Excellence in Structural Engineering

NCSEA Ninth Annual Awards Program

JURY OF AWARDS
2006 Excellence in Structural Engineering

ROBERT ZAHL
Zahl-Ford, Inc., Oklahoma City, OK

GENE PAULSGROVE
ZRHD, P.C., Oklahoma City, OK

BEN WALLACE
Frankfort Short Bruza, Oklahoma City, OK

JOHN KELLY
B &T Engineering, Tulsa, Ok

DAVID PUSKAS
BSW International, Tulsa, OK

At their annual meeting in Salt Lake City in September, NCSEA announced the winners of the 2006 Excellence in Structural Engineering Awards. This award program honors some of the most innovative projects in the world.

Jeanne Vogelzang, NCSEA Executive Director, was impressed with the diversity and geographic representation of this year's program entries. "We used to have a problem bringing in projects in certain categories. No more. The NCSEA Awards Program now attracts a wide variety of both firms and projects."

The 2006 Awards Committee was chaired by Carrie Johnson (Wallace Engineering, Tulsa, OK). In her third term as Chair of the Committee, Ms. Johnson continues to be impressed with the caliber of all of the entries. "There were a wide variety of projects submitted including a renovation of the Hollywood Bowl, an addition to Soldier Field, the longest cable stayed bridge in North America, and an innovative seismic retrofit design. The project locations also varied widely, with projects from throughout the continental United States, Alaska, Hawaii, Mexico City, and one in Taiwan. It is always amazing to see the creative solutions that structural engineers can use to solve unique problems, meet challenging schedules, and save the client money."

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 2006 winners will appear in the magazine over the course of 2007.

OUTSTANDING PROJECT AWARD WINNER

New Buildings under $30 Million

ROCKING AND RESTORING BRACED FRAMES

Orinda City Hall

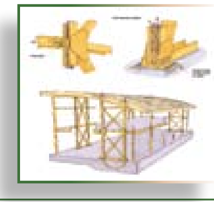
Orinda, California

Tipping Mar & Associates – Berkeley, California

Photographs and rendering courtesy of Tipping Mar + associates

Orinda City Hall was designed to reduce potential economic and environmental losses from earthquakes. As a seismic solution, braced frames were employed. Under small to moderate earthquake stresses, almost no other system is more effective. However, braced frames are brittle under large earthquake stresses, and can result in soft story mechanism (SSM) — and compensating for SSM can significantly drive up the initial cost.

The solution was to keep the advantages and minimize the disadvantages, while improving the general design by adding restoring characteristics and replaceable yielding elements. The structural system's elastic strength is high, with a base shear set to be 125% of that of an ordinary braced frame. This keeps the building stiff and strong to resist frequent small to moderate earthquakes with little architectural damage and little economic loss. For large, rare earthquakes, the system changes modes to a controlled in-elastic response.



Key features include the rocking mode shape, restoring force characteristics provided by post-tensioned cables parallel to the steel columns, and replaceable yielding elements. When the tension force on the angles exceeds yield, they form flexural plastic hinges to accommodate the uplift and are designed to be replaced after permanent deformation.

The new Orinda City Hall is proof that designing for seismic performance and sustainability does not need to sacrifice aesthetics.

OUTSTANDING PROJECT AWARD WINNER

New Buildings $30 Million to $100 Million

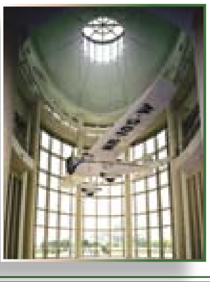
Oklahoma History Center

Oklahoma City, Oklahoma

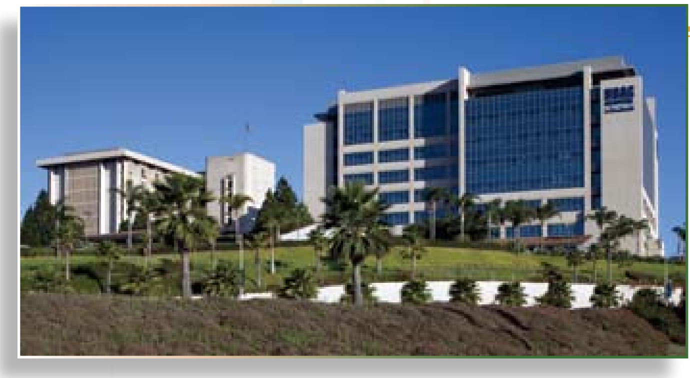
Wallace Engineering – Tulsa, OK

The Oklahoma History Center is the new home of the Oklahoma Historical Society. Its unique, curving geometry was created in response to its site. The three-story office/library wing is an S-shaped element. The C-shaped gallery wings are nested into the office/library wing and face toward the State Capitol. The two wings are joined by a three-story atrium spine and an elliptical-shaped Grand Hall, reaching 88 feet in height and completely glazed on the exterior.

