Outside the Box

highlighting the out-of-the-ordinary within the realm of structural engineering

Figure 1: Exterior. © 2011 Elon Schoenholz Photography.

Walls of Sound

The New Sierra Vista High School Music Building

By Steve Ratchye, P.E., S.E., LEED AP

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Project Team

Structural Engineer: Thornton Tomasetti
Owner: Baldwin Park Unified School Dist.
Architect and Construction Manager: Osborn
Mechanical Engineer: S.Y. Lee Associates
Electrical Engineer: WBM & Associates
Civil Engineer: Barbara L. Hall, P.E., Inc.
Contractor: Harik Construction

The quest for exceptional acoustics pushed the design of the new Sierra Vista High School Music Building in unconventional directions. Warped concrete masonry walls improve the sound on the interior and reflect sunlight distinctively on the exterior (*Figure 1*).

The new 7,000-square-foot choral and band facility expands the music program of Sierra Vista High School, which is part of the Baldwin Park Unified School District. The City of Baldwin Park lies in the central San Gabriel valley, approximately eight miles east of downtown Los Angeles.

Acoustics dictated the design from the earliest stages of collaboration between Osborn Architects and Thornton Tomasetti. Corbelling the masonry walls outward to create warped surfaces minimizes standing waves and flutter echo. In addition, placing a service core between the two main rehearsal spaces and breaking the roof diaphragms provides sound isolation (*Figure 2*). The walls and slab on deck roofs supply acoustic mass to damp out exterior noise. High ceilings create enough space to aid in volume control. Ribbons of gypsum board that fold in a jagged geometry serve as sound diffusers and leave over forty percent of the ceiling open to acoustic absorbers above (*Figure 3*).

Structure

Walls typically hold up a roof but, in the new Music Building, the reverse is true as well. Gravity pulls the leaning walls outward, and the Music Building's roof holds them up by diaphragm redistribution of the tensile forces to the perpendicular walls. Additional reinforcement in the concrete slab-on-deck roof resists the dead and live loads due to the sloping masonry walls and also the high seismic forces characteristic of the Los Angeles region.

Each course of masonry in the warped walls is laid in a straight line, with the blocks plumb at one end and overhanging the block below by an inch at the other end. The resulting geometry creates a maximum slope of seven degrees.

The warped reinforced masonry walls, punctuated with openings for glass block, carry both lateral and gravity loads. The project was designed to the California Building Code 2001 version, which incorporates the Uniform Building Code 1997 seismic provisions with modifications. The code provisions are further modified by the Division of the State Architect, the California plan-checking authority with jurisdiction over schools.

The twelve-inch-wide masonry walls span one way from ground to roof, with fixity at the strip footings and lateral restraint at the

Figure 2: Cross section.

roof. Despite the slope of the walls, which creates gravity bending forces, seismic out-of-plane loads constituted the great majority of the force resisted by the double layer of reinforcing. The vertical construction joints, spaced roughly at thirty feet on center, are expressed on the building exterior.

Steel roof beams span between walls to carry the roof gravity loads. The construction documents showed economical, deep cellular beams with regular hexagonal holes and also wide flange beams as an alternate (*Figure 4, page 20*). The contractor selected the wide flange alternate and spent more money on steel due to concerns about schedule.

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Figure 3: Interior.

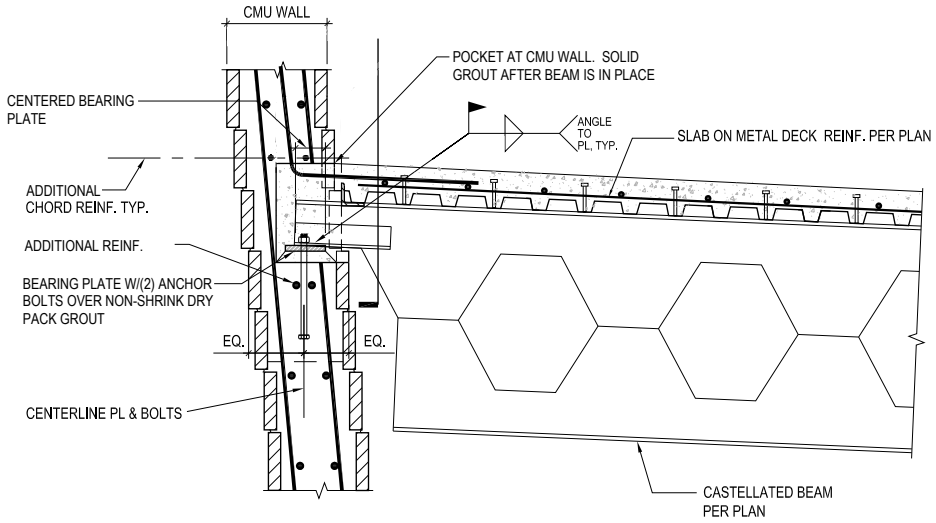

Figure 4: Castellated beam to sloped wall detail.

At corners, each plumb wall extends forward beyond its footprint in order to meet the wall that leans out. In this area, openings for glass block have been placed to let in natural light and also give architectural expression to the idea of the wall being "stretched" to meet the leaning wall (*Figure 5*).

Despite the fact that Pittsburgh Corning, the manufacturer of the solid glass block used for the Music Building, lists the compressive strength as 80,000 psi – higher than the yield strength of the steel used on the project – the glass masonry was not used structurally. The glass block windows were designed as openings in the walls, with horizontally reinforced bands of masonry at those areas bridging between strips of additional vertical rebar. The mortar by the glass block is reinforced by gage wire reinforcement.

Figure 5: Intersection of plumb and leaning wall with glass block.

At the interior, cold-formed metal studs form a framework to carry the faceted ribbons of gypsum board that stand in counterpoint to the gentle warp of the masonry walls.

The fact that the new wunderkind conductor of the Los Angeles Philharmonic, Gustavo Dudamel, is merely twenty-nine years of age at the time of this writing underscores the importance of music education. Hopefully the new Sierra Vista High School Music Building will serve the development of more great musicians.▪