Clear Choice

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Structural steel meets an aggressive construction schedule and provides nearly column-free space in this Chicago office tower.

A chevron-brace system transfers lateral loads to the foundation while minimizing the number and cost of gusseted bracing connections.

The 3” metal deck can span nearly 16’, minimizing the number of secondary floor members required at each level, and significantly reducing the total number of members to be erected for the project.

Congress Center is one of the latest speculative office developments in Chicago’s West Loop area, and features some of the largest column-free office space in the city. Development Resources, Inc. developed the 18-story, 560,000-sq.-ft office building. It is the “big brother” to the company’s earlier project, Union Tower, a 16-story, 330,000-sq.-ft speculative office building featured in the April 1999 issue of *Modern Steel Construction*. Congress Center is a variation of the Union Tower project, and an opportunity to test the long-span capabilities of a steel design solution in a traditional office building typology. The building features several floors of 75’ spans and column-free space with an efficient floor-to-floor height of only 13’-0”.

The success of Congress Center can be attributed largely to the client’s clear goals, an experienced design and construction team, and the use of structural steel as a primary building material. OWP/P, one of Chicago’s largest architectural engineering firms, provided architectural and structural engineering services for the Congress Center project, similar to its role on the Union Tower project. The continuity of the team on both projects allowed Congress Center to take advantage of team synergy, knowledge base and lessons learned from the previous Union Tower project.

MEETING THE CLIENT’S EXPECTATIONS

The developer had several specific expectations for this project: to develop a high-rise office building that was

Union Tower, a 16-story, 330,000-sq.-ft speculative office building completed in 1999, gave designers an opportunity to test the long-span capabilities of a steel design solution in a traditional office building.

Congress Center under construction. The project schedule allotted 15 months for construction.

both marketable and economical within Chicago's competitive market. The design team was challenged to create a design solution that was architecturally responsive, functionally efficient and within the project budget.

One of the biggest challenges of the project was meeting the Nov. 21, 2001 occupancy date. OWP/P began design of the project in April 2000, with an extremely aggressive design schedule and only a 15-month construction schedule. A structural steel frame was critical to meet the project goals and schedule. Steel was chosen because it was lightweight, could be erected quickly, could span long distances with minimal depth, and because it provided flexibility to accommodate potential changes resulting from an aggressive design and construction schedule.

COLUMN-FREE OFFICE SPACE

The developer's experiences on Union Tower provided valuable information about Chicago's market for speculative office space: the column-free space in Union Tower would be valuable to prospective tenants. Tenants would demand flexibility within their space and Congress Center was an opportunity to create column-free spaces of almost 10,000 sq. ft at its upper levels.

STRUCTURAL SYSTEMS

After studying various structural solutions with general contractor Power Construction Company, the design team determined that structural steel was the most economical structural system for the overall cost and schedule of the project. Each floor of the building has a floor plate of approximately 32,500 sq. ft, composed of 30′-0″ × 46′-0″ bays between the core and the perimeter of the building. The floor framing consists of composite beams and girders with composite metal deck. The design solution maximized the longer-span capabilities of a 3″ composite metal deck and used a 3¼″ lightweight concrete topping to achieve the required fire rating. The deeper deck (as compared to typical 2″ deck) minimized the number of secondary floor members required at each level, and significantly reduced the total number of members to be erected for the project.

The deck, which can span approximately 16′, did not require shoring as the concrete slab was placed. The deck also had sufficient reserve capacity to support light-storage loads in the event potential tenants had requirements where the reserve capacity was needed.

