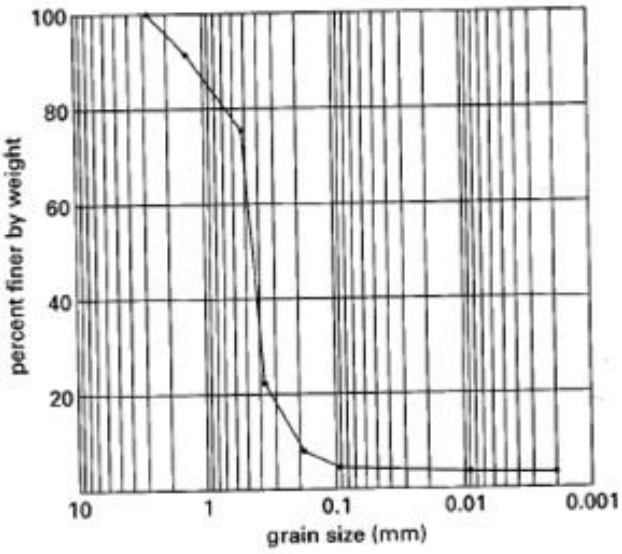
Diagnostic Quiz
Soil Mechanics and Foundations
15% of PM Portion. 9 questions total.
4 minutes allotted per question

1. **Index properties and soil classifications**

A soil's grain-size distribution curve is as shown.



The uniformity coefficient is most nearly

(A) 1.6
(B) 2.1
(C) 2.6
(D) 3.2

2. **Phase relations (air-water-solid)**

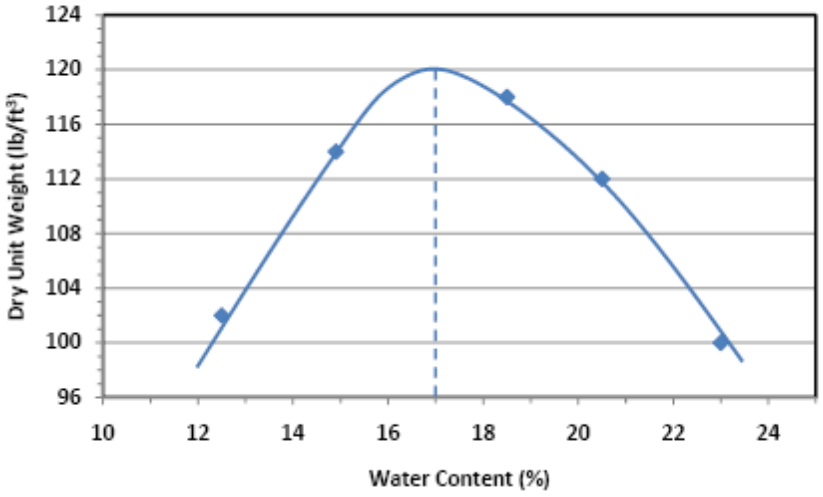
A soil sample has a total mass of 30.5 g, a volume of 12 cm^3, an oven-dry mass of 21.2 g, and a specific gravity of 2.5 for the solids.

The void ratio of this soil sample is most nearly

(A) 0.42
(B) 0.53
(C) 0.62
(D) 0.71

3. Laboratory and field tests

Given below is the Standard Proctor moisture-density curve for a soil. The specifications for the compaction of the above soil require a compaction water content of $w_{optimum} \pm 2\%$ and compaction to 95% of maximum Proctor density.



The data obtained from a rubber-balloon density test are as follows:

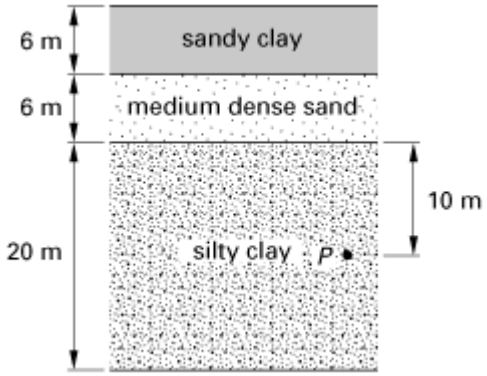
Weight of wet soil = 8.0 lb
Weight of dry soil = 6.8 lb
Volume of test hole = 0.062 ft^3

Based on the data from the field density test which one of the following conclusions would you make?

