2014

Geotechnical Engineering: Optimum moisture content for compaction of in situ soil at a residential construction site on Five Mile Prairie, WA.

Natasha Garland Clark
Eastern Washington University

Carly Sorensen
Eastern Washington University

Camie Bearup
Eastern Washington University

Geotechnical Engineering: Optimum Moisture Content for Compaction of In-Situ Soil at a Residential Construction Site on Five Mile Prairie, WA.

Natasha Garland Clark, Carly Sorensen, Camie Bearup, & Dr. Richard Orndorff
Geology Department, Eastern Washington University

Abstract

The residential construction site is located at 9117 Scarlet Sky Drive on the southwest margin of Five Mile Prairie, WA. The footprint of the proposed structure overlaps two soils. Near the road is fill material brought in to form the extended roadbed. Further from the access road is the extant soil that formed in place on the prairie. This site is approximately 2,400ft in elevation, atop basalt. Over time loess and the Glacial Lake Missoula floods shaped the landscape. Grassy, small rolling hills cover the in-situ soil. There is a natural drainage basin below the site that features basalt boulders rimming the edge as a result of many years' past mass wasting. This study presents results for moisture content and compaction of in-situ soil according to ASTM Standard D698. Compaction prior to construction increases unit weight and shear strength for soil, hence increasing resistance to settling and structural damage.

Specific Gravity
ASTM D854

- We collected in-situ soil samples from the Derkey homesite
- In the lab we added ~150g of soil to half a beaker full of water
- Removed entrapped air from the pervious voids of the soil sample by heating the sample for 10 minutes
- After the sample cooled, we filled the flask with water to 500ml, and then poured the contents into a pan to dry
- The G_s of the Derkey home site in situ soil is 2.6

FIG.1. Groups preparing to gather samples at Derkey home site

FIG.2. A. Camie collecting in-situ samples

B. Using Edelman auger to get deep soil samples

FIG. 3. Carly and Natasha gathering samples at another location on the Derkey property

Compaction
ASTM D698

- We weighed out a sample of 7.08lbs of soil
- Added 3% water content of air-dried soil and mixed it into the soil
- Compacted 3 lifts of soil into a standard mold with a 5.5lb hammer dropped from 12inches
- A hydraulic press was used to extrude the soil from the mold
- We took a small sample from each lift, placed it in a small dish, weighed it, and set it in the oven to dry. We then weighed the dry sample to determine the water content percent
- We completed six tests by adding 3% increments of the water content of air-dried soil at the beginning of each test until we reached 18%
- The optimal water content for compaction is 12.7%, with a 95 percentile range of 107 – 113 unit dry weight (pcf)

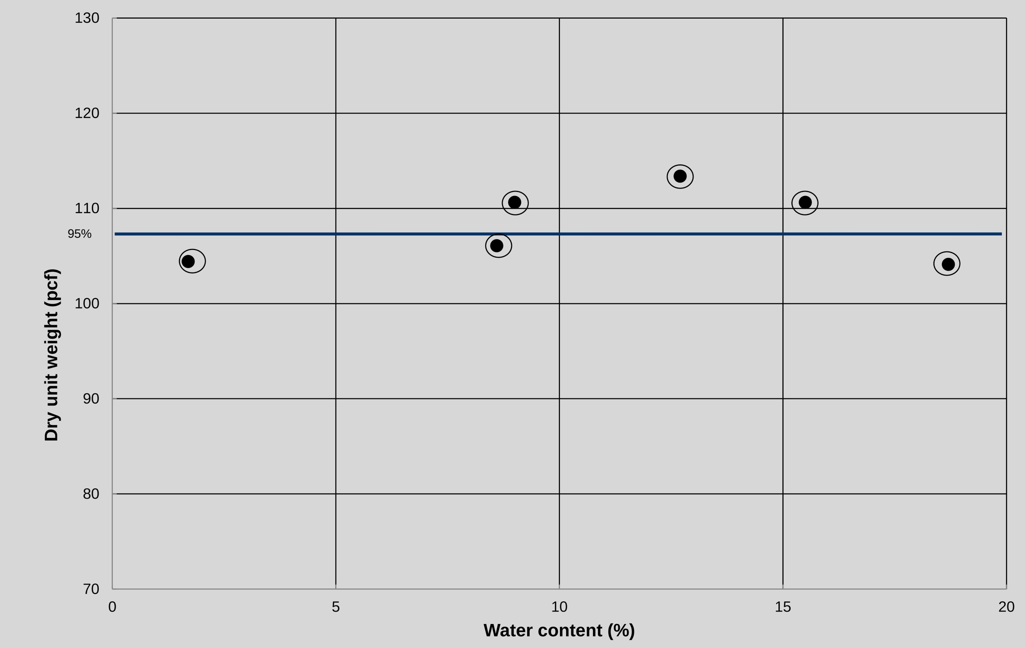


FIG. 5. Graph shows optimum water content and 95 percentile range for optimal compaction

