Use of Micropiles to Rehabilitate High Rise Tower Foundations in Vancouver, B.C.
A Case Study
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Thanks to Anthony Tam, Kani Foundation Technologies
INTRODUCTION

- A 33 Storey High Rise Tower was Constructed in 2005 in downtown Vancouver. The superstructure was supported on up to 5 levels of below grade parking, founded up to 18 m below grade.
- Conventional Foundations were used to support superstructure loads.
- A new tunneled transit link was under construction beginning in 2007 to link the Vancouver International Airport to downtown Vancouver.
- The link included two circular tunnel bores that passed beneath the subject tower.
- The tunnels were to be drilled using a pressure compensated TBM.
SUBSURFACE CONDITIONS

- Dense Lodgement Till Overlying Pre-Glacial Sand at about 10 m Below Grade
- Groundwater table at 15 m Below Grade
- SPT values of 50 to 100 blows/foot
- Pre-Glacial Sand: Fine Grained Silty Sand to Silt with 25 to 65 Percent Fines.

- Shoring Completed Using Staged Anchored Shotcrete (Tensioned Soil Nails)
Figure 1. A Design Section - Southwest Elevation of The Shoring
Figure 2. The Zone of Disturbance (Plan)
Figure 3. The Zone of Disturbance (Section)
PROPOSED REMEDIAL DESIGN BY GEOPACIFIC

- Titan Hollow Core Bar with High Pressure Injection Grouting/Jetting
- Grouting/Jetting at 80 BAR and 120L/min
- Integrate Hollow Core Bar into Foundation Elements After Grouting/Injection Completed
- Structural Designer Consulted to Determine Methodology for Integration with Foundation Elements
- Passive Connection between Foundation and Bar Installed through Cored Hole
Figure 4. The Proposed Hollow Bar Micropile Layout Proposed By GeoPacific Consultants Ltd.
Figure 5. Design of The Micropile
Alternative Remedial Design by Kani Foundation Technologies

- Solid Threadbar Proposed with 3 stages of Secondary Grouting
- Initial/Primary Grouting at 8.5 BAR During Casing Withdrawal
- Secondary grouting at up to 4 levels at 51 BAR
- Secondary Grouting Ports Installed According to Drilling Resistance (Low Resistance Locations were Presumed to be Disturbed)
- Where excessive loose zones were noted 50 mm diameter plastic casing installed with no anchor part to carry out Initial/Primary Grouting
- Anchors and Secondary Grout Tube installed with Centralized after drilling out Initial/Primary Grouted Zone

- Grout Volume Recorded During Primary and Secondary Grouting
Figure 6. General Layout of The Micropile Underpinning Elements With Respect To The Foundations
General Notes.

1. Material
1.1 Anchors
Grade 75 Kai Dywidag #14 Threadbar by
Dywidag Systems International.
Yield Capacity of Threadbar = 1334 kN
Ultimate Capacity of Threadbar = 1779 kN

1.2 Grout
Type 30 Cement, w/c = 0.6(max) for primary grouting with maximum pressure = 125 psi.
Type 30 Cement, w/c = 0.7(max) for post-grouting with maximum pressure = 80 psi.

2. Drilling
Drill hole by using air percussion drilling method with or without casing hammers as required.

3. Installation and Grouting
3.1 Install the pre-assembled threadbar into the bore hole.
3.2 Attach a single post grout line to the anchor with the valve placed at the relativly soft soil strata determined during drilling operation.
3.3 Trim the bore hole with the grout line attached to the bottom of the Anchor.
3.4 Post grout the anchors to maximum 80 psi or 6 bags of Type 30 cement whichever reaches first.

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Figure 7. Proposed Micropile Notes And Details
Figure 8. Results of Drilling And Grouting of The Micropile Installation