A preeminent medical research facility makes the most of limited space with an attractive addition.

TIGHT Tower

BY EDWARD J. ZINSKI, P.E.

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THE WISTAR INSTITUTE in Philadelphia has a long and distinguished history of helping to cure devastating diseases.

The nation's first independent biomedical research facility's discoveries have led to vaccines for rabies and rubella, and it is now focused on the goals of developing cancer prevention vaccines and early detection blood tests, creating first drug responses against Epstein-Barr Virus (EBV) cancers, uncovering the viral cause for breast cancer and conducting a curative HIV trial.

With the September 2014 opening of the Robert and Penny Fox Tower, Wistar has dramatically empowered its talented scientists to reach these goals. Located between the academic campus of the University of Pennsylvania and Wistar's world-renowned Hospital of the University of Pennsylvania (HUP), the new ten-level tower increases Wistar's overall footprint to 272,000 sq. ft and adds 50% more lab space while unifying the institute's campus, the earliest buildings of which have been around since 1894.

Stackable Functionality

The ideal location for the new tower was determined to be in the center of the campus, rising out of the surrounding existing research and office buildings. Within the tower, varied functions stacked vertically require the integration of large column-free spaces with the more closely supported lab spaces. The structural steel framing system had to efficiently accommodate long spans, column transfers, hanging columns, two pedestrian bridges and a variety of cantilevers on all sides, including the building corners. Also, the lower four floors had to match in elevation with the adjacent building.

Starting at street level, a 62-ft-wide space for truck entry and turnaround for the new replacement receiving area is embedded within the heart of the new tower. The floor immediately above street level incorporates a new 2,100-sq.-ft multiuse auditorium with stepped seating, again mandating column-free space that is offset from the receiving area on the floor below. Above the

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▼ The steel-supported atrium.

▲ The structural steel framing system had to accommodate long spans, column transfers, hanging columns, two pedestrian bridges and a variety of cantilevers.

◀ A cutaway of the new structure.

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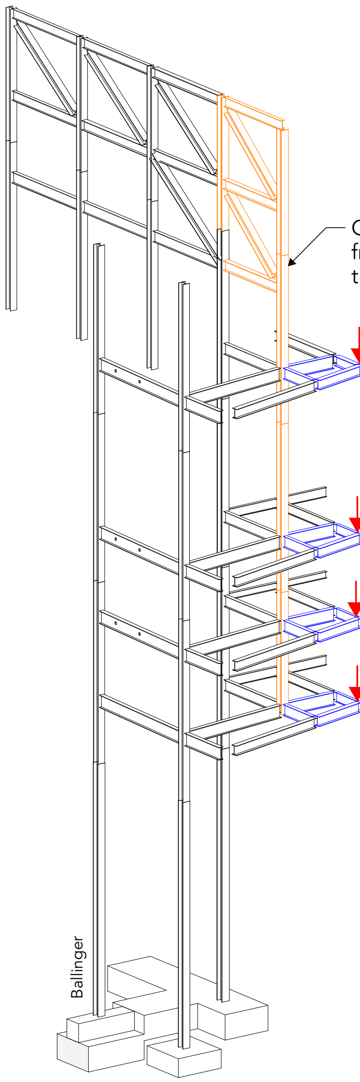

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◄ A Revit model of the main entry corner framing.

auditorium level are multiple floors of prime laboratory space, requiring more moderately spaced W14 columns than the floors below in order to achieve the desired floor stiffness.

The versatility of structural steel framing afforded a variety of creative design solutions to meet each of these challenges. Several columns are supported on transfer girders or trusses depending on the magnitude of the load, while others hang from penthouse trusses. Overall, 20% of the major building columns are designed and constructed with interruptions from top to bottom, in order to accommodate the various functions stacked vertically throughout the building. Besides these column transfers, the tower design incorporates a large atrium serving as both a collaborative gathering place for the scientists and a break-out space for those using the auditorium. The atrium features a uniquely shaped steel-framed skylight and two long-span pedestrian bridges linking the new tower to the existing buildings.

Resisting Vibration

The lab space is the centerpiece of the tower's design, with multiple floors of advanced laboratories transforming Wistar's research environment into one of interaction and innovation. The circulation is a continuous loop around the labs, with breakout areas for spontaneous collaboration, framed with a perimeter corridor that cantilevers as much as 10 ft. At the edge of the cantilevered corridor is a glass curtain wall that acts as a double-skin façade to buffer the highly controlled environment of the labs from the exterior at the south façade while allowing natural light to enter the labs.

Within the research labs, vibration resistance that met stringent National Institutes of Health (NIH) requirements for laboratories was essential. The design team was able to achieve stiffness and limit vibration from footfall traffic throughout to a maximum of 2,000 micro-in. per second, while keeping steel member depths to an absolute minimum through composite action of both the beams and the girders. Steel framing stiffness was greatly enhanced along each of the column lines, with the use of creative vertical "trusses" hidden within the side walls of the mechanical shafts serving the labs. These lightweight trusses provided high stiffness to the ends of the longer span framing members, enabling the use of 16-in. beams and 18-in. girders to accommodate the intensive laboratory mechanical and electrical systems above 10-ft. ceilings within 13-ft, 4-in. floor-to-floor heights.

Urban Constructability

The construction process had to overcome severe constraints associated with an urban site surrounded by multiple existing buildings and a major street. Steel erection was performed by locating the tower crane within one of the elevator shafts. With

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▲ The atrium during construction...

▲ ...and completed.

▼ Steel erection was performed by locating the tower crane within one of the elevator shafts.

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almost no laydown area, steel was picked directly from truck beds in carefully staged lots.

The structure needed to be relatively lightweight to reduce the magnitude of the new foundations, which were placed next to the generally unknown existing shallow footings of the abutting 120-year-old building. Twenty-ft-deep underpinnings were installed at strategic points, including sections of heavy brick bearing wall construction from the original building, as well as individual existing shallow column footings for the other adjacent buildings.

The constrained site of the tower structure also led to the use of multiple cantilevered edges, including three of the four building corners. One of the most significant cantilevers occurs over the inset freestanding "glass box" foyer at the tower entry, leading to a monumental stairway as the gateway to the multiuse auditorium and atrium level. This main entry is positioned beneath the overhanging tower façade, which is supported by a series of additive cantilevers—first in the form of a major corner column hanging from an 18-ft.-long cantilever in the building's penthouse, then with a 9-ft.-long cantilevered girder that in turn supports an additional 11-ft.-long cantilevered corner beam. Given the strict deflection limits for the façade, detailed analyses with both the Bentley Ram Structural System and STAAD.Pro were used to determine the cumulative effects of this series of linked cantilevers, plus the progressive axial strains of the suspended column, to ensure a design that met both strength and serviceability requirements.

Boasting the highest rating of "exceptional" with the National Cancer Institute, Wistar is one of only 69 NCI-designated Cancer Centers out of the approximately 1,500 facilities in the U.S. dedicated to cancer research. And with the aid of structural steel's versatility, it has a new facility that will help it maintain this level of excellence far into the future. ■

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▲ The building is located between the academic campus of the University of Pennsylvania and the school's hospital.

▼ The atrium features a steel-framed skylight and two long-span pedestrian bridges linking the new tower to the original facilities of Wistar.

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