A. Both water content and density requirements have been met.
B. Water content requirement has been met but not the density requirement.
C. Water content requirement has not been met but the density requirement has been met.
D. Neither one of the requirements have been met.

4. Effective stress (buoyancy)

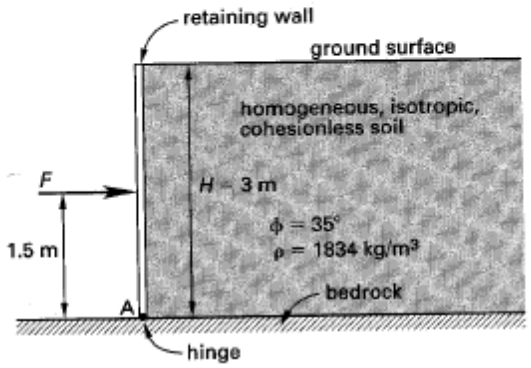
A soil profile consists of 6 m of compacted sandy clay, another 6 m layer of medium dense sand, and a layer of compressible silty clay 20 m thick, as shown in the illustration. Initially, the groundwater table is located at the bottom of the sandy clay layer. If the densities of the sandy clay, medium dense sand, and silty clay are 2000 kg/m^3, 1900 kg/m^3, and 2200 kg/m^3, respectively, and the dry density of the silty clay layer is 1200 kg/m^3, what is most nearly the effective stress at a point, *P*, 10 m below the top of the silty clay layer?



(A) 110 kPa (B) 160 kPa (C) 290 kPa (D) 450 kPa

5. Retaining walls (e.g., active pressure/passive pressure)

A retaining wall extends from the top of bedrock to the ground surface. A resisting force, F, is located on the opposite side of the wall to provide support. A frictionless hinge at point A prevents the base of the wall from sliding. Soil is homogeneous, isotropic, and cohesionless.



Using Rankine's theory, the total active resultant lateral earth force per unit length of retaining wall is most nearly

(A) 15 kN/m
(B) 22 kN/m
(C) 44 kN/m
(D) 82 kN/m

6. Shear strength

The unconfined compression strength of a saturated clay, q_u = 160 psi [Recall that ϕ=0° for these conditions]. An unconsolidated undrained triaxial test (UU-Test) with a confining pressure of 40 psi was conducted on the same saturated clay. At what value of **axial stress** (major principal stress, σ_1) do you expect the UU-Test sample to fail?

A. σ_1 = 80 psi
B. σ_1 = 160 psi
C. σ_1 = 200 psi
D. σ_1 = 120 psi

7. Bearing capacity (cohesive and noncohesive)

The base of a 2 m wide continuous footing is 1 m below the ground surface. The soil under the footing has the following parameters.

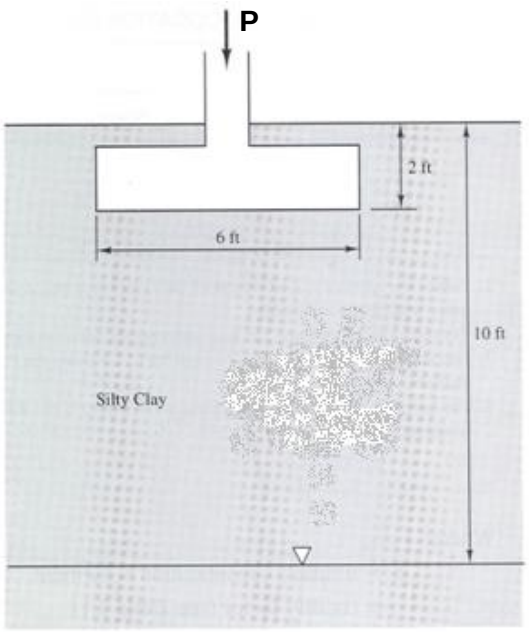
$\rho = 1835\ kg/m^3$
$N_c = 9.6$
$\phi = 10^\circ$
$N_q = 2.7$
$c = 0.0$
$N_\gamma = 1.2$

If a factor of safety of three is required, the allowable bearing capacity of the soil under the footing is most nearly

(A) 17 kPa (B) 23 kPa (C) 49 kPa (D) 70 kPa

8. Foundation types (e.g., spread footings, piles, wall footings, mats)

The figure shows a round concrete footing with an applied load, P, of 85 kips. Calculate the **induced vertical stress** at a depth of 8 feet below the ground surface, at the edge of the footing.



