Room to Grow

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MIT takes advantage of an adjacent, unused industrial area to increase its living space.

EVERY YEAR, PRESTIGIOUS UNIVERSITIES have to turn away several times more students than they can accept. Many of these schools are located in or near large cities, which limits their capacity to expand their campus to accommodate more students.

In the case of the Massachusetts Institute of Technology, however, former industrial portions of Cambridge, Mass. adjacent to campus allowed the university to transform abandoned spaces to modern, useful buildings of architectural significance. And part of MIT's expansion and reclamation plan was to provide more on-campus housing options for students pursuing graduate degrees.

MIT wanted a large-scale housing complex that allowed for the intermingling of students away from the classroom, and to provide the northwest portion of the campus with a beacon indicating the school's commitment to improving the community by complementing its housing needs with a unique structure. The 265,000-sq.-ft project, called NW35, includes five interconnected buildings with low floor-to-floor heights in order to provide the maximum number of housing units in a relatively low-rise complex.

The design team had to consider ways to ensure MIT could boast a completed building with a signature look and at the same time be able to maintain an aggressive 18-month schedule. William Rawn Associates, the architect, incorporated a curved building massing, rooftop monitors, and a large-span window into the design. These design features, coupled with the relatively short schedule, drove the design team to choose a steel framing system. Plus, steel allowed for repeatable framing, minimizing the need for special detailing at unique shear connections. In fact, the entire project was designed with the use of only a single transfer girder.

LeMessurier Consultants, the structural engineer, undertook the painstaking process of "smoothing" the framing of each of the buildings to achieve repeatable beams despite there being bay-spacing and beam spans that were non-regular. The intent was to streamline the shop drawing review and erection processes so that there were not 6,000 unique pieces of steel—the approximate number used on the project—to be reviewed, delivered, and erected. This effort produced hundreds of W14×22 beams with ½-in. camber. However, the process was simplified by LeMessurier's in-house composite beam framing program, Chiquita, which allows engineers to specify steel beam depths and/or sections and receive instantaneous feedback regarding the strength and stiffness design characteristics of the composite beams. The resulting integration of lightweight concrete slab-on-deck forcing composite action with the steel beams was instrumental in reducing the floor-to-floor heights throughout the project. These low heights correspondingly drove the demand for hundreds of beam penetrations throughout the project. The beam penetrations were

Curved metal panels (above) alternate with red brick to provide visual transition points between the interconnected buildings.

A pedestrian bridge with a curtain wall links two buildings within the complex.

mainly coordinated early in the design phase to ensure shop installation, which kept costs down. In addition, implementing the penetrations in a repeated beam size made the analysis of the beam penetrations, prior to detailing and erection, significantly more efficient.

Springtime in New England is always an adventurous time of year to plan outdoor work, as the rain, and sometimes even snow, can potentially be extensive. The MIT Graduate Housing Facility project was fortunate to have an extended period of dry weather, which allowed the steel to be erected near continuously for as long as the weather would allow. With the steel framing for the five buildings proceeding at such a frenetic pace, with steel topping out a mere two-and-a-half months after erection had begun.

With such a vast project, steel erection was completed in some portions of the five-building complex while it was still underway in other areas of the project. With the complexities in the progression of erection, the concrete work had to be fit in to accommodate the steel schedule. During pre-construction meetings, the project team discussed a scheme that would have the structural steel in place prior to the placement of the ground-level structural slabs at each of the five buildings. At the upper levels of the complex, all of the buildings are interconnected to allow for the flow of students throughout, but at the ground level, there are several distinct breaks between the buildings to allow access to the two courtyards. The breaks in the slabs at the ground level created the need for expansion joints in similar locations in the composite steel framing above. Many of the expansion joints between buildings would pass through arterial hallways and would be visible to the buildings' inhabitants. William Rawn felt that minimizing the width of the expansion joints would be the aesthetically preferable option thanks to this high level of traffic. However, this would be a challenge due to the site's poor soil conditions, as such conditions tend to increase the seismic base shear required for lateral force analysis. In response, LeMessurier instituted a complex series of ordinary concentrically braced frames (OCBFs) that provided a stiff lateral system, keeping the elastic deflection of each isolated structure to less than 1 in.

A design model of the NW35 graduate student housing facility, which features five separate buildings and two inner courtyards.

With the expansion joints minimized, efficient delivery of the lateral forces into the foundations was the next step. LeMessurier detailed the lateral-force resisting system to allow the lateral forces to be transferred from the OCBFs to the structural slab. The lateral forces were distributed to the structural slab, and in turn to the pile caps and grade beams via steel elements that were to be poured monolithically into the structural slab. Early in the steel erection process, the construction manager recognized the potential to advance the overall schedule by placing the structural slab for one of the five buildings that had not yet seen its first steel erected. In addition to adding a cold joint in a structural slab, a major hurdle in this proposed change was that the shop drawings for steel columns to be changed had already been reviewed. LeMessurier was able to adeptly change the lateral-force distribution detail from a series of embedded bars to a plated member with shear studs embedded in the slab. This solution did not interfere with the architecture of the space along the braced frames, as they had been placed only in solid wall sections.

LeMessurier Consultants

Consistent beam depths and non-regular column bays were key structural goals for NW35.

Countless factors, including the low floor-to-floor elevations, expedient erection time, and ease of detail alteration, made the design team very happy with its choice of framing system. With its successful opening in time for the fall 2008 semester, NW35 not only expanded MIT's housing stock, it also replaced a parking lot with contaminated soils and a decrepit warehouse with an environmentally conscious gathering spot for some of the world's most ambitious students. Given the university's prominence in the field of engineering, everyone involved with the project foresees the facility as another feather in MIT's collective cap. MSC

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