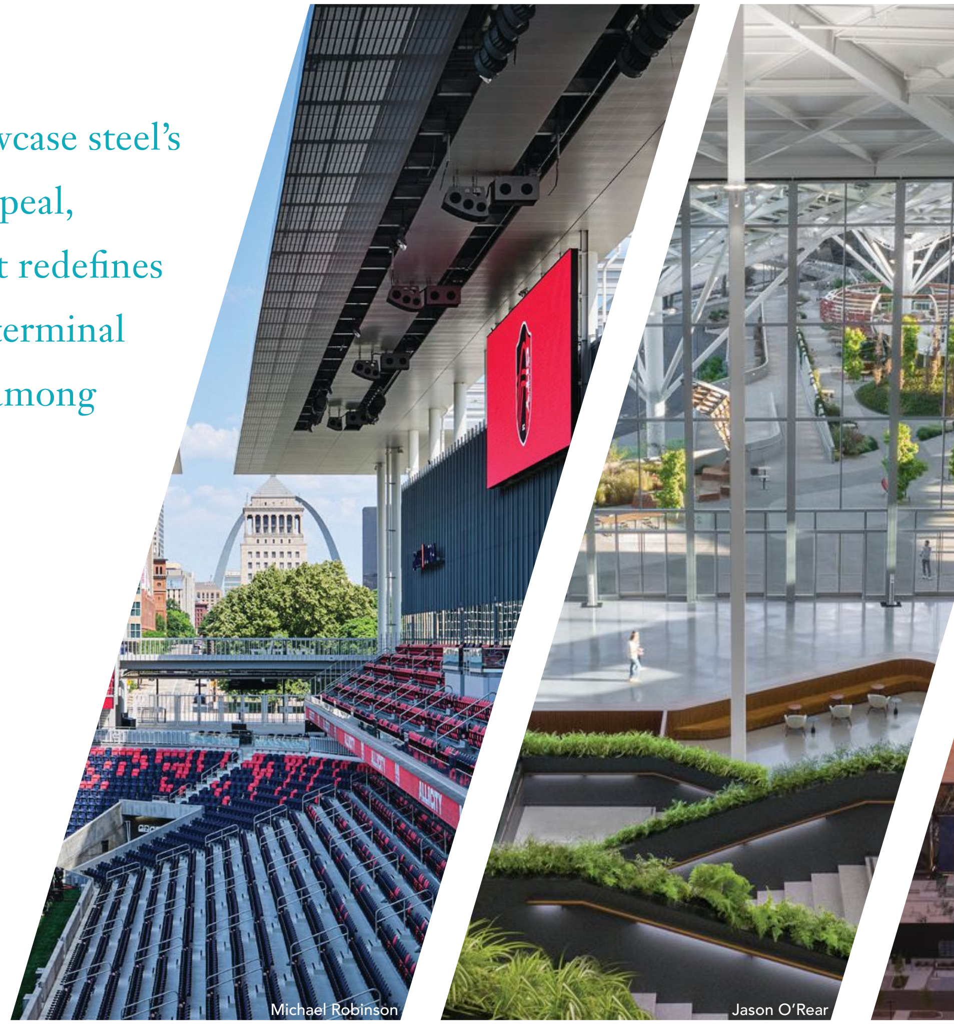
Two soccer stadiums that showcase steel's architectural and structural appeal, a vertical campus building that redefines mixed-use, and a new airport terminal that honors its home city are among the six structures to win 2024 AISC IDEAS² Awards.



Michael Robinson

Jason O'Rear

Super Six

SIX NEW STRUCTURES have joined a reputable and respected club: winners of an Innovative Design in Engineering and Architecture with Structural Steel (IDEAS²) Award.

Presented annually by AISC, the IDEAS² awards recognize projects that illustrate the exciting possibilities of building with structural steel and highlight how steel can help express architectural intent while harnessing its unique advantages for simple and complex structural systems.

The awards showcase the innovative use of structural steel in:

- the accomplishment of the structure's program
- the expression of architectural intent
- the application of innovative design approaches to the structural system
- leveraging productivity-enhancing construction methods

All entries must meet the following criteria:

- New buildings, expansions, and renovation projects (major retrofits and rehabilitations) are eligible. There is also a category for sculptures, art installations, and non-building structures.
- Building projects in the 2023 competition must be in the U.S. and must be completed between January 1, 2021, and September 30, 2023.
- A significant portion of the framing system of a building must be wide-flange or hollow structural steel sections (HSS).
- Most of the steel used in the project must be domestically produced.
- The project must have been fabricated by a company eligible for AISC full membership. Projects with a unique or distinctive feature fabricated by a company eligible for AISC full membership will also be considered.
- Pedestrian bridges entered in the competition must be an intrinsic part of a building and not standalone structures. We encourage members of project teams for standalone bridges to enter the 2024 National Steel Bridge Alliance's Prize Bridge Awards.

Previously, awards were based on budget categories. The 2024 jury, though, wanted to find projects that took full advantage of specific benefits—sustainability, cost, speed, reliability, and resilience—that make structural steel the best choice for designers. Many winners are landmark structures, but the awards program also honors smaller, less well-known projects. All winners share a commitment to innovation and imaginative design.

Tom Harris Jordan Powers Turner Construction Company

Two projects won awards for excellence in architecture, two more won excellence in engineering, another won excellence constructability, and another won excellence in sustainable design and construction. Another category, excellence in adaptive reuse, did not have a winner this year.

The 2024 winners are a mix of aesthetically appealing structures and captivating additions to existing buildings. Two new structures are stadiums that house new Major League Soccer teams, one in St. Louis and one in Nashville, Tenn. Each venue sought to inject more life into a neighborhood and create an inviting community space, with steel an instrumental piece in the latter part.

Nashville is home to another winner: the new terminal lobby and international arrivals facility at Nashville International Airport. The primary element of the project is a new roof that pays homage to the Music City and creates an inviting space for passengers.

Elsewhere, a new corporate headquarters in Santa Clara, Calif., with glass walls from ceiling to floor is an innovative workspace with ample natural light and aesthetically appealing exposed steel. Creative and complex engineering allowed several different facilities—from a gym to host basketball games to student residences—to fit into one New York University building. Finally, a pedestrian bridge linking a new hospital with an existing one demonstrates clever engineering and was erected in little time.

Those six projects were deemed winners by a six-person jury:

- Eddie Jones, FAIA, founding principal, Jones Studio
- Max Puchtel, SE, PE, LEED Green Associate, director of government relations and sustainability, AISC
- Larry Rickels, PE, principal, Datum Engineers
- Brian C. Smith, vice president, Doing Steel Fabrication
- Jay A. Taylor, SE, PE, Hon AIA Sea, senior principal (retired), Magnusson Klemencic Associates
- Hannah Valentine, PE, structural steel specialist – Los Angeles, AISC

Read on to learn more about and see fantastic images of all this year's winners.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION
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2024 IDEAS² AWARDS

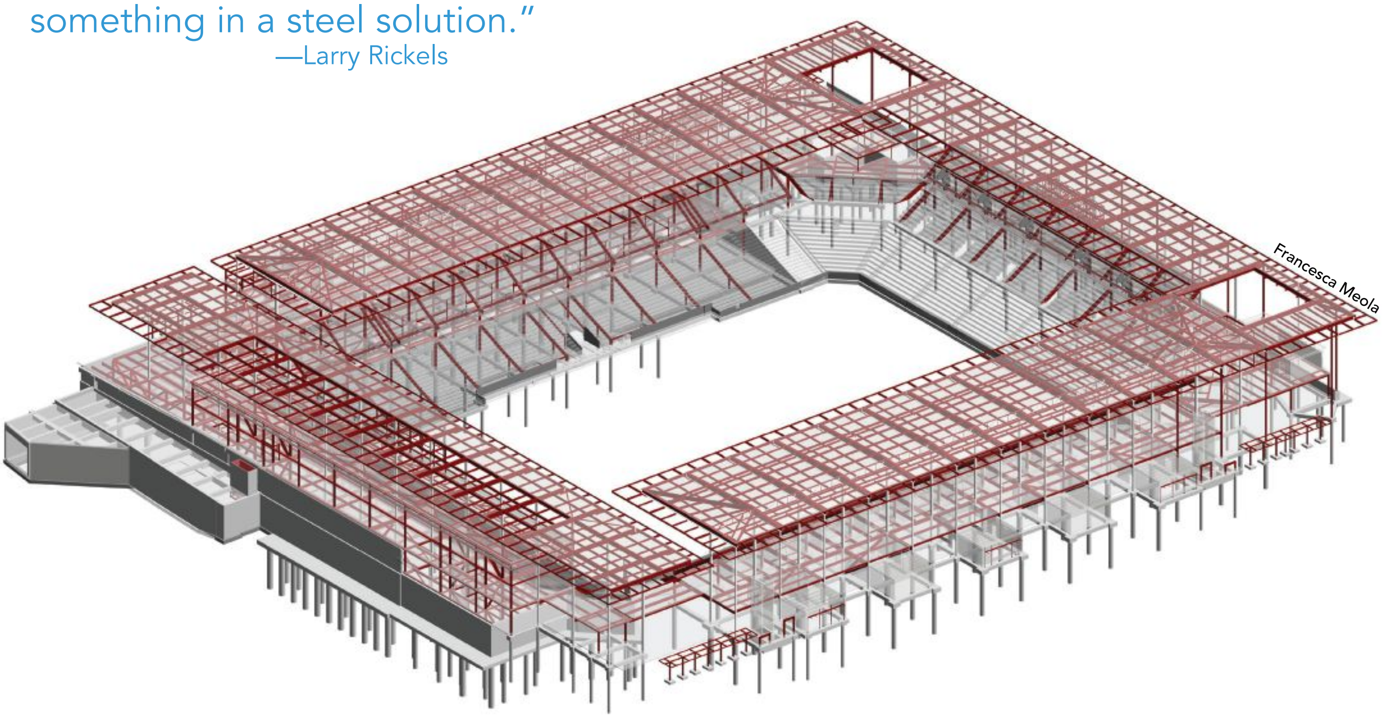
Michael Robinson

Michael Robinson


“It looks extremely efficient with its sharp edges on the roof, thin columns, and long cantilevers. It’s sleek and unadorned. We’re always impressed with how thin you can make something in a steel solution.”
—Larry Rickels

2024 IDEAS² AWARD

EXCELLENCE IN ARCHITECTURE
CITYPARK, St. Louis



THE OWNERS of St. Louis CITY SC, a new Major League Soccer franchise in St. Louis, envisioned more than a stadium when considering their club’s future home venue. They aimed to create a vibrant mixed-use stadium district in the city’s Downtown West neighborhood that impacted the area beyond game days.

Their vision birthed 22,500-seat CITYPARK, designed to fit comfortably into its urban neighborhood. The stadium is across the street from historic Union Station and at the end of the Gateway Mall, linking the stadium to the Gateway Arch and Mississippi River through a stretch of green and public spaces. Its compact, transparent form allows views into the pitch from surrounding streets and views of the city from the seating bowl. The main concourse aligns with the west end of the Gateway Mall, extending the urban fabric into the stadium.

The stadium exterior features glass, metal panels, and stone walls. Open concourses promote movement and social spaces, with ground-floor retail and gathering spaces further integrating the venue into the neighborhood. All four sides of the stadium are open and inclusive, welcoming fans from every direction. The stadium corners’ openness serves a dual purpose: draw people together during games and create flexible plazas for non-gameday community events. Both align with the vision of enhancing Downtown West.

The design features a flat portico, cut-out corners, and slender columns framing the upper seating bowl. A flat canopy was fabricated from material that reflects light similarly to the Gateway Arch. The canopy, spanning 120 ft with a 25-ft backspan, protects fans from the elements while letting in daylight, amplifying fan noise, and creating a sense of enclosure to focus attention onto the field. The seating bowl is 40 ft below street level, ensuring no seat is more than 120 ft from the pitch.

The southern portion of the stadium, which extends from the Gateway Mall, is slightly detached from the northern structure, acknowledging its position opposite the Gateway Arch by providing enhanced views from premium seating areas.

CITYPARK exhibits a seamless fusion of structural engineering and architectural design. The design reflects the stadium’s urban surroundings and prioritizes openness by inviting the neighborhood inside. The structural engineering complements the architecture with a coordinated system that features steel throughout, creating open, interconnected spaces and fluid exterior forms.

The coordinated structural approach dramatically reduces lateral framing to allow transparency, opens corners to reveal the urban setting, and extends the steel canopy outward to link the stadium to the neighborhood visually. The interplay of engineering and architecture transforms the stadium into a new landmark for downtown St. Louis.

Structural steel met the architectural goal of creating an open and transparent structure with streamlined gravity and lateral systems while ensuring expedited fabrication and erection. Steel framing with slender columns and discreet braces allows the lateral system to disappear, avoiding the imposition of perimeter-braced frames that would obstruct views. Steel trusses and girders enable long canopy spans while keeping structural depth minimal for a thin, lightweight aesthetic.

Steel connections were precisely engineered to eliminate stiffeners and optimize the slender column designs. Steel's lightness reduced foundation loads on the variable rock profiles. CITYPARK was also designed to utilize 100% recycled structural steel. The structural components are designed for easy disassembly and reassembly, allowing for adaptive reuse and reducing environmental impact.

The steel framework comprises trusses spanning to primary tapered girders supporting the canopy roof structure, with steel girders and open web joists at retail and concession levels. Custom connections were designed in close coordination with the architectural team. Integrating lightweight spanning trusses and girders balanced aesthetic aspirations with structural requirements.

Design Decisions

CITYPARK's innovative design and construction addressed complex site conditions while integrating structural and architectural design objectives.

The Downtown West site presented numerous challenges, including intricate rock contours, access constraints, varying perimeter retaining wall conditions, and high seismic design parameters. The stadium's foundation is engineered to adapt to the diverse geotechnical conditions of the site, comprising spread footings, friction piles, and mat foundations. Using steel to reduce the structural self-weight was key to optimizing the foundation strategy.

Using perimeter-braced frames would have detracted from the design intent of a sleek, transparent structure with maximum openness to the surrounding area. The design team, in response, wanted to make the lateral system effectively disappear. Three pieces helped them achieve their goal: Designing the feature columns to act as frames, relying on the rigidity of the seating bowl, and integrating discreet braced frames at the base.

That approach effectively concealed the lateral system within the stadium's structure. The arrangement optimized functional efficiency within the aesthetic framework, further contributing to the stadium's open and streamlined appearance.

The engineering team designed all structural connections to accelerate the schedule and achieve constructability and aesthetic considerations. At critical and repetitive conditions, finite element modeling enabled optimization of design performance, material reductions, and cost savings. All three modeling benefits allowed precise calibration of structural behavior and enhanced the design and construction team's ability to tackle problems quickly.

