Grain Size Analysis of Fine-Grained Fraction

Procedure

1. Obtain the equivalent of 50 gm of dry soil. (do not oven dry the soil, use $W_{wet} = W_{dry} (1+w_c)$)
2. Obtain a water content.
3. Mix the soil to a thick slurry using 125ml of a 40 gm/litre solution of sodium hexametaphosphate (or Calgon) and distilled water as necessary.
4. Allow the solution to soak for 16 hrs.
5. Mix the slurry in a blender for 60 sec.
6. Transfer to 1000cc cylinder and fill with distilled water.
7. Mix thoroughly and begin sedimentation experiment.
8. Obtain two sets of specific gravity readings ($r_h$) for the first two minutes of sedimentation with the hydrometer remaining in suspension. Obtain readings at 4, 15, 30, 60, 90, 120 seconds.
9. Remix the slurry and obtain readings at 2, 4, 8, 16, min., etc. Take readings for at least two days or until suspension is clear.
10. At the end of the experiment, obtain the final dry weight of soil.

Procedure: Hydrometer Calibration

1. Correct the hydrometer readings for temperature, the dispersing agent and the meniscus by taking a specific gravity reading ($r_w$) or a liquid composed of distilled water and dispersing agent in the same proportion as in the sedimentation test. Obtain this correction each time the sedimentation specific gravity is measured.
2. Calculate (and plot) the effective depth ($H$) of the hydrometer versus the hydrometer reading.
   a) Determine the center of volume as the midpoint of the bulb.
   b) Calculate the reading depth ($H_r$) as the distance from a particular reading and the center of volume.
   c) During the first 2 min. of a test the effective depth is the reading depth plus the meniscus correction ($c_m =$ top to bottom of meniscus).
   d) Calculate the area of the cylinder ($A_j$) from the volume and distance between calibration marks.
   e) Measure the volume of the hydrometer ($V_H$) by water displacement.
   f) For readings after 2 min. the effective depth is
      \[ H = H_r - \frac{V_H}{2A_j} + C_m \]
Calculations:

Grain Size

a) Mechanical Method.
The sieve size is printed on each sieve.
b) Sedimentation Method.
The maximum diameter still in solution at and/or above the center of volume of the hydrometer is

\[
D = \left( \frac{18 \eta H}{t(\gamma_s - \gamma_w)} \right)^{1/2}
\]

where \( \eta \) = Viscosity of water
\( H \) = distance from top of meniscus to center of hydrometer bulb
\( t \) = elapsed time
\( \gamma_s \) = unit weight of soil
\( \gamma_w \) = unit of weight of water

Quantity of Soil Less Than Given Size

a) Mechanical Method

\[
N(\%) = \frac{\text{Total wt.} - \sum \text{wt. on larger sieves}}{\text{Total wt}} \times 100
\]

b) Sedimentation Method

\[
N(\%) = \frac{V}{W_s} \cdot \frac{G_s}{G_s - 1} \gamma_c (r_h - r_w) \times 100
\]

where \( V = \) volume of suspension
\( W_s = \) total dry wt. of soil
\( \gamma_c = \) unit weight of water at hydrometer calibration temp.
\( r_h = \) hydrometer reading in suspension
\( r_w = \) hydrometer reading in calibration liquid

b) Error Analysis

Check the mass balance between the initial ‘wet’ weight and water content, and the sum of the oven dried portion retained on the sieves and passing #200.
# Hydrometer Analysis Data Form

**Date**  
__________________________

Tested by  
__________________________

**Sample Description**  
________________________________________________

<table>
<thead>
<tr>
<th>Wt. Container + Dry Soil</th>
<th>__________</th>
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<tbody>
<tr>
<td>Container Wt.</td>
<td>__________</td>
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<tr>
<td>Wt. Dry Soil</td>
<td>__________</td>
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<tr>
<td>Specific Gravity</td>
<td>__________</td>
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<tr>
<td>Hydrometer No.</td>
<td>__________</td>
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<tr>
<td>Meniscus Correction</td>
<td>__________</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Elapsed Time (min)</th>
<th>$r$</th>
<th>$r_w$</th>
<th>Temp ($^\circ$C)</th>
<th>$r - r_w$</th>
<th>$N$ (%)</th>
<th>Fall Dist, H</th>
<th>$(H/l)^{1/2}$</th>
<th>D</th>
<th>$N'$</th>
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