A. 900 psf

B.1020 psf

C.1500 psf

D.1920 psf

9. Consolidation and differential settlement

Calculate the **settlement (in inches)** that would occur in a 20-ft thick, normally consolidated clay layer when subjected to a stress increase of 1500psf. Use the following data.

Initial Effective Stress = 2000 psf

Stress Increase due to load = 1500 psf

Compression Index = 0.2

Recompression Index = 0.05

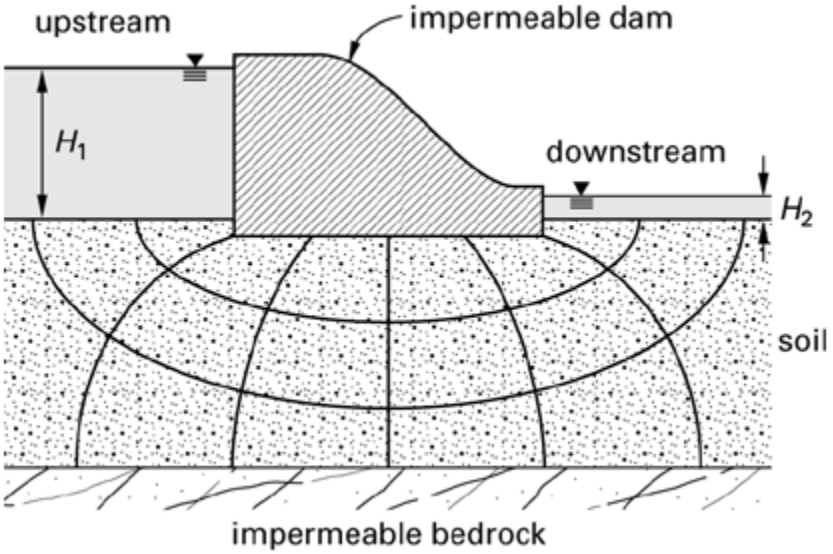
Initial void ratio = 0.6

Soil Layer thickness = 20 ft.

A. 7.3 inches
B. 1.8 inches
C. 0.6 inches
D. Cannot determine settlement because preconsolidation stress has not been provided.

10. Seepage

A flow net is drawn for the homogeneous, isotropic soil beneath an impermeable concrete dam as shown. Beneath the soil lies impermeable bedrock. The upstream water level, H_1, is 3 m above the top of the soil, and the downstream water level, H_2, is 1 m above the top of the soil. The coefficient of permeability, k, is 3×10^{-2} cm/s.



The rate of flow per lineal meter of dam width is most nearly

Ⓐ 3×10^{-4} m^2/s Ⓑ 5×10^{-3} m^2/s Ⓒ 2×10^{-2} m^2/s Ⓓ 2×10^{-1} m^2/s

11. Slope stability (e.g., fills, embankments, cuts, dams)

An infinite slope with slope angle 18° consists of a cohesionless (C = 0) soil material. This material has an angle of internal friction, $\phi = 32°$. What is the **Factor of Safety of the slope**?

A. F.O.S. = 1.77
B. F.O.S. = 0.52
C. F.O.S. = 0.56
D. F.O.S. = 1.92

12. Soil stabilization (e.g., chemical additives, geosynthetics)

Identify the statements that are TRUE with regard to the use of lime to stabilize clay soils with high plasticity?

I. Mixing soil with lime causes a reduction in soil plasticity index and that in turn improves workability

II. Soil shear strength improves when mixed with lime

III. Coefficient of permeability of the soil increases when lime is added

IV. Volume change behavior (shrink/swell) tendency is suppressed when soil is mixed with lime

A. I, II and III are true
B. I, II and IV are true
C. None of the statements is true
D. All 4 statements are true