In one case, on the eve of the mill order issuance, the team learned that the feature interior hollow structural section (HSS) 24-in. columns would not be available in ⅝-in. wall thickness for several months. The final wind tunnel test results were not yet available, creating risk of reducing wall thickness to an unconservative degree.

The design team quickly developed a detail that would strengthen the HSS columns at their peak demand locations, if the final wind tunnel results required it. The fast analysis, collaboration, steel connection, and fabrication flexibility helped maintain the schedule. Ultimately, the strengthening detail was not required.

Close collaboration between the design and steel fabrication teams from conception through construction facilitated mutual understanding and ensured a smooth transition from design to construction, including accelerated submittal review. The teams worked collaboratively through the complexity of the connection details, including fabricated mockups of multiple weld details to ensure the final product met client expectations. The teams also coordinated the timing of mill orders to ensure that the appropriate shapes were available when needed.

Complex Canopy

The canopy and its primary supporting columns—two defining features of the stadium—underwent three major design iterations to arrive at an optimal tapered steel plate girder system that aligned with the architectural vision of a thin look while adhering to budget and constructability considerations. An outrigger system enhances the shallow cantilevered appearance along the entire canopy interior and exterior perimeters, adding to the stadium's aesthetic.

Initially, the team examined a constant depth built-up plate girder system. Cost concerns necessitated a second analysis to economize the design and explore a tapered truss system that used less material. The numerous connections in the second design option increased costs, though, despite the material savings.

A subsequent design iteration led to the final canopy girder design: a tapered built-up plate girder system where the bottom of the girder maintains a constant elevation and the top slopes. The 1½-in.-thick flange plates vary in width along the entire length of the beam, with the overall girder depth ranging from 3 ft at the ends to 6 ft at the center. Outriggers at each canopy end are typically 14 in. deep and 15 ft long, adhering to the desired light and thin appearance.

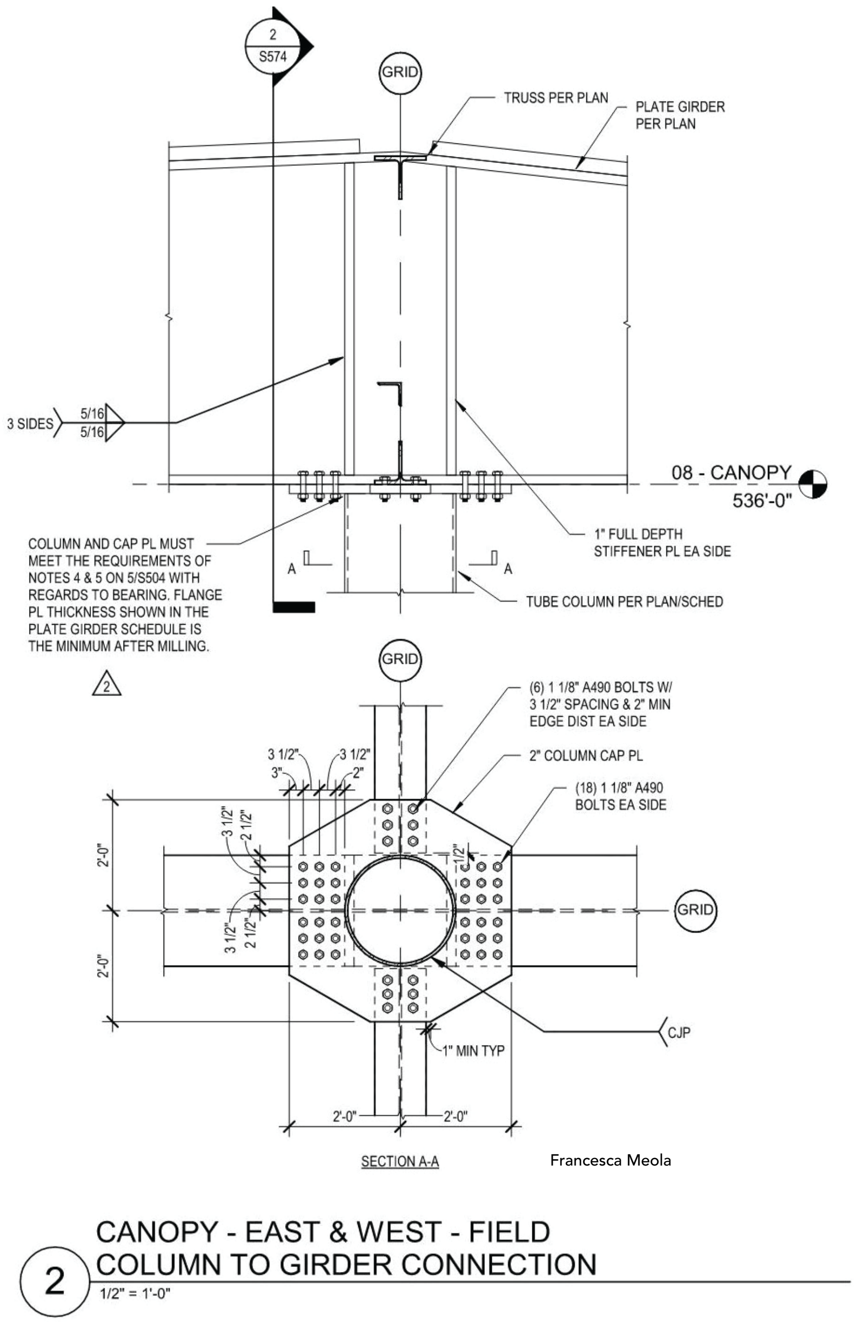
The canopy projects outward from the seating bowl perimeter, bringing diffused daylight into the stadium. Its steel framework, with slender columns spaced at 25 ft by 36 ft typically, supports metal panels defined by the architectural form. Discreet bracing and minimal pipe columns enhance transparency.

The canopy's stability is provided through a combination of steel moment frames and the rigid precast seating bowl, which also aids in efficient load distribution as part of the diaphragm system. While the canopy roof shape is uniform on all four sides, the supporting conditions below vary substantially due to differing program spaces and required close collaboration to locate braced frames in discreet locations throughout the concourses and back-of-house areas.

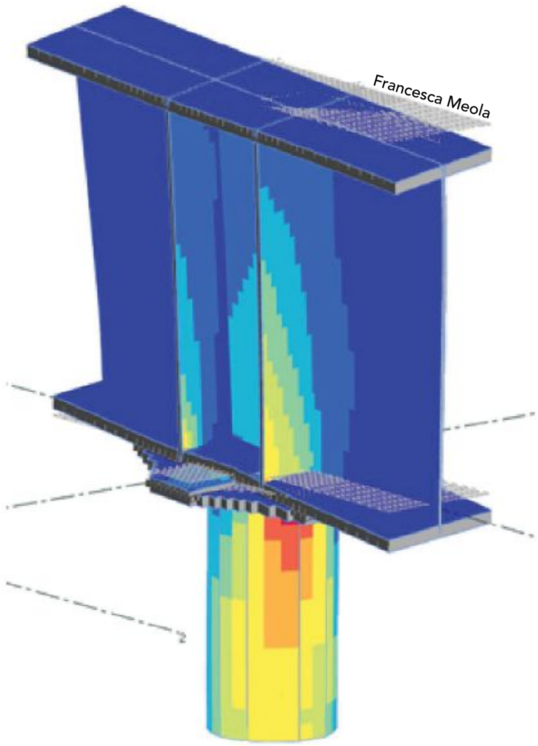
The final design of girder-to-column connections included a bolted connection of the girder to the cap plate over the column, eliminating the need for additional stiffeners in the column. The largest columns, HSS24, are placed along the fulcrum, with HSS16 along the exterior side of the stadium and back support of the canopy.

Corner canopy openings extend the inviting nature of the stadium beyond match days by creating flexible community gathering areas. This collaborative and iterative design process between architectural vision and engineering practicality resulted in community-centric architecture, integrating the canopy with the stadium's overall structural and aesthetic narrative.


Michael Robinson



Francesca Meola


Francesca Meola


MAK JV

Michael Robinson

Constructability Friendly

CITYPARK's loading dock introduces an uncommon approach to the stadium service area. A tunnel on the south side allows services to enter the stadium below grade, eliminating the typical back-of-house services area at street level.

The team designed the loading dock as an open, column-free space to maximize operational efficiency. A full-height concrete truss supports the tunnel lid for service entry below grade, and a parallel steel truss structure supports the stadium and plaza above. Built-up plate girders, approximately 73 ft long and 4 ft deep, transfer column loads and support sections of the elevated structure. The combination of concrete, steel, and plate girder systems enabled an obstruction-free loading dock space.

Detailing the interface between concrete and steel structures required close coordination, demonstrating an integrated design approach for architectural openness and practical utility.

The corporate constructability program implemented by the Mortenson, Alberici, L. Keeley joint venture (MAK JV) introduced early contractor engagement, which reduced material lead times by expediting the design process and improving design efficiencies.

A notable feature was MAK JV's self-perform and fabricating capabilities covering steel fabrication, steel erection, precast erection, earthworks, and underground utilities, giving MAK JV better control over the project's schedule. MAK JV could store materials on its corporate sites until they were required, streamlining operations and ensuring materials were available when needed.

Constructability reviews began before the construction phase. The construction team engaged with HOK designers to discuss material selection and procurement during the schematic design phase. In the design development phase, MAK JV and HOK refined steel shape selections based on the extended lead times exacerbated by the COVID-19 pandemic.

Members of the MAK JV self-perform team collaborated with the designers during the constructability review, which was key in manufacturing the required shapes and sizes of structural steel and selecting connection types to keep the project on schedule. The team's value engineering exercises helped lock in prices and meet the long lead times associated with materials and equipment procurement.

The design team and MAK JV implemented Procore, Tekla, and Solibri for constructability reviews throughout the project, and also implemented lean principles, such as pull planning, to address the schedule and the construction sequence. Internal coordination for steel fabrication, steel erection, and precast erection, along with progressive 4D schedule modeling, benefited the project schedule.

Self-performance of all the initial construction activities allowed MAK JV to start strong, work through issues with minimal impacts by resequencing, and collaborate with the design team for efficient solutions.

Initially, project specifications called for an architecturally exposed structural steel (AESS) designation. However, close coordination with the design team and the owner allowed MAK JV to understand the owner's true design intent and build mockups.

MAK JV

After viewing the mockups, the owners realized they could achieve the desired look without AESS and for less cost.

MAK JV also ensured quality by closely coordinating with precast fabricators, especially during long lead times. That quality assurance process included having an employee on-site for a month for quality control. The constant communication and collaboration with subcontractors also contributed to the project's success.

CITYPARK exemplifies the expertise and dedication of the project team and CITY SC's commitment to the region. The stadium has left a lasting impact on St. Louis and its residents, who have embraced CITYPARK and the club wholeheartedly. Investment has poured into Downtown West, with approximately $820 million in development and 300 new occupancy permits issued. The stadium and team have become engines of St. Louis' revival.

Owner
St. Louis City SC

General Contractor
Mortenson | Alberici | Keeley (MAK JV), St. Louis

Architect and Structural Engineer
HOK, St. Louis

Architect
Snow Kreilich Architects, Minneapolis

Associate Structural Engineer
David Mason + Associates, St. Louis

Fabricator
Hillsdale Fabricators (AISC Certified Fabricator), St. Louis

Jason O'Rear

2024 IDEAS² AWARD

EXCELLENCE IN ARCHITECTURE

NVIDIA Phase II – Voyager, San Jose, Calif.

THREE-DIMENSIONAL graphics chip manufacturer NVIDIA is in the middle of a multi-step project to overhaul its corporate headquarters in Santa Clara, Calif. The hexagon-shaped Voyager Building is Phase II of the project, which aims to create a workspace that matches NVIDIA's core beliefs and help employees thrive and create in a high-tech environment. The high, cavernous ceilings allow for large, open spaces that invoke the outdoors right next to the more intimate workspaces.

The Voyager building has a 275,000 sq. ft footprint with 700,000 sq. ft of working space to accommodate more than 3,000 employees. It's laid out on a 70-ft triangular grid system that adds a signature look and design to every element. The overall building consists of a two-level, below-grade garage podium under a large exterior shell enclosing multiple seismically separated interior office building structures.

The building's unique design highlights the owner's desire for a meaningful, collaborative space at the center of the building—named "the mountain"—where a dark gray staircase leads to mezzanine levels. The reception "base camp" area is on one side of the mountain, with more conventional offices, dining area, and meeting spaces on the other. The 60-ft-tall ceiling features numerous triangular skylights, and the undulating roof structure lets in enough natural light to the center atrium to give employees a feeling of being outdoors.

Structural steel was the only viable option to meet the owner's desire for the open space with long spans and a seemingly floating roof canopy structure. The design also needed to match the structure of the existing Phase I building at the headquarters campus, its equally impressive smaller sibling next door.

The structural steel was incorporated with other materials, such as glass and wood, to open up the workspaces and provide ample light to the open working areas. The open roof structure was left with exposed steel to express the support structure.

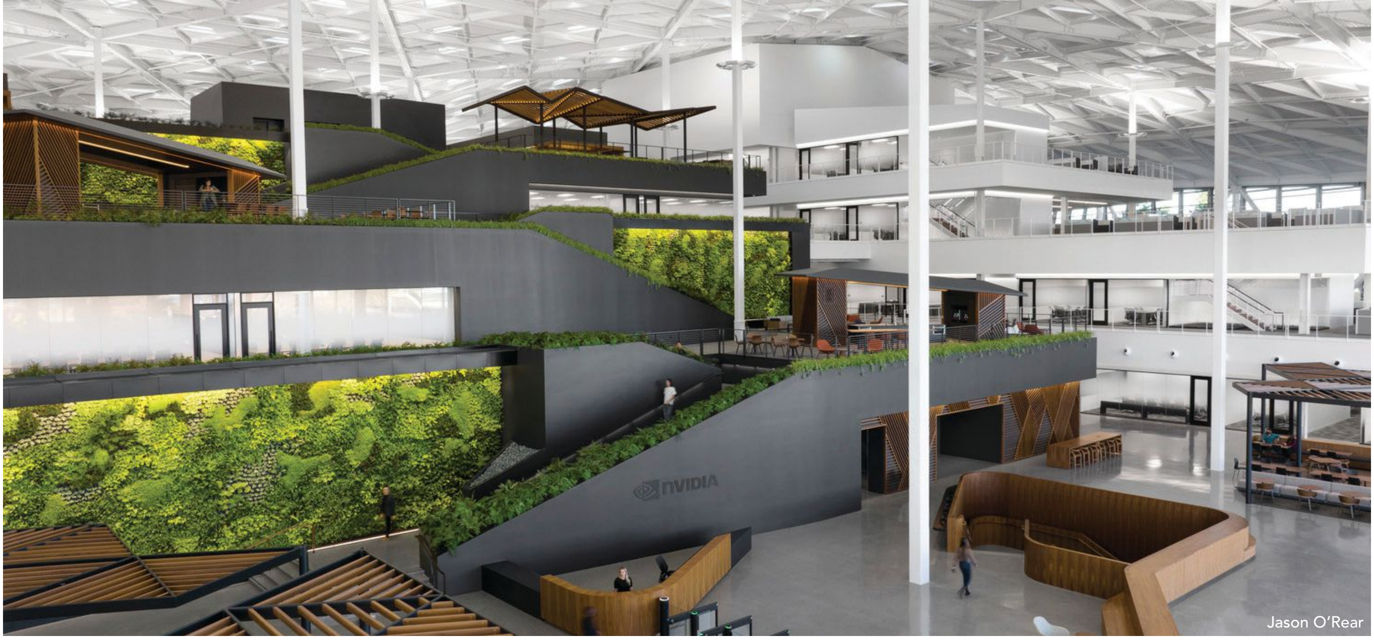
The overall building has three structural design elements: the roof, the office buildings, and the parking structure.

