Base Building in a High-Density Urban Area

New York City

By Marco Shmerykowsky, P.E.

Figure 1: Street view of the completed Esprit North American flagship store.

Building in New York is sort of like decorating one of the city's notoriously cramped apartments. You've got to make the best of a space that's small, inconvenient, and, too often, leaky. A new, three-level, base building, which would become home to retail giant Esprit's North American flagship store (*Figure 1*), presented structural firm Shmerykowsky Consulting Engineers with challenges unique to Manhattan's dense and idiosyncratic cityscape.

Conceptually, it was a simple building: a structural frame of ASTM A992 Grade 50 steel columns spaced approximately 25 feet on center in both directions and a floor construction consisting of a 2½-inch thick normal weight concrete slab on a 3-inch composite metal deck spanning to composite steel beams (*Figure 2*). To preserve an all-important floor area for the eventual retail space, the structural engineers chose to use moment frames rather than braced frames as the lateral load resistance system. In this city, losing a few square feet of retail space could cost a client millions. In all, the three levels – a subsurface cellar plus the ground and second floors – totaled 24,000 square feet.

Foundation Design in Unique New York

When designing a foundation for new construction in this urban environment, an engineer must consider the foundations of the adjacent buildings. If these buildings contain more sub-grade or basement levels, and therefore deeper foundations than the proposed new construction, the new foundation elements must be extended to match the adjacent foundation's depth. The design team must be cognizant of the 'influence lines' of each foundation element, ensuring that no undue load is transferred to adjacent foundations or other sub-grade structures, such as subway tunnels.

For this new retail development, geotechnical engineers had initially called for a traditional spread footing foundation to support the new base building. In urban settings, where property lines often run tight against the building footprint, eccentricities between columns and footings are typical. In this case, all perimeter footings were designed to handle footing-column eccentricities, with the overturning moments taken by strap or grade beams connecting the perimeter column footings to the interior column footings.

This, of course, was the *initial* design. After a ground water condition was unexpectedly discovered at an adjacent construction site by the geotechnical team, the proposed spread footings were scrapped in favor of a pile foundation system. This pile system would rely on mini-caissons, a foundation element common in New York City construction. Mini-caissons, which can be anywhere from 8 inches to 12 inches in diameter, are favored by construction teams for their ease of installation. Also, a relatively small pile rig can drill 8-inch to 12-inch diameter holes quickly and easily, resulting in significant cost savings. The mini-caissons at the new development were made up of an 8-inch diameter steel pipe casing filled with 5,000 psi grout and a #18 threaded bar core. The steel casing reached 30 feet down to the rock elevation, with the caisson's grouted core then socketed an additional 6 feet into the supporting rock.

Like the initially proposed spread footing system, the pile system also had to be designed for column-footing eccentricities. The width of the micro-pile rig brought in to drill holes for the mini-caissons limited how close its drill mechanism could get to the face of the building (*Figure 3*). As a result, the pile groups had to be pulled back from the column line and strap beams had to be installed to handle the pile caps' overturning moments.

Figure 2: The structural frame as it neared completion.

Figure 3: The micro-pile rig. The width of the rig limited how close its drill mechanism could get to the face of the building.

Engineering around Pre-Existing Elements

In order to construct the new base building, contractors first had to demolish the turn-of-the-century structure that stood in its place. In the demolition process, certain facets of the original building were left intact, specifically the south and west foundation walls.

Contractors had planned to tear down the original west foundation wall later, but this secondary demolition process would have created vibration and noise levels that were unacceptable to the owner of the adjacent property. The team left the existing foundation wall in place and pulled the new foundation wall to the west. Supports were then modified to suit the westward shift. First floor girders were designed to cantilever over the existing foundation wall, transforming that site condition from a deal-breaking inconvenience to a structural complement.

The original west foundation wall also supported a fifteen-story chimney in the far northwest corner of the site that serviced the adjacent building. The team could either remove the chimney or engineer a new support for it. In the end, they settled on a compromise – the team decided that the most cost-effective and schedule-friendly option was to redesign the northeast corner of the building to accommodate the existing structure.

A similar condition existed at the original south foundation wall. This wall supported a sidewalk vault – one of New York's structural idiosyncrasies. Sidewalk vaults are sub-grade building spaces that extend beyond the face of a building beneath the sidewalk. The vault at this construction site was supported by steel beams that supported a series of brick arches. However, sometime after the original construction, these brick arches had been further reinforced by additional steel beams installed directly underneath the original existing beams. These additional steel beams were framed in the north-south direction and were supported by seated connections expansion bolted into the old south foundation wall. The team could not demo the old foundation wall without rebuilding the entire vault. This process would have vastly increased the scope of design and construction and would have led to higher costs and a lengthier building process. The construction team therefore left the wall in place and built a new foundation wall behind it.

Figure 4: The primary construction crane was lifted from the street level and into the excavated site during the Department of Transportation's sanctioned off-hours.

Figure 5: The primary construction crane before the erection of the structural frame. Here, it is positioned in the southeast corner of the site.

Structural Erection in High-Traffic Urban Corridors

When it finally came time to erect the structural frame, the construction team had to face their most daunting condition yet – a New York City street. The new construction took place along 34th Street between Fifth and Sixth Avenues – one of Manhattan's busiest thoroughfares and a prominent retail strip bound at the ends by Macy's city block-spanning department store and the south-facing edge of the Empire State Building. Thirty-forth street is without a doubt one of Manhattan's busiest public and commercial transit corridors. The Department of Transportation set a number of restrictions, among them that material deliveries could only take place during early morning off-hours and that a traffic lane could not be blocked off to make way for an essential construction crane.

And here was the rub: that crane would erect the building's two story steel frame. The construction team responded with typical creativity. It was a surreal image: a massive construction crane lowering another crane, half its size but otherwise identical, into the excavated site (*Figure 4*). From the excavated site, this crane erected the bulk of the building's structural steel frame. From within the pit, the crane lifted the columns into place. Beams were similarly lifted into place by the crane and then secured by workers (*Figure 5*). Because of the confining nature of the site, the final structural bay was erected only after the crane was lifted off the site. Erection for the final structural bay proceeded during the Department of Transportation's sanctioned off-hours, during which time the crane could operate from the street level.

This litany of challenging and sometimes odd site conditions should not be confused for a list of grievances. Base building in urban environments may be irksome, but intransigent existing elements and surprise soil reevaluations can lead to feats of structural creativity and derring-do that might never be unleashed in a tamer situation. Particularly in New York, urban construction is not about pre-packaged solutions. It is about working with the site you have, even if the site you have happens to be small, inconvenient, and a little leaky.▪

*Marco Shmerykowsky, P.E. is a Principal at New York-based Shmerykowsky Consulting Engineers and a licensed professional engineer in New York, Connecticut, and New Jersey. Contact Shmerykowsky Consulting Engineers via email at **info@sce-engineers.com**.*