**Case Study: Frank Slide at Turtle Mountain, Alberta, Canada**

CEEn 544 – Seepage and Slope Stability

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**History**

The Frank slide occurred in Alberta Canada in the small mining town of Frank in April of 1903. It is the deadliest landslide in Canadian history, which resulted in an estimated 80 deaths and caused a large amount of damage to the town and local mining industry. The slide had many effects as well to town operations and the economy.

The town of Frank is situated at the base of Turtle Mountain and was established in 1901 as a result of the discovery of coal in the area. Mining operations were set up immediately and the small town began to flourish as a result. Unfortunately, Turtle Mountain was the site of what many believed to be an unstable limestone deposit. Two years after the town was established 90 million tons of Turtle Mountain slid into the town and wiped out its entire eastern half burying many residents and miners. The lack of efficient technology to excavate such a large slide meant the debris could not be cleared and buried residents could not be rescued. The coalmines were cleared of debris eventually and mining operations resumed in the town. However, the mines were closed in 1917 and the town no longer saw any growth. The site of the slide remains today almost completely untouched and is a popular tourist destination.

**Failure Background**

The stratigraphy of the mountain is by far the leading cause of failure according to researchers. The geological formation of the mountain is such that rock layering is almost vertical in the area where the slide occurred. A minor thrust fault is even present where the slide pushed out. Although sections of rock would have needed to shear a large portion of the rock would have needed to slide along existing joints.

Several other factors could have also contributed to the failure. In 1901 there was a magnitude 7.8 earthquake in the Aleutian Island that could have weakened the slope. In the 4 years preceding the slide there was above-average rainfall. The higher groundwater table would decrease friction and contribute to the force that displaced part of the mountain. The last major factor is that there was a large amount of coal mining at the base of the mountain. Although the mine did not collapse during the slide, movement in the mine was seen in the days preceding the slide. Researchers conclude that the mine could have acted as a triggering mechanism.

**Analysis**

 We started the analysis by figuring out the geography of Turtle Mountain. We then recreated a general outline of Turtle Mountain using Utexas Educational. The next part was figuring out the materials and the material properties, this also proved to be the most difficult part. We were able to find that the mountain is rock, primarily made of limestone and shales, and the base of the mountain was shale and coal. The information we found gave varying values of unit weight, and friction angle, only one paper gave us cohesion. So we used approximate values and tried to fit the model with how the mountain failed. We then place a starting circle and ran our first model without a tension crack. We got a factor of safety of 0.751 and a slide force inclination of 55.76 degrees.

 The main argument surrounding the slide was if over mining caused the slide, or if it was caused by something else. So we ran our Utexas model while changing the slope of the base of the mountain to represent mining, and by adding tension cracks. The analysis with tension cracks decreased the factor of safety against failure and the changing of the slope of the base of the mountain had no effect on the factor of safety, this is what Benko and Stead argued in their analysis. We agree with them that the failure was not due to mining, but due to tension cracks, an unusually wet period, and mountain creep.

**References**

Benko, Boris, and Doug Stead. “The Frank Slide: A Reexamination of the Failure Mechanism.” Canadian Geotechnical Journal Can. Geotech. J. 35.2 (1998): 299-311. Web.

Cruden, D.m., and J. Krahn. “Frank Rockslide, Alberta, Canada.” Developments in Geotechnical Engineering Rockslides and Avalanches, 1 – Natural Phenomena(1978): 97-112. Web.

Norris, D.K. 1955. Blairmore, Alberta. Geological Survey of Canada,Ottawa, Ont., Paper 55-18.