IDEAS²

Innovative Design in Engineering and Architecture with Structural Steel

THE DESIGN AND CONSTRUCTION INDUSTRY RECOGNIZES THE IMPORTANCE OF TEAMWORK, COORDINATION, AND COLLABORATION IN FOSTERING SUCCESSFUL CONSTRUCTION PROJECTS TODAY MORE THAN EVER BEFORE. In support of this trend, AISC is proud to present the results of its annual IDEAS² Awards competition. This program is designed to recognize all team members responsible for excellence and innovation in a project's use of structural steel.

Awards for each winning project were 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, detailer, fabricator, erector, and owner.

New buildings, as well as renovation, retrofit, or expansion projects, were eligible. The projects also had 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, 2004 and December 31, 2006;
- Projects must be located in North America;
- Previous AISC IDEAS or EAE award-winning projects were not eligible.

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

- Less than $15 million
- $15 million to $75 million
- Greater than $75 million

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;
- The aesthetic and visual impact of the project, particularly in the coordination of structural steel elements with other materials;
- Innovative uses of architecturally exposed structural steel;
- Advances 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 specialty contractors such as steel fabricators, alternative methods of project delivery, or other productivity enhancers.

Both national and merit honors were awarded. The jury also selected two projects for the Presidential Award of Excellence in recognition of distinguished structural engineering.

2007 IDEAS² Awards Jury

Jennifer Goupil, *Structural Engineer* magazine, Seattle

Keith Grubb, P.E., S.E., Managing Editor, *MSC*

Tom Harrison, S.E., OWP/P, Chicago

Jim Luckey, Architect and Principal, SmithGroup, Chicago

Bill Nash, Quality Assurance Director, McCarthy Building Companies, Inc., St. Louis

Ray Phillips, President and CEO, Cives Corp., Roswell, Ga.

Lindsey Purcell, Director of Operations, The Nature Conservancy in Indiana, Indianapolis

Frederic C. Hamilton Building, Denver Art Museum.

National Winner—Less than $15M

TRIPLE-S STEEL SUPPLY COMPANY SERVICE CENTER—SAN ANTONIO

All photos: Chris Cooper

The winning project for the less-than-$15-million award this year is itself a steel-related facility: a steel distribution center for Triple-S Steel Supply, a family-owned structural and ornamental steel service center in San Antonio.

The company wanted more than just a typical warehouse; it wanted an iconic building. To meet this goal, the architects chose to showcase steel detailing by devising a kit-of-parts using the structural shapes and sections found in the company's catalogue. The facility consists of three main building areas, all of which strongly emphasize exposed steel.

The office/showroom building consists of high-sloped, multi-level roofs supported by exposed steel HSS columns and framed with exposed steel beams, joists girders, and joists with extensions. The joist extensions protrude through the exterior and past the roof line in order to support the upper angle-framed shade structures on three sides of the building. In addition to the upper shade structure, there is a matching lower shade structure framed in a similar manner, on three sides of the building. The lateral bracing consists of steel tube X-bracing located outside of the main building.

The steel distribution building is supported by exposed W24x176 columns located on concrete piers that support the nearly 100-ft span joist girders for the low roof and 80-ft span joist girders for the high roof. Moment connections are utilized for the connections between the girders and the steel columns. Steel purlins are spaced at 5 ft on center and cantilevered on the ends as overhangs, beyond the last girder supports. Inside, there are three bays of W24x131 crane support beams for the entire length of the building. Similar to the office/showroom building, lateral bracing is achieved with exposed steel tube X-bracing.

The small parts warehouse is conventionally framed with simple joists and joist girders. Exterior WT sections support the angle and steel purlin shade structure on the north side of the building.

For more on this project, see "At Your Service" in our August 2006 issue at **www.modernsteel.com**.

