Arizona State's new law school in downtown Phoenix continues the legacy of the Supreme Court justice who cut her legal teeth there.

LEGAL Lessons

BY JEFF THOMPSON, P.E., AND ERIKA YARONI

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THE FIRST WOMAN nominated to the Supreme Court of the United States now has her name on a law school in the city and state that launched her to national prominence.

The new Sandra Day O'Connor College of Law will expand Arizona State University's downtown Phoenix campus with a modern facility that connects students and faculty to the existing Phoenix legal community. The location couldn't be more fitting, as O'Connor served as Assistant Attorney General of Arizona, The new Sandra Day O'Connor College of Law will expand Arizona State University's downtown Phoenix campus with a modern facility that connects students and faculty to the Phoenix legal community.


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The facility's signature V-column, which supports the five stories above it.

the Arizona State Senate, on the Maricopa County Superior Court and also on the Arizona State Court of Appeals.

The 280,000-sq.-ft steel-framed building will include classrooms, offices, research clinics, a law library, a public cafe, a bookstore, the ASU Alumni Law Group and below-grade parking; these program spaces are configured in six stories above grade and two below. Prominent architectural features include stacked double height spaces located in the heart of the building, a 250-seat auditorium with a retractable seating system and facade system on level 1, the law library on level 3 and a shaded exterior roof courtyard on level 5. An indoor/outdoor continuous circulation track at each level connects the east and west portions of the building with pedestrian bridges, and a canyon-inspired outdoor pedestrian promenade traverses through the site at level 1, providing sight lines into interior spaces and a public face to the law school.

Building Blocks

The design was completed within one year to meet an aggressive fast-track schedule, with construction beginning in the summer of 2014 and being substantially completed last month. A steel structure was the ideal solution to meet programmatic requirements for long-span, column-free interior spaces that maximize the clear floor-to-floor height. The steel superstructure uses composite slab construction with typical bay sizes ranging from 24 ft by 35 ft to 24 ft by 50 ft. A 3-in.-deep metal

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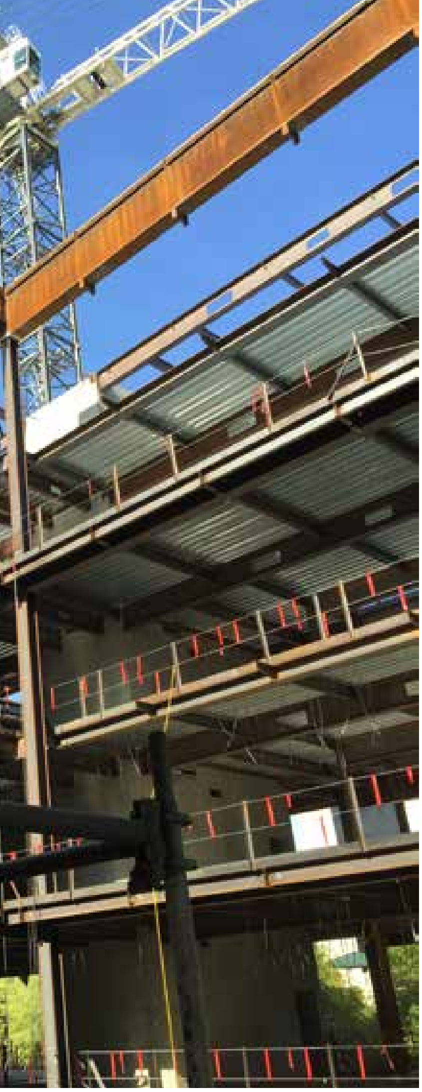
deck with 4½-in.-deep normal-weight topping slab is supported by composite wide-flange beams and girders spanning to steel columns. Lateral stability is provided by six 12-in.-thick concrete cores located at egress corridors and elevator shafts. Embed plates are used to connect steel floor framing into the cores and drag diaphragm loads into shear walls.

Approximately 1,750 tons of structural steel in the form of approximately 3,000 members is used above grade. The structural steel design features suspended outdoor pedestrian bridges linking the building across the "canyon," a sloped exterior V-column supporting five stories above and a roof diaphragm truss to support a fabric canopy shading system over the courtyard.

Bridging Education

Five stories of suspended, open-air pedestrian bridges span approximately 60 ft to 75 ft connecting the east and west portions of the building. The bridges are part of the main horizontal circulation corridor and stitch together important interior programmatic spaces. Each bridge will be clad in an architectural mesh serving the dual purpose of providing fall protection and allowing the opportunity for programmable content to be displayed via LEDs embedded in the mesh. Structurally, the bridges presented multiple technical challenges, including providing adequate redundancy for five stories of stacked bridges supported from the roof level, linking buildings together with different stiffness properties, minimizing thermal bridging between interior and exterior steel and meeting strict vibration criteria to ensure pedestrian comfort.

