In the Open

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Economical exposed structural steel framing supports a multi-function building at California State University, Northridge.

California State University, Northridge, needed a new building to house its Health and Human Development Department and a campus-wide Technology Center (HHD/TC). Since the devastating Northridge earthquake of 1994, the University has been committed to rebuilding its campus with architecturally significant, structurally innovative and cost-efficient buildings.

The University turned to integrated architecture and engineering firm AC Martin Partners (ACMP) to meet the project requirements: to serve the diverse functions of the various departments now and in the future, to provide extensive space on an extremely limited budget, and to create an aesthetic building in accordance with campus planning priorities. Integrating architecture and engineering from the beginning allowed designers to address those needs elegantly and efficiently—with a structural solution that became an architectural expression.

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STEEL OPPORTUNITY

Early in project discussions, the team of architects and engineers determined that a relatively lightweight steel frame system would serve the clients better than a concrete structural system. Steel offered multiple opportunities to reduce costs and shorten construction duration while also providing architecturally interesting spaces. In order to stay cost efficient, the team used a standard-size steel module for the entire building frame. This decision not only saved the clients money on fabrication, but also saved time in both the design and construction phases.

Maximizing the efficiency of the selected steel module, the team designed a U-shaped building that frames a central courtyard. This design responds to the University's need for courtyard buildings to promote interaction among students, faculty, and visitors—creating an informal collegial environment. Within the steel modular framework, the architects defined the particular spaces currently needed while allowing for future spatial flexibility. The HHD/TC building would house design studios, sewing and textile studios, textile chemistry labs, several food service and nutrition kitchens, and faculty offices for the Human Development Department. In addition, one wing would house the Technology Center—the center of services, operations, and equipment for the technological infrastructure critical to the life of the campus. This included all central computer servers and computer-repair and storage facilities.

The design team focused on maximizing structural efficiency in the management of gravity loads as well—choosing a standard-sized open-web joist system. The building's live load varied from 50 lb. per sq. ft-reducible in most of the spaces to 125 lb. per sq. ft for some of the libraries, technical centers, and laboratories. In order to accommodate the larger loads, designers spaced the joists more closely together rather than changing their depth. Thus, a single-size joist supports the gravity load throughout the building, allowing the ceiling depth to remain uniform. The typical floor joists at the 30'-9" spans were 24LH10 series, spaced at 6'-8". The joists at the 38'-9' spans were 28LH12 series, also spaced at 6'-8". The joists within the laboratory and library areas were spaced at 4'-0" center-to-center. The typical roof joists were 24LH07 series, spaced at 10'-0" center-to-center.

Using open-web joists not only reduced the total weight of the steel used, but also allowed much of the building's wiring and ductwork to run through the open webs. While initially chosen for their practical appeal, the open-web joists inspired the designers with their aesthetic potential. Exposing the joists exemplified the designer's understanding of the importance of an integrated, team-oriented approach to building design.

FIRE CONSIDERATIONS

The design team also worked together to reduce the building's fire rating. This effort incorporated decisions on multiple scales, from circulation planning to material choice, and required the cooperation of the entire group of architects, engineers, and consultants. Designers created multiple exits, reduced floor-to-floor heights, and widened corridors, earning a Type V one-hour fire classification. This rating saved the cost of fire-coating and insulating all of the steel throughout the building.

The cost benefits of this are clear, but the team saw design benefits as well. Steel members would have to be primed, but not covered in spray-on protective fire coating. Therefore, they could be exposed as the lightweight, structural bones of the building without being hidden by the coating or by gypsum board.

Having eliminated the need for high fire-rated, concrete-fill roof decking, the team chose a lighter-weight and more aesthetically appropriate Epicore roof decking. The soffits on the underside of Epicore were primed and finished for interior exposure. While the Epicore material itself was slightly more expensive than traditional concrete fill decking, it weighed less, allowing for the additional roof cost to be made up by the reduced cost of the supporting steel.

CLASSROOM STYLE

With ducts and wiring running neatly through the open webs, steel members primed rather than covered in fire coating, and the underside of the roof designed for exposure, the team had created an opportunity to expose the steel structure. Together with the client, the ACMP team chose to expose the structural ceiling of the second-floor design studios.

For symbolic purposes, exposing the structure of the building would inspire the design students who continually deal with issues of structure and surface. It would remind the students of the connection between structure and form, and inspire them to create inventive solutions in their own designs.

For spatial purposes, exposing the ceiling structure would open up the rooms by adding several inches of vertical space. Building on this sense of exposure, designers placed floor-to-ceiling windows along the studios' north walls.

Interior spaces, visible through walls of glass in this night photograph, feature exposed mechanical and structural systems.

Filled with light, the studios conveyed a feeling of openness. Although not exposing the steel columns themselves, the glass panels alluded to the lightness and elegance of the structure.

BRACED FRAMES

The HHD/TC building's steel framing provided a second opportunity for structural exposure. The design team implemented a special concentric-bracing system that had proven to consistently perform well seismically. The diagonal members of the X-bracing system were W10×49 steel shapes installed with their strong axis in the out-of-plane direction. Steel angle shapes (L3×3×$^3/_8$) connected these diagonals to the gusset plates with bolts. The smaller area and moment of inertia of these angles formed the weaker link outside the member, gusset plate and bolted areas, which was desirable for better performance during an earthquake.

This bracing system offered additional benefits: it lightened the frame, reduced construction and inspection costs, and allowed for the use of smaller, streamlined members. The building's U-shape allowed for the strategic placement of the bracing, mostly along the perimeter of the building. This provided desired redundancy in the response of the building to earthquake-generated strong ground motion. This layout also enabled future flexibility, since interior walls would not house bracing members and could be relocated or removed as future needs would dictate.

Special attention was given to the detailing of the bracing system. All field connections were bolted rather than welded. This accelerated construction and inspection time, saving the client both time and money. The detailing of the connections also ensured ductility at the connecting angles, rather than in the steel members themselves.

GRAND ENTRANCE

In order to highlight the framing solution and to articulate the entryways while remaining within the limited budget, ACMP designed an exposed-steel trelliswork portico at each main entrance. Relating to the structural frame, each entrance was defined by dramatic steel latticework—four steel beams extending out from the building were criss-crossed by eight smaller beams. The latticework was supported by triangular-configuration framework composed of W6 horizontal steel beams and 2”-by-3” diagonal angles. The steel was painted, but left exposed. The trellis was covered by glass panels to protect the entryways from rain, while permitting light to filter through the steel lattice. The thin exposed-steel members hinted at the equally attractive steel inside the structure, and reiterated the exposed steel in the design studios.

Project design began in early 1998. Construction began in September 1999 and was completed in March 2001. Structural steel main framing was erected in three-and-a-half weeks. The final cost of the project was $10.1 million.

From beginning to end, it was important that the engineers, architects, and client worked closely together on this project. With a tight budget, limited time frame, and variety of needs to be addressed, decisions had to be integrated immediately. The ACMP team viewed this collaboration as an opportunity to strengthen both the structural and aesthetic design. In the end, the team's integration not only created an economical solution, but also defined a poetic and functional building. Exposing the steel highlights the elegance of the structural solution and creates a distinctive architectural articulation. ★

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STEEL FABRICATOR AND DETAILER
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ENGINEERING SOFTWARE
Microstation, ETABS

STEEL ERECTOR
Mid-state Steel Erectors, Stockton, CA (NEA member)

DETAILING SOFTWARE
Design Data's SDS/2