Owner
Triple-S Steel Supply Co. (AISC member)

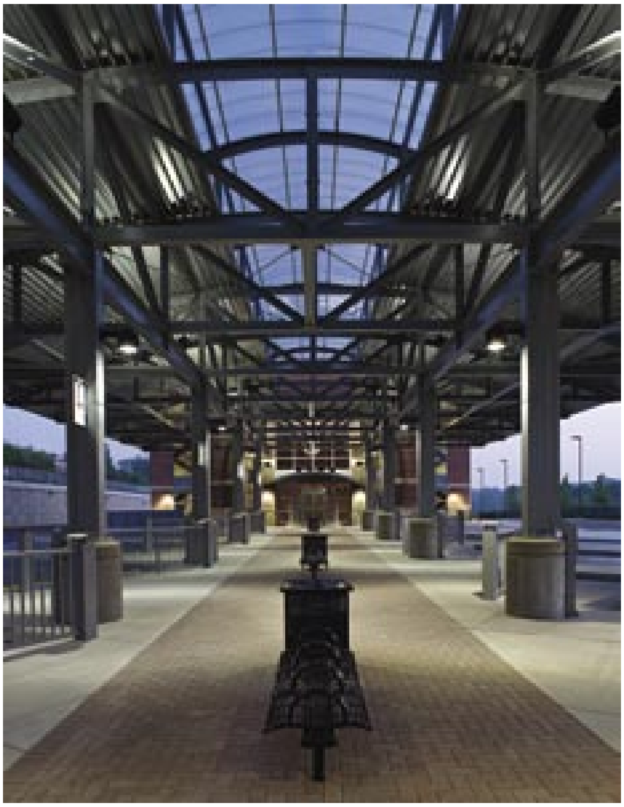
Architect
Lake|Flato Architects, San Antonio

Structural Engineer
Steve G. Persyn, P.E., San Antonio

General Contractor
Hooker Contracting Company, Inc., San Antonio

Merit Award—Less than $15M

ATHENS MULTI-MODAL TRANSPORTATION CENTER—ATHENS, GA.



The Athens Multi-Modal Transportation Center provides a new hub for various transportation modes in the Athens, Ga. area, connecting Athens Transit, Regional Express bus service, University of Georgia Transit, a future commuter rail line, Southeastern Stages bus service, and pedestrian and bicycle travel into one complex.

From an architectural standpoint, the project mixes glass, brick, wood, glass, and cast stone with exposed steel to take a contemporary approach to the traditional train station aesthetic. It is composed of three main components—the main building/waiting area, an exterior canopied bus waiting area, and a pedestrian bridge—all of which employ exposed structural steel. The exterior bus canopy shelters passengers at 17 bus bays and uses exposed steel for its long spans. Standard shapes were used for the trusses and canopies that will need to be matched for aesthetics in a future bus bay expansion. The covered pedestrian bridge uses steel trusses for its long span over an active rail line, linking the transportation center to a parking deck and Athens' central business district. The center's indoor waiting area features exposed steel arch trusses combined with wood paneling.

Exposed steel for the project is coated with intumescent paint for fire protection, provided by A/D Fire Protection Systems, and all exterior steel is protected with a high-performance finish to reduce maintenance. The finish is a three-coat system consisting of a two-component moisture-cured zinc-rich primer, polyamine epoxy intermediate coat, and aliphatic acrylic polyurethane top coat.

The engineers used STRAP software to design the canopies and RAM software for the building. Large uplift and lateral wind forces on the canopies presented the most significant loading requirements. In addition, large arched windows at each end of the building presented design and detailing challenges, but these were resolved with standard steel shapes and controlled with AESS specifications.

Steel fabrication took place during the site development phase in order to have the steel delivered to the site at the beginning of the erection phase, and the owner provided storage space for the steel during the latter stages of site development when the staging area and building pad were completed.

Supporting the bridge was a considerable design challenge, as the long bridge span rested on relatively small building columns. When it came to erecting the bridge, the design team had to coordinate with the railroad so that the existing rail line could stay functional during bridge erection. The bridge was delivered to the site in two pieces and bolted together on-site—and was hoisted into place with no impact on the railroad's schedule.

