Anchor Shoring Celebrates 40 Years of Growth and Innovation

by Sasha Gollish, B.A, B.E.Sc
and Dawn Tattle, P. Eng

Overview of Maple Leaf Square site (bottom) and TELUS site (top), Air Canada Centre (right). Anchor Shoring was the contractor on all three projects.

ADSC Contractor Member, Anchor Shoring & Caissons Ltd., is headquartered in Toronto, Canada, a design-build contracting firm that specializes in soil retention and foundation solutions. Anchor Shoring was founded in 1968, forty years ago by Gord Demetrick and Gord Stack. Al Demetrick joined the partnership team the following year. Their values of hard work, ingenuity, mutual respect and honesty created the foundations for Anchor's current philosophy and ongoing business relationships. They borrowed $15,000.00 from the bank and used $10,000.00 of it to purchase an antique drill rig from a scrap dealer. The current fleet of drilling equipment includes a mix of multiple Bauer*, Calweld*, Hain, IMT*, Klemm*, Texoma* and Watson* rigs. The original antique rig is long retired, but retains a place of honor at the end of the Anchor entranceway where it remains permanently mounted.

Succession planning is one of the major challenges for any construction company. The founding partners of Anchor recognized the need to ensure that their business would have a smooth transition and succession plan. They had a long term vision that Anchor would continue to operate and expand long past their retirement. This led to a major reorganization in the mid eighties with the current operating team of Dawn Tattle, Tom Stack, Paul Kreycir, and Derrick Speakman becoming shareholders in Anchor Shoring & Caissons Ltd.

Anchor is comprised of three companies, Anchor Shoring & Caissons Ltd., Banner Piling & Excavating Limited, and Crown Drilling Limited. This dynamic arrangement gives Anchor maximum flexibility on projects since it can offer an extensive range of soil retention and foundation solutions allowing the optimum solution to be selected for each specific project. These include options such as lagged shoring, caisson walls, shotcrete, caissons (drilled shafts), driven pile foundations, sheet piling, tiebacks and rock anchor installations. Having completed over 4,000 projects, Anchor recognizes the importance of providing reliable, superior service on all contracts regardless of their size. The ability to train and maintain long-term employees in a cyclical industry is another key to Anchor's success.

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Aerial view of completed caisson walls, rock protection, temporary ramp, sheet piling and drilling of south caisson wall at the Maple Leaf Square Project.

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Drilling caisson walls and structural caissons with crane mounted and track mounted drilling equipment at the Maple Leaf Square and TELUS sites.

Over the past year Anchor has been involved with many projects, three of which are the complex and diverse projects that are featured in this article.

Maple Leaf Square, a condominium, hotel and retail centre in downtown Toronto, is located just down the street from the Simcoe Street Extension project. The site required drilling of 500 holes to form a continuous caisson wall around the perimeter of the site. The soldier piles extended 70ft from the surface; the bottom 45ft into the shale bedrock. Each pile was tied back with two rows of rock anchors. The site was complicated by the presence of loose saturated soil, multiple aquifers and fractured rock.

Safety is a major priority at Anchor. Rigorous training and standards are maintained. In recognition of this commitment to safety Anchor was presented with a safety award for the Maple Leaf Square project by PCL Constructors Canada Inc.

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The *Simcoe Street Extension*, which connects Upper and Lower Simcoe Streets under the CN rail yard, required installation of 173 rock socketted piles, 2,500ft of lateral bracing, 24,000ft^2 of timber lagging, 6,000ft^2 of steel sheeting, 22 temporary trestle supports for rail traffic and driven pipe piles. The two temporary, interior, parallel shoring lines and train trestle supports allowed the General Contractor, Soncin Construction to construct a 90ft wide tunnel extending 246ft in length below 13 live rail lines.

Along the Toronto waterfront will be the new headquarters for *Corus Entertainment*. The building is situated less than 100ft from Lake Ontario. The site required 115 structural foundation caissons up to 96 inches in diameter 70ft deep with rock sockets ranging from 8ft to 25ft. This project was complicated by the presence of extensive obstructions, deep rock sockets, concrete cut-offs below lake level and the need to tremie the concrete.

