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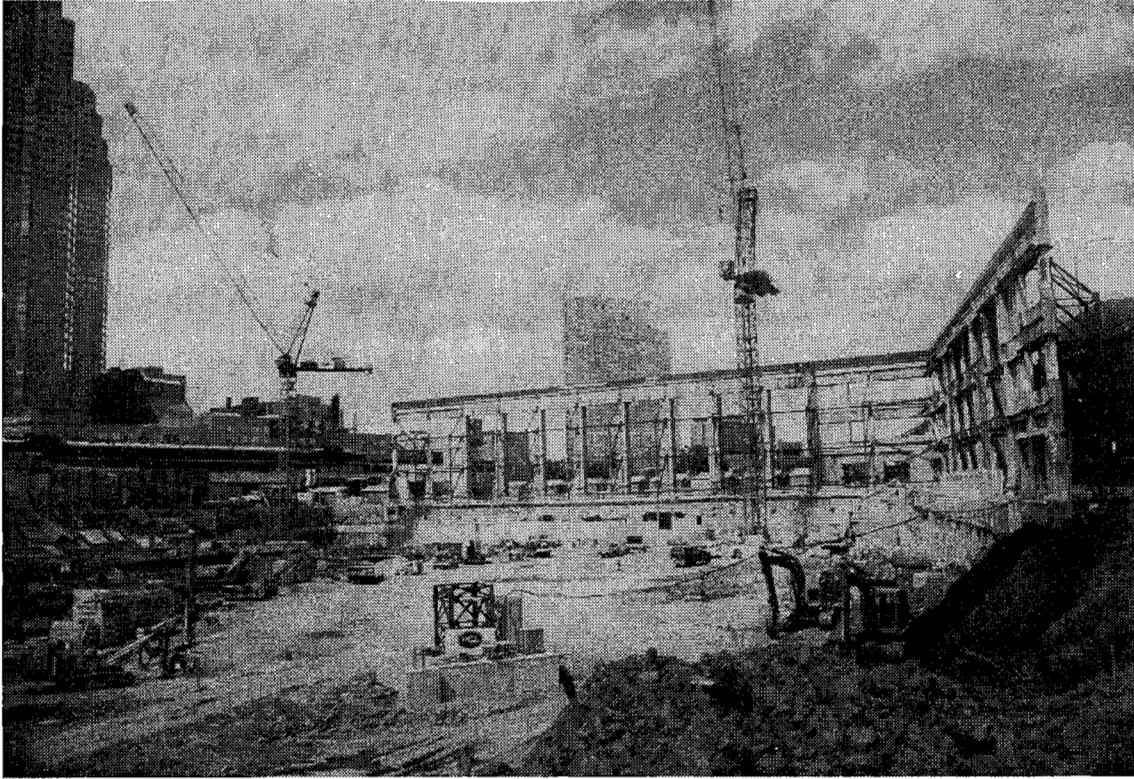
**SHORING AND CAISSONS AT THE  
AIR CANADA CENTRE / RAPTORS STADIUM**

**Dawn C. Tattle, Michael J. LeSage**

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## **Shoring and Caissons at the Air Canada Centre/Raptors Stadium**

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and  
Michael J. LeSage <sup>2</sup>



### **Panoramic View of Completed Facade Supports**

The following case history describes the installation of earth retention systems, historical facade supports and structural caissons by Anchor Shoring & Caissons Ltd. at the Air Canada Centre/Raptors Stadium Project in Toronto, Ontario, Canada.

The Air Canada Centre/Raptors Stadium project includes a 140,000 square foot office tower, a 20,000 seat basketball arena and their support facilities. The arena within the complex will also have the ability to host hockey, ice shows, concerts and family events.

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<sup>2</sup> Project Superintendent, Anchor Shoring & Caissons Ltd.

The site is surrounded by transportation corridors with Lakeshore Boulevard to the south, Bay Street to the east, York Street on the west and the TTR rail lands to the north.

As the existing post office building located on the south west corner of the site had been designated as a heritage building the south and east walls have been incorporated into the design of the new facility. Support of the facade walls were required prior to demolition of the interior of the existing building.

