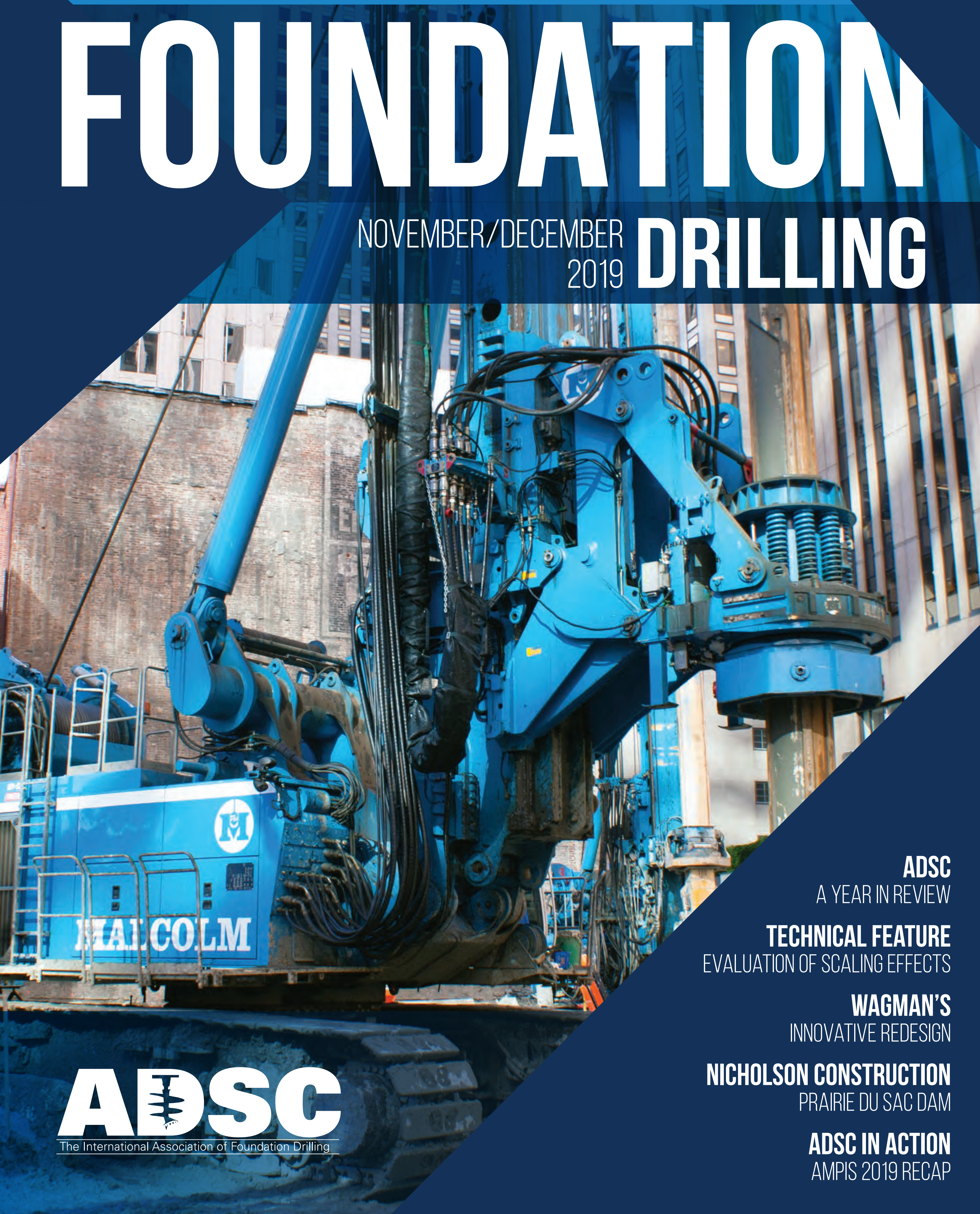
MALCOLM DRILLING CO. OCEANWIDE CENTER

FOUNDATION DRILLING

NOVEMBER/DECEMBER 2019



ADSC
A YEAR IN REVIEW

TECHNICAL FEATURE
EVALUATION OF SCALING EFFECTS

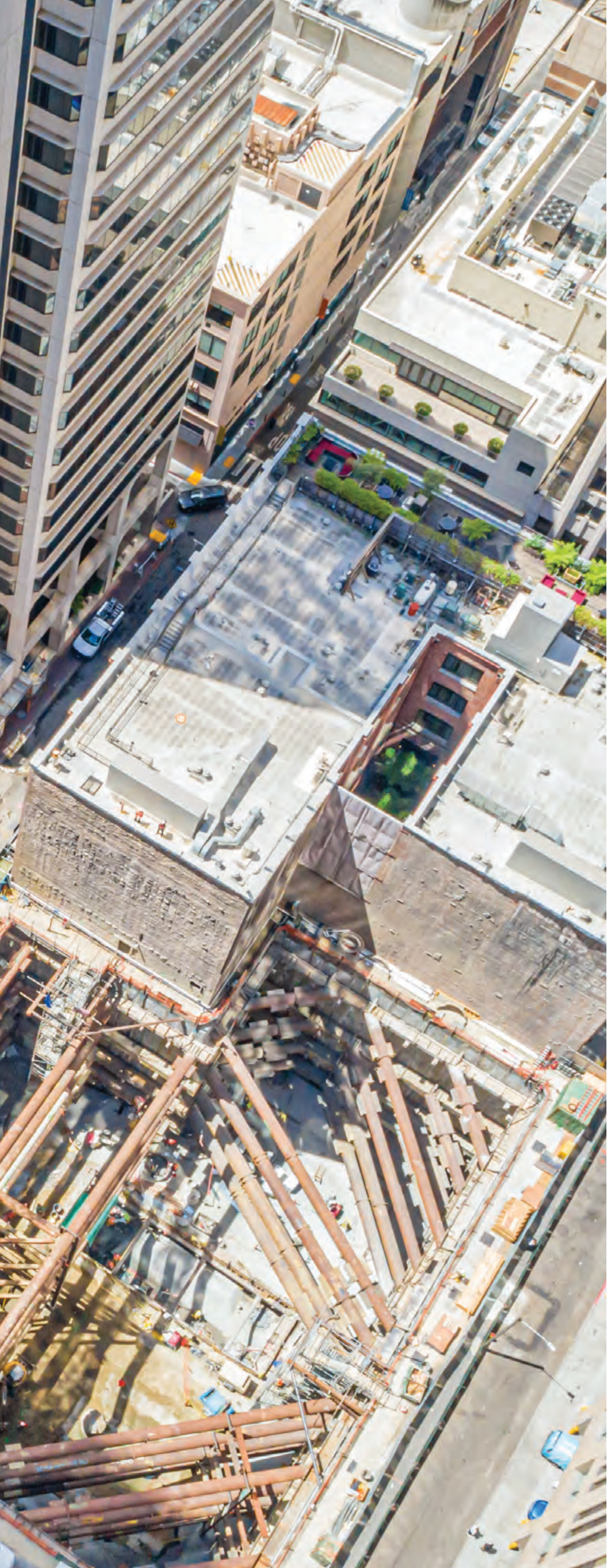
WAGMAN'S
INNOVATIVE REDESIGN

NICHOLSON CONSTRUCTION
PRAIRIE DU SAC DAM

ADSC IN ACTION
AMPIS 2019 RECAP

ADSC
The International Association of Foundation Drilling

COVER STORY



OCEANWIDE CENTER MEGA CHALLENGE IN DOWNTOWN SAN FRANCISCO

BY JOSE ZARCO, MALCOLM DRILLING

PROJECT OVERVIEW

Situated in the San Francisco downtown financial district, the Oceanwide Center project comprises of two high rise towers. Tower 1 extends north-south along First Street being a 61-story steel mixed-use building. Tower 2 runs east-west along Mission Street which is a 53-story concrete residential building.