Maple Leaf Square

The site of Maple Leaf Square, a two-tower condominium complex, will feature a hotel, restaurants, retail space, office space, and a day care. It is located west of the Air Canada Centre (ACC) home of the Toronto Maple Leafs and Raptors. PCL Constructors Canada Inc. was retained by York Bremner Developments Limited as Construction Manager, who in turn awarded the design build contract for the caisson walls, sheet piling, concrete ramp structure and demolition to Anchor Shoring & Caissons Ltd. Anchor Shoring had already completed other projects in the immediate area; having just finished the shoring for the TELUS Tower to the north of the site and the Air Canada Centre to the east in 1997.

The schedule for the Maple Leaf Square project was very aggressive. It was also complicated due to the phasing required to accommodate construction of a temporary ramp from the Air Canada Centre, partial demolition of a section of the Air Canada Centre access ramp through the Maple Leaf Square Site, relocation of utilities and the need to drill within four inches of an existing live gas main along the south wall of the site.

Situated near Lake Ontario, on reclaimed land, the Maple Leaf Square Project required a continuous caisson wall system to act as a water cut-off wall above the shale surface around the perimeter of the site. With an excavation depth of approximately 65ft, the building is founded 43ft below the surface of the shale bedrock.

A caisson wall is composed of a series of interlocking drilled holes which are backfilled with a weak concrete mix with strength of about 4MPa. Steel soldier piles are placed at specified intervals in the wall to provide lateral and vertical support. The caisson wall at Maple Leaf Square required

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Installation of rock anchors by Crown Drilling to brace the south sheet pile wall at Maple Leaf Square.

Installation of temporary sheet piling and rock anchors along the south wall is complete. Excavation is continuing.

the drilling of 500 interlocking holes, the majority of which were 40 inches in diameter. The soldier piles in the caisson wall were in excess of 70ft long and required about 45ft of rock drilling per hole. The drilling was further complicated by the nature of the material above the rock. The soil above the rock was composed of loose, saturated backfill which was littered with old rock and timber wharfs and other obstructions. Anchor Shoring elected to use Bauer drilling rigs for the majority of the drilling due to their ability to install sectional casing without the need to use a vibratory hammer. The casing is advanced ahead of the auger ensuring that ground loss does not occur. Each soldier pile hole required 45ft of rock drilling. The high productivity the Bauer rigs offer in drilling through shale was another important consideration for the selection of drilling equipment.

Problems with water in the rock during drilling at many locations of the site were far more severe than had been encountered on the adjacent sites and could only be controlled by extending the temporary casing through the rock all the way to the base of the drilled hole. In order to ensure the schedule was achieved even under these challenging conditions, Anchor provided five drill rigs which included three Bauer rigs; a Bauer BG20H, a BG24H, a BG28H, a Hain drill mounted on an LS218 crane and an IMT AF180. In order to increase the efficiency of the operations, an LS208 Service Crane and several loaders were provided as support equipment.

The footprint of Maple Leaf Square intersects with the exit ramp from the Air Canada Centre. The south caisson wall was located adjacent to an operational exit ramp from the Air Canada Centre. With all the activity at the Air Canada Centre, it was impossible to close the ramp at any time, and drilling for this caisson wall could not commence while this ramp was in use. To solve this problem a temporary, raised concrete ramp from the Air Canada Centre was constructed north of the existing ramp which would allow demolition of the original ramp. The new temporary ramp was supported on 20 caissons 70ft deep. Anchor awarded the demolition subcontract to Priestly Demolition Inc. and the formwork subcontract for the temporary concrete ramp to Verdi-Alliance. As well as servicing the Air Canada Centre, this ramp also aided in excavation and construction, allowing trucks to enter from the west side and exit using this ramp.

The temporary ramp solved the challenge regarding how the south drilling could be accomplished without cutting off the Air Canada Centre access; however, the timing of when this last shoring wall could be done was a major problem to the schedule as this fourth side was required to complete the "bathtub" around the site. Without that cut off wall in place, excavation to allow the start of the construction for the crane footings and building slabs could not commence. This would have resulted in a delay of four to six months to the schedule. To avoid this delay, a temporary sheet pile cut off wall was installed to the north of the Air Canada Centre ramp to act as the fourth side in the "bathtub." The sheet piling prevented water from infiltrating the north end of the site, where excavation and construction had begun. With the sheet piling in place, this also permitted the construction of a ramp to the bottom of the excavation, making it easier for concrete placement,

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Anchor drilling adjacent to live gas main with a BG24H for the south caisson wall.