The bridge deck is formed by a composite metal deck supported by steel stringers and beams with diagonal angle bracing to provide lateral stability. Moment-connected W12 secondary beams with tapered outriggers span between con-



▲ Erecting the pedestrian bridge.

▼ The angle of each leg of the V-column was determined by equalizing the horizontal thrust forces resulting from dead loads transferred from the columns above.

◄ Thermal break isolation (at center of photo) between steel elements.

tinuous W14 bridge stringers. Outriggers are field welded to continuous 3-in.-diameter high-strength rods spaced at approximately 7 ft on center and hung from built-up steel box beams at the roof level. To provide redundancy, the stringers were engineered using heavy W14 column sections to support bridge gravity and live loads without the use of hangers. Fabreeka bearings at each end allow stringers to translate longitudinally and rotate to accommodate thermal expansion/contraction and differential building movements. The bridge was designed to achieve a vertical natural frequency of 5 Hz through the combined stiffness of roof supports, bridge stringers and high-strength hanger rods. The bridge deck was shop fabricated and fully assembled by Able Steel Fabricators before being shipped to the site, where it was erected and supported by a temporary tower until hanger rods were field welded into position.

Balancing Act

An exterior double-height V-column supporting five stories of the west building forms a unique architectural feature at the northwest corner of the site. The column base connects to the plaza at a single point, minimizing the amount of structure touching the ground and opening the building to the canyon space beyond. A tiered outdoor seating area wraps the column base providing a shaded public space, which will be furnished with tables and benches. The V-column included unique technical challenges such as optimizing the geometry based on the applied loading and minimizing thermal bridging between interior and exterior steel in the level 3 soffit.

Each leg of the column is formed by sloped W14×426 members welded to the underside of a W30 beam acting as a tension strut. The top of the column aligns with vertical columns above level 3, and the base is supported by a concrete column within the plaza podium structure. The angle of each leg of the V-column was determined by equalizing the horizontal thrust forces resulting from dead loads transferred from the columns above. Live loads are assumed to be unbalanced with the worst-case design condition of one column unloaded and one column fully loaded. Unbalanced horizontal thrust forces are resolved at level 3 by a steel diaphragm truss formed from wide-flange floor beams and HSS diagonals, which connect the V-column to a concrete core to provide stability. Shock Isokorb thermal breaks are located at all steel beams and braces spanning from interior to exterior space as well as the structural slab at the level 3 soffit, and insulation and a topping slab above the level 3 structural slab form the climate barrier between the interior and exterior space of the soffit.

Floating Shades

A PTFE fabric shading canopy spans the north-south direction approximately 80 ft across the level 5 exterior courtyard of the east building. The canopy provides shade for added thermal comfort in addition to creating a unique 3D sculpture. Canopy catenary cables are attached to triangulated steel trusses located above the roof level on both sides of the courtyard. Large horizontal truss reactions are taken into the base building through two 14-ft-deep floor diaphragm trusses that span 90 ft to 170 ft between concrete shear walls under the roof structural slab. Canopy truss reactions were coordinated to coincide with roof diaphragm truss panel points, and truss chords were formed using a combination of wide-flange roof beams and W14 sections, with HSS forming the truss diagonals. To provide added redundancy, the composite roof slab was also designed to resist the canopy reaction loads.

The project is currently scheduled to be completed for the fall 2016 semester at ASU. The final design will provide a new landmark for ASU's downtown campus, further enhancing the existing urban fabric for both students and public alike, and paying homage to the legal legacy of its namesake.

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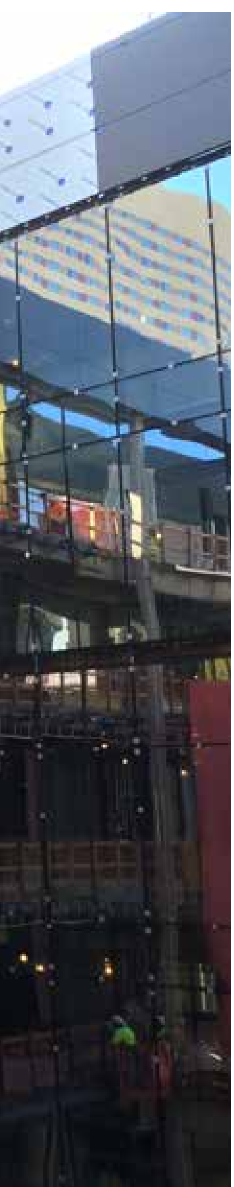

▲ The "canyon."

◄ The southern pedestrian bridges.

► The V-column prior to cladding.

▼ A Revit 3D model of the building.