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Q1 - 2020

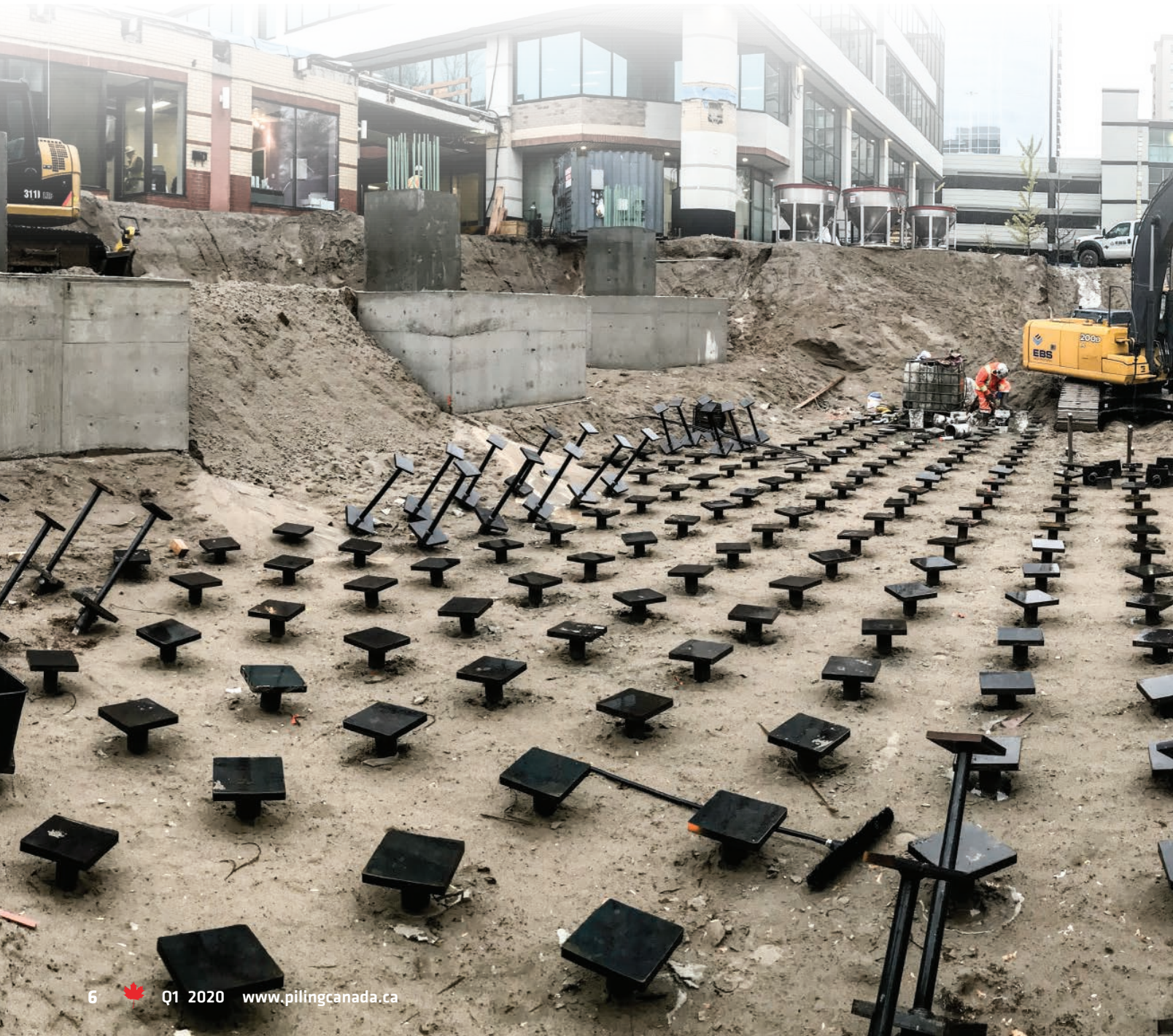
North America's Tallest Building on Helical Piles

