Memo

From: Flagstaff Fireshed Hydrology

Date: 11/12/2013

Re: Dry Sieve of Soil

Introduction

The distribution of the various particle sizes is very important in determining the classification and characteristics of a coarse soil. This test is to determine particle size distribution of a coarse soil to sort the soil through a series of wire mesh sieves, and use the calculation results to identify the soil used in the Shultz fire site. Sieve analysis is a method used to determine the grain size distribution of soils. The sieve analysis consists of preparing a soil sample with known weight of solids, and passing it through the stack of sieves. The sieves are arranged in order with the coarsest one on top of the stack and decreasing sieve sizes down the stack. In this memo, the data is from Flagstaff Fireshed Hydrology group test, and the two classifications (AASTHO and USCS) will be used to determine the soil's property.

Methodology

a) Equipment used: Sieves: (# 4, #10, #20, #40, #100, #140, #200), Pan, Lid, Electronic balance sensitive to 0.01g, Mortar and rubber-tipped pestle, Mechanical sieve shaker, Bowl.
Table 1: The U.S. standard sieve numbers with their corresponding opening sizes.

Sieve No.	Opening (mm)
4	4.75
10	2.00
20	0.85
40	0.425
100	0.150
140	0.106
200	0.075

b) Procedure:
   1) Obtain a stack of sieves including #4, #10, #20, #40, #100, #140, and #200 meshes, and a pan and lid. Clean the sieves thoroughly so that no particles are stuck or adhering to the mesh. Weight each of the sieves and the pan, and record the masses to the nearest 0.01 gram. Assemble the stack of sieves with the pan on the bottom, #200 next, and

increasing in size toward the top.

2) Carefully pour the sample into the #4 sieve and cover with the lid. Securely place the sieve stack on a shaker and shake for about six minutes.
3) Very carefully separate the sieves (sometimes four hands are required). Weight each sieve and the pan along with the contents of each. Record all of the information on the supplied data sheet and complete the calculations.
4) Graph the data on the sheet and draw a smooth curve through the data points. Determine the sizes, in mm, for D10, D30, and D60.
5) Compute the Coefficient of Uniformity, Cu=D60/D10; and the coefficient of Curvature, Cc= $(D30)^2$/ (D10*D60).
6) Using the above data and the appropriate tables in Coduto text book, determine the Unified and AASHTO classifications of the soil.

c) AASHTO Classification

The AASHTO classification system uses both particle size distribution and Atterberg limits data to assign a group classification and a group index to the soil. This system can be used to determine the group classification. To use the table in appendix B, begin on the left side with A-1-a soils and check each of the criteria. If all have been met, then this is the group classification. If any criterion is not met, step to the right and repeat the process, continuing until reaching the first column for which all the criteria have been satisfied.

USCS Classification

The USCS system is an all-purpose system. To use USCS, begin with an initial classification to determine whether the soil is organic or not:

- Composed primarily of organic material
- Dark brown, dark gray, or black color
- Organic odor, especially when wet
- Soft consistency

Conduct a sieve analysis to determine the particle size distribution curve. On the basis of the particle size distribution curve, determine the percent by weight passing the 3-in., #4, and #200 sieves, and then compute the percentages by weight of gravel, sand, and fines. If 100% of the sample passes the 3-in. sieve and 5% or more of the soil passes the #200 sieve, then conduct Atterberg limits tests to determine the liquid and plastic limits. If the soil is fine-grained (i.e., ≥50% passes the #200 sieve), follow the directions for fine-grained soils. If the soil is coarse-grained (i.e., <50% passes the #200 sieve), follow the directions for coarse-grained soils.

