Geological Engineering Students at UBC Tackle Geological Uncertainty in their Geotechnical Design Projects

by Dr Erik Eberhardt, P.Eng., Associate Professor, Geological Engineering
Each year, as part of their course “EOSC 433 – Geotechnical Engineering Practice”, Geological Engineering students at UBC take up the challenge of investigating geotechnical design aspects related to a major construction project. Last year, students formed 6 small “consulting” groups of 4 each to study different stability and deformation issues related to different aspects of Vancouver’s Canada Line.

The Canada Line is a 19-km long light metro line that will connect Vancouver’s airport with the city’s downtown (http://www.canadaline.ca/). The line will involve both elevated rail, cut & cover tunnels and a twin-bored TBM tunnel that will pass under False Creek.

The different design objectives the students were given included:

- Stability of deep cut & cover trench in soils and weak rock for vertically double-stacked tunnel layout;
- Settlements around deep cut & cover trench in soils and weak rock for double stacked tunnels;
- Stability of cut & cover trench in basalts along Queen Elizabeth park;
- Stability and minimum cover for twin-bored TBM tunnels in water saturated soil/rock beneath False Creek;
- Minimum pillar width between twin-bored TBM tunnels under downtown; and
- Stress and strain interactions between twin-bored TBM tunnels and downtown office towers.

The teams were required to collect as much data as possible for their study sites (location overview, problem geometry, geology, groundwater conditions, etc.), to use in a series of analyses they performed using one of the techniques covered in class (limit equilibrium, boundary element, finite element, etc.). The familiarity the students gained with the Rocscience software through their weekly lab exercises for the course led most of them to choose either Phase2 and/or Slide for their analyses.
One of the major issues the students had to contend with was parameter and model uncertainty, given that many of the site investigations for the Canada Line were still in progress and therefore data was limited. Students visited their study sites and compiled data from feasibility reports, from which they were required to estimate the required model inputs and justify their assumptions.

Initially, the students expressed frustration at the lack of available information, but quickly began to learn such valuable concepts as “start simple and add complexity as required” and “computer analyses should not be used as a substitute for thinking but as an aid to engineering judgment”. The quickness and ease of the Rocscience software also allowed students to familiarize themselves with the practice of performing sensitivity and probabilistic analyses to contend with parameter and model uncertainty.

Upon completion of their study, each team was required to prepare a professional report and make oral presentations of their findings to the rest of the class. Some of the more interesting presentations were by groups that started to think “outside the box” and worked to answer “what if” scenarios (for example, the influence that any future buildings may have on tunnel stability; for those familiar with the downtown Vancouver skyline, the likelihood of a new high-rise condo development along the Canada Line is highly probable). Students were also quick to point out assumptions made by their classmates that they thought were not valid (how do you install a soil nail that is significantly longer than the excavation is wide at the bottom of a deep trench – it may be easy to do in a model, but in real life…).

Feedback from the students was positive, and they appreciated that the importance of geology and a proper site investigation was reinforced by the issues of uncertainty they faced (and therefore the marketability of their Geological Engineering degrees as they prepare to enter the workforce). Feedback from local mining and geotechnical consulting companies was likewise positive. Many local companies use the Rocscience software and hiring a new graduate who already comes with some familiarity in using these programs, and more importantly, understands the importance of geology and good modelling practice is a bonus.

Dr Erik Eberhardt, P.Eng.
Associate Professor, Geological Engineering

Click the links found on the next page to view two interesting student presentations
Minimum Pillar Width Between Twin Bored Tunnels along Granville St.

International Solutions Ltd.
Veronica Lau, Murthy Pathi, Roaid Strand, Daniela Welkner & Marcia Wilson

Vortech Engineering Ltd.
Canada Line Project

Stability of the Twin Bored Tunnels Under False Creek
Vancouver, British Columbia

By: Catherine Paul, Jen Ramezeh, Matt Gellis, Matthew Yip, and Rual Sharma