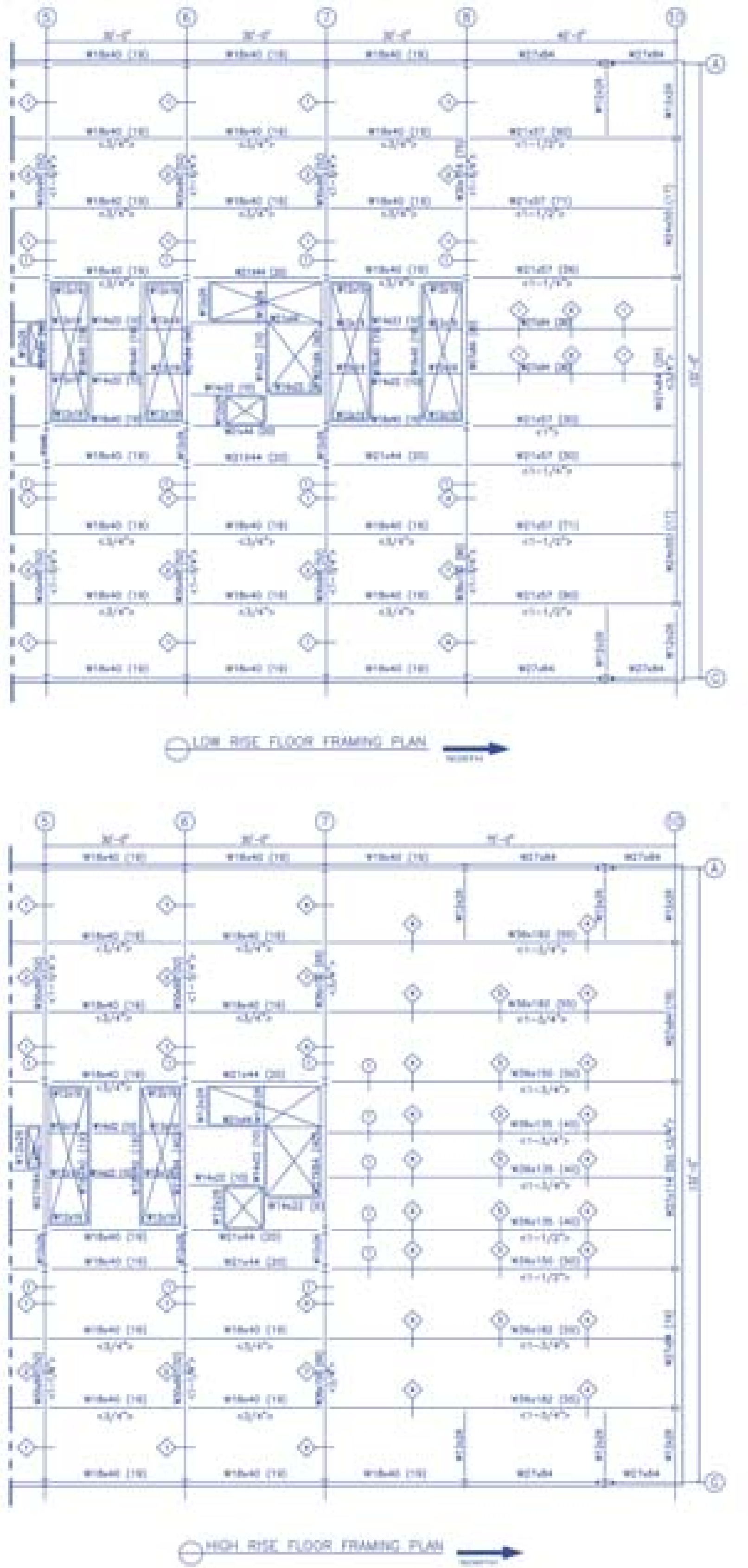
Floors one through 10 are considered the low-rise portion of the building, and floors 11 and above are considered the high-rise levels. The difference between the low-rise and high-rise floor plates is that one of the elevator banks terminates at the tenth floor, reducing the size of the building core at the upper levels. To maintain the marketability of a "column-free" building at the upper levels, the columns adjacent to the terminated elevator bank also terminate above the tenth floor. This required the floor framing at the high-rise levels to span a distance of 75′ from the core to the perimeter of the building. The resulting column-free space at the north end of the high-rise levels is 132′ × 75′, or almost 10,000 sq. ft of column-free office space.

Discussions between the design team and the contractor confirmed that a braced-steel lateral system was the most economical choice for the project. Steel bracing provided sufficient stiffness to limit building drift. Fabrication and erection of the entire superstructure could be assigned to a single subcontractor—and would also reduce the duration of construction. A chevron-brace system was designed, efficiently triangulating the lateral loads to the foundation while minimizing the number and cost of gusseted bracing connections.

