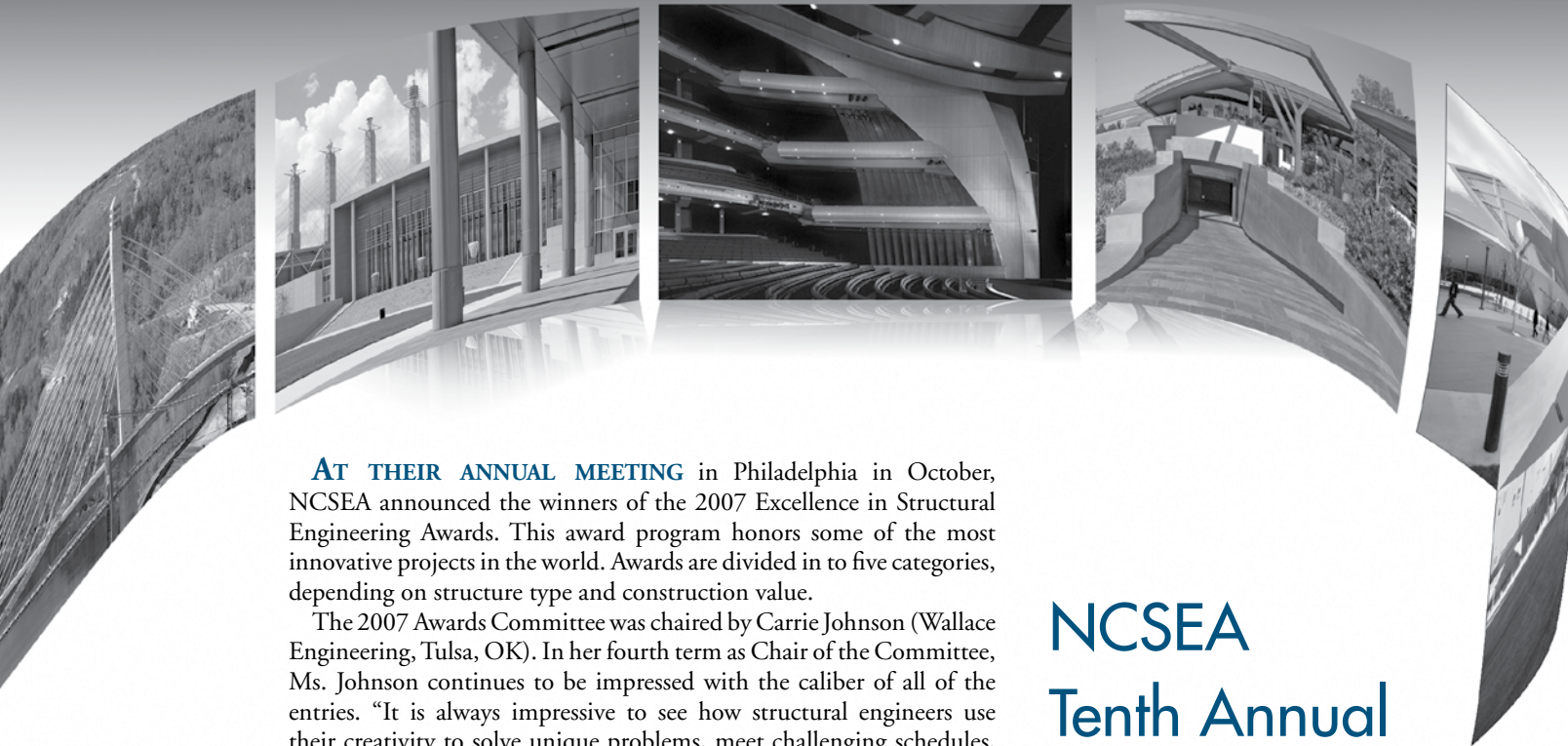


Excellence in Structural Engineering



AT THEIR ANNUAL MEETING in Philadelphia in October, NCSEA announced the winners of the 2007 Excellence in Structural Engineering Awards. This award program honors some of the most innovative projects in the world. Awards are divided into five categories, depending on structure type and construction value.

