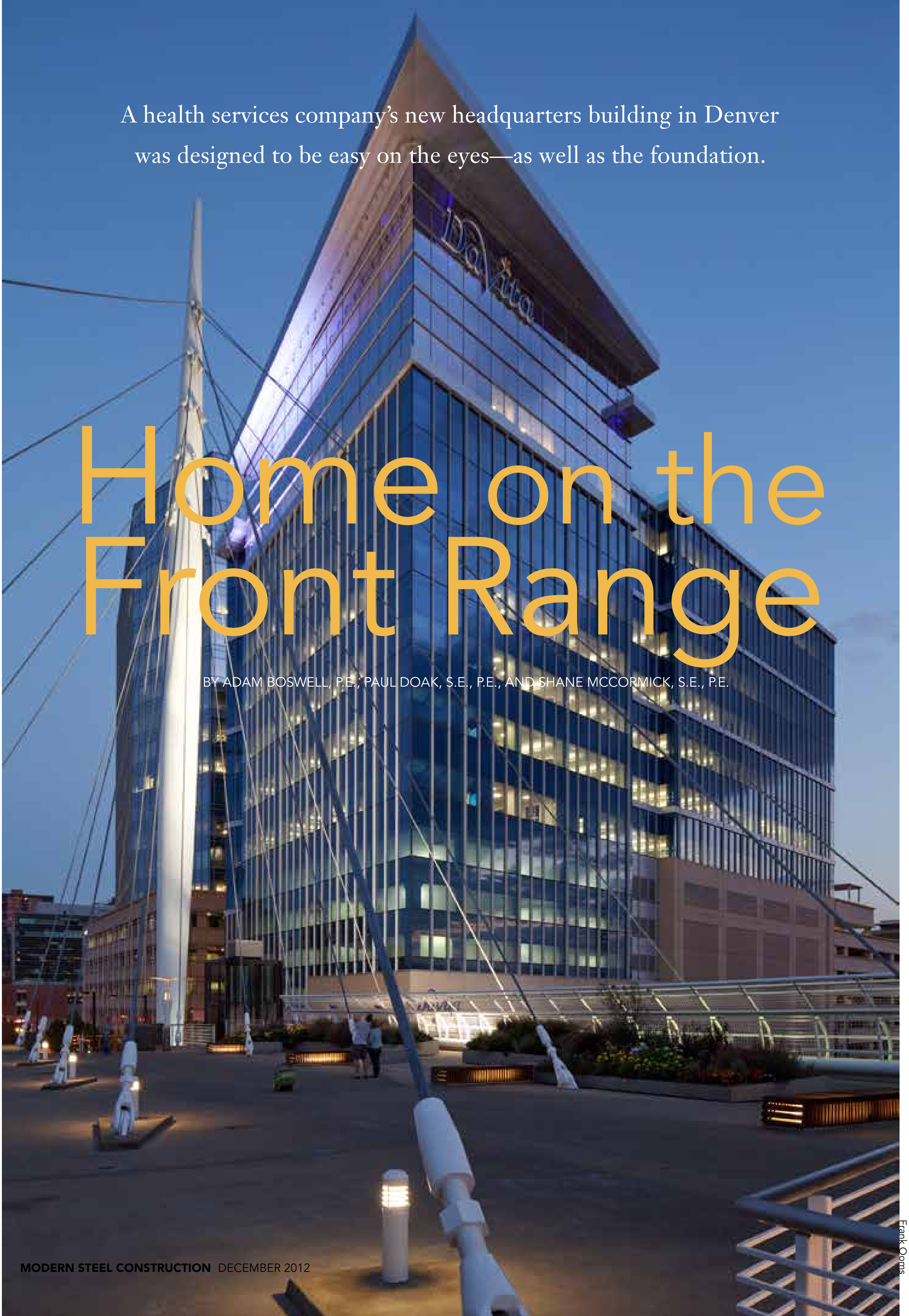


A health services company's new headquarters building in Denver was designed to be easy on the eyes—as well as the foundation.

Home on the Front Range

BY ADAM BOSWELL, P.E., PAUL DOAK, S.E., P.E., AND SHANE MCCORMICK, S.E., P.E.