All photos: Brian C. Robbins/Robbins Photography, Inc.

Owner
Unified Government of Athens-Clarke County, Ga.

Architect
Niles Bolton Associates, Inc., Atlanta, Ga.
Cox Graae + Spack Architects, Washington, D.C.

Structural Engineer
Uzun & Case, Atlanta

General Contractor
Aldridge, Inc., Athens, Ga.

Engineering Software
RAM
STRAP

Merit Award—Less than $15M

LIBRARY LEARNING RESOURCES CENTER AT EL CAMINO COLLEGE COMPTON CENTER, COMPTON, CALIF.

RAW International, Inc.

Architecture can be catalyst for change. This was the approach that RAW International took when designing the Library Learning Resources Center at El Camino College Compton Center in Compton, Calif. The college wanted a signature building image that would not only identify the library and its growing campus as high-tech center for learning, but also change its image from hopeless to hopeful in a historically underserved area of greater Los Angeles.

The new 45,000-sq-ft. facility's design scheme is transparent, open, and daylit. This solution is a direct response to the college's request for a program-flexible, column-free universal space for both the reading room/stacks area and the second-floor computer learning center. The unobstructed spans of the reading room, stacks area, and atrium were achieved by developing a 3-ft-deep curved tube truss, with the top and bottom chords of the truss using 8-in.-diameter curved steel tube. The two-dimensional truss vault of the reading room and atrium was designed to transfer lateral loading to a conventional moment-resisting frame.

The design required the least amount of structural obstruction and the greatest amount of design flexibility for the present, as well as future expansion. This flexibility would have been difficult to achieve with interior and exterior brace frames, which would have divided the space up into a small maze of structural-resisting elements. As such, conventional strong-column weak-beam moment frames were chosen for lateral force resistance in lieu of braced frames.

Following the 1994 Northridge earthquake, the State of California Division of State Architect's rules for the design of conventional moment-resisting frames, especially in school buildings, were reviewed and stringently upgraded. Adherence to FEMA 151 and 153 as a blueprint for approved and tested moment frame-resisting joints, beams, columns, and welding was a must. Any deviation from these standards would have required the design team to construct and test its own moment frame joints and certify the testing with an approved FEMA testing laboratory.

Because of the building's geometry and connection point complexity, the State Architect required four separate computer simulations using SAP 2000 engineering software to simulate the building's three-dimensional performance under different dynamic loading conditions—both earthquake and wind separately and earthquake and wind forces combined—to create a unified picture of the loading. The fourth simulation combined all of the design components to create a three-dimensional dynamic loading picture of how the structure would perform. The simulations revealed that in the horizontal plane, the library's length-to-width ratio reacts in a similar fashion to a high-rise building in the vertical plane under dynamic loading conditions.

Each 120-ft-long radial tube truss was shop fabricated in two sections, and each section was trucked to the job site for field erection. The layout of the steel trusses posed a challenge for the fabricator because of the sizes of the parts and also because of the tolerances required by the design for field fitting. The curved tube trusses also had to be fabricated to near-perfect tolerances, because a glass skylight was designed to be placed on top of the curved tube truss. In the end, the fabricator's attention to precision reduced erection time by an estimated 15%.

Owner
El Camino College Compton Center, Compton, Calif.

Architect
RAW International, Inc., Los Angeles

Structural Engineer
Farhad/Tabb Consulting Structural Engineers, Los Angeles

Software
SAP 2000

General Contractor
Douglas Barnhart, Inc., San Diego

Mark Robert Halper

National Winner—$15M to $75M

HEIFER INTERNATIONAL HEADQUARTERS—LITTLE ROCK, ARK.

An organization geared toward fighting world hunger, Heifer International's impact in communities starts with the delivery of one animal to one family, known as "passing on the gift." As a drop of water generates ripples that flow outward from the impact point, the gift of an animal creates "concentric rings of influence" radiating through a village, allowing sustainable methods taught to the original family to be passed on to others as the animal's offspring.