The project manager/general contractor PCL Constructors Eastern Inc. awarded the design build shoring and caisson subcontract to Anchor Shoring & Caissons Ltd. Construction began on site in February 1997 with the Raptors scheduled to play in the completed arena in February 1999 immediately following the NBA all star break. Anchor retained the firm of RWB Engineering Ltd. to design the earth retention system and the facade support caisson foundations. The structural caissons for the new building were designed by Yolles Partnership Inc.

There were several aspects to this project which made it uniquely challenging. Among these were:

- i) Limited Headroom - Installation of the soldier piles for the south and east faces of the excavation were restricted by limited available headroom beneath the Gardiner Expressway (which is located above Lakeshore Boulevard) and within the partially demolished post office building.
- ii) Soil Conditions - As the site is located on reclaimed land the soil consists of saturated backfill to shale bedrock. The drilling operation was further impeded by numerous below grade obstructions such as wharfs, rubble fill and boulders. Additionally it was often necessary to tremie the caissons and soldier pile toes due to water entering the drilled holes through fractures in the shale.
- iii) Schedule - The project schedule which was set and enforced by PCL was aggressive. Considerable co-ordination of subcontract work was required due to interdependency of work between trades.

#### Earth Retention Systems and Facade Support

The project required shoring along the TTR rail lands earth retention and facade support of the east and south walls of the existing postal building and shoring of the south parking ramps adjacent to Lakeshore Boulevard. Due to sufficient clearance from the property lines along the west side of the site this area was open cut. A total shored area of twenty-six thousand square feet of shoring was installed by Anchor at this site. Anchor's work began on the north side of the site where a seven metre high earth berm supported the TTR tracks to the north. To permit the construction of the office tower and galleria structures, approximately five thousand square feet of shoring and removal of the berm was required. Faced with limited access along the berm for

equipment, and poor soil conditions Anchor elected to drive the soldier piles. This simplified the installation as a service crane to handle liners and vibratory hammers, removal of spoil and transport of concrete to drilled holes were eliminated.

Due to the proximity of the shoring to the railway tracks Terraprobe Limited, the geotechnical consultant recommended a value of  $K = 0.4$  in this area for use in the design. The additional precautions of pile spacings reduced to eight foot from traditional ten foot centres and timber lagging of four inch rather than standard three inch thickness were incorporated into the design to minimize possible movements of the shoring system.