The steel roof structure has buckling-restrained braces (BRBs) at the exterior that are seismically separate from the interior steel structures. The roof framing sits on interior columns with a sliding connection at the top of the column, and the roof consists of insulated metal decking.

Due to the limitation in the length of the braces that could be produced, an intermediate beam breaks the lateral elevation into a multi-level brace frame. Columns and beams are designed for the unbraced middle beam out of plan forces. The BRB frames are supported on the concrete podium structure below.

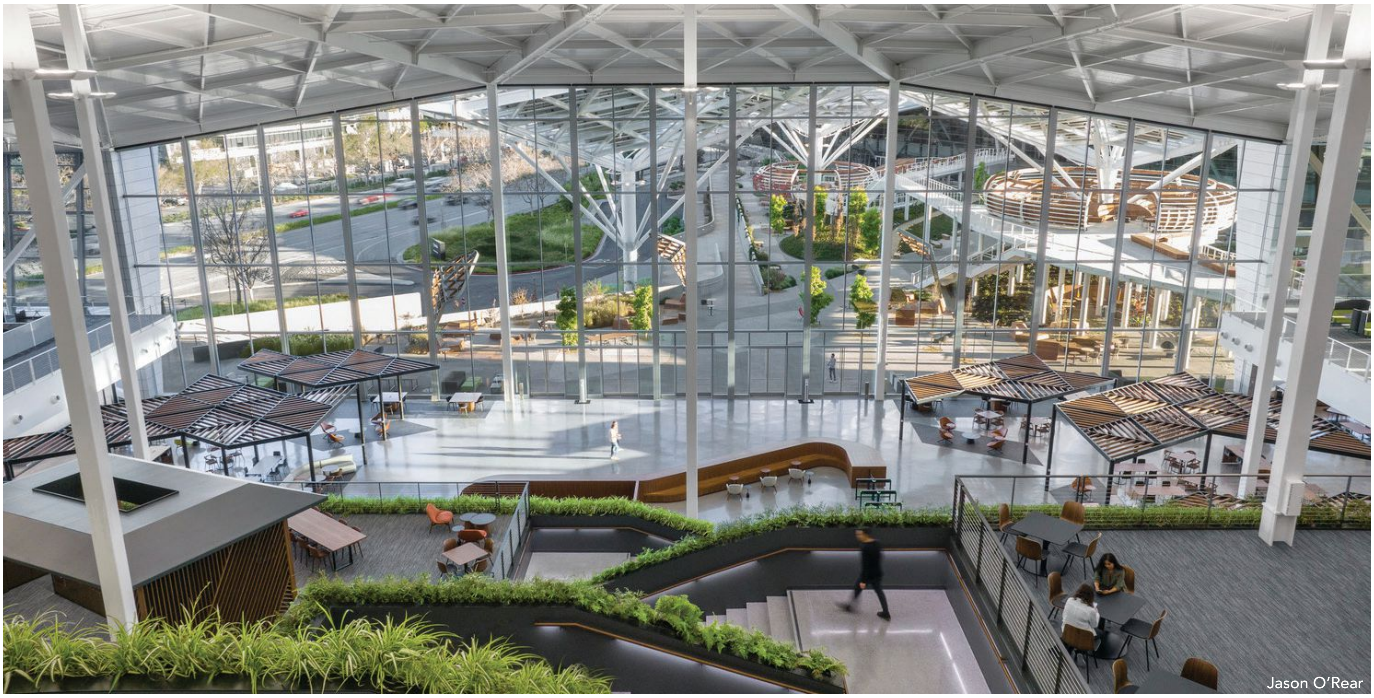
Interior office structures consist of steel framing that rises to four levels at the center. Four independent structures exist under the roof canopy, each entirely seismically independent. The floor consists of concrete-filled metal deck, and the lateral system consists of BRBs.

Voyager's parking garage is designed on a 62-ft rectangular grid, with the building above built on a 70-ft triangular grid. Matching the framing and translating it to the concrete parking garage was a significant coordination effort among all design team members.

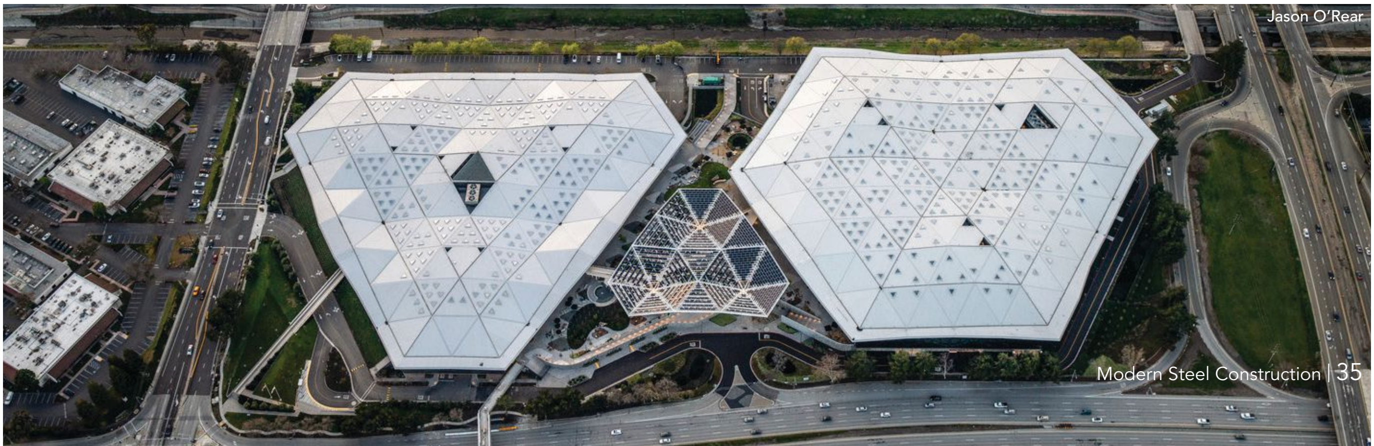


Jason O'Rear

"The apparent complexity of the structure lent itself to prefabrication and a field assembly that was not dependent on the usual orthogonal cut connections, conventional construction techniques, and the structure's thinness and the lightness. It can only be done with steel."
—Eddie Jones



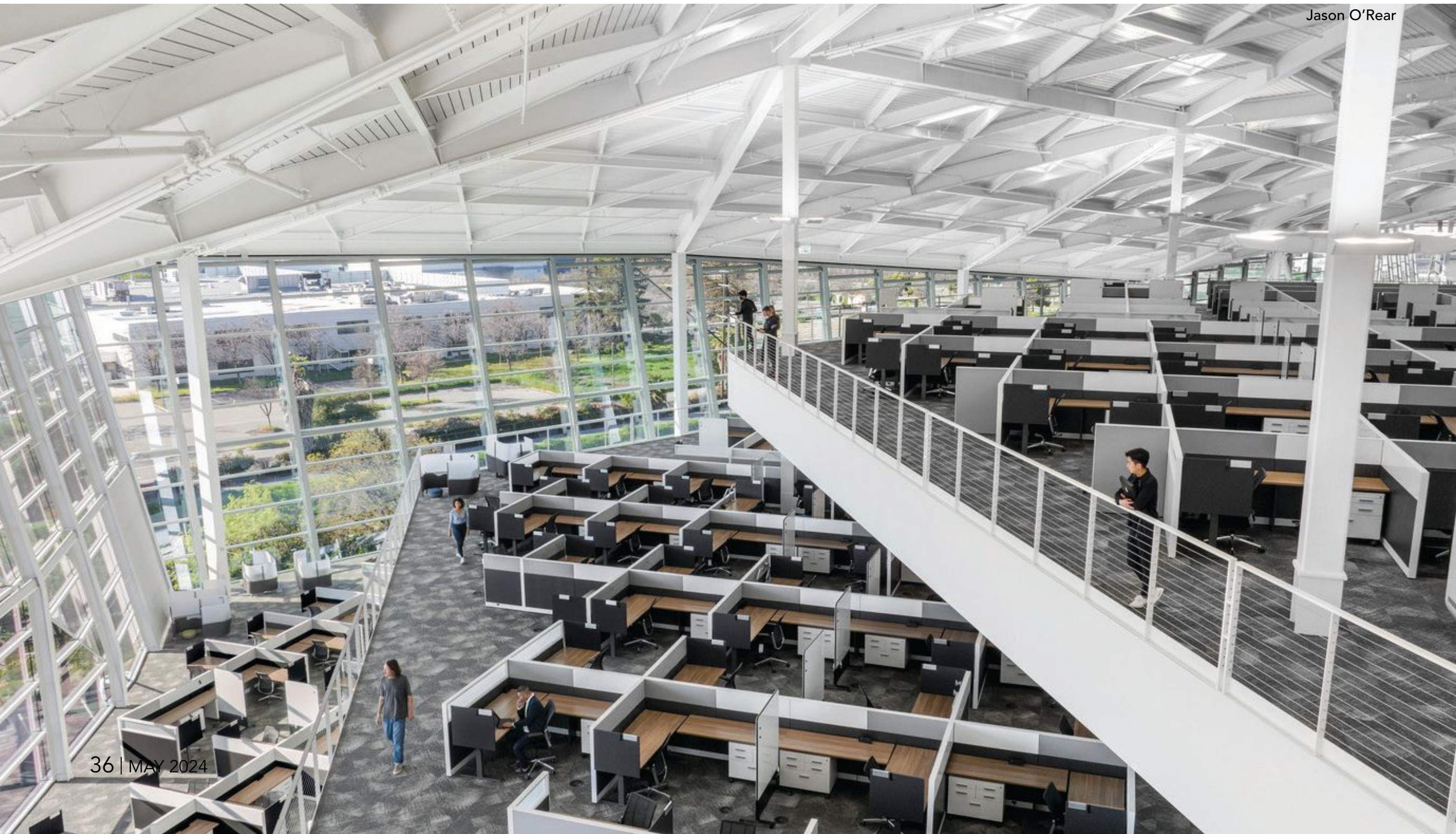
Jason O'Rear

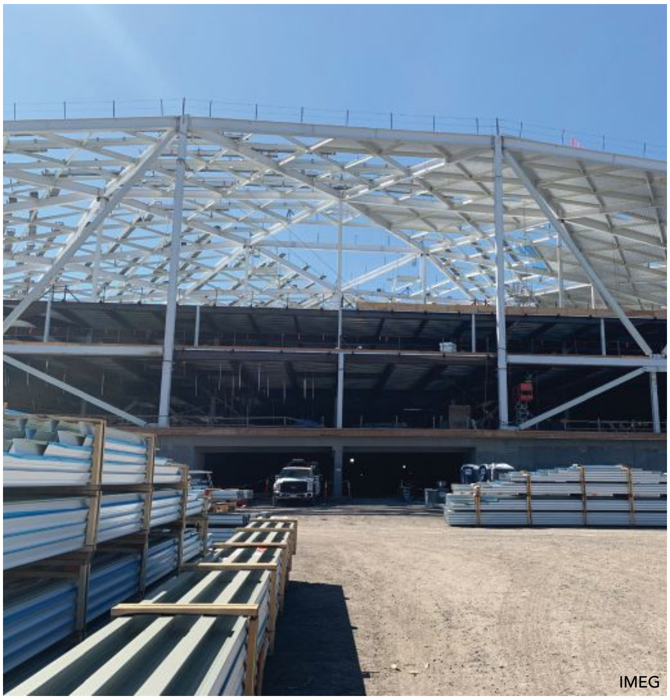


Jason O'Rear

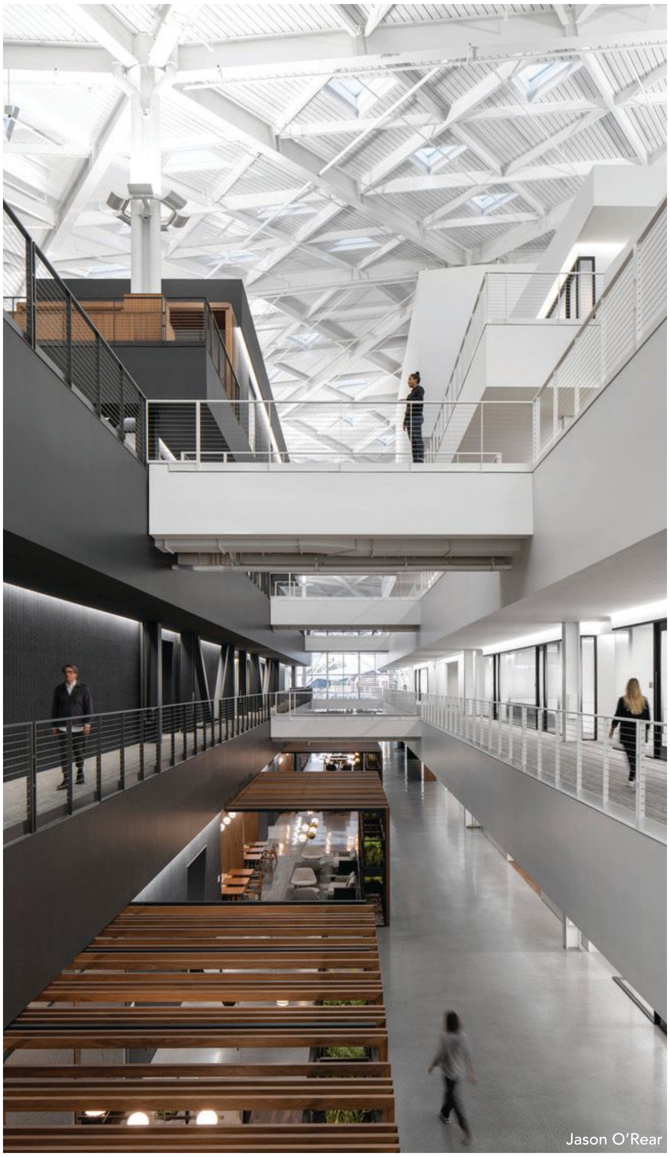
IMEG

Jason O'Rear





IMEG



Jason O'Rear

The exterior shell structure is clad in an all-glass façade with a ring of BRB frames and steel columns supporting a horizontal steel truss roofing system. The BRB frames had a maximum brace length of 57 ft with designed stiffness to handle the seismic demand from the trussed roof system and meet the manufacturer's deflection requirements for the glass façade.