Photographs courtesy of Don Wheeler Photography



The floor plan geometry of the History Center created interesting and difficult framing challenges. The structural grid system is laid out on a radial coordinate system, with the radial grids dimensioned angularly and the concentric grids dimensioned using distances. The floor framing consists of composite steel framing. The floor and roof framing are configured so that straight girders run along the concentric grids, creating a segmented curve. Beams were placed perpendicular to the girders, so that all beam-to-girder connections were at 90 degrees. Beams at the radial grids were placed along the grids and the columns were rotated normal to the radial grids, which created 90-degree connections for these beams. This system simplified the primary framing so that the only skewed connections occur at the girder-to-column connections.



Assassi Productions and Image courtesy of TMAD TAYLOR & GAINES

OUTSTANDING PROJECT AWARD WINNER

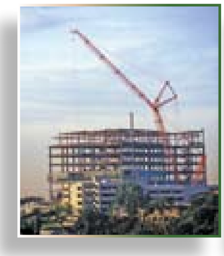
New Buildings over $100 Million

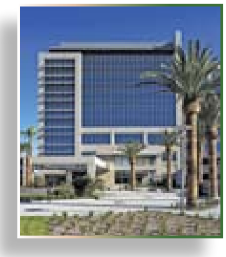
Hoag Memorial Hospital Presbyterian
Sue and Bill Gross Women's Pavilion
Newport Beach, California
TMAD Taylor & Gaines – Pasadena, California

The Pavilion is the first hospital building built in California combining a lateral moment frame system with base isolation. The site is located less than two kilometers from the closest earthquake fault, the Newport-Inglewood Fault, which is anticipated capable of producing an earthquake of 6.9 Richter magnitude. The building is designed to remain operational in consideration of seismic activity from nearby faults as well as other, in the region. Special moment frames allow maximum exterior window openings and interior remodel flexibility.

Challenges addressed on this project included complex and unique solutions: tuning frame and isolator layout and properties for balance between the lateral moment frame system and base isolation system; use of 1-story truss moment frame girders at interstitial floor level to create a large 2-story volume at the entry; a full scale moment frame joint testing program; a full scale base isolator testing program; an esteemed peer review committee was established to review and approve the structural design criteria.

This building was delivered 2 months ahead of schedule and under budget. Office of Statewide Health Planning & Development (OSHPD) stated that teamwork and cooperation between the owner, construction manager, contractor, design team and OSHPD was the primary reason for such a successful project. Of particular importance was the fact that the hospital continued full operations during construction.





Left: Photograph courtesy of McCarthy Building Companies;
Right: Assassi Productions and Image courtesy of TMAD TAYLOR & GAINES

OUTSTANDING PROJECT AWARD WINNER

BRIDGES AND TRANSPORTATION STRUCTURES

I-94 Modified Tied-Arch Bridge
Taylor, Michigan
Alfred Benesch & Company – Chicago, Illinois

Photographs courtesy of Alfred Benesch & Company

The proposed single-point interchange at I-94 and Telegraph Road required single-span bridges carrying I-94 over Telegraph Road to ensure adequate sight distance for ramp terminal traffic. To maintain existing vertical clearance over Telegraph Road, I-94 would need to be raised or Telegraph Road lowered. To avoid these impacts, arches with a shallow floor system were selected.

Locating the bridges closely together required placing the inner arch base at interstate level and the outer arch base at local road level, resulting in unequal arch rib lengths. The rib sections of the two arches vary to achieve the same stiffness. Building the new structure in the wide median space reduced the impact to traffic and allowed existing roadway to be converted to green space.

The foundation is redundant. In these arches, concrete foundation ties beneath Telegraph Road are sized so that the tension of the concrete is sufficient to carry the arch thrust. However, should the concrete crack, there is adequate reinforcement in the tie. In addition, batter piles and earth pressure against the foundation also add to the redundancy.