Heifer wanted its new headquarters in Little Rock, Ark. to serve as a symbol for this process. The building's gentle curve emanates from the overall four-phase master plan, conceived as a series of concentric rings expanding outward from a central commons that represents the impact point of a gift.

The four-story, semi-circular, office building, framed with steel plate shear walls, was constructed on one the largest Brownfield recoveries in the state. Roof framing consists of a wood roof deck spanning sleepers on top of steel beams spanning steel girders that in turn span steel tree columns. The tree columns consist of round pipe columns that continue from the floors below, cantilevering approximately 8 ft above the fourth floor, with steel pipe members creating the branches supporting the roof framing. The roof is inverted to provide a "valley" in the middle of the building to collect and recycle rainwater. Extended steel beams at the roof edge are capped with galvanized steel grates to extend the sun protection and lighten the edge in a crown-like fashion.

Floor framing consists of a minimum of 2½ in. of normal weight concrete on top of composite steel deck spanning between wide flange steel beams that span wide-flange steel girders and round steel columns.

Lateral stability for the building is provided by the floor deck acting as a diaphragm, spanning between steel plate shear walls from the foundation to the fourth floor. Lateral loads at the roof are resisted by the roof deck acting as a diaphragm spanning the tree columns, which cantilever above the fourth floor. The columns transfer lateral loads at the roof to the fourth floor diaphragm. The design employed extensive cantilevered floor elements to minimize the number of columns and provide a feeling of openness.

The building presented several challenges to the design team, one of which was working with round columns. The project team initially considered round cast-in-place concrete columns and a steel floor framing system, but eliminated this option due to concerns with tolerances for the concrete and connecting the steel to the concrete. It then considered round precast concrete columns, but ultimately decided on large round steel pipe columns in order to satisfy the architect's desire for round columns, as well as to ease connection of the steel framing to the columns.

The semi-circular shape of the building was another challenge, as it complicated the layout of the steel system and expansion joint; the building is more than 440 ft long, so an expansion joint was added near the center of the building. Due to building irregularities, each half of the building was analyzed for lateral loads using static and dynamic methods.

Since the structural steel system was exposed in the majority of the facility, it required closer coordination with the architectural, mechanical, and electrical details including details at windows and tree columns and up-lighting in tree columns. In addition, a raised floor system was used on most of the building to run utilities and wiring.

Because Heifer seeks attainable agricultural solutions within the parameters of each project's region, the building had to reflect this methodology as well. As such, one of the major goals for the building was to use locally sourced materials that would exceed LEED requirements for distance to site and recycled content. Steel was fabricated at a facility just three blocks from the site, and the aluminum curtain wall and skin, making up over 90% of the exterior, was fabricated directly across the street at a major glazing company. In all, 97% of the project's materials was recycled.

Architect
Polk Stanley Rowland Curzon Porter Architects, Ltd., Little Rock, Ark.

Owner
Heifer International, Little Rock

Structural Engineer
Cromwell Architects & Engineers, Little Rock

Fabricator
AFCO Steel, Little Rock (AISC member)

General Contractor
CDI Contractors, LLC, Little Rock

All photos: Timothy Hursley/The Arkansas Office

Merit Award—$15M to $75M

THE TRANSPARENT HOUSE, GULF BREEZE, FLA.

TGRWA

The coastal town of Gulf Breeze, Florida, while tiny, is home to an impressive example of modern glass-and-steel architecture. The Transparent House—so called because of its glass exterior walls—is a 20,000-sq.-ft residence consisting of a three-story main house, a 2,700-sq.-ft three-story guest house, and a pool and deck structure. The project uses metal deck composite slabs supported by a structural steel frame, which in turn is supported by stainless steel tubes dubbed "the sprouts."

Due to its location in a relatively hurricane-intensive area, local building codes required the lateral loads to be based on a maximum sustained wind speed of 110 mph. However, in order to protect the structural system of the house against a relatively moderate-strength hurricane, the design team decided to increase the base wind speed to 150 mph; this increased wind speed yielded an average lateral applied load of 58 psf. In fact, even before completion, the house was put to its first hurricane test. Toward the end of construction, Hurricane Ivan—with wind speeds reaching 130 mph—hit land directly over the house. The house suffered no structural damage.

