22 November 2013

Project Number: WX17253

Attention: Mr. Edmund Ho, P. Eng
MMM Group Limited
111-93 Lombard Avenue
Winnipeg, Manitoba
R3B 3B1

Re: Temporary Shoring
Soldier Piles & Timber Lagging System
Proposed New Gate Chamber
McDemot Ave and Waterfront Drive
Winnipeg, Manitoba

1.0 Introduction

As requested, AMEC Environment & Infrastructure (AMEC), a Division of AMEC Americas Limited, has re-evaluated the potential use of a soldier pile and timber lagging shoring system for the proposed new gate chamber to be constructed on the east side of the intersection of McDemot Avenue and Waterfront Drive in Winnipeg, Manitoba.

This memorandum should be read in conjunction with AMEC's geotechnical report of project number WX17253, dated 12 November 2013. At the time of the previous report, a soldier pile and timber lagging option was not preferred for the following reasons:

- Base shear failure of the excavation
- Piping at the base of the shoring due to high water pressures and the potential for permeable soils at the base. It was felt that dewatering outside of the excavation (i.e. perimeter dewatering) may be needed
- Base heaving at the base of the shoring due to high water pressures
- Difficulty in excavating below the water tale to establish a suitable bearing surface for footing construction

2.0 Soil Properties

AMEC has performed additional laboratory soil testing, including unconfined compressive strength, lab vane, torvane shear and pocket penetrometer tests to evaluate the undrained shear strength of the clay at depth near and below the expected base of the excavation (9.2 m below the ground surface of test hole TH01).

Based on the assessment, it is determined that the undrained shear strength of the clay varied from about 30 kPa to 65 kPa with lower strength with increased depth, where frequent sand lenses and layers were encountered. Considering that the gate chamber will have a footing width (B) of 5.4 m, the critical shear strength zone will be from the bearing surface to a depth of about 1/2B below. On this basis, the operating shear strength is estimated to average about 45 kPa through this zone.

3.0 Soldier Piles and Timber Lagging System

Based on the current shear strength estimate, determined using the additional test results, it is determined that from a shear failure perspective, the soldier piles and timber lagging shoring system is possible as the excavation base stability meets the design criteria with a factor of safety (FS) of 2.0. However, in addition to shear failure, the base of the excavation will still need to be protected against piping from water seepage and base heave due to groundwater pressure. Considering that the groundwater is about 5 m above the base of the excavation at the time of investigation and potentially higher during some stages of construction, this potential still exists. Depending on the base conditions encountered (i.e. sand or clay), it is expected that the groundwater would need to be dewatered to a minimum of 1 m below the base of the excavation (i.e. elevation 219.4 m). While an interior dewatering system (i.e. construction sump at base of excavation) could be attempted, it is AMEC's opinion that an exterior perimeter dewatering system is preferred.

It should be noted if an interior dewatering system is implemented, the groundwater level inside the shoring will need to be kept below the current excavation level (likely a minimum of 1 m below the excavation base) during all stages of the excavation and after excavation is complete.

An exterior dewatering system would allow the excavation to be dewatered prior to excavation commencing. This would create an easier excavation process and would reduce the amount of seepage through the lagging. An external dewatering system would typically consist of wells with pumps. This system would also be more flexible in the event that higher water levels occurred during construction. More details of the construction dewatering are presented in the previous geotechnical report, dated 12 November 2013.

Ultimately, the contractor should provide a dewatering plan to the design team prior to construction commencing. The plan should be reviewed to verify that it meets the design requirements.

3.1 Consideration of Soldier Piles and Timber Lagging System

If groundwater dewatering can be achieved, it is expected that solider and timber lagging shoring can be utilized. Typically, for shallow excavations a cantilevered system would be used; however, given the depth of the excavation, internal bracing or tie backs will be needed.

Lateral earth pressures that are needed for the solider piles and timber lagging system shoring design can be obtained in Section 5.2.4 of AMEC's geotechnical report, dated 12 Nov 2013. It should be noted that the passive earth pressure for the solider piles below the excavation base should be applied to the flange width of the piles (or diameter in the case of a concrete solider pile). Other shoring considerations that including surcharge loads, excavation staging and shoring wall monitoring are presented in previous AMEC's geotechnical report as well.

Generally in Winnipeg, H-piles are utilized as soldier piles and are installed in one of two manners:

- Driven to refusal in the glacial silt till or bedrock
- Drilled hole with H-piles concreted in place in the till, such that the flat faces of the H-piles are directed toward the interior of the excavation.

During the pile installation, vibrations created during pile driving may affect the nearby existing structures. The effect of vibration can be reduced by pre-drilling the pile hole (i.e. to about 6 m) as opposed to driving the pile right from the ground surface.

If solider piles are installed in a drilled hole, the contractor should be use a protective steel casing to maintain the pile holes in an open and dry condition. Where seepage cannot be controlled, all concrete will have to be placed using tremie methods. In addition, the glacial silt till commonly contains cobbles and boulders and therefore drilling of the steel soldier piles holes may require the removal of these obstructions.

Following installation of the piles, the soil in front of (i.e. on the interior of the proposed excavation) and immediately between the piles is excavated in a staged manner to ensure stability of the shoring system. During each stage, the timber lagging boards are placed between the pile flanges and bolted as required. At pre-determined depths steel anchors or struts can be installed. To prevent seepage and soil migration through the small gaps between the lagging boards, a non-woven geotextile should be installed behind the wood lagging.

4.0 Closure

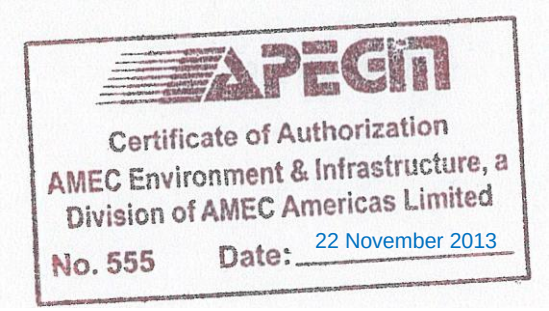
The findings and recommendations presented herein for design of the proposed McDemot Ave Outfall New Gate Chamber are based on a geotechnical evaluation of the conditions identified in the geotechnical test hole drilled at the site. If conditions are encountered that appear to be different from those shown in the test hole log and described in this report, or if the assumptions stated herein are not in keeping with the design, AMEC should be notified and given the opportunity to review the current recommendations in light of any new findings. Recommendations presented herein may not be valid if an adequate level of inspection is not provided during construction, or if relevant building code requirements are not met.

Soil conditions, by their nature, can be highly variable across a construction site. The placement of fill during and prior to construction activities on a site can contribute to variable soil conditions. A contingency amount should be included in the construction budget to allow for the possibility of variations in soil conditions, which may result in modification of the design, and/or changes in construction procedures.

This memorandum has been prepared for the exclusive use of MMM Group Limited, and their design agents, for specific application to the development described within this report, and should be read in conjunction with AMEC's geotechnical report of project number WX17253, dated 12 November 2013. The data and recommendations provided herein should not be used for any other purpose, or by any other parties, without review and written advice from AMEC.

The findings and recommendations of this report have been prepared in accordance with generally accepted soil and foundation engineering practices. No other warranty is made, either expressed or implied.

Sincerely,
AMEC ENVIRONMENT & INFRASTRUCTURE



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