Frank Ooms

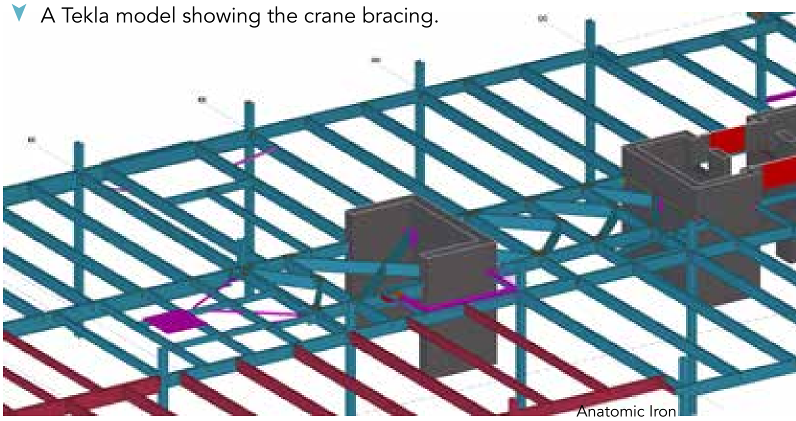
Martin/Martin, Inc.

Martin/Martin, Inc.

▲ Crane bracing built into floor framing.

◄ Aspen tree art fabricated from 8-in., 10-in. and 12-in. HSS.

▼ A Tekla model showing the crane bracing.



Anatomic Iron

EVERY COMPANY has different priorities when it comes to choosing a location for a new headquarters.

For DaVita, a company that provides kidney dialysis services, it was a matter of finding someplace that meshed with its corporate culture of creativity, teammate well-being and interaction on all staff levels. The company determined that Colorado's environment, and the active lifestyle it promotes, was a natural fit for the company, and recently opened its new world headquarters building in downtown Denver (its previous headquarters were in El Segundo, Calif.).

The 215-ft-tall building, adjacent to Denver's Union Station and the signature cable-stayed Millennium Bridge, was designed as a rhomboid in plan. DaVita hired MOA ARCHITECTURE to design the building due to its collaborative approach to projects. The building includes primarily office space for company management but is also a training and education facility, where teammates from all over the country will come to learn key elements of the business, including clinical instruction as well as management and leadership skills. Accordingly, MOA envisioned a building with unique teammate gathering places

Adam Boswell (aboswell@martinmartin.com) is a professional engineer, **Paul Doak** (pdoak@martinmartin.com) is a principal and **Shane McCormick** (smccormick@martinmartin.com) is an associate, all with Martin/Martin.

◄ The 215-ft-tall building was designed as a rhomboid in plan.

The building includes five levels of precast-framed parking space, seven levels of steel-framed office space and an upper steel-framed marketplace/cafeteria level.

scattered throughout, the crown of which is the marketplace/cafeteria level on the top floor that includes a 5,600-sq.-ft exterior terrace and an 8,000-sq.-ft dining and assembly area with sweeping views of the Rocky Mountains and Denver skyline.

The building includes five levels of precast-framed parking space, seven levels of steel-framed office space and an upper steel-framed marketplace/cafeteria level; in total, the structure incorporates approximately 1,750 tons of steel. Using structural steel framing, as opposed to concrete, at the top half of the building reduced the dead load on existing foundations. It also helped with erection sequencing. Site constraints required the contractor to phase the construction sequence, so a structural steel truss was built into the steel floor framing to brace one of the tower cranes since the partially constructed floor diaphragms were not suitable. Steel is prominently used in many of the building's architectural features as well. Within the building there are three winter garden spaces used not only to provide circulation to adjacent floors, but also to provide places for teammates to pause and interact throughout the day. The winter gardens feature custom steel stairs as well as steel serving as art. In addition, the steel-framed roof is made of two sloping planes; the highest plane cantilevers out to create the building's signature element.

