SEPTEMBER 2005  Vol. 27 No. 9

Concrete International
The Magazine of the American Concrete Institute—an international technical society
www.concreteinternational.com

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Mixing, Placing, and Curing
Separate Placing Boom Maximizes Production on High-Rise

Detachable boom supported by self-climbing forming system

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Mounting a placing boom directly on self-climbing forms used for the elevator shaft reduced crane time for high-rise deck placements. The pumpline was mounted on the outside of one elevator core, allowing crews to safely remove the line later while working from each floor instead of working from scaffolding inside the elevator shaft. Photo courtesy of Schwing America.
Separate placing booms are often used for placing floors on high-rise buildings. With a reach of 100 ft (30 m) or more, they can cover areas greater than 30,000 ft² (2800 m²) and deposit concrete precisely where it’s needed. Mounting a detachable boom on a mast projecting from the floor below, however, has some disadvantages. The tubular towers often used for a mast require a 3-ft (1-m) diameter hole in each floor that must later be filled with concrete. Lifting the boom and mast to each new elevation also requires costly crane time. For the 23-story Conrad Indianapolis Hotel and Residences complex in Indianapolis, IN, these disadvantages were avoided by attaching the boom to self-climbing forms that transmitted the placing-boom loads to the core-forming supports.

FOUNDATION CHALLENGES

Figure 1 shows a construction photo of the cast-in-place concrete structure. The completed building comprises one level below grade, street-level retail space, and 243 upper level luxury hotel rooms topped by 18 residential condominiums. The concrete frame is bound by streets on two sides and by two existing buildings. The offset dimensions to the two adjacent buildings are tight—about 6 in. (150 mm) and 3 in. (75 mm). In addition, one corner of the frame cantilevers over a portion of an adjacent building.

A two-level, below-grade parking garage for one of the adjacent buildings was directly beneath part of the new structure. This presented the first challenge of supporting the garage, as foundations and 10,000-psi (69-MPa) concrete columns had to be installed through it. The existing parking garage beams had to be shored while sections of concrete beams were removed, keeping the reinforcing steel intact. Then, new vertical reinforcing bars with sizes up to No. 14 bar were fished through the exposed beam reinforcing (Fig. 2).

As installation of these foundations progressed, the main excavation for the basement was also commencing adjacent to the underground parking facility. This part of the foundation was a combination of drilled soldier beams and lagging on the south end of the site, auger-cast tangent wall to support the adjacent Indianapolis Arts Garden, and drilled tiebacks through the foundation wall for the old Roosevelt Building that had previously occupied the site. During the excavation, a preliminary test dig at the existing Arts Garden foundation was needed to determine whether or not the foundation rested on piles as was indicated by the original design of that building. The test dig revealed that there were no piles present and that a conventional spread footing had been installed. This required a redesign of the auger-cast tangent wall to hold the spread footing at street level while a 26-ft (8-m) deep excavation exposed one side of the installed tangent wall (Fig. 3).
During excavation of the basement area, foundations for the Roosevelt Building were also to be removed. It was found, however, that these foundations had been built on deeper foundations from an even earlier building. Removing both foundations would have increased cost and created a deep layer of disturbed material. The owner's construction director and the structural engineer solved this problem by having the concrete contractor excavate between the foundations down to suitable bearing soil and then encase the existing foundations in 2500-psi (17-MPa) concrete (Fig. 4). The foundations for the new building were then placed and backfilled.

**PLACING BOOM SOLVES PROBLEM**

Levels 1, 2, 5, and 6 are wide module joist systems, while Levels 3 and 4 are post-tensioned beam and slab parking decks, and Levels 7 and above are post-tensioned flat plates. Formwork for the joist system and parking decks was supported by conventional shoring, while flying-form truss tables supported formwork for Levels 7 and above.

The limited space on the job-site allowed use of only one tower crane that also had to cycle the flying forms. That made crane time scarce. Because it could also carry a placing boom, a self-climbing system used to form the two elevator-shaft cores was part of the solution to this problem. Placements for the first six floors were all completed with a 170-ft (52-m) truck-mounted boom pump, but placements for the remaining floors were made with the detachable boom from a Schwing 105-ft (32-m) 2023-5 truck-mounted concrete pump.

The boom was mounted on a cross frame attached directly to the top of the forming system for one of the cores. If there had been only one core located at the center of the building, all of the deck area could have been reached by the boom. With two cores, and the boom mounted on only one of them, extra line was needed to reach some of the deck, but this was more efficient than moving the boom from one core to the other. The larger core terminated at the condominium level, so the boom was mounted on the smaller core that passed through the full height of the building.

The cross frame for the placing boom consisted of 16-in. (400-mm) wide-flange beams that were bolted to the formwork (Fig. 5). Once the boom was pinned to the mounting frame, it remained in place through completion of the job.
ROUTING THE PUMPLINE

After completion of each deck, carpenters jacked the forms and boom into position for the next placement while the pumping crew added additional pumpline to reach the boom's new location. Installing the pumpline inside the elevator shaft would have permitted the crew to add line sections while working from scaffolding suspended below the form. When the job was completed, however, removing the line would have been more difficult and dangerous with most of the elevator shaft being open, and no scaffolding present.

To make teardown easier, the pipeline was routed through a ventilation chase adjacent to the elevator core. Crews safely removed the line later while working from each floor, thus eliminating the need for scaffolding.

PUMPING THE CONCRETE SAFELY

The construction schedule called for completing one deck per week, with two placements required for each deck. Placements on the flying forms started in January, so rapid early strength development of the concrete during cold weather was crucial to meeting the schedule. The 5800-psi (40-MPa) deck concrete set so rapidly that floating and troweling operations were being carried out within 20 ft (6 m) of the pump discharge. The fast-setting properties of the concrete rapidly increased pump pressure as the building height and line length increased.

The 105-ft (32-m) truck-mounted concrete pump kit permits piston side pumping to convert the pump from a low-pressure, high-volume machine to a high-pressure, low volume machine. At the 15th floor, with 250 ft (76 m) of line, the pump operator switched to the piston side of the pump to increase pressure on the concrete and reduce stress on the pump while still keeping the output at the desired level.

When pumping on the rod side of the piston, less area is available to push the concrete through the line and less force can be applied to the concrete. Switching to the piston side raises the force and the maximum pressure on the concrete, so the entire delivery system must be rated to handle the higher pressure and also must be maintained in like-new condition. It's even more important than usual for the pumping crew to observe safety rules for:
- Opening lines under pressure;
- Sucking back plugged lines before opening;
- Checking the pressure-handling capacity of pipes, hoses, and clamps in the delivery system; and
- Avoiding the dangers of line blockages.

The pump, operator, and crew handled this construction challenge, and the building was topped out in June 2005. Occupancy is expected by March 2006.

Selected for reader interest by the editors