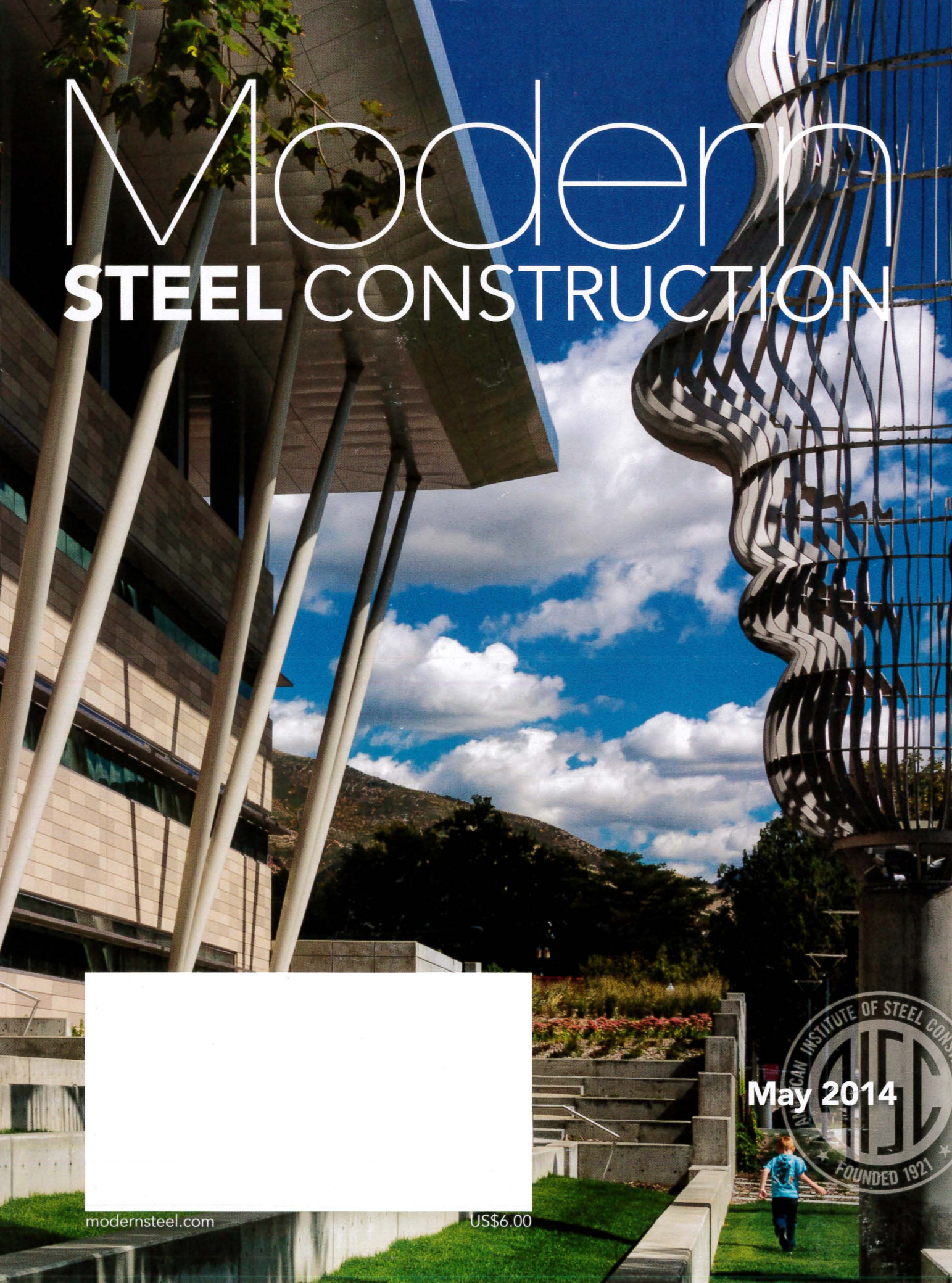
Modern STEEL CONSTRUCTION



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modernsteel.com US$6.00

A prominent structure in the San Diego skyline, this is a **monument to steel** as a building material, providing both aesthetic and functional benefits to the many patrons of this iconic library.

—Chad Clinehens

National Award—Less than $15 Million

SAN DIEGO MAIN PUBLIC LIBRARY DOME, SAN DIEGO

A 140-ft diameter post-tensioned steel-leaved dome serves as a beacon for San Diego's 10-story, $185 million downtown main library, and adds a new focal point to the city's skyline. Conceptual designs of the dome spanned eight years and explored six different circumferential and segmented options. The final scheme resulted in eight intersecting post-tensioned, moon-shaped truss elements with a saddle-shaped cable net on each. Adjacent to the dome, the vertical stair tower forms a strong structural core that anchors the two wings of the building. Thrusting outward and upward from this anchor are projecting triangulated arms that catch a few of the dome rib bases. The computer model of the dome enlisted more than 6,000 "tension only" members and required programs written specifically for post-processing filtering.

