1. In a rock core sampling method at site, the total length of drilling was **2 m** in rocky strata. There were seven intact pieces of rocks of lengths **150 mm, 220 mm, 75 mm, 185 mm, 235 mm, 250 mm and 265 mm** were collected. Compute the recovery ratio and RQD for the rock sample. Also comment on the in-situ rock quality as per Peck et al. (1974).

2. At a site for soil exploration, three types of sampler tubes were available with outside diameter, inside diameter and length respectively as follows, (i) Sampler tube 1: **75 mm, 72 mm, 600 mm**; (ii) Sampler tube 2: **110 mm, 107 mm, 600 mm**; (iii) Sampler tube 3: **50 mm, 35 mm, 600 mm**. Now to obtain undisturbed soil sample, which sampler tube you will recommend and why? Also mention among the above, which sampler tube is used for SPT.

3. In a triaxial shear test for a soil sample, cell pressure (confining pressure) was measured as **25 kN/m^2** and the failure occurred at an additional vertical axial stress of **35 kN/m^2**. If the obtained failure plane makes an angle **52^0** with horizontal, estimate the basic shear strength parameters of the soil sample.

4. At a site in Mumbai, number of blows during SPT in a borehole of **15 cm** diameter at depth of **5 m** below ground level for three consecutive penetration of **15 cm** each were recorded as **12, 15 and 16**. Water table was found at **2 m** below ground level and the visual soil classification was reported as fine silty sand. Saturated unit weight of soil above and below water table was reported as **17 kN/m^3**. Actual velocity of impact of hammer was measured as **2.5 m/sec**. After incorporating necessary corrections, estimate the corrected **$(N_1)_{60}$** value for the soil sample at that depth. Also comment on the soil friction angle of this soil.

5. A rigid concrete vertical retaining wall of height **6 m** is supporting cohesionless dry backfill soil with unit weight of **18 kN/m^3** and soil friction angle of **35^0**. The backfill soil slope is inclined at **15^0** with horizontal. Estimate the total earth pressure at rest acting on the wall using Jaky's equation. Two designers have given total active force and passive resistance acting on the wall using respectively Rankine's and Coloumb's methods of earth pressure analysis. Compute these values and as a chief designer, mention which value can be adopted for