The truss roof structure translates seismic loading from the interior of the building out to the exterior BRB frames, which are supported on the exterior concrete walls and columns. The steel truss roof mimics the equilateral triangular grid system and is supported by up to 60-ft-tall steel columns with a tributary area of 3,100 sq. ft. The undulating roof changes elevation by 30 ft from its lowest to highest points, giving the appearance of rippling water. A cantilever overhang extends more than 30 ft from where the roof meets the exterior façade and is supported by custom tapered W33 steel beams.

The three-level interior office structure was designed to be seismically separate from the exterior shell and was constructed utilizing structural steel and BRB frames, with concrete over metal deck slabs. Seismic isolation was accomplished by providing bearing and slip joints between the interior and exterior beams and columns.

Columns shared by the interior building and roof shell structure were fitted with a bearing pad connection to release any translated seismic loading, allowing the interior and exterior shell structures to move independently and removing any shared seismic loading. The decision to isolate the interior structure from the exterior shell also allowed the interior BRB frames to be downsized, providing reduced steel weights for a more sound and efficient engineering design and reduced cost. Structural engineers also created a custom bearing connection for the roof structure to sit on top of building columns so the exterior brace frames support the lateral load.

The building design also considered the horizontal displacements, including bridges, stairways, and glass panels, which required the structural engineer's coordination with the glass manufacturers on how much deflection would occur during a seismic event so that the connections that hold the glass in place are designed to accommodate the movement.

The design team worked closely with the fabricator from an early design stage, and the fabricator used state-of-the-art 3D modeling software, which helped the design team resolve difficult aesthetic challenges before they showed up in shop drawings or in the field. That close coordination gave all disciplines time to work through any potential clashes and resolutions early, created opportunities to explore LEED options, and gave the fabricator time to prepare the steel for exposed conditions to ensure a flawless product.

Owner's Representative
NVIDIA

General Contractor
Devcon Construction, Inc., Milpitas, Calif.

Architect
Gensler, San Francisco

Structural Engineer
IMEG, San Francisco

Steel Team

Fabricator and Erector
SME, West Jordan AISC CERTIFIED FABRICATOR & ERECTOR, Utah

Detailer
DBM Vircon AISC DETAILER, Auckland, New Zealand

NASHVILLE'S GEODIS PARK made history the moment it opened.

The 30,000-seat venue, home to Major League Soccer's (MLS) Nashville SC, is the largest purpose-built soccer stadium in the United States and Canada. It's designed to capture Nashville's distinct architectural character and is constructed from structural steel, mass timber, and exposed brick.

GEODIS Park was built to do more than host soccer matches. It's the anchor of a renewal effort in the city's historic but underutilized Nashville Fairgrounds, a well-loved destination known for its 50-year-old flea market, short-track speedway, and municipal fairs. It catalyzed more than $500 million in investments in the historic but underserved neighborhood.

The stadium's carefully crafted exposed steel, mass timber, and exposed brick expresses the city's industrial roots and echoes the industrial architecture prevalent throughout Nashville while improving sustainability and reducing overall construction costs. Limited cladding on the stadium's exterior makes exposed structural steel the dominant architectural material, and the steel gracefully integrates with the dowel-laminated-timber (DLT), precast, and masonry systems.

Structural steel was the natural choice as the primary element of the stadium. It provides the needed strength to support the long spans in the seating bowl, canopy cantilevers, and extra-wide concourses while conveying the chiseled aesthetic sought by the client to reflect Nashville's industrial roots.

The exposed steel elements, in concert with brick and timber, create the public spaces and the dynamic visual form of the structure, and carefully crafted connections give it the desired industrial feel. The innovative and client-responsive structural engineering set a new standard for the design and construction of a complex structural steel building, meeting all client needs and creating a new asset for the city of Nashville while showcasing structural steel.

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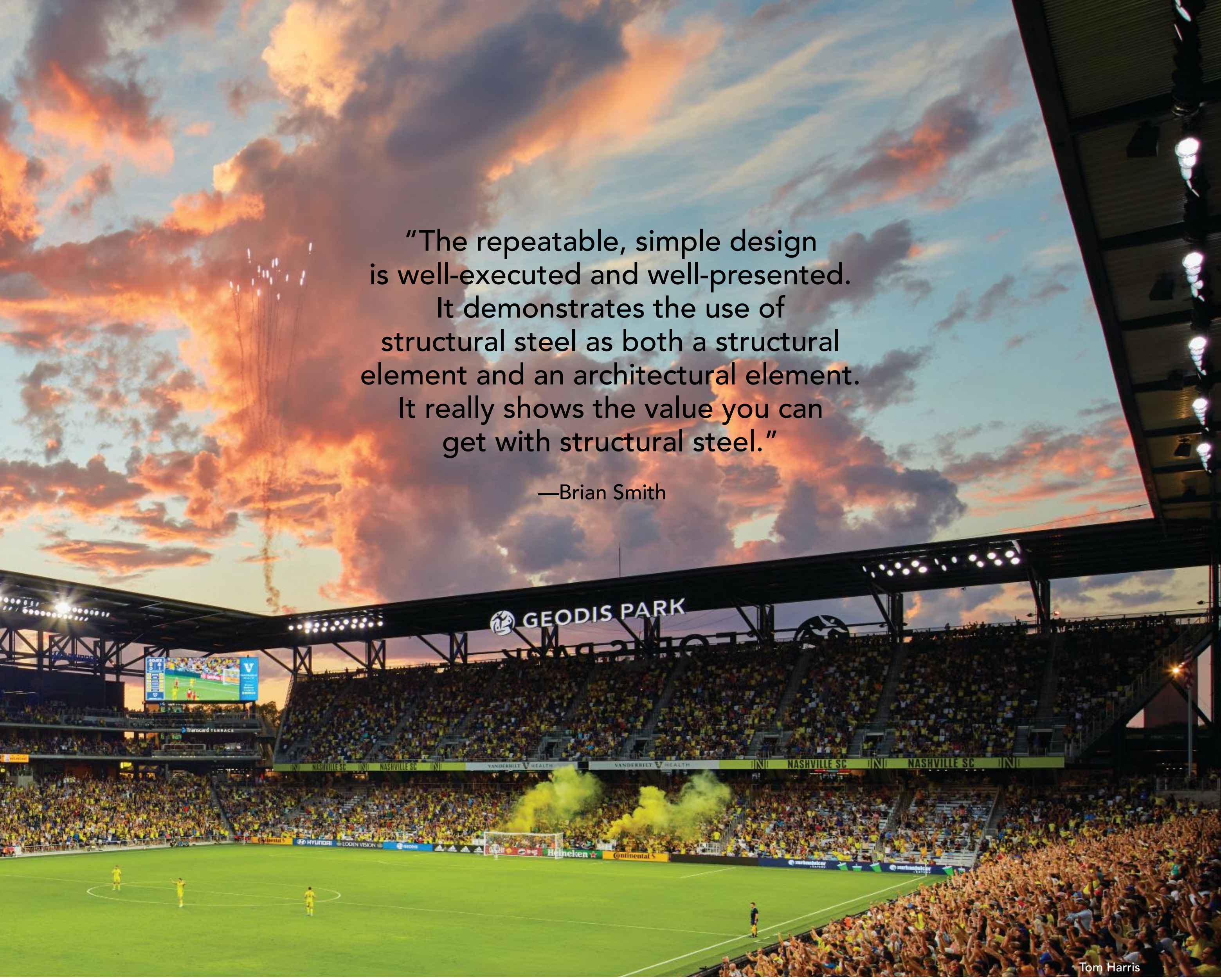
2024 IDEAS² AWARD

EXCELLENCE IN CONSTRUCTABILITY

GEODIS Park, Nashville, Tenn.



"The repeatable, simple design is well-executed and well-presented. It demonstrates the use of structural steel as both a structural element and an architectural element. It really shows the value you can get with structural steel."

—Brian Smith

Tom Harris

Numerous exposed structural steel features greet fans as they enter GEODIS Park, including:

- A 360° steel canopy cantilever that extends 85 ft over the upper seating bowl
- A signature steel X-frame, incorporating W14s for the columns and cross-bracing members, at the stadium canopy around the seating bowl
- A 65-ft-wide concourse with fully exposed steel connections

The stadium's signature 152,600-sq. ft, 360° main canopy enhances the architectural expression of the stadium with crisp 90° corners at each entry and a rectangular opening over the pitch. It also created significant design complexity that demanded innovative engineering.

Structural steel's strength permits the graceful and economical 85-ft canopy cantilever that protects 80% of seats from sun and rain. The main canopy girder has a single propped strut supported by the signature X-frame that serves as an elegant hold-down at each grid. These open corner entries are the stadium's signature architectural features. The main canopy continues 48 ft beyond the last column line, creating a column-free space with a soaring canopy above. The four open corners create a distinctive aesthetic, allowing fans inside the stadium to see the city beyond and fans approaching the stadium to see inside.

Steel provided the flexibility to integrate seamlessly with the other materials chosen for the project, including the precast concrete seating elements, mass timber at the entries, brick throughout the concourse, and other premium spaces. Steel became the foundational workhorse that formed the overall spaces and easily handled the long cantilevers, the complex geometry, and the need to be erected quickly. It nimbly supported exposed timber construction at each entry point and exposed brick masonry throughout the venue.

"The structural steel is the architectural hero of GEODIS Park and honors the industrial heritage of Wedgewood Houston, the neighborhood where the stadium is located," said Chris Melander, a design architect with Hastings and the lead project designer. "The steel detailing is integral to the stadium's identity and is celebrated with muscular bolted connections and contoured stiffeners.

"Collaborating with Walter P Moore in an integrated delivery process allowed the design team to influence and tailor the connection design, ensuring their compatibility with the overall design intent. Collaboration helped our team coordinate pathways for stadium utilities without sacrificing the structure's beauty and created schedule efficiencies by allowing the steel fabrication to begin much sooner than with a traditional delivery method."

Masterful Modelling

Walter P Moore modeled all connections in 3D early in the project using a self-developed proprietary delivery process called ConnecTID, "Transformative Integrated Design for Buildings," which fueled thorough discussions with the architect regarding the desired architectural expression. The advanced modeling fostered highly detailed coordination across all trades to ensure the aesthetic was achieved. That level of careful and advanced coordination helped integrate conduit, plumbing pipes, and other utilities into the building while maintaining each piece of the structure as an architectural feature.

The project's first challenge was to design and coordinate an efficient exposed structural system that could economically support a modern MLS stadium's many different span and load conditions. Early in the design phase, it became clear that exposed structural steel was the key architectural element. The challenge then became to develop, design, and detail every exposed steel member and connection early in the project so the engineer could fully coordinate every aspect with the architect and other project team members for aesthetic intent and functionality with various trades.

The solution was for the structural engineering team to fully model the structural steel superstructure to LOD400 completeness before procuring steel. LOD400 models are fabrication-ready models typically developed by a steel fabricator and include every part needed for steel fabrication, including bolts, welds, shim plates, stiffeners, and copes.

The fabricator performs LOD400 modeling on most projects after completing architectural coordination. On GEODIS Park, though, early high-fidelity modeling allowed the architect and engineer to visualize and refine every connection during design.

The engineer had to create a space-efficient concourse to accommodate the required concessions, restrooms, and other amenities while allowing free-flowing circulation for 30,000 fans. Conventional braced frames would have disrupted patron flow and consumed much of the limited concourse space.

Instead, the engineer leveraged the steel's strength and adaptability by utilizing moment frames in both directions, maximizing patron circulation while providing the needed strength and lateral stability to support the concourse and canopy. The design team leveraged early high-fidelity detailing to enhance the structural steel expression throughout the concourse, including carefully sculpted raker-to-column connections at each grid.

The design and construction team worked under schedule pressure from the start, seeking to deliver the stadium on an accelerated time frame to enable the owner to host as many games as possible in the stadium's opening season. Land acquisition issues threatened to delay stadium opening until midway through the 2022 soccer season, strengthening the schedule pressure.

ConnecTID facilitated ten weeks of process acceleration from a conventional stadium schedule by overlapping the LOD400 model development with the final design and construction bidding phases. The ConnecTID process and resulting LOD400 model also eliminated delays during construction to resolve coordination problems, because the design team identified and solved those potential problems virtually during the creation of the LOD400 model instead of solving them after discovery in the field.

The ConnecTID process tightly integrated structural steel design, connection design, and advanced 3D modeling to develop high-fidelity, fabrication-ready digital deliverables. It provided tight and accurate steel bids, improved overall coordination, and eliminated nearly all steel change orders costs. Six steel bids ranged from 9% to 20% below budget, with a total spread of 15% between high and low bids.

As a result, steel erection ended four weeks early, and the overall project wrapped up seven weeks earlier than planned. The schedule savings allowed Nashville SC to play the entire 2022 season at GEODIS Park, generating revenue nearly two months earlier than anticipated.

The early and thorough LOD400 detailing allowed design details down to the bolt's orientation and tapered shapes of every stiffener plate to be considered part of the overall architectural intent. Thorough connection design by the structural engineer is uncommon for modern stadiums and makes GEODIS stand out to patrons for its well-crafted appearance throughout.

Having steel as the dominant architectural feature of GEODIS Park meant the exposed steel had to be intentionally designed and detailed to be exposed throughout the stadium. In typical projects, particularly in the eastern half of the United States, connection design is delegated to the steel fabricator and is completed after design team drawings are issued with limited interaction between the connection designer and the design team. In this case, the ConnecTID process began in early design development, as the structural engineer collaborated with the architect on preliminary connection concepts for the critically exposed connections on the project.

The engineer then modeled an entire frame of connections in Tekla for review by the architect. Starting the connection design early in the project allowed for multiple iterations on the exposed connection, with the design team reviewing in Tekla each time to capture the overall impact. The details were then documented on early pricing sets to capture the complexity of the connections for accurate pricing.

