MEMBRANE REVOLUTION

Bart Miller from Walter P Moore discusses the future of transparent foil membrane technology in stadium design.

There is a "clear" trend in the design of major sports facilities toward lightweight, transparent, and translucent materials for roofing and façade applications.

From the most state-of-the-art facilities in the **National Football League** to new builds in **Major League Soccer** and at least three roofed ballparks now being proposed in **Major League Baseball**, transparent and translucent foil membranes are becoming the material of choice for top designers in our industry.

Ethylene tetrafluoroethylene (ETFE) in particular has captured the imaginations of stadium owners and designers.

ETFE roof and façade applications create that authentic, outdoor atmosphere in an indoor, conditioned space, providing a protected and temperature-controlled experience. Lightweight materials reduce structural support requirements and costs—especially for long-span roofs—and allow for lighter, often more elegant structures.

A clear but static roof eliminates the need for mechanisation and the operational and maintenance costs of a retractable roof solution. Finally, abundant natural light can reduce lighting and energy costs during operation.

Conventional ETFE also has some very significant limitations, including minimal mechanical strength and capacity to support environmental loads due to snow, ponding water, and high winds, resulting in closely-spaced structural elements and frequent cable reinforcement. ETFE exhibits poor or non-existent intrinsic thermal properties and must be layered and/or fritted, substantially compromising the desired clarity, to improve thermal performance. ETFE also has poor acoustic properties, creating challenges with sound management in large spaces.

Fortunately, revolutionary transparent materials are being developed to incorporate higher mechanical strength and better thermal performance. Researchers and material specialists at **Walter P Moore** are partnering with manufacturers to develop better solutions with each new project.

Utilising a variety of coatings, laminations, and new product applications, the next generation of transparent foil membrane technology will replace conventional ETFE materials with advanced, composite solutions that are customisable to any project.

Foil membranes that provide enhanced strength, clarity, thermal and acoustic performance, customisable colours, and even missile-impact resistance will expand the market into applications typically reserved for glass and metal panels, allowing designers to redefine what is possible in long-span and lightweight structures.

But why stop there? Creating composite cladding foil paves the way for technologies borrowed from aerospace, automotive, and other industries to be included within the material without sacrificing natural light.

Soon, membranes will incorporate nanoparticles to enable electrochromic technology for active shading, thermochromic technology for active infrared radiation reflectivity, active colour, and imaging—even transparent solar harnessing.

Electrochromic technology, which is currently used in energy-efficient "smart" windows in buildings and rearview mirrors in automobiles, will enable the transformation of membranes from transparent to opaque with electric current and could be used to black-out otherwise clear roofs for concerts or other live shows.

Thermochromic technology, which can selectively target specific wavelengths of infrared radiation, will control the transmission of solar heat while filling the space with the full visual spectrum of natural light.

Eventually, nanotechnologies employing particles triggered by surface temperature will enable venue owners in colder climates to allow heat to enter the space in winter, but then reflect heat in the summer, and those in warmer climates to allow latent heat built up during the day to escape during cooler night hours.

As light-emitting diodes (LEDs) become smaller and more efficient, nano-LEDs may be applied directly to a composite foil membrane. Organic light-emitting diodes (OLEDs), where the illuminating layer is a film that emits light in response to an electric current, may allow the material itself to become the light source.

As LED and OLED technology develops and is adequately scaled, image projection within the material may allow for branding, advertising, and even live-action broadcasting directly from the membrane.

Finally, transparent solar harnessing, which will essentially employ the entire membrane as a giant photo-voltaic panel, may eventually be used to supply energy for the entire venue and perhaps the surrounding community.

While there have been relatively few innovations in long-span roof design in the last several years that have significantly altered the landscape, materials research and development around lightweight, transparent roofing and façade materials may prove truly game-changing. ■

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