Result

These data is showed in Appendix A

Sieve Size	Mass Retained (g)	Mass Passed(g)	Total Percent Passed
4	66.18	433.82	86.76%
10	80.29	353.53	70.71%
20	77.02	276.51	55.30%
40	67.56	208.95	41.79%
100	89.68	119.27	23.85%
140	59	60.27	12.05%
200	47.26	13.01	2.60%
Pan	12.15	0.86	0.17%

The coefficient of uniformity Cu= 12
The coefficient of curvature Cc= 0.27

Analysis and Discussion

AATHO Classification:
Use the table in Appendix B
#10(%) = 70.71
#40(%) = 41.79 <50
#200(%) = 2.60 < 25
Therefore, group classification: **A-1-b.**
The soil is granular material.
USCS Classification:
Use the figure in Appendix C
%sand= #4-#200=86.76%-2.60% = 84.16%
%sand > %gravel
2.60% passes #200
Cu>6, Cc<1
The group sample is SP.
%gravel<15%
Soil Description: **SP-Poorly graded sand.**
This soil is reasonably unstable because Cc is less than 1.
From the data, we can figure out that the experiment is almost precise. There also have

some errors during the process: the equipment has some errors for the result and the shaker can’t perfectly separate the soil. But the errors can be ignored, and they have little influence on the final result.

Conclusion

This test is to determine particle size distribution of the soil which is excavated from Schultz fire site. At first, we sort the soil through a series of wire mesh sieves, and then we determine the Unified and AASHTO classifications of the soil. According to the AATHO classification, the soil can be described as A-1-b. The soil is also described as SP-Poorly graded sand based on the USCS classification. It is unstable when value as fill material.

Reference

Professor Nelson, “Dry Sieve of a Coarse Soil” Guidance.

Appendix A

Mass of total air-dried sample: 500.00g

Sieve Size	Mass of Sieve (g)	Mass Passed(g)
4	515.96	582.14
10	447.82	528.11
20	414.18	491.20
40	357.64	425.20
100	413.91	503.59
140	336.51	395.51
200	350.48	397.74
Pan	367.75	379.90

Cu= D60/D10= (1.2mm)/ (0.1mm) = 12

Cc= $(D30)^2$/ (D10*D60) = $(0.18mm)^2$ / (0.1mm*1.2mm) = 0.27

Appendix B

Table for AASHTO Soil Classification System

The **AASHTO Soil Classification System** was developed by the American Association of State Highway and Transportation Officials, and is used as a guide for the classification of soils and soil-aggregate mixtures for highway construction purposes. The classification system was first developed by in 1929, but has been revised several times since.

AASHTO Soil Classification System (from AASHTO M 145 or ASTM D3282)

