

Concrete Construction at 7 World Trade Center

The Automatic Climbing System

By Robert K. Otani, P.E.

The terrorist attacks on 9/11 severely damaged the 7 World Trade Center (WTC7) building, which subsequently collapsed after reportedly succumbing to an uncontrollable fire inside the building. Constructed in 1985, the beautifully granite-clad building was relatively new and its slow but inevitable demise was a devastating sight to witness. Soon after the cleanup of the site, the redesign and construction of a new WTC7 began and was an inspirational sight to all.

The original WTC7 was a steel-framed building with a steel braced core and perimeter moment frame, conventional for high-rise buildings in New York City at the time. However, increased security concerns, coupled with the potential for fire from the Con Edison substation located within the lower floors, called for a new approach in the redesign of the structure. The team of architect Skidmore, Owings and Merrill, structural engineer WSP-Cantor Seinuk Group, and construction manager Tishman Construction considered concrete construction for the core given its inherent robustness and increased fire-resistance. As with any building project, the construction cost and schedule were primary factors for selection of the structural system. The team concluded that a steel-framed building and concrete core using a climbing formwork construction system was the best structural system to satisfy both concerns.

PERI Formwork Systems, Inc. designed the Automatic Climbing System (ACS), which has been utilized worldwide, with ever increasing applications in New York City. To learn more about the formwork system and its performance, the Structural Engineers Association of New York (SEAoNY) sponsored a presentation, in February of 2008, by Tom Ameel (Chief Executive Officer of PERI), Allan Paull (First Vice President of Tishman Construction), and Bart Sullivan (Vice President of WSP-Cantor Seinuk) to discuss ACS and its use at WTC7, including the technical aspects, cost and schedule implications, and the engineering challenges.

As discussed by Tom Ameel, the Automatic Climbing System is a self-climbing



Automatic Climbing System Unit being Raised Through Steel-framed Skeleton in Building Core. Courtesy of Austin Gelbard (Tishman Construction).

form that is raised from the subsequent pour without the use of a crane, which is one of its advantages over other more conventional formwork systems. The climbing unit is raised by means of a hydraulic mechanism to which the formwork panels are connected via a carriage, or trolley, to allow for the retraction/stripping of the formwork. For the specific system used at WTC7, galleys were included that allowed the outer formwork panel to be raised and moved out of the way to facilitate the placement of rebar. A 4-day pour cycle was achieved for the concrete core, despite the winter weather, that encompassed a plan dimension of approximately 70 feet by 90 feet.

Having chosen the system, Tishman Construction compared the pros and cons of constructing either the concrete core or structural steel first. An additional factor to be considered, as noted by Allan Paull, was the fact that the labor union in New York City does not allow concrete construction to be performed above steel workers. The steel-first approach was chosen based on the following advantages: expedited construction of the mechanical/electrical work, simplified building hoist, simplified crane logistics, expedited curtain wall construction, and a reduced overall construction schedule and cost.

The steel-first approach further challenged the structural engineers, Bart Sullivan contended, with the integration of the two structural lateral systems in steel and concrete. Additionally, without the core in place to stabilize the steel framing, the issue of stabilizing the building during construction was a

concern since the main lateral resisting system and the large floor openings required for the ACS created a situation where the floor diaphragms would be discontinuous. To solve these problems, Bart explained in detail the structural solutions to maintain the continuity of the floor diaphragm by using embedded link beams to behave compositely with the concrete core walls, and temporary perimeter bracing to stabilize the building during construction.

The construction of WTC7, which encompasses 1.7 million square feet, was completed in late 2005 and is now accepting tenants. The successful use of Automatic Climbing System for WTC7 relating to both schedule and cost advantages has led to its planned use in other new high-rise buildings. As Allan Paull announced, Tishman Construction is planning to use a similar climbing system on the 2.1 million square foot building soon to rise at One Bryant Park. ■

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