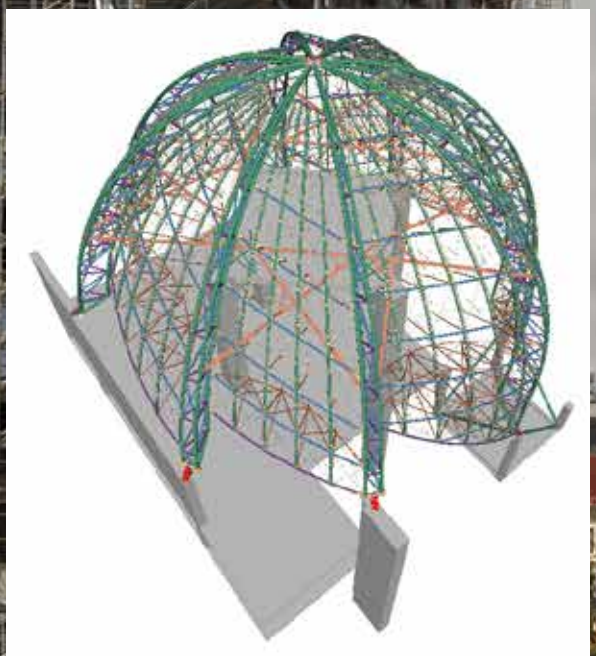
A steel-framed dome crowns the newly expanded San Diego Central Library and gives visitors something to look at besides books.

A (Reading) Room with a View

BY PATTY JOHNSON



THEY ALWAYS TELL YOU to keep quiet in the library.

But the reading room of San Diego's new downtown children's library, called the San Diego Library Dome, might elicit a number of "oohs and ahs."

That's because it's housed in a 140-ft-tall steel-and-glass dome, on top of a nine-story building, with magnificent views of downtown San Diego, the harbor and the Coronado Bridge.

The children's library is part of an expansion project that will add 498,000 sq. ft of space to the city's Central Library, effectively doubling the size of the current library. The new $185-million building will also feature a technology center, outdoor plaza and cafe, 350-seat auditorium, 400-seat multi-purpose room, teen center and two levels of underground parking. In addition, two floors of the library, totaling 76,000 sq. ft, will be used for a charter school serving up to 400 students. The building is also being designed and constructed to achieve LEED Silver certification.

The dome not only provides a beautiful reading environment but also a new architectural icon for the city. Comprised of steel sails with thousands of steel connection points to support the aluminum panel covering, which is perforated with thousands of light points, the dome's design allows natural light to illuminate the space below. Each aluminum panel is spaced with gaps on either side to allow for additional light to enter the building. Triangular Vierendeel trusses outline each of the steel sails, which connect to form an arch, with additional sails connecting below to form a secondary arch; Vierendeel trusses are ideal for such a structure as they allow fixed joints to resist or transfer bending moments or moments of force. More importantly, these trusses create an exterior envelope that made the creative interior lighting possible.

The dome required 285 tons of hollow structural sections (HSS) in all, and the largest steel sail measures 123 ft high and 53 ft wide. Each sail is comprised of multiple curved members, which are $6^{5}/_{8}$ in. in diameter and ½ in. thick. The largest sail has 59 curved members, 5 trusses, 20 spreaders, 102 stainless steel bars, 204 rod ends, 40 cables, 40 swage turn buckles, 40 swage ends and 20 spreader packs. Curved members lace the cross sections to form the eight 13-ton steel sails, which were individually hoisted into place. Roughly 60% of the sails were assembled in Utah prior to shipping, and the remaining sails were assembled on site. Vertical and horizontal pipe grid members create the two-parameter motion sail shapes, which appear to be torus-like in a ladder-type construction. The torus shape is created as the axis of revolution of the sails does not touch the circle; rather, the ring shape is implicit as it shifts downward to form a point. Interestingly, there is not a single coplanar straight line in this intricate design. The dome sits on eight custom rib seat sections that are anchored to the building. The interior sides of the sails include horizontal trusses to assist in lateral stability.

▲ The steel dome uses 285 tons of HSS in all. The largest steel sail measures 123 ft high by 53 ft wide.

◀ The children's library, topped by the San Diego Library Dome, is part of an expansion project that will add 498,000 sq. ft of space to the city's Central Library.

Model: A 3D SDS/2 model showing the sails and various other assemblies within the dome.

Photos: Courtesy of Michael Moore

Patty Johnson is the marketing director for SME Steel Contractors, Inc. You can reach her at **patty.johnson@smesteel.com**.

The dome is 140 ft tall.

One of the dome sections being lifted into place.

Special machined plate packs were developed for the dome. The packs accomplish two tasks: separation and point location restraint of the 5/8-in.-thick cables that give the sails the inside shape as well as provide tension. There are 608 individual machined plates, 152 spreader packs, 140 cable assemblies and more than 6,400 individual custom stainless steel hardware pieces. The spreader packs clamp the cable to the spreader bars, thus allowing the cables to separate to their required spacing, removing the possibility of friction between the cables and creating an appealing finished look. Every steel piece on the dome project is designated as architecturally exposed structural steel (AESS) per AISC. As such, each piece was sandblasted and hot-dip galvanized and connected via metalized field welds to create a structure that could withstand the elements; the only exception is the stainless steel components.

Given the complexity of the dome—it's approximately 181 ft in diameter with very few identical members—14 months of detailing were required to prepare 3,300 drawings. The structure took 27,000 labor hours to fabricate and more than 19,000 labor hours to field assemble and erect.

The lowest point of the dome is 108 ft off the ground, and the jobsite had limited staging area and is surrounded with constant pedestrian and vehicular traffic. Due to these constraints, a Liebherr LR 1300 crane was used as it has a 193-ft boom and 183-ft luffing jib for a total working reach of 185 ft. Two platforms were built and surfaced with metal decking in order to furnish a safe working environment and stable assembly platform for the ironworkers to use during the construction of the sails. A boom brace system was built to stabilize the cross sections and hold them in place until the sails were hoisted and locked into position. Additionally, a shoring tower was erected and placed under the compression ring to keep the center level and stable during the erection of the cross sections. One crawler crane and one assist hydraulic crane were used to lift the completed sails into place and remove them

Each steel piece was sandblasted, hot-dip galvanized and connected via metalized field welds to create a structure that could withstand the elements.

The structure took 27,000 labor hours to fabricate and more than 19,000 labor hours to field assemble and erect.

from the platform. Slowly, they were "tailed" into relative position before the final lift into the dome. (To tail a steel member, the piece is hoisted horizontally until it is lifted far enough off the ground to allow the crane to rotate the piece into its erected position without risk of damage.)

The dome topped out on July 3 and was completed on August 31. The new library is scheduled to open this coming summer. MSC

Owner
City of San Diego

Architect
Rob Wellington Quigley, FAIA, San Diego

Structural Engineer
EndreStudio, Emeryville, Calif.

General Contractor
Turner Construction, San Diego

Steel Team

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