Medical Marvel

BY RANDY KARL HAGENS, AIA, P.E.

A new hospital tower overcomes access and siting challenges to become a welcome and appropriate addition to the Boise skyline.

COMPLETION OF THE NEW PATIENT CARE TOWER AT BOISE'S SAINT ALPHONSUS REGIONAL MEDICAL CENTER REPRESENTS SOME EXCEPTIONAL FEATS OF ARCHITECTURE, ENGINEERING, AND CONSTRUCTION INGENUITY. The building team faced challenges in three primary areas: the building's site in relation to the local environment, its adjacency to existing buildings, and access issues relating to uninterrupted connectivity between those buildings.

Rooms with a View

The initial design of the new tower was largely configured on a purely functional basis that took into account nursing ratios, the ability to accommodate the largest nursing unit on one floor, centralizing core circulation, and decentralizing the nursing functions, explains Jeff Cramer, AIA, of HDR, the project's architect and structural engineer. "But the real driver ended up being the desire to ensure that all patient rooms have views to the surrounding landscape. This resulted in reconfiguring the tower into its current bow tie-shaped footprint. This smaller footprint—32 beds per floor versus the original 48 per floor—allowed for a taller patient tower to extend further above the adjacent patient towers to better capitalize on views of the Boise foothills."

The original 30-ft by 30-ft framing bay scheme was driven by the operating room layouts on the second floor of the tower. However, the final shape and orientation of the bed tower dictated that a larger 42-ft by 42-ft bay be used instead. This larger bay reduced the quantity of the columns, but increased the load on the individual columns.

Wide-flange columns as large as W14×605 were also originally specified, but columns of this size are not domestically produced, so imported steel and its associated costs had to be considered. By using 65 ksi steel in lieu of 50 ksi steel, the savings from reducing column sizes and steel tonnage offset the higher material and shipping costs.

The original structural design was executed under the 2000 *International Building Code* that permitted use of a braced frame. However, due to the bow-tie configuration of the building, an inefficiency in the layout of braces allowed the tower to twist when subjected to a lateral load. To solve this problem, moment frames were added near the building perimeter to control the twisting behavior. This created a "dual lateral system" in the eyes of the building code and building official.

The design intent of adding moment frames to the braced frame system was to provide just enough stiffness to limit rotation, because the braced frame system had been designed to carry the full lateral load. However, in order to meet the building code requirements, a higher capacity in the moment frame portion of the system needed to be provided to meet the code provision stipulating that the moment frames carry at least 25% of the total design forces. This additional strength requirement resulted in a slightly higher construction cost that was necessary to maintain the desired building shape.

Connectivity Challenges

Another challenge in the project was to join the new tower project to the existing north and south towers. Because of the new and existing buildings' irregular configurations, many cantilever beams, cantilever girders, and transfer girders were used to

Central Building Steel Facts

Floor Area: 399,500 sq. ft

Height: 153 ft

Construction cost: Approximately $95 million

Structural steel: 3,710 tons (including 317 tons of 65 ksi steel used in the largest columns)

The new patient care tower was constructed around an existing two-level pedestrian sky bridge. During construction, the upper level of the sky bridge was demolished, and the bottom level was shored using 3- and 4-ft-diameter steel pipe sleeves. The lower level of the bridge remained in place and operational until the new building was in place, at which time it was demolished and the steel pipe sleeves were removed down to just below the basement slab level.

The lateral system is formed by a combination of braced frames (shown) and moment frames.

extend the new building to the existing buildings, creating the appearance of one continuous building.

Another challenge involved an existing sky bridge. The new patient tower needed to be built completely around the bridge that connected the existing north and south towers. Because this sky bridge was critical to patient transport and used as a utility conduit, uninterrupted access/egress was mandatory until a new corridor could be established. Also, hospital management rejected the idea of relocating the existing services and pathway to an area outside of the construction zone. As a result, the proposed central tower had to be placed over and under the two-story sky bridge, which measured approximately 200 ft in length and 30 ft in width, and connected at the second and third floor levels relative to the existing towers on the campus.

Several construction options were considered, and the hospital agreed that only the lowest of the two stories of the sky bridge was needed during the initial part of the construction period. That allowed temporary shoring to support only level two after level three had been demolished. Once an adjacent pathway through the new tower was sufficiently completed, the remaining sky bridge could be removed.

Initially, cast-in-place concrete columns were considered for the shoring design. However, the shoring contractor felt that demolition of the concrete columns would be difficult and time-consuming when the time came to remove the sky bridge completely. Consequently, the shoring design that was eventually selected consisted of 3- and 4-ft-diameter steel pipe sleeves acting as cantilevered columns to support new girders located near the existing sky bridge columns. (These pipe sleeves are typically used to confine concrete in the construction of drilled piers in unstable soil.) Though designed as hollow structural tube columns, the design team decided to fill the columns with gravel to guard against local buckling in the event of impact from construction equipment. In order to transfer the column load to a deep soil stratum, the bottom portion of the sleeve was filled with concrete.

When the time came to remove the shoring columns, the contractor could simply cut and remove the hollow shoring columns without having to jackhammer any concrete. Though larger than concrete columns of equivalent capacity, the steel sleeves worked perfectly and were easily removed and recycled. Only the lowest portion of the steel sleeves (the concrete-filled part located beneath the basement floor slab) was left in place.

Once the sky bridge load was transferred to the shoring, the existing sky bridge columns were cut and removed along with the shallow footings. This enabled basement construction to proceed beneath the sky bridge.

The weight of the sky bridge was successfully transferred to the shoring structure with almost negligible differential deflections due to the skill of the field crew and an adjustable leveling connection at each point of load transfer. The projected pre-load deflections were calculated with the help of the RAM Advanse finite element analysis program and reported to the field crew as a part of the construction documents.

Prior to the start of the tower construction, however, the general contractor proposed a further modification of the sky bridge that eventually saved several months in the construction schedule. The sky bridge being 30 ft in width prevented the installation of two columns that were critical in the erection sequence. Therefore, the modification called for reducing the sky bridge width by 10 ft. Simple in concept but challenging in practice, removing the 10-ft-wide by 200-ft-long section from the bridge's one-bay-wide frame required creating new rigid frames at each floor and roof beam along the length of the bridge. To support the new rigid frames and transfer loads to the shoring support girders, a continuous side girder was added along the cut area. Again, projected preload deflections were calculated for use at adjustable leveling bolt connections installed at each frame. Once this additional shoring work was completed, the surrounding frame erection activities could more closely approach the sky bridge and allow the new path through the building to be constructed sooner.

Flexibility is Key

This project was essentially a fast-track project executed in several phases. As with any fast-track project, new design criteria can occasionally impact the structure that is already in place. This exact situation occurred when it was discovered that the glazing manufacturer needed a tighter floor deflection tolerance than was originally designed. Though tower steel erection was substantially complete, the cantilevered girders of the tower floors had to be modified to meet the more restrictive deflection criteria for the glazing system. Since these girders cantilevered more than 13 ft, a substantial amount of additional stiffness was needed to meet the new deflection requirement. Fortunately, it was relatively easy to add structural WT shapes to the bottom of the cantilevered girders and add reinforcing steel in the composite slab to achieve the increased stiffness.

Similarly, as the interior finish portions of the project were developed during construction, additional steel beams were added to support hanging partitions. The use of a structural steel frame made these modifications quite easy. MSC

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