Project Team

Project:	Maple Leaf Square
Client:	PCL Constructors Canada Inc. Bruce Norman, Construction Manager Mike Clark, General Superintendent Brian Delichte, Sr. Superintendent Daniel Balazs, Project Manager
Shoring, Caisson, Sheeting Contractor:	Anchor Shoring & Caissons Ltd. Sam Daaboul, P. Eng./Dawn Tattle P. Eng., Anchor Project Managers Mike LeSage, P. Eng., Anchor Superintendent
Shoring Consultant:	Isherwood Geostructural Engineers*

material delivery, and removal of excavation spoils. Once the caisson wall south of the Air Canada Centre ramp was installed, the sheeting could be removed.

This south caisson wall was the most difficult and complicated of the job due to the close proximity of a live 16in diameter gas main and the presence of existing shoring from construction of the Air Canada Centre which would interfere with drilling for the new caisson wall. The gas main was located only four inches from the edge of the proposed caisson wall drill holes. Prior to final design of the shoring in this area, the gas main was exposed to determine its exact location. To protect it during drilling, several sections of 24in diameter steel liner were cut in half and compressible material was fastened to the inside of the liners. This was placed on top of the gas main to completely cover it during drilling operations. A Bauer BG24H was used for drilling the caisson wall in this area as its sectional casing and auger system minimizes potential disturbance and vibration, which was required in this extremely sensitive area.

In order to save time and money for the owner, Anchor Shoring proposed several alternatives for the south caisson wall. There were existing shoring piles that were left in place from the construction of the Air Canada Centre access ramp. It was not feasible to remove the existing piles without disturbing the adjacent live gas main; therefore, instead of removing the existing piles, it was proposed that they be incorporated into the new caisson wall. Filler caissons were drilled and keyed into the existing piles holes. It was not possible to create a complete interlock between the old shoring and the new fillers. To achieve the required seal, shotcrete was applied to the face of the caisson wall at these locations. As the excavation continued, shotcrete was used to ensure sufficient closure of the caisson wall interlocks, ensuring there was no breach in the wall as the excavation was below the water table. Anchor also proposed that a section of the Air Canada Centre ramp foundation wall could be left in place to act as "shoring" in lieu of a new caisson wall which saved considerable time, money and disruption.

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Two rows of rock anchors were required to brace the caisson wall. The upper row tiebacks were 45 ft in length. The lower row was only 25 ft long as they were located just above the top of rock elevation. The majority of the tiebacks were drilled with "MacDrill" tieback rigs, which were custom built by Crown Drilling, a sister company of Anchor Shoring. There were some areas of restricted access below the concrete ramp and tight areas which were drilled with a Klemm 806-4. Within close proximity to Maple Leaf Square is the excavation for the new TELUS Building, which was also completed by Anchor Shoring. As construction was underway, it was paramount that rock anchors from the two projects did not intersect as it would compromise the stability of the TELUS shoring wall. This was analysed prior to construction and the layout modified to ensure that this did not occur.

During the bulk excavation, significant vertical fractures in the rock were discovered. If not secured, these fractures would create an unsafe condition during excavation. Several methods of rock support were proposed. It was decided to use a system of mesh and rock bolts, which was installed by Anchor in order to secure the excavation wall. The mesh ensured that any rock that broke free from the wall would be captured, preventing injuries. To secure the mesh, compression rock bolts were installed. These were drilled to a sufficient depth to ensure the anchor zone was beyond the fracture and would not pull out.

Performance of the caisson walls, sheeting and rock anchors were monitored during the excavation which confirmed the systems were performing as anticipated. Due to the complicated nature and phasing it would have been easy to "paint the excavation into a corner" on this project. Throughout the project, PCL and Anchor took a proactive approach to scheduling and planning operations to ensure that this did not occur. The work was completed as scheduled and Maple Leaf Square is expected to open in 2009. When complete, Maple Leaf Square will be a landmark building in downtown Toronto, piercing the skies with its two great towers.

