

2017 | IDEAS² awards

INNOVATIVE DESIGN in ENGINEERING and ARCHITECTURE with STRUCTURAL STEEL

MODERN STEEL CONSTRUCTION is proud to present the results of AISC's annual IDEAS² Awards competition, which recognizes Innovative Design in Engineering and Architecture with Structural Steel. Awards for each winning project will be presented to the project team members involved in the design and construction of the structural framing system, including the architect, structural engineer of record, general contractor, owner and AISC member fabricator, erector, detailer and bender-roller. New buildings, as well as renovation, retrofit and expansion projects, were eligible, and entries were asked to display, at a minimum, the following characteristics:

- ▶ A significant portion of the framing system must be wide-flange or hollow structural steel sections
- ▶ Projects must have been completed between January 1, 2014 and December 31, 2016
- ▶ Projects must be located in North America
- ▶ Previous AISC IDEAS² award-winning projects are not eligible

The judges considered each project's use of structural steel from both an architectural and structural engineering perspective, with an emphasis on:

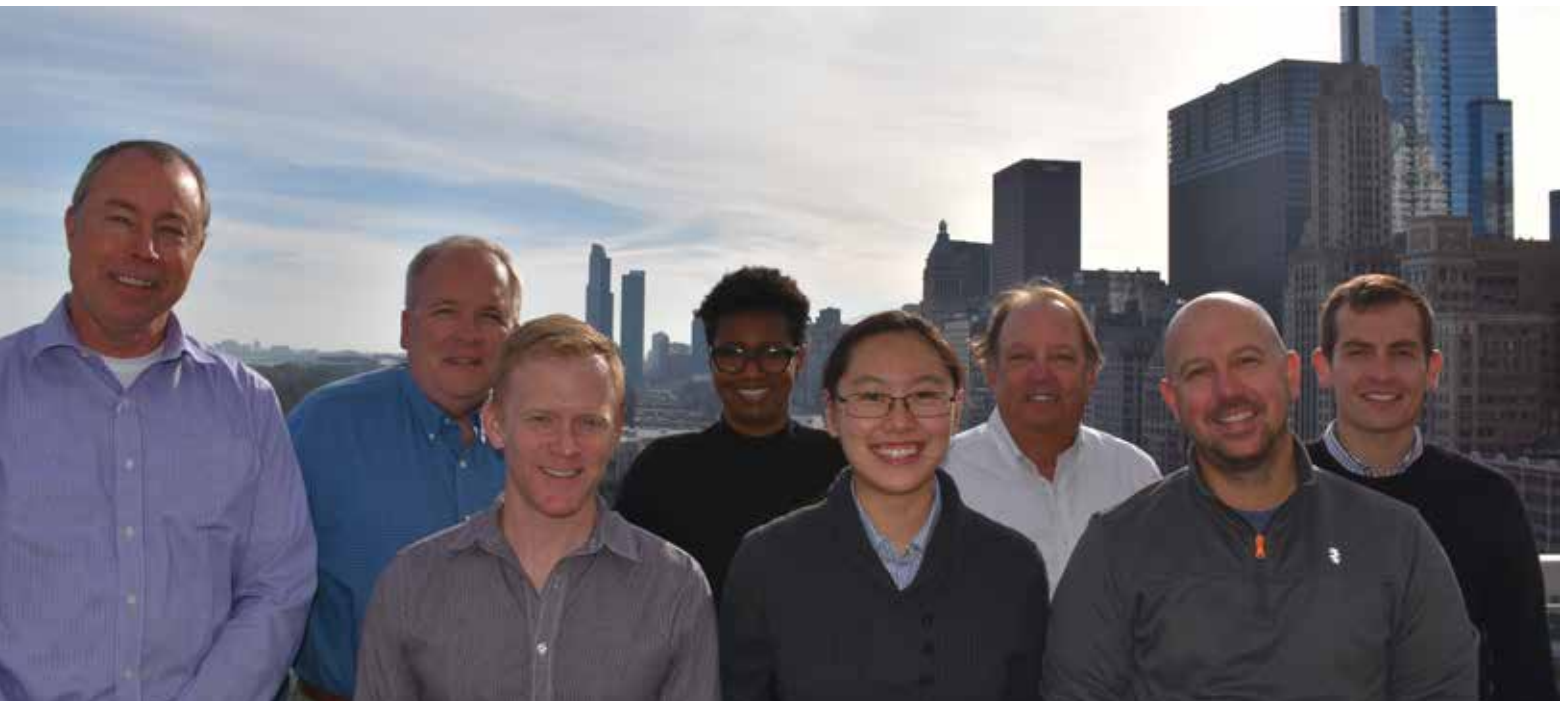
- ▶ Creative solutions to the project's program requirements

- ▶ Applications of innovative design approaches in areas such as connections, gravity systems, lateral load resisting systems, fire protection and blast protection
- ▶ The aesthetic impact of the project, particularly in the coordination of structural steel elements with other materials
- ▶ Innovative uses of architecturally exposed structural steel
- ▶ Advancements in the use of structural steel, either technically or in the architectural expression
- ▶ The use of innovative design and construction methods such as 3D building models, interoperability, early integration of steel fabricators, alternative methods of project delivery and sustainability considerations

A panel of design and construction industry professionals judged the entries in three categories, according to their constructed value in U.S. dollars:

- ▶ Under \$15 million
- ▶ \$15 million to \$75 million
- ▶ Over \$75 million

National and merit honors were awarded in all three categories, a Presidential Award of Excellence in Engineering was given and the jury also recognized steel's important role in public art by selecting an outstanding sculpture project.



▲ Jurors from left to right: Steve Clymer, David G. Allen, Geoff Weisenberger, Chris-Annmarie Spencer, April Wang, Sam Boykin, David Barista and Ben Varela.

Meet the Jury

David G. Allen, owner juror. David is the Space and Facilities Manager with the United States District Court for the Southern District of California and has been with the Federal Judiciary for 20 years. He has represented the interests of the federal courts in various design, construction and renovation projects across the country, including new United States courthouse building projects in San Diego, Cleveland and Rockford, Ill. He also has contributed to the development of operations continuity and emergency response plans for several district courts and has been FEMA trained as a federal emergency response official. Prior to his government service, David worked as an architect in the private sector for over 20 years. A native of Cleveland, David is a graduate of Miami University.

David Barista, trade media juror. David has covered the U.S. construction industry for more than 17 years, including multiple editorial roles at *Building Design+Construction* magazine, where he currently serves as editorial director. Previously, David was editor-in-chief of *Professional Builder*, *Custom Builder* and www.probuilder.com, which, combined, reach more than 200,000 residential design and construction professionals. He is a six-time Jesse H. Neal Award winner and a seven-time finalist. David has also won numerous editorial awards from the Construction Media Alliance and the American Society of Business Publication Editors.

Sam Boykin, III, steel fabricator juror. Sam was born and raised in Birmingham, Ala. He is a graduate of the University of Alabama and also took master's classes for finance and accounting at DePaul University. After graduating from college, Sam worked for Russell Athletic, living in Chicago for several years, then moved to Atlanta to work for his father in the steel fabrication business until the company was sold. Sam is now with SteelFab, Inc., in Atlanta, and is on the board of the Southern Association of Steel Fabricators.

Steve Clymer, general contractor juror. Steve has been with Shiel Sexton, a construction manager and self-performing general contractor in Indianapolis, since 1998. He started as an estimator and became director of pre-construction in 2000, then a partner in 2008. He managed the pre-construction department until 2014 but wanted to get back into operations, so he started his own industrial group within Shiel Sexton, where he manages projects from pre-construction through construction completion. Prior to working at Shiel Sexton, Steve worked as an estimator at Wilhelm Construction in Indianapolis from 1986 to 1998. Steve is a graduate of Indiana University-Purdue University at Indianapolis (IUPUI)

Chris-Annamarie Spencer, architect juror. Chris-Ann earned a bachelor of arts in architectural studies from the Caribbean School of Architecture at the University of Technology, Jamaica, and a master's degree in architecture from the University of Illinois at Chicago. During her studies there, she spent a semester in Rome studying historical design and its application to contemporary design. She was awarded the Martin Roche Fellowship for Independent Study, which allowed her to

travel and continue her study of urban and housing strategies in South African cities. She has served as project architect for residences in Glencoe and Chicago and recently completed the award-winning Inspiration Kitchens restaurant and the Alice B. Rapoport Center for Education and Engagement at the Goodman Theatre, both in Chicago. In 2012, Chris-Ann was recognized as a local innovator by the Chicago Urban League during their Economic Empowerment Summit. She was AIA Chicago's Dubin Family Young Architect for 2015 and the AIA National Young Architect for 2017.

Ben Varela, SE, PE, structural engineer juror. Ben is a licensed structural engineer with over 12 years of experience in the design of structural systems, specializing in seismic resisting design, complex geometry rationalization and efficient use of materials. In 2015, Ben founded WORKPOINT engineering following a nine-year tenure at Thornton Tomasetti in Los Angeles. Ben received his bachelor's degree in civil engineering from Monterrey Tech in Monterrey, Mexico, and his master of science from the University of California, Berkeley. He has participated in a broad range of projects, being responsible for the analysis and design of mixed-use, high-rise and commercial buildings, education facilities, performing arts centers, museums, sports facilities and transportation centers. He has also performed seismic evaluations and retrofits of existing structures.

April Y. Wang, engineering student juror. April is a structural engineering master's student at Purdue University's Bowen Laboratory and also earned her bachelor of science in civil engineering at Purdue. April worked five co-ops with HNTB during her undergraduate years, mainly on bridge design projects and bridge inspections. Her current research project at Purdue, "Seismic and Wind Behavior and Design of Coupled Concrete-Filled Composite Plate Shear Walls Core Walls for Steel Buildings," involves evaluating the use of concrete-filled steel shapes for core walls in high-rise buildings instead of standard reinforced concrete.

Geoff Weisenberger, AISC staff juror. Geoff has more than a decade of experience as a construction industry journalist. He has been the senior editor of *Modern Steel Construction* since 2012 and was in the same role from 2006 to 2009 before taking a three-year "hiatus" to be AISC's director of sustainability. Prior to his time with AISC, Geoff was an editor with *Consulting-Specifying Engineer* magazine. He has also contributed to several other publications, construction and otherwise, including *Colorado Construction* and the Chicago installment of hotel publication *Where*. Prior to his work in publishing, he worked in the software industry for several years. Geoff attended the University of Iowa, where he received a bachelor's degree in communications and minored in English.