The 2007 Awards Committee was chaired by Carrie Johnson (Wallace Engineering, Tulsa, OK). In her fourth term as Chair of the Committee, Ms. Johnson continues to be impressed with the caliber of all of the entries. "It is always impressive to see how structural engineers use their creativity to solve unique problems, meet challenging schedules, and exceed their client's expectations. Each year, the awards submittals continue to be impressive. The panel of judges was assigned a very difficult task to judge projects which included buildings, bridges and a variety of other structures throughout twenty-two different states, and three separate countries. The outcome was very close in several of the categories, which attests to the high quality of the entries."

Victoria Arbitrio, P.E., SECB, Associate Partner, Gilsanz Murray Steficek, LLP, Judge and NCSEA Past President, praised the entrants saying, "An incredible house, a bridge with an observation deck, and a restored opera house – this was a great set of entries! We judged incredibly imaginative and creative structures and some which, on the surface, seemed quite simple. Each had one or two overbearing constraints, such as budget, site logistics or, more often, heroic architecture. The NCSEA Awards Committee looks forward to seeing more examples of Excellent Structural Engineering."

Outstanding Project Awards were presented in all five categories. Please join STRUCTURE® magazine and NCSEA in congratulating all of the winners. More in-depth articles on several of the 2007 winners will appear in the Spotlight Department of the magazine over the course of the 2008 editorial year.

NCSEA Tenth Annual Awards Program

2007 PANEL OF JUDGES

VICKI ARBITRIO

Gilsanz Murray Steficek, New York, New York

ROBERT HALVORSON

Halvorson and Partners, Chicago, Illinois

ROBERT JOHNSON

Bowman, Barrett & Associates, Chicago, Illinois

KENNETH PRICE

HNTB Corporation, Chicago, Illinois

DEBORAH ZROKA

Zroka Engineering, Chicago, Illinois

Outstanding Project Award Winners

The Estate "Suncatch"

New Buildings under \$30 Million

Rancho Santa Fe, California

SDSE Structural Engineers, - San Diego, California

Located in Rancho Santa Fe, California, this 27,000 square-foot residence is built over a 20,000 square-foot subterranean garage. One of Suncatch's main features is exposed structural steel beams painted with oxide red primer and infilled with Douglas fir. The beam spans and cantilevers reach up to 80 feet. One of the main design challenges involved calculating the camber required for the cantilevered beams so that the exposed wide-flange steel beams would end up straight and level. Complicating this was the variety of conditions involved in supporting the W24x229 beams with concrete structures, other cantilevered beams, bent columns, and column "trees".



Photograph courtesy of Norm Applebaum Architect, AIA.



Photograph courtesy of Paul Barnett

The lateral force-resisting system for the home was comprised of ordinary steel braced frames, moment frames, cantilevered steel columns, and concrete, masonry, and plywood shear walls. Because the shear walls do not extend to the roof diaphragm, columns cantilever above the walls through the clerestory glass to support the roof, and are connected to the shear walls at the bottom of the glass to transfer lateral forces into the walls.

The home also features glass window panels up to 30 feet in height, some of which include leaded glass doors supported by inverted U-shaped frames of solid steel plate construction cantilevered from the floor framing.



Kansas City Convention Center – Bartle Hall

New Buildings \$30M to \$100M

Kansas City, Missouri

HNTB Architecture, Inc. – Kansas City, Missouri

This project consisted of renovations and expansion of the Kansas City Convention Center. The new expansion consisted of a state-of-the-art ballroom, which was built over an active interstate system (I-670) in downtown Kansas City. This location, along with structural performance requirements inherent to convention centers, created numerous challenges, including: design and construction of a long-span floor the size of a city block capable of transferring loads, resisting vibrations induced from rhythmic activities, and supporting the 60-ton crawler cranes required to erect the roof structure.