For Malcolm Drilling, this meant installing 101 drilled shafts socketed into rock over 250 feet below grade and over seven million pounds of steel within the 86,000 square foot site to provide internally braced support of excavation around the full perimeter of the site with a cross-wall between phases, and an internal dewatering system.

GROUND CONDITIONS

Typical for much of the recently developed Transbay area, ground conditions at the site generally comprise fill and dune sand overlying recent alluvial and marine soils, in turn underlain by a consistent layer of very dense sand (Colma Formation), a thick layer of stiff, over-consolidated clay (Old Bay Mud), a thinner gravelly layer of alluvium/colluvium deposits and then the Franciscan Bedrock Formation. Bedrock was typically encountered about 265 feet below grade. The bedrock formation is predominantly a Mélange of shale mixed with greywacke, sandstone and deposits of serpentine and greenstone.

CONSTRUCTION DETAILS

Drilled Shafts

In January 2017, we started the pre-production load test program for drilled shafts using a Bauer BG50 drill rig, a Leffer oscillator and temporary sectional casing. The test program consisted of a sacrificial method shaft and two load test shafts. The method shaft provided an opportunity for the owner's design team to review and understand proposed means and methods for the construction of all foundation shafts. The two load test shafts were instrumented with bi-directional load cells to obtain load transfer data that would be used to finalize the foundation design, including but not limited to the quantity, diameters and rock socket depths of the proposed drilled shafts. Sectional casing was advanced, concurrent with shaft excavation, to the top of the rock interface. The test program rock sockets, as designed, were 50 and 60 feet long and were stabilized solely with polymer slurry.

BG50 DRILLING OPERATIONS AND REBAR CAGE INSTALLATION

Production shaft installation started in July 2017 and was completed in September 2018. Shaft work was continuous except for a short break in May/June 2018 to allow for the completion of the shoring wall. Crews worked 24 hours a day, six days a week. The Bauer BG50 drill rig was used to drill the shafts from 275 to 330 feet deep. Rock was drilled conventionally with a combination of rock augers, buckets and core barrels. The shafts were heavily reinforced with double cage configurations with up to 36 each #18 bars. The cages were prefabricated and delivered to the job site in 60 to 80 foot long sections. Cages were spliced vertically over the hole as the reinforcement steel was lowered into the shaft using one of our Liebherr LR1300 service cranes.

BG50 ROTARY DRILLING MACHINE

We implemented a rigorous quality control program during drilled shaft installation. Polymer slurry was constantly monitored to ensure that it not only stabilized the open rock socket but also keeping the entire excavation as clean as possible. During excavation, the shaft was checked for verticality at 100 feet below grade and then

JOB SITE LOGISTICS. MULTIPLE ONGOING OPERATIONS

again at final depth using the Sonic Caliper method to ensure compliance with the 24 inch maximum deviation allowed by the specifications. We also completed two different base hardness tests on the shaft bottom to ensure that the bottom was sound and ready for concrete. The test data had to be submitted and approved by the owner's design team before concrete could be placed so the owner's design team had to work 24 hours, six days per week as well.

Malcolm's team of field engineers logged every pass of every excavation tool during the rock socket drilling. The collected data allowed for examination of the actual bedrock conditions that lead to shortening of some of the rock sockets.

The concrete mix for the shafts was developed with a special emphasis on workability, which was needed for the extreme placement depths and the extended workability time required for tremie concrete placement operation that was concurrent with the removal of 280 feet of casing. Design followed the guidelines outlined in the newly published EFFC-DFI TREMIE CONCRETE GUIDE. For all shaft concrete operations, Malcolm again implemented a demanding and laborious quality control program. On some pour days, each load was spread and visually tested but at a minimum one of four of every loads were spread tested. Concrete bleed and segregation was also checked frequently throughout the project. Up to 400 cubic yards of concrete were delivered to the job site almost every other day, usually beginning at 2 am, in order to maintain the tight construction schedule. The quality control program also included cross-sonic-logging (CSL) of each shaft.

