90 days to Complete Foundation Construction in Chicago’s West Loop

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The Project

The new home to McDonald’s Corporation’s world headquarters, the 9-story commercial building located on the old Harpo Studios property at 110 N. Carpenter in Chicago’s West Loop, called for accelerated project delivery methods to meet aggressive scheduling demands. As opening this building was seen by the developer, the City of Chicago, and others as a key to future local projects, innovative solutions were required to showcase forward-thinking design as well as expedite the construction process.

Background

The construction of this 55,750m² (600,000 ft²) structure is significant to the continued commercial development of Chicago as nearly 46,450m² (500,000 ft²) of the building houses the new world headquarters for McDonald’s Corporation, which had moved from Chicago to the suburb of Oak Brook in 1971. McDonald’s recommitment to this urban environment was not only a reinvention of the long-established fast food giant, but the anchor for a broader redevelopment of the West Loop neighborhood.

Challenges

Complicating the project design methods, the building would be constructed using three separate permits in order for construction to begin prior to completion of design. The foundation permit would be issued first so that the appropriate substructure work could commence. This was followed by permits for two tower cranes, designed by the general contractor, McHugh Construction Company. The final permit addressed the construction of the building superstructure and civil improvements to occur in the public right-of-way.

The overlapping of construction schedules with design phases that were still in flux meant that the foundation system had to be able to facilitate a variety of design scenarios that could occur while attempting to minimize the use of conservative design assumptions to keep project costs down.

There were also a significant number of underground utilities in close proximity to or in conflict with the proposed project, be it the primary structure or planned civil improvements. Given that the success of this project rode on its ability to navigate its expedited schedule, coordination with the local agencies to identify and address the concerns of all parties would be paramount to the project’s success.

Winning Approach: Top-Down Allows for Work to Proceed in Parallel

Using more conventional bottom-up methods of construction are suitable when the project schedule is very linear, requiring excavation, foundation construction and above-grade construction to occur in consecutive order to complete the overall scope of the project. When top-down construction methods are utilized only the most critical substructure components are constructed from grade, thus allowing for construction of the above-grade structure to begin. From this point, above-grade construction and the remaining substructure components are completed in parallel, thus reducing the overall project schedule.

That’s one of the interesting things about many of Michels’ projects: the average passerby can’t see the majority of our work as it is performed below the surface.
Savings with a Secant Wall System

While the use a top-down construction was decided early in the planning process, the type of foundation wall to be utilized was not agreed upon until just prior to beginning the permitting process. Original design discussions focused on the use of slurry walls as the means of foundation wall construction. Given the large footprint of the site, approximately 76m x 100m (250ft x 330ft), it was believed that slurry wall methods, which utilize wider panels in lieu of individual secant shafts, would yield the most efficient production rates in order to meet scheduling restraints. However based on internal design and production reviews, it was Michels’ opinion that a secant wall system would be able to yield similar production rates to slurry wall construction but at a lower overall cost. There were a couple key factors that led to this conclusion and eventually to its selection as the system of choice for the final structure.

1. The first factor was related to the equipment utilized and logistics of working on site. Since the perimeter walls and the interior shafts/columns needed to be constructed simultaneously, utilizing a secant pile wall system allowed for the use of the same equipment to be utilized for both operations. This operation created a more fluid site condition in order to keep equipment working, particularly if any unforeseen conditions would arise.

2. The second factor involved the design efficiencies a secant wall provided for the loading requirements associated with the project. To address out-of-plane lateral load demands, the secant pile lengths could be optimized to where the unreinforced primary shaft length was minimized and the longer reinforced secondary shafts would be the means of stabilizing the toe of the wall, in a similar manner to a soldier pile wall. To address vertical demands, the reinforced secondary shafts would vary in length depending on load requirements. This ability to fine tune the extent of excavation and material replacement required when compared to the larger panels associated with slurry wall construction yielded significant savings. Refer to Figure 1, which summarizes the final secant wall geometry selected for the project based on the efficiencies described above.

Since the secant wall system was contractually established as a design/build portion of the project, it required significant and rapid coordination between the structural engineer of record for the building (Magnusson Klemencic Associates, MKA), the civil engineer of record for utility/infrastructure coordination (Terra) and the design/build foundation team (Collins Engineers, Inc./Michels) to ensure all parties understood critical aspects of the foundation system and how it would be married to the other aspects of the structure that were already under development.