Additional project requirements included a three-hour fire protection for the floor system, an erection sequence coordinated with traffic control and construction operations, concurrent replacement of two adjacent city street bridges, and operable partitions suspended from the long-span roof. The structural design team used prestressed concrete panels attached to the bottom of the steel trusses as a soffit, which gave increased fire and force protection for the steel structure. Two structural systems were selected for the floor: a composite precast/prestressed I-girder assembly and 16-foot deep continuous-span custom steel trusses for the ballroom and public space floors. This building enhances the Center's role as an anchor for downtown revitalization, including the new downtown entertainment district and arena.





Denver Art Museum – Frederic C. Hamilton Building

New Buildings over \$100M

Denver, Colorado
Arup – Los Angeles, California

The building doubled the size of the Denver Art Museum. The new building is constructed with a 2740-ton steel superstructure, which is an interwoven cluster of leaning braced frames and trusses clad in titanium shingles. Over 3100 pieces of steel are contained by 20 sloping planes, including a 194-foot prow, which extends 167 feet over the street and looms 100 feet above the ground. None of the planes are parallel or perpendicular to one another – adding to the design and construction challenges.

The massive structural steel frames and trusses shared the task of supporting the weight of the cantilevered overhangs while resisting the lateral loads for wind, earthquake, and gravity loads generated by the unusual geometry. The steel columns were manufactured with special alignment control holes that held a surveyor's prism and reflective tape "targets" were placed on the column faces. Station surveying instruments were programmed with this information. Up to 26 surveyors' prisms were in use on the structure at one time to ensure accurate placement and alignment.

For the first time in Denver's history, the city allowed subcontractors to participate in the design process, and the project team spent over two years planning every detail of the structure.



Penobscot Narrows Bridge and Observatory

Bridges and Transportation Structures

Linking Waldo & Hancock Counties, Maine
FIGG – Tallahassee, Florida

Maine's first cable-stayed bridge features the world's tallest public bridge observatory on top of the western pylon. By partnering with the state Department of Conservation, who manages adjacent Fort Knox, Maine's most visited historic location, the new bridge provides necessary transportation while also attracting visitors to the site.



Strands in the cable stay cradle system are independent primary tensile strength elements that run from an anchorage at the bridge deck through the cradle in the pylon and back to the bridge deck, transferring naturally compressive forces to the pylon through the curved portion of the cradle. Since each strand acts independently, a pioneering method for individual stay strand assessment was possible, the first use in the world of a force monitoring system on each of the 40 stays in the bridge. Recording stay forces and comparing them with predicted values allows Maine DOT to monitor the health of the bridge without additional expense, special equipment or interruption to traffic.

Given the remote location, steep banks and severe weather of the river, the bridge is cast-in-place concrete segmental technology, constructed in balanced cantilever using form travelers. This minimized the impact on the environment, allowed construction to continue year round and delivered a bridge with a service life that will exceed 125 years.

