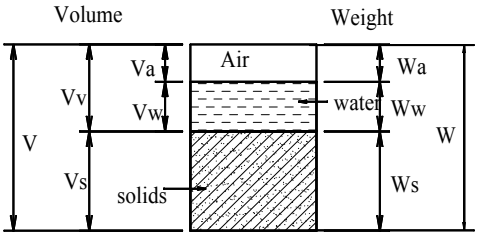
Example 1

A soil sample has a void ratio of 0.8, degree of saturation of 0.9 and G_s of 2.68. Using SI units compute, total unit weight, dry unit weight, water content, and saturated unit weight.

Solution



Phase diagram

Assume $V_s = 1\ m^3$

$$e = \frac{V_v}{V_s}$$

, $V_v = 0.8\ m^3$

$$S = \frac{V_w}{V_v}$$

, $V_w = 0.9x0.8 = 0.72\ m^3$

$W_w = 0.72 \times 9.81 = 7.063\ kN$

$W_s = 2.68 \times 9.81 \times 1 = 26.29\ kN$

$$\gamma_t = \frac{7.063 + 26.29}{1.8} = 18.53\ kN/m^3$$

$\gamma_d = 26.29/1.8 = 14.61\ kN/m^3$

$$w = \frac{7.063}{26.29} \times 100 = 26.87\%$$

$V_w = 0.8\ m^3$

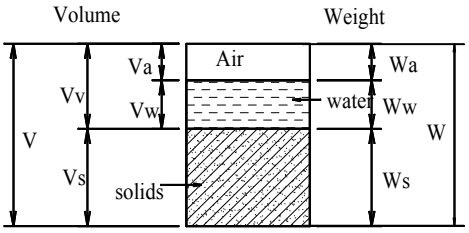
$W_w = 0.8 \times 9.81 = 7.848\ kN$

$$\gamma_{sat} = \frac{7.848 + 26.29}{1.8} = 18.97\ kN/m^3$$

Example 2

A saturated sample of soil in a water content container weighed 60g. After drying in air its weight was 50g. The container weighed 10g. Specific gravity of the soils was 2.7. Determine

water content
void ratio
total unit weight
dry unit weight



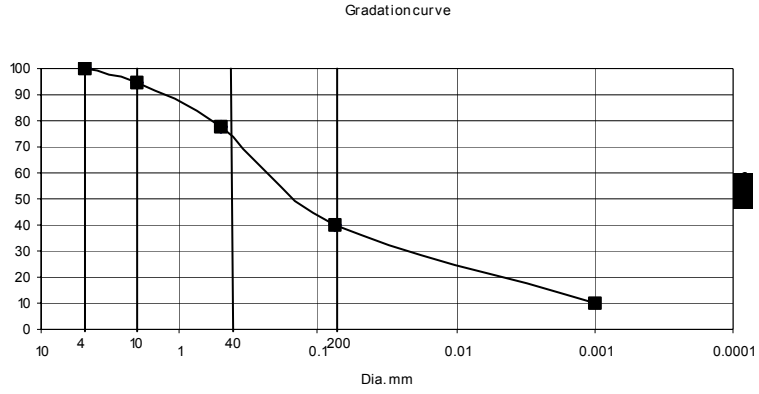
Phase diagram

effective unit weight
Solution:

a) water content
W_w = 60-50=10g
W_s= 50- 10 = 40g
w = (10/40)*100 = 25%
void ratio
$V_w = V_v$ = 10/1 = 10ml
V_s = 40/2.7*1 = 14.815
e = 10/14.815=0.675
c) Total unit weight
γ = (60-10)/(10+14.815) = 2.05g/ml
Dry unit weight
γ_d = 40/(10+14.815) = 1.61g/ml

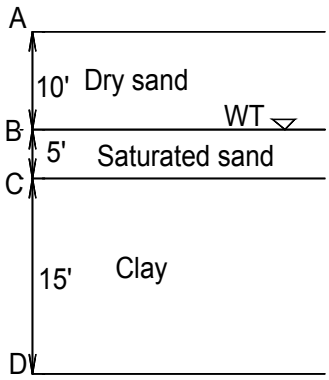
Example 3

Classify the soil shown. LL =40, PL = 26



Example 4

At a site there is 15 thick layer of sand with water table at 10' depth. Top 10' of sand was dry with e = 0.6, G_s = 2.65. Below the WT the sand had e = 0.48. Underneath the second sand layer was 15' thick clay deposit, with w = 33 %, G_s = 2.75. Draw total stress, pore water pressure and, effective stress diagrams for the entire depth.



