



## Portland's Shriners Hospital

By Chris Thompson, P.E., S.E. and N. Jacob Stept, P.E., S.E.

Since 1924, Shriners Hospitals for Children™ has provided health care to children in the Pacific Northwest. The hospital's mission is to provide no-cost treatment to children up to the age of 18 for orthopedic conditions, burns, spinal cord injuries, cleft lip and palate. In Portland, surgery, rehabilitation, and research are also conducted. Built in 1980, the Portland facility was over-utilized, impacting their ability to provide care in the region. As the region experienced a growth in population, so did the need for care. The wait list for treatment was ever increasing, and the existing facility needed updating to address Code and regulatory requirements.

In 2005, the Shriners retained a design team led by SRG Partnership, Inc. to study options for updating the aging facility located on Oregon Health & Science University's Marquam Hill campus. Andersen Construction Company was retained by Shriners as the Construction Manager/General Contractor. Catena consulting engineers worked with the design and construction team to study several replacement options, including: relocating the hospital to another site; demolishing part or all of the existing hospital; and, renovating the existing hospital and constructing an adjacent facility. Several key factors drove the evaluation of the options including the synergistic relationship with OHSU, cost, schedule, and disruption to service.

The team developed an innovative approach in a structural system for the expansion that spanned over an existing parking structure and maximized key project drivers. The application of structural transfer trusses integrated into the program of the hospital, and integration of Buckling Restrained Braces for resistance to lateral forces, made for a creative solution on a challenging and constrained site.

The chosen option called for a 73,000 square foot, four-story addition housing surgery suites, patient rooms, laboratory, clinical, and support spaces. The addition was constructed adjacent to the existing hospital, over the existing parking structure. This option maintained the proximity to OHSU that allows the Shriners to collaborate with University doctors in providing care and conducting research. It also was the least cost solution – approximately 33% less cost than the next option. This option allowed for the shortest project schedule, saving six months. Given the expanding need for services,

the Shriners could not afford disruption to operations. A clear benefit was that it provided the least disruption to service, allowing the Shriners to continue operations throughout the entire construction process.

### Structural System

The team investigated several structural systems for the expansion, and quickly arrived at a steel composite deck system for floor framing, with steel trusses that spanned over the existing parking structure supporting the expansion. Structural steel was chosen due to the irregular bay layout (a result of the constrained site) and constructing the expansion over the existing parking structure, which remained operational throughout most of the construction.

Catena incorporated Buckling Restrained Braces (BRB) to resist the seismic loading and motions – the first project in the City of Portland to employ this emerging technology. The use of BRB in the structure helped to minimize the effects of the seismic ground motions at the site through the ability of BRB to dampen and absorb the energy of the ground motion. By using BRB, catena helped the owner to save approximately 10% of the seismic force resisting structure cost, including the supporting foundations.

### Construction Challenges and Design Solutions

Constructing the hospital on the constrained and steeply sloping site, over the existing parking structure, provided for a high level of project complexity. The supporting foundation wall on one side of the project was constructed in a gap between the hillside and parking structure that had a maximum width of 30 inches. The team devised a foundation system robust enough to withstand the building loads that could be constructed in this minimal space. The foundations employed were micro piles which extended to the underlying basalt strata.

Modern hospitals demand high quality in the construction of the floors, with strict limits on the variations from level in the floor structure and on vibrations for highly sensitive equipment used by staff. Spanning over the existing garage added complexity to meeting these criteria. Additionally, the supporting trusses needed

to be designed to accommodate a future three-story expansion. The trusses were designed to support the current expansion, and additional transfer trusses placed at the uppermost level of the future expansion are planned to help share loads between current and future building configurations.

Predicting the truss deflections during construction was a key element. Truss deflections were estimated for a range of conditions, including variations in connection fixity. The trusses were cambered to minimize initial deflections based on deflection estimates. By working closely with the contractor on this aspect of the project, floor leveling to meet project specifications was minimized.

### Exceeding Client/Owner's Needs or Expectations

Given the complexity of the project and site constraints, the team understood the potential for project cost overruns. Through a close collaboration of the team, owner, and contractor, coupled with the effective use of Building Information Modeling (BIM), the design and construction team was able to minimize the scope modifications during construction. The team exceeded the owner's needs and project goals by bringing the project construction cost almost \$2M under the established budget. The Shriners elected to utilize the savings to complete a badly needed exterior façade replacement of the existing hospital.

Catena spent significant effort in the preliminary design of the structure, along with extensive field verification and constructability review with the contractor. The result was that the final cost of the completed structure came within 1% of the cost established in the budget. ■

*Chris Thompson, P.E., S.E. is Managing Principal at catena consulting engineers. He served as Principal in Charge for the Shriners Hospital for Children Expansion and Renovation. He can be reached at [cbris@catenaengineers.com](mailto:cbris@catenaengineers.com).*

*N. Jacob Stept, P.E., S.E. is an Associate at catena consulting engineers. He served as Project Manager for the Shriners Hospital for Children Expansion and Renovation. He can be reached at [jake@catenaengineers.com](mailto:jake@catenaengineers.com).*