Because residential coastal construction requires that the main living levels be elevated above the local base flood elevation, the design team positioned the first floor at 10 ft above grade. The main house is supported by 11 groupings of four columns (the sprouts) attached to a single foundation point, which gives the building the appearance of floating above the ground. The sprouts are constructed of 8-in.-diameter stainless steel pipes, support W18 girders at the first-floor level, and are supported by hubs composed of 1½-in.- to 2-in.-thick stainless steel plates.

The "floating" concept was also incorporated into the interior of the main house, as several locations of the second floor framing were held back from the main building columns. At these locations, 3-in.-diameter hanger rods support the second floor framing. These hanger rods are in turn supported by the composite steel framing at the roof level.

Architecturally exposed steel was another prominent feature of the project, and this type of steel requires greater tolerances during fabrication and erection than that of conventional steel framing. Additionally, the architect specified horizontal and vertical member proportions to achieve the desired visual appearance. For example, the superstructure columns are composed of two 5-in.-diameter HSS columns tied together with sculpted plates that match the exterior wall horizontal mullion spacing.

Architect

Krueck + Sexton Architects, Chicago

Structural Engineer

TGRWA, Chicago

Engineer (curtain wall)

Advanced Structures, Inc. Marina Del Ray, Calif.

National Winner—$75M and greater

UNIVERSITY OF PHOENIX STADIUM, GLENDALE, ARIZ.

University of Phoenix Stadium, the new home of the NFL's Arizona Cardinals as of last August, certainly stands out against the surrounding Glendale landscape. Its metal panel-clad exterior shimmers like a space-age desert flower during the day and glows like an enormous lantern at night.

While its skin makes a bold statement, its skeleton is equally as impressive. Perhaps the most interesting structural element is the 500,000-sq.-ft long-span roof structure, the backbone of which is formed by two lenticularly shaped Brunel trusses (so named because of their resemblance to I.K. Brunel's Royal Albert Bridge) that each span 700 ft. Due to the lenticular shape of the trusses, the structure behaves as a self-resolving superposition arch and a catenary tension element.

The sloping component of the top and bottom chord axial forces carry all the system's shear, and light steel rod web members resist unbalance loads, replacing the large diagonals and gusset plates typical of large roof trusses. The rods were prestressed by induced catenary action from a single rod that pinched the sets of cables on opposing faces together. As such, 15 kips introduced into the single draw-in rod produced 100 kips of prestress in four sets of rod pairs, greatly expediting the construction process.

When it came to the aesthetics of the roof, the design called for a relatively low-rise dome. The shape of the Brunel trusses allowed the externally visible rise of the roof to be only half the overall structure depth, with the lower half extending down into the building structure, but above spectator sight lines.

The central portion of the roof is retractable and opens or closes depending on weather conditions and facility use; it is the first retractable roof in the U.S. to traverse an inclined rail. For the operable roof panels, the engineers created a lenticular-Vierendeel HSS truss system—a similar principal to the Brunel truss—in order to eliminate all vertically oriented diagonal elements.

The project was also innovative from an erection standpoint. The fabricator/erector and structural engineer assembled the Brunel trusses and all framing between them—including the operable roof panels—on the ground. In the largest operation of its kind ever completed, this entire assembly was lifted into place over three days using strand jacks mounted atop four supporting supercolumns. This method both greatly enhanced safety and shortened the erection schedule, since the majority of the work was performed close to the ground.

Not only is the roof retractable, so is the field. This operable playing field can slide from its game position inside the stadium to outside the stadium though the south end in only one hour; below the field is a state-of-the-art convention floor. While there were no established playing field vibration guidelines, the engineer developed criteria to provide a suitable playing surface through a series of physical mock-up tests as well as extensive analytical work.

