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ASCE

CIVIC INSPIRATION

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COPENHAGEN'S NEW STAR

Civic Beauty

When the City of Newport Beach, California, needed a city hall more central in its location, designers took the opportunity to construct more than just an administrative building, creating an inviting civic space that includes a community room, city council chambers, family-friendly parkland, and an expansion to a branch of the city's library—all on a site that offers stunning views of the Pacific Ocean.

By Janice Mochizuki, P.E., LEED AP, Joseph Collins, S.E., and John Worley, S.E., LEED AP

The steel framing members of the repeating-wave roofs were made from readily available wide-flange members that were bent in the fabricator's plant to achieve the double curves.

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THE COASTAL CITY of Newport Beach, California, has been a victim of its own success: between 1948, when its first city hall was constructed, and the dawn of the new millennium, its boundaries grew to such an extent that the city hall was no longer centrally located. The city needed to create a modern civic center that would be more accessibly positioned and could bring the growing community together, so it commissioned the Newport Beach Civic Center and Park, a 20-acre complex offering an optimal location.

The project comprises a city hall, a community room, city council chambers, and a parking garage, as well as an addition to one branch of the public library, four pedestrian bridges, and 14 acres of parkland. A team of architects from the San Francisco and Philadelphia offices of Bohlin Cywinski Jackson (BCJ) designed the buildings and the largest pedestrian bridge. PWP Landscape Architecture, of Berkeley, California, designed the park and the three smaller bridges, which are referred to as landscape bridges. Engineers from the San Francisco office of the international firm Arup provided structural, mechanical, electrical, plumbing, and civil engineering, along with consulting services for lighting, sustainability, and telecommunications. C.W. Driver, through its Irvine, California, office, was the general contractor.

As a public project, the effort began with an open call for design entries. After a series of public meetings, a design committee was established to review the entries and make recommendations to the city. The project team of BCJ, PWP, and Arup was placed on the short list, and the five teams on that list were then invited to participate in a design competition. In November 2008 the BCJ, PWP, and Arup team's entry was chosen as the winner of the competition. Site work began in the spring of 2010, and building construction followed that December. Construction of the buildings, bridges, and park was completed in April 2013, and the project obtained gold certification in the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) program shortly thereafter. The total construction cost of the project was $106 million, financed through city funds and bonds.

BCJ aspired to provide a true civic gathering place that would meet the cultural aspirations of the seaside town. The site consists of two parcels of parkland separated by a nine-lane east–west thoroughfare, San Miguel Drive. The northern portion features a dog park, walking trails, and bioswales. The largest of the four bridges crosses San Miguel Drive, leading visitors south to the main park, which features a children's play area, a continuation of the trails (for 1.2 mi in total), protected wetlands, and the landscape bridges, which cross the wetlands. The main civic center area lies south of the park. To the west are the city council chambers, the community room, and the city hall; to the east, separated by a landscaped space known as the Civic Green, is the new parking structure. Farther south of these structures is a branch of the public library, and an expansion of this building on the side facing the Civic Green was part of the overall project. (See the illustration on pages 76 and 77.)

As a result of the project team's careful coordination from the competition phase to the completion of the project, the overall vision for the projects remained constant. The firms took a "total architecture" approach—first espoused by the famed architect Walter Gropius and championed by Arup's founder, Ove Arup—to devise integrated solutions that could solve multiple problems. Using this approach, the team developed solutions that integrated architecture, engineering, and landscape architecture into a seamless whole.

The signature element of the new city hall is its light, wavelike canopy, which covers ample outdoor space on the Civic Green. A backlit, polytetrafluoroethylene (PTFE) fabric creates a "sail" above the street-facing facade of the council chambers, adding to the complex's beach atmosphere.

