CE 468 GEOTECHNICAL DESIGN

DESIGN PROBLEM:
FOUNDATIONS ON SWELLING AND COLLAPSING SOILS

Problem 1 : Airport in Expansive Soils

An airport is to be constructed in an expansive soil area. The thickness of the swelling soil layer is 12m. The unit weight ofthe soil 20 kN/m^3 and the natural water content is 18% , liquid limit is 65% and the plasticity index PI = 40.

i.   Estimate the free swell percent and swell pressure of the clay using the empirical correlations given below.

Log P_s = − 2.132 + 2.08(LL) + 0.665 γ_d − 2.69 W_n (Komornik and David 1969)

P_s : swell pressure (kg/cm^2); LL: Liquid Limit (decimal);
γ_d: dry unit weight (gr/cm^3) ; W_n: natural water content (decimal)

S_p = 2.27 +0.131(LL) − 0.27 W_n (O'Neil and Ghazzaly, 1977)

S_p : şişme yüzdesi (%)
W_n: natural water content (%)
LL: Liquid Limit (%)

ii.   Suggest a cut off depth if the allowable swell is 2.5cm for the airport pavement using the swell test data given below.

Pressure (kPa)	% Swel
0	6 (free swell)
10	4.5
30	3
60	1.5
90	0.5
120 (swell pressure)	0

iii.   A footing, situated in the swelling soil profile with swell characteristics given above, supports a column load of 1000 kN which includes the weight of the footing. The footing has plan dimensions of 2 m x 2 m and foundation rests on the ground level.

Determine the amount of heave of the footing if the soil profile gets fully saturated. **Hint:** You may assume 2:1 stress distribution.

If upper 5 m of the expansive soil is replaced with a non-swelling soil,what would be the heave of the footing?

Hint: $\%S_i = C_s \log(\dfrac{P_o + \Delta P}{P_s})$

Problem 2 : Pile in Collapsing Soils

An industrial complex is to be constructed in a site where top 5m of the soil profile consists of collapsible silts and it is expected that collapse mechanizm shall be active after the construction due to wetting of the ground. The unit weight of the silt is 18 kN/m^3 .

The foundations of the complex are designed as pile foundations due to presence of collapsing soils.

In the site a dense sand underlies the collapsible silt . The unit weight of the sand is 20 kN/m^3, and the angle of shearing resistance $\Phi' = 36°$. The ground water level is at a depth of 10m below the exsting ground level. In preliminary design stage, it is proposed that the bored piles having 20m length and 0.8m diameter shall comprise the foundation system.

Determine the allowable load bearing capacity of a single pile for a factor of safety of 2.5, assuming that the upper silt shall collapse after construction of the piles.

Hint: consider the negative skin friction acting on pile shaft due to collapse of the silt
  Assume that negative unit skin friction $f_n = 0.3*\sigma'_v$. Assume that ground water
  level shall rise to ground level.