The dome, believed to be the largest steel post-tensioned segmental dome in the world, rises 221 ft above ground level to provide shade and acclimatize the reading room. It is constructed of more than 3,000 individual steel members, weighing 285 tons in all, and is clad in 1,500 perforated aluminum panels to shade the eighth floor reading room beneath it. The dome is made up of eight unique truss "ribs" that rise from base to apex in varying heights (from 72 ft to 113 ft) and eight "sail" structures located between the ribs.

Sails are oriented in plan with a pinwheel configuration, an effect created by offsetting each of the sails' vertical leading edges to the outside of the ribs, while the sails' trailing vertical edges are connected to the inside rib surfaces. Each sail has an external pipe grid that is spherical at the upper part of the dome. However, the spheres are tipped vertically and horizontally so the center of each sail does not coincide with the center of the dome. Unfurled, the largest sail is 123 ft by 53 ft wide and comprised of 175 HSS and 60 cable segments.

Due to its discontinuous circular form and peaked pinnacle, the dome behaves as a series of intersecting three-hinged arches. At the base, each rib is supported on a large pin that allows the ribs to rotate or expand with increasing temperature, and each pin falls on a fixed rectangular grid. Four of the sails were configured at equal plan angles and the other four were configured at different angles, giving a unique condition at each connection.

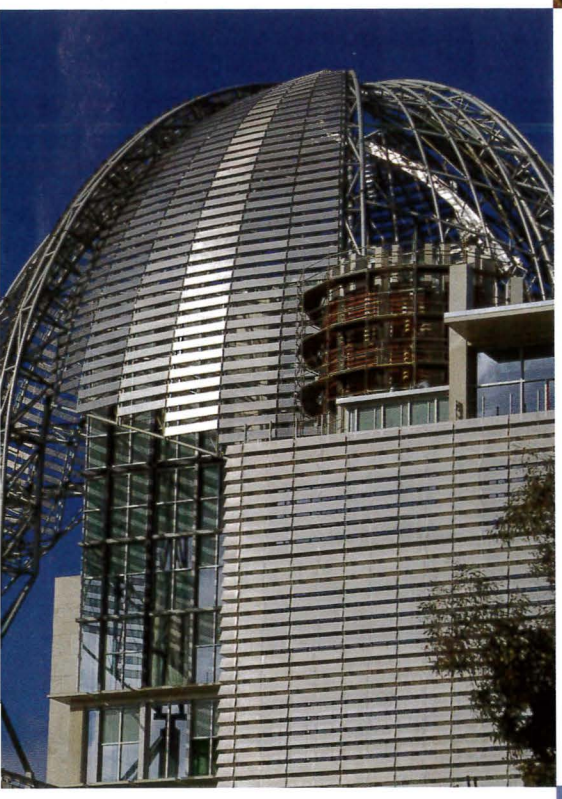
The erection process was challenging not only because of its inconsistent geometry, but also because large curved trusses had to be lifted and erected after their assembly. In addition, the fabricator and erector, SME Steel, expressed the desire to erect the sails in one piece.

Each sail was assembled with tubes, cables and intricate parts all welded and bolted on the ground. Due to the curvature of each sail, ground assembly would require temporary racks to support the sail parts. Furthermore, working off of aerial lifts would be both cumbersome and costly. Instead, a temporary ramp was proposed in order to hold the members in place and provide access for the work. The ramp followed, as closely as practicable, the curvature of the sails. The erection crew could then work on the decked platform under much safer conditions. Posts protruded through the deck, where needed, to support the shop assemblies that were shipped to the site.

Once the sails were assembled, they each needed a picking scheme. The upper end of the sail was ultimately hung with four lines when erected into the dome ribs. However, in order to get the sail into position, it required a second crane to lift it from its resting position on the sail rack. The lower crane was fitted with two rolling blocks on four lower pick points. Once the sail was high enough, the lower hook elevation remained constant as the upper crane continued

to lift, until the four upper lines were all engaged. The lower lines were then released so that the sail was hanging true, ready to erect.

Erection of the sails was expected to be difficult due to the many connection points between the two ribs. However, after the first sail was erected, more specific geometry checks were done on the racks before picking, and this eased the erection. SME planned its schemes well in advance with the erection engineering team, Hassett Engineering, Inc., and also included input from structural engineer Endrestudio, based on its knowledge of the analysis and final design. Many different options were considered, and collaboration was crucial for each step of the process. There was important constructive criticism given by the field crew throughout the assembly of this new San Diego landmark. The constant communication within the erection team greatly accelerated the erection process, allowing the project to be a success for all parties as well as the public. (For more on this project, see the November 2012 issue.)



Owner
City of San Diego Main Library, San Diego

Architects
Rob Wellington Quigley Architects, San Diego
Tucker Sadler, San Diego

Structural Engineer
Endrestudio, Emeryville, Calif.

Construction Engineer
Hassett Engineering, Inc., Castro Valley, Calif.

General Contractor
Turner Construction, San Diego

Steel Team

Fabricator, Erector and Detailer
SME Steel Contractors, Inc., West Jordan, Utah (AISC Member/AISC Certified Fabricator/Advanced Certified Steel Erector)

Bender-Roller
Albina Pipe Bending Company, Inc., Tualatin, Ore. (AISC Member)

Photographs
Rob Quigley - Rob Wellington Quigley Architects

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