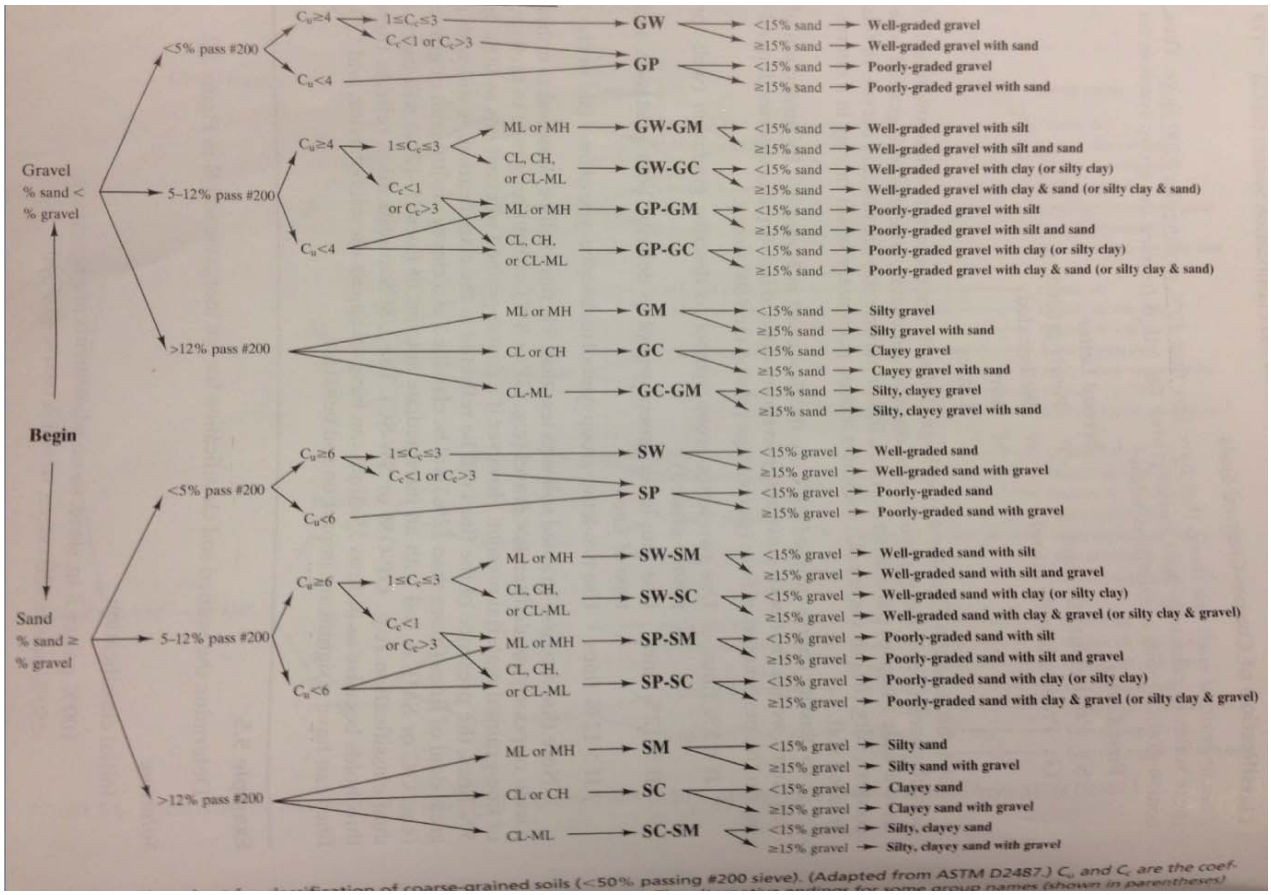
General Classification	**Granular Materials (35% or less passing the 0.075 mm sieve)**							**Silt-Clay Materials (>35% passing the 0.075 mm sieve)**			
Group Classification	A-1		A-3	A-2				A-4	A-5	A-6	A-7
	A-1-a	A-1-b		A-2-4	A-2-5	A-2-6	A-2-7				A-7-5 A-7-6
Sieve Analysis, % passing											
2.00 mm (No. 10)	50 max	...	...	...	...	...	...	...	...	...	...
0.425 (No. 40)	30 max	50 max	51 min	...	...	...	...	...	...	...	...
0.075 (No. 200)	15 max	25 max	10 max	35 max	35 max	35 max	35 max	36 min	36 min	36 min	36 min
Characteristics of fraction passing 0.425 mm (No. 40)											
Liquid Limit	...		...	40 max	41 min	40 max	41 min	40 max	41 min	40 max	41 min
Plasticity Index	6 max		N.P.	10 max	10 max	11 min	11 min	10 max	10 max	11 min	11 min[1]
Usual types of significant constituent materials	stone fragments, gravel and sand		fine sand	silty or clayey gravel and sand				silty soils		clayey soils	
General rating as a subgrade	excellent to good							fair to poor			

Note (1): Plasticity index of A-7-5 subgroup is equal to or less than the LL - 30. Plasticity index of A-7-6 subgroup is greater than LL - 30

www.absoluteastronomy.com/topics/AASHTO_Soil_Classification_System

Appendix C

Chart for USCS Soil Classification System



...classification of coarse-grained soils (<50% passing #200 sieve). (Adapted from ASTM D2487.) C_u and C_c are the coef-...for some group names (shown in parentheses)

Appendix D

Particle size distribution curve for the soil