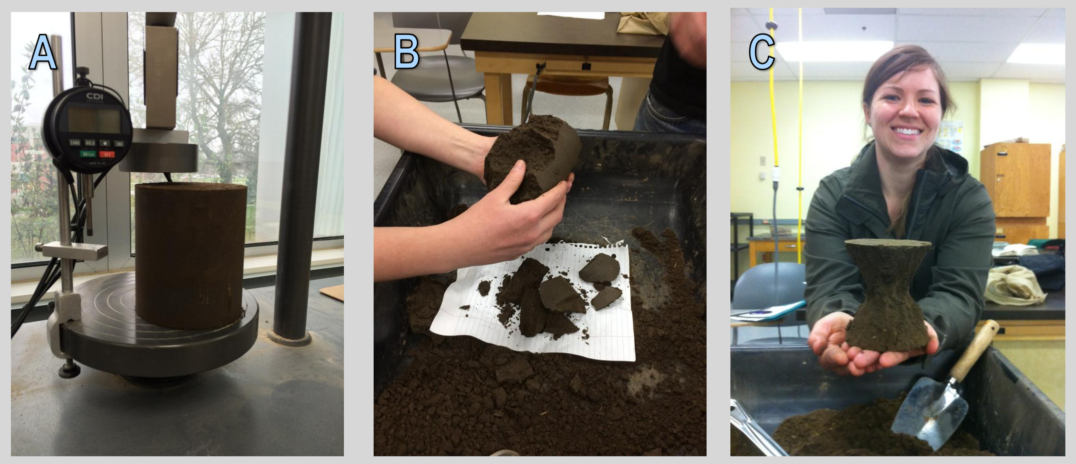


FIG.4. A. Sample on load frame B. Breaking sample apart C. Measuring shear planes

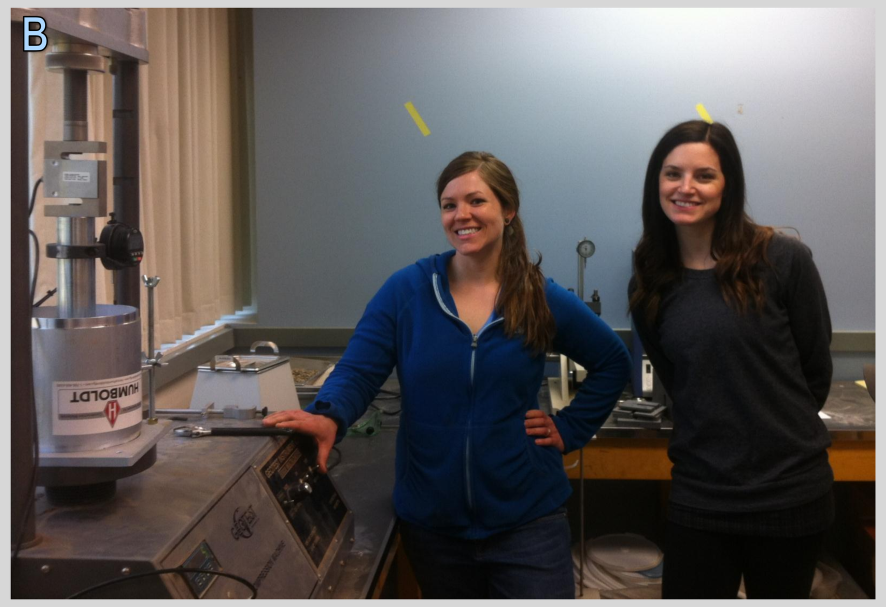
FIG. 6. A. Natasha breaking compacted sample B. 1 of 6 in-situ soil samples in frying oven

California Bearing Ratio (CBR)
ASTM D1883

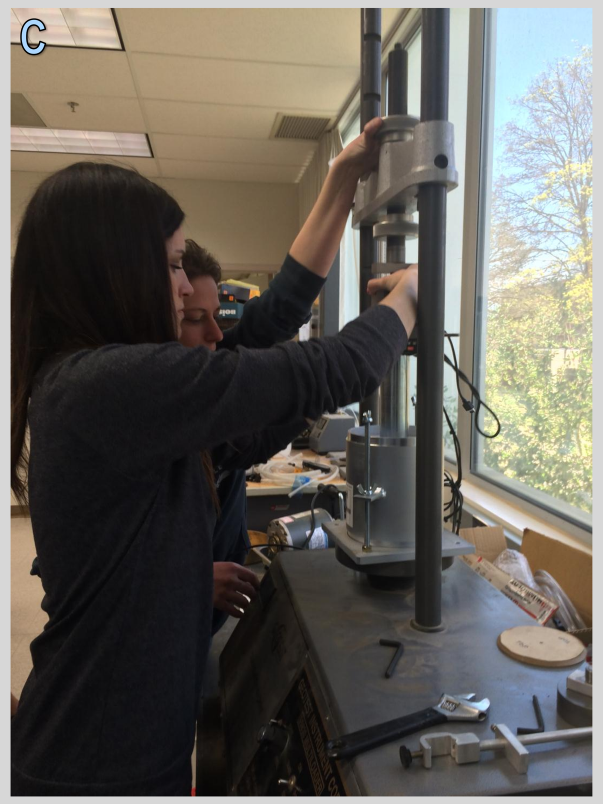
This test is used to determine a soils penetration resistance. It determines the quality of a soil and its ability to hold weight (for example how it will behave under a highway). A summarized prep for this test includes:

- Weigh out between 10-12lbs of in-situ soil, sieve using 3/4mm opening
- Add 12.7% maximum weight in water to soil sample (mix)
- Create 3 lifts using 5.5lb hammer, 56 blows to each lift
- Place mold with soil on penetration load frame and begin to test sample
- Record force in pounds (lbs) and calculate stress in pounds per square inch (psi) to determine were sample classifies on CBR standard
- The sample was (8.04%) for good subgrade to fair sub-base soil, which means it is of decent quality

FIG. 7 A. Natasha preparing 1 of 3 lifts



B. Camie and Carly getting machine prepared for test



C. Carly and Natasha preparing the sample for CBR testing

Sieve and Hydrometer Analysis
ASTM D422

Testing for the uniformity coefficient (C_u) and the coefficient of curvature (C_c) using sieve and hydrometer analysis under ASTM Standard D422.

Sieve Analysis:

- Used mortar and pestle to separate soil into individual particles
- Measure 500.0g in-situ soil
- Sieved soil, weighed, and calculated percent finer

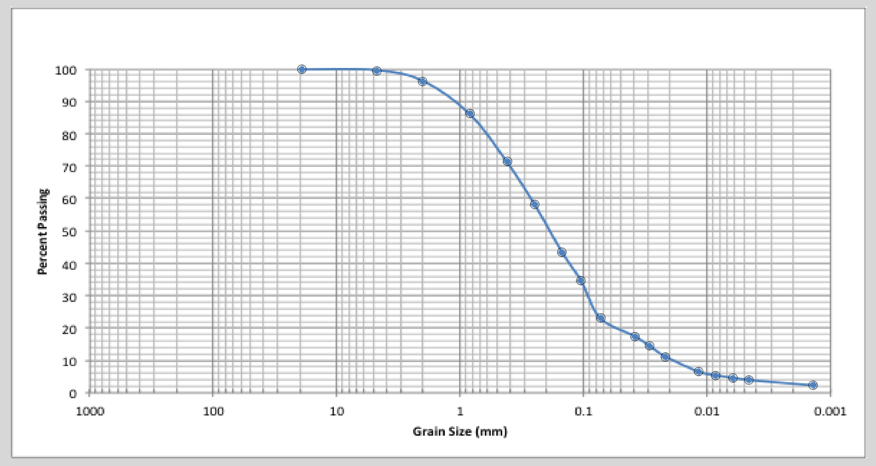


FIG.8. Graph of grain size distribution for sieve and hydrometer

Hydrometer Analysis:

- We measured a 51.4g in-situ soil
- Dissolved exactly 5.0g of $(NaPO_3)_6$ in water to prevent soil from sticking together
- Mixed soil with extra water and blended together before adding to hydrometer tube
- Poured sample into the hydrometer tube and filled with water to 1,000 mL
- Inserted hydrometer into the hydrometer tube and let stabilize
- Readings were taken from the hydrometer including temperature, after specific elapse times, ranging from 1 minute to 4 hours
- The readings and standard tables were used to calculate the percent finer for the hydrometer sample, and then adjusted values were calculated for plotting and correlation
- The data was used to calculate the uniformity coefficient and the coefficient of curvature

Cc:	Cu:	Gravel %:	Sand %:	Fines %:
2.06	15.0	1	76	23

Table 1. Coefficient of curvature value, coefficient of unconformity and percentages of grain size

FIG. 9. A. Mixing the sample B. Natasha sets the sieve C. Camie weighs pans D. Hydrometer test

Key Points

- **The specific gravity of the sample was 2.6**
- **The in-situ sample was composed of 1% gravel, 76% sand, and 23% fines**
- **The optimum water content for compaction was 12.7% with a 95 percentile range of 107-113 unit dry weight (pcf)**
- **The CBR test shows that the in-situ soil at 8.04% is considered a good subgrade or fair sub-base soil**

References and Acknowledgments

Schroeder, W.L., Dickenson, S.E., and Warrington, D.C., 2004, Soils in Construction, Upper Saddle River, NJ, 5th edition, p. 1-354.

Thank you to Dr. Richard Orndorff in the Eastern Washington University Geotechnical/Geology Department.