HYBRID DESIGN REDUCES COSTS

Switching from a concrete frame to steel beams and concrete columns proved advantageous

WHEN DESIGN FIRST BEGAN ON THE 30-STORY IJL FINANCIAL CENTER IN DOWNTOWN CHARLOTTE, the project team assumed that the building would be cast-in-place concrete. However, AISC Active Member SteelFab, Inc., with the help of Nucor-Yamato Steel, proposed a steel alternative to the owner with a guaranteed maximum cost.

While the proposal included some common steel design concepts, such as cambered beams and the use of LRFD, it also included some creative methods to minimize steel weight. SteelFab proposed framing steel beams spaced 15' on center into perimeter columns in four places at each level. A 3 ¼" lightweight structural concrete slab was placed over a 3", 19-gage composite steel deck. While the 3", 19-gage composite steel deck is typical, it was not adequate for the 15' span. Instead of reducing the deck span by adding another beam, the deck was increased to a 16-gage deck in these spans, as well as one adjacent span.

FABRICATOR INPUT

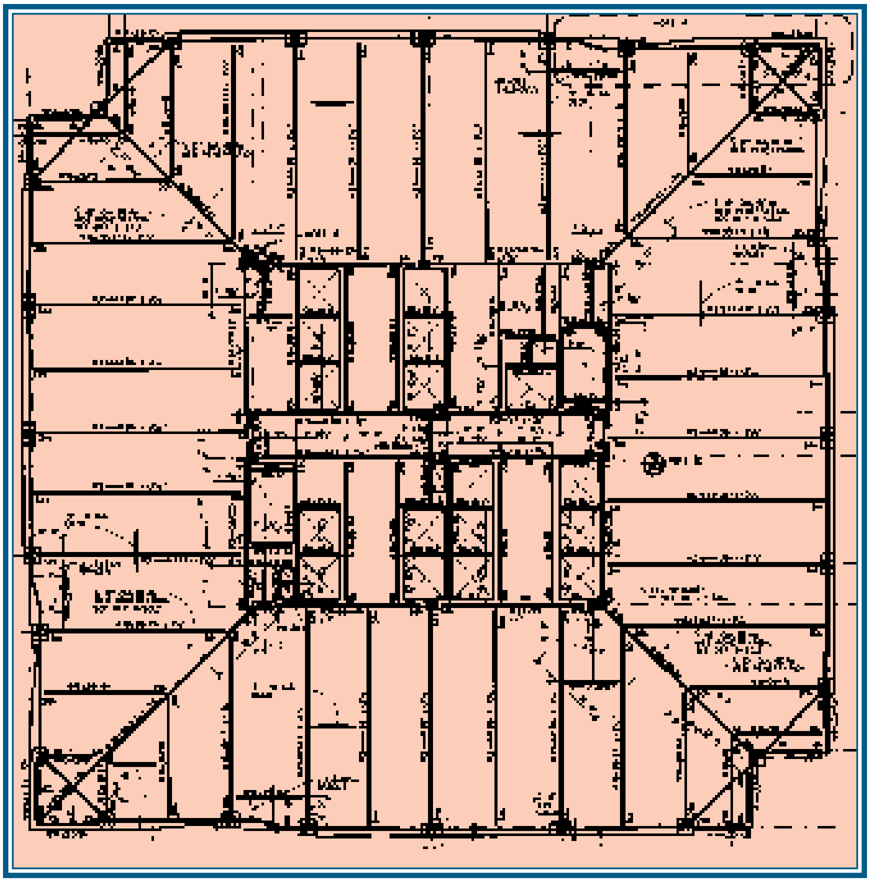
After reviewing SteelFab's proposal, the owner decided that structural steel was the most economical material for the building. Steven Hamvas, P.E., with Stanley D. Lindsey and Associates, Ltd., said it was the push by SteelFab and Nucor-Yamato Steel, which provided material pricing and availability information, that persuaded the owner to switch from concrete to steel. "The effort put forth by the steel fabricator and steel producer in convincing the owner to use structural steel should serve as an example for future projects," Hamvas added.

The lateral support system for the structure comes from a hybrid system consisting of steel spandrel wide flange sections and concrete columns. However, the integration of the concrete columns with the structural steel presented a challenge since the connection between the steel spandrel beam and the concrete column had to be designed as a rigid joint. Closely spaced column ties within the depth of the joint were required to confine the concrete and vertical reinforcing bars. Holes were provided in the webs of the steel spandrel beams, within the depth of the joint, to allow for two ½" diameter reinforcing bars to pass through where the bars could be lapped for continuity.

