Best Laid Expansion Plans

BY STEVE WYLIE

WKHS Marketing and Public Relations Dept.

A Louisiana hospital grows one story taller—and more seismically stable—and stays fully operational during the process.

THE BUILDING CONSTRUCTION INDUSTRY PRESENTS THE MOST WIDE-RANGING and abundant illustrations of the phrase, "The best laid plans of mice and men often go awry." However, it is the work done to find a way through the challenges of unforeseen problems that drives innovation and makes for a high degree of satisfaction at the end of a project.

An industry example of "best laid plans" is the preparation and effort that goes into designing a structure for future vertical expansion. Columns are typically up-sized to prepare for future splicing of columns not yet designed. Girders and rigid frames are bulked up far in excess of the requirements of the current building in anticipation of more floors being added later. And though the engineer may design a structure that incorporates a vast and authoritative range of considerations for the future expansion, the reality is that no one can prepare in advance now for everything that may happen in the future.

Hospitals represent one of the most active building types in terms of expansion activity. Willis-Knighton Health System (WKHS), for example, began serving the Shreveport, La. community in 1925. Since then, it has grown to become the largest healthcare organization in the state and one of the top 100 hospitals in the country. In 1983, Willis-Knighton South opened as South Park Hospital and became the first satellite hospital in Louisiana. By 1989 it had extended its focus on women's services, carrying out a major renovation and expansion to open the Center for Women's Health.

Planning and design of this three-story, 69,540-sq.-ft wing of the hospital had been undertaken in 1987 by architect R. Wayne Estopinal during his tenure as vice-president at VHA Health Facilities Group in Irving, Texas, with additional design services performed by the Dallas firm of Page Southerland Page (PSP). Constructed in steel, the wing included what was then considered a state-of-the-art neonatal intensive care unit (NICU). Anticipating later growth of the NICU, PSP developed the design to accept a future fourth-floor vertical expansion, with seismic requirements based on the most recent regulations at the time, the 1984 Uniform Building Code (UBC).

By 2005, Shreveport had experienced a great deal of growth and therefore WKHS was ready to embark on fulfillment of their "best laid plans" for the NICU. Anything but a whim—or a capital surplus in need of a project—construction of the vertical expansion would be a critical and necessary venture, fulfilling a recog-

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nized need for a timely upgrade and greater capacity for neonatal care in the community.

Since completing the 1987 wing, Estopinal had gone on to found his own firm, the Estopinal Group (TEG), based in Jeffersonville, Ind. and with an office in Shreveport. The relationship with WKHS had continued during that time, and they again turned to Estopinal for the new expansion. TEG in turn used TRC Worldwide Engineering of Brentwood, Tenn. to provide the structural design.

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The NICU addition to Shreveport, La.'s South Park Hospital is a braced seismic tower composed of HSS16×8×3/8 for all vertical members and HSS8×8×3/8 for all bracing and horizontal members.

Challenges

The initial request by WKHS was to provide a proposal for a two-story addition. Accompanying the design challenge were several other requirements by the hospital that would affect how the project could proceed. The first and most important of these was the need to keep the facility operational while minimizing disruption during construction, not only because of the critical role of the facility in the community, but also because of the necessity of keeping expectant mothers and mothers with newborns as calm and comfortable as possible. Another requirement would be to extend the existing stairs to the new floor and roof while maintaining egress from the other floors during the entire construction process. Minimizing the downtime of rooftop units during construction of new mechanical penthouse facilities was also a crucial consideration. Overall budget and a 365-day construction schedule rounded out the list of principal issues.

Seismic Dilemma

These issues were trumped, however, during preliminary structural analysis. Seismic design for the proposed new addition would be per the requirements of the 2000 International Building Code (IBC). Given that seismic design conditions had increased substantially since the 1989 renovation, project architects and engineers discovered the existing structure could no longer be considered able to support even one additional floor without significant modifications to the building and its foundation. In fact, governing seismic loads had increased approximately 70% from the 1984 UBC requirements to those of the 2000 IBC. Since the level of modifications required would mean shutting down the facility during construction, the project was on the verge of demise.

However, the absolutely vital purpose of the expansion pressed WKHS and the project team to continue to look for a solution. WKHS agreed to scale back their initial request for a two-level addition in favor of a 23,180-sq.-ft single level, with penthouse areas for elevators, stairs, and mechanical units. This would limit the amount of additional seismic forces on the existing structure to the columns and foundation only.