Outstanding/Merit Project Award Winners

The Quigg Newton Auditorium & Ellie Caulkins Opera House

Outstanding Project Award Winner: Other Structures

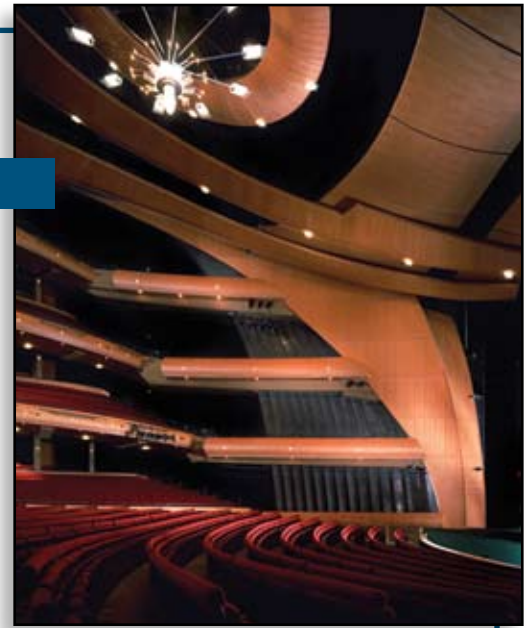
Denver, Colorado

Martin/Martin, Inc. – Lakewood, Colorado

The “Ellie Caulkins Opera House” is the crown jewel of Denver’s Performing Arts Complex. The “Ellie” was built completely within the massive volume of the original Auditorium Theater, which was constructed in 1908 and opened to great national fanfare by hosting the 1908 Democratic Convention. The reconstructed theater is home to local opera and ballet, and features 2100-seats in a unique double-warped seating bowl in the form of the famed La Scala Opera House.

The project involved completely demolishing the building interior, preserving only the historic masonry and riveted steel frame shell. Extensive bracing of the historic walls and shoring some of the riveted steel roof trusses was required to stabilize the shell during the demolition of the original structure contained within. The quarried stone foundation walls were underpinned to allow the sub-basement level to be excavated an additional twelve feet. Much of the existing historic riveted steel structure was cleaned and coated with fire-protecting intumescent paint and left exposed to patron view in the Lobbies.

The entire project was completed from within the building shell to allow shows to continue in the other spaces in the Complex. The construction process was often referred to as “building a ship in a bottle,” but those close to the project joke it was more like “trying to stuff a salmon into a sardine can.”



Merit Project Award Winners

Clyde Companies Corporate Office

New Buildings under \$30 Million

Orem, Utah

J.M. Williams & Associates, Inc. – Salt Lake City, Utah

Large portions of the wall panels have been omitted in this 3-story tilt-up concrete office building, accommodating views, reducing seismic mass and providing natural light. A prominent feature of the building is the 40-foot long self-supporting atrium designed to provide natural light to the interior. The atrium rises 50 feet above the main floor, and is topped with a Kalwall skylight. The main stairway is constructed with glass treads and enclosed in an exterior wall also of Kalwall.

Panels are off-set, vary in height, and were positioned to best support gravity loads and to withstand seismic forces while maintaining flexible interior space and views. Tilt-up construction accelerated the construction schedule, reduced forming costs, crane time and overhead work.

This unique building has greatly improved the industrial area of Orem, Utah. The incorporation of state of the art structural design with unique architectural features provides the Clyde Companies a first class corporate office building.

South Orange Performing Arts Center (SOPAC)

New Buildings under \$30 Million

South Orange, New Jersey

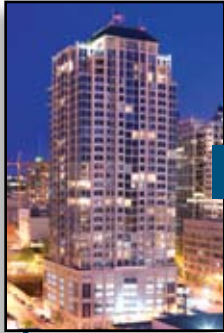
Gace Consulting Engineers, PC – New York City, New York

The Center houses a 415 seat performance hall, five movie theaters, and third floor loft space that holds up to 145 people plus a full-service catering kitchen. The building is predominately framed using steel framing with concrete on metal deck. A light gauge framed exterior skin encloses the south and west sides, while the north and east exterior walls are load bearing pre-cast concrete. Different finished material thicknesses were used throughout floor areas.

In order to create a sophisticated performing arts center on a very limited budget, a reduction of steel at the roof level was paramount. Open web steel joists were used rather than wide flange beams to support the roof deck. Pre-cast concrete construction and ready-to-order decorative wall panels helped to achieve the goals. The innovative use of an exterior load-bearing pre-cast concrete system and an integrated interior structural steel frame combine to accommodate the challenging building aesthetics and the long-span spatial requirements.