Football-shaped lateral braces commemorated Super Bowl XL. These braces and the shadows they produce create an interesting aesthetic appearance. The space between the bridges, when seen from above, resembles a football with laces.

OUTSTANDING PROJECT AWARD WINNER

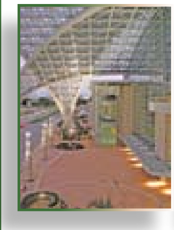
OTHER STRUCTURES

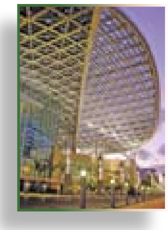
Puerto Rico Convention Center
San Juan, Puerto Rico
Walter P Moore and Associates, Inc. – Atlanta, Georgia

Photographs ©Brian Gassel / TVS

With a roof structure that evokes ocean waves, the Puerto Rico Convention Center is a work of art that met its many design and structural challenges, including a reclaimed landfill site in a highly seismic zone with soils prone to liquefaction. The building, which is largely clad in glass, must also safely withstand Category 5 hurricanes.

Its 580,000 square feet make it the largest convention facility in Latin America. The signature posed roof structure soars above the vibration-controlled 40,000 square-foot ballroom, which is located over the ground-level facilities.





The structural engineers created the roof of two thin shell elements that float over the building. The high roof is elliptical, curving in two directions as it spans 375 feet and reaching 130 feet at its apex. The ballroom roof is a barrel vaulted tied-arch that spans 270 feet.

With this roof system, substantial analysis and design were required to determine the geometry, member sizes and the connection details. The highly repetitive details minimize the number of different roof elements and greatly simplify the already complex job of steel detailing, fabrication and erection. The structural engineer used its 3D CAD model to optimize the design and to define spatial coordinates for each intersecting roof element.

MERIT AWARD WINNER

New Buildings under $30 Million

Seismic Isolation Design for Los Angeles Regional Transportation Management Center
Los Angeles, California
Coffman Engineers, Inc. – Encino, California

The LARTMC building was designed to be the home of the Regional Transportation Management Center for CALTRANS District 7 and the Los Angeles Communications Center (LACC) for the California Highway Patrol.

The structure was designed to be base-isolated and, in all likelihood, remain operational during and immediately after a major seismic event. An exceptional modeling technique was devised to account for the different tension and compression properties of the isolators. Since the behavior of isolators is different in compression and tension, each isolator was modeled using combinations of different ETABS elements.

Seismic-isolators have considerably lower tension capacities compared to compression strength. This creates challenges when resisting seismic over turning forces. A bracing scheme was devised that dramatically reduces tension forces on the isolator bearings. By skipping isolators adjacent to each corner and using the braced frames as transfer trusses, dead load was concentrated at the building corners to minimize the upward (tension) forces.

MERIT AWARD WINNER

New Buildings under $30 Million

ImaginOn — The Joe and Joan Martin Center Charlotte, North Carolina King Guinn Associates – Charlotte, North Carolina

Photograph courtesy of Tom Kessler

The Joe and Joan Martin Center integrates two separate entities, the Public Library of Charlotte and Mecklenburg County and the nationally recognized Children's Theatre of Charlotte, into a new and innovative type of facility. Encompassing an entire city block, ImaginOn is a two story facility with multiple mezzanines between floors, all built over underground parking. The main column grid is skewed approximately 18.5 degrees from the typical 90 degrees, i.e., there are few right angles.

Glazed ceramic cubes house library and classroom spaces. The story telling and blue screen theater space and the enclosed courtyard are in the form of a helix, the 250-seat theater is a rectangular box, the elevator at the entrance is a pentagon, and the 570-seat theater is a standing seam metal skin created by the intersection of two elliptical cylinders truncated at one end and rising about 80 feet above street level. The main floors and roof are parallelograms. Roof slopes result in every column being a different height.

MERIT AWARD WINNER

New Buildings $30 Million to $100 Million

Providence St. Joseph Medical Center, Northeast Building
Burbank, California
TMAD Taylor & Gaines – Pasadena, California

Image courtsey of TMAD TAYLOR & GAINES

The site is located less than five kilometers from the the Verdugo fault, which is capable of producing an earthquake of 6.9 Richter magnitude. The building is designed to remain operational under seismic activity from regional faults.