Fitting the Foundations

The structure is built on an existing platform at Denver's Block 19 development. Existing foundations, columns and core walls were originally designed for a building having heavy mass elements in different areas from the initial proposal for the DaVita headquarters. To keep the building design true to the architectural vision, the design team evaluated both the capacity of and demand on the existing foundations. For gravity loads, initial designs showed that most of the existing columns and drilled piers lacked sufficient capacity for the new building. Several measures were taken to minimize gravity loads and reduce demand on the existing structure: steel framing was used from the seventh floor up to the roof; lightweight precast concrete framing was used in the parking garage (levels two through six); and 5¼-in. lightweight concrete composite metal deck slab was used at the office levels. After reducing the loads and accounting for actual in-place material strengths, six drilled pier foundations were still deficient. New 7⅝-in. micropiles embedded 25 ft into bedrock were coupled with the existing piers using 12-ft by 12-ft by 6-ft, 6-in. pier caps to add more capacity to the deficient foundations. This was accomplished by first excavating around the drilled piers and installing two to six micropiles, depending on how much additional capacity was needed. The piles and pier cap were then linked to the drilled piers by a 2-in.-deep by 2-ft, 3-in.-tall key and (70)¾-in. by 26-in. dowels installed in the existing pier.

Though the new building shape is different than what was initially planned to sit upon the foundation, the existing cores were extended vertically and used for the lateral system. Rigorous analysis was used to evaluate the interface between the new tower and the existing platform, accounting for actual diaphragm stiffness and shear interaction between the interior core walls and exterior foundation walls, in order to verify that demand on the existing walls did not exceed their capacities.

Construction was phased to allow the operation of existing Regional Transportation District's light-rail tracks, which run through the northwest corner of the building lot. Phase 1 included 75% of the floor plan, and phase 2 followed with the other 25% after the rerouting of the train tracks. The general contractor had an aggressive schedule to get the headquarters occupied by the summer of 2012. Two tower cranes were used for erection; one was located during the first phase and was braced directly to one of the concrete cores, while the other crane was located during the second phase. In order to brace the second tower crane during construction, a steel truss (made primarily from W24×55 with ¾-in. gusset plates and A490 bolts) built into the floor framing was supported by two of the concrete cores and cantilevered 45 ft out from the Phase 1 construction. The truss beams were left in place and are now visible in parts of the building.

Gardens of Steel

The building includes three, two-story seasonal garden spaces—all different designs. Custom steel stairs wind through the gardens and connect the floors. Each stair is different in directional flow, and because each has some part exposed, HSS members were used for the stringers; all stair framing was designed for a frequency of 8 Hz. In one garden (between the 10th and 11th floors), 8-in., 10-in. and 12-in. HSS was crafted and arranged to make it appear as if teammates are passing through an Aspen grove as they move from one level

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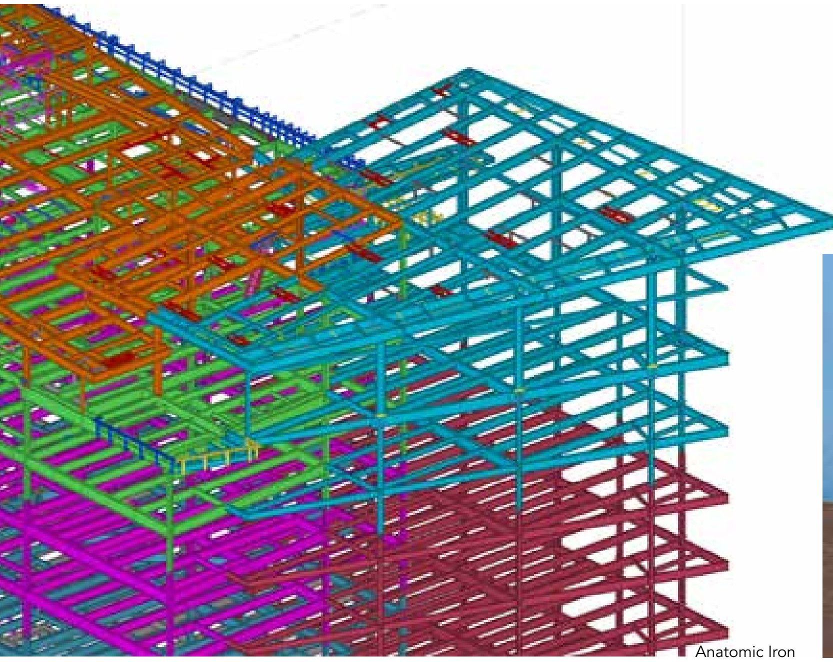
to another. The steel "trees" were provided by a local artist, and engineers provided special details at the top for lateral support while accounting for deflection of the floor above. In another garden, a retired gondola from a Colorado ski resort (Keystone) was refurbished and cantilevered over the space from the floor framing, and provides a unique space for teammates to hold a small meeting. Architecturally exposed HSS provides a support frame, and the feet on the gondola were replaced with ⅝-in.-diameter threaded rod for vertical adjustability to provide flush alignment with the finished floor. At the upper marketplace/cafeteria level, an outdoor terrace faces west with unobstructed views of the Rocky Mountains, and a sloping 12-ft to 26-ft-high glass wall separates the interior space from the terrace. The tallest sections of the wall are braced by exposed HSS16×8 girts, and as a finishing touch, the girt supports were also left exposed with the DaVita star etched into the side. In the main lobby, an interior canopy, supported by four HSS 10×4 members, cantilevers over the main desk, mirroring the headquarters' signature roof.