Merit Project Award Winners



The Cosmopolitan, Seattle Washington

New Buildings \$30M to \$100M

Seattle, Washington
Cary Kopczynski & Company, Inc. –
Bellevue, Washington

Constructed of cast-in-place concrete, the Cosmopolitan includes 33 stories of parking and residential condominiums, ground level retail, and a roof-top terrace. A shear wall system was combined with a two-way slab drop head system, allowing the 8-inch post-tensioned slab to span uninterrupted nearly 40 feet from the central core to the glass line. This provides open living units and parking without interior columns on three sides. By eliminating most interior columns, the additional gravity load placed on the walls resulted in a reduction in net flexural tension under seismic and wind loading.

High strength (10,000 psi) concrete was used in the shear walls. Mechanical ductwork, water supply and most utilities were placed in the concrete slabs. A significant challenge was the design of the main lateral force resisting system. In order to meet code intent for strength, deflection, and ductility, a nonlinear model was developed and a pushover analysis was completed in each direction.

New Austin City Hall

New Buildings \$30M to \$100M

Austin, Texas
Datum Engineers, Inc. – Austin, Texas



The new Austin City Hall is a four story, 150,000 square-foot building atop a 3 level underground garage. It has a complex layering of irregular-shaped overlapping plates, creating cantilevers upon cantilevers as the building rises. Over half of the columns stop above the garage, resulting in post-tensioned transfer girders at the plaza level. The plaza level design features 40 distinct slab elevations.

An amphitheater seating area is covered by a 30-foot wide cantilevered sun screen covered in photo-voltaic panels. The canopy was designed with a torsional tube spine running along one side, with cantilevered rib members extending from it. The rib members had to be cambered variable amounts so that when loaded with dead load they would deflect to a nearly perfect straight line.

The design of City Hall recently became LEED Gold Certified by the USGBC by including 24% fly ash replacement, recycled steel and rebar, and reuse of excavated in-site materials for fill.



The New Beijing Poly Plaza

New Buildings over \$100M

Beijing, China
Skidmore, Owings & Merrill –
San Francisco, California

The Poly Plaza was designed to minimize the perimeter exposed to the elements, while a series of interior atria provides office areas with maximum access to daylight. Minimal glass membranes supported by two-way cable-nets form the exterior walls of the atrium.

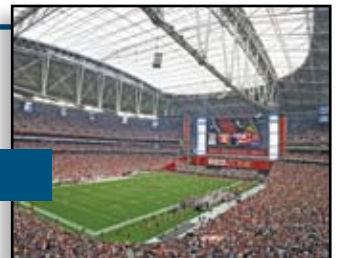
The base building is a composite structure consisting of three reinforced concrete cores at the ends and intersection of the 'L' shaped office plan, with structural steel moment resisting frames between. Two reinforced concrete cores were placed to provide rigid boundary conditions for the primary cable-net. A three story high steel truss connects the top of these cores, providing the final boundary condition to the cable-net façade.

The primary cable-net supported glass is 90 meters high by 60 meters wide, about four times larger than previous examples of this type of façade. Large diameter parallel strand cables under high levels of pre-tension were used, while adding a significant design complexity in seismically active Beijing.

University of Phoenix Stadium

New Buildings over \$100M

Glendale, Arizona
Walter P Moore – Austin, Texas



Photograph by Aaron Dougherty.

Two kinetic structures were developed to allow this facility to host a wide variety of events. Accommodating open-air events, the 500,000 square-foot long-span roof structure is the first U. S. retractable roof to traverse an inclined rail. Two lenticularly shaped "Brunel Trusses" span 700 feet to form the primary backbone. The truss diagonal rods were tensioned by induced catenary action from a single rod that pinched the sets of cables on opposing faces together.

Engineers developed first-ever playing field vibration guidelines to provide a suitable playing field for professional football games. The operable playing field was designed to slide into game position in only one hour, allowing convention floor trade events on non-game days.