2017 IDEAS² awards

OVER \$75 MILLION – NATIONAL AWARD

Samsung Americas Headquarters (Device Solutions), San Jose, Calif.

BALANCE AND INTEGRATION of indoor and outdoor office spaces drove the design of Samsung Americas' new Silicon Valley headquarters.

The idea was to create a collaborative campus that engages the public and encourages staff to reach their full potential, and the resulting 10-story tower is organized around a central courtyard. With no perimeter columns on the east and west sides, the tower appears to float at every third level and offers occupants unobstructed external views. The resulting spaces, and the atriums around them, are dedicated collaboration areas, facilitating casual meetings and breaks from the traditional work spaces.

The open-air garden floors required the structure to accommodate 45-ft × 300-ft column-free areas at the east and west sides via two-story cantilevered trusses. Considering the building's location in a highly seismic area, the effects of vertical seismic accelerations had to be modelled through a site specific vertical response spectrum analysis. Contributing lateral stiffness of the two-story, 180-ft-long trusses also had to be considered and led to the development of a unique sliding joint detail, at the truss bottom chord, that ensures that lateral forces are not picked up by the truss diagonal elements. As the bottom chord of the truss sits on top of the floor slab, a floating bench was created to integrate the structure into the finished space.

Stability for the courtyard tower is provided by ductile reinforced concrete cores on the north and south ends of the tower, and steel link beams are used to carry the high demand from combined tension and shear forces in the shear walls near connections of the cantilevered trusses. In consideration of differential shrinkage and thermal movements of the two materials, special details were developed for the steel truss-to-concrete core connections. Service coordination was especially critical into and out of the tower cores as space had to be shared between MEP services and elevator and stair openings without compromising ductile reinforced coupling beams and shear wall boundary elements.

With vast column-free areas, large deflections of the structure had to be calculated, reported on drawings and coordinated with curtain wall details. In order to keep pace with the quickly developing design and track changes in loading and geometry, a parametric Grasshopper script was written to link deflection output from the ETABS analysis model directly to Revit. The Revit model was also used for detailed 3D coordination and clash detection throughout design and construction, resulting in the integration of services via openings in the steel and concrete beams. These openings had to be carefully studied and precisely located since some of them penetrate truss chords and concrete link beams. This coordination helped the team to reach the maximum possible ceiling height, critical to delivering the collaboration and

focus spaces throughout the building. An efficient structural design was also realized through strategic selection and placement of tree pits, planted areas and pedestrian zones on the suspended garden levels of the office towers, and the design team ensured that soil buildups were optimized and accurately modelled to keep steel weights down.

The façade for the open-plan office configuration is designed to maximize daylighting through the courtyard while at the same time reducing solar heat gain. The façade design received input from the entire design team to create the patterns of the punched windows, maximizing direct daylight into the building while also strategically shielding it to avoid hot spots. Around the inner courtyard perimeter, curved glazing allows the truss diagonals to be visually expressed and contribute to the unique image and feel of the building.

Buckling restrained brace frames provide stability for the smaller data center and café buildings adjacent to the main tower. The structural strategy carefully considered the continuity required for occupants to move between the various areas while allowing for buildings to move independently under seismic, wind and thermal loading via separation joints.

In order to meet energy- and resource-efficiency goals, the team incorporated elements such as low-energy mechanical systems, low-flow water fixtures and LED lighting; not surprisingly, Samsung LED light boards are used in all of the light fixtures throughout the space. The lighting control systems across the project use sensors and programming to automatically optimize energy savings, maximize the use of daylighting and ultimately enhance the occupant experience.

Careful planning and coordination with the contractor ensured an efficient sequencing of construction on the densely populated site—which was crucial as the schedule allowed only nine months for design—and the architects and engineers worked together three days each week at a colocation space on-site.

Owner

Samsung Americas, San Jose, Calif.

Owner's Representative

Samsung C&T, San Jose, Calif.

General Contractor

Webcor, San Francisco

Architect

NBBJ, Los Angeles

Structural Engineer

Arup, Los Angeles

Steel Team

Fabricator

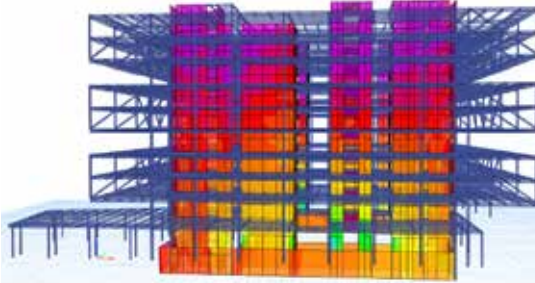
Gayle Manufacturing, Woodland, Calif.



Detailer

A.D.S. Engineering, Inc.

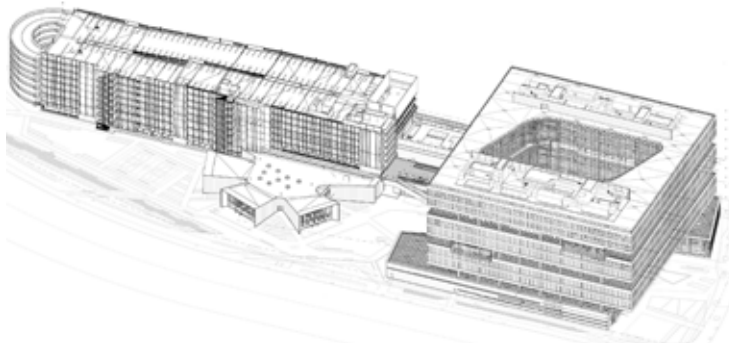




Wow! How creative can a design team get?
—Steve Clymer



Griffith Photographer, San Francisco;
Arup, Los Angeles



SAMSUNG

Modern STEEL CONSTRUCTION

OVER \$75 MILLION – NATIONAL AWARD

National Museum of African American History and Culture, Washington, D.C.

IN AN AREA DENSELY POPULATED with eye-catching edifices of monumental proportions, the National Museum of African American History and Culture (NMAAHC) fits right in.

Located on Washington's National Mall in the shadow of the Washington Monument, the museum, which opened this past fall, features an inverse truncated pyramid, known as the corona, covered by bronze coated panels and supported by a network of steel trusses. To keep the five-level, 409,000-sq.-ft structure from obstructing views of the Washington Monument and to maintain the sight lines along the mall, 60% of the museum is below ground, going as deep as 70 ft. In addition, the overall height of the building (90 ft aboveground) was reduced to align with key elements of the Commerce Building to the north.

The programmatic and architectural designs required column-free spaces at the ground-floor lobby and above-grade floors. To achieve this, the entire superstructure and façade system is supported on four composite structural cores consisting of steel floor beams and corner columns infilled with reinforced cast-in-place concrete walls. The cores support steel framing and cantilevered steel beams at each floor as well as perimeter vertical trusses on certain sides; this framing carries the gravity loads on each floor. The exterior façade system—a combination of glazing and architectural panels—is hung from the fifth floor by exposed steel plate box cantilevers.

In addition to achieving programmatic goals, these systems were selected for constructability, schedule and cost purposes. The design and construction team explored multiple potential structural systems, and the hybrid steel-and-concrete core system allowed a quicker sequence of construction than the other options due to integration of temporary shoring and bracing for lateral stability into the construction and reduced dependence on concrete and its associated requirements. There were challenges with this approach, including coordinating the shear studs and concrete infill wall reinforcement with the many architectural and MEP openings in the core walls and placement of significant structural reinforcement in fairly confined spaces. The design and construction teams worked closely during erection in the form of frequent on-site observation, multiple reviews of shop drawings and daily coordination calls to resolve field issues.

Similarly, the at-grade history gallery roof, which had to span over a 120-ft by 350-ft opening that was 70 ft deep, was originally designed as concrete but was changed to steel construction for cost and schedule reasons. The steel design, using long-span beams and plate girders, allowed long-span construction with minimal columns to provide the required gallery space—plus it eliminated the need for complex and costly shoring that would have been necessary for concrete construction, which would have delayed interior work in the gallery. The biggest challenge involved the welded splices required in the plate girders. Some of these girders spanned the entire length of the history gallery, with multiple field splices per girder. Upholding the overall dimensions of these plate girders, all while maintaining the allowable root gaps for the PJP welds, required precise fabrication and field fit-up.

The main tower was built like a conventional steel tower, the exception being the concrete cores at each corner, which were integrated into the steel frame. The cores were poured concurrently

while steel erection took place, with lower core elevations being poured while higher steel elevations were still being constructed. The steel in these cores had to be approved and signed off on prior to concrete pours, and these core areas needed to be detailed and completed prior to the rest of structure as the concrete needed to be in place before the next phase of erection could begin. Extra coordination was also required in the cores to locate all of the hardware that was required in such tight spaces. Weld studs, weldable couplers and rebar were constantly found occupying the same space. Meetings were held daily with the design team to discuss the day's specific challenges and generate solutions that often meant creating one-of-a-kind details for each corner of the core.

Once the main building was erected and the cores were poured and cured, shoring towers were placed at the entire perimeter of the building to erect the cantilever steel, and this shoring remained in place until the fifth-floor corona steel box girders could go into place.

The final phase of erection was the “porch,” a freestanding canopy structure at the south entrance that supports a green roof. The main challenge for this assembly was the size of the members and proximity to the building to which the crane could sit. Due to the loads imposed on the structure's basement walls by the crane, the crane had to be placed at 15th St. NW and Madison Dr., with the furthest pick taking place from 168 ft away. The limited time that these roads could be closed created a narrow window of time to complete the porch, and the entire assembly was erected in 10 days, including hoisting 32-ton box columns and 66-ft-long plate girders, with the girders spanning 170 ft between the columns.

For more on this project, see “Engineering an Experience” in the November 2016 issue (www.modernsteel.com).

Owner

Smithsonian Institution, Washington, D.C.

General Contractor

Clark/Smoot/Russell A Joint Venture, Bethesda, Md.

Architects

Adjaye Associates, London
SmithGroupJJR, Washington, D.C.
Perkins + Will, Durham, N.C.

Structural Engineers

Silman, New York
Guy Nordenson and Associates, New York

Steel Team


Fabricator

SteelFab, Inc., Charlotte, N.C. 

