular panels of glass. Instead, the glass panels are leaning

### "OUTSTANDING CLIMATE CONTROL"

Don McCann of glass fabricator Viracon said: "Aside from safety and strength, three main reasons for using laminated glass for the barrel roof were solar control, aesthetic appearance and cost efficiency. The custom-designed construction is made of a 5 mm layer of grey, heat treated glass followed by a 1.52 mm Butacite® PVB interlayer, followed by a layer of 5 mm glass with a Low E pyrolytic coating on the inside. Testing confirmed that we got a better U value by incorporating the coating on the inner surface: a 51 percent shading coefficient is achieved. The architects wanted a good degree of natural light coming in through the roof but they also wanted to control heat build up and glare. The grey glass gives 43 percent light transmission and also reduces reflectivity by 8-10 percent compared to standard laminated glass."

Blomberg commented: "Laminated glass was essential for building the shading

**"By using the strength of laminated glass, we found an economical solution for the end walls – about half the price you would expect for a structural project of this type!"**

Dewhurst Macfarlane and Partners Inc.

city block! The use of laminated glass enabled us to exercise outstanding climate control.

"For the end walls, we specified that fabricator Dlubak of Blairsville, Pennsylvania



The Kimmel Center for the Performing Arts, Philadelphia.

against glass fallout." The end walls invite visitors to visually take in the city of Philadelphia when they attend arts performances; likewise, since the facades are largely transparent at street level, passers by can see freely into the Center's impressive public plaza."

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## Spectacular atria for Singapore Esplanade

The Esplanade/ Theatres on the Bay in Singapore (completion October 2002) will be a focal cultural centre for the country. DP Architects of Singapore and Michael Wilford & Partners of London drew up the initial design proposals for the project including early versions of the shell roofs, and together with London-based engineers Atelier One developed the current spectacular, complex geometry shell roofs of laminated glass incorporating DuPont™ Butacite® PVB that give

a 1,800 seat theatre and an equally large concert hall two distinct identities. DP Architects Project Director for the Esplanade, Vikas Gore, told LGN: "The laminated glass roofs were designed to give people inside the building wonderful views in all directions including the river, waterfront and nearby civic district including Parliament House, while keeping Singapore's hot and sultry climate out." (Singapore is located just one degree north of the equator.)

Gore noted that the original design, with MWP, when exhibited in its preliminary form, was found 'too Western' by critics in Singapore. In a revised design, these concerns were met by using a combination of folded aluminium sunshades and an organic geometry for the structural mesh, which together are evocative of the textile and basket weaves of South East Asia. He explained: "The geometric shapes we selected for the roofs were calculated using computer aided design (CAD) to reduce solar build up. The combination of fixed, aluminium sunshades and double glazed, laminated glass with a Low E coating enabled us to meet Singapore's Overall Thermal Transfer Values (OTTV) code, a strict environmental law designed to optimise the thermal co-efficient and save energy consumption in Singapore's new buildings."

Neil Thomas of the UK-based structural and environmental engineering firm Atelier One/ Atelier Ten commented: "These huge laminated glass domes are 125 m long and span 95 m wide. No less than 25,000 m<sup>2</sup> of laminated glass was mandatory for the extensive, overhead glazing the architects

wanted. What is amazing is that, while reducing solar gain sufficiently to meet the OTTV regulations, the glass is at the same time very transparent, so the views are fabulously clear."



The glass roofs keep the interior cool and give great views to people inside.

Mero of Würzburg, Germany is the cladding contractor while AGP Pte. Ltd. of Singapore is supplying the

laminated glass for the project. The glass construction is 28.76 mm Enviro-Cool Double Glazed Units made up of 6 mm Saint-Gobain Parsol Green tinted tempered glass, separated by a 12 mm air space, 5 mm Pilkington LOF Low-E clear float glass, 0.76 mm DuPont™ clear Butacite® PVB interlayer and 5 mm Guardian clear float glass. AGP's Managing Director, Lim Chuin Yong, commented: "The complexity of the project is that there are over 9,000 panes of glass in this project of different shapes!"

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The aesthetics of the atrium is designed to evoke South East Asian textile and basket weaves.