Temporary Shoring Wall

Construction of the planned basements and slab foundation required excavations extending up to 72 feet below the existing ground surface. Subgrade was near the base of the Colma formation or already in the Old Bay Mud crust. Two elevator pits on Tower 1 and one elevator pit on Tower 2 extend up to an additional 23 feet below the main subgrade, at a total depth of 98 feet below the original grade. Additional shoring inside the main excavation was needed in order to excavate the elevator pits. Cutter soil mix (CSM) panels up to 140 feet deep were installed to create an adequate perimeter shoring system to restrict ground movement, protect the surrounding buildings

BG42 WITH CUTTER SOIL MIX ATTACHMENT

from settlement and allow for internal dewatering. The CSM unit shears the soil into small particles and blends it with injected cement grout into a homogeneous soil mix. After each CSM panel was complete, steel soldier beams were set in place while the panel was still wet to complete the shoring wall. Extremely high fabrication and placement standards of verticality were needed to avoid encroaching into the future permanent building structure.

2D and 3D Finite Element Modeling (FEM) was performed to evaluate the behavior of the ground deformation induced by such deep excavation in the vicinity of several nearby buildings. The bottom of the shoring walls extending into the Old Bay Mud created an effective groundwater cut-off, which allowed the required internal dewatering to be completed.

Temporary Working Trestle

A street-level trestle was built to create access during the excavation and below grade construction of Tower 2. Later, the trestle was extended to cover the necessities of Tower 1. This eventually resulted in a single 14,250 square foot trestle capable of supporting the construction of the entire site. Due to the large scale of the project the trestle was key for efficient bracing installation and logistics of excavation. Multiple access points allowed Malcolm to organize activities and operations depending on the logistics and phases of the project. For example, while bracing walers and struts were delivered and installed on the north end of Tower 1, the trestle supported excavation and soil off haul at the south end of Tower 1.

TEMPORARY WORKING TRESTLE AND LR1300 CRANE

After the completion of all drilled shafts, the LR1300 service crane was used on top of the trestle as a service crane for all bracing installation. The size of this crane, specifically the combined long reach and heavy lift capabilities, permitted an efficient bracing installation without the need for constant relocation of the crane.

Temporary Bracing

Adjacent building basements, anticipated difficulty obtaining tiebacks easements and poor ground conditions led us to install internal bracing for the temporary support of excavation (SOE). Given the size and depth of excavation, approximately six million pounds of steel was needed. Four levels of bracing with double walers and 36-, 42- and 48-inch diameter pipe struts maintained the open excavation and met the design requirements. Property limits of existing buildings surrounding the Oceanwide Center created a unique footprint of excavation with multiple corners and pockets. Therefore, a complex and challenging bracing design was needed. This meant high fabrication and installation standards were followed to successfully install the steel temporary structure according to the schedule.

Bracing structures for each tower were required to be designed, fabricated and installed as independent systems to allow for separate schedules of each tower. While above-ground the towers will be independent, the basements of Tower 1 and Tower 2 are interconnected. Consequently, the shoring was constructed around the full-site perimeter, with an internal cross wall dividing the two towers. This shared wall had to be designed to balance the bracing loads between the two separate structures as their excavation and construction advanced on different schedules. For example, excavation of Tower 2 was completed prior to installation of Level 1 bracing on Tower 1, while at a later stage in the project, Tower 2 concrete construction was completed back up to grade, prior to placement of the foundation slab in Tower 1.

Dewatering

The presence of the Young Bay Mud layer essentially creates two separate aquifers within the depths of excavation. One aquifer lies above the marine deposits in the dune sand formation and the lower aquifer lies in the Colma Sand formation. Twelve dewatering wells, eight within Tower 1 and four within Tower 2, were installed inside the shoring walls to lower the groundwater table within the excavation. A third aquifer situated below the bottom of the excavation was identified in several sand lenses within the Old Bay Mud layer. This third aquifer also had to be depressurized within the excavation using four additional deep wells in order to mitigate the risk of bottom blow-out.