PHOTOGRAPH BY DAVID WAKELY

THE SINGLE-SPAN pedestrian bridge across San Miguel Drive was designed by BCJ to have a low profile so as to preserve sight lines. Two wide-flange steel girders 150 ft long and more than 40 in. deep span from the abutment on the north end to an elevator tower on the south end. The steel girders were cambered to achieve the flatness to provide a low profile. At the south end the girders are supported by the elevator tower and extend above a pair of wide-flange beams embedded in the tower and cantilevering from it. Concrete shear walls in the tower serve as the sole lateral-force-resisting system at the south end of the bridge.

The girders cantilever outward beyond the tower to form a 52 ft observation platform, the girders stopping 10 ft before the edge of the platform. A 6 in. thick slab comprising a steel plate and concrete fill in combination with a clear glass guardrail allow the last 10 ft of the observation platform to cantilever, enabling visitors to feel as though they are floating above the park as they take in striking views of Santa Catalina Island.

Installation of the San Miguel Drive bridge proved to be a significant logistical challenge. This nine-lane highway connects two significant thoroughfares, Avocado Avenue and MacArthur Boulevard, and it also serves as an important point of ingress to the popular Fashion Island shopping center, which is northwest of the project site. The bridge was installed in mid-November 2012 and involved only three nights of closures to San Miguel Drive. The highway reopened with plenty of time to spare for that year's Black Friday shopping crowd.

The park that is divided by the highway includes restored wetlands spanned by the three landscape bridges, as well as picnic facilities, walking paths, and sculptures. One of the three bridges, the "bird blind" bridge, was designed with tall vertical steel slats to enable users to view birds that reside in the wetlands. The other two bridges over the wetlands are low-profile steel-framed structures that connect to the walking paths. Since the team aimed to install these bridges in such a way as to minimize the effects on the protected wetlands, the majority of the steel was fabricated in the shop or at a nearby site and then lifted into position.

The new, 155,000 sq ft parking garage has capacity for 450 cars and will serve the city hall complex, the library, and park visitors. The structure is partially below grade to provide enough parking spaces but not obstruct views from MacArthur Boulevard.

The branch of the public library at the site was expanded with a two-story, 17,000 sq ft addition that provides a children's play area as well as space for reading. A café and a credit union were positioned in the entryway. With the additional square footage, it was also possible to include a media center that gives the public access to high-tech digital graphic arts programs and to a high-quality sound recording room. Except for the removal of the facade facing the park, no changes were made to the library building, which was constructed in the early 1990s. An expansion joint along the interface between the new and old portions of the building will prevent them from impacting each other during a seismic event.

Steel gravity framing and moment-resisting frames were used in the library addition. Large built-up steel columns in the main entry were detailed to match the architectural aesthetics of the existing structure and to be of sufficient size to support a roof that cantilevers 50 ft. The central built-up column was made from $^3/_4$ in. thick steel plate welded into two channels 18 in. deep and roughly 7 in. wide. The channels were placed back-to-back and slightly skewed, the gap between them varying from 6 in. to 9 in. The channels were tied together vertically along the height of the columns with $^1/_2$ in. thick horizontal plates.

Tapered steel plate girders splay out from a central node that balances over the central built-up column to form a dramatic cantilever. A large raised patio under the roof overhang can double as a stage for such community events as movie nights, civic ceremonies, and live performances.

The design and construction teams were able to integrate the extension of the library building and its heating, ventilation, and air-conditioning in a way that minimized the effect on library operations, especially with regard to closures of library spaces. The construction sequencing and schedule were