Going forward with this adjusted scope of work, the project team explored the idea of petitioning for a variance to the building code. Specifically, Section 1614.1.1 of the 2000 IBC stated:

"An addition that is not structurally independent from an existing structure shall be designed and constructed such that the entire structure conforms to the seismic force resistance requirements for new structures unless the following conditions are satisfied: 1) The addition conforms with the requirements for new structures, and 2) The addition does not increase the seismic forces in any structural element by more than 5%, unless the element has the capacity to resist the increased forces determined in accordance with Sections 1613 through 1622 [i.e., Earthquake Loads and Seismic Design]. (331)"

In other words, any vertical addition to the facility would require the entire existing structure to meet the latest seismic force requirements. This section of the IBC would have to be waived by local building officials if the expansion was to proceed with limited modification to the existing structural frame.

The arguments for considering a variance request were based on several factors. The first was that seismic consideration for the new addition would be in compliance with the original 1984 UBC, meaning the design strength of the existing structural elements would not be reduced. The new addition also would be detailed and connected to the existing structure as required by the 2000 IBC and include provisions to reinforce existing members to transmit loads to the foundation. The proposed alterations would not create a structural irregularity or increase the severity of any existing irregularities. Finally, the risk of seismic activity in Shreveport was considered relatively low.

However, before active pursuit of a variance request got under way, an assessment by project engineers revealed that even with the variance, any and all seismic strengthening of the building through the existing structure would create an unacceptable level of disruption if not outright shutdown of the facility. The severity of the predicament was clear: Increasing the capacity of neonatal care in the community was vital, yet just as vital was the necessity of continuing uninterrupted care in the existing facility.

The Solution

The first glimpse of a way through the central challenge of designing an addition that would minimize invasive work in the existing facility came about through a closer reading of the 1614.1.1 section of the 2000 IBC. Rather than interpreting the section as a directive to enhance existing members, a different reading will yield the equally valid interpretation that no seismic strengthening of an existing structural frame is required if the shear loads are sufficiently reduced. After reviewing the feasibility of removing shear forces through reinforcement of the stair towers on the north and south elevations, the idea was seized upon to create a central seismic tower off the face of the west elevation.

A design went forward for a braced seismic tower composed of HSS16x8x3/8 for all vertical members and HSS8x8x3/8 for all bracing and horizontal members. The decision to use a steel tube truss for the tower would accomplish several goals. First and foremost, it appeared to solve the fundamental problem of how to bypass any additional seismic shear loads through the existing columns and foundation in favor of structurally draining them down a braced-frame tower located outside the functional footprint of the building. By designing the tower as a vertical tube truss, fabrication could be done in sections either in the shop or on the ground near the site. The sections could then be lifted into place as complete units, with infill members installed and connections to the existing structure being completed in less time, further reducing the impact of construction on the existing facility.

The tower would be clad in new materials to complement vertical and horizontal elements on the structure. A panel system matched the sheathing on the new elevator tower on the north face, while open aluminum frames on the outer face of the tower corresponded to existing vertical glass areas over the front entrance, as well as to window rows along the west elevation. In addition to its structural functionality, the new tower also provided an important aesthetic function in breaking up the otherwise unremarkable horizontal flow of the existing west elevation.

Ground was broken on the project in May 2006. The construction team chose to shop-build truss bents in three sections that were then assembled on site, erected using two 82-ton truck cranes and then braced. The new 42-bed Level III NICU opened one year later. Only the third floor was temporarily vacated during construction of the stair towers and fourth floor. Though some disturbance to facility operations was unavoidable, the overall impact was considerably less than anticipated and construction flowed smoothly.

Results

The innovative seismic tower solution allowed the project to proceed swiftly and efficiently while keeping disruption of a critical facility to a minimum. The steel design proved very straightforward to build and install, allowing the project to make up a significant amount of time during the construction phase. Further, the mobility inherent in the use of steel truss sections proved much more adaptable to meeting shifting facility demands; imagine shutting down concrete pours due to patients in labor versus simply lowering a boomed section and turning off the crane engine. The solution in steel was instrumental in meeting the project requirements, and the effort to adapt to best laid plans gone awry reinforced the confidence in the project team by WKHS. Perhaps most importantly, the continued operation of the facility and the successful opening of the new NICU earned the likely gratitude of many area families and their newest members. MSC

Steve Wylie is vice president of Total Steel Service, a steel consulting division of TRC Worldwide Engineering, Inc. in Brentwood, Tenn. He can be reached at swylie@trcww.com.

Architect
The Estopinal Group, Jeffersonville, Ind.

Structural Engineer
TRC Worldwide Engineering, Inc., Brentwood, Tenn.

Steel Erector
Ranger Steel Erectors, Inc., West Monroe, La. (SEAA Member)

General Contractor
McInnis Brothers Construction, Inc., Minden, La.

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In anticipation of future growth, the original design for the NICU was developed to accept a fourth-floor vertical expansion, which recently came to fruition.