

8 Conclusions

North Spur stabilization works designs have been developed and updated over the years from 1964 to today. Information on soils stratigraphy, properties and groundwater behaviour are critical to the preparation of the engineering design for the stabilisation. Use of data collected from the early investigations, updated with more recent studies, and the use of more powerful assessment tools has helped to prepare a better final design.

8.1 Stratigraphy:

Use of more accurate investigation tools (CPTu, Sonic drilling, Tromino) gave a better stratigraphy understanding. The major inputs have been to define the lower clay deposit upper limit and to eliminate the presence of clean sand deposit in the stratified drift.

8.2 Mechanical Properties

From 1965 (NGI) to 2013 (Amec), mechanical properties does not change a lot and the effective cohesion and internal friction angle are very similar. Small change can be come from interpretation process instead the result itself. Mechanical in situ parameter (as shear strength) has been measured in 2013 using the CPT probe to have a continuous profile with depth. Correlation has been done with Cu value from Vane test. OCR show clearly the effect of erosion occurred on both side of the spur.

8.3 Groundwater

Dissipation test done with CPTu confirm and implement the downward gradient on each side of the spur. New data have been used to review the slope stability analysis before, during and after stabilization works.

8.4 Software

The use of more powerful calculation tools permitted building numerical 3D models to represent the North Spur topography and the groundwater conditions. These models are used to reproduce the groundwater behaviour before, and after construction and to follow the effects of the construction activities.

Finite Element Models (FEM) have been used to perform the dynamic and progressive failure studies. 1D and 2D models have been used to refine calculation.

The final design including all information and data has been improved and optimized to stabilise the North Spur accordingly with current standards for dam safety.

9 REFERENCES

- Atkinson, G., 2009. *Earthquake Hazard Analysis: Gull and Muskrat and Gull Damsites, Lower Churchill, Labrador*. Report to SNC-Lavalin.
- Atkinson, G., 2014. *Earthquake Hazard Analysis: Muskrat Damsite, Lower Churchill, Labrador*. Draft Report to SNC-Lavalin, May 22, 2014.
- MWH Americas Inc, 2013. *Interim Independent Engineer's Report, Lower Churchill Project*, November 2013.
- Hatch Ltd, 2013. *Cold Eyes Review of Design and Technical Specifications, North Spur Stabilization Works*, October 2013.
- Idriss, I.M., 2014. *Review of Seismic Performance of the North Spur, Lower Churchill Project*, December 2014.
- Hatch Ltd, 2015. *Three Dimensional (3D) Hydrogeological Study for the North Spur - Final Report*, June 2015