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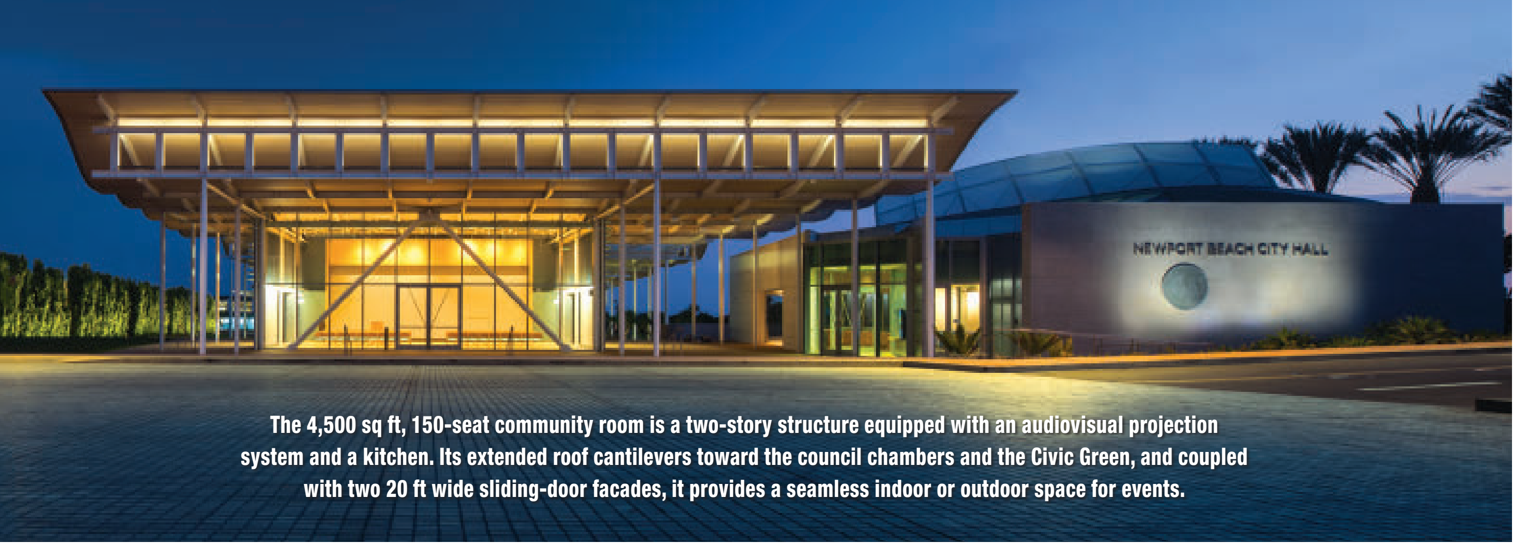

The 4,500 sq ft, 150-seat community room is a two-story structure equipped with an audiovisual projection system and a kitchen. Its extended roof cantilevers toward the council chambers and the Civic Green, and coupled with two 20 ft wide sliding-door facades, it provides a seamless indoor or outdoor space for events.

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adjusted on the basis of careful coordination with the library's management staff.

The new city council chambers can seat 150 people, and there is standing room for up to 299. The 3,500 sq ft structure also houses the local government's cable channel, Newport Beach Television. The trusses that support the roof of the building have tension rod bottom chords $^{3}/_{4}$ in. in diameter, cruciform struts made from steel plates, and top chords built up from steel plates and back-to-back steel channels. The minimal size of the trusses creates a dramatic column-free space.

A backlit polytetrafluoroethylene (PTFE) fabric creates a "sail" on the street-facing facade of the council chambers. The wall providing structural support for the sail is behind the chamber's dais bench. The curved wall in the chambers was assembled from vertically canted, concentrically braced frames made of steel hollow structural section (HSS) elements of rectangular or square cross section. A theater-style seating bowl for the council chambers was formed from concrete and light-gauge steel stud framing to permit an air distribution system beneath the floor.

The 4,500 sq ft, 150-seat community room is a two-story structure equipped with an audiovisual projection system and a kitchen. Its extended roof cantilevers toward the council chambers and the Civic Green, and coupled with two 20 ft wide sliding-door facades, it provides a seamless indoor or outdoor space for events. Steel HSS frames rise from perimeter concrete trench walls to provide support for the overhead tracks of the top-hung, 10 ft tall sliding doors, as well as for the stationary facade above. The trenches carry conduit, plumbing, and duct distribution systems, and air diffusers above the trench are supported on small steel frames. The floor of the community room is a 6 in. thick slab on grade reinforced with welded wire mesh to control cracking above the cast-in-place tubes that convey warm air through the floor.