Erector

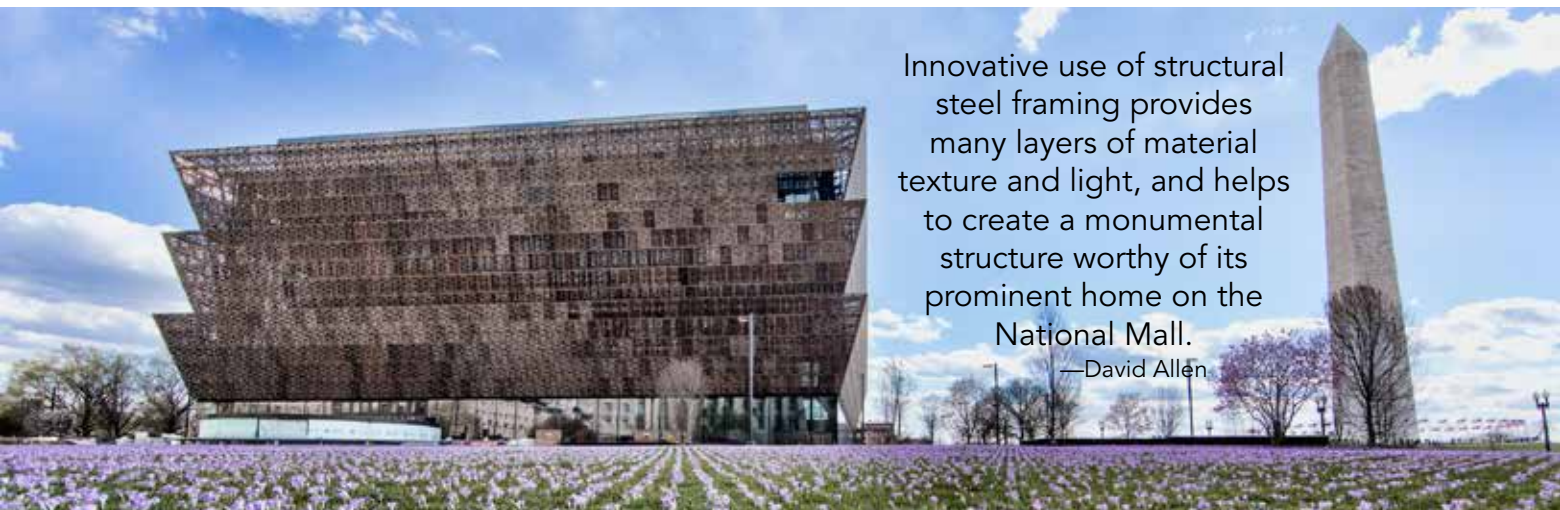
Bosworth Steel Erectors, Dallas 

Detailers

Prodraft, Inc., Chesapeake, Va. 
SteelFab, Inc.

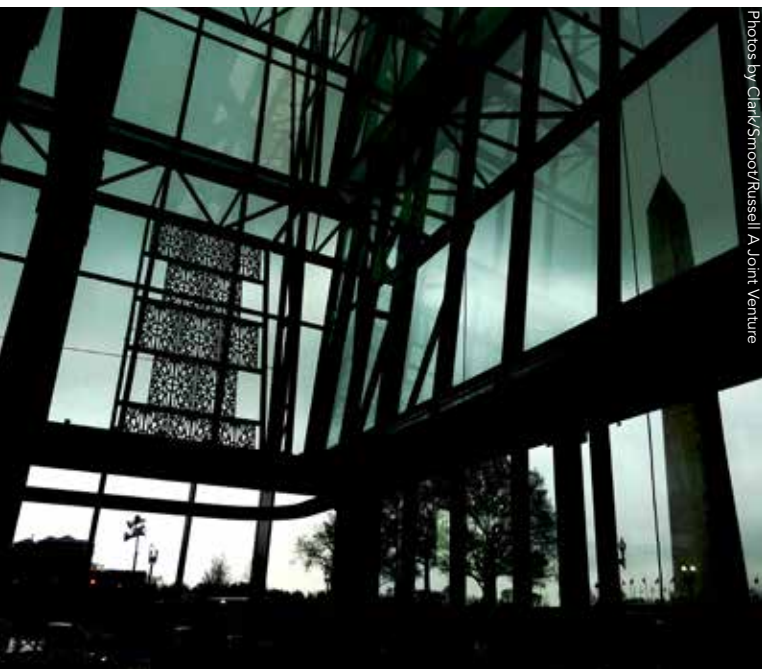
Bender-Roller

WhiteFab, Inc., Birmingham, Ala. 



Innovative use of structural steel framing provides many layers of material texture and light, and helps to create a monumental structure worthy of its prominent home on the National Mall.

—David Allen



Photos by Clark/Smoot/Russell A Joint Venture



OVER \$75 MILLION – MERIT AWARD

Fulton Center, New York

FULTON CENTER IN LOWER MANHATTAN brings people together. Lots of them.

The new transit hub unites six formerly separate New York City Subway stations that were originally constructed between 1905 and 1932 and were ill-equipped to meet the 21st century demands of a transit system serving a metropolitan area of 20 million people. The \$1.4 billion center, which includes the new transit center building, the renovated historical landmark Corbin Building, new underground concourse and numerous access and platform improvements, serves more than 300,000 travelers every day.

The extensive aboveground and underground construction, in the midst of a bustling urban environment, was made even more complex by the need to maintain continual subway service and street access in the area. The events of 9/11 added an additional burden, requiring the design to account for significant changes in building codes, security and safety requirements.

In addition, the design team was called upon to ensure compatibility between old and new elements of the project. The geotechnical design of the Fulton Center had to account for the adjacent historic Corbin Building, whose shallow footings sit approximately 20 ft above the final concourse level of the new transit center. The coordination of these two associated build-

ings, built on fine sands and silts, required particular attention including an interstitial building, rigorous monitoring and a stiff soil-retaining system of internally braced secant pile walls.

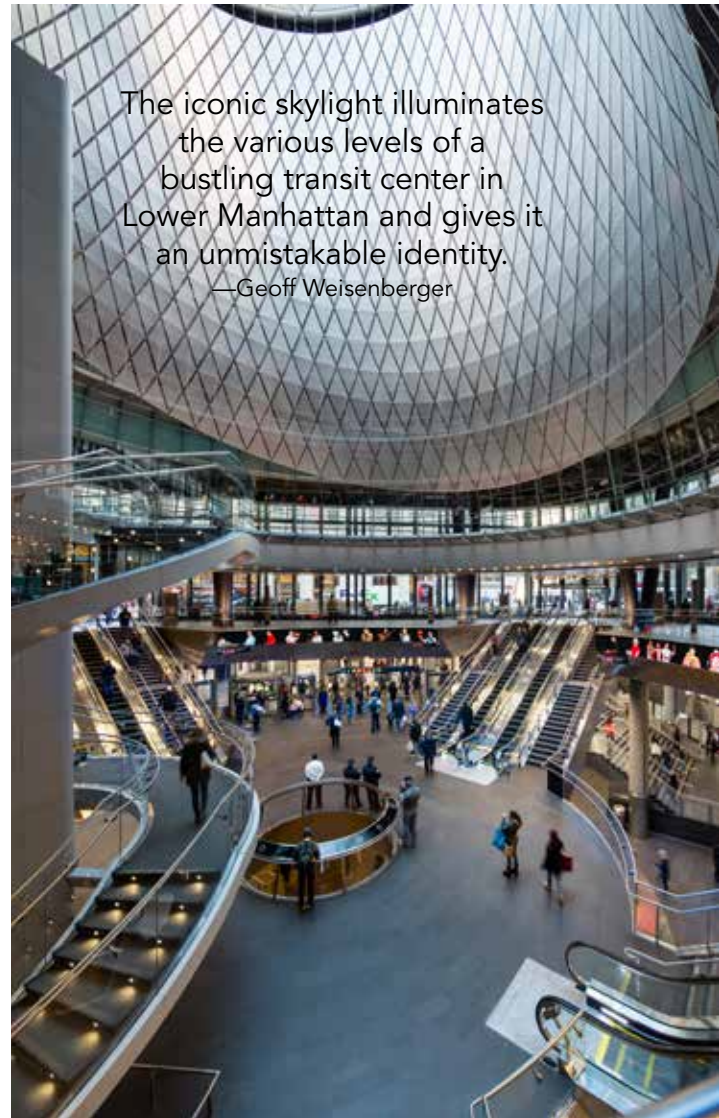
The complexity of the project area required a combination of conventional and high-definition 3D laser scanning techniques to collect extremely accurate data on the ground conditions and existing buildings—a first for a Metropolitan Transportation Authority (MTA) project. The design integrated a rigorous sampling and materials analysis program with a detailed 3D CAD/BIM analytical model of the station to assess both stresses and displacements of the century-old cast iron and concrete tube under various hypothetical construction sequences.

To simplify construction, new framing was erected from inside the existing A/C Train line mezzanine, with some structural components delivered by train, eliminating the need for street openings. Supports for existing structures were transferred directly onto newly installed systems using modern jacking techniques, reducing the need for temporary structures and maintaining passenger routes with limited service disruptions.

The renovation and upgrade of the Corbin Building called for significant structural modifications. The design team applied mechanically fixed shear anchors to existing wrought iron



Photography: James Ewing Photography, Aup



The iconic skylight illuminates the various levels of a bustling transit center in Lower Manhattan and gives it an unmistakable identity.

—Geoff Weisenberger



beams, allowing them to act compositely with the new concrete slabs to support programming requirements. This allowed integration of lighting and power cable into the reengineered floorplate. An interstitial building provides access to the neighboring Fulton Center, a fire egress route and structural support for both buildings, as well as gas, electrical and data connections. The resulting design has ensured the preservation of many of the building's original historical elements while bringing it up to code.

When it comes to the new building, engineering elements have been seamlessly integrated into the existing stations and platforms, and the more visible elements offer inspiration through the meeting of art, architecture and engineering. Grimshaw, one of three architectural designers on the project, provided a building concept for the main transit center head house, which includes a three-story glazed pavilion set around a central eight-story dome structure. The centerpiece of the entire station is comprised of the oculus and tensile "sky-reflector net" assembly that top the pavilion. An inclined, circular skylight measuring 50 ft in diameter collects and redirects natural sunlight down and through the building to the subterranean levels below.

The design team worked closely with the artist, James Carpenter, to realize the sky-reflector net, which is made of 112 stainless steel cable pairs descending from the top of the oculus overhead. Suspended within the openings of the net are

896 rigid, anodized aluminum infill panels, held together by universal node connection assemblies and positioned to reflect and diffuse natural light into the public spaces below.

The cable net extends the full height of the central public space. It is suspended from 56 connection points around the compression ring of the oculus and is anchored to as many cantilevered beams at levels 2 and 3. Its form is that of a skewed hyperboloid (hyperbolic paraboloid shape). Unlike a regular hyperboloid, this form is not a single-ruled surface. Moreover, the skewed form has only one axis of symmetry. As a consequence, the shape of each four-sided diamond-shaped infill panel is unique. These shapes are set out by the lengths and intersecting angles of cable segments adjacent to each side.

