Soil Classification Systems
- Soil classification systems are used to class soils into groups and subgroups based on their engineering behavior.
- Systems use common language to concisely express general characteristics without detailed descriptions.

Soils Classification Systems
- USDA
- AASHTO
- USCS

USDA Classification
- Developed by United States Department of Agriculture to provide indication of soils ability to support plant/crop growth.
- Textural classification system.
- Based on relative proportions of Sand, Silt, and Clay.
USDA Classification
- Complete a grain size analysis of soil
- Determine %G, S, M, C
- Adjust %S, M, C based on gravel content
- Use textural triangle to classify soil
- Use name modifier to account for gravel content

USDA Example

<table>
<thead>
<tr>
<th>Grain Size, mm</th>
<th>% Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.002</td>
<td>P = 4%</td>
</tr>
<tr>
<td>0.05</td>
<td>R = 84%</td>
</tr>
<tr>
<td>2</td>
<td>P = 20%</td>
</tr>
<tr>
<td>20</td>
<td>R = 80%</td>
</tr>
<tr>
<td>84</td>
<td>S = 64%</td>
</tr>
<tr>
<td>12</td>
<td>M = 16%</td>
</tr>
<tr>
<td>4</td>
<td>C = 4%</td>
</tr>
<tr>
<td>1</td>
<td>S = 16%</td>
</tr>
<tr>
<td>0.1</td>
<td>M = 20%</td>
</tr>
<tr>
<td>20</td>
<td>S = 80%</td>
</tr>
<tr>
<td>100</td>
<td>C = 5%</td>
</tr>
</tbody>
</table>

USDA Example
- 20%G, 64%S, 12%M, 4%C
- 80% S,M,C
- Modified S,M,C contents
  - %S' = 64%/0.8 = 80% S
  - %M' = 15% M
  - %C' = 5% C
Gravel Modifier
- If \%G<15\%, no modifier
- If 15\%<\%G<50\%, add gravelly
- If \%G>50\%, add very gravelly

- In example, \%G=20\%; therefore, soil is classed as Gravelly Loamy Sand

AASHTO Classification
- Developed in 1929 by the Bureau of Public Roads
- Currently uses seven major groups of soils, A1 to A7
- Provides a general rating of the soil as a subgrade for road construction
- Considers grain size distribution and plasticity of fines (P_{40})
AASHTO Classification
- Coarse grained, granular soils have $P_{200} \leq 35\%$ (A1 to A3 soils)
- Fine grained silty and clayey soils have $P_{200} > 35\%$ (A4 to A7 soils)
- Soils classes based on elimination using Table 2.4 in text or with plasticity chart
- Group Index also calculated as a relative within group indicator

AASHTO Group Index
- $GI = (F - 35)[0.2 + 0.005(LL - 40)] + 0.01(F - 15)(PI - 10)$
- $F = P_{200}$
- For A-2-6 and A-2-7, use $GI = 0.01(F - 15)(PI - 10)$
- GI reported in parenthesis as integer
- If GI < 0, use 0

AASHTO Plasticity Chart
- Low Compressibility, Shrink-Swell
- High Compressibility, Shrink-Swell
AASHTO Example

- $P_{10} = 80\%$
- $P_{40} = 52\%$
- $P_{200} = 20\%$

Because $P_{200} < 35\%$, Coarse Soil

Because $P_{10} > 50\%$, not A-1-a

Because $P_{40} > 50\%$, not A-1-b

Because $P_{200} > 10\%$, not A-3

So must be A-2 soil, use plasticity chart

AASHTO Plasticity Chart

Plasticity Index (PI) = 15

Loam with moderate plasticity
AASHTO Classification
- A-2-6 Soil
- GI=0.01(20-15)(15-10)=0.25=1
- So soil is A-2-6 (1)
- Clayey Sand & Gravel

Unified Soil Classification
- Developed by Casagrande in 1942
- Widely used by geotechnical engineers
- Considers grain size distribution and plasticity of fines ($P_{40}$)
- Coarse Grained: $P_{200} < 50\%$
- Fine Grained: $P_{200} \geq 50\%$

USCS Symbols
- G – gravel  S – sand
- M – silt  C – clay
- O – organic
- W – well graded
- P – poorly graded
- L – low plasticity (LL < 50)
- H – high plasticity (LL \geq 50)
USCS Process

- If $P_{200} < 50$; Coarse Grained
- G or S based on which proportion is greatest
- If $P_{200} < 5$, consider only gradation parameters $C_u$, $C_s$
- If $P_{200} > 12$, consider only plasticity
- If $5 \leq P_{200} \leq 12$, consider both

USCS Process

- If $P_{200} \geq 50$ – Fine Grained
- M or C based on plasticity
- O based on LL before and after oven drying

USCS Plasticity Chart
USCS Process

- Group Symbol determined as outlined previously
- Group Name determined based on percentages of other soil components using decision tree process shown in Figures 2.13 and 2.14
USCS Example

- $P_4 = 93\%$
- %G = 7
- $P_{200} = 20\%$
- %S&G = 80
- %S = 73

USCS Example

- $P_4 = 93\%$, $P_{200} = 20\%$, %G = 7, %S = 73
- LL = 35, PL = 20, PI = 15
- Because $P_{200} \leq 50\%$, Coarse Soil
- Because %S > %G, Sand
- Because $P_{200} > 12\%$, use plasticity chart

USCS Plasticity Chart

- LL = 35, PI = 15
- Soil fines are Clay
USCS Example

- Group Symbol is SC
- Because %G<15, Group Name is Clayey Sand