On the second floor, an elevated walkway spans between the community room and the city hall. Since the two buildings must move independently during seismic events, a lateral sliding connection was implemented on the city hall side of the bridge to account for the differential movement.

ANCHORING THE PROJECT is the 89,000 sq ft city hall, which has two stories above grade and a partial basement. The building houses office and meeting spaces for city employees, a permit center, a customer service center, and an emergency command center. Maintaining sight lines to the Pacific Ocean was a very important criterion in the design of the facility; in fact, one of the greatest challenges of this project was conforming to the city's view plane requirements. In its original condition, the ground itself was in violation of these requirements. To make the site work, a hill comprising 284,000 cu yd of soil (enough to fill 20,000 trucks) was removed. Moreover, each bay of the city hall was designed to step down by 18 in. so as to provide clear sight lines to the bay. The excavated soil was removed through a well-organized plan that sought to minimize disruption to the nearby residential neighborhoods and the shopping center.

The signature element of the new city hall is a light, wavelike canopy that covers a significant area outside the entrance. This airy covering takes advantage of the city's mild climate. The structural steel used for the roof was sculpted to create a thin profile, which also helped to convey the weightless aspect of the design.

The steel framing members of the repeating-wave roofs were made from readily available wide-flange members and were bent in the plant of the steel fabricator—SME Steel, of West Jordan, Utah—to achieve double curves. The tapered section of the high side of the waved roofs thinned the profile at the ends of the members. To achieve a very slim roof edge, many iterations of intricate steel detailing were explored for the structural buildup above the exposed tapered, wide-flange curved beams. A flat steel plate stiffened by angles was used at the extreme ends of the waved roofs as well as on the roof that extends from the library. This method allowed a smaller profile at the cantilevered roof ends, where there was not as much structural demand.

Beneath the waved roofs, coordination of sprinkler pipes and lighting conduit through evenly spaced penetrations in the structural steel made it possible for the lateral service systems to be pulled in close to the underside of the wood ceiling. In this way the space beneath the structural steel waved beams could remain clear of utilities.

The form and placement of the roof structures perform many functions. The slope of the waved roofs is optimal for photovoltaic panels, and the structure has been designed to receive such panels if the city chooses to incorporate them in the future. The large roof overhangs of both the city hall and the library branch make for a very transparent and open facade, the glass entryways being protected from the sun.

The geometric proportions of the roof overhangs were informed by patterns of natural light and shadow to reduce the thermal loading on the structure while maximizing daylight indoors.

Extending the roof structures from the inside to the outside blurs the lines between interior and exterior space and gives building occupants access to fresh air, natural light, and views of the bay and landscaping. The city hall's open-plan office space, loop corridor, and meeting rooms, which are located along the perimeter and have translucent walls, have been designed to help staff members interact with one another more efficiently and to facilitate interactions with the public.

The exterior spaces beneath the roof overhangs encourage the use of the outdoor areas by city staff members, members of the community, and visitors. One of the city's goals was to provide a transparent civic institution, and this was realized quite literally by implementing a glass facade along the perimeter of the city hall and library and at the main entrance to the council chambers. The interface of the overhangs with the curtain wall presented a formidable challenge, one requiring multidisciplinary coordination in order to achieve a flawless continuation of structure from interior to exterior.

The glass facade, which has manually operable units, fulfills the city's sustainability goals by taking advantage of natural ventilation and daylight. Given the narrow floor plan, all staff members are in close proximity to the windows and thus have desirable views. High-performance glazing that incorporates a low-emissivity coating admits light while resisting heat. In locations at which the solar gain is likely to be higher at certain times of the day, automated shading systems are available. Permanent trellises also were incorporated as needed and are prominently featured on the south facade of the city hall.

