CE3509 Soil Mechanics II - Homework

1. The following standard penetration tests results were obtained in uniform silty sand with a 45% energy ratio. The ground water table is at a depth of 2.5m. $C_B=C_R=C_S=1$

a. Calculate $N'_{1,60}$.

b. Assume a reasonable value for γ, then determine ϕ′ for each test.

c. Finally, determine a single design ϕ′ value for this stratum.

Depth (m)	N_{field}
1.5	6-8-9
3.0	5-6-8
4.5	9-12-15
6.0	11-14-16

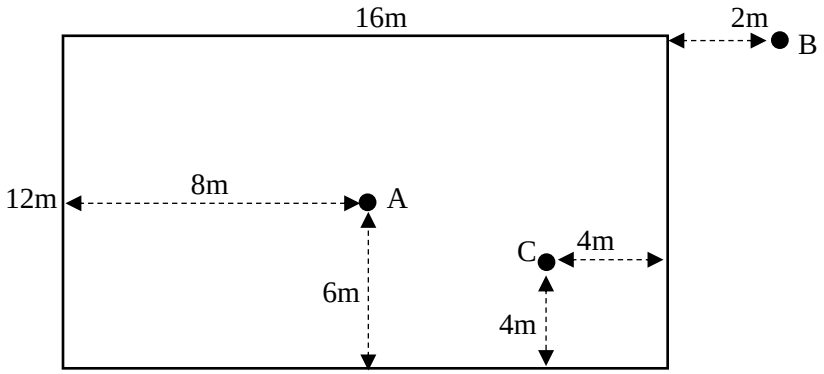
$$\phi = \sqrt{18N'_{70}} + 15$$

$$\phi = 0.36N_{70} + 27$$

$$\phi = 4.5N_{70} + 20 \text{ (in general)}$$

Description	Very loose	Loose	Medium	Dense	Very dense
Relative density D_r	0	0.15	0.35	0.65	0.85
SPT N'_{70}: fine	1–2	3–6	7–15	16–30	?
medium	2–3	4–7	8–20	21–40	> 40
coarse	3–6	5–9	10–25	26–45	> 45
ϕ: fine	26–28	28–30	30–34	33–38	
medium	27–28	30–32	32–36	36–42	< 50
coarse	28–30	30–34	33–40	40–50	
γ_{wet}, kN/m^3	11–16*	14–18	17–20	17–22	20–23

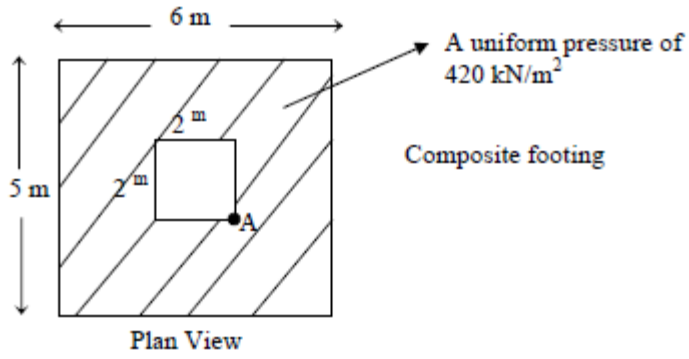
2. The plan view of a small building (12x16 m) is given in figure below. There is no ground water at the site, and the unit weight of the soil is 20 kN/m^3.
For 28800 kN maximum uniform load, determine the change in the vertical stress at point A, B, C and D at 10m depth from the ground level.



3. The cone penetration test results of a soil profile are given in the table and the water table is at 3.5m below the ground surface. If the cone factor N_k=20, estimate the undrained shear strength at depth 8m. (γ_{dry} = 16 kN/m^3, γ_{sat} = 18 kN/m^3).

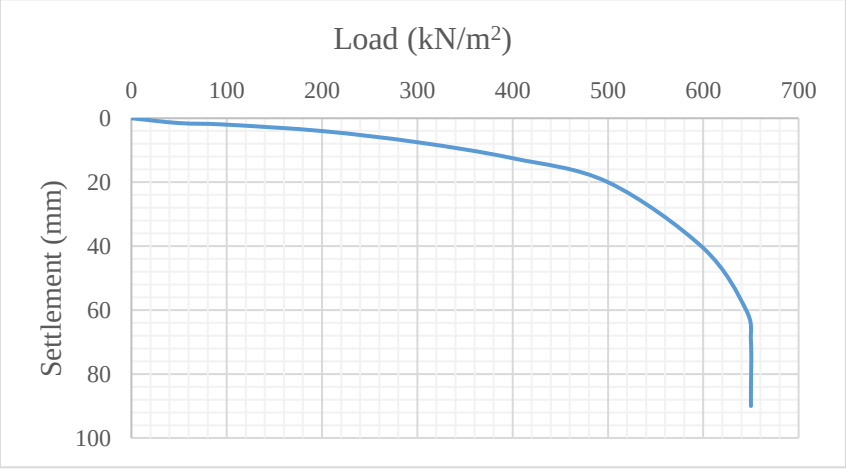
Depth (m)	q_c (kN/m^2)
0.00-2.00	3000
2.00-4.75	1000
4.75-6.50	8000
6.50-12.00	12000
12.00-15.00	10000

4. A rectangular footing as shown in figure below exerts a uniform pressure of 420 kN/m^2. Determine the vertical stress due to uniform pressure at point A for a depth of 3m.

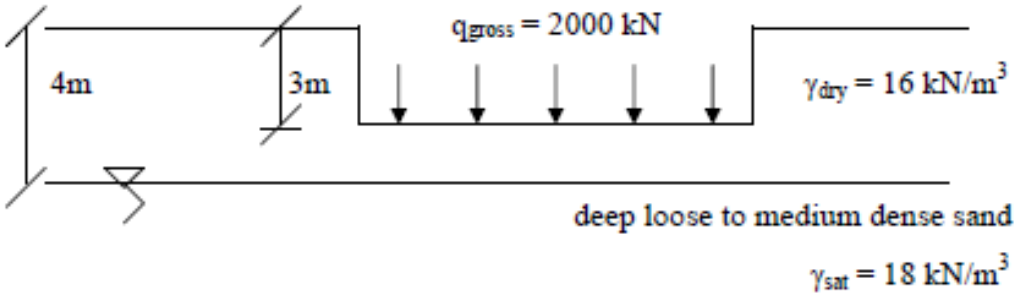


5. The result of a plate load test is shown in the graph. If the plate dimensions are 0.75m*0.75m, calculate the safe bearing capacity of soil for 2m*2m footing, taking factor of safety as 2.5 .

a) If the soil is clay
b) If the soil is sand



6. A 3.5m*3.5m square footing is located as shown in the figure. Determine the required depth of exploration for the given profile.



7. A vane 60 mm in diameter and 90 mm long was used to measure the undrained shear strength of a soft clay. A torque of 40 Nm was required to shear the soil. The vane was then rotated rapidly to remould the soil completely. The ultimate torque recorded was 20 Nm. Determine the undrained shear strength of the clay in the natural and remoulded states, and hence find the sensitivity of the clay.

8. Consider the soil profile given in the figure below, calculate the initial values of total vertical stress, pore water pressure and effective vertical stress at points A and B.