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Surrounded by Science

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An urban research campus expands its knowledge base with a new, steel-framed addition.


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Supporting connections for the precast panels were welded to columns in the fabricator's shop, greatly reducing field welding requirements.


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With the seats for the wall panels already in place on the columns the panels could be put in place much earlier in the process.

opposite page: Selecting an all-steel frame rather than using concrete framing for the garage and below, as originally considered, saved approximately $4 million and 10 weeks of construction time. The building uses about 2,200 tons of structural steel in all.

Jeffrey Totaro

All the steel columns in the enclosed and mechanically ventilated garage were encased in concrete for impact protection.

PHILADELPHIA'S UNIVERSITY CITY SCIENCE CENTER has been, in a word, prolific. Set within the University City neighborhood near leading science institutions the University of Pennsylvania, Drexel University, Children's Hospital of Philadelphia, and the Wistar Institute, the nation's first urban research campus has created more than 16,000 jobs. Its resident companies have raised more than $400 million in venture capital and other funding in the last five years alone, and the Science Center has grown to 15 buildings on 2 million sq. ft of real estate.

The latest component of the complex, 3711 Market Street, was completed last year. This urban redevelopment project is a flexible wet laboratory facility with science and technology incubator services available on-site. The new building contains ground-level retail and five stories of structured parking capped with four more stories of flexible laboratory and office space. The building's state-of-the-art laboratory infrastructure, coupled with the Science Center's unique business incubator services, help small and growing life-sciences and high-technology companies get to market faster and more efficiently

Time and Money

Initial design concepts for 3711 Market Street suggested two types of structural framing: steel for the upper laboratory floors and concrete for the garage levels and below. Comparative options were prepared by structural engineers Keast & Hood Co. for both concrete and steel framing on the lower levels. The construction manager's estimates showed that the steel scheme would save approximately $4 million and 10 weeks of construction time. Given the need for economy and speed-to-occupancy, the steel structure was immediately more attractive to the entire team. The steel design also was quite efficient, with an average of 10 lb of steel per sq. ft of building area. The typical column bay size is 31 ft 6 in. by 31 ft 6 in. This works well for both the typical lab bench module and parking stall. On the garage levels, these typical bays are framed with W18×35 beams at 10 ft 6 in. on center and W21×55 girders on the column centerlines. On the laboratory floors, beam sizes jump to W18×40 and girders to W24×84. Beams and girders were initially cambered between ¾ in. and 1 in.

Speed to Occupancy

Schedule was one of several challenges faced by the project team. Complex funding and land-use agreements resulted in a short window of time between concept and occupancy. Once the structural system was selected, the design team was charged with producing a full steel bid package in seven weeks, beginning in June 2006—no small task for a 420,000-sq.-ft, nine-story, mixed-use building. Successfully meeting the schedule required a multi-faceted approach, including a streamlined design process and the use of building information modeling (BIM) software.

Integrated project delivery contributed to the project's efficiency and speed. Keast & Hood Co. used RAM Structural System and RAM CADstudio, BIM software packages from Bentley designed to streamline development of analytical models and construction documents. Structural engineers used RAM Structural System to prepare a complete, three-dimensional model of the structure; perform analysis and design for gravity, wind, and seismic forces; and evaluate floor vibrations. The model was exported to AutoCAD using RAM CADstudio for creation of two-dimensional construction documents. Once the design was optimized, a structural team went to work finalizing details. Structural engineers created floor plans, a column schedule, and braced-frame elevations straight from the computer model.

Design Complexity

Another project challenge was the accommodation of demanding architectural design features. The front entrance canopy cantilevers approximately 12 ft over the sidewalk, does not align with any floor framing or interior building structure, and features a very thin architectural profile. To meet the architects' expectations, Keast & Hood Co. developed an innovative framing solution through extensive finite element modeling with STAAD software.

Several building skin systems added to the design complexity. There are two types of curtain walls with different profiles and window mullions on the building. A composite, insulated metal "sandwich" panel encloses the penthouse while a single-skin panel system is used on the north wall. Complementing the metal panel systems are brick-clad precast concrete and thin-stone veneer on

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The 3711 Market Street entrance canopy cantilevers 12 ft out over the sidewalk, requiring an innovative framing solution.

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To accommodate the variety of building skin systems on this project, numerous details were developed, such as this galvanized tube for the front façade.

structural steel framing, as well as stucco on cold-formed steel framing. The slab edge varies in distance from 1 ft, 6 in. to 2 ft from column centerlines.

Extensive edge details were developed to accommodate the different skin systems. To maintain project economy, the edge details used small steel angles and tees to efficiently support the decks during slab placement. Once the slab cured, it acted compositely with the light steel sections to support live loads and the curtain wall attachments. This detailing saved more than 80 tons of steel that would have been required if additional beams at the slab edge had been incorporated. In total, the building used approximately 2,200 tons of steel.

Preventive Measures

As steel was also chosen for the garage framing, attention turned to preventing the deterioration so common in parking garages. Empirical research showed that some of the most common corrosion-related deterioration in steel garages occurs near the perimeter where garage floors take on rainwater. Coincidentally, the owner and architects were interested in a more refined aesthetic than would have been possible with the conventional open-sided garage approach. Hence, enclosing and mechanically ventilating the garage made sense from a variety of perspectives and was readily adopted.

Additional protection methods included partial reinforcement of the slabs on steel decking and a silane sealer applied on all the garage slabs. By using epoxy-coated reinforcing bars at the top of the slab over all the beams and girders, crack widths were kept to a minimum, thereby enhancing the water-resisting performance of the silane. Within the garage, all columns were encased with concrete for impact protection, and HSS 12×6×5⁄16 steel tubes were employed as car barriers at all perimeter slab edges.

In the Shop

The steel fabricator, Cives Steel Company, contracted Ted F. Duggan and Sons, Inc. to detail the garage's complex geometry. Duggan's computer drawings were used to generate CNC files for precise cutting, burning, drilling, and punching of materials within the Cives shop; accuracy and efficiency were maintained throughout as a result. To further accelerate the project, Cives was contracted to install precast wall panel connections in the shop, saving valuable field labor and allowing the precast panels to be installed on site much earlier.

In the Field

While the rest of the design team was finalizing its drawings, steel fabrication was under way and foundation construction sped along in the field. By spring 2007, steel erection took place in four, full-height lifts. Limited available space on the urban site required careful sequencing. Material deliveries were scheduled only as needed to avoid unnecessary congestion on the site.

All members of the project team leveraged their experience and expertise to optimize design and construction without compromising safety or serviceability. Optimization resulted in both tonnage and bids well below pre-construction estimates. The project's sustainability features were recognized with U.S. Green Building Council Leadership in Energy and Environmental Design (LEED) registration, and 3711 Market Street is a LEED Registered Building at Level 2.0 for Core and Shell. The project was awarded LEED silver certification in October 2009. MSC

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