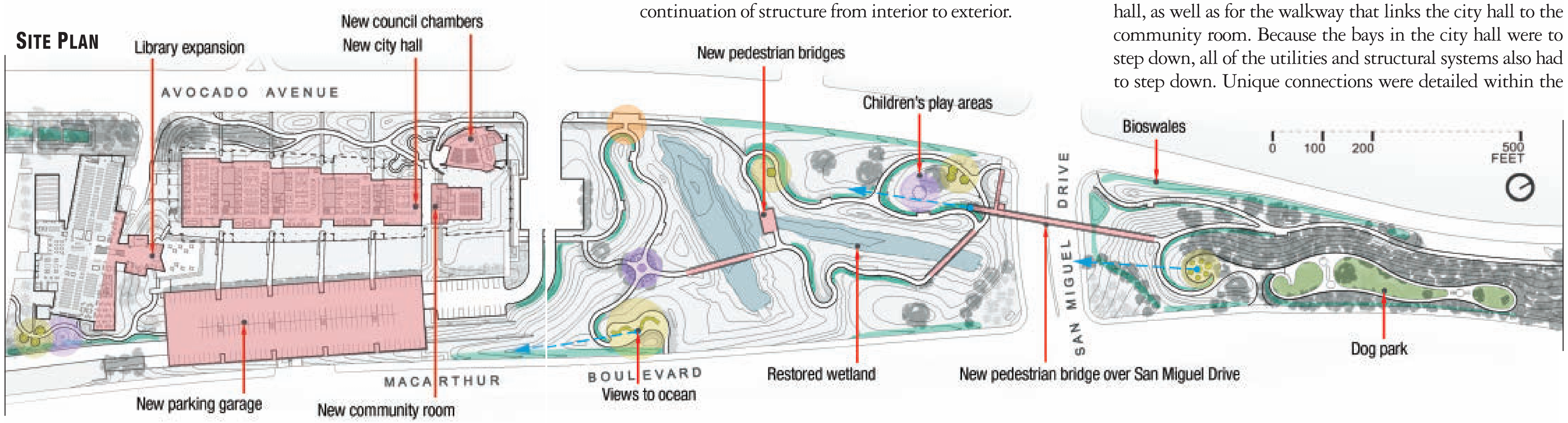
North-facing clerestory windows are integrated with the structural Vierendeel trusses that support the high ends of the waved roofs. These windows have automated dampers that open during certain periods. Lighting fixtures are nestled into the Vierendeel trusses and pointed toward the interior ceiling, which is made of wood, to provide warm, indirect lighting in the evening.

For the majority of the day, the office spaces of the city hall are illuminated solely by daylight; when required, lighting is available with various levels of dimming. Other indirect lighting features include luminous membranes backlit with light-emitting diodes in the first-floor corridors of the city hall and step lights in the library's grand stair. Theatrical lighting was incorporated into the community room for lectures. Arup implemented advanced lighting and climate controls in the city hall, and these features, combined with the strategic layout of the floor plan, are expected to save $85,000 per year in operating costs.

Transparency, as mentioned above, was an important aspect of the design, the goal being to encourage community interaction and collaboration. Thus an 18 in. raised floor was used to conceal a variety of functions in the city hall that could have detracted from the uncluttered open-plan concept. Mechanical ducts and diffusers, plumbing pipes, and electrical conduit occupy the cavity beneath the floor. Air distribution beneath the floor can be easily adjusted by manually operated floor diffusers scattered throughout the office spaces.

The raised floor also provided a concealing pocket for back-spanning structural members that support cantilevered balconies on the west (street) side of the second story of the city hall, as well as for the walkway that links the city hall to the community room. Because the bays in the city hall were to step down, all of the utilities and structural systems also had to step down. Unique connections were detailed within the

SITE PLAN



raised floor at the step locations along the structural collector beams to enable them to carry axial loads during a seismic event yet still be installed with minimal field welding. In typical conditions the structural slab sits 18 in. below the surface of the raised floor.