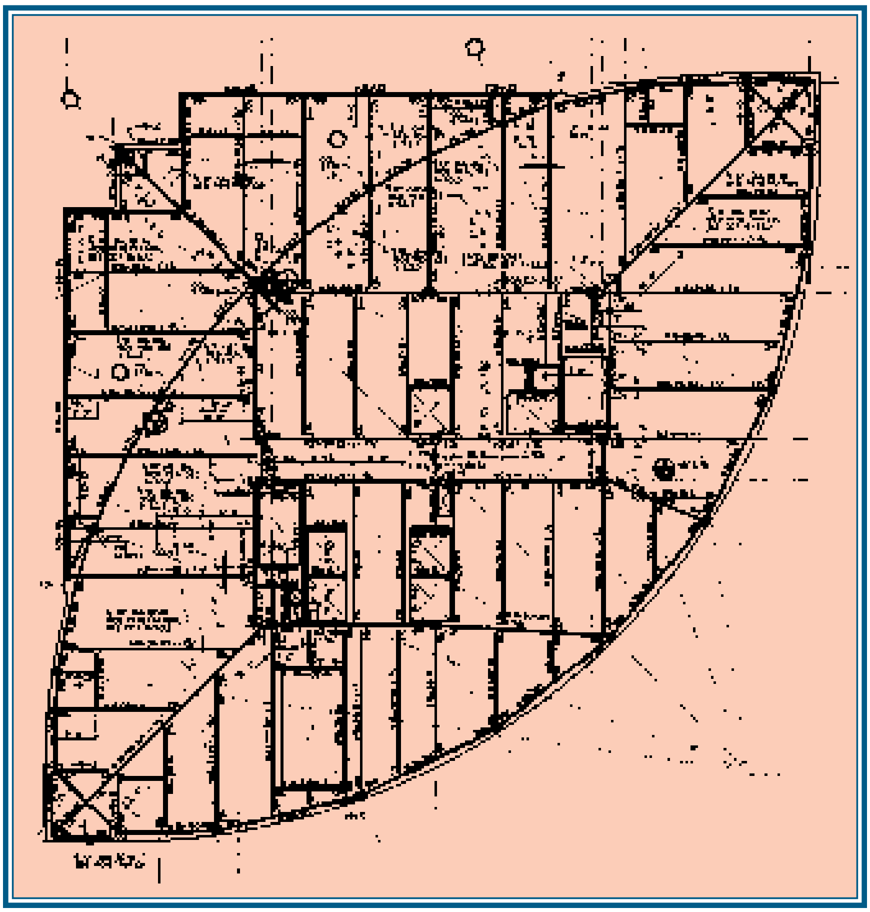
The structural engineer worked closely with the steel fabricator to assure that at each location there would be a hole in the steel spandrel beam web. Another complication was that vertical reinforcing steel for the concrete columns could not be spaced evenly at the perimeter of the column, a typical method for concrete construction, but had to be placed strategically to avoid both the steel spandrel beams and the floor beams framing in to the joint.

