New York's Trump Tower:

Climbing tower crane and extended-life superplasticizer solve difficult placement problems

Tower crane located off center at Trump Tower lifted forms and reinforcement, then with bucket attached placed concrete on a two-day cycle for the 11,700-square-foot residential floors.

Two-day placement cycle achieved with three different concrete mixes

Trump Tower is a 58-story, 644-foot-high multiuse building offering retail, office and condominium units next door to Tiffany's on New York's Fifth Avenue. The recently completed luxury building—where condominiums sell for $1 million of more—is an all-concrete structure with an unusual structural design. Rather than using a tubular frame whose many closely spaced columns would have obstructed window views, designers chose a complex combination of core walls, shear walls and columns instead. Only 8 of the 52 columns in the upper residential floors (the top 38 floors) extend all the way to the ground. At the 19th floor level, load from the 44 other columns is picked up by transfer girders which are about 24 feet high and 18 to 24 inches thick. Below the 19th floor shear and core walls and the remaining 8 columns carry the load through the lower stories where office and retail use requires column-free space.

The structural designers considered using a steel frame up to the 19th floor, but a 7-month wait for steel delivery tipped the balance to concrete. Current high costs for financing made construction speed all the more important in this high-rent district.

Crane and bucket place concrete

Limited access to a tight urban site posed some problems in selecting the best method of concrete placement. Because a crane was needed on the site to raise the forms and reinforcing steel and because several dif-

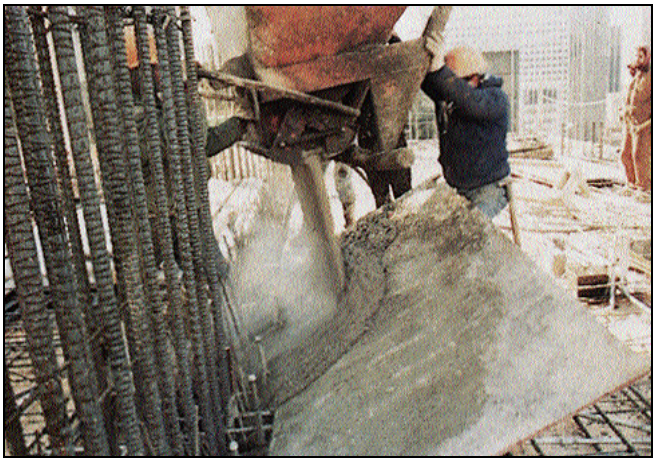
ferent strengths of concrete had to be placed, sometimes almost simultaneously, a crane and bucket were chosen. The contractor estimated that power buggies would have called for three times the number of men needed with crane and bucket.

The crane used was a diesel-powered, hydraulic luffing crane (the jib of a luffing crane moves up and down, unlike the jib of a hammerhead crane which remains horizontal). The crane location was offset from the building center, as the photograph shows. Using a luffing boom avoided having the boom hang over neighboring property, a feat which would not have been possible with a hammerhead crane.

The luffing crane chosen for use on Trump Tower had a 140-foot boom, a 145-foot mast and a 550-foot-per-minute lifting speed, more than twice that possible with a hammerhead crane. This high lifting speed made possible a placing rate of 60 cubic yards per hour at the 600-foot level, and higher rates up to 80 cubic yards per hour at lower elevations. All pin connections in the tower and jib made erection and dismantling of the crane easier and faster, too.

Crane mast climbed with building

Rather than raising the height of the crane by adding extension sections to the mast, the mast itself climbed up the interior of the building on a steel climbing column. In only 2½ minutes, the mast could be raised 30 inches up the steel column by two hydraulic jacks. After the mast had been moved up the desired height—usually three floors—it was anchored to the building and the steel climbing pole was raised by the same hydraulic jacks. Once raised, the climbing column rested on the building structure and the mast was unanchored, ready to be raised again. In this manner, mast and climbing column leapfrogged up the building as the structure was built.



Superplasticized concrete dumped from bucket against plywood panel flows into forms where heavy reinforcement has been set. Extended-life superplasticizer helped speed crane-and-bucket placement at the 58-story Trump Tower on Fifth Avenue.

Three different concrete strengths

Three different concrete mixes were required in the construction of each floor of Trump Tower. To reduce weight and thus the structural load, 4250-psi lightweight concrete was used in the slabs, saving 35 pounds of weight per cubic foot of concrete. This concrete in the slabs, however, was not strong enough for proper load transfer between slabs and the 7000- and 8000-psi concrete in the columns. Therefore, an intermediate strength circular layer 2½ times the diameter of the column had to be cast at every column. With a concrete strength of 6000 psi, these circular layers are adequate for transfer of loads between column and slab.

With these three different concretes required on each floor level, the sequence and timing of concrete placement became crucial. Pours had to be planned strategically so that a truck with the right concrete mix arrived at street level at the right time.

Typically three floors were placed each week, one floor every two days, in the upper residential areas of the building. A schedule was developed for erecting forms on Tuesday, Thursday and Saturday, and placing slab concrete on Monday, Wednesday and Friday. Most column concrete was placed on the afternoon of the day the forms were erected, permitting the concrete to compact itself by its own weight, and allowing some time for initial shrinkage of the columns. The remaining columns were placed the next day along with the slab, though a wait of at least 2 hours was necessary between placing columns and slab. In constructing the floor slab, the circular sections of 6000-psi concrete were placed first; then the remainder of the slab was done in lightweight concrete.

Extended-action superplasticizer added at ready mix plant

To improve the workability and thus ease the placement of concrete in the 6000-psi circular layers and the highly reinforced columns, a superplasticizer was used. Unlike the more familiar superplasticizers, however, the type used here was added at the ready mix plant, not at the jobsite. Available in the U.S. for 2 years now and referred to as a rheoplasticizer by the manufacturer, this admixture has been described as a synthesized sulfonated complex polymer. It provided an 8- to 10-inch slump with no segregation and little or no bleeding. Moreover, the concrete reportedly retained this high slump and remained workable for over an hour at 68 degrees F. Longer periods of high slump are available—up to 3 hours—with other types of superplasticizers available from the same manufacturer.

A ready-to-use liquid, the superplasticizer is dispensed into the concrete with the mixing water, normally at a rate of 12 to 18 fluid ounces per 100 pounds of ce-

ment. Used on Trump Tower in only the 6000 and 8000 psi concrete, it was added at a rate of 12 to 13 fluid ounces per 100 pounds of cement at the batch plant. Adding the superplasticizer at the plant gave the concrete producer total control over the concrete mix design. Furthermore, by adding the admixture at the plant, the time required to add it and mix it into the concrete at the jobsite was eliminated.

In placing the lightweight concrete of the floor slabs in cold weather, a chloride-free accelerator made by the same manufacturer was also used.

Credits (all New York City firms):

Structural design: The Office of Irwin G. Cantor

Architectural design: Swanke Hayden Connell Architects

Project management: HRH Construction Corporation

Concrete subcontractor: Dic-Underhill Industries

Photo: Handen Crane Corporation

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