Inside: The 3rd Great Canadian Projects Issue

North America's Tallest Building on Helical Piles

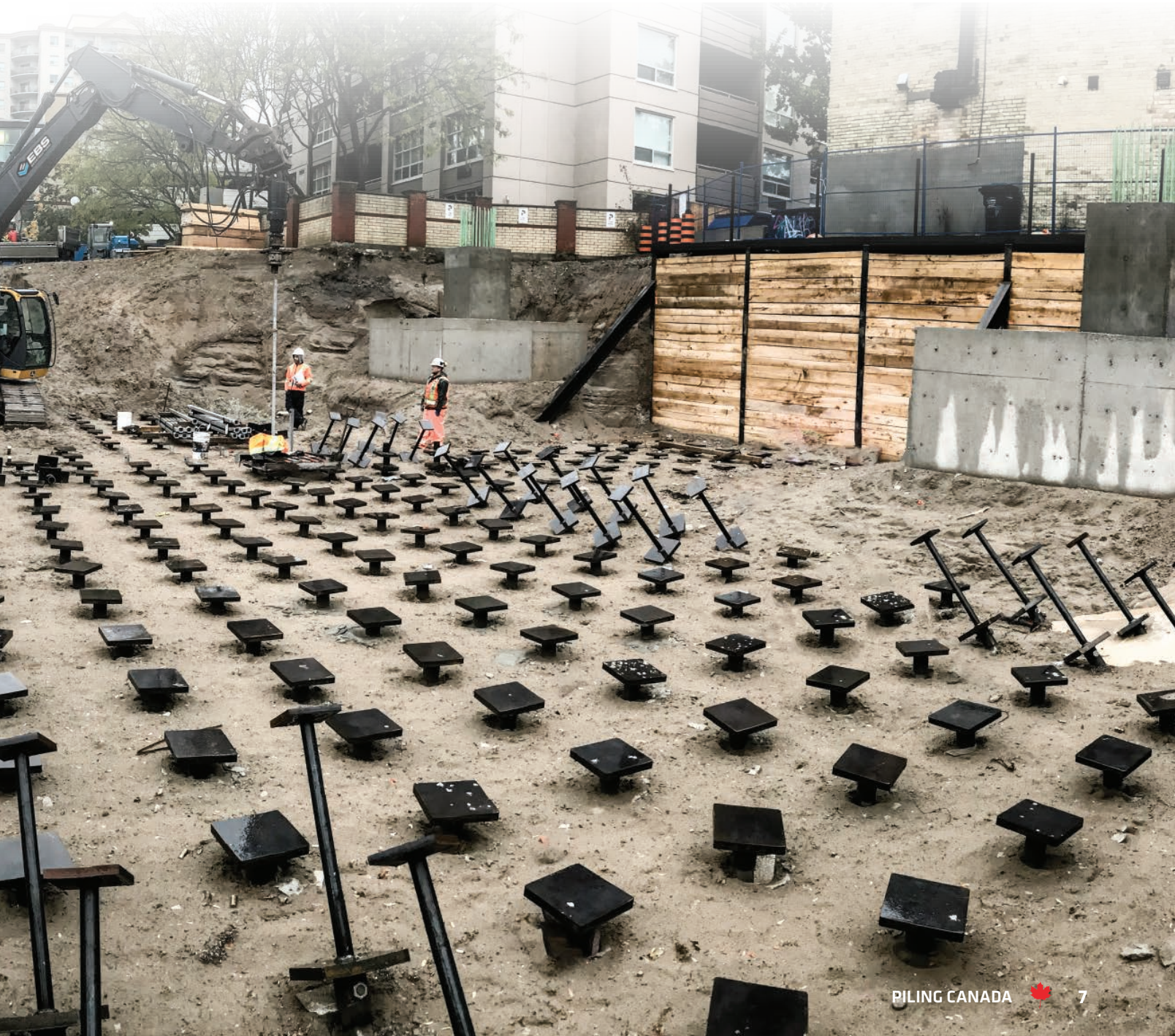
Revolutionary engineering technology proves to be the best, most efficient and most economical solution for a challenging site

