A Preliminary Study on the Engineering Properties of Clay Soil

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Supported By:

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Introduction

- Karl Von Terzaghi, the father of soil mechanics, says, “There is no other soil which is as problematic as clay soil”. However, in many places across the badlands of Alberta, there is an abundance of this problematic soil.
- Climate conditions, erosion and weathering can cause the unstable clay soil to create landslides, which consequently damage many structures.

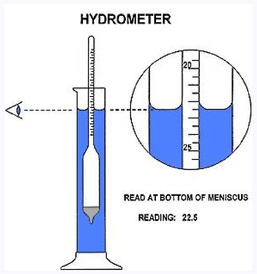


Figure 1: Hydrometer apparatus

- The purpose of this study is to learn and understand the properties of different clay soils through soil classification tests.
- This knowledge will help us to have a better understanding about the soil properties of the land in the Central Alberta region and the main cause of landslides in these areas.

Lab Testing

- The properties of fine grained soils are influenced by both the size and composition of their particles.
- Index tests were performed to determine the basic properties of clay soil. These tests are an indication of likely engineering properties.
- The tests performed for this study include:
  - Pycnometer Analysis: to determine the specific gravity of the soil
  - Hydrometer Analysis: a sedimentation process to determine the particle size of silts and clays.
  - Atterberg Limits
    - Liquid limit
    - Plastic limit

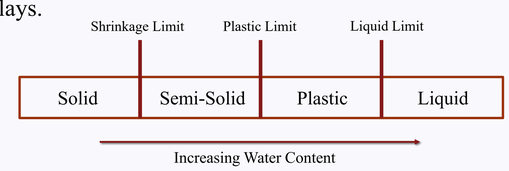


Figure 3: Atterberg limits diagram (modified from Das, 2009)

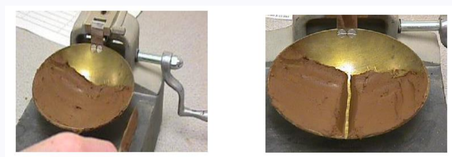


Figure 2: Liquid limit apparatus with soil - before and after cutting the groove (Pic Courtesy: ASTM 4318)

Results

Specific gravity of kaolinite clay at 20℃ = **2.51**

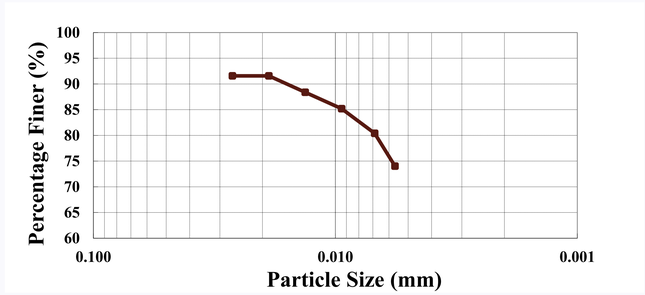


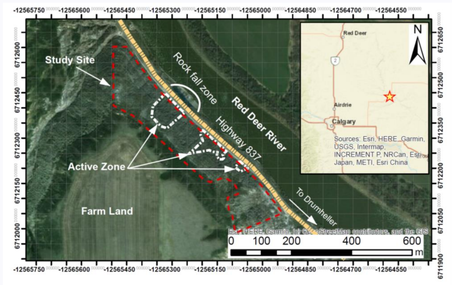
Figure 4 : Hydrometer analysis of kaolinite clay soil

Soil + Pore Fluid	Kaolinite + Distilled Water	Kaolinite + Saline Water	Bentonite + Distilled Water	Bentonite + Saline Water
Liquid Limit	57.25%	54.33%	311.94%	155.36%
Plastic Limit	37.23%	33.85%	70.15%	44.15%
Liquidity Index	20.02%	20.48%	241.79%	111.21%

Table 1: Atterberg limits test results

- The Atterberg limit values of kaolinite clay are less than that of bentonite. This is due to the high swelling capacity of montmorillonite content in the bentonite soil and is also due to the high cation exchange capacity of bentonite.
- For both soil types, the liquid limit value and plastic limit value decreases with the addition of salt water. This is accounted for as the exchangeable cation present in salt water and is also due to the reduction in the thickness of diffused double layer by the addition of saline water.

Field Work Site



- On July 31, 2019, a site visit was performed to monitor the conditions of a slope in the Drumheller area one year after a landslide occurrence.
- This map shows the location of the site, which is located near Drumheller, next to the Red Deer River.

Field Work

- During the field trip, soil was collected from the site prone to landslides for further investigation at laboratory. The soil of this area mainly consisted of bentonite, silt stone, and clay shale.
- In-situ tests were performed on site to get an estimation of the strength properties of the failed and not failed soil samples.
- The tests performed on the site are known as the pocket VANE shear test and pocket penetrometer test.
- The results from the in-situ tests and lab will be used to correlate the soil properties to the mechanism of landslide in this site.

Figure 5: Research group observing the conditions of the site.

Conclusions

- This research is a preliminary study to get hands-on-experience with a few lab tests that are used to evaluate the strength and stiffness of a soil.
- Index tests have been done in order to find the basic classification of some clay soils. Properties of different clay soils can alter their index test results greatly, such as the comparison between kaolinite and bentonite clay.
- Field work was conducted to a landslide prone site to perform some in-situ tests and take more samples for lab tests.
- The same index tests as well as shear strength tests need to be done in the future to evaluate the effect of soil properties on the occurrence of landslides in Alberta’s badlands and similar areas.

Acknowledgments

- I would like to thank the members of my research and field work team; Akhila Palat, Dr. Mahya, Jorge Rodriguez, and Saeed Abdulghany.
- I would also like to thank my sponsors, the WISEST board and Dr. Hendry’s lab, for making this research a reality, and for giving me the opportunity to learn so much. Thank you!

Literature Cited

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- Das, B. M., Fundamentals of Geotechnical Engineering, 3rd edition, Chris Carson, 637 P., 2009.
- Hydrometer picture retrieved from http://www.iricen.gov.in/LAB/res/html/Test-02.html