Fast Erection

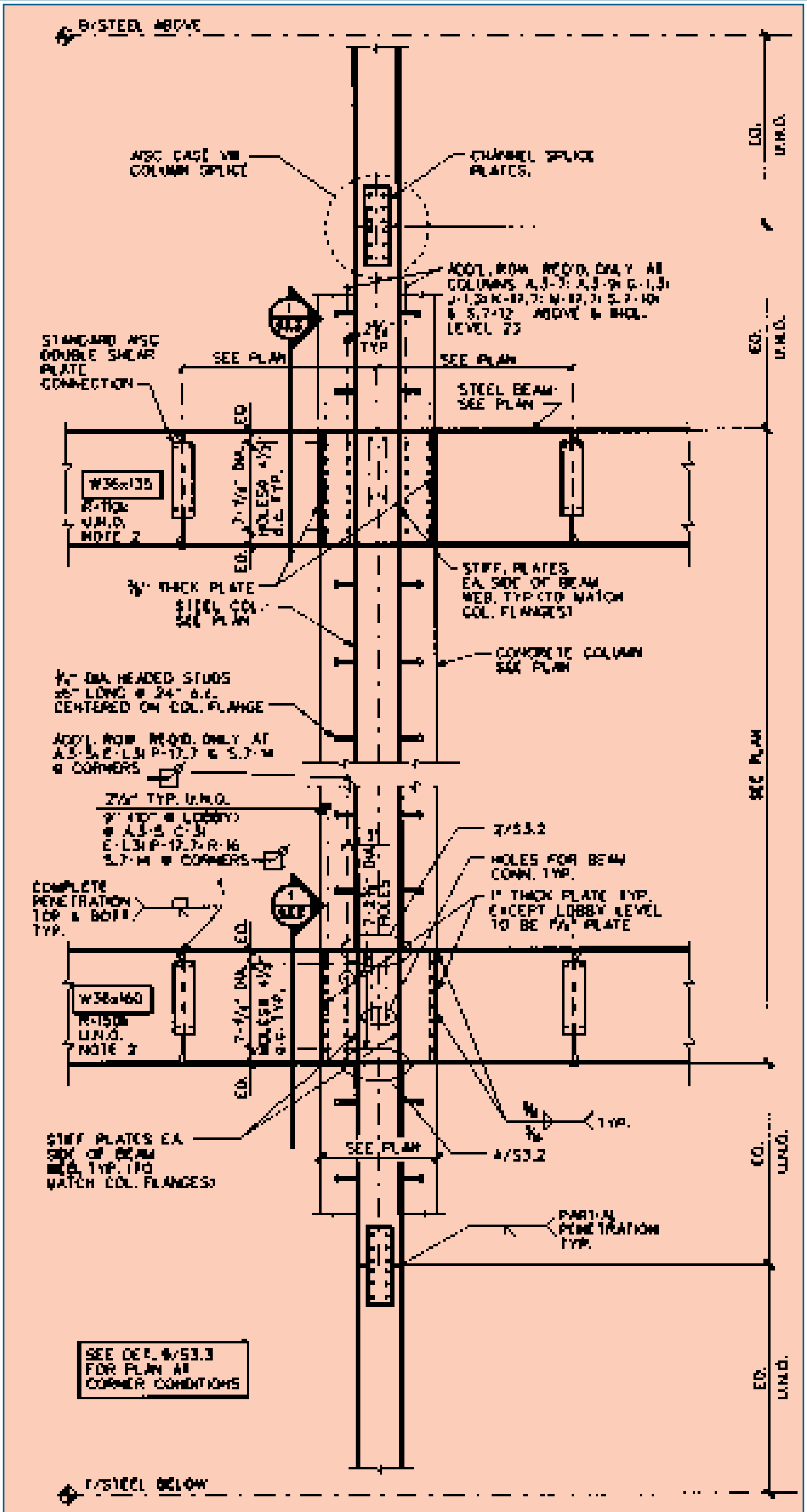
Anticipating that steel would rise faster than concrete, the contractor wanted to construct 10 levels of structural steel ahead of the concrete column construction. W14x109 steel erection columns were constructed to support 10 levels structural steel, steel deck and concrete slab. The rigid connections between the steel erection columns and the spandrel beams enabled the columns to provide some of the temporary bracing for the structure during the con-



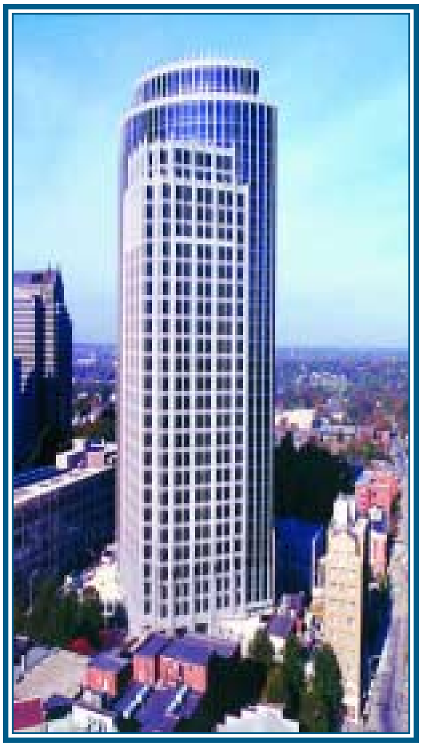
Tower Framing Plan — Levels 4-12, 14 & 15