For more on this project, see our August 2006 issue at **www.modernsteel.com**.

Owner
Arizona Sports and Tourism Authority

Architect
HOK Sport + Venue + Event, Kansas City, Mo.

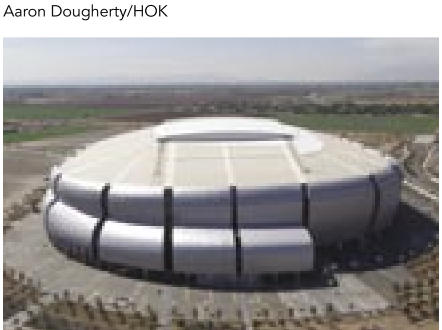
Concept Architect
Eisenman Architects, New York

Structural Engineers
Walter P. Moore, Austin, Texas (roof; consultant for operable field)
TLCP Structural, Inc., Phoenix (bowl structure and south concourse bridge)
Crown Corr, Inc., Gary, Ind. (façade support system)

Fabricator and Erector
Schuff Steel Co., Phoenix (AISC member)

General Contractor
Hunt Construction Group (Phoenix)

Aaron Dougherty/HOK



Visions in Photography

Aaron Dougherty/HOK

Merit Award—$75M and greater

HEARST TOWER—NEW YORK

The new headquarters for the Hearst Corporation mixes old with new, with a modern skyscraper rising out of a six-story landmark art deco building. The new 46-story glass and steel Hearst Tower stands at 600 ft tall and comprises 856,000 sq ft of floor space.

Preserving the existing landmark façade was a must. The original building footprint was 200 ft by 200 ft, but the design for the new tower called for a 120-ft by 160-ft footprint. In addition, the new tower would be supported by new foundations behind the original façade.

For the upper tower, a diagrid structure system was employed, creating a highly efficient tube structure composed of a network of triangulated trusses that interconnect all four faces of the tower. The nodes for the diagrid were set on a 40-ft module and placed at four floors apart. The diagonal elements were braced at the floor level between nodal levels, necessitating a secondary lateral system connected to the common diaphragm floors. The system is inherently highly redundant by providing a structural network that allows multiple load paths, as well as inherent lateral stiffness and strength.

Besides being an effective structural system, the diagrid is also highly efficient and was constructed with 20% less steel than an equivalent moment frame structure would have used. This, coupled with the fact that more than 90% of the project's steel contains recycled material, lead to Hearst Tower receiving a LEED Gold rating. In fact, it's the first building to earn such a rating for "core and shell and interiors" in New York.

For an in-depth profile of this project, see our July 2006 and April 2007 issues at **www.modernsteel.com**.

Owner
Hearst Corporation, New York

Architect
Foster + Partners, London, England

Associate Architect
Adamson Associates, Mississauga, Ontario, Canada

Structural Engineer
WSP Cantor Seinuk, New York

Fabricator
Cives Steel Company, Gouverneur, N.Y. (AISC Member)

General Contractor
Turner Construction, New York

Michael Ficeto/Hearst Corp.

Presidential Award of Excellence

DENVER ART MUSEUM—DENVER

When it came to expanding its facilities, the Denver Art Museum had ambitious plans, to say the least. Not only did it wish to nearly double its size, it also wanted to create an icon for the city.

The end result is the Frederic C. Hamilton Building, a shiny, angular, abstract form that pays homage to the nearby Rocky Mountains. The building's 2,740-ton superstructure is an interwoven cluster of leaning braced frames and trusses clad in 230,000-sq.-ft of titanium shingles. More than 3,100 pieces of steel are contained within 20 sloping panes that define the structure.

None of the planes are parallel or perpendicular to each other, which required the use of 3D modeling software (SAP 2000 and Tekla Structures) and building information modeling—key to understanding spatial relationships and detecting conflicts prior to construction and component fabrication. The architect used Form-Z to create a 3D wireframe model that resulted in 3D coordination of all disciplines.

