Beauty and the Beast

Wild Beast Music Pavilion at the California Institute of the Arts (CalArts)

By Bruce Gibbons, P.E., S.E. CEng, LEED AP

Thornton Tomasetti, Inc. received an Outstanding Project Award for the Wild Beast Music Pavilion project in the 2010 NCSEA Annual Excellence in Structural Engineering awards program (Category – New Buildings under $10M)

Courtesy of Tom Bonner 2009.

Composer Morton Feldman used the metaphor "wild beast" to describe what he believed was the generative vigor within art. The new indoor-outdoor music pavilion on the CalArts campus in Valencia, California, is wild but welcoming, featuring a flowing, arched roofline. Positioned just inside the main campus entry, the new structure serves as a prominent gateway to the campus.

The Wild Beast's versatility expands the educational resources of the school. The venue functions as a classroom, as a 100-seat indoor music hall and, when the hangar-style doors are open, as an outdoor amphitheater with a capacity for up to 500 spectators. It can be used for instruction, rehearsal, performances and student gatherings. Through creative collaboration between the architect and engineer, the image of the project evolved from the client's functional requirements for additional classroom space for their music program into an iconic project that has now been adopted by CalArts as a primary symbol of artistic creativity.

LA-based architectural firm Hodgetts+Fung envisioned a space echoing the interior of a string instrument and called for a light and flowing roof form. This aesthetic goal required the structural engineer to optimize the balance between form and function, and two concepts were investigated with the goal to minimize the structural depth of the curved structure.

First, a system consisting of a concrete "sandwich" shell with a central styrofoam core and rebar "trusses" at 24 inches on-center in both the longitudinal and transverse directions was studied.

Alternatively, a system of longitudinal curved steel beams at the outer edge and valley lines supporting a composite deck with 3-inch shotcrete was studied. By providing fixity at the base and roller supports at the tip of the roof, it was possible to take advantage of the curvature to minimize deflection and bending in the members. The form of the curve was adjusted to maximize structural efficiency by balancing positive and negative moments, and this proved to be the most cost-effective solution.

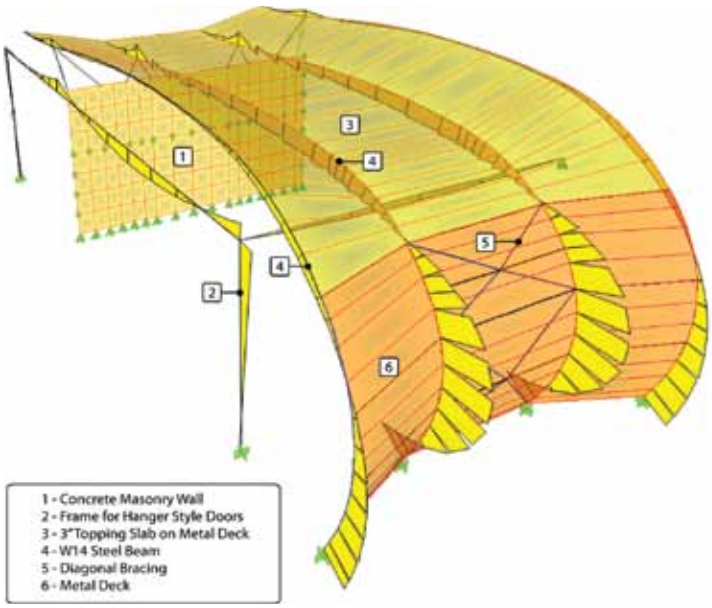

Diagram showing bending moments in primary structure due to gravity loads. Courtesy of Thornton Tomasetti.

The primary structure consists of four parallel ribs that spring up from the floor, arch over the space, and then rest lightly on a concrete masonry wall. These ribs – 14-inch wide-flange sections rolled the 'hard way' to radii as tight as 12 feet – achieve a 60-foot roof span. The shell's geometry was originally designed using NURBS curves and then rationalized into a series of segments with defined arc lengths and radii. Frame action is utilized where the roof is curved, transitioning to composite action where the roof flattens out.

Composite metal deck spans between the ribs, connecting to the webs of the two outer members to minimize apparent structural depth. High-strength concrete was sprayed on the outer face of the metal deck to provide acoustic mass and increase overall rigidity.

The structure's longitudinal lateral system comprises a series of curved cantilevered columns, although the struts at the end resting atop the masonry wall provide some additional restraint through frame action. During an earthquake, the structure will undergo lateral drift along its primary axis. The strut connections employ pins and clevises to allow out-of-plane rotation, effectively creating a horizontal roller joint that accommodates large drifts and minimizes load transfer to the cantilevered concrete masonry wall below.

The transverse lateral system is more rigid, with behavior similar to that of a concentric braced frame. The inclined struts at the cantilever end transfer lateral load directly from the roof diaphragm to the concrete masonry wall, and at the curved end diagonal bracing is provided between the relatively vertical portions of the W14 ribs, hidden behind acoustical panels.

The 600-square foot hangar-style doors were designed to be particularly heavy to provide acoustic mass. The door frame, requiring both vertical and horizontal stiffness, is formed from two side-by-side W24 beams welded flange-to-flange to form a flanged box beam, and braced out-of-plane at its corner by a single, wide-flange beam that doubles as rigging for spotlights and microphones.

Copper shingles, mullionless glazing and custom plywood panels give this building the refined finish it deserves. Together with the exposed structure, they form a unit that communicates the elegance of a musical instrument and the athletic poise of a wild beast.▪

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