In order to reduce steel tonnage and achieve better drift control, SMRFs with RBS and deep columns were proposed. However, the prequalification of RBS connections was limited only to W12 and W14 columns in FEMA-350. OSHPD (Office of Statewide Health Planning & Development) required full-scale testing for the proposed connections. Full-scale moment frame joint testing was done using ATC-24 loading protocol to verify and ensure that yielding is limited to the RBS and no yielding occurs in either the panel zone or the column.

The project benefited from a clean design, well coordinated construction documents, and cohesive teamwork among the design team, as well as an innovative contractor who produced the building ahead of schedule and under budget.

MERIT AWARD WINNER

New Buildings over $100 Million

731 Lexington Avenue
New York, New York
Thornton Tomasetti – New York, New York

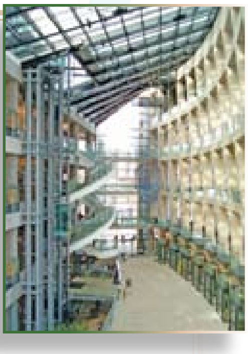
It is easy to see the slender proportions established by Design Architect Pelli Clarke. Pelli Architects and Architect of Record SLCE on the 55-story tower on Lexington Avenue. Less visible is the innovative structural engineering by Thornton-Tomasetti Group that reconciles several unusual project requirements: 24 stories of luxury condominium residences atop 26 stories of office space, 3 stories of retail and three basement levels. The floor plate sizes, spans and column layouts vary for different uses.

The principal tenant, the headquarters of Bloomberg LLP, required that no mechanical equipment levels occur between office floors to permit easy communication between them, affecting locations of transfers and outrigger trusses. Residents of the luxury apartments must be comfortable on windy days. And a dramatic mid-block horseshoe atrium must reconcile the behaviors of the tall tower and shorter building it links. With the combination of steel framing on lower floors and concrete flat plate construction on upper floors, needs of the different users were met.

MERIT AWARD WINNER

New Buildings $30 Million to $100 Million

Salt Lake City Library
Salt Lake City, Utah
Reaveley Engineers & Associates – Salt Lake City, Utah



Photograph courtesy of Jeff Ambrose

The Library's elegant design combines basic geometric shapes: triangles, rectangles, circles, and arcs. 90% of the structural elements are visually exposed. Choosing the most appropriate structural systems to unite the complex assortment of geometric shapes was challenging. All of the major building components were designed as independent structures interconnected with bridges, skylights, and curtain walls. Each connecting element was designed and detailed to accommodate the seismic deformations anticipated for the major building components, up to 15 inches in all directions, as required by the 1997 Uniform Building Code.

The glass "Lens Wall", which forms the southeast enclosure of the 5-story main library triangular element, was especially challenging. The structure supporting this glass wall not only must resist high wind forces, but was required to disappear visually as to not interfere with the magnificent views. A system of vertical and horizontal pre-tensioned, high strength cables were attached to a grid of steel tube sections to create a sturdy and rigid structure to which the glass could be attached.

MERIT AWARD WINNER

New Buildings over $100 Million

Union Pacific
Corporate Headquarters Office Building
Omaha, Nebraska
Walter P Moore and Associates, Inc. – Kansas City, Missouri

Photograph courtesy of Aker Zvonkovic Photography / Gensler

Union Pacific had specific ideas for its new corporate headquarters. The 19-story, 1.3 million-square-foot building has a glass exterior over a structural steel frame. The central atrium extends the building's full height and is topped with a clerestory that lights the building's core. The atrium's openness allows employees to see each other across the building, and the public to see inside.

The building's vertical circulation, mechanical rooms and rest rooms are scattered around the large floor plate. The design team took advantage of the full-height central atrium by developing a unique system to resist wind and seismic loads. Four-story-tall steel X-bracing forms an efficient 120-foot square braced tube lateral system. Thanks to the braced tube's large plan extent and low slenderness ratio, the columns and supporting foundations are dominated by gravity loads instead of lateral loads.

Employees walk on a series of slender "bridges" along the atrium. Above them, a vierendeel frame allows six levels of office space to span 90 feet across the entry.