Owner

Metropolitan Transportation Authority – New York City Transit

General Contractor

Plaza-Shiavone Joint Venture, New York & New Jersey

Architect

Grimshaw Architects, New York

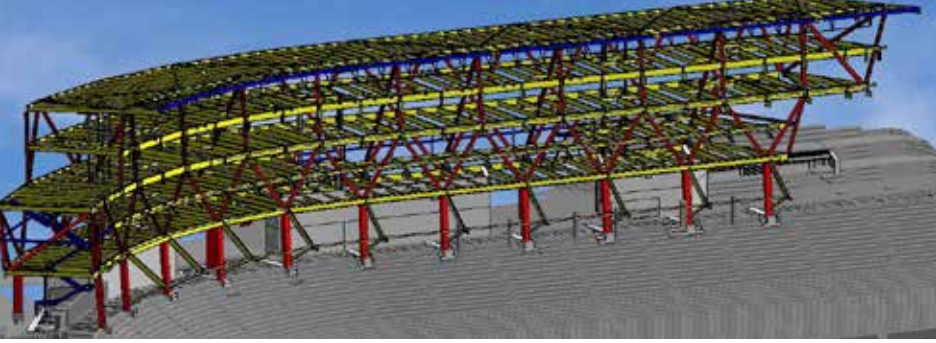
Structural Engineer

Arup, New York

Steel Fabricator and Detailer

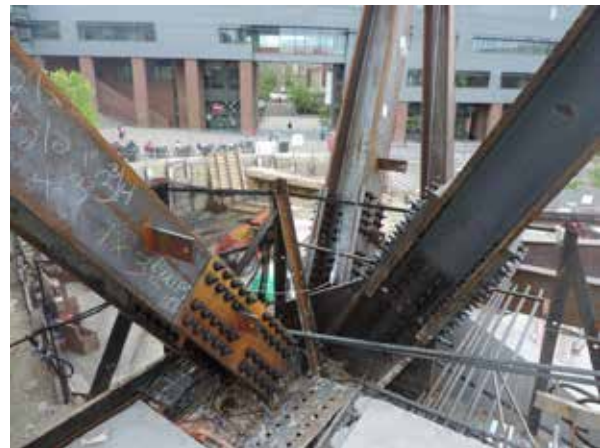
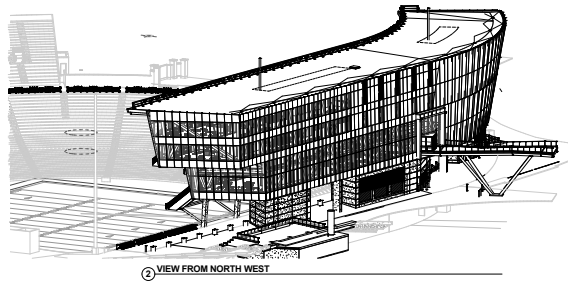
STS Steel, Schenectady, N.Y. 





A refreshing take on stadium press boxes. Where such structures are often stoic and boxy, this one is expressive and fluid.

—Geoff Weisenberger



OVER \$75 MILLION – MERIT AWARD

Nippert Stadium West Pavilion, Cincinnati, Ohio

THE UNIVERSITY OF CINCINNATI'S Nippert Stadium, home field to the school's Bearcats football team, is more than just a venue for a half-dozen or so football games every year.

It's also left open for the student body to enjoy as a campus green space on non-game days. Originally constructed in 1924 and last updated in 1992, the stadium was in need of a major renovation to increase seating capacity and, as many college stadiums have done in recent years, create more revenue-generating spaces and improve fan amenities.

In the case of Nippert Stadium, this manifested in an \$86 million addition that includes a 115,000-sq.-ft, 130-yard-long West Pavilion with premium seating, luxury suites, press facilities, a footbridge connecting to the adjacent Tangeman University Center (TUC), an elevated pedestrian concourse cantilevered from the existing east pavilion seating and a terrace with below-grade restrooms and concessions.

The signature element of the renovation is the west pavilion, which wraps the upper west edge of the seating bowl and towers more than 120 ft above the field below. The building's dynamic form defines the stadium edge, and a curtain wall with large glass panels facilitates views through and from the structure, showcasing the efficient X-braced structural frame that helps to establish the building's identity.

The facility's shape and design evolved out of the need to solve several challenging site constraints, including proximity to TUC, accommodation of a busy loading dock and a fire lane and avoiding one of the university's main utility tunnels below

the building. With the fan experience in mind, the designers soon realized that it was impossible to locate the building over the concourse and still provide optimal viewing angles from the new suites and premium seating with a traditional vertical layout. The creative solution was to lean the field-side columns 10° off vertical and the back row of columns 18° off vertical above the first elevated level. Internal four-story super-diagonals resist this "lean" and provide lateral bracing for the upper portions of the building.

With leaning columns and long spans, it was evident that a steel superstructure was necessary. Several iterations of the building's shape were considered before the final design was settled. The end result included a dramatic 60-ft north cantilever, a 178-ft-long curved column-free span over the loading dock and a 1,400-sq.-ft outdoor terrace for special events. These structural engineering accomplishments were made possible by the dramatic X-braced frame, which provides strength and stiffness for both gravity and lateral loads.

To limit displacement of the football team to only one season, a fast-track construction process was employed, including early packages for demolition, foundations and the structural frame. Demolition of the existing press box started while the design process was continuing, and structural steel fabrication began while the architectural and MEP documents were being completed. Also, a complete 3D scan of the existing lower levels was performed, generating a digital model that could be used by the design team during design to



set foundation locations while avoiding obstructions below the concourse.

While the majority of the main structural frame is steel, the ground level of the stadium is exposed cast-in-place concrete, requiring a direct transfer of large forces from the steel frame to the concrete walls. Steel columns were embedded in the concrete to provide a direct transfer of the loads. L-shaped precast seating at the upper two levels required direct communication between the structural steel fabricator and the precaster to coordinate support points. But perhaps no other element created as many coordination challenges as the glass curtain wall. This one-of-a-kind curtain wall was a design-build element completed after the structural frame was erected, and the structural team guided the curtain wall contractor on the selection of attachment methods and locations along the structural frame. The end result was a diagonally oriented parallelogram-shaped glass and metal panel façade that solidifies the building's place among the other signature structures on campus.

With the building's sloping geometry, 3D modeling of the steel frame was necessary to determine how the pieces would fit together. It was not until this modeling was underway that the complexity of the nodes was fully appreciated. The perimeter X-shaped frames all slope in three dimensions and yet have to provide support for floor framing at each level. Members meet at theoretical nodes at a common plate to transfer large gravity and lateral loads. To complicate detailing even further, steel beams along the east façade cantilever through the node to support precast seating at two levels. Fabrication of large portions of the nodes in the shop provided better quality control, and

the use of oversized holes with slip-critical bolts allowed for additional field adjustment.

Because of the sloping frame, traditional construction methods could not be used, and a detailed erection plan was needed. The overlapping steel and concrete structure required specific sequencing, with several planning sessions held to discuss various construction scenarios. The design team's knowledge of the structural frame was shared with the erector's engineer to guide the development of the erection process. An intertwining series of wire bracing and soldier beams was installed and kept in place until several levels of steel were erected and slabs were poured. The building was intentionally constructed out of plumb, knowing that it would continue to lean as erection continued upwards, and ongoing surveys of critical locations ensured that the steel frame ended in the desired location.

Owner

University of Cincinnati, Cincinnati

General Contractor

Turner Construction Co., Cincinnati

Architect

Heery Design, Atlanta

Structural Engineer

THP Limited Inc., Cincinnati

Steel Team

Fabricator

Cives Steel Co. – Mid-West Division, Wolcott, Ind.



Erector

Ben Hur Construction, Fairfield, Ohio



\$15 MILLION TO \$75 MILLION – NATIONAL AWARD

Los Angeles Valley College Monarch Center, Valley Glen, Calif.

THE MONARCH CENTER is a new hub of activity on the Los Angeles Valley College campus.

The dramatic soaring architectural forms of this new 41,000-sq.-ft student union showcase the versatility and elegance of structural steel as a building material. The U-shaped structure includes a health center, a cafeteria, a bookstore, a convenience store and administrative services, and the enclosed courtyard is topped with a sloping butterfly-form canopy that reaches 41 ft above grade at its highest point.

The student union portion of the building is located on a second-floor “skybox” supported by a steel truss system between the roof and second floor. These 100-ft-long, roof-to-floor trusses, with six bays of diagonal steel webs, span over steel columns at each end, providing unobstructed ground-floor space for student gathering and pedestrian circulation to the cafeteria. The trusses also define the interior space of the second floor. With steel beams spanning 50 ft between the trusses, the skybox is virtually column-free. And via extensive use of glass, the truss system allows the floor space to maximize harvesting of natural daylight, a key part of the sustainable energy performance strategy of the building. Tapered steel floor beams are cantilevered from the trusses to create the floating effect of the skybox, and these beams also support the outdoor second-floor patio and walkway.

Beyond its aesthetic intent, the butterfly roof canopy also serves an important role in the performance of the “sustainable mall” below. The structural steel framing of the canopy was designed and optimized such that only five 16-in.-di-

ameter hollow structural section (HSS) columns land in the nearly 9,000 sq. ft of the courtyard below. The elegant edges of the canopy are supported by a series of tapered steel beams that cantilever up to 20 ft to create the dramatic form of the canopy. Due to the complex geometry of the intersecting cantilevered steel beams, a special steel box plate connector was designed to facilitate constructability and rapid erection of the main steel components. The canopy is also designed to transfer all seismic or wind-induced loading into the lateral force resisting system of the main structure, rather than relying on the canopy columns to aid in resistance through cantilever action. This allowed the columns to be much smaller in both size and quantity, and ultimately less intrusive to the open space of the courtyard.

For more on this project, see “Light as Air” in the February 2017 issue (www.modernsteel.com).

Owner

Los Angeles Community College District, Valley Glen, Calif.

Owner’s Representative

BuildLACCD, Monterey Park, Calif.

General Contractor

McCarthy Building Companies Inc., Newport Beach, Calif.

Architect and Structural Engineer

LPA, Inc., Irvine, Calif.