Tower Framing Plan —- Level 30

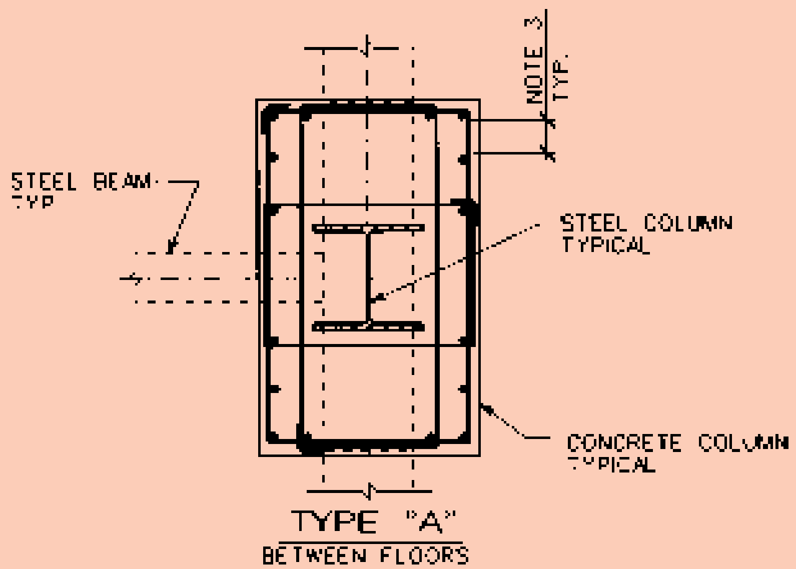


Typical steel beam to concrete column connection detail

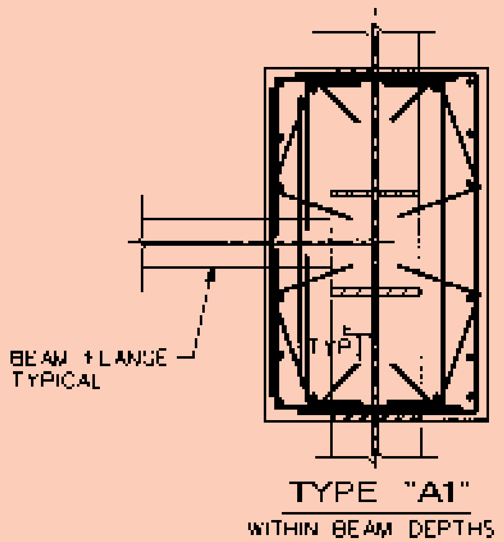


struction.

Another difficult challenge of the project was to calculate the amount of differential column shortening that would occur between the interior steel core columns and the perimeter concrete columns. Steel columns shorten due to elastic shortening, which is related to the magnitude of the load. Concrete columns shorten due to elastic shortening as well as creep and shrinkage strains. In order to make an estimation of the axial shortening in the steel erection columns, it was important to know how many levels of slabs would be placed ahead of the concrete columns. The contractor intended to place concrete on the steel deck just seven levels behind the steel erection and place concrete for columns nine levels behind the steel erection. It was determined that the perimeter concrete columns would shorten about 1” more than the steel columns. In order to counterbalance this difference, the steel columns at the 10th level were fabricated ⅝” longer, and at the 19th level they were ⅜” longer than the theoretical length.



Typical column tie detail



Typical column tie detail

Tree Columns

A concept discussed early in the project—and ultimately adopted—was the use of prefabricated "tree columns" consisting of 36" deep spandrel beams and W14x109 erection columns. The two-story tree columns consisted of 10' long spandrel pieces, one full story erection column and two half-story erection columns. The tree columns were connected to the top of the lower tree columns, and then fill-in pieces of spandrel beams were placed between the spandrels of the tree columns and welded together to make a continuous spandrel beam at the perimeter of the building. Unfortunately, the full benefit of the tree columns could not be realized.

While the steel erection was fast, the concrete column construction lagged behind to the point where temporary suspensions of steel erection were required in order to allow the concrete construction to catch up. Despite these delays, the structural steel for the building was completed in 24 weeks.

The initial design of the core columns indicated that column sections as large as W14 x 730 would be necessary. One of the key elements to guaranteeing the cost was that the steel had to provided by Nucor-Yamato, which at the time of construction only produced members up to W14X398.

"If we used something larger, we would have to have gotten something from overseas," Hamvas said. If the shapes had to be obtained from overseas, the fabricator would not have been able to keep to the project's guaranteed price. Instead, it was agreed that a built-up box section consisting of plates welded to the flanges of the W14x398 would be used for any column required to be larger than a W14x398.

The use of structural steel goes beyond just the building's frame. The foundation system for the building also utilizes structural steel. It consists of

HP14x89, grade 50, piles with a capacity of 200 tons driven into partially weathered rock. Again, the economical value of using steel prompted the owner's decision.

Project:
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Charlotte, NC

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Atlanta

Structural Engineer:
Stanley D. Lindsey and Associates, Ltd.
Atlanta

Architect:
Smallwood, Reynolds, Stewart, Stewart & Associates, Inc.
Atlanta

AISC Member Fabricator & Detailer:
SteelFab
Charlotte

General Contractor:
Beers Construction Co.
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