During construction, operable panels were assembled on the ground. In the largest operation of its kind, this assembly was then lifted into place over a period of three days using strand jacks mounted atop the four supporting supercolumns.

Merit Project Award Winners



Lee Roy Selmon Crosstown Expressway Expansion

Bridges and Transportation Structures

Linking Brandon & Tampa, Florida
FIGG – Tallahassee, Florida

Span-by-span precast concrete segmental construction solved the challenge of providing expanded expressway capacity in a developed urban corridor. Capacity was accomplished by locating slender cast-in-place concrete piers in the median of the existing expressway to support a superstructure that accommodates three lanes of traffic.

The 59-foot wide uniquely shaped box girder has cantilevered “wings” that limits the view of the at-grade driver to only half of the smooth structure underside, limiting the structure’s visual size.

A total of 3,032 segments for the superstructure, cast off site, were delivered to the erection sites during off-peak hours. As much as 2,400 linear feet of bridge was constructed in a single month as traffic flowed on the existing lanes.

Creative use of the existing median provides necessary capacity, at a price that is feasible. Locating the concrete piers in the median accommodates three lanes of traffic and reverses traffic direction to coincide with rush-hour traffic.



Portland Aerial Tramway

Other Structures

Portland, Oregon
Arup – Los Angeles, California

Connecting the Oregon Health & Science University Hospital and the Marquam Hill neighborhood with a new medical redevelopment neighborhood, the tramway consists of three structures:

Lateral and vertical loads on the Upper Station structure are shared by a concrete core wall, which is also utilized as an elevator shaft, a stairwell and four diagonal steel legs. The design provides substantial lateral and torsional stiffness, and creates a unique architectural form.

With its steel plated construction and leaning toward the Lower Station, the Central Tower provides intermediate support for the tram. The trapezoidal cross section varies along the tower with height, with the narrowest section at approximately two-thirds of the height, reducing risks associated with vortex shedding.

The Lower Station, a simpler structural system, is covered with a 45-foot tall steel canopy supported by a reinforced concrete basement. The structure is subjected to substantial uplift due to potential high water levels and lateral forces due to the tram loads.

Rattlesnake Creek Pedestrian Bridge

Bridges and Transportation Structures

Missoula, Montana
HDR – Missoula, Montana



This pedestrian crossing is environmentally friendly – using recycled materials with a sustainable design – that fits well into the context of its surroundings. The bridge is complex because it not only uses lattice stiffening trusses, it requires that those trusses be made from 6-inch diameter bug-killed trees in order to satisfy the conditions of the U.S. Forest Service grant.

The solution was to use trusses constructed of half-rounds with the flat sides facing inward. By using many small overlapping members, the forces at the connections are spread out over a large number of connections and minimized. This material had never been used for a bridge, and it is the first time this type of wood had been used for lattice trusses.

The deck is made of a new industrial-grade wood/plastic composite, with rubber mats made from recycled tires atop to provide a non-slip surface for pedestrians, bicycles and horse traffic.

Photograph courtesy of Michael Gallacher Photography.

United States Air Force Memorial

Other Structures

Arlington, Virginia
Arup – New York City, New York



The striking US Air Force Memorial consists of three slender 82-meter stainless steel spires, splaying out to evoke an image of aircraft in a “bomb-burst” maneuver. A series of 20-inch diameter $\frac{3}{4}$ ton lead balls, free to roll within oversized padded boxes, are located towards the top of each spire. The boxes which enclose the spheres are also fabricated from steel, with internal vertical surfaces coated with synthetic rubber.

These “impact dampers” were designed to control the movements of the spires in high winds and prevent galloping. When the spires vibrate, collisions occur inside the box, which moves with the spire and the free-rolling balls. Each collision dissipates energy and protects the structure.

The dampers had to be built into the structural sections prior to their erection, with no opportunity for future maintenance. The ball-in-box impact dampers are robust and, when designed to avoid fatigue, have no limit to their design life.