

53:030 SOIL MECHANICS
Civil & Environmental Engineering
The University of Iowa
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Supplemental Problems for Homework Assignment #1.

The textbook does not define the term relative density. Since this a term commonly used in American soil mechanics, it is defined here.

Relative density D_r is a dimensionless measure of the tightness with which a given soil's grains are packed. It has the following mathematical definition:

$$D_r = \frac{e_{\max} - e}{e_{\max} - e_{\min}} \cdot 100\%$$

where :

e is the soil's current void ratio

$e_{\min}$ is the soil's void ratio when the grains are as **tightly** packed as possible

$e_{\max}$ is the soil's void ratio when the grains are as **loosely** packed as possible

Therefore, when a given soil has $e = e_{\min}$, $D_r = 100\%$. And when the grains of the same soil are re-arranged loosely such that $e = e_{\max}$, then $D_r = 0\%$.

Theory Questions:

1) Prove the following relations:

$$a) \quad S = \frac{wG_s(1-n)}{n}$$

$$b) \quad D_r = \frac{\gamma_d - (\gamma_d)_{\min}}{(\gamma_d)_{\max} - (\gamma_d)_{\min}} * \left\{ \frac{(\gamma_d)_{\max}}{\gamma_d} \right\}$$

Problem-solving Questions:

2) The mass of a sample of saturated soil is 520 grams. The dry mass after oven drying is 405 grams. Determine: a) the water content, b) the void ratio, c) the saturated unit weight, and d) the effective unit weight. Assume $G_s = 2.7$.

- 3) A saturated silty clay found in a deep excavation is found to have a water content of 23%. Assuming that $G_s = 2.65$, determine the soil's porosity and bulk unit weight.
- 4) A sandy soil has a natural water content of 27.5% and bulk unit weight of 19.5 kN/m^3 . The void ratios corresponding to the loosest and densest state of this soil are 0.87 and 0.51, respectively. Find the relative density and degree of saturation for this soil in its natural state. (Assume $G_s = 2.7$)