The 3D wireframe model was loaded into Tekla Structures to refine and reshape the model into an exact virtual replica of the entire structure, including every structural member, plate, bolt, and weld. Detailers dedicated nearly two months to detailing the connections specifically to ensure an accurate advance bill of materials. Multiple connection points had up to 10 members from multiple planes converging on a single point. To handle all loads and solve connectivity issues, the team fabricated columns with massive clusters of gusset plates designed to efficiently receive the field-bolted beams, braces, and struts. In addition, bolt holes were oversized in all piles, allowing for the use of full-sized fit-up pins during construction.

For a complete profile of this project, please see our April 2007 issue at **www.modernsteel.com**.

Carole Lee; Courtesy of the Denver Art Museum

Owner
Denver Art Museum

Lead Architect Studio
Daniel Libeskind, New York

Executive Architect
Davis Partnership, Inc., Denver, Colo.

Structural Engineer
Arup, Los Angeles

Steel Fabricator
Zimmerman Metals, Inc., Denver
(AISC member)

Steel Erector
LPR Construction Co., Loveland, Colo.
(AISC member)

General Contractor
M.A. Mortenson Company, Denver

Software
SAP 2000
Tekla Structures
Form-Z

Presidential Award of Excellence

PORTLAND AERIAL TRAMWAY, PORTLAND, ORE.

There's a new method of transportation in Portland: the Portland Aerial Tram. While by no means a citywide transit system, the tram does connect the Oregon Health & Science University Hospital (OHSU) and the Marquam Hill neighborhood, located at the top of a canyon hillside, with a new medical redevelopment neighborhood on the bank of the Willamette River, just south of downtown Portland. Passengers are transported in two tram cars with a capacity of 79 people each.

The tram project consists of three steel structures: two stations—upper and lower—and a central support tower. The upper station is an open steel structure, a covered platform on braced legs balanced on a steep site wedged amongst hospital buildings. The lower station, like the upper, is an open network of exposed steel frame construction and expanded aluminum cladding. The central tower is a steel structure whose geometric form is the result of the forces acting upon it.

The two 3,300-foot long track cables from which the passenger cars are suspended are fully tensioned at all times, therefore exerting substantial loads on the two stations and central tower; the trams are pulled by a third haul rope connected to a drive engine at the lower station. Lateral loads exerted onto the platform level at the upper station range from 500,000 to 800,000 lb, when factoring in the tension load on the tram cables, forces due to wind and temperature variations, and the weight of fully occupied tram cars.

The 200-foot tall upper station has a dual structural stability system. Lateral and vertical loads are resisted by a concrete core—which also serves as an elevator shaft and stairwell—and four diagonal steel legs. Each leg is a parallelogram measuring 6 ft by 4 ft and made with 1-in.-thick steel plates. The legs resemble two pairs of compasses and provide stiffness in all directions, providing substantial lateral and torsional stiffness.

The central tower, which provides the intermediate support for the aerial tram, measures 196.5 ft from the drilled pier cap to the highest point. The trapezoidal cross-section varies along the height of the tower, measuring 22 ft wide by 20 ft long at the base, narrowing to 8 ft wide by 8 ft long at the neck region 2/3 of the way up the tower, and expanding again 8 ft wide by and 32 ft long at the top. This variation reduced the risks associated with vortex shedding.

The lower station's structural system is simpler. The station is covered with a 45-ft-tall steel canopy supported by a reinforced concrete basement, and is subject to substantial uplift due to potential high water levels and lateral forces due to the tram loads.

The central tower was fabricated in three pieces and transported to the construction site on barges. The 90-ft-tall base piece, weighing 112,000 lb, was installed first, followed by the 60-ft-long second tier and the 45-ft-long third tier of the tower.

Owner
The City of Portland and Oregon Health Science University

Architect
agps Architecture, Los Angeles

Structural Engineer
Arup, Los Angeles

Fabricator
Thompson Metal Fabricators, Inc., Vancouver, Wash. (AISC Member)

Engineering Software
SAP 2000

General Contractor
Kiewit Pacific Co., Vancouver, Wash.