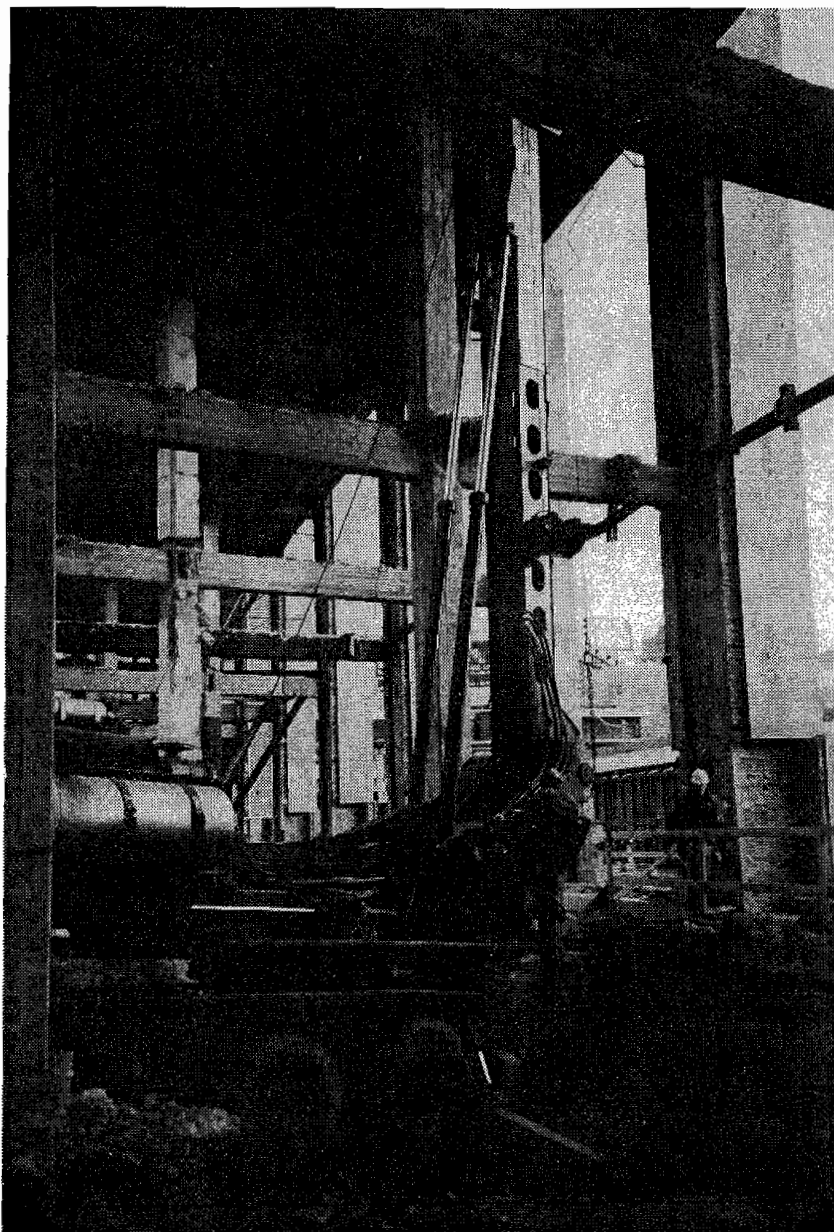
The soldier piles were driven forty five feet to sound shale bedrock using a D12 hammer on leeds mounted on a 108 LS Linkbelt crane. The shoring was braced by two rows of prestressed rock anchors. Drilling was completed by two custom tieback rigs working from the berms. Both drill rigs had been designed and built by Crown Drilling Ltd., a member of the Anchor Group of companies. Anchor Shoring subcontracted the supply, grouting and stressing of the tiebacks to Canadian BBR. These tiebacks were prestressed to loads in excess of three hundred kips per tieback.

Concurrent with installation of the track shoring, Priestly Demolition began demolition of the post office building. The building was to be selectively demolished with an "L shaped" strip of the building two bays wide to remain along the south and east walls. This "support strip" provided structural integrity for the facades until steel support framing could be installed.

Demolition began with the careful removal of an "isolation corridor" one bay wide which would separate the support bay from the remainder of the building. This isolation corridor served two purposes. It permitted early access for drilling equipment to begin installation of soldier piles within the post office building while providing separation from the general demolition operations for the portion of the structure which was to remain for this phase of the work.

