



## GEO-FOUNDATIONS Contractors Inc.

### Maid of the Mist

Date: 2002  
Technology: Soil Anchors

The Maid of the Mist Steamboat Company has operated continuously, in one form or another, since 1876, providing tourists with unparalleled closeup views of Niagara Falls. In 2002, the company installed new winches on the Canadian side of the Niagara Gorge for transferring their six-boat fleet into and out of the river.

Geo-Foundations installed 18 post-tensioned, solid bar soil anchors at the site. Four of the anchors were required for a temporary winch foundation - the other 14 anchors were permanent, double corrosion protected, grade 1030MPa, 26mm solid bar anchors installed to hold down the foundations of the three permanent winches.

A sophisticated approach to drilling was crucial to the success of this project. Access to the site is very restricted - only small trucks can negotiate the narrow driveway down to the base of the gorge, and existing marine rail tracks crowd an already tight location that sees a peak customer presence of 30,000 patrons a day. Compounding this restriction of access is the makeup of the gorge talus deposits that underlay the site. Bedrock is variable in depth (>22m at anchor locations), and the talus deposits are consistently strewn with multiple layers of 6' thick boulders surrounded by a matrix of clean pea gravel and large voids.

In order to tackle these very challenging drilling conditions, holes were drilled using eccentric percussive duplex drilling method. Each anchor hole was cased to its target depth, whereupon the anchor tendon was installed and pressure grouted through a casing cap during casing retraction. At each winch location, grout takes decreased with every anchor installed, as the ground intersected by the anchor borings was progressively consolidated by grout augmented with washout-inhibiting additives.



*Installation of permanent soil anchors using eccentric overburden drilling technique*



*Maid of the Mist Steamboat Company, at the base of the Niagara Gorge*