Merit Project Award Winner

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MERIT AWARD WINNER

BRIDGES AND TRANSPORTATION STRUCTURES

Arapaho Road Bridge
Addison, Texas
URS Corporation – Dallas, Texas

The Arapaho Road Bridge is a 14-span, 1575-foot long bridge carrying four lanes of traffic. The centerpiece is a 170-foot signature arch-span over Midway Road. The approach spans range from 100 to 114 feet long. The entire bridge superstructure, including the main span, utilizes precast, prestressed concrete Texas U-54 beams and precast, prestressed concrete deck panels. Four lines of U-beams are utilized in the cross-section throughout the length of the bridge. The main span is supported by twin unbraced steel pipe arches, which rise 29 feet above the bridge deck. The steel pipe arches tie the bridge to the landmark public art sculpture titled "Blueprint of Addison." The bridge deck is suspended by a series of nine hangers that attach to the arch ribs. The triangular reinforced concrete thrust blocks are founded on three 60-inch diameter drilled shafts. The approach structures consist of U-beams supported on single column inverted "T" bents, founded on single 96-inch diameter drilled shafts.

MERIT AWARD WINNER

BRIDGES AND TRANSPORTATION STRUCTURES

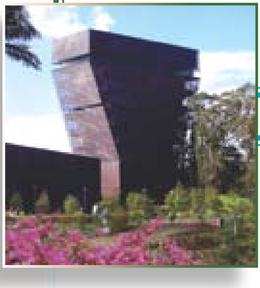
Victory Bridge
Perth Amboy-Sayreville, New Jersey
FIGG – Tallahassee, Florida

Photograph courtesy of FIGG

Investing in the upkeep of a rapidly deteriorating 75-year old steel truss swing span bridge was minimized by opening the new Victory Bridge as quickly as safely possible. The first of the twin 3,971-foot precast concrete segmental structures opened just 15 months after notice to proceed, while the second was subsequently erected in eight months.

A larger navigational channel to accommodate shipping traffic on the Raritan River was desirable, resulting in the record-setting fully match-cast 440-foot main spans of the twin bridges. The main span units were erected in balanced cantilever, concurrent to the span-by-span erection of the approach spans. The new navigational channel has 355-foot horizontal clearance, an increase of 227 feet, dramatically improving safety.

The analysis of various factors resulted in a foundation design that reused pipe piles from a previous, but abandoned, design/build attempt in three foundations and all land based piers. Water based piers consisted of drilled shaft foundations up to 8 feet in diameter, the largest constructed in the state.



Photograph courtesy of Don Wheeler Photography

MERIT AWARD WINNER

OTHER STRUCTURES

Exterior Skin System for the DeYoung Museum
San Francisco, California
Wallace Engineering – Kansas City, Missouri

The perforations in the building skin of the new de Young Museum in Golden Gate Park mimic the dappled sunlight that comes through the surrounding trees. The exterior skin system consists of 950,000 pounds of copper fabricated into over 7,200 unique panels, with a total area of over 163,000 square feet. There are over 1,500,000 embossings, dimples and perforations in these panels.

The Exhibit Building panels are supported by a girt system that is directly attached to the framing, with no isolation from the frame movement.

The framing system either had to be well-coated or made from a material not subject to dielectric corrosion when placed in contact with the copper. Designers proposed that cold-formed copper framing sections be used and designed to act as long-span girts between the trusses.

The skin panels on the ten-story Administration Building are supported by vertical steel pipe girts attached to the building frame with a special joint, which isolates the skin panel frames from the building during a seismic event.

MERIT AWARD WINNER

OTHER STRUCTURES

General Motors Renaissance Center, North Entry Pavilion
Detroit, Michigan
Skidmore, Owings, & Merrill, LLP – Chicago, Illinois

Photograph courtesy of Skidmore, Owings & Merrill LLP / Justin Maconochie

The entry pavilion for the new General Motors' Global Headquarters at the Renaissance Center in Detroit is a large cable-net system that has been shaped to provide an efficient, stiff structure. The pavilion uses anticlastic cable-nets on the two vertical faces of a lens shaped building. This plan was created to provide two circular arcs of cables that are pre-stressed against parabolic vertical cables. The result is a geometrically stiffened cable-net that resists uniform and non-uniform wind pressures and suctions. The vertical cables are stressed against a roof truss that spans to supporting vertical trusses at the apexes of the lens. These vertical trusses in turn form the system against which the horizontal cables are stressed. The major compression elements are the compression chord of the roof truss and the vertical trusses. These elements are partially braced by the cables, resulting in very slender 12.75-inch pipe sections.