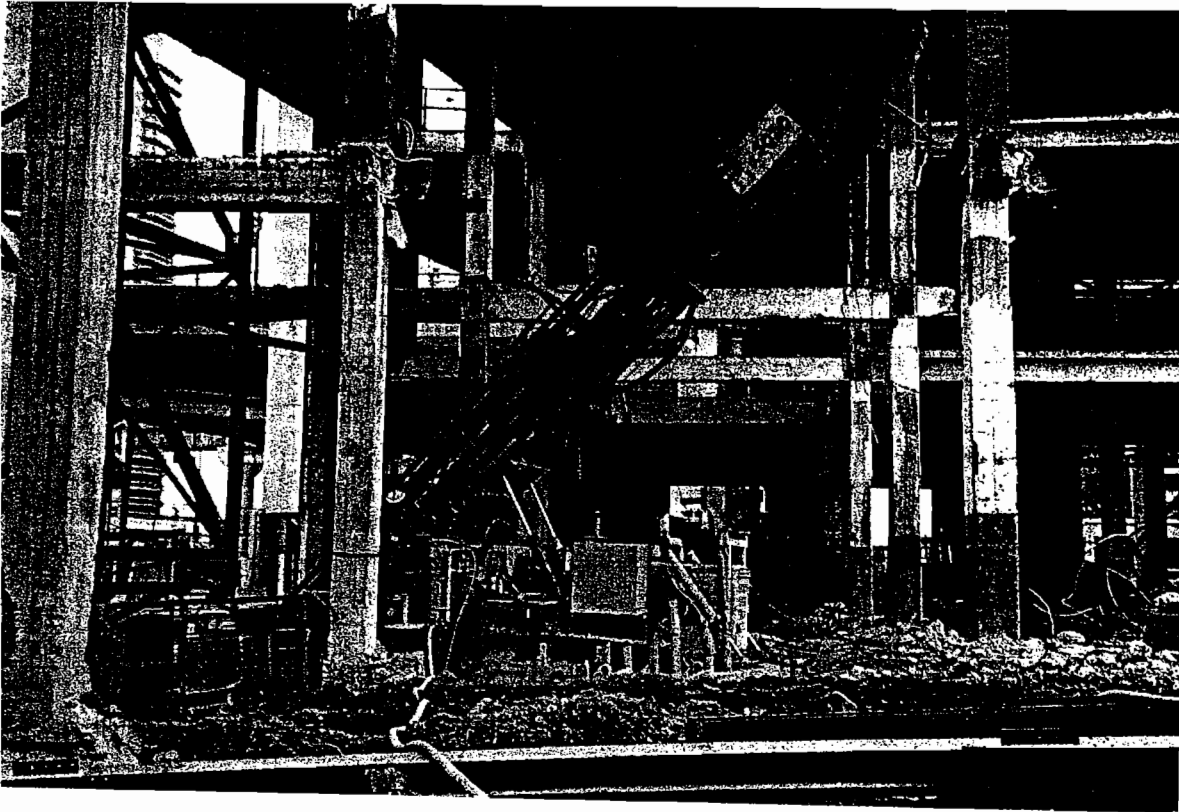
The facades were to be braced by structural steel support framing. On the east side of the site, the traditional approach of installation of the support framing outside the structure was not practical due to traffic restrictions and the presence of overhead services along Bay Street. Conventional exterior support framing was used along the south side of facade.

Installation of soldier piles for facade support and structural bracing was required prior to final demolition of the support bays. To provide thirty nine feet of overhead clearance at the location of the first support frame the second and ground floor slabs were demolished in that bay and some eight feet of local excavation was completed. The soldier piles were installed using both a Texoma 900 truck mount drill and a CM 100 drill attachment mounted on a modified 98 LS Linkbelt crane. These piles were socketed eight feet into shale to provide a sufficient toe to accommodate the final design excavation levels.



### **Texoma 900 Truck Drill Installing Soldier Piles For Facade Within Post Office Building**

Following installation of the above soldier piles additional local excavation was prepared to permit the installation of rock anchor tiebacks. The facade support steel was then installed on the braced soldier piles. A staggered installation sequence not unlike underpinning was continued along the "isolation corridor" until the support frames were complete and the facade was fully braced.