A vibrant and uplifting steel structure that takes full advantage of California's climate and sunshine.
—David Allen



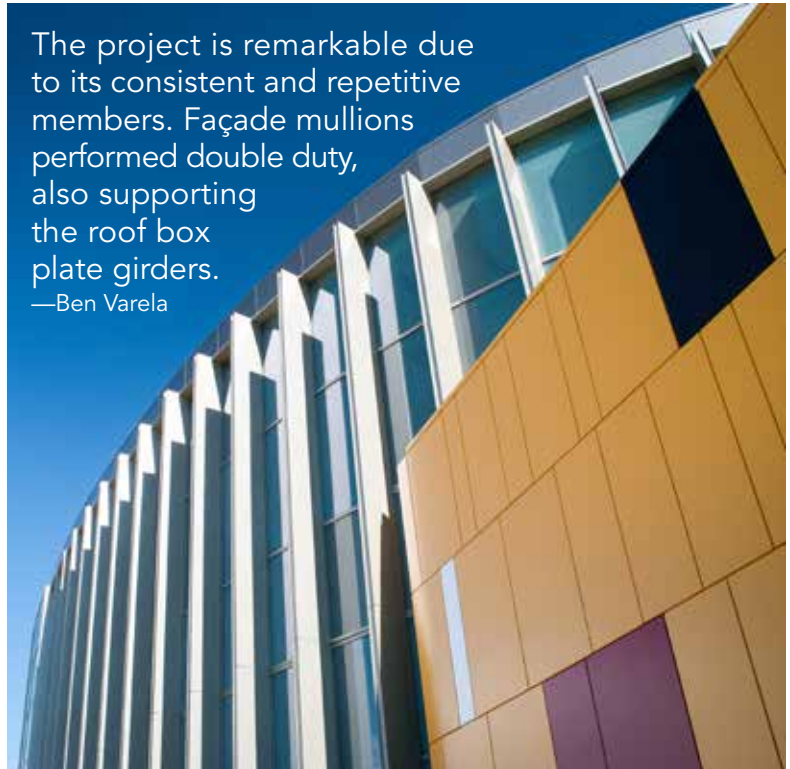
Photos by Costea Photography, Inc.





The project is remarkable due to its consistent and repetitive members. Façade mullions performed double duty, also supporting the roof box plate girders.

—Ben Varela



\$15 MILLION TO \$75 MILLION – NATIONAL AWARD

Terminal East Infill at Austin-Bergstrom International Airport, Austin, Texas

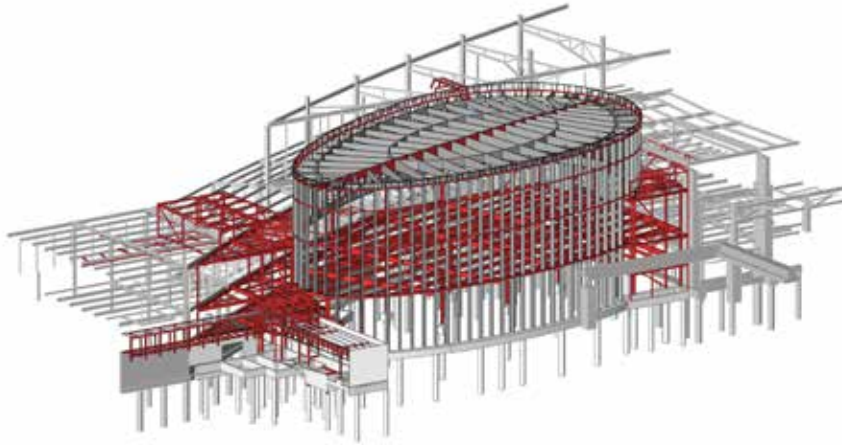
AS AUSTIN HAS GROWN, so has the need to expand its airport.

Opened in 1999, Austin-Bergstrom International Airport recently completed an expansion project—the Terminal East Infill—that included 55,000 sq. ft of new space and renovation of 17,000 sq. ft of existing space.

Bound on three sides by the existing terminal and one side by the terminal access road, the new building is oval in shape and is roughly 115 ft by 200 ft, with its centerline rotated roughly 15° from the existing terminal. The new building's feature space is a grand hall on the concourse level. In order to facilitate passenger queuing, preserve sightlines for TSA security requirements and create a soaring aesthetic for the 50-ft-high space, the hall needed to be free of interior columns and employ a long-span roof system. Traditional systems such as long-span trusses and space grids were considered but were deemed undesirable by the architect.

Instead, the space is topped by an elegant exposed steel “two-way” roof system, in which loads are distributed in both the short- and long-span directions to the supporting elements around the perimeter. The system is composed of custom steel shapes created by welding steel plates into built-up sections; these shapes were used for all primary exposed structural steel in the new building. A central roof spine runs nearly 200 ft between the east and west ends of the building, with symmetric pairs of roof box beams flaring out from the spine to perimeter box columns spaced at 12 ft on center around the perimeter of the space. Each pair of beams joins the spine in a visually seamless “node,” with welded connections providing an elegant transition between the various roof elements. Similarly, the roof beams are welded to the tops of the box columns at the perimeter.

The roof structure varies in depth from perimeter to center and along the length of the central spine, and the depth of



Photos by Architectural Engineers Collaborative

the members roughly follows the moment diagram of the two-way system. Individual roof beams are tapered, with the deepest tapering from 30 in. at the perimeter to 70 in. towards the center of the room, where the moment demands are highest. In addition, two rings of bracing members—consisting of the same built-up box sections—are located to maximize both the stability of the roof beams and the aesthetic expression of the roof structure. Similarly, standard HSS wall girts ring the oval perimeter at three different elevations, tying together and stabilizing the dozens of moment frames comprised of pairs of box columns and roof beams.

Early in the design, a mock-up was constructed to simulate the fabrication of box beam elements and their intersection at the roof, with a particular focus on the localized deformation effects due to welding during fabrication and fit-up. This exercise informed weld detailing during design and prompted the addition of internal W6×16 stiffener members in many of the roof box beams. The central spine member was also modified to a cover-plated truss to streamline constructability and facilitate full moment connections at each roof beam connection.

For more on this project, see “Looking Skyward” in the September 2015 issue (www.modernsteel.com).

Owners

Austin-Bergstrom International Airport
City of Austin

General Contractor

Hensel Phelps, Austin

Architect

Page, Austin

Structural Engineer

Architectural Engineers Collaborative, Austin

Steel Team

Fabricator

Hirschfeld Industries, San Angelo, Texas



Erector

Patriot Erectors, Dripping Springs, Texas



Detailer

Consteel, Saltburn-by-the-Sea, U.K.



\$15 MILLION TO \$75 MILLION – MERIT AWARD

Weber County Library Headquarters Branch, Roy, Utah

THE WEBER COUNTY LIBRARY certainly encourages “light reading.”

Located adjacent to the new North Park Elementary School in Roy, Utah, the nearly 75,000-sq.-ft facility was built to serve as the new library headquarters for Weber County and also allowed the original main library branch in Ogden to begin seismic renovations needed to meet life safety standards.

And it incorporates a 143-ft “light bar” that begins in the main entrance and continues east through the building. The light bar is a 7-ft, 3-in. by 7-ft raised section of roof, designed with a Vierendeel truss system, that cantilevers 28 ft beyond the east face of the building. The truss is constructed of HSS6×6 members for the top and bottom chords, with an average spacing of 6 ft, 8 in. between vertical web members. The truss structure was infused with glass panels to provide natural light throughout the art gallery and east lobby, and the book stacks area is surrounded by glass windows on three sides and features large skylights throughout the roof structure to bring in even more natural light.

Extensive analysis of the cantilevered truss system was performed, and potential movement due to wind, snow and seismic loads was studied to minimize deflections and protect the glass panel system. The top of the light bar was built using 1½-in. b-deck between the trusses, and a few of the truss panels were infilled with b-deck to transfer shear loads, allowing the truss to become part of a folded diaphragm system and providing a load path to transfer lateral loads to shear walls.

The roof structure is supported by HSS 10.75-in.-diameter columns that gradually taper to 6-in.-diameter sections at the base and roof. This taper provides a slender profile to the columns within the book stacks area as well as a desirable transition into the exposed wide-flange beam system that is infused with large skylights to provide natural light throughout the building. To create the tapered column sections, ½-in. plate was rolled into a conical shape with intermediate stiffener plates, and all seams used full-penetration welds that were ground smooth to eliminate blemishes.

The exposed roof structure, which cantilevers over the two-story central curriculum area on three sides, consists of wide-flange beams with sections that gradually reduce in depth as they cantilever 22 ft over the outdoor reading area. Continuous girder beams align between columns, and continuous W-beam joists overlay these girders. The girders and beams step down in depth as they cantilever beyond the building’s footprint to create a thin roof profile that is accented by a continuous bent plate at the roof’s edge.

One of the library’s central features is a sculptural stair that overlooks the reading room with a two-story glass wall. The stair is designed with a folded steel plate tread that extends beyond the centrally placed stringers. Attachments to support the structure were designed with eccentric connections buried within wall cavities, and the top landing is designed to cantilever into open space.

The southeast portion of the building, home to pre-teen services, incorporates floor-to-ceiling exterior glass walls on three sides. To accommodate these walls, moment frames were inset from exterior windows, and exterior W-columns were installed proud of the glass wall, with tall narrow continuous HSS beams installed at the inside face of the column to support the roof structure.

