

Case Study:

Paul Andreu's Shanghai Oriental Art Center uses SentryGlas® ionoplast interlayer for "magical" facades

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The Shanghai Oriental Art Center encompasses a 1,979-seat philharmonic orchestra hall, a 1,054-seat lyric theatre, and a 330-seat chamber music hall. The facade's laminated glass construction incorporates SentryGlas® ionoplast interlayer, combined with perforated metal sheeting at upper levels for sun screening.

In the Shanghai Oriental Art Center, China, architect Paul Andreu of Paris has created a building that is "bright and transparent as if by magic" in the words of the architect. However, like the best architectural magic, the building's foundations are rooted in meticulous engineering. One of the most impressive aspects of this is state-of-the-art architectural façade technology incorporating laminated glass with SentryGlas® interlayer, supplied by leading Chinese glass manufacturer Shanghai Yaohua Pilkington Glass Company (SYP).

The Shanghai Oriental Art Center is one of the biggest and most talked about projects to be completed in Shanghai, if not the whole of Asia, in the past couple of years. It is a first rate public cultural building, financed by the municipality of Shanghai, China. The complex encompasses three venues: a 1,979-seat philharmonic orchestra hall, a 1,054-seat lyric theatre, and a 330-seat chamber music hall. It also features ancillary public facilities such as an exhibition hall, music shops, a restaurant and an arts library, as well as a multimedia and training centre.

Architect Paul Andreu of Aeroports de Paris (ADPi) says: "When I first conceived the Shanghai Oriental Center, one of my first thoughts was that I wanted it to glow beautifully at night. After all, what is an art center? It's a place where music and theatre are performed. It should be appealing, especially in the evenings, when the crowds are attending. It

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should project a sense of mystery. It should certainly not feel closed, stuffy or boring.”

Andreu approached the Shanghai Oriental Art Center fresh from completing the Osaka Maritime Museum in Osaka, Japan (1993-2000) where he says he had “the vision of a round, geodesic dome floating in the water and glowing at night”. Andreu told Laminated Glass News: “As an architect and an engineer I am always trying to find better solutions. So when we approached the Shanghai Oriental Art Center I wanted it to glow even more beautifully at night than the Osaka Maritime Museum does. I wanted the whole construction to be glowing. I wanted the Shanghai Oriental Art Center to say: “The Show’s Beginning!”

“We were very fortunate to find a Shanghai-based glass supplier - SYP - who could make the exact laminated

metal / glass construction we wanted, comprising very large panels of laminated glass incorporating SentryGlas® interlayer, together with a perforated, galvanized steel metal sheet.

“We selected structural interlayer for its great properties including its ability to encapsulate the perforated steel sheet. the structural ionoplast interlayer has much superior mechanical properties than EVA-based thermoset adhesive film, and superior durability. The interlayer adheres strongly to metal, which opens it to a wide range of functional and aesthetic innovations. In the case of the Oriental Art Center, I also particularly like the color and effect that this new type of ‘metal / glass envelope’ gives to the building.” SYP carefully reviewed Paul Andreu’s design and aesthetic requirements, then reviewed the façade construction alternatives.



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Andreu wanted a shimmering, glass-metal effect, which glowed beautifully at night. Laminated safety glass was a must for such a façade. However, PVB, the traditional bonding ingredient of laminated glass, does not adhere well to metal. The solution: SentryGlas® interlayer, which not only adheres to glass but creates an incredibly strong bond to metal as well.

Architecturally the design is striking, beautiful and innovative. From an engineering point of view, however, the stresses on the glass panels of the façade are highly complicated. Again here, use of SentryGlas® made the project possible. The interlayer provides the necessary additional strength required to accommodate the dominant bending stresses in the construction.

SYP technical director, Mr Pan Wei, told LGN: "The glass construction is 12 mm ( $15/32$  in) heat-soaked fully-tempered glass + 1.52 mm (60 mil) SentryGlas® + 0.5 mm ( $1/64$  in) perforated metal sheet + 1.52 mm (60 mil) SentryGlas®

+ 15 mm ( $19/32$  in) heatsoaked fully tempered glass. The Shanghai Oriental Art Center is the first use of this construction worldwide.

"The main reason for our selection, with architect Paul Andreu, of this laminated glass construction with SentryGlas® is the ability to use perforated metal of varying hole sizes and spacings - this was the technical blueprint to achieving the new and startling aesthetic the architect wanted. This particular distribution of hole sizes and spacings was used by the architect for solar heat gain reduction, as well as for decorative and aesthetic reasons. As a side benefit the perforated metal sheeting also blocks out mobile phone signals, which should be a great relief to SOAC patrons!