Additionally, starting the process early and designing the connections during the design phase allowed coordination with the entire design team. The early coordination helped the team create pathways for the conduit to run inside steel column webs by stopping stiffeners or creating openings in gusset plates. Drainpipes were routed through beam openings, effectively hiding the piping at the leading edge of the bowl rather than having the pipe visually exposed going under beams.

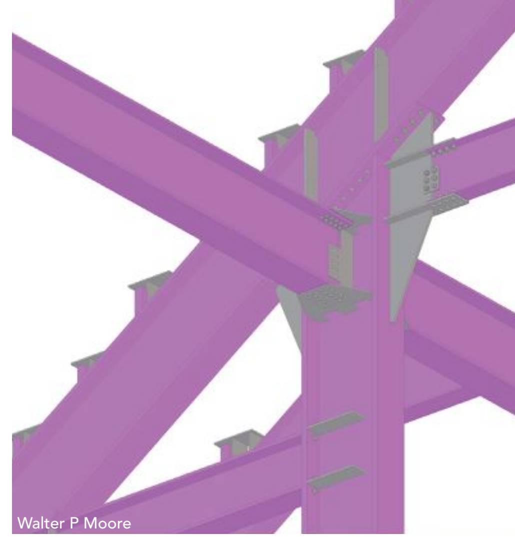
Crafty Constructability

GEODIS Park's steel delivery process combined numerous industry-leading activities to create a modern and streamlined construction process. It stands out as a model for the future of structural steel delivery compared to other stadiums with construction delays and cost overruns.

The ConnecTID process is based on producing more detailed and complete design information that includes fabrication-ready bid documents, meaning the steel fabricator bidders have a clearly defined project scope. In typical projects, the fabricator performs steel connection design and LOD400 modeling. But the GEODIS Park team pulled those services forward to have the engineer of record complete them during the design and bidding phases. These services are typically 3% to 5% of the total steel contract and require the owner's early investment to complete.

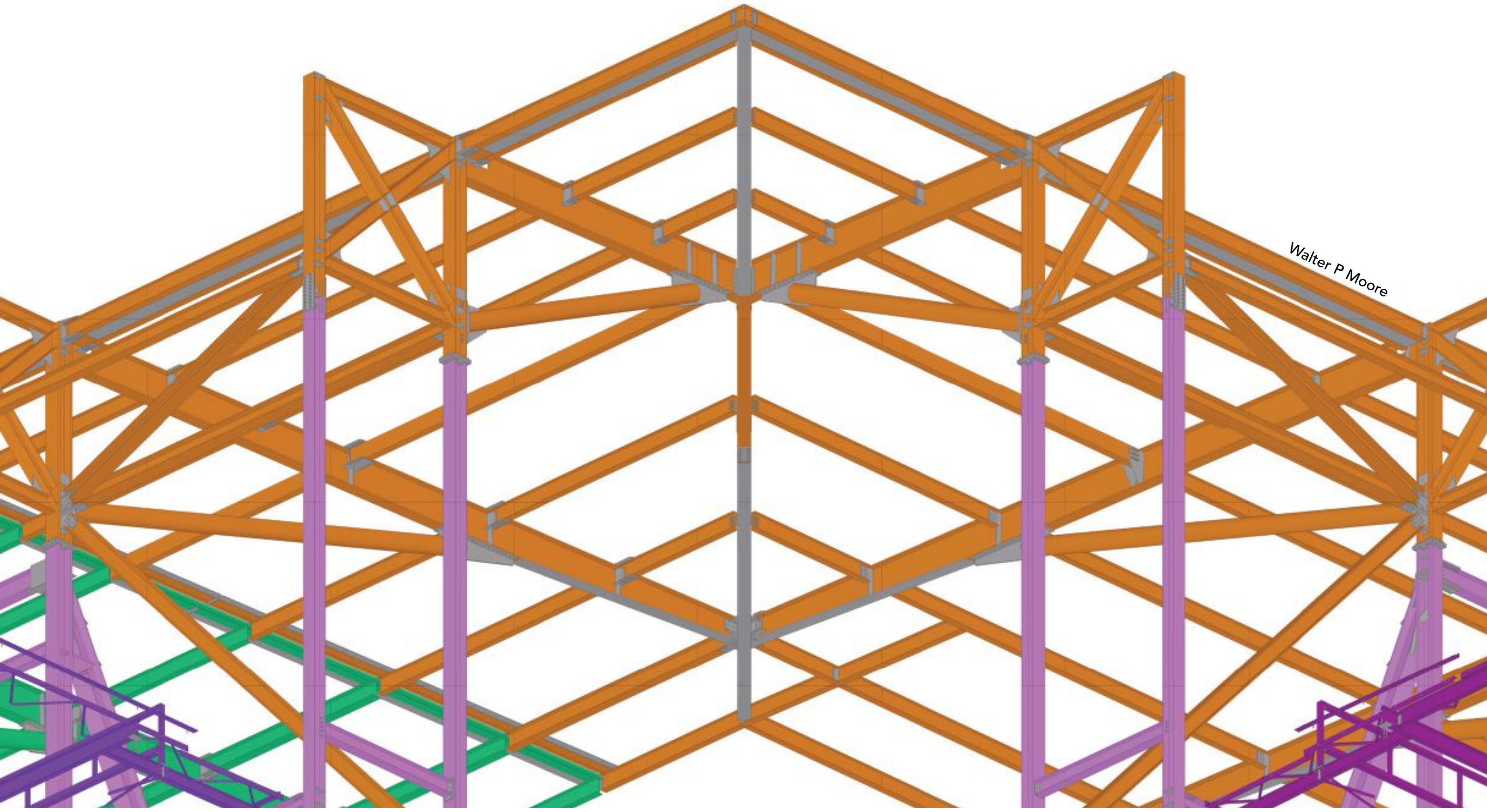
The engineer of record providing connection design and LOD400 modeling transformed and accelerated the entire delivery and documentation process. The steel bid documents included a traditional set of construction documents, structural steel specifications, completed connection design (including 3D representation on the drawings for all the complex connections, connection


Walter P Moore


Walter P Moore

Walter P Moore

Nashville Soccer Club


Walter P Moore

design for the vast majority of typical beam-to-beam and beam-to-column connections, and the LOD300 Tekla model (called the stick model).

The engineer rapidly transferred the steel members and geometry from the Revit model to a LOD300 Tekla model through a digital-based design process. The LOD300 model helped level-set the steel bidders for a baseline tonnage and piece count. The first half of the LOD400 Tekla model was released as an addendum, allowing fabricators to understand the exact project requirements.

The updated Tekla model also included locations and extents of all four steel finishes: exterior high-performance, galvanized, interior prime only, and interior fireproofed—which eliminated another common source of scope confusion.

The modified process resulted in multiple competitive and qualified bids, ultimately leading to a steel contract 10% below budget value.


Tom Harris

The ConnecTID process completed the LOD400 model early, meaning trade coordination occurred at a higher fidelity immediately. Trade partners coordinated within pre-planned and fully modeled structural pathways. The model helped reduce steel RFIs by 90% from conventionally delivered projects. Most importantly, steel change orders totaled less than 3% of the contract value, about 70% less than what is commonly experienced in other highly accelerated steel projects.

Sustainability Success

GEODIS Park is the first professional stadium in the United States that couples the aesthetic and sustainability benefits of mass timber and structural steel by innovatively marrying them into a hybrid structural system that leverages the strengths of each material. The combination of minimalist steel frames and the long-span DLT decking created a resource-efficient dynamic entry feature that reduced the embodied carbon emissions of the stadium.

The strength and stiffness of steel provided the needed gravity and lateral support with just minimalist steel frames at 27 ft on center, providing ample width to optimize the positioning of entry queues and screening equipment, weather-protecting the equipment, and enhancing the guest experience. A pure timber structure would have been unable to accomplish these programmatic requirements.

Coupling steel and timber allowed each material to play to its strengths in a holistically optimized system. Additionally, the DLT panels do not have the environmental impacts associated with the glues required for CLT panels. The design team crafted hidden connections and utility runs. Fastener holes to connect the timber to the steel beams were pre-drilled in the shop, allowing quick and simple field installation of the timber. Perimeter steel channels conceal the roof slope, providing a clean steel perimeter fascia as the dominant architectural expression as fans approach the stadium.

*For more on the GEODIS Park project, see "Southern Exposure" in the June 2023 issue, available at **www.modernsteel.com**.*

Owner
Nashville Sports Authority

Owner's Representative
CAA ICON

General Pontractor
Mortenson | Messer Construction Co., Nashville

Architects
Populous, Kansas City, Mo.
HASTINGS Architecture, Nashville

Structural Engineer
Walter P. Moore and Associates, Inc., Kansas City, Mo.

Steel Team

Fabricator
LeJeune Steel, Minneapolis

Erector
LPR Construction, Loveland, Colo.

Detailer
DBM Vircon, Tempe, Ariz.

2024 IDEAS^2 AWARD

EXCELLENCE IN ENGINEERING

Nashville International Airport Terminal Lobby and International Arrivals Facility Addition, Nashville, Tenn.

THE TERMINAL LOBBY and international arrivals area renovations to Music City's main airport took inspiration from an instrument.

A sweeping canopy that anchors the overhauled lobby and international arrivals facility (IAF) at Nashville International Airport (BNA) has multiple guitar-like features and resembles musical airwaves. Designing it brought some challenges. Erecting it while keeping the airport operational brought even more.

The IAF and terminal lobby project aimed to provide additional airport capacity to meet the rapidly increasing domestic and international passenger demand. Structural engineer Magnusson Klemencic Associates (MKA) and the Hensel Phelps/Fentress architect team collaborated to design and build a $436 million renovation and expansion of BNA's terminal lobby, which includes the state-of-art IAF and a central food court featuring world-class retail, dining, and entertainment.

MKA thought beyond the project's practicality. It wanted to create a remarkable visitor experience for the growing passenger count and be bold and beautiful in the design.

Aspirational renderings of the envisioned expanded terminal contained a grand ticketing lobby with abundant natural light and transparency. That included unencumbered views from the pedestrian bridge entry to the new international gates and a vibrant food court. To achieve this vision, MKA introduced a long-span, structural steel, curvilinear roof design that clear-spans the active roadway and terminal below. The roof design reduced the number of interior columns by 80% compared to a short-span roof design, achieving the architectural vision while significantly reducing the construction cost and schedule.

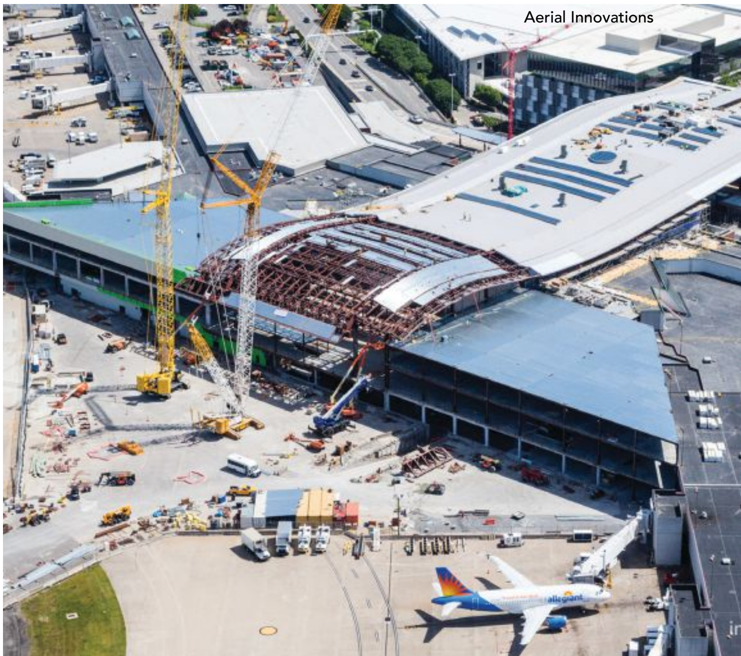
The 151,285-sq. ft structure weighs 1,750 tons and is comprised of twin, 685-ft-long contiguous spine trusses forming a gentle, wavy form symbolic of the Grand Ole Opry's radio waves, which BNA dubbed the "airwave." The terminal roof tapers to a finely pointed edge reminiscent of an airplane wing. Linear skylights throughout the roof evoke guitar frets, while an oculus skylight evokes the guitar's sound hole. The grand entry lobby and airwave roof completely reshape the terminal's form and volume, providing dramatic architectural expression.

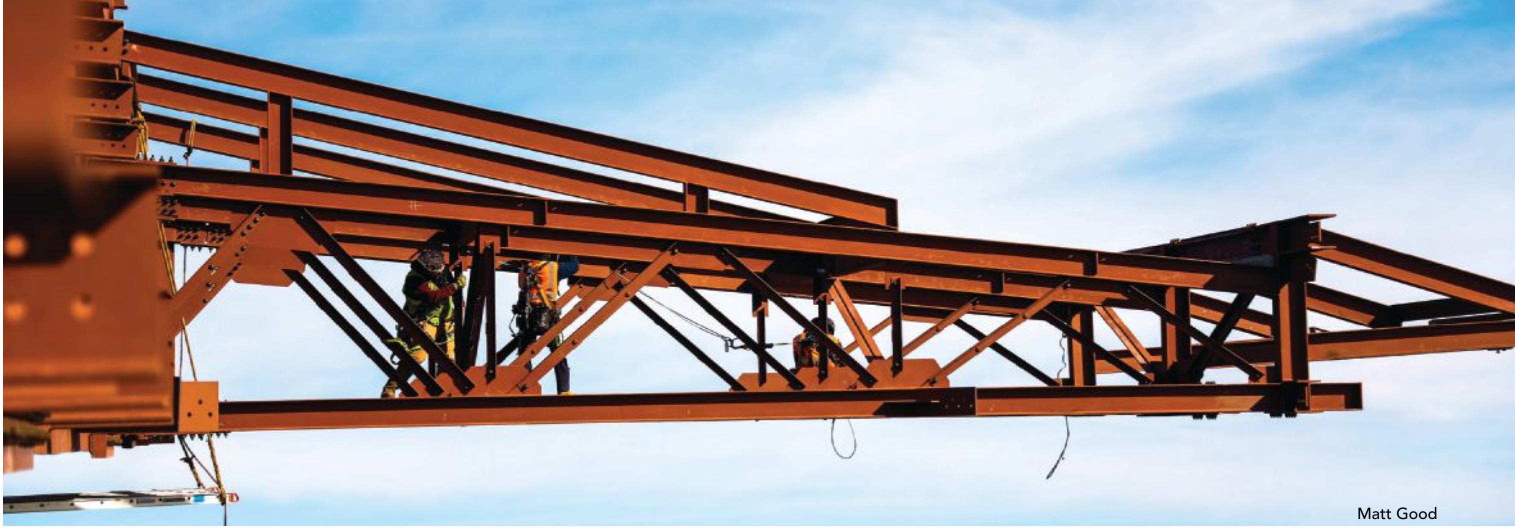
Steel Success

Steel was the only material with merit because it provided the long spans needed to fly the new roof trusses over the existing roadway and terminal and the gentle, wavy geometric form essential to the desired architectural expression. Equally important, steel offered the most economical solution and the highest strength-to-weight ratio. Steel