### **Drilling Rock Anchors With “Macdrill” Anchors Within Post Office To Brace Facade Columns**

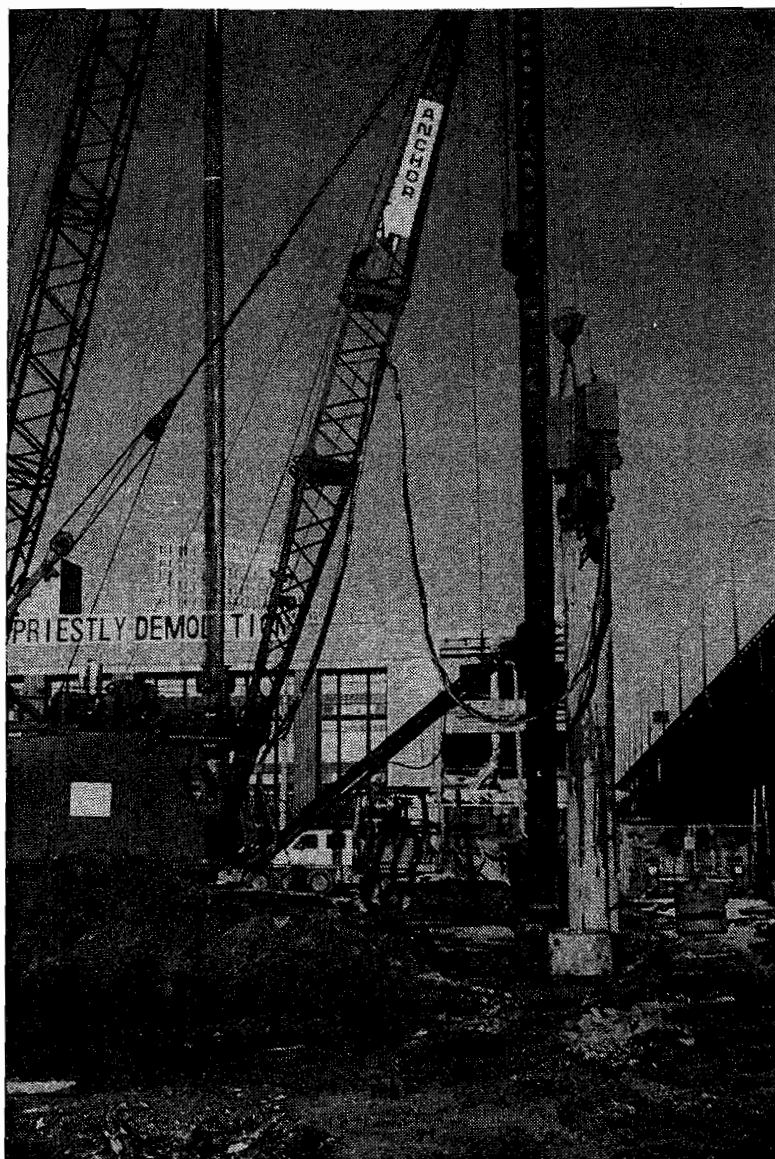
Demolition of the interior support bays was then performed permitting excavation and lagging to proceed in a conventional manner. Approximately thirteen thousand square feet of shoring were required to permit construction of the arena structure.

An additional eight thousand square feet of shoring for the parking ramps was installed adjacent to Lakeshore Boulevard.

### **Structural Caissons**

The soil conditions consisted of about twenty feet of saturated fill to the top of the shale bedrock. The column design loads were as high as 10,000 Kn. with substantial uplift forces in the core area. Caissons were selected to support the tower and galleria structure as both pile foundation and footings were uneconomical in these loading and soil conditions. The resultant caisson diameters ranged from 36” to 72” with rock sockets up to 15 feet in depth.

Caissons were also utilized for the support of the proposed entry and exit ramps adjacent to Lakeshore Boulevard. A portion of the entry ramp extended beneath the existing Gardiner Expressway. Overhead restrictions made it necessary to drill these caissons using the low headroom equipment which was used within the post office building.



**Installation Of Temporary Liners In Ramp Area With A Vibratory Hammer**

In areas with unobstructed headroom, the caissons and soldier piles were installed by vibrating a temporary steel casing into the weathered bedrock using an ICE 812 vibratory hammer mounted on a 318 LS link belt crane. The soil within the liner and the rock sockets were drilled using either a Taurus XL track mounted drill or a Calweld 155 mounted on a 318 LS Linkbelt crane. In areas where obstructions were encountered it was necessary to predrill to remove the obstructions to allow installation of the liner.

### Conclusions

Anchor Shoring & Caissons Ltd. completed our subcontract on target for this demanding project. Our firms experience in major projects and extensive inventory of material and equipment enabled us to apply the appropriate resources when they were required to meet the schedule. Our recent experience in the area at the Metro Toronto Convention Centre and earlier at the Sky Dome has provided us with a breathe of experience with local soil conditions.

Our project team developed a synergy with PCL and their primary subcontractors and the consultants for this phase of the work (Priestly Demolition, York Excavating, Atlas Dewatering, Mometal Structural Steel Erectors, Yolles Partnership and Terraprobe) which as Raptor fans we hope will continue with our basketball team in their new home.