"Aesthetically and creatively, we have achieved the manufacture of a totally new type of laminated glass incorporating perforated metal sheeting - only made possible by the use of SentryGlas®."

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When LGN asked Mr Pan the benefits of SentryGlas® for the Shanghai Oriental Art Center's facade he cited four reasons: "First: the high structural integrity afforded by the high rigidity and strength of SentryGlas®. Second: in Florida (USA) testing, the interlayer has demonstrated no edge delamination after many years of exposure to highly humid conditions. Third, the structural interlayer also provides an effective UV barrier that prevents the ageing and discoloration known as 'yellowing'. Fourth, this laminated glass construction for provided the best light transmission of any construction tested!"

This is not the first time that SYP has used SentryGlas®. Mr Pan confirmed that his firm used the interlayer on other projects such as structural glass ribbing on the Shanghai Citibank Tower, completed 2004. However, of all the projects to date, the Shanghai Oriental Art Center is certainly the one he is proudest of. He summed up: "This has been a great project to work on and we could not have done it without Kuraray Glass Laminating Solutions. The business unit provided excellent support to us here in Shanghai, covering all our technical and supply chain needs. The service was outstanding!"

"According to what we have learned about SentryGlas® during the construction of the SOAC, and our knowledge of the Chinese construction market, SentryGlas® will be widely welcomed for its many breakthrough properties in Asia, especially for architectural construction regarding events like the 2008 Beijing Olympic Games and 2010 Shanghai World Expo."

Architect Paul Andreu on the Oriental Art Center, Shanghai: "(The Oriental Art Center)... something precious and mysterious must be happening inside, something at once solemn and joyous, something set here in the middle of the city like a familiar object, an object that is here for the sole beauty of the city and the pleasure of its inhabitants."

"At night the building becomes bright and transparent as if by magic. It shines like a light in the darkness. One can see all the people entering the building, moving about, climbing the stairs, spreading out in all directions around three interior volumes whose contrasting colors fade in the color of the ceiling as they rise. There is a sense of gaiety and brightness in the movements of the people, the colors and the lights."

"The Oriental Art Center of Shanghai: What is it? A place made for this calm, happy crowd. A place that the light opens up, and that you progressively enter, gradually approaching something important and simple, something that you love. It is, of course, a place of art, a place for exhibitions and performances."

"The three interior volumes that rise out of the base in which they are rooted, becoming lighter in color as they reach the ceiling, house three auditoriums. They house and protect them as one might protect a place that is precious and fragile. The common space around them, composed as a variation on the twin theme of transparency and curves, comprises an entrance lobby, lounges, the circulation space and exhibition areas."

Functionally and visually, this space links the auditoriums to the city, visible from everywhere, and to the surrounding landscape, the trees and the sky above.

"What is it? Simply this: a place for music. Covering very few square metres in a city where so much is being built every day, but encompassing so much happiness and enthusiasm. And, beyond the architecture, which is but a servant, plenty, plenty of music."

### Lighter façade panels enable more subtle supporting structures

For decades, interlayers made of polyvinyl butyral (PVB) have been the industry standard when producing laminated safety glass. Architects are well aware of the possibilities and limitations of such glass when used extensively in façade engineering, for roofing and window panels. In contrast, SentryGlas® enables an entirely new approach because the interlayer is over 100 times stiffer and five times stronger than PVB. As a consequence, there is an

almost perfect transmission of load between two laminated sheets of glass, even at high temperatures, leading to the excellent flexural behavior of the glass when under load - also under direct sunlight in high summer. Accordingly, laminates with SentryGlas® show less than half the rate of deflection when compared to laminates with PVB, when under the same load, and thus almost the same behavior as monolithic glass of the same thickness.

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As well as improved strength and stiffness, other benefits of SentryGlas® include:

- **Safety:** In the event of breakage, glass fragments remain firmly bonded to the interlayer, reducing the chance for injury
- **Security:** SentryGlas® can be used in glazing that withstands bullets, hurricane-force winds and even bomb blasts
- **Durability:** SentryGlas® is extremely durable and resistant to clouding, even after years of exposure
- **Design Versatility:** SentryGlas® can be used in glass manufactured flat or curved, including annealed, toughened, heat-strengthened, spandrel, wired, patterned and color tinted glass
- **UV control:** SentryGlas® is available with or without UV transmittance

**Architect:** Paul Andreu, Aeroports de Paris (ADPI)

**Laminator:** SYP

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