Owner

Weber County, Ogden, Utah

Owner’s Representative

Weber County Library System, Roy, Utah

General Contractor

R&O Construction, Ogden, Utah

Architect

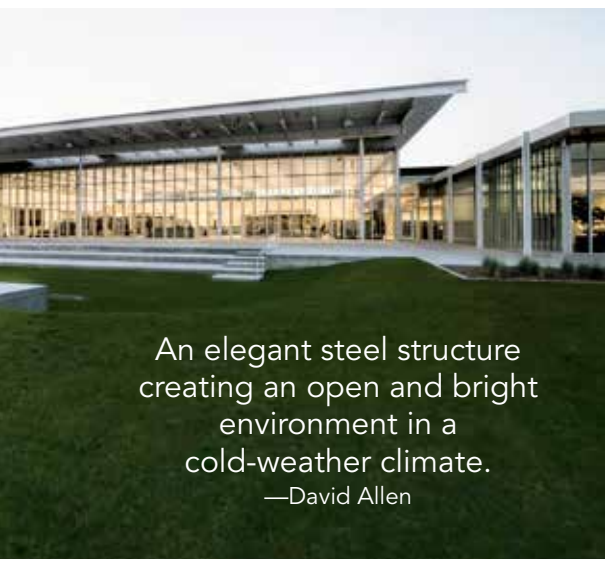
Prescott Muir Architects, Salt Lake City

Structural Engineer

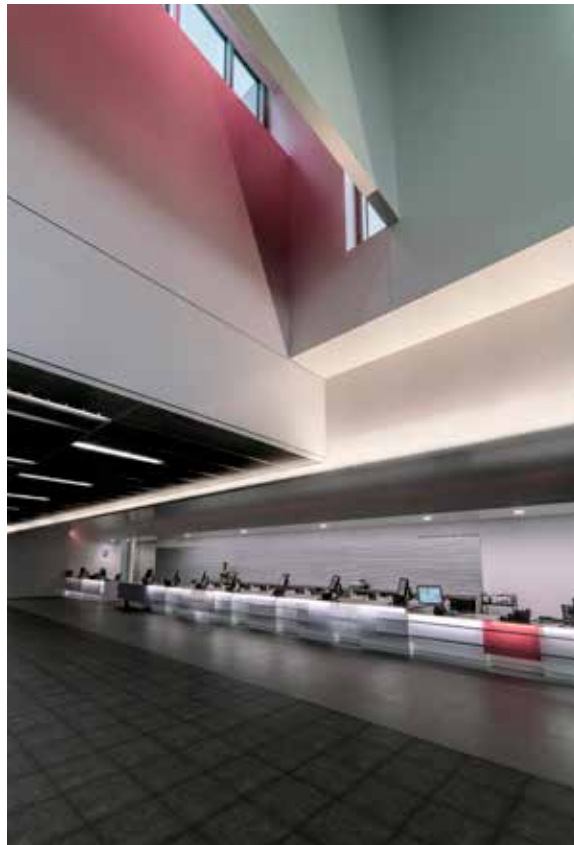
ARW Engineers, Ogden, Utah



Photos by Scott Peterson Studio



An elegant steel structure creating an open and bright environment in a cold-weather climate.
—David Allen



\$15 MILLION TO \$75 MILLION – MERIT AWARD

Southwest University Ballpark, El Paso Texas

EL PASO'S TRIPLE-A BASEBALL TEAM, the El Paso Chihuahuas, are in a tight spot.

Not necessarily in terms of standings, as the season has only just started, but rather in terms of location. The team's home, Southwest University Ballpark, is located in the downtown area immediately adjacent to active Union Pacific Railroad tracks. In fact, portions of the 7,500-seat stadium cantilever over the tracks, which are located 22 ft below field level.

Inspired by early twentieth century ballpark design and architect Daniel Burnham's nearby El Paso Union Depot, located just a few blocks away, the project turned to structural steel to accommodate the associated design requirements, tight site and required delivery speed.

Regarding the latter, in order to meet the team's required April 2014 opening date, the design and construction team had less than 18 months to design the venue, demolish the 15-story former city hall (located on the project site), clear the site and build the ballpark.

Given the site's constraints and relatively small size, the team designed the new ballpark to comprise four levels and two suite levels, rather than the three total levels typical of Triple-A ballparks. To maximize suite space, the upper suite level is hung from the roof structure, a strategy that helped leverage the depth of the steel gable roof trusses and their ability to support a slender hanger tube concealed within the suite wall, which prevented a column from taking usable space in the suite below.

The initial design concept proposed curved steel members at the concourse beam-column joints to reference the Diocletian windows of the nearby train depot, but these were determined to not be stout enough to serve as part of the structural frame. The architectural and structural teams evolved the design to one where the steel serves as both structure and architecture, with the truss bottom chords using curved sections to evoke Burnham's windows and both literally and figuratively frame the concourse.

The park's steel framing is a modern take on the riveted joints and built-up framing members found in historic ballparks. The trusses consist of double-angle web members and WT chords, and the back-of-bowl column line, which serves as a moment frame to resist lateral loads, is formed from two wide-flange sections laced with flat bars rather than a deeper single-rolled shape. Most connections are exposed, and bolted connections feature button-head bolts in homage to the classic rivet head.

When it came to drilling deep foundations, the contractor discovered that the railway retaining wall's foundation extended well beyond what was indicated in 1940s-era record drawings. This meant that the piers and columns nearest the railway were directly above the wall footing. However, the railroad had previously imposed strict requirements prohibiting any new loads from being applied to the existing retaining wall or footing.

With the ballpark design completed and steel being fabricated, reframing the superstructure was not an option. In lieu of using beams to transfer the loads, the team conceived a novel solution uniquely enabled by structural steel: Construct the piers to prevent skin friction above the wall and only load the soil once below the wall footing. However, this idea required a readily available material that would need to both permit vertical slip and serve as a permanent structural "jacket." The solution came in the form of salvaged steel oil pipe, which was used to individually encase the piers along their top 30 ft in salvaged steel oilfield pipe; the piers also penetrated holes in the existing footing. This solution allowed the piers to be installed quickly and economically and without the need for costly concrete cantilevered grade beams.

For more on this project, see "Faster than a Speeding Locomotive" in the July 2015 issue (www.modernsteel.com).

Owners

Mountain Star Sports Group, El Paso, Texas
City of El Paso, Engineering and Construction Management, El Paso

Owner's Representative

International Facilities Group, LLC, Chicago

General Contractor

Jordan-Hunt, A Texas Joint Venture, El Paso

Architects

Populous, Kansas City, Mo.
MNK Architects, El Paso

Structural Engineers


Walter P Moore, Austin
Robert Navarro & Associates Engineering, Inc., El Paso

Steel Team

Fabricator and Detailer

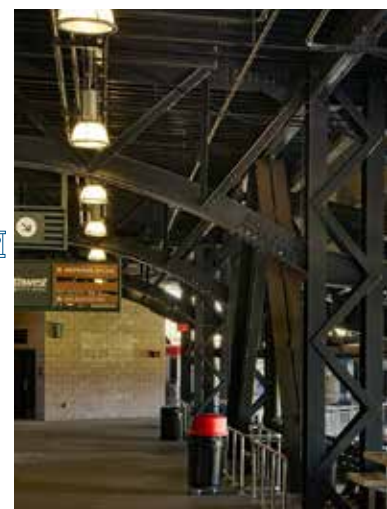
W&W | AFCO Steel, Oklahoma City 

Erector

Derr & Isbell Construction, 
Eules, Texas

Bender-Roller

Max Weiss Co., Milwaukee, Wis. 

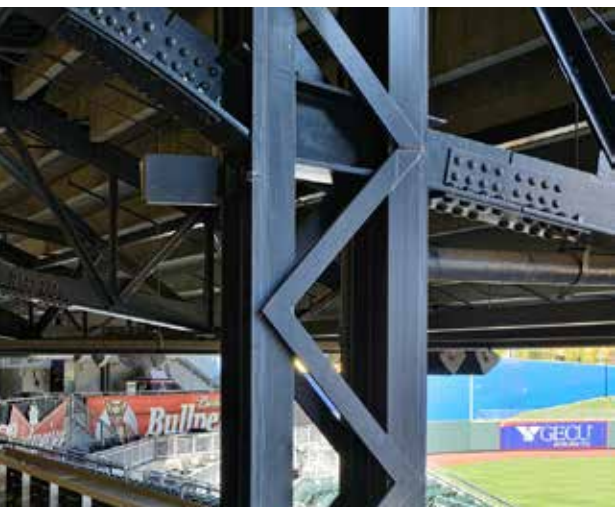




Photos by Brian Wancho Photography; Dirk Kestner, Walter P Moore; Miguel Orozco, Jordan-Hunt, A Texas Joint Venture



This ballpark takes me back in time. I really like the way it mixed the old style with new steel and technology.
—Sam Boykin



UNDER \$15 MILLION – NATIONAL AWARD

Pterodactyl Office, Culver City, Calif.

YOU’VE PROBABLY NEVER SEEN anything quite like the Pterodactyl.

Rather than being built next to a parking garage, this angular office building was actually constructed right on top—and hanging over the side—of an existing four-story steel-framed parking garage in Culver City, Calif. And a number of the existing columns are cantilevered beyond the top of the parking structure to provide support for the mezzanine and roof superstructure.

Structurally, the building is made up of a series of nine rotated “boxes” that provide just enough space at the corners and at their intersections to efficiently house the structural support members. During the early design phase, through numerous meetings and studies, the feasibility and constructability of each box was determined while preserving numerous architectural features of each box as well as their complex architectural interactions.

Placing such an irregular building over an existing building presented several structural challenges. First of all, the structural design was limited by the size and orientation of the existing columns, which were not necessarily located in the most favorable location or orientation for the support of each individual box. Some columns were not stiff enough to laterally brace the boxes, so each box was strategically reinforced internally and interconnected to others to reduce loads to a particular column.

At the same time, the differential rigidities of each box, in conjunction with their interconnecting mezzanine space bridges, had to be fully optimized to allow for mechanical and other utility space and pass-through. The boxes were initially designed individually, using careful stiffness assumptions. Then the boxes were brought together and reevaluated as a whole for compatibility.

Additionally, because the office building is laterally flexible in contrast with the very rigid concrete block core elevator shaft and three access stairs—which unevenly extend

down to the top floor of the parking structure—very specific slip connections and separation joints are used to completely control all inter-body movements as designed.

To support the nine blended, yet individual, box components that make up the building, the design team employed ring-like frames attached to each column and coordinated within the interior design, which doubled as support beams (though not in straight line) holding up the main and secondary structural members. Because column size and orientation were based on the demands of the parking structure, and because the Pterodactyl’s distinctive modular design did not particularly align with the support point location, a few intricate stiffness-sharing systems of main structural members were used to further normalize the loads on to the weaker columns and help comply with required deflection and vibration expectations.

On the west face of the garage, several boxes actually overhang the structure. The design of each box against numerous degrees of freedom was particularly challenging due to the shape of each element, the location and stiffness of the supports and the desired clearances and style of the building envelop. Secondary members hidden in the longitudinal direction within the corners of the boxes—and cantilevering out to support the ring frame at the far end of the overhangs—also function as stabilizers. These secondary members resist direct gravity as well as provide lateral support and rotational and racking movement.

Owner

Frederick and Laurie Samitaur Smith, Culver City, Calif.