Piezometers around the job site's perimeter were installed outside the shoring walls to continuously monitor groundwater levels in all three aquifers. Constant monitoring ensured detection of any possible drop in the groundwater table outside the excavation. The CSM shoring wall was installed deeper than all three aquifers and successfully managed to create an almost impermeable barrier. This allowed Malcolm to extract groundwater from only inside the excavation. The groundwater table outside of the excavation remained at natural levels throughout the entire dewatering program.

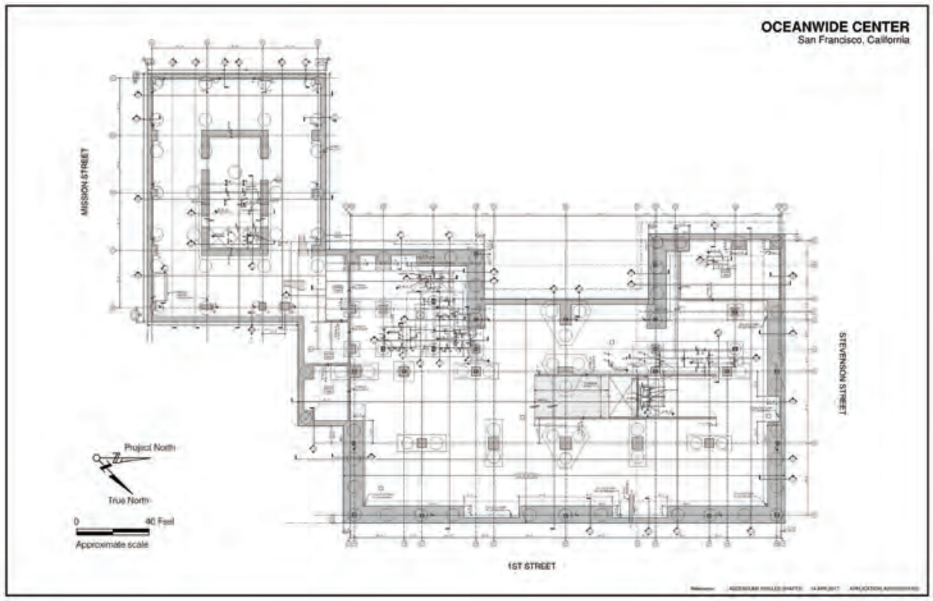
TOWER 1 INTERNAL TEMPORARY BRACING AND T1 NORTH ELEVATOR PIT

TOWER 2 INTERNAL TEMPORARY BRACING AND T2 ELEVATOR PIT

SETTLEMENT MONITORING

Due to the location of the project right in downtown San Francisco, it was of great interest to the owner, the design team and Malcolm to detect any and all ground movement at the earliest possible moment. To that end, multiple slope inclinometers were installed on each shoring wall to monitor lateral wall movement during the excavation process as well as placement of basement walls. In addition, two automated monitoring total stations (AMTS) units were deployed to provide real-time, precise readings of targets placed on soldier beams of the shoring system and on all surrounding buildings. Ultimately, the monitoring systems all indicated that the shoring system performed better than expected and measured deflections and deformations were all less than predicted by the multiple FEM analyses.

Project location, size and depth of excavation as well as drilled shafts in combination with very strict performance criteria were clearly amongst the most challenging conditions ever faced by Malcolm Drilling. Construction methods and equipment we had to employ pushed the boundaries of what is currently possible in the deep foundation industry. To bring all this to a successful completion without any lost-time accidents, a unique combination of site quality control combined with tight engineering oversight and qualified site management was needed. Our utmost respect goes, therefore, to our team on the ground. Well done, guys!



MALCOLM DRILLING CREW HAS WORKED OVER 285,000 MAN HOURS

THIS JOB WAS MANAGED BY OUR NORTHERN CALIFORNIA DIVISION LOCATED IN HAYWARD, CALIFORNIA

MALCOLM TEAM

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Adam Hinton | Jose Zarco
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Zach Cross | Mike Giannandrea
Dave Husak

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Brierley Associates
Middour Consulting
Dan Brown and Associates

GENERAL CONTRACTOR

Swinerton Webcore Joint Venture

OWNER

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OWNER DESIGN TEAM

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