Solution:

$\gamma_{dry(sand)} = 103.35$ lb./ft^3 $\gamma_{sat(sand)} = 131.97$ lb./ft^3 $\gamma_{sat(clay)} = 119.65$ lb./ft^3

	thickness ft	σ - psf	u - psf	σ' psf
A	0	0	0	0
B	10	103.35×10 = 856.7	0	1033.5
C	5	1033.5+131.97×5=1693.4	62.4×5=312	1381.4
D	15	1693.4+119.65×15=3488	62.4×20=1248	2240

Example 5

For a NC soil in the following data were obtained from a consolidation test:

Stress, tsf	void ratio
1.30	0.95
3.50	0.70

Determine C_c, and void ratio corresponding to a stress of 2.0 tsf.

Solution

$$C_c = \frac{e_1 - e_2}{\log p_2 - \log p_1}$$

$$C_c = \frac{0.95 - 0.70}{\log 3.50 - \log 1.30} = 0.581$$

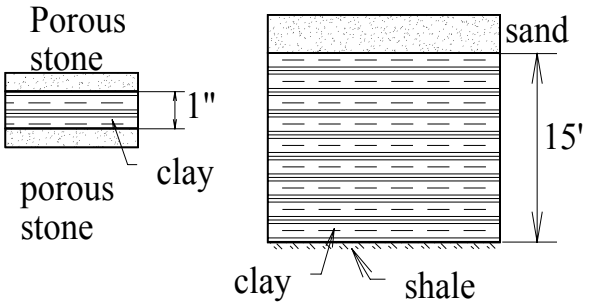
$$0.581 = \frac{0.95 - e_2}{\log 2.0 - \log 1.3}$$

Therefore, $e_2 = 0.841$

Example 6

For the clay soil in example 5 a test specimen for consolidation test was 1 in. thick. Under a stress of 2.5 tsf, time required for 50% consolidation was 5 min 20 sec. How long will it take for 50% consolidation for the 15 ft thick clay layer in the field if:
there is impervious shale under clay
(b) there is sand under the clay
(c) 80% consolidation for (b)?

Solution:



(a) $$\frac{T_1 H_{d1}^2}{t_1} = \frac{T_2 H_{d2}^2}{t_2}$$

$$\frac{0.5^2}{320} = \frac{(15\times 12)^2}{t_2}, \quad t_2 = 480 \text{ days}$$

(b) $$\frac{0.5^2}{320} = \frac{\left(\frac{15}{2}\times 12\right)^2}{t_2},$$

or $t_2 = 120$ days

$T_{50} = 0.197$ $T_{80} = 0.567$

$$0.197\times\frac{0.5^2}{320} = \frac{0.567\times\left(\frac{15}{2}\times 12\right)^2}{t_2}$$

or $t_2 = 345$days

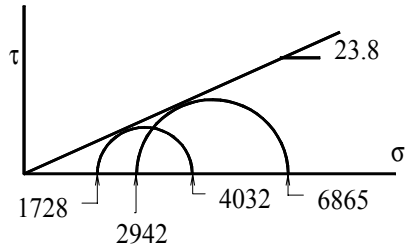
Example 7

Data for consolidated-undrained triaxial test on a saturated normally consolidated clay is shown. Determine ϕ and ϕ'.

Test	σ_{1f} lb/ft^2	σ_{3f} lb/ft^2	u_f lb/ft^2
1	4032	1728	648
2	6865	2942	1103

Solution

Since for NC soils c=0,
courses\341\shear



From Mohr circle, $\phi = 23.8°$
For ϕ' corresponding to effective stress, use formula

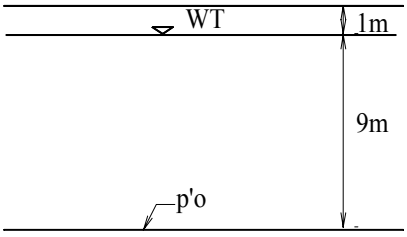
$$(4032-648) = (1728-648).\tan^2\left(45+\frac{\phi'}{2}\right) \text{ or } \phi' = 31.1°$$

Redo for 2nd test and get the average.

Example 8

Unit weight of a saturated clay is 19 kN/m^3, water table is 1m below ground surface, PI = 34. Estimate its shear strength at 10m depth.

Solution:



$p'_0 = 19 \times 1 + (19\text{-}9.81)9 = 101.7$ kPa
For NC soil

$$\frac{c_u}{p'_o} = 0.11 + 0.0037 \times 34 = 0.236$$

$c_u = 0.236 \times 101.7 = 24$kPa