General Contractor

Samitaur Constructs, Culver City

Architect

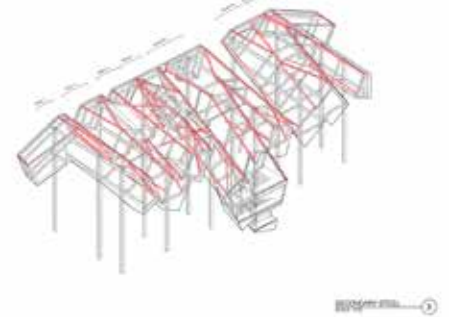
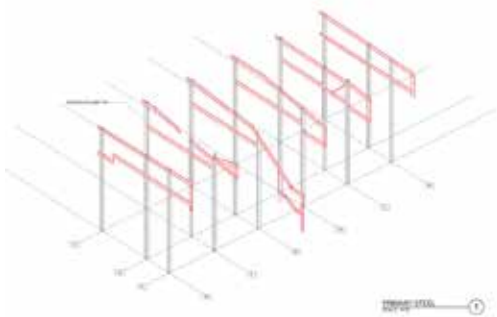
Eric Owen Moss Architects, Culver City

Structural Engineer

Nast Enterprises Corp., Los Angeles



Photos by Tom Bonner Photography



Pterodactyl appears almost as a living creature. The design overcame the inherent limitations of supporting the new building over the existing parking structure layout.

—Ben Varela



UNDER \$15 MILLION – MERIT AWARD

Chinatown Public Library, Chicago

CHICAGO'S NEWEST public library is small but stunning, sporting a modern design that both fits in with and enhances its surroundings in its Chinatown home.

The two-story, 16,370-sq.-ft building's interior space radiates from a central atrium, and the main structural beams are similarly arranged on a radius. Round HSS was selected for the columns, as it provided a clean surface where several beams connect into a single point and also facilitated and simplified the non-orthogonal lateral bracing connections.

To satisfy fire-resistance requirements, the columns are encased in round prefabricated fireproofing shells. In addition, smaller round sections are used as bracing members in order to create a more uniform appearance between the columns and lateral bracing. The braces are strategically located on the exterior of the building in the bays located on the three "flats" of the building curved triangular structure, resulting in an unobstructed and flexible interior. The softened triangular shape of the build-

ing not only reflects the triangular point where it sits but also helps it stand out as a focal point in the midst of the surrounding rectangular buildings. And the exposed structural steel showcases the beauty of the building while maintaining a pleasing, light-filled environment for library patrons.

For more on this project, see "What's Cool in Steel" (the "Light and Enlightening" segment) in the August 2016 issue (www.modernsteel.com).

Owner

City of Chicago

Construction Manager

Wight & Company, Chicago


Architects

Wight & Company, Chicago
Skidmore, Owings & Merrill LLP, Chicago

Structural Engineer

Drucker Zajdel Structural Engineers,
Chicago

Steel Fabricator

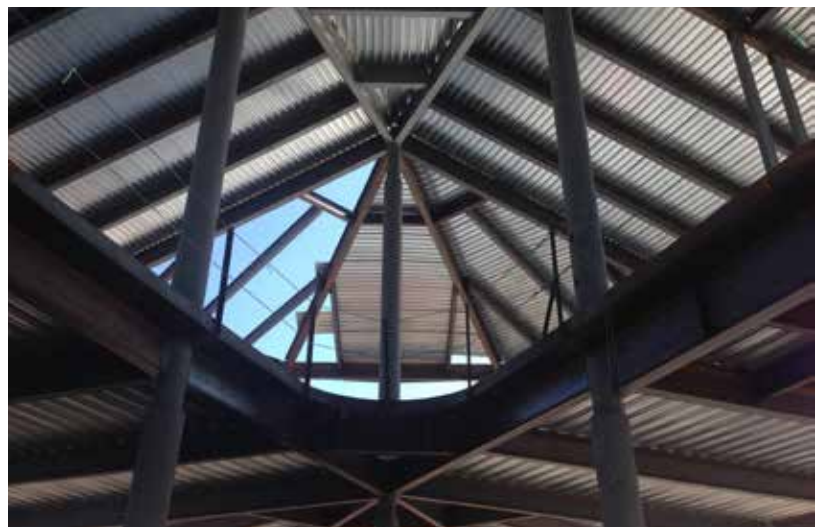
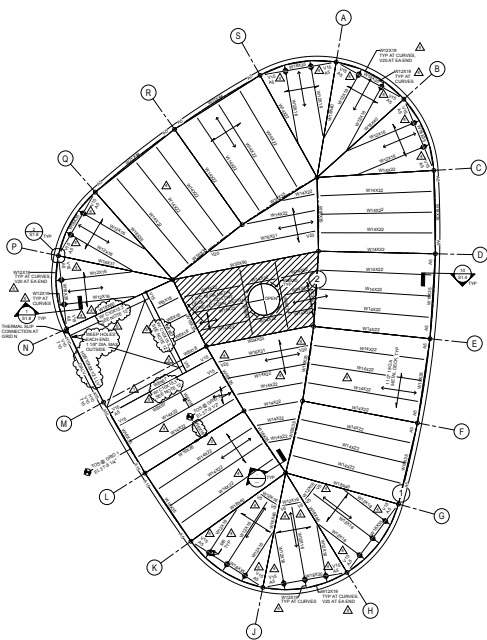
McFarlane Mfg., Sauk City, Wis. 

Its rounded form, accented with vertical fins, serves as a beacon for the surrounding neighborhoods.

—David Barista



Photos by Hedrich Blessing; Wight & Company; DZS



MAY 2017

UNDER \$15 MILLION – MERIT AWARD

Lamar Station Classroom for Urban Farming, Lakewood, Colo.

COLORADOBUILDINGWORKSHOP serves the broader community by partnering with local not-for-profit organizations on a variety of projects.

As the design-build studio at the University of Colorado Denver, it centers on educating graduate-level architecture students in the practical application of architectural theory through integrated project delivery (IPD). The IPD team is made up of professors, architects, engineers and consultants from Colorado, many of them donating their time to help educate these young professionals.

In the spring of 2014, 16 students worked with Metro West Housing Solutions, the City of Lakewood's housing authority, to design and build the Lamar Station Classroom. The classroom's mission is to educate residents of the nearby transit-oriented development about urban farming, while simultaneously providing space for environmental education and other youth programs. The project brief required the structure to have an opaque wall preserving the privacy of the classroom near the path leading to the light rail line; Metro West was concerned that the foot traffic would distract residents from learning in the classroom. Coincidentally, it also wanted the structure to maintain a clear sightline from the classroom to its main office,

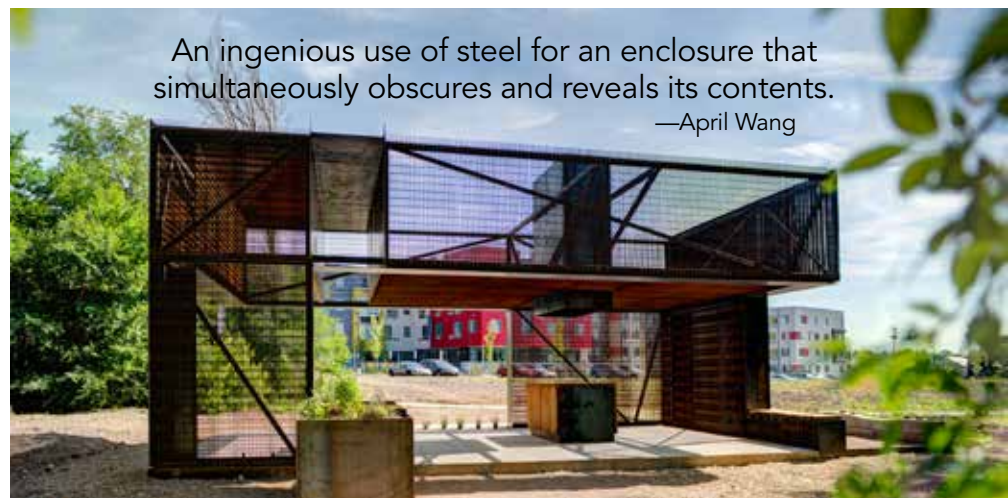
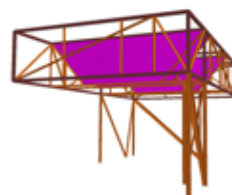
located over 300 ft away. But the transparency of the sightline and opacity of the wall were in direct conflict. The students' response to this dichotomy resulted in the most innovative element of the project.

To achieve a simultaneously transparent and opaque wall, the students researched a number of material skins for the building, eventually settling on vertically oriented steel bar grating. The bar grating allowed the structure to appear opaque when approached from an angle but transparent when facing the structure perpendicular to a wall. With proper siting, this allowed the classroom to be visible to the client from the main office but opaque from the sidewalk. When the students reviewed their solution with the structural engineer, he pointed out that their proposed steel bar grate cladding could also act as part of the structure.

The final solution is a statically indeterminate ring truss comprised of four primary trusses. Each of the four primary trusses is a different unique version of a modified Warren Truss, whose typically coplanar vertical web members were replaced with out-of-plane GW series steel bar grating panels. What the individual grating bars lack in sectional stiffness, they make up for in sheer numbers, using 970 $\frac{3}{4}$ -in. \times $\frac{1}{8}$ -in. vertical steel bars evenly spaced



Photos by Jesse Kurrowa, University of Colorado Denver



An ingenious use of steel for an enclosure that simultaneously obscures and reveals its contents.
—April Wang

around the perimeter of the ring truss. The ring truss and the vertical bars of the grating form the primary structure of the classroom. The structure's gutter and oculus contribute structurally to four out of the five secondary trusses spanning the interior of the ring truss. These unconventional interior trusses use rolled steel plates as the vertical web members in two trusses and completely replace all the truss webs, acting as a slender deep beam web, in two other trusses. The ring truss is supported by three partial-length wall sections through a combination of full-height bar grating panels and single-angle corner braces.

Laterally, each wall section is a combined braced frame and steel plate shear wall. With only five primary points of support for gravity loads and three lines of lateral resistance, the gravity and main wind-force resisting systems had to be analyzed simultaneously. This balanced aesthetics and individual member stresses with global stability and deflection. Of particular interest is the use of full-height narrow steel plate shear walls at the ends of the braced frame walls. Similar to the bar grating skin turned structure of the ring truss, these steel plates serve architecturally as both the finish and the closure at the ends of the double-wide bar grate walls, and also as shear walls providing redundancy to the main wind-force resisting system while reducing torsional deflection due to eccentricity.

The importance of the structural engineer as a critical member of the IPD team cannot be overstated. The engineer provided feedback about design proposals, often on the fly as

the proposals were being generated, and was on-site during construction with a laptop and structural finite element analysis model to verify how last-minute changes would affect the whole structure. These "on-demand" changes eliminated the typical lag in design and construction, allowing the team to optimize project results, reducing construction waste and time and maximizing efficiency.