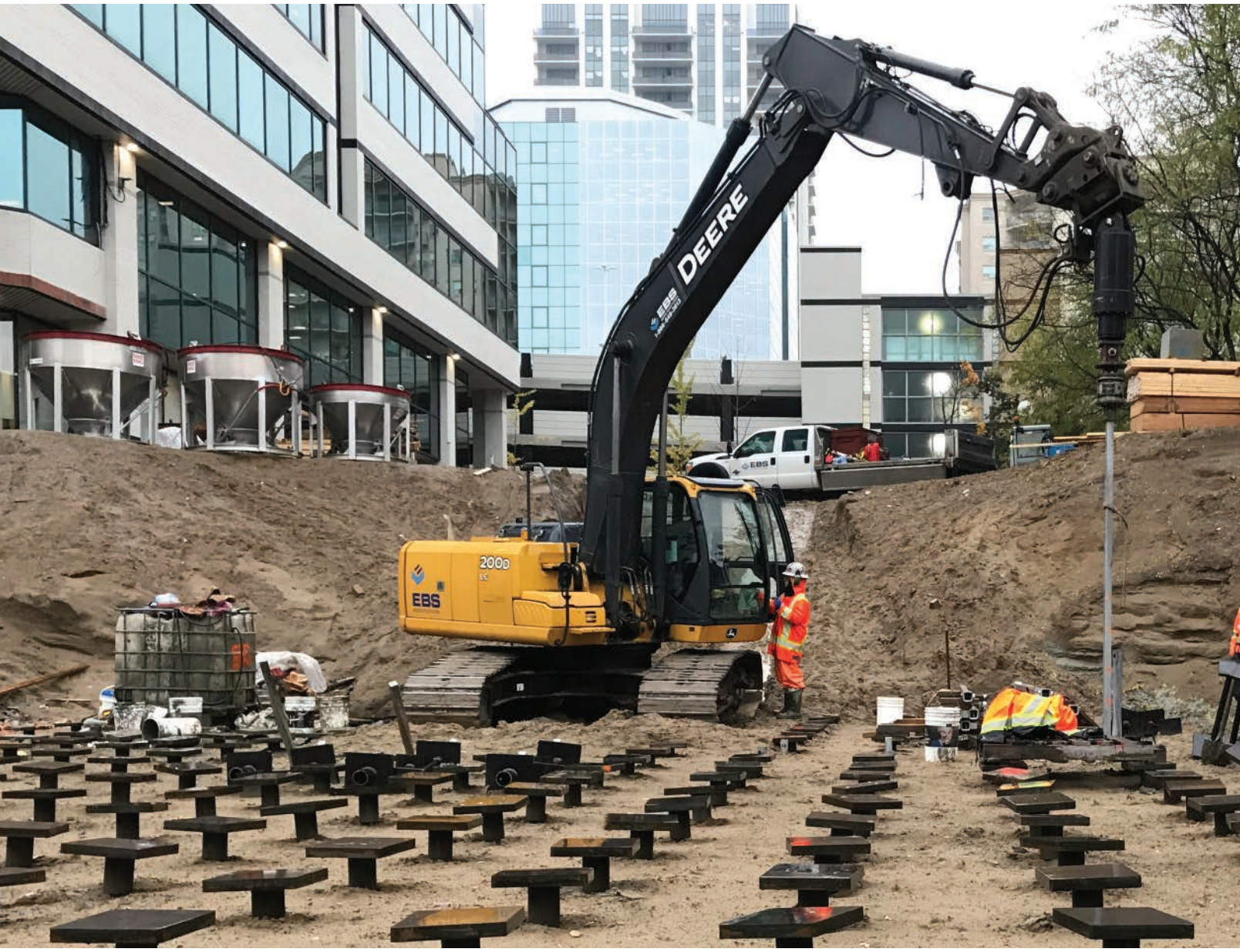
By Barb Feldman



One Richmond Row, a 32-storey apartment tower rising in London, Ont., will soon be the tallest building on helical piles in North America. The project site at 517 Richmond St. is in the middle of a city block in a desirable area of downtown London. That was one of the developer's main selling points to potential renters of its one-bedroom and two-bedroom suites, who will be "immersed in the culture and excitement of a thriving city centre."

The site presented the project's structural engineers with particular challenges, including its high water table and deep deposits of sand material as well as close proximity to surrounding buildings and its restricted street access. Although the initial geotechnical report recommended driven piles or caissons to support the proposed 32-storey tower, driven piles were considered unfeasible because of the potential damage to nearby structures due to vibration and the disruption installation would cause in the city's





core. Caissons would have come with their own challenges – long construction time, substantial traffic control plans and, most importantly, costs – that would have made the project economically unviable.

Structural engineers explored all the options to give their client the best, most efficient and most economical design, says Brian Huber, project manager for EBS Geostructural of Breslau, Ont. EBS has specialized in micropiles and helical piles for almost 20 years and is the Ontario distributor and main installer of Chance helical piles, which are manufactured in Centralia, Mo., by Chance Foundation Solutions, now a division of Hubbell Incorporated.