The Simcoe Street Extension

There are major problems with traffic congestion in the vicinity of The Roger's Centre (formally the Skydome) and The Air Canada Centre. Without improving the traffic flow, the situation will only worsen once construction of several new condominium and office towers in this vicinity are completed. Simcoe Street is a busy, downtown Toronto road that dead ends at the TTR rail lands. Lower Simcoe Street is located just south of the railway tracks and continues towards Lake Ontario. In an attempt to improve the traffic patterns in this neighborhood and eliminate the discontinuity in Simcoe Street, the Simcoe Street Extension is under construction, a four-lane roadway below the rail yard to connect Simcoe Street to Lower Simcoe Street. The final underpass will be 246ft in length and 90ft wide.

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Drilling soldier pile holes at track level for the Simcoe Extension project. A LoDril is working below skywalk. An IMT is drilling for piles in areas with unrestricted headroom.

LoDril and IMT drilling at the Simcoe Extension project. Note restricted working area between trains for drilling and placing concrete.

General contractor Soncin Construction Corporation, the successful bidder for the project, retained Anchor Shoring & Caissons Ltd. to design and construct the shoring system and piled foundations. Four parallel lines of shoring were required to create two trenches to allow the excavation and construction of the piers and abutments. Temporary trestle bridge supports were required to support 13 train tracks over each of the two trenches. After construction of the structure is complete, the rail lines will be reinstated on top of the final bridge deck.

But what made this project uniquely challenging?

All work had to be completed in the vicinity of an operational rail yard and live train traffic with only limited track closures permitted. Just to the east of the rail yard is Ontario's largest train station, serviced by VIA, GO and Amtrak. Each day approximately 120,000 people travel through the train station. Therefore, no interruption to train service could be tolerated. This required the majority of the work to be completed at night and on weekends. The project required auguring of 126 soldier piles immediately adjacent and in some cases even below the train tracks. At 5am every weekday morning, all construction at track level had to be completed with all tracks ready to be reopened for rush hour train service. The work area was extremely congested due to the very tight area; therefore, working productively under these conditions was a continuous challenge.

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The Skywalk, an elevated sidewalk connecting the Roger's Centre to Union Station borders the east edge of the project. The Skywalk crosses over the CN rail yard and above the new tunnel structure. This height restriction complicated the installation of the 22 piles below the Skywalk by reducing the available headroom to less than 23ft in this area. The soldier piles were required to support vertical loads from the temporary train trestles and permanent loads from the structure. It was specified that they be socketted ten feet into shale. To accomplish this drilling work under these challenging conditions Anchor Shoring purchased a LoDril DH60-60* mounted on a Liebherr 944* excavator. Due to the extremely poor ground conditions and low headroom available, double and triple lining of the drill holes was required to ensure that loss of ground did not occur. To further complicate the operations, there were 45ft piles required in this area with only 23ft of available headroom to work under. Therefore, it was necessary to develop a splice detail that could be quickly and easily connected within the tight time frames that were available for the work.

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Anchor Shoring elected to use a bolted splice connection. It was necessary to design this connection to withstand both vertical and lateral loads. There were 37-1 inch bolts per splice plus the required splice plates. After drilling of a hole was completed, the longer of the two pile sections was lowered into the hole and held in place by the drill rig. A service crane was used to hang the shorter section above it. The two sections were then bolted together and torqued to specified values to ensure a quick and quality connection. The pile was then lowered down to bedrock and backfilled with concrete for the toe with U-fill placed above the concrete to the ground surface. Drilling for

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Drilling DCP rock anchors from tunnel base slab.

piles, which did not have overhead restrictions, was completed with an IMT AF180 in stage 1 and a Bauer BG20H in stage 2.

Further complication of the project was the condition that each of the two open cut trenches intersected 13 live train tracks. It was necessary to install temporary steel trestle bridges to support the trains above the open cut during excavation and construction. The vertical load from the trains was supported on W24x162 piles, which were socketed into the shale bedrock. These

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trestles were installed during specific weekend track closures. The connections were extremely complicated and during these short windows it was also necessary to install sheeting for soil retention and an upper row of bracing for lateral support of the shoring. Proactive planning and coordination between all of the parties involved in the weekend operations were key to ensuring that the trains would run as scheduled for the Monday morning rush hour.