LOW FLOOR-TO-FLOOR HEIGHTS

An important design consideration to the success and economy of the project was minimizing the building's floor-to-floor heights, while maximizing the finished ceiling heights available to potential tenants. Each vertical foot of building height reduced the cladding cost by approximately $25,000. Low floor-to-floor heights also minimized the length of vertical components such as columns and mechanical/electrical/plumbing stacks, reducing the construction and overall project cost. Minimizing the structural beam depths and allowing the mechanical/electrical/plumbing systems to co-exist in the same interstitial space as the structure resulted in 13′–0″ floor-to-floor heights while still allowing 9′-0″ finished ceiling heights. 13′-0″ floor-to-floor-heights are not particularly low for typical office buildings, but this structure also offered 75′ spans of column-free office space while still maintaining a minimum of 9′-0″ finished ceiling heights.

Shallow composite girders with beam-web penetrations were used to minimize the depth of the structure. The mechanical/electrical/plumbing systems penetrate each composite girder, parallel to and in between the secondary framing members. Reduced spacing between the W36 girders was necessary at the upper levels to achieve the 75′ spans. Many of the framing members were cambered, and the entire floor design was reviewed and surveyed to achieve true floor levelness once the concrete slabs were placed. Vibration of the floor system was also scrutinized, since both floor levelness and vibration perceptions were important considerations to the developer.



Typical floor framing plans for the low-rise and high-rise portions of Congress Center. Note that the columns on line 8 (adjacent to the low-rise elevator banks) are not continued into the high-rise portion of the building, creating a column-free office area of 75' by 132'.

FLOOR LEVELNESS AND FLOOR VIBRATION

The developer required level floors without significant floor vibrations, even at upper levels that had shallow longer spans. Detailed deflection calculations were performed at beams and girders to determine the initial camber required to meet the deflection limit. The calculations took into account inherent beam-end connection fixity and the variation of fixity across various beam sizes and spans. Vibration considerations were evaluated in accordance with AISC's steel design guide on floor vibrations. These two important serviceability requirements were continually evaluated throughout the design process, and were closely monitored during construction.

Initial beam and girder deflections were limited under the initial construction loads. Ponding and excessive deflection due to the concrete placement on metal deck was monitored and minimized during construction. During construction, surveys were performed to ensure the proper camber was initially present and that it was dissipating as anticipated, leaving the finished floors as level as possible.

FABRICATOR EXPERTISE

To meet the project's aggressive construction schedule, beam and column sizes had to be finalized in the earliest stages of architectural design. The first columns were scheduled for erection on Dec. 26, 2000, and the 4,500 tons of structural steel would be topped out five months later in May 2001. The steel was erected in two-story lifts, which proved to be much more effective than the three-story lifts attempted on the Union Tower project. On average, two floors were completed every one and a half weeks. The communication and collaboration between the structural engineer and the fabricator saved the client more than $70,000 in structural steel costs.

TENANT BUILD-OUTS

While steel was the logical choice for the fast-paced construction schedule, it was also the logical choice for a speculative office building where the tenant's specific needs were unknown at the time of the original structural design. Fortunately, steel could be modified to suit various tenants' needs with relative ease. This was clearly the case with Congress Center.

Since the completion of the building shell in November 2001, many businesses have chosen to move their offices into Congress Center. Many of these tenants have space requirements for storage areas, high-density files, or computer server rooms. These types of spaces require higher local floor load capacities than was planned in the original design. Congress Center's steel framing system is able to accommodate the various tenant requirements for heavy loads, with only minor modifications to the existing structure. Steel cover plates have been added to existing steel beams and girders when necessary, and new supplemental beams have been added to support the heavy concentrated loads in local areas.

Ultimately, the developer and the tenants were satisfied and the building was constructed quickly, easily and economically. The office space offers flexibility for a wide variety of tenants—and a great view of downtown Chicago. ★

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