The proposed tower's location, which previously had a one-storey commercial building and a parking garage on it, was already owned by Old Oak Properties.

"From a cost perspective it made more sense for the developer to demolish existing buildings on the site than find a new vacant site elsewhere," said Huber, who notes that many of the logistical challenges that caisson installation would have posed for this restricted-access downtown site were eliminated by using helical piles; including the need for access and egress for drill rig equipment, dump trucks removing spoils, the ready-mix trucks delivering concrete and the need for laydown areas for rebar cages.

"When we were first contacted, we were given a set of preliminary loading and asked, 'Hey, is it even remotely possible?'" said Huber. After a thorough review process, EBS and Chance engineers came up with a budget based on the existing geotechnical structural loading information, preliminary loading calculations and piling depth assumptions. Compared to the cost of installing caissons, helical piles would save approximately 80 per cent, and would be substantially faster to install. This started a dialogue, Huber said, "How can we determine if this is feasible? What are the next steps?"

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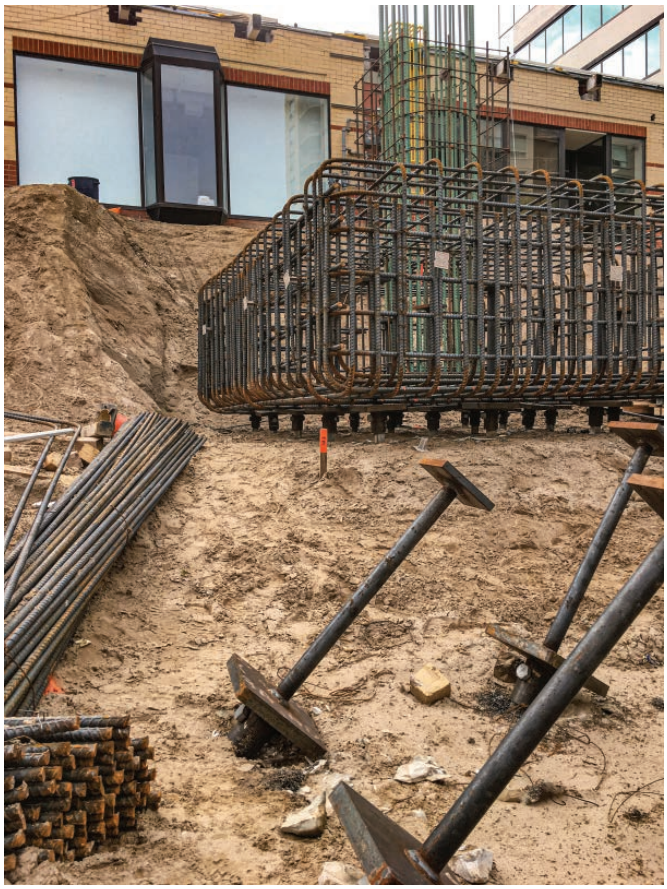


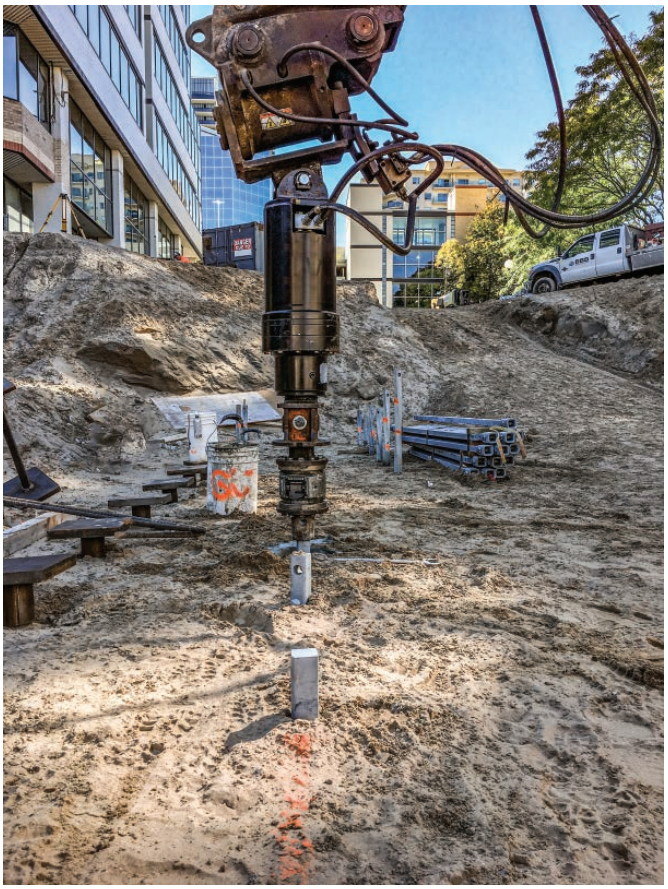
Value engineering using load-test results

After meeting with the owners and reviewing the site, EBS recommended pre-production pre-design load testing.