There were a total of three bracing levels required to provide lateral support to the shoring system. Continuous walers were installed at each of the three levels and struts were installed between the opposing shoring walls. Accurate placement of piles in a straight line and to the proper elevations was essential due to the complicated

Another challenge with the project concerned the installation of the permanent double corrosion protected (DCP) rock anchors.

trestle and waler connections. The lagging for the last cut of excavation was set back behind the pile and brackets were preweld-ed to the soldier piles prior to drilling, as the soldier pile was designed to work as an integral part of the permenant structure.

Another challenge associated with the project concerned the installation of the permanent double corrosion protected (DCP) rock anchors. These rock anchors were drilled along the outer east and west walls of the tunnel and were required to prevent overturning. The bedrock here was highly fractured and required that many of the rock anchors to be grouted, left over night, and re-drilled the following day. This ensured that fractures were sealed and that the necessary capacity could be reached. The two working tunnels were quite narrow, one was 25ft and the other only 22ft, and headroom was limited by the struts. Conventional rock anchor equipment could not be used. Anchor elected to use a modified Airtrack drill rig for this work. It was necessary to install the Dywidag* DCP tieback bars in two pieces and connect them in place with a coupler as the anchors were 40ft long and the tunnel width was a maximum width of only 25ft.

Three rows of struts have been installed to brace the shoring walls. Excavation continuing to top of shale bedrock.

It was also necessary to construct the shoring in two stages due to track relocation, signal work and demolition at the north end of the site. In order to accommodate this phasing, bulkhead shoring walls were installed. This reduced the working area within the tunnel and complicated removal of the excavated material. In the

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Aerial view of track level at the Simcoe Street Extension. Trestle installation work underway. Five trestle bridges are complete.

Completed Simcoe Tunnel structure.

initial stage, access was only available from one end of the tunnel.

The third phase of the work required the driving of 47 pipe piles north of the Simcoe Tunnel structure. Headroom was also a constraint on the north side of the tunnel for a third of the piles. Some of these piles were to be installed beneath the ceiling of an existing building to support a permanent retaining wall. To accommodate the 10ft height restriction, a Linkbelt LS 98* crane with a short boom was used to drive the piles. The body of the crane sat outside the building and with its long boom it reaches the hammer underneath the ceiling. An internal hammer was used in these low headroom areas to use the drop length within the pile itself to increase the driving energy. The internal hammer required a steel plate or shoe to be welded to the bottom of the pile and one foot of gravel to be added above the base to form a gravel plug. Where height was unrestricted an external hammer was used to provide additional driving energy, which increases the productivity of operations. After driving, the piles were backfilled with concrete increasing their compression capacity.

Currently the concrete structure is complete, the temporary trestles have been removed and the trains are now running over the permanent bridge deck. Proactive planning and continuous communication between all parties were key to the successful completion of this challenging project. The tunnel is scheduled to officially open in October 2008, and is expected to alleviate some of the traffic trying to access the Gardner Expressway and Lakeshore from Yonge Street all the way to Spadina Avenue.

Project Team

Project:	The Simcoe Street Extension
General Contractor:	Soncin Construction Inc. Dennes Soncin/Clyde Crocker, Soncin Management Team Paul Soncin, Construction Manager Manny DaSilva, Superintendent
Shoring, Piling & Permanent Anchor Contractor:	Anchor Shoring & Caissons Ltd. Dawn Tattle, P. Eng., Project Manager Toben Jerry, B.A.Sc., Superintendent
Shoring Consultant:	TARRA Engineering Inc.

The Corus Entertainment Toronto Headquarters

The Toronto Economic Development Corporation (TEDCO) announced that Aecon Buildings would construct the headquarters for Corus Entertainment. Corus Entertainment is Canada's leading specialty television and radio producer including additional assets in pay television, advertising and digital audio services, television broadcasting, children's book publishing and children's animation. In September 2007, Aecon awarded Anchor Shoring & Caissons Ltd. the contract to construct the foundation, which included 115 structural caissons. These caissons ranged from 36 to 96 inches in diameter with drill lengths of 75ft and rock sockets up to 25ft in depth. Reinforcing steel cages were installed in each caisson. The schedule was demanding and required the project to be completed in only three and half months.