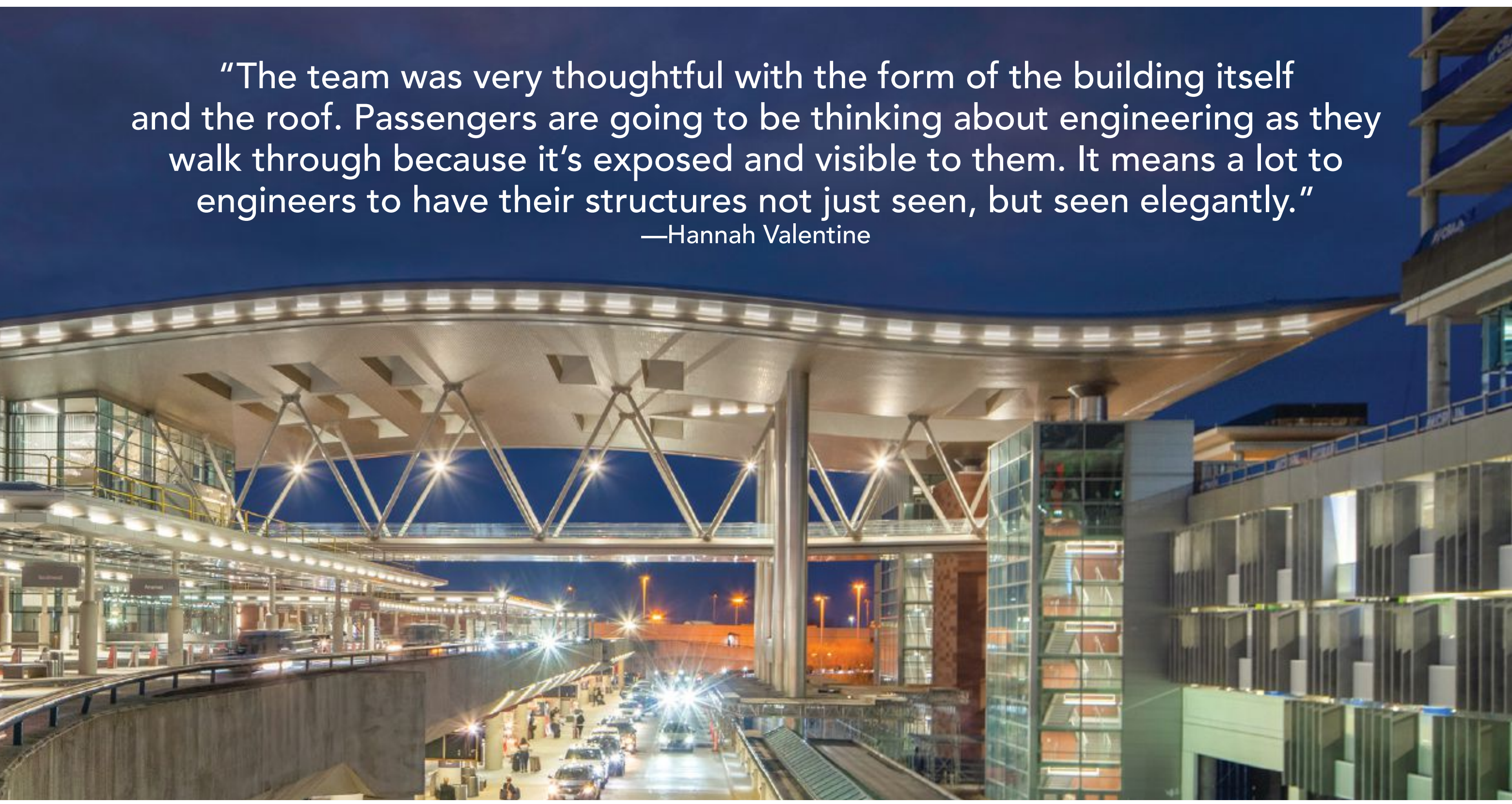

Matt Good


Jordan Powers


Aerial Innovations

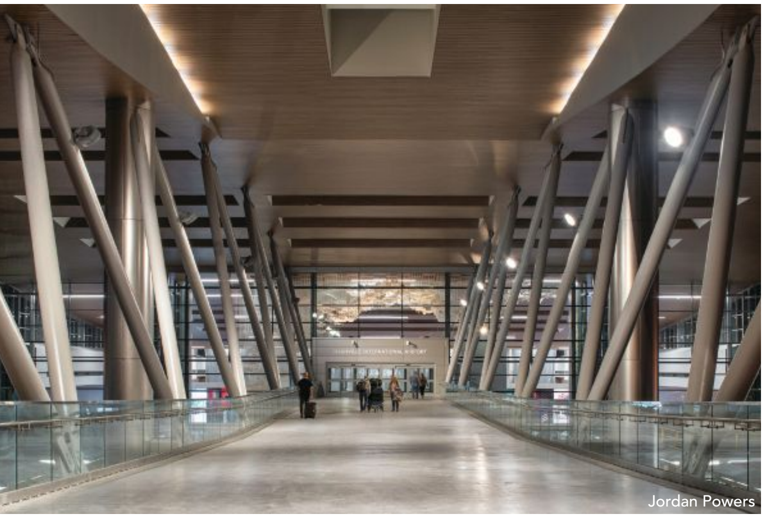


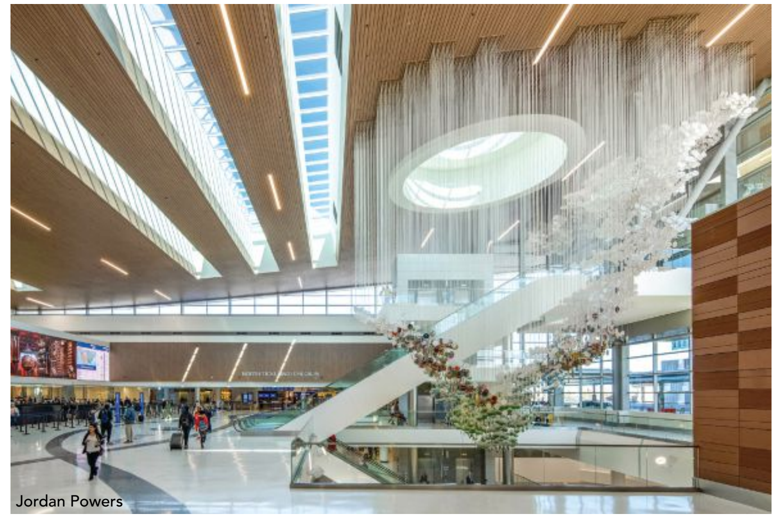
Matt Good



"The team was very thoughtful with the form of the building itself and the roof. Passengers are going to be thinking about engineering as they walk through because it's exposed and visible to them. It means a lot to engineers to have their structures not just seen, but seen elegantly."
—Hannah Valentine

Aerial Innovations


Jordan Powers


Jordan Powers

comprises the airwave roof's moment frame lateral system—from steel trusses to built-up steel plate girders to cruciform steel columns—to provide unparalleled stability during and after construction.

The original bridging documents called for a braced frame lateral system, but MKA understood this system clashed with an architectural design that summoned grand open spaces. MKA prepared an alternate design scheme to show how a moment frame lateral system could capitalize on a more optimized steel design, reduce costs, and deliver on the vision for open and light-filled space.

The entire project capitalized on the power of structural steel long spans to provide maximum drama, views, and elegance with an optimized design. For example, new steel cruciform roof support columns were placed outside the new terminal's perimeter, allowing the ticketing area, passenger screening checkpoint, and food court to be predominately column-free, since no existing columns within the interior spaces were required to support the new roof. The result is tremendous, unobstructed views and intuitive wayfinding throughout.

A mass timber roof structure would have been far more expensive and required long-term maintenance to resist adverse weather. It also needed deeper trusses that would have completely changed the roof's desired slender form.

Likewise, concrete roof girders would have resulted in shorter spans, more support columns, and increased costs associated with bolstering roadway loads. Forming and casting a concrete roof or erecting precast girders were unviable options. With concrete, the roof structure would have been eight times heavier, and the carbon footprint would have increased dramatically if made from concrete.

Airwave Assist

The BNA project had to be completed while maintaining ongoing and uninterrupted operations throughout construction. MKA's novel "airwave" roof traverses the existing terminal and limited disruptions to the 50,000 daily passengers that travel through the airport and on the main roadway. The new roof was the engineering equivalent of a Swiss Army Knife, with several methods that ensured no passenger interruptions and no roadway closures.

The airwave trusses and W36 cruciform columns have fixed base foundations and support the entire roof, and they needed little temporary shoring or bracing throughout steel erection. That meant steel erection could proceed over the occupied terminal and active roadway.

The airwave also acted as an umbrella that provided weather protection while contractors safely demolished the existing roof below. The cost and schedule benefits were substantial, especially because the baggage handling system and electrical components below the departures level had to stay dry and remain fully operational throughout construction.

The existing columns were not needed to support the new roof, meaning workers didn't have to strengthen the existing columns and foundations—another considerable schedule and cost-benefit. Before it was demolished, the existing terminal roof was a safe temporary work platform to facilitate the installation of the new roof's mechanical, electrical, piping, and ceiling supports within. Installation was six times faster than using scissor lifts on the departures level to install these systems.

Once the new, long-span steel airwave roof was in place and weather-tight, the new steel roof trusses were used by the demolition contractor to rig from and safely demolish the existing roof below.

The airwave spans the arrivals roadway with two curvilinear mega-trusses supporting the new pedestrian bridge from the adjoining parking garage to the new Grand Entry Lobby. Hollow structural section (HSS) pipe diagonals laced between the lower bridge girder and the upper roof trusses allow the bridge to meet stringent vibration criteria. Cast Connex attached sleek steel castings to these girders, eliminating the need for bulky, bolt-laden gusset plates that would have restricted views through the glass handrailing on the pedestrian bridge.

The airwave's engineering was innovative beyond its ability to keep the airport open during construction. The steel roof structure was fabricated precisely to create the true roof geometry (for example, the one-and-the-same roof profile shadows the steel profile) and achieve the sleek and iconic airwave form essential to the architectural design intent. Like an airwave that rolls gently through the sky, the light and delicate roof form created by the steel fabricator allows ceiling, roofing, and skylight elements to be attached directly to the steel structure.

Throughout the design process, MKA worked closely with the fabricators and steel detailers to embrace constructability details that performed best. Truss splice locations were positioned so the trusses could be fabricated, shipped to the site, and erected fast, safely, and quickly. Each member fit seamlessly.

Elsewhere, the straight trusses were prefabricated in the shop and shipped to the site. They spanned between and through the spine trusses to complete the roof's undulating form with straight-line-generated geometry, greatly simplifying fabrication and erection. Straight trusses also formed beautiful recesses in the ceiling


Matt Good

Matt Good

finish so light from the linear skylights above could cascade onto the floor below, creating a remarkable, naturally lit space.

As a finishing architectural expression, the truss cantilever reminiscent of an airplane wing allows architectural cladding elements to be attached directly to the structure. Suspended art hangs directly from the structure above to create a phenomenal impression in the entry lobby.

Constructability and Sustainability

Hensel Phelps, Fentress, and MKA involved the steel fabricators and erector early in the project to provide valuable design assist input on prefabrication, connections, and erection.

The 685-foot-long dual spine trusses were designed and fabricated to be only 10 ft deep, facilitating pre-assembly at the fabrication plant and shipping to the site, minimizing cost- and schedule-related issues. In addition, the fabricators suggested MKA incorporate steel castings into the pedestrian bridge design to achieve a clean and simple pinned connection that preserved views while meeting stringent vibration criteria.

The design team working closely with the steel fabricator and erector early on provided insights on refining roof geometric clarity for the radial arcs and tangents of the desired roof form and determining the most cost-effective way to bend and connect the steel roof members. MKA determined at design inception that inserting the two longitudinal steel spine trusses traversing the 685-foot-long airwave roof—from the parking garage to the airfield—would best create the long-span roof form. That solution minimized the number of curved trusses, eased fabrication costs, and enhanced the roof's stability during erection.

Input from the steel erector and fabricator led MKA to change the moment frame connections from welded to field-bolted, minimizing steel erection time and reducing costs. During the design phase, the steel team vetted the tower crane's reach to ensure it could span the occupied roadway and placed a tower crane directly through the roof's oculus skylight opening to facilitate erecting steel above the terminal and roadway.

When expanding and renovating existing facilities, the most effective sustainable design solutions revolve around reusing and repurposing as much of the existing structure as possible, embracing solutions that do not require strengthening or demolishing the existing structure, and avoiding rebuilding with all new materials. The reuse efforts reduced the renovated terminal's carbon footprint by 50%, and all demolished steel was recycled.

Spanning the existing roadway with the airwave roof meant the project team did not need to strengthen the existing roadway, avoiding expensive, time-consuming, and disruptive measures such as roadway-related seismic upgrades, column strengthening, and micropiles.

The project design reused the existing terminal's departures, apron, mezzanine, and basement levels. Further, some of the original roof support columns were simply trimmed off and repurposed to support a video screen wall in front of the passenger screening checkpoint. The new design also employed an existing upper-level office floor as a new mechanical room.

The old terminal building remains, but passengers have little way of knowing as they stroll through the pedestrian bridge, into the column-free grand lobby, and onward to the vast retail and dining area—all with spacious views, natural light, and openness.