One challenge that resulted from using a raised floor was coordination at the stairways, with particular attention given to the pedestrian bridge ramps located within the building's core. Given the thin profile of the ramp and stairs, the structural elements had to double as the walking surface. The ramps consist of shallow wide-flange girders with a 4 in. steel plate and a reinforced-concrete slab, the top of the slab matching the elevation of the raised floor. Because of the lack of usable diaphragm area in the open core areas, the ramp was required to double as diaphragm.

The core stairs are "scissor stairs," and the intermediate landing is not gravity supported locally. This configuration induces a horizontal thrust at the first and second floors. Since both the ramp and the stair were required to carry lateral forces, a transfer of these forces between the raised structure of the ramp and the stair to the second-floor structural slab was required. This was achieved by extending the steel beams that support the stair and ramp beyond where they were required for gravity connections and by using steel studs on the bottom of the beams to connect to the concrete slab below. This detailing was accomplished and concealed within the raised floor.

The scissor stairs presented an additional design challenge because of the interstory drift between the first and second floors. It is anticipated that the second floor could displace more than $1\frac{5}{8}$ in. relative to the first floor in either horizontal direction. Since the scissor stair is gravity supported only at one location on the first floor and one on the second floor, the structure was essentially spanning vertically between the two floors. Without specialized detailing, if the second floor were to displace during a seismic event, it would cause the stair, just as with a wishbone, to pull apart at the switchback. The design team implemented a sliding plate connection at the base to permit movement in one horizontal direction during a large seismic event and thus avert this wishbone effect.

THE LATERAL-LOAD-RESISTING systems were carefully chosen for each building on the basis of size, use, and layout. One of the primary goals was to maximize efficiency through a judicious use of structural material. Buckling-restrained braced frames (BRBFs) were used in the above-grade portions of city hall and in the community room. BRBFs are structurally efficient and architecturally desirable in that since they are effective in both tension and compression, the number of frames can be reduced. Statistics revealed that using BRBFs in lieu of traditional braces saves up to $2.40 per square foot. A significant challenge was fitting the required steel core area within the architecturally desired round HSS casing size. Complicating matters, a pinned end connection was preferred. The BRBF fabricator—CoreBrace, of West Jordan, Utah—worked closely with Arup's structural engineers to develop new details, as well as testing and performance criteria, for meeting both the casing size limits and the end detailing criteria. With the exception of the two-story focal braces of the community room, all of the BRBFs within the city hall and the community room use an 8.6 in. diameter casing. Those braces are 22 ft long and have a 12.75 in. diameter casing.

The columns in the city hall and the community room are architecturally exposed, so HSS columns of circular cross section with a tapering section and a shadow "reveal" at the top were chosen. The exterior columns also have a base tapering section with a specially detailed pin connection. The roof collector and chord beams run along the entire length of the building and sit at an elevation near the low end of the waved roofs. As the waved roof diaphragms transfer their force down to the low end, the collectors pick up the lateral forces and carry them to the BRBFs in the cores. These collectors are also HSS elements of circular cross section and have pinned ends, a shape chosen to conform to the architecture, and they carry only axial forces. With specialized steel detailing to impart the desired architectural interest to the structural members, there was no need to conceal the structural elements with walls or boxed-out columns. In this way the available interior space was increased.

SME, along with Southwest Steel, of Henderson, Nevada, and their detailers, worked closely and diligently with the structural engineers at Arup to produce very accurate shop drawings for the geometrically complicated steel elements. The meticulous production and review of shop drawings maximized the amount of fabrication that could be accomplished within the steel fabrication plant and minimized the amount of work that needed to be redone in the field. BCJ, C.W. Driver, and Arup were invited to the SME and CoreBrace fabrication plants in West Jordan, Utah, for quality review and to determine the desired and achievable levels of architecturally exposed structural steel that would be used in the project. Once the structural steel had been erected to tolerances within the standards of practice in the field, BCJ worked closely with its subcontractors to customize fascia and trim elements so as to create extremely level roof edges. This effort was facilitated by accurate on-site surveying of the steel elevations and by flexibility in the fabrication of the fascia elements. The resulting craftsmanship and appearance of the structural steel exceeded expectations.

