Braced for the FUTURE

BY KIM CARAVALHO

Buckling restrained braced frames maximize aesthetic appeal, seismic preparedness and flexibility for the City of Pasadena's new office building.

WATER AND POWER NEEDS are ever-growing—especially in Southern California.

Recognizing these needs and the subsequent need to accommodate expanding programs and future growth of on-site staff, the City of Pasadena, Calif., hired Gonzalez Goodale Architects and structural engineer Brandow and Johnston, Inc., to design the new two-story, 31,400-sq.-ft City of Pasadena Department of Water and Power Office Building.

As the new facility is set in the foothills of Pasadena, the architect elected to use two-story curtain wall systems along the entire north face of the building and part of the west face to maximize daylighting. A structural steel framing system was chosen to further support this goal, as it minimized visible framing and brought more natural light into the building. As the building is located in a high-seismic zone—and considering its critical nature—the designers decided to employ a buckling restrained braced frame (BRBF) system for the lateral system. (Brandow and Johnston worked directly with BRBF-manufacturer Star Seismic during the design phase to determine the widths of the braces and gusset plate sizes, and the system uses Star Seismic Power Cat braces with pin-type connections.) Not only does the BRBF system provide better ductility and seismic performance, it also helps control the framing member and foundation sizes. And as it remains exposed along the west and north sides, the designers felt it provided a clean and more pleasing aesthetic than that of a conventional braced frame system.

Lightweight concrete fill over metal deck supported by composite steel framing supports the second floor, while the roof is constructed as rigid insulation over metal decking supported by steel framing. The foundation system consisted of conventional spread footings with grade beams at the braced frames and continuous wall footings at the remainder of the building. In all, the building uses approximately 180 tons of structural steel.

To emphasize the north curtain wall system, the second-floor diaphragm at the north side of the building was set back 12 ft, 6 in. from the exterior two-story wall. Since the BRBFs are located at the perimeter of the building, an exposed horizontal truss system was designed using 20-in.-deep HSS and 8-in.-diameter standard HSS to transfer the lateral loads to the braced frames. This exposed horizontal truss system blended well with the exposed BRBF along the north wall.

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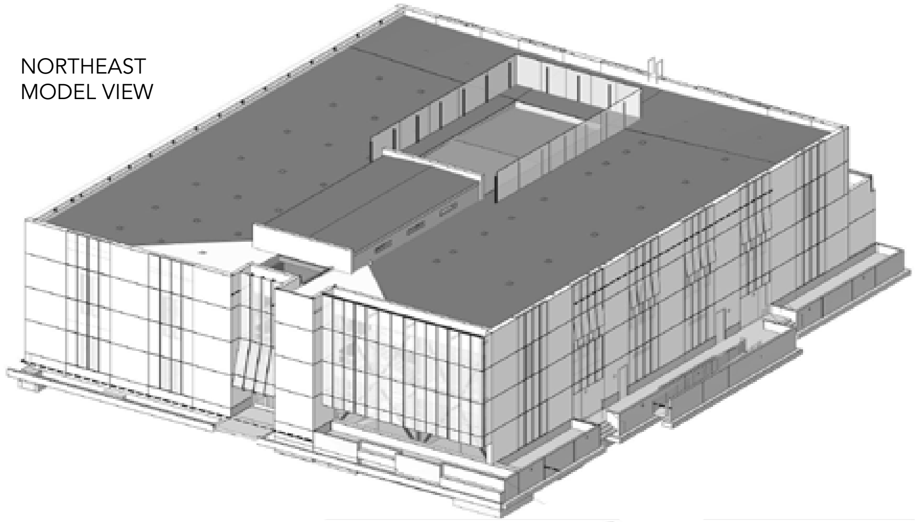

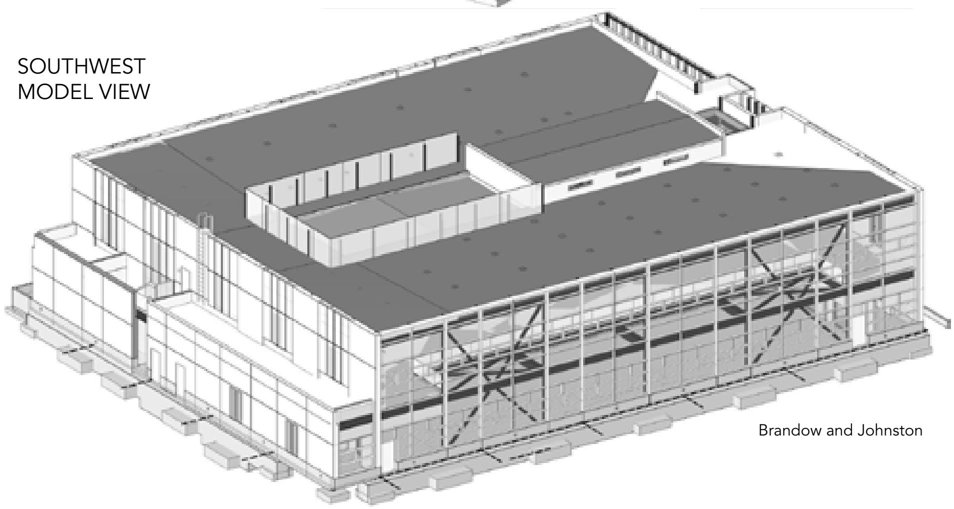

Brandow and Johnston

A view from the north elevation.

