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Feature

Location is good, location is bad for high-rise

Good real estate offers nightmare site


Lower levels with wind truss system tough to build.

Calling the project a nightmare, designers and builders of a 47-story high-rise in New York City are experiencing firsthand that what's good for a developer is not necessarily good for them—especially concerning location.

The lower-Manhattan site is considered prime real estate because it is part of the World Trade Center complex. But the WTC's famous twin 110-story towers nearby cause frightening wind conditions. Because the land is publicly owned, the developer received zoning and financial breaks not otherwise available. But the breaks came along with big obstacles on the site. Caissons had to be installed through a utility power substation without tripping a blackout, and alongside a busy WTC service ramp and a subway.

The new office building, called Seven World Trade Center, is on Port Authority of New York and New Jersey land. Construction problems are worth the trouble because "we didn't pay for the land up front," says Harold Jupiter, project executive for developer Silverstein Development Corp., New York City. Instead, Silverstein will share a percentage of the development's income with the port authority. "Nearby, developers are paying $300 million for land alone," Jupiter adds. "We're building the entire project for that."

Port authority projects are exempt from city real estate taxes. A payment in lieu of taxes, usually less than a straight tax, is made, says Jupiter. Similarly, projects are exempt from city zoning requirements. Project architect Emery Roth & Sons, New York City, was therefore free to design a building that fills its footprint and has no setbacks. The 48,000-sq-ft floors are considered a plus for leasing. Nevertheless, Emery Roth principal Richard Roth, Jr., says the job "was the most difficult he's seen and a nightmare from day one."

Analysis. A wind tunnel study showed that wind forces were greater than the local code indicated, mostly due to the WTC towers. "Winds blowing in the north-south directions would create forces in perpendicular directions," says Akbar Tamboli, vice president and project manager for structural engineer The Office of Irwin G. Cantor, New York City. This prompted a three-dimensional wind analysis for the entire building at once run on a time-sharing mainframe computer, says Tamboli. So much capacity was needed that the analysis was done at midnight on a Sunday, when few others would be on the system.

From level seven to the top, the structural-steel building has a perimeter moment-resisting frame. Two two-story-high belt trusses, one at the 22nd story and one at the seventh, reduce deflection during high winds.

The first seven stories are more complicated. To resist lateral loads, the structural engineer designed a seven-story braced core linked through floor diaphragms to seven-story-high wind truss systems on the shorter sides of the building. "The end frames create channel action to stiffen the building," says Tamboli. Horizontal bracing in the fifth and sev-


Caisson core on way into utility substation (left) tough to maneuver on narrow street.

Bulky building fills its entire footprint.

enth-story floor slabs transfers lateral loads from the moment frame to the braced core.

For the 1.8-million-sq-ft building, Cantor had to use caissons intended for a 1-million-sq-ft building. The location of new caissons was limited, mostly by the two-story substation and the ramp. Problems lining up old caissons and new columns prompted use of three reinforced-concrete caps as big as 64 x 6 ft to spread column loads to caissons.

In the braced core, however, lateral loads are transferred to a braced foundation-slab diaphragm and into existing and new caissons, some of which are clustered and battered. The steel bracing in the diaphragm connects the caissons and redistributes their loads, says Tamboli. Like a tug of war, "the moment one caisson starts to lift, bracing goes into action and transfers extra load to another not being used to full advantage," he says.

For project construction manager Tishman Construction Corp. of New York, New York City, the biggest problem was logistics on site—an irregular trapezoid 154 ft on its short sides and 350 and 250 ft on its long sides. Of 50 new caissons, their steel cores as long as 110 ft, fewer than half went into the excavated area, which is itself crossed by utility lines and required continuous dewatering. Others went through the substation and alongside the ramp and subway.