The overlapping of construction schedules with design phases that were still in flux meant that the foundation system had to be able to facilitate a variety of design scenarios that could occur while attempting to minimize the use of conservative design assumptions to keep project costs down. While the superstructure loading was fairly well established during the design process for the substructure elements, there were tie-in substructure elements to be located in the public right-of way that could not be finalized until after issuance of the foundation construction permit. These elements included exhaust vaults...
to properly ventilate the below-grade parking, an electrical utility vault, and various utility tie-ins to the building. Each of these elements required significant penetrations through the secant wall system, thus requiring the wall design to be able to accommodate all potential configuration options. With schedule driving the project decisions, the option(s) that would be chosen was predicated solely on achieving the necessary approvals in the least amount of time.

**Geotechnical Mindfulness**

As this project site encompassed an entire city block, typical urban construction issues such as working directly adjacent to existing building structures did not dictate design requirements. However there were a significant number of underground utilities in close proximity to or in conflict with the proposed project, be it the primary structure or planned civil improvements. Given that the success of this project rode on its ability to navigate its expedited schedule, coordination with the local agencies to identify and address the concerns of all parties was paramount to the project’s success. Refer to Figure 2 for an overall view of the project site.

Geotechnical analyses performed to design the secant walls were primarily based on limit equilibrium methods, considering each stage of excavation/construction and its influence on the overall requirements for design. On the retained side of the wall, multiple pressure profiles were considered including: active pressures (Rankine), apparent earth pressures (Terzaghi) and at-rest pressures. Rankine passive pressures were utilized on the toe of the wall. Use of these pressure profiles were based on the stage of construction being evaluated and the magnitude of movement the wall could accommodate in order to mobilize said pressures. As the soils on site are primarily cohesive in nature, both total stress pressures and effective stress pressures were considered, with the former being considered both during construction and in the final condition and the latter being considered solely in the final condition.

As part of the project, additional steel sheet piling shoring was required to construct the building core along with various vaults and civil structures located in or near the public right of way. Figure 3 shows as-built details of the core cofferdam shoring system.

**Construction**

Once on site, the first tasks to perform after initial site preparations were completed included: excavate, form and pour the secant guide walls necessary to properly locate and construct the secant pile wall; construct and test an interior drilled shaft to confirm bearing capacity of rock; and install the sheet piling cofferdam needed to excavate and construct the building core. Despite having a relatively large site for an urban project, these initial tasks were located on a much smaller portion of the site and each task necessitated
different pieces of equipment. Due to this congestion, careful coordination was required to ensure all tasks were completed efficiently and safely.

After these initial tasks had been completed, secant wall construction, interior drilled shaft construction, and the building core excavation/construction were all performed in parallel. To avoid project delays, these three tasks needed to be completed at the same time in order to proceed with the next task, construction of the structural slab located at grade, which ties all of the mentioned substructure components together. To meet these project schedule demands, four drill digs were typically working simultaneously on site. This initial substructure construction, consisting of 100 drilled shafts, 458 secant piles, and 252' of sheeting cofferdam with subsequent core construction was completed within 90 days as required by the project schedule.

Both above-grade and below-grade construction tasks were allowed to proceed. By the time the two levels of below grade construction were completed, five of the nine above-grade floors has been completed, thus compressing the project schedule by several months.

Results
The final result of the design/planning process is a the successful creation of a marquee structure consisting of nine levels of above-grade commercial space and two levels of below-grade parking, providing approximately 300 parking spaces, that will be used to help reinvent a fast-food giant as well as the urban area in which it resides. The above-grade structure consists of a reinforced concrete flat plate system, including two-way slabs, columns, and two core/shear wall systems for lateral support. With an average depth of 7m (23ft), the below-grade structure consists of interior components similar to the above-grade structure (structural slabs, columns, shear walls) but includes a perimeter secant pile wall that was designed to support lateral earth pressures; vertical forces from the exterior curtain walls, perimeter columns, and the construction tower cranes; and in-plane lateral forces to reduce the demand on and quantity of interior shear walls.

Accomplishments
• Accelerated construction schedule met 90-day window allotted for initial foundation construction
• Rapid project delivery not only was paramount to the success of 110 N. Carpenter but also critical to the viability of numerous projects scheduled to follow in the region
• Utilization of innovative design/build methods and efficient use of materials and site logistics
• Facilitated significant collaboration between owners, tenants, designers, contractors, and local agencies

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Contact dsutfin@michels.us to discuss this project further and to find out how Michels can help you with your upcoming projects!