A Revit structural model of the building.

Going for Gold

Achieving LEED Silver certification was an initial goal for the design team, but the project was actually able to achieve Gold certification thanks in part to a 950-sq.-ft green roof that was incorporated into the design. While this element elevated the project's green status, it also created a structural challenge by requiring the entire second floor of the east side of the building to be set back 10 ft, 6 in. from the first floor, as it was to be located on top of the first floor. This created a discontinuous lateral system at the second floor since the braced frames were only located at the building perimeter. Through coordination with the architect, the columns for the east-side second-floor braced frame were continued down to the foundation level, eliminating the need for a large transfer girder.

The roof diaphragm also features two discontinuities along the middle section. The properties directly to the east are residences at a finished grade, varying from approximately 8 ft to 15 ft above the finished grade of the building. To minimize the view of the mechanical units on the roof from the neighboring residences, an approximately 24-ft-wide × 47.5-ft-long area was depressed about 1 ft, 6 in. to create a mechanical well. The perimeter beams around the mechanical well were sufficiently increased in depth to support both the main roof deck and the depressed deck and provided direct shear diaphragm transfer. A cantilevered roof screen was still required, but the team was able to reduce its depth thanks to the depressed mechanical well. The roof screen was designed using HSS4×4 cantilever posts welded directly to the steel roof beams.

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West elevation at night.

West elevation, and BRBs, under construction.

Rather than using concrete fill over the metal deck at the mechanical well to reduce acoustical issues, raised concrete platforms were designed at the perimeter of the units to reduce the weight and, therefore, seismic impact. Additional steel beams were required between the main beams to support stem walls at the edges of the raised pads, and rebar dowels were welded directly to the steel beam flanges.

Immediately adjacent to the mechanical well, an approximately 24-ft-wide × 48-ft-long clerestory was designed over the conference/training room. To minimize the obstruction of the clerestory windows, a series of 5-in.-diameter double-extra-strong HSS columns were designed to cantilever off the roof framing to resist lateral loads.

The architect selected perforated metal panels to shield the west and south sides from the Southern California summer heat. A system of HSS6×4 outriggers and posts cantilevering from the structure were designed to support the panels; the width of the member sizes was minimized in order to maximize the amount of natural light coming into the building.

Avoiding Conflict

The entire design team, incorporating a BIM mindset, used Revit to produce construction documents, allowing coordination between disciplines to determine any conflicts between the structural system and the mechanical/electrical/plumbing systems early on. This was particularly effective in the area of the mechanical well. Since the well was dropped slightly, there was less ceiling space below for ductwork. Clash detection found one instance of ductwork conflicting with a steel girder; the girder was subsequently reduced in depth to avoid conflict.

Revit was also useful in determining the required top of steel elevations, particularly at the east and west ends of the building. In general, the roof sloped downward to the north and south from either side of the mechanical well and clerestory. Due to the width of the well and clerestory, this presented a challenge for a small section at the middle of the east and west sides where the roof sloped in two directions along some of the roof beams; these roof beams were subsequently lowered enough to avoid protruding above the metal decking. Where required, shim plates and/or tapered WT sections were added above the beams to allow for bearing of the metal decking. These lowered beams required special detailing for the connections since the steel beam/girder top flanges were at different elevations and the bottom flanges of the beams were below the bottom flange of the girders.

A second phase of the project (yet to be constructed) includes a seismic upgrade of the existing office building and warehouse, as well as the addition of a 180-ft-long × 39-ft-wide carport canopy, topped with photovoltaic panels. The structure will feature a series of cantilevered columns at the middle, with the roof framing cantilevering off the columns in both directions. This second phase will further enhance what has already proven to be a successful greener-than-expected building that acts as a good neighbor to nearby residents. ■

Owner
City of Pasadena, Calif.

Architect
Gonzalez Goodale Architects, Pasadena

Structural Engineer
Brandow and Johnston, Inc., Los Angeles

General Contractor
Morillo Construction, Inc., Pasadena

BRBF Supplier
Star Seismic, Park City, Utah (AISC Member)

The horizontal truss at the second floor of the north elevation.

The perforated metal panel system of the west elevation.