As recommended by the geotechnical engineers, Leighton Group, Inc., of Irvine, California, two grouted steel soil anchors linked by a spread footing were placed beneath each BRBF and moment-resisting frame column. The two lateral foundations in each pair are linked by a grade beam. In the basement of the city hall, the retaining walls of cast-in-place concrete double as shear walls and are supported by continuous wall foundations.

One of the greatest challenges on the project arose when these foundations were being constructed. A large underground transformer vault was relocated very close to the structure, and sump pits were repositioned beneath the basement. The design and construction team had to carefully coordinate the congested rerouting of pipes and conduit above and below the basement wall foundations through a combined approach of

The 150 ft long pedestrian bridge that crosses San Miguel Drive connects to an elevator tower, its deck cantilevering 52 ft beyond the tower's wall to create a viewing platform. The "bird blind" bridge is one of three that cross protected wetlands. It was designed with tall, vertical steel slats so that pedestrians can view the habitat's rare birds.

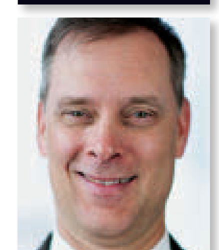
lowering footings and using thinner slabs of concrete under the continuous footings. Furthermore, the foundations for both the building and an adjacent site's retaining wall had to be depressed and thickened to avoid inducing bearing pressure on the underground transformer vault. The expedited collaboration by Arup's electrical, plumbing, civil, and structural design engineers and by C.W. Driver and its subcontractors resulted in a concealed solution that in addition to being architecturally pleasing did not require any reworking in the field and only minimally affected the schedule.

The natural wetlands at the site currently receive polluted dry-weather flows from upstream sources. Arup proposed a low-impact development system that would extract the polluted runoff from the downstream end of the wetlands and then treat and reuse the water on-site. The results are lower amounts of pollution entering Newport Bay and one of the largest storm-water containment systems in the city.

Many aspects of design and construction contributed to the project earning gold LEED certification, including the site restoration and preservation work. The project achieved modeled energy savings of 30 percent in relation to a traditional complex of this type and water savings of 45 percent in the buildings and 50 percent in the park. Nearly all (95 percent) of the construction waste was diverted from landfills, and local construction materials that promote indoor air quality were chosen whenever possible. High fly ash to cement ratios were achieved in the concrete mixtures, and the steel used contained both pre- and postconsumer recycled material. The project's gold certification places it among the top 1 percent of buildings nationwide in terms of holistic green design.

Mochizuki

Collins



Worley

The city and its residents have shown enthusiasm for their new civic center complex's iconic design as well as for its adherence to the goals of sustainable development, and the venue is expected to serve as a community gathering place for generations to come. **CE**

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PROJECT CREDITS **Owner:** City of Newport Beach, California **Architect:** Bohlin Cywinski Jackson, San Francisco and Philadelphia offices **Landscape architect:** PWP Landscape Architecture, Berkeley, California **Structural, mechanical, electrical, plumbing, and civil engineering and lighting, sustainability, and telecommunications consulting:** Arup, San Francisco office **Geotechnical engineering:** Leighton Group, Inc., Irvine, California **General contractor:** C.W. Driver, Pasadena, California **Steel fabricator:** SME Steel, West Jordan, Utah **Miscellaneous metals fabricator:** Southwest Steel, Henderson, Nevada **Buckling-restrained braced frame provider:** CoreBrace, West Jordan, Utah **Concrete subcontractor:** Bomel Construction, Anaheim Hills, California **Acoustics:** Charles M. Salter Associates, Inc., San Francisco **Mechanical subcontractor:** Critchfield Mechanical, Inc., San José, California **Electrical subcontractor:** Rosendin Electric, San José, California **Plumbing subcontractor:** Pan-Pacific Mechanical, Fountain Valley, California