One of the headquarters' signature architectural elements is the roof, where two sloping roof planes cantilever beyond the building face. This primary cantilever serves as a landmark element and embraces the Millennium Bridge mast. The prominent position of the space presented many design and construction challenges. One challenge was that the roof planes are elevated above the main roof diaphragm and do not connect to the main building core walls. Careful architectural detailing gives the impression that the roof planes float above the 28-ft-high curtain wall. To address this, wide-flange steel shapes were welded together to create cruciform columns that act as moment frames around the perimeter and also resist out-of-plane loads from the curtain wall. Another challenge was that the roof's northwest corner projects to a point 20 ft beyond the building envelope. To allow for a prominent column-free space in the office levels below, there is no corner column below the cantilever, so the roof beams create a 35-ft, double cantilever frame (figure 4). The roof depth was architecturally sensitive, so engineers used heavy W27 sections for the cantilever framing to keep the profile within the desired depth and provide necessary stiffness.

Because of the sensitivity of the roof profile, it was imperative to maintain tight construction tolerances, especially at the cantilever. The steel detailer modeled the steel in 3D using Tekla to capture the complexity of the steel connections and geometry. The erector kept the steel within specified tolerances by creating a cable-stayed rigging system from the roof beams and lifting the cantilevered corner to the correct elevation. Once it was in position, the welded moment connections were made. The general contractor carried out considerable coordination for window washing supports, roof soffit framing and curtain wall connections to ensure that everything fit the steel framing and remained within the soffit depth.

Notable from a detailing point of view was the deep coordination required between the detailer's model and the precast contractor, the window washer davit supplier and the supplier of the façade access monorail system. In many instances while coordinating these complex scope items, quick decisions and revised details were needed to be scrubbed into the model by the detailer without delaying the construction schedule. Only close cooperation between the design team, GC, fabricator, detailer and these other trades, along with the use of advanced Tekla revision management software tools, made this coordination successful.



Anatomic Iron

◂ Anatomic Iron used Tekla to help with the complex detailing at the roof.

▾ The structure incorporates approximately 1,750 tons of steel.

Frank Ooms

Steel provided different solutions from the foundations to the roof. It saved cost and time at the existing foundations by reducing the dead load, it serves as art in the seasonal gardens and it creates a signature crowning element for the headquarters, providing a recognizable, eye-catching focal point for DaVita's new home. MSC

Owner
DaVita, Inc., Denver

Architect
MOA ARCHITECTURE, Denver

Structural Engineer
Martin/Martin, Inc., Lakewood, Colo.

General Contractor
Saunders Construction, Inc., Centennial, Colo.

Steel Team

Fabricator
Zimmerman Metals, Inc., Denver (AISC Member/AISC Certified Fabricator)

Erector
LPR Construction, Loveland, Colo. (AISC Member/AISC Certified Erector)

Detailer
Anatomic Iron Steel Detailing, North Vancouver, B.C. (AISC Member)