spotlight

Gerald Ratner Athletics Center

By David E. Eckmann S.E., P.E., AIA and Stephanie J. Hautzinger S.E., AIA

The University of Chicago Gerald Ratner Athletics Center is a $51 million state-of-the-art athletics facility with 150,000 square feet of health, fitness, and sporting activity space. Located in Chicago, Illinois, the project includes a competition gymnasium, an Olympic-sized natatorium, and a myriad of other spaces that accommodate virtually any conceivable athletic pursuit.

The Gerald Ratner Athletic Center was presented a Merit Award (New Buildings over $30M) in the NCSEA 2004 Excellence in Structural Engineering Awards program.

Designed by internationally renowned architects Cesar Pelli & Associates, in collaboration with OWP/P, the project features a first-of-its-kind asymmetrically supported cable-stayed structure that gracefully suspends S-shaped roofs over the large volume gymnasium and natatorium spaces.

The primary structural challenge for this project was to develop the best and most efficient structural solution to fulfill programmatic requirements for large volume column-free spaces on a restrictive site, while still satisfying the university's high-quality design objectives. Project requirements included the need for a "signature" facility that would serve as a campus landmark, and provide functional space with the flexibility to host a variety of athletic activities.

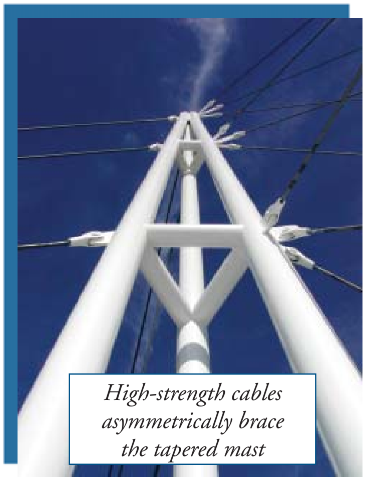
The cable-stayed structure gracefully supports the natatorium and gymnasium roofs with 10-story tall masts; the elegant masts are among the tallest structures on campus, successfully achieving the university's desire for a dramatic campus landmark.

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-inch diameter steel hollow structural sections (HSS) filled with high-strength concrete that are 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. Advanced dynamic and buckling analysis were also evaluated throughout the design process.

The masts incorporate new engineering knowledge, designing composite columns with greater lengths and using an innovative pumping technique to fill the masts with concrete. Each leg of the hollow mast is filled with 10,000 psi concrete, placed through "ports" located at the building roof level. The cast-in-place concrete was allowed to free-fall 30 feet to the base of the steel mast, and then was pumped *up* the remaining height of the in-place masts. This innovative approach to filling the masts reduced the possibilities of internal air pockets and voids.

The use of multi-level splayed cables allowed the structural roof members to form a thin and uniformly curved roof plane that is only 33 inches deep. The curved shallow members support 7 ½-inch long-span metal roof deck that spans 25 feet between the roof girders. The W33x169 girders are cold bent to shape about their strong axis with reverse curves to multiple radii using the latest steel bending technology.

The curved roof planes are suspended from "full-lock" steel cables imported from Germany, and include three outer layers of interlocking Z-shaped wires designed to minimize water infiltration and corrosion. 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.



High-strength cables asymmetrically brace the tapered mast

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 located 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 through the use of 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 Ratner Athletics Center makes a significant contribution to the advancement of the art of structural engineering, and amplifies the important role structural engineers play in the creation of innovative architecture. The structural details *are* the architectural finishes, using circular base plates, acorn nuts, and sculpted gusset plates to create interest and aesthetic appeal.▪

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