"We mobilized our equipment into a sector of the site and installed test piles down until they hit their installation torque and load-tested them to failure to see how much capacity we could achieve," said Huber. Chance helical piles are a hybrid pile, "When they're installed to a depth of 30 feet to 40 feet, they have a grout column that encapsulates them that is formed when the pile is being installed. So, we were testing not only how competent the soil is to bear a load of 23,000 foot-pounds (ft-lb) of torque applied to the helical pile, but also how much extra capacity we achieved from skin friction – that is, the grout-column-to-soil interface."

Testing in the dense, sandy soil conditions at the site established that the helical piles achieve an 18 per cent to 20 per cent higher capacity than the manufacturer's recommended maximum, Huber says, and at fairly shallow elevations. The engineers were able to revise the plan to reduce the number of piles, which would shorten the construction schedule and lower costs by a further 20 per cent compared to the original proposal.

Pretium Engineering, which, like EBS, is owned by the C3 Group of Companies, worked closely with Van Boxmeer and Stranges Structural Engineers in the multi-step process to design the pile foundation. This involved carefully reviewing the load tests with the client's engineering team to determine the allowable settlement for the building and re-evaluating the building's loading whenever construction



methods or inside finishes were changed until the final loading and final pile count was calculated, says Huber. Then a third-party engineering consultant reviewed the entire project for any possible problems and signed off prior to construction.

EBS has replaced all the buckets on its fleet of excavators with geared hydraulic torque motors, customizing the hydraulics to increase flow rates, "which gives us higher capacity for quicker installs," Huber said. "Even if the modification gives us just three extra [revolutions per minute], that makes a big difference when you're installing 400 to 500 feet of pile a day. Each time the pile spins 360-degrees, it's advancing three inches. At the end of the day, an extra foot of pile installed every minute has a huge effect on our production pile numbers. And if you modify the hydraulics on a small machine to the point where it can now handle a larger standard torque motor head," it gives EBS the ability to install higher-capacity piles with smaller machines in tight-access areas, he said.

Chance's digital torque indicators improve safety

For the past few years EBS has used Chance's digital torque indicators installed below their torque motors. The units, powered by single nine-volt batteries and operating at temperatures ranging from -30°C to 70°C, measure torque as it is applied to the pile in 100 ft-lb increments, from 500 ft-lb to 30,000 ft-lb. The indicators have high-visibility digital readout screens as well as wireless remote Bluetooth connectivity, which improves safety, says Huber.

"In tight-access areas where parameters need to be accommodated – whether proximity to adjacent buildings, overhang concerns or vibration – helical piles really excel."

– Brian Huber, EBS Geostructural Inc.

"Being able to stay back, still monitor the torque values and see the numbers clearly, that's a big deal," he said.

Installers need to maintain their certification to work with and even obtain Chance piles. To be certified they must complete six hours of online training and pass tests on their understanding of all aspects of foundation installation and repair, including anchoring and pier systems, soil quality, classification and mechanics and construction equipment, as well as helical pile installation. Huber himself, as well as EBS's foremen, lead hands and many of the company's full-time labourers have completed this rigorous certification process, which needs to be renewed every two years.

