Gerald Ratner Athletics Center

Chicago

Photograph courtesy OWP/P

The University of Chicago Gerald Ratner Athletics Center is a $51 million state-of-the-art athletics facility with 150,000 sq. ft of health, fitness, and sporting activity space. The project is a "village" of athletic amenities that includes a competition gymnasium, an Olympic-sized natatorium, and other athletic spaces. The project features a first-of-its-kind asymmetrically supported cable-stayed structure that suspends S-shaped roofs over the large-volume gymnasium and natatorium spaces.

The primary structural challenge for this project was to develop the most efficient structural solution to fulfill the programmatic requirements for large volume column-free spaces on a restrictive site, while still meeting the university's design objectives and an aggressive construction schedule. Project requirements included the need for a "signature," architecturally expressive facility that would provide a flexible space to host athletic activities.

The cable-stayed structural solution gracefully supports the natatorium and gymnasium roofs with 10-story-tall masts. The elegant masts are among the tallest structures on campus, creating a campus landmark. The asymmetrical structure supports the roof loads from the "back" of the facility, allowing the community to experience the athletics center through large expanses of glass that abut the plaza and property line.

Juror Comment

"Elegantly detailed and fabricated—structurally ambitious and well considered."

The three-dimensional configuration of splayed cables at multiple levels makes this structure an engineering breakthrough. The structural solution adds a new classification of masted structures in the United States, providing a precedent for future structures with similar goals.

The structural solution for the gymnasium and natatorium space is a system of tapered composite masts, each supporting and stabilized by 15 splaying cables: 9 fore-stay cables and 6 back-stay cables, which in turn support the flattened S-shaped roof girders. The masts consist of three, 18"-diameter steel hollow structural sections (HSS) filled with high-strength concrete, arranged in a tapered, tied-column configuration. The non-linear analysis of the structure included a complex stability analysis for each of the masts, which are not symmetrically braced about their vertical axis, and are braced at multiple levels by tension-only elements of varying stiffness. Advanced dynamic and buckling analysis, including studies of several critical-mode shapes, were evaluated throughout the design process.

An innovative pumping technique was used to fill the masts with concrete.

Photo courtesy of OWP/P.

Each leg of the hollow mast is filled with 10,000 psi concrete, placed through "ports" located at the roof level. The cast-in-place concrete was allowed to free-fall 30′ to the base of the steel mast, and then was pumped up the remaining height of the in-place masts, past internal stiffeners located at the cable connections. This innovative approach to filling the masts reduced the possibilities of internal air pockets and voids. The horizontal HSS that tie the mast legs together were connected without gusset plates, transferring the cable forces through the masts in a clean and attractive fashion.

The use of multi-level splayed cables allowed the structural roof members to form a thin and uniformly curved roof plane only 33″ deep. The curved shallow members support a 7-1/2″ long-span metal roof deck that spans 25′ between the roof girders. The W33x169 girders are cold-bent to shape about their strong axis with reverse curves to multiple radii, and are suspended over the 160′ spans.

The curved roof planes are suspended from "full-lock" steel cables imported from Germany, which include three outer layers of interlocking Z-shaped wires specifically designed to minimize water infiltration and corrosion. Backstay cables stabilize the masts and transfer the roof load to massive concrete counterweights. The cable-stayed solution, along with a creative cable erection sequence that reduced the number of required shoring towers, reduced both construction time and cost of the overall project.

As with any cable-stayed structure, significant settlement of the masts could adversely affect cable tensions. This challenge was of particular significance on the Ratner Athletics Center given the soft-clay layer near the surface at the project site. To minimize and control settlement of the masts, ground improvements were necessary to transfer the large loads of the masts to a more suitable soil stratum. The improvements were achieved with triple-fluid jet grouting, an erosion-replacement grouting technique developed in Europe approximately 30 years ago, but used for the first time in Chicago on this project.

The project team was conscious of sustainable and environmental design opportunities. Environmental design considerations included the use of local suppliers and recycled materials. Structural steel, which is virtually 100% recycled material, was the primary structural building material. A fabricator located within 500 miles of the project site was awarded the project, minimizing transportation energy costs.

The Ratner Athletics Center makes a contribution to the advancement of structural engineering, and amplifies the role structural engineers play in the creation of innovative architecture. The building's structure is key to its architecture. The structural details are the architectural finishes, using circular base plates, acorn nuts, and sculpted gusset plates to create interest and aesthetic appeal. The Ratner Athletics Center offers a strong statement about the powerful architecture that can be created through mutual respect and collaborative efforts between architects and structural engineers. ★

Read more about the Ratner Center in the March 2004 issue of Modern Steel Construction *at www.modernsteel.com.*

Photo courtesy of LeJeune Steel Company.

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