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The first challenge presented by the Corus Entertainment Toronto headquarters was recognizing the difficulties in building on a sensitive site; it was defined as a sensitive site since it is within 75ft of Lake Ontario. Over 50 years ago, Toronto began infilling the lake to create more real-estate. To retain the new shoreline a deadman anchored seawall has been constructed upon two rows of battered timber piles which had been driven at an angle to the bedrock. Due to the proximity to Lake

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Ontario and the loose, saturated nature of the backfill material, temporary casing was required for each drilled caisson. Traditionally this casing would be installed with the use of a vibratory hammer mounted on a crane. However, due to the concern about the potential impact of vibration on the seawall, it was specified that vibrations be limited while drilling within 60 feet of the seawall and that extra care be taken to ensure that there was no contact with the existing battered piles.

To minimize vibrations in this sensitive area a Bauer BG28H was selected. The Bauer machines use an integrated auger and liner system to install sectional casing without the need of a vibratory hammer. The casing is advanced prior to drilling to ensure that ground loss does not occur. Open-hole drilling was not an option here as the soil strata ranged from wet sand and gravel to a silt layer above the shale bedrock. The casing had to be advanced down to rock to prevent a cave in. These foundation caissons were all drilled with a 46in liner ranging in depth between 56ft and 72ft with a rock socket depth distribution from 8ft to 25ft. Each caisson contained a reinforcing cage and 29yd^3 to 37yd^3 of concrete was placed in each of these holes.

Open-hole drilling was not an option here as the soil strata ranged from wet sand and gravel to a silt layer above the shale bedrock.

There were also four areas with core foundation caissons; two sections with six caissons and two sections with four caissons. These 20 caissons were 70ft deep with a 22ft rock socket depth. Each contained a 49ft to 56ft long reinforcing cage and 30MPa concrete was specified. Each caisson was 96inches in diameter and required over 130yd^3 or 12 truckloads of concrete. With minimal site space and the necessity for several concrete trucks, coordination of concrete delivery to minimize congestion was a challenge. The site in downtown Toronto faces high traffic volumes for the majority of the day. Planning concrete deliveries required utmost diligence.

The proximity of Lake Ontario caused further challenges to the drilling operations. The water level of Lake Ontario sits at a geodetic elevation of 245ft. While drilling, casing was advanced 50ft down to top of shale elevation, to approximately 195ft. Thereafter, open-hole drilling in the rock was used. The shale had many horizontal fractures that permitted water inflow at a rate which made it impossible to dewater the drilled shafts. This necessitated the placement of concrete using tremie methods. Simplified, tremie concrete is a process that pumps concrete to the bottom of a caisson. The pipe is then raised as the concrete is pumped, being careful to ensure that a sufficient head of concrete is always maintained above the bottom of the pipe. Concurrently, a pump removes the displaced water. The water went through a multiphase filtration system before it was discharged. Attention to detail is important during the tremie process to ensure that the integrity of the concrete is maintained.

Installing caissons at the Corus Entertainment Headquarters with a Bauer BG28H, a Hain drill mounted on an LS208 crane, an IMT AF180 drill rig and associated support equipmen

Anchor provided three drill rigs and three service cranes to the project. In total 6,100yd^3 of concrete and 360 tonnes of reinforcing steel were required. The caissons were completed by Anchor Shoring earlier than promised. As Aecon Buildings continues with the project, its final structure should be a majestic landmark on Toronto's changing waterfront.

**Indicates ADSC Associate Member.*

Project Team

Project:	The Corus Entertainment Headquarters
Construction Manager:	Aecon Buildings Guido Paniccia / Jamie Robertson, Construction Managers
Project Managers:	EDEV Real Estate Advisors - John Levitt Jag Con Inc. - George Pawlak Soskolne Associates - Ron Soskoine Wertheim Consulting Inc. - Moshe Wertheim
Structural Consultant:	Halcrow Yolles
Caisson/Drilled Shaft Contractor:	Anchor Shoring & Caissons Ltd. www.anchorshoring.com Derrick Speakman, P. Eng./Sam Daaboul, P. Eng. Project Managers Toben Jerry, B.A.Sc., Superintendent