*For more on the Nashville International Airport project, see "Riding The Wave" in the October 2022 issue, available at **www.modernsteel.com**.*

Owner
Metropolitan Nashville Airport Authority

General Contractor
Hensel Phelps, Nashville

Architects
Fentress Architects, Denver
TMPartners, Brentwood, Tenn.
Corgan Associates, Dallas (BNA Vision Design Architect)

Prime Structural Engineer
Magnusson Klemencic Associates, Seattle

Foundation Engineer
Logan Patri Engineering, Inc., Nashville

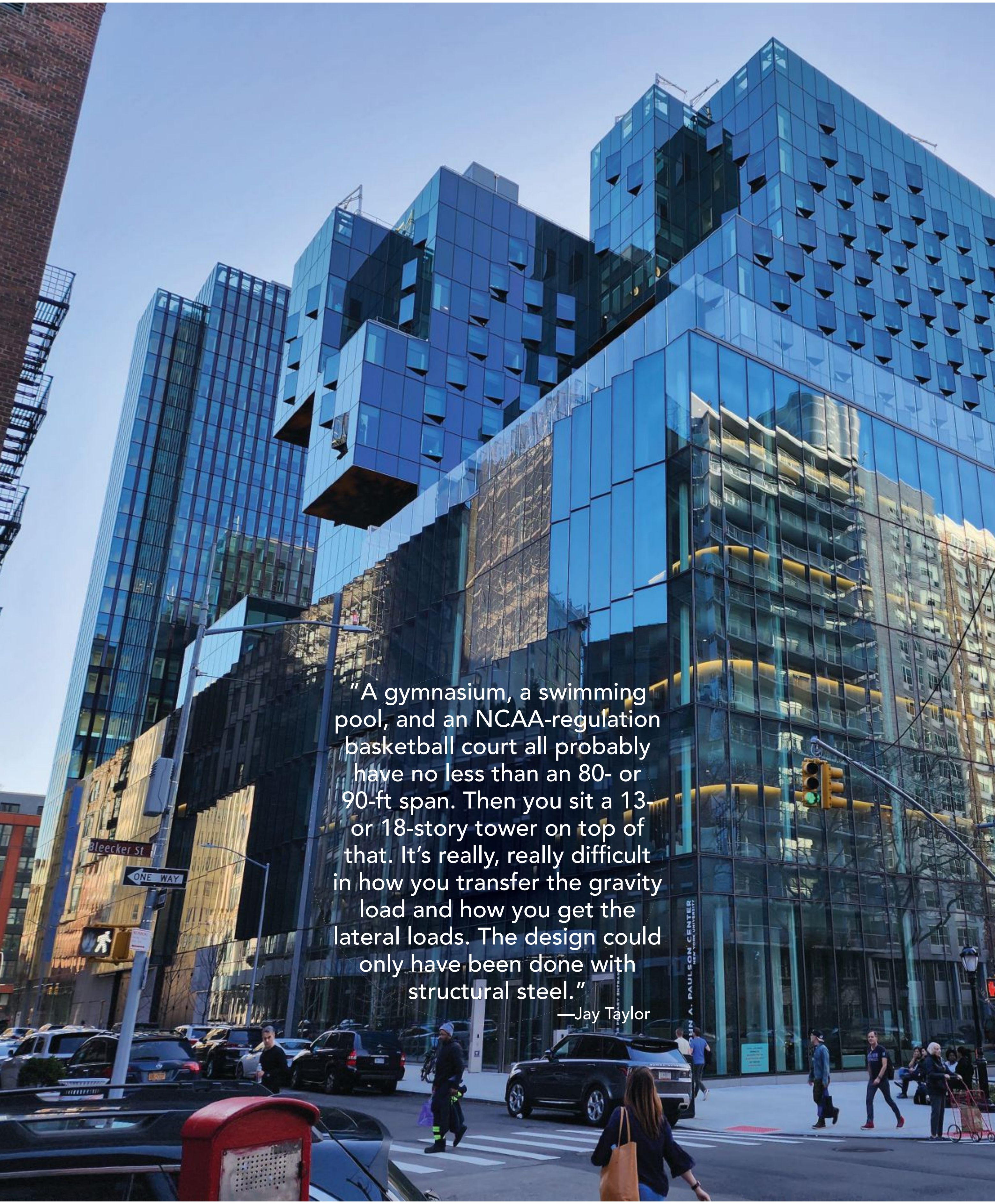
Steel Team

Fabricators
Banker Steel (AISC Certified Fabricator), Lynchburg, Va.
Irwin Steel LLC (AISC Certified Fabricator), Justin, Texas
TrueNorth Steel (AISC Certified Fabricator), Lubbock, Texas

Erector
Schuff Steel Company (AISC Certified Fabricator & Erector), Euless, Texas

Bender/Roller
Chicago Metal Rolled Products (AISC Associate), Chicago

Casting Manufacturer
Cast Connex (AISC Associate)



"A gymnasium, a swimming pool, and an NCAA-regulation basketball court all probably have no less than an 80- or 90-ft span. Then you sit a 13- or 18-story tower on top of that. It's really, really difficult in how you transfer the gravity load and how you get the lateral loads. The design could only have been done with structural steel."

—Jay Taylor

Severud Associates

2024 IDEAS² AWARD

EXCELLENCE IN ENGINEERING

New York University John A. Paulson Center, New York

NEW YORK UNIVERSITY'S John A. Paulson Center houses a mix of campus spaces rarely, if ever, grouped in one building.

The Paulson Center, which opened in early 2023, combines athletic facilities, classrooms, performing arts spaces, and faculty and student housing in a 735,000 sq. ft steel-framed tower that meets the diverse needs of students, faculty, and neighboring residents. NYU's location in the population-dense West Village neighborhood mandates a vertical campus, and steel's long-span potential allows a wide variety of facilities to be housed in one building.

The five-story performing arts podium anchors the building to its entire city block site, where the Jerome S. Coles Sports Center once stood. The building includes a 350-seat proscenium theater, two additional theaters, instruction and practice rooms, and classrooms. Double walls, floating floors, and dropped ceilings acoustically isolate the venues from noise and vibration.

Two below-grade levels house four regulation NCAA basketball courts—including NYU's new home court—and a six-lane swimming pool. Four floor-deep steel trusses, three at ground level and one at the fifth floor, span 130 ft over the basketball courts to create a 115-ft by 250-ft open space. The trusses transfer columns above and support a hanging running track below with a 25-ft clearance over the courts, which will not interfere with play.

An 18-story faculty housing tower springs from the south end of the podium, while a 13-story dormitory block sits atop the podium's midsection. Two additional levels of rehearsal rooms fill the space between. The residential structures are framed with conventional structural steel and the Girder-Slab floor system, which combines proprietary steel shapes with precast concrete plank. The system allows speedy erection, reduces dead load, and minimizes construction depth.

The building's performing arts spaces required extensive vibration and acoustic isolation between the foundation and the southern two-thirds of the ground floor. Beam pockets, column splices, and complex isolation details provide the necessary attenuation at column bases.

The building's myriad uses occupy architecturally distinct regions, each constructed with an appropriate structural system. A combination of structural steel—including long-span trusses and plate girders—cast-in-place concrete and precast concrete plank supported by proprietary steel shapes minimized the dead load of each component and maximized construction speed.

Take a Load Off

The Paulson Center's main program elements—the proscenium theater and other performance venues, the basketball courts, and the swimming pool—required large open spaces, and their arrangement mandated many column transfers. Performing arts spaces throughout the podium are located directly beneath the faculty tower and student dormitories, resulting in 80 plate girders at the podium roof.

Most of the podium is transferred on the four floor-deep trusses. Structural steel was the logical choice to carry the accumulated loads efficiently without adding significant dead load.

Truss members are box sections, built up from 4- to 6-in.-thick plate. These sections offer maximum lateral stability and high strength, allowing engineers to minimize material quantities further and effectively control deflections, which were limited to about 1 in. for live load. The trusses' openness and smaller member sizes also accommodate occupant circulation by allowing doorways through truss panels—especially critical at the high-traffic ground level. Further, the openings inherent to steel trusses facilitated coordination with the extensive mechanical systems in the building.

Dead load reduction, headroom, and speed of erection were drivers for selecting the Girder-Slab system and structural steel for the residential structures. Conventional wisdom would dictate concrete flat plates, which was considered, but its greater dead load would have increased demands on the transfer system and taken longer to construct.

The proprietary steel tee shapes were combined with conventional structural steel and hollow-core precast concrete plank and kept dead load to a minimum while allowing a faster construction schedule. The tee shapes also help maintain a uniform soffit and reduced floor-to-floor heights.

One of the podium's program and sustainability features is the circulation corridor at the perimeter of each floor, which promotes connectivity between the building's occupants and city residents on the street and provides natural light and passive solar heating. A necessary consequence of the corridors is that students, faculty, and staff spend a lot of time near the exterior walls.

Engineers and architects designed perimeter columns using architecturally exposed hollow structural sections (HSS)—typically HSS14×14 and spaced at 20 ft—fireproofed with intumescent paint. At stair openings, HSS beams supplemented the spandrel framing. Similarly, HSS12×8 exterior columns were used at the residential towers.

Stacking Uses

Stacking the Paulson Center's mixed uses on top of each other was a pivotal piece of the building design and engineering: The residential towers sit atop the performing arts podium, which bears over the below-grade athletic facilities. None of the tower columns and a few interior podium columns extend continuously to the foundation. In fact, there are over 220 column transfers in the building, including the four long-span trusses and 80 plate girders at the podium roof.

The extensive column transfers meant the loads on the columns reaching the foundation were much higher than expected for a building of this size. As a result, high-capacity caissons were drilled to reach and socket into bedrock. Temporary caissons were installed to provide support for the transfer trusses during erection.

The high groundwater elevation at the site necessitated that the caisson-supported perimeter walls and cellar slab be designed as a waterproofed "bathtub" to resist lateral earth pressure and hydrostatic uplift. Consequently, the caissons supporting the slab under the basketball courts are also designed for tension.

The swimming pool and basketball courts prevented extension of much of the lateral bracing directly to the foundation. Instead, loads from the podium were transferred to the perimeter walls at ground level using horizontal steel trusses and concrete diaphragms. That transfer approach increased loads in the ground floor framing and complicated the slab reinforcement and connection designs, especially at the numerous changes in slab elevation.

The podium's centerpiece is the proscenium theater. The podium structure, which also includes additional performance spaces, music instruction and practice rooms, and classrooms, is framed in steel, with concrete fill on metal deck floors. Massive double walls, raised floating floors, and specially detailed dropped ceilings further acoustically isolate the venues from noise and vibration transmitted through the framing from the athletic facilities.

Prescriptive building code lateral requirements do not explicitly address the building's multi-tower configuration. Therefore, wind tunnel testing was conducted to determine appropriate load patterns, and a seismic response spectrum analysis captured the response of the complex structure. The lateral force resisting system includes a combination of braced and moment-resisting frames. Horizontal trusses at the podium roof transfer lateral loads from the towers to lines of bracing surrounding the large open spaces of the theaters.

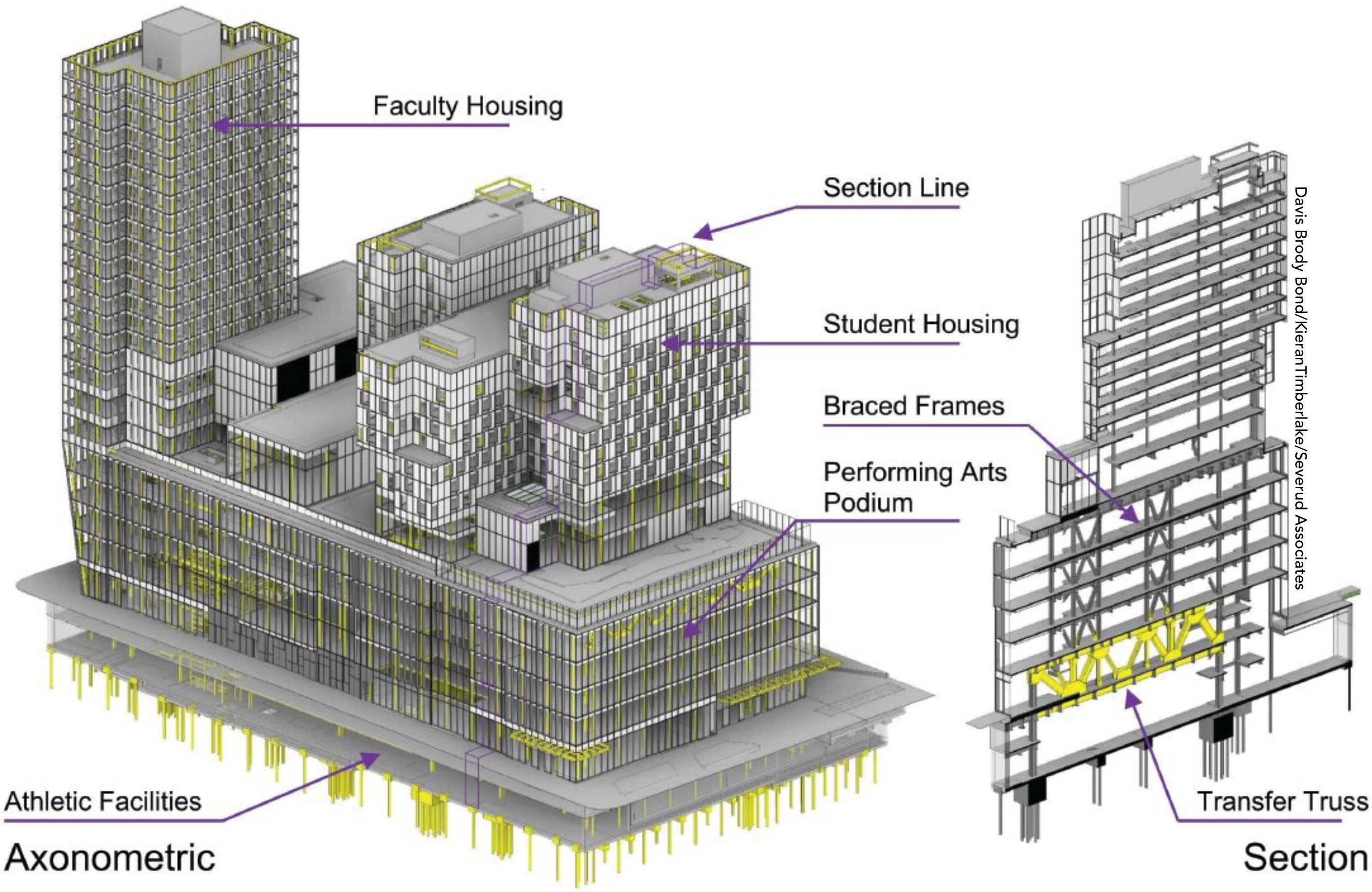
Acoustic isolators between the foundation and the steel framing of the southern two-thirds of the structure attenuate vibrations and noise from subway trains and vehicle traffic. At column bases, layers of polyurethane material are between the top of the caisson cap and base plate and around the pressure slab opening. The same material sits between the base plate and plate washer at each anchor rod, and the assemblage is covered with a cap. Finally, the base plate was grouted and the pocket filled with concrete to create a rigid base for stability and load transfer that would not transmit undesirable vibrations. A similar detail was used at beam pockets.

The column base detail was modified to account for shear transfer where lateral bracing extends to the cellar level. A wide flange steel lug was welded to the underside of the column base plate, which was set into a recess in the caisson cap lined with a similar polyurethane material.

The lateral load transfer at the ground level to avoid the athletic facilities resulted in higher-than-usual shears between the diaphragms and foundation walls. The structural engineers devised an innovative interlocking "sawtooth" connection of the floor slab to the foundation walls—intermittent projections of the underside of the slab cast into wall pockets lined with a polyurethane material—to maintain acoustic isolation.

The combination of the sawtooth slab, beam pocket and column base isolation details, and isolation of column splices in some locations allow the entire superstructure to carry the necessary gravity and lateral loads without creating a path through the framing for unwanted vibrations.

Careful coordination between the architect, structural engineer, and MEP consultant maximized the number of floors—and their ceiling heights—that could be built in the available space. An extensive number of large beam and plate girder openings allowed most of the ductwork, conduits, and piping to occupy the same space as the structural framing. Strategically locating the columns



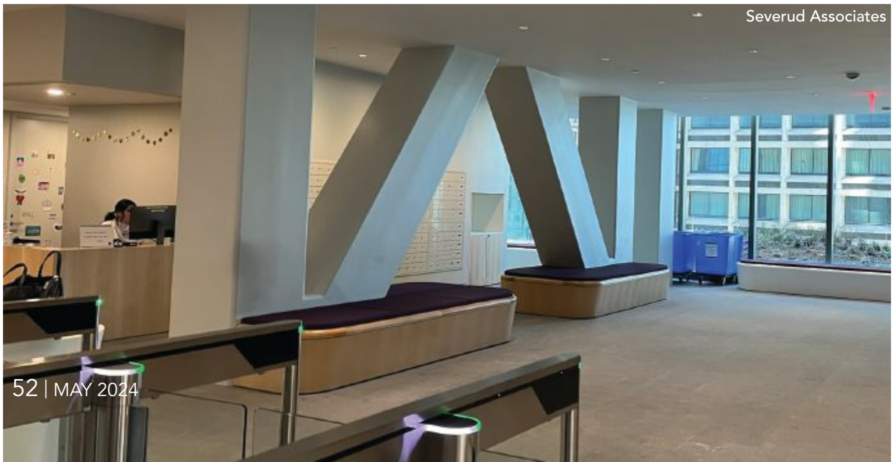
Davis Brody Bond/KieranTimberlake/Severud Associates

W&W | AFCO Steel

Severud Associates

Severud Associates


Davis Brody Bond


Severud Associates

at the tower-podium roof interface reduced demands on the plate girders and trusses, which further facilitated accommodation of the mechanical systems while giving the architects the high ceilings they desired.

The orientation of individual elements became critical to limit transfers and minimize loads. For instance, the natural alignment for the swimming pool is longitudinal to the building, while the proscenium theater needed to be across the building's width. Both are located at the same end of the building. The team finessed the specific location of each so that they formed a cruciform shape in projection. Engineers located continuous columns at each of the reentrant corners of the cross.

The four floor-deep trusses and many braced frames provided aesthetic possibilities for the architects. In several locations, the vertical and diagonal members become sculptural elements within a room or are expressed in the wall finishes. The compact size of the members—made possible by using steel box sections at the trusses—gave the architects greater flexibility in choosing the extent and appearance of the expression.

The architectural and client requirements led to extremely tight clearances, which impacted column dimensions, beam and slab depths, and mechanical clearances in the ceilings. Consequently, the structural engineers had to push the bounds of certain materials to optimize the design. The results emphasize the importance of teamwork and coordination between design disciplines and construction trades. Due to the design team's collective efforts, the building delivers NYU's extensive programmatic requirements in a shorter building height than the initial design.

The Girder-Slab system was considered in the early design phase as an option to reduce the floor-to-floor height in the residential towers and increase the number of floors. The building's engineers worked with their counterparts at Girder-Slab to determine appropriate system components and criteria for the corresponding conventional structural steel elements to achieve the fullest benefit. The resulting floor heights are 10 ft at the student dormitories and 9½ ft at the faculty housing tower.

Early in the steel detailing process, the steel contractor developed a modification to the column base isolation detail. The isolation material was applied to the underside and perimeter of the base plate in the shop, after which a steel leveling plate on the bottom and closure plates around the sides were adhered to form a box. That process allowed the entire base isolation assembly to be prefabricated.

On site, the base-isolated columns could be erected in the same manner as a standard column. Once installed, the column bases were grouted in the typical manner, using access holes through the base plate sandwich. The modified detail eliminated the need for additional field labor and helped speed up erection of the steel frame.

The structural engineer worked closely with the steel contractor during the shop drawing phase to supply detailed shear and moment values along the length of each plate girder, which gave the contractor freedom to tailor the flange and web plate thicknesses, widths, and welding to minimize material and labor while still providing the required strength and stiffness.

Sustainable Thinking

The Paulson Center will contribute to NYU's goal to achieve carbon neutrality by 2040 and is expected to achieve LEED Gold certification. Materials from demolition and construction waste were recycled, and the structural steel framing contains over 90% recycled material.

The building is connected to NYU's existing co-generation plant for heating, cooling, and dehumidification, which minimizes its consumption of fuel and potable water. Extensive high-performance glazing—also designed to minimize bird collisions—and the location of circulation corridors at the building's perimeter facilitate passive solar heating in winter, reduce heat gain in summer, and provide year-round natural lighting.

More than 25,000 sq. ft of terraces and green roofs provide natural cooling, capture rainwater for reuse in a 135,000-gallon tank, and reduce the building's heat island effect. The outdoor spaces also promote biodiversity and improve occupant health.

Owner
New York University

General Contractor
Turner Construction Company, New York

Architects
Davis Brody Bond, New York
KieranTimberlake, Philadelphia

Structural Engineer
Severud Associates Consulting Engineers, PC, New York

Fabricator and Erector
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Severud Associates

THE WINSHIP CANCER INSTITUTE is expanding its footprint in Atlanta with a state-of-the-art new hospital.

The new location, called the Winship Cancer Institute at Emory Midtown, is a 17-story cancer hospital in the heart of Atlanta that brings 450,000 sq. ft of inpatient, outpatient, and research facilities to the Emory University Hospital Midtown campus. It consists of a new cancer care center located directly across the street from Emory's existing hospital, with the two buildings connected by a new pedestrian bridge.

The two-level bridge—designed by Skidmore, Owings & Merrill (SOM) and constructed by Batson-Cook Construction—spans 184 ft with a main span of 134 ft across Linden Avenue, linking the two buildings without impacting the existing hospital's drop-off area and architectural design. Its transparent lower level connects public spaces in both buildings, while the upper level provides patient access and is clad in fritted glass to maintain patient privacy. The bridge also carries major mechanical, electrical, and plumbing services across the street to service the new cancer center.

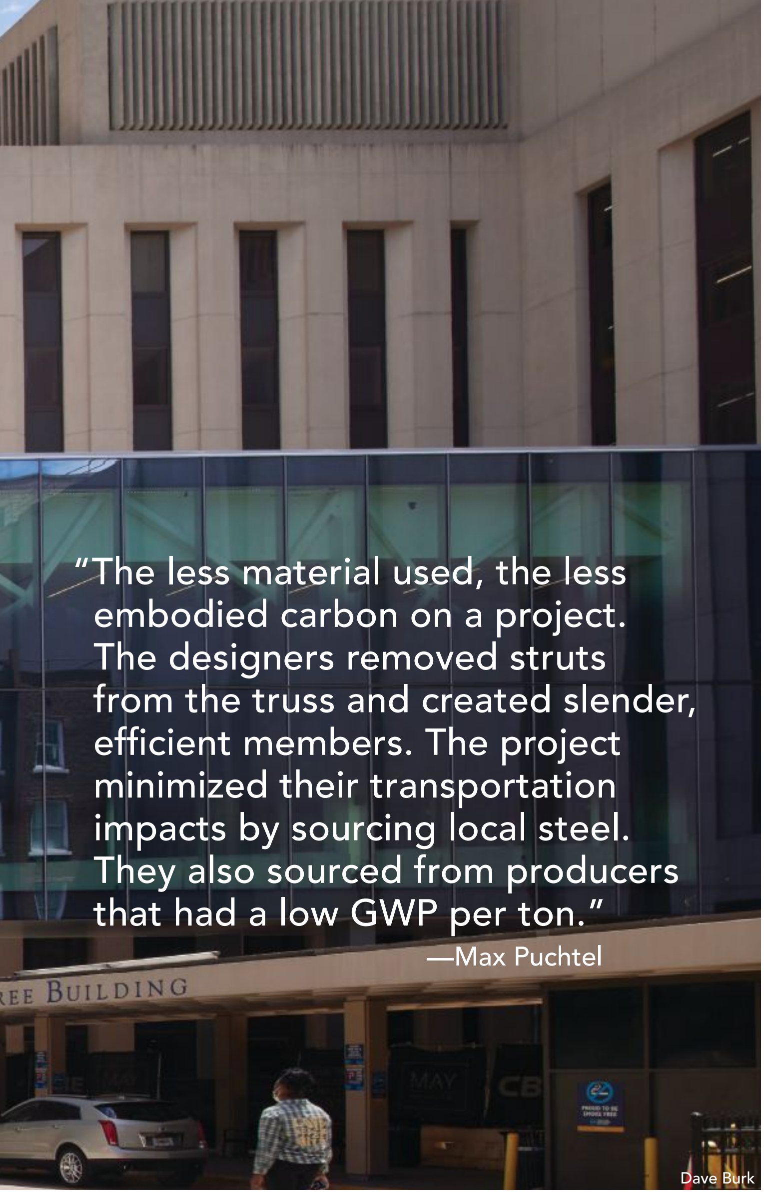
Though the bridge has two levels, the design team determined that the span could be efficiently managed with a single-story truss. The top level of the bridge comprises a structural steel truss at each side, while the lower level is hung from hollow structural section (HSS) hangers at the truss panel points. Besides these efficiency and constructability considerations, this choice also reflected the functional differences between the two levels. The top private level is more enclosed, while the lower public level is as transparent as possible.

The Emory Bridge spans Linden Avenue—a highly trafficked road that functions as an on-ramp to Interstate 85—an exterior courtyard, and a patient drop-off area for the current hospital's Peachtree Building. Ideally, its design would minimize road closures and bring negligible impact to the hospital, which needed to remain open during construction.

The design team chose structural steel because its bridge could be pre-assembled into the largest possible sections on the ground—before being lifted into place and assembled in just a single weekend. One lane of Linden Avenue was a laydown area to assemble the delivered pieces into two large box trusses that could be erected quickly and safely over the road. Two mobile cranes lift the two box trusses into place in one weekend. The sections were bolted together while suspended in the air, and the cranes remained hooked to the trusses until all back welds were complete.

Construction crews hung the bridge's lower level from the trusses, allowing Linden Avenue to be reopened while work remained ongoing.

Where exposed to view, the bridge members are architecturally exposed structural steel (AESS), consisting of square HSS sections connected to a milled steel node at the intersections of



"The less material used, the less embodied carbon on a project. The designers removed struts from the truss and created slender, efficient members. The project minimized their transportation impacts by sourcing local steel. They also sourced from producers that had a low GWP per ton."
—Max Puchtel

Dave Burk

Batson-Cook Construction

Dave Burk

the truss diagonals. The AESS material's aesthetic purposes were another factor in choosing steel because they allowed for the most slender profiles possible. The simple yet elegant detailing puts the structural steel's beauty on full display. The square HSS hangers supporting the bridge's lower level practically disappear behind the enclosure mullions and give that level the appearance of floating.

One of the major design challenges was the bridge's need to connect two buildings at different corresponding elevations. The lower level had to reconcile an elevation change of 4 ft 1 in., while the upper level had a change of 1 ft 4 in.

The design team strategically connected the two springing points with straight and slightly inclined walking surfaces to meet the maximum allowable slope. It then investigated several options for forming the geometry of the structural elements to accommodate these elevation constraints. The solution was to keep the top and bottom chords of the truss horizontal to simplify fabrication, and more importantly, to preserve the clarity and purity of the truss geometry.

Additionally, the chosen configuration maintained a consistent node geometry to facilitate fabrication and provided a regular datum for the attachment of the facade modules. The walking surface's slope was achieved using a slab-on-grade over-shaped geofoam. The bottom level framing, which hangs from the truss, was sloped to follow the walking surface. The lower-level façade units extend down from the bottom of the structure along the bridge to avoid trapezoidal glass elements.

The existing building structure did not have sufficient capacity to support a new bridge and would have required reinforcement. In response, the design team cantilevered the end of the bridge beyond the last support, ensuring that no new loads were imposed on the existing building.

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EXCELLENCE IN SUSTAINABLE DESIGN AND CONSTRUCTION

Pedestrian Bridge at the Winship Cancer Institute at Emory Midtown, Atlanta

Dave Burk


Dave Burk

Batson-Cook Construction

Dave Burk

The construction sequence aimed to minimize the time when highly trafficked Linden Avenue was closed by erecting the largest possible sections.

Trusting the Trusses

The bridge's primary distinctive feature is the upper-level truss that utilizes web members arranged in an innovative geometry, increasing the structure's efficiency.

SOM used several academic and internally developed structural optimization tools to arrive at an efficient structural form and minimize total material usage. One program, Polytop, starts with a design space of a solid 2D continuum of material and iteratively removes material to arrive at a solid-like approximation of the most efficient structural form. The other program, Ground Structure, utilizes a design space of a densely interconnected grid of linear elements and iteratively removes members to arrive at a sketch-like approximation of the most efficient structural form.

The results were combined with an applied rationalization considering the fabrication and construction of the bridge. The resulting geometry consisted of truss bays with skewed X-bracing that is symmetrically oriented about the mid-span of the bridge.

SOM has successfully designed several high-rises with a similar geometry for vertical bracing, including 800 W. Fulton Market in Chicago. However, the Emory Winship at Midtown Bridge is the first constructed example of a long-span structure with this truss geometry.

The truss diagonals were considered AESS, and the design team worked with aesthetic purposes and facilitating construction in mind. The team decided to maintain a consistent outer dimension for all the truss diagonals within each truss bay, ensuring a visual continuity of elements and avoiding connections with members of varying dimensions.

Similarly, the design team minimized the changes in member dimensions between bays to ensure a seamless transition along the truss. At the asymmetric connection of the truss diagonals, the team used a milled steel node to provide a clean, easily repeatable piece for a consistent connection. The resulting truss consists of W12×96 top and bottom chord members, while the truss diagonals comprise HSS4×4 through HSS8×8 elements.

The design team's preferred topology optimization tools determined the most structurally efficient form of the truss, ensuring material is used only where required and minimizing the overall embodied carbon footprint of the bridge. The support points of the bridge were also chosen to reduce the impact on existing structures, allowing them to remain in place and minimizing demolition and waste. ■

Owner
Winship Cancer Institute of Emory University

Owner's Representatives
Turner & Townsend Healthcare

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