

HSS: DESIGNS FOR THE 21st CENTURY



Kimmel Center for the Performing Arts

A SOARING HSS BARREL VAULT



The Kimmel Center for Performing Arts in Philadelphia is a 450,000 square-foot structure designed as a public plaza for the arts. It houses the Verizon Theater, home of the Philadelphia symphony orchestra and the Perelman Theater for performing arts. The entire plaza is encompassed in a transparent barrel vault that soars 174-feet over the theaters. The ribs of the vault are comprised of 61,048 linear feet of structural steel tubing (HSS) which form 144 separate, but identical, Z-shaped trusses.

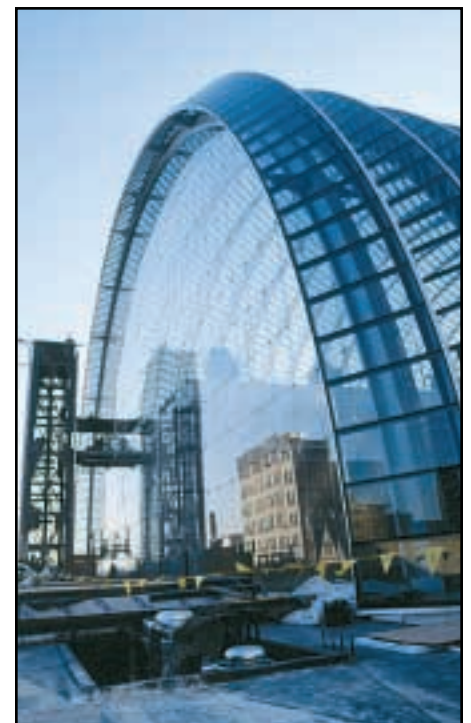
HSS Provided the Look and the Necessary Strength

HSS was selected because it provides a minimum of structure, therefore maximum transparency, and because it offers the torsional strength needed to resist the lateral forces of the wind, which push and pull on the sides of the structure, and also provide the support capabilities to handle the heavy dead load weight of snow on the roof of the vault during the winter months.

The vault is a transparent, folded plate-glass structure, a full city block long, whose ends form colossal glass arcs. It was conceived as an extremely light enclosure that was essentially invisible by the architect, Rafael Vinoly, who wanted a very light, thin structure and enclosure system.

At night, from a distance, the Center sparkles, giving passersby the impression they are looking inside through the facets of a cut diamond.

The bending, rolling and assembly of the HSS had to be very precise. The radius bending was done by Chicago Metal Rolled Steel and shipped to Boardman Steel in Youngstown, Ohio for fabrication. Tolerance was a critical issue. But the fabricator was able to provide a 1/16-inch tolerance by the invention of a precise jig. The finished arches were too large to be transported in one piece to Philadelphia, so they were divided into four sections, each 58-foot-long.



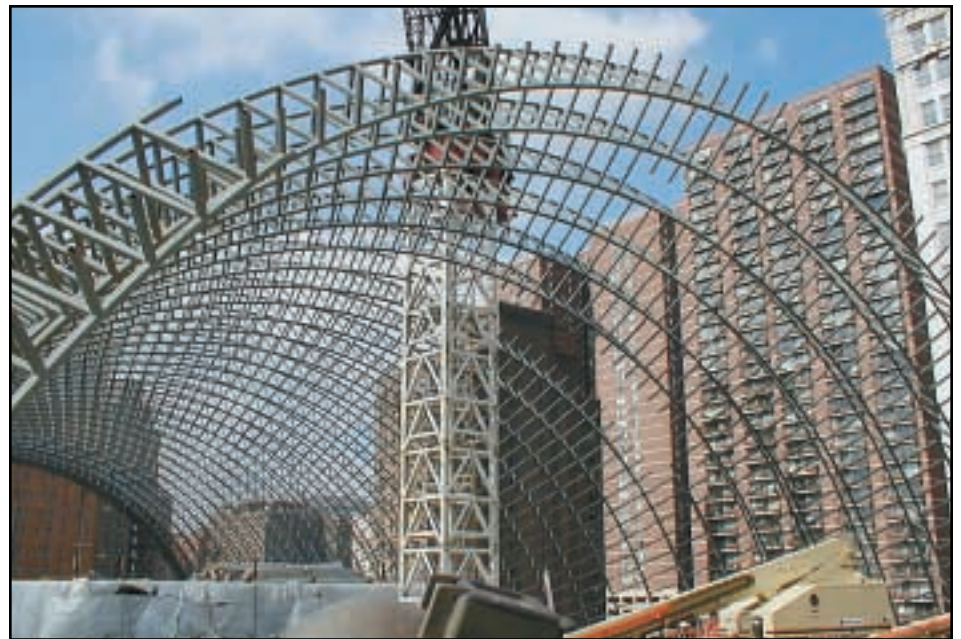


including the steel fabricators, agreed that the project would not have been possible without the use of HSS structural steel tubing. The material was not only cost-effective at the time of construction, compared to other options, but only HSS had the high strength required at minimal profiles to achieve the transparency and lightness so essential for the design. An additional factor was the complex geometry of the vault. The bending and connections would have been difficult if not impossible to execute with anything but HSS.



Unique Connections Allowed the HSS Sections to be Joined On-Site

The main stems of the arch are 5" x 5" square HSS. Four-inch by five-inch lengths of HSS were welded on for lateral connections. The lateral splice between the 4" x 5" HSS is a telescoping joint. This unique connection allowed the joint between the 4" x 5" "Z" ends to be completed on-site. "Blind bolts," similar to Molly bolts with a washer that spreads out and forms a friction fit, were used to lock the joint in place without distorting the side walls of the HSS tube. The arches were installed in sections, beginning at the spring points. The "keystone" pieces were then lowered



into place and welded.

Architectural Skylight, a company in Maine, was able to develop a skylight system that minimized the profile of the connection from the glass to the HSS tubing. The company also developed a machine with wheels that climbed mullion tracks on the outside of the vault to facilitate installation. The machine was later adapted for window washing.

Members of the Kimmel design, engineering and construction team,