It was the collaboration between the architecture students and the structural engineer at the earliest stages of design that proved the importance of introducing alternative forms of project delivery. This project provided an opportunity to teach the students about steel's inherent benefits, structural analysis, design, detailing and fabrication and erection. By integrating architectural and structural analysis and design, the project became clearer and the architecture stronger. By eliminating excessive layering in the building envelope, the students saw the beauty of a structural expression in steel. This reinforced their architectural design, and Metro West was rewarded with an innovative design that met their needs.

Owner

Metro West Housing Solutions, Lakewood, Colo.

General Contractor and Architect

ColoradoBuildingWorkshop, Denver

Structural Engineer

Structuralist, Ft. Collins, Colo.



Photos by Peter Vandewalker Photographer

ART INSTALLATION/ SCULPTURE

Antony Gormley Sculpture,
Cambridge, Mass.

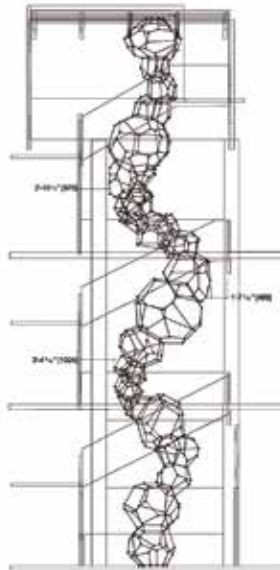
A NEW SCULPTURE in Cambridge, Mass., is striking quite a chord.

Designed by British sculptor Antony Gormley, the work, called CHORD, is a large winding form made of 33 irregular polyhedra installed in a 12-ft by 12-ft stairwell of a university mathematics building. The sculpture—which is 56 ft high, weighs 1,800 lb. and is comprised of 541 stainless steel balls connected by 905 specially formed duplex stainless steel rods—was created in six sections at Summit Metal Fabricators' (SMF) Salem, N.H., shop, then carefully transported to Cambridge and installed.

Close collaboration between the SMF team, Antony Gormley Studio and structural engineer Ian Schmellick of Robert Silman Associates allowed the team to meet the many challenges faced during the construction and installation of the sculpture. Most of the communication with Antony Gormley, who is located in London, was done via Skype.

In order to accurately translate Gormley's vision into actual stainless steel components, SMF employed specialized jiggging and computer numerical control (CNC) manufactured templates to precisely fabricate and assemble every node and element of the massive sculpture. All welding was done using the tungsten inert gas (TIG) process, and special equipment such as hoisting frames and strapping designed by SMF was used to successfully install the sculpture in the tight confines of the staircase; the installation process took only one month. In addition, SMF developed and employed a special procedure to fabricate the sculpture. Using building information modeling (BIM), it was split into six sections and fabricated horizontally rather than vertically, providing a safer work environment and avoiding compression of the art during fabrication.

The sculpture design required that the connecting bars be square. However, the 2205 duplex stainless steel specified by Gormley was manufactured as round. To create square bars from the round stainless steel rods, SMF worked with Gormley and steel supplier Penn Stainless Products to



The viewer's eye is slowly drawn upward, piece by piece, until the enormity of the full sculpture is realized.

—David Allen



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create several prototypes using specialized dies until Gormley was satisfied with the shape and look of the bars. To maintain the integrity and coloration of the stainless steel, all welds were performed with a welding inter-pass temperature of less than 300 °F.

It was critical to get the placement of the bars at exactly the correct angle so that the weld interconnections were perfectly centered on the steel balls. SMF designed and fabricated a jig that allowed the interconnection between the bars and the balls to be at the exact angle and position specified by Gormley. To achieve full-penetration welds between two dissimilar surfaces, the square bars and the round balls, the SMF team worked with a Level III welding inspector to develop and implement a procedure that allowed full-penetration welds while maintaining the desired look and feel.

Once the six sections of the sculpture were created, they were safely transported to Cambridge, with each section secured in its own trailer using special strapping techniques. Once SMF delivered the six sections to the mathematics building, getting them inside required removing several doors and casings, which was done at times when normal university activity would not be affected.

When it came time to assemble the sculpture, the stairwell was enclosed in reinforced poly, allowing students and faculty to travel safely between floors. An additional “peg board” was used within the installation space to properly orient each of the six sections to fit precisely to the next section. The SMF team

designed and fabricated a unique lift and frame system that allowed the sections to be assembled on the ground floor and then hoisted into position. This approach eliminated a serious fall hazard and allowed the sculpture to be assembled in a very narrow space. An additional jig was designed and fabricated to replicate the glass ceiling to which the sculpture would be secured. This ensured that when the seven balls of the top section were installed, they would be on the exact plane—1 in. from the glass ceiling.

Owner

Antony Gormley, London

General Contractor

Summit Metal Fabricators, Plaistow, N.H.

Architect

Antony Gormley Studio, London

Structural Engineer

Robert Silman Associates, Boston

Lead Design Engineer

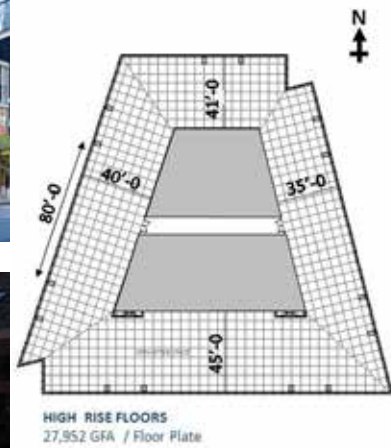
Tristan Simmonds, Simmonds Studio, London

Engineering Consultant

Fenagh Engineering and Testing, LLC, Everett, Mass.

Steel Fabricator, Erector and Detailer

Summit Metal Fabricators 



This project has a complex structural system that is elegantly concealed.

—Chris-Annemarie Spencer



Photos by Joe Woolhead Photography, Leslie E. Robertson Associates



PRESIDENTIAL AWARD OF EXCELLENCE IN ENGINEERING

Four World Trade Center, New York

THE WORLD TRADE CENTER site is hallowed ground.

Its redevelopment poses the challenge of not only redefining the iconic Manhattan skyline, but also influencing the greater cultural fabric of American society. As an office tower, 4 World Trade Center (4WTC) serves as a beacon for businesses returning to downtown Manhattan; 250,000 daily commuters pass through the lower levels on their way to one of 13 subway or commuter rail lines that surround the tower.

More importantly, the structure pays respect to the tragic history of the grounds commemorated by the National September 11 Memorial. More than a decade after the devastating attacks of September 11, 2001, the 72-story, 2.3 million-sq.-ft 4WTC became the first tower to open on the original 16-acre site.

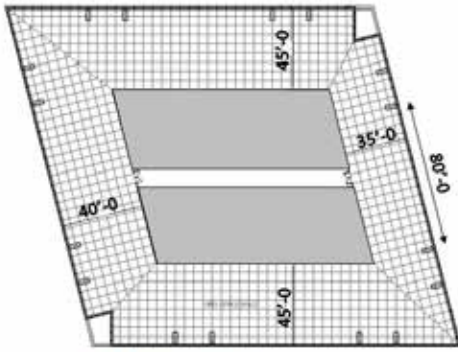
When it comes to columns, a typical building of this size and shape contains seven to ten perimeter columns on each side, spaced at roughly 20-ft to 30-ft intervals. 4WTC has only four columns on each side. The columns are grouped in pairs with an 80-ft clear span between them and 20-ft to 45-ft cantilevers at each end, providing dramatic column-free corners and nearly limitless opportunities for future tenants to maximize views regardless of office layout.

Beneath 4WTC lies a precarious maze of subway lines, commuter circulation and mechanical spaces. In order for the tower to be built to its intended specifications, these had to be accounted for and were a major driver of the tower column placements. The below-grade complexity affected retail column placement as well,

and retail program requirements and vertical transportation needs demanded additional points of support. To avoid adding columns all the way to the basement, alternative solutions were explored, such as the possibility of branching columns or including structure around other elements. The final design incorporates a massive split V-column supports the retail entrance while additional steel structure is built around the elevator and escalators, acting together to elegantly meet demanding load path requirements.

Another innovation was sparked by the erection sequence set forth by the construction manager and local labor officials, who stipulated that a structural steel frame would be erected first, followed by encapsulation of the service core in reinforced concrete. Typically, for steel-concrete buildings outside of New York City, the concrete core is constructed first with embed plates and followed by steel floor framing. The engineers behind 4WTC embraced the possibilities of this encapsulation and adapted it to the perimeter columns.

Again, in the typical construction of perimeter steel columns, the steel beams and columns are aligned. For the long spans and cantilever conditions at 4WTC, however, the standard method would have required a significant moment connection at every column. To sidestep this dilemma, the decision was made to offset the spandrel beam from the columns, allowing the beam to be continuous and bypass the column uninterrupted. This drastically reduced the number of moment connections required to support



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80-ft clear spans. Splice locations were then chosen at points of low moment along the length of the spandrel beams.

The advantage of this approach was threefold: 1) On each side, it reduced the number of moment connections from eight (one at each face of the four columns) to two; 2) it reduced the required number of spandrel pieces from five to three, resulting in more efficient shipping and fewer crane picks; and 3) it reduced the size of the remaining moment connections because they were designed for much smaller forces than would have been required at the face of the columns.

The steel frame also led to efficiency in the link beams embedded in the core. Link beams, which connect two very stiff vertical elements (such as elevator cores) are highly stressed elements. When made of concrete, they are very congested with reinforcement, which can also lead to problems with concrete consolidation in construction. In 4WTC, the link beams are made from steel built-up shapes. Steel is much better at resisting shear forces than concrete, and the steel link beams were much smaller than comparable concrete beams would have been. The steel link beams were also erected with space left between the top of the beam and the floor above, allowing ductwork and other utilities to be run above the tenant-finished ceiling.

Another significant technique to reduce construction time was in placing the erection columns to which these link beams were connected within the elevator core wall but offsetting them from the end of the wall by 6 ft. This meant that the steel-link-beam-to-steel-erection-column connection could be a simple, cost-effective shear tab instead of the highly stressed, expensive moment connection

that would have been necessary had the erection column been placed at the end of the wall. The shear forces from the link beam were directed into the concrete by composite action between the end of the wall and the erection column. This approach simplified the connections, resulting in further savings in time and cost. ■

For more on this project, "Four at the Fore" in the April 2015 issue (www.modernsteel.com).

Owner

Silverstein Properties, New York

General Contractor

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Architects

Maki & Associates, Tokyo


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Structural Engineer


Leslie E. Robertson Associates, New York


Steel Team

Fabricators

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Banker Steel Co., LLC, Lynchburg, Va. 

Littell Steel Co., New Brighton, Pennsylvania 

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