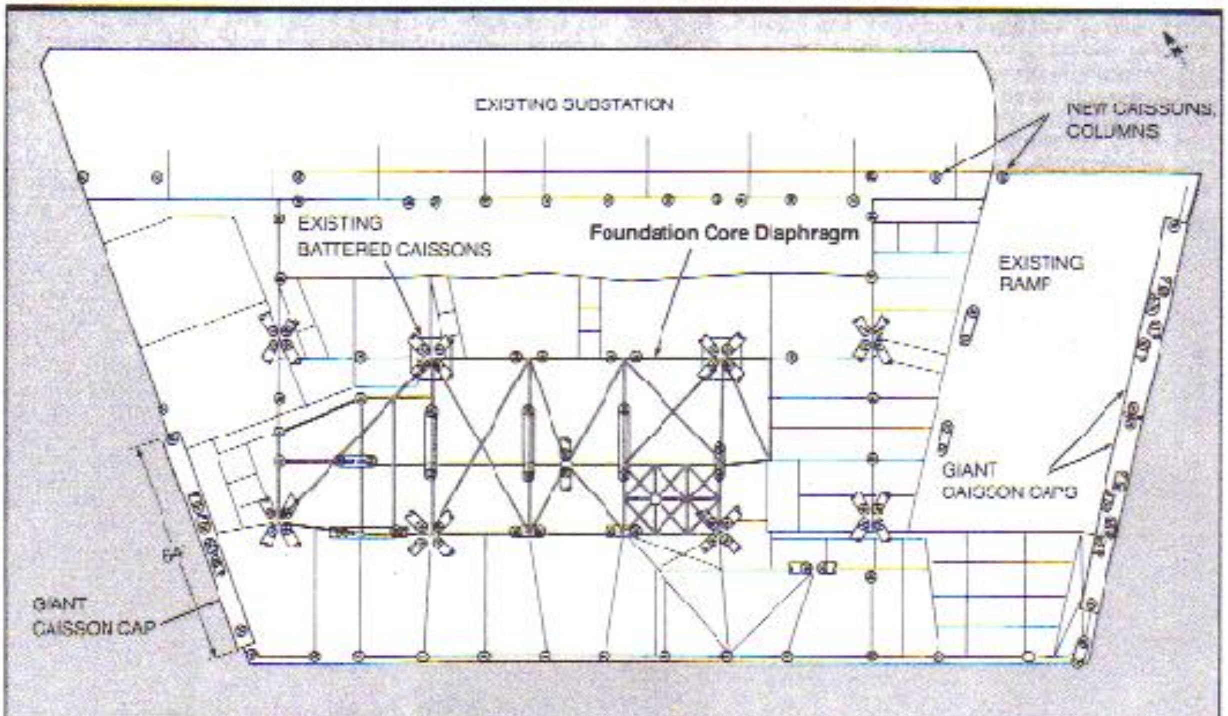
Trying. The most trying work was through the substation (along the 350-ft side). After breaking open the roof, workers had to cut holes through two floor slabs, near active transformers. Then, using a crane with a hammer attachment, the caisson shells were "pounded," not drilled, to rock to minimize vibrations. "If vibrations had reached a certain level," says Robert J. Washlick, Tishman project manager, they would have tripped switch gear, causing a lower-Manhattan blackout," he says. When possible, work went on during off hours.

"We mobilized for four conditions on site—the substation, truck ramp, subway and open area," says Washlick. "It was an expensive foundation, no two ways about it."

The first seven floors were also difficult. The building's 350-ft side cantilevers 7 ft over the substation from the seventh floor to the roof. Eight 55-ton, 60-ft-long girders that taper from 9 to 3 ft deep had to be lifted over the substation and placed under seventh-floor framing to carry cantilever loads to the core. The weight and reach involved prompted the use of two cranes and a derrick to lift each girder.

Silverstein decided to construct its own building power substation, buy bulk-rate utility power and resell it to tenants. Locating the substation in the fifth-to-sixth-story mechanical level complicated construction of the fifth floor. Its 14-in.-thick slab on metal decking had to be poured in two stages because it was too heavy to pour at once without shoring under the high ceiling of the lobby directly below.

The location delayed work on the substation itself. "We could not begin until the eighth-floor slab had been poured," says Ralph E. Tabasko, Tishman project engineer. Meanwhile, the equipment was fabricated and stored so there was no delay once the area was ready, he adds. Double shifts are helping workers catch up. With 22 stories framed, initial occupancy is set for October, 1986. ■



Foundation obstacles included substation, ramp and existing caissons that had to be tied together by diaphragm slab.