EBS, which has about 40 employees and from five to nine crews "putting one or two truckloads of material in the ground all over the province every week," said Huber,

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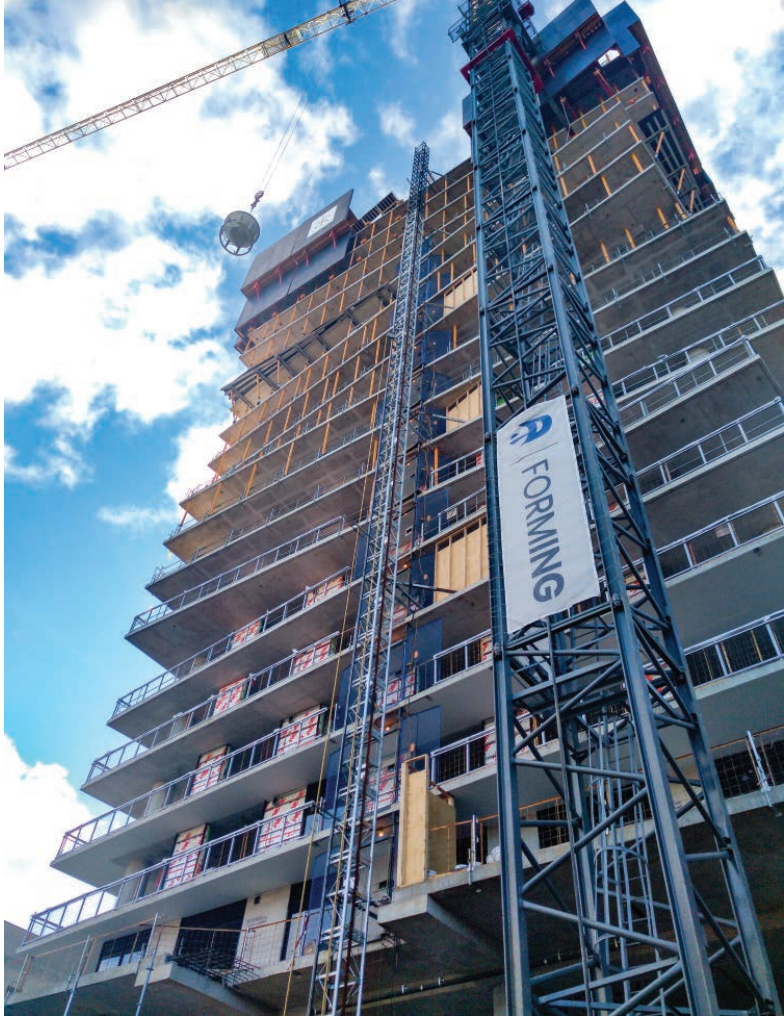

previously installed helical piles for 10- and 14-storey structures and is currently installing them for a building that is 20-storeys high.

For the One Richmond Row project, EBS crews of four and sometimes five took 42 days to install 543 2¼-inch solid-steel square-shaft helical piles, the largest square shaft that Chance currently manufactures, to depths ranging from 30 to 45 feet, on a 680-square-metre footprint.

"A minimum spacing is required between each individual pile, and with the number of piles required in that very small space, there was a very small margin for error," said Huber. "The surveyors had to be very accurate with their layout and we had to be very accurate with our install."

200-year-old engineering technology finally gaining traction

"Many engineers have the idea that helical piles should only be used for residences or anything where the loads are light," Huber said. "Some engineers won't even give them a second look due to the stigma that they're small – like putting a toothpick in the ground and expecting it to hold up a bridge."

In fact, from the time they were developed in the U.S. in the early 1800s, helical piles, also known as helical foundations, screw piles or screw anchors, were recognized as a revolutionary engineering technology. Even then, helical piles made the construction of bridges, lighthouses and piers in difficult locations possible.

Chance has been an international leader in earth anchoring since 1912. Hubber said, "With their years of experience, pushing the limits on these piles, creating new products, going for higher capacity per pile, I think they're a step ahead of most other manufacturers. In the last five years helical piles have gained traction, and a lot of pile suppliers have popped up, but they have a lot of ground to catch up on."

EBS is proud to have earned its reputation as a North American leader in high-capacity helical pile foundations and has been pleased to contribute labour and equipment to the load-testing research Chance is conducting on helical piles in conjunction with civil and environmental engineering researchers at London's Western University.

The One Richmond Row project is ongoing, with the building slated to open for occupancy in the fall of 2020, but it is already "a major showcase, not only for EBS but for helical piles in general," said Huber. "I'm not saying that in every scenario they're going to be the preferred method, and it doesn't mean helical piles are always the most economical, but they should be considered for many more situations than they are now.

"And in the tight-access areas where you cannot get conventional deep-foundation equipment in and where there are parameters that need to be accommodated – whether proximity to adjacent buildings, overhang concerns or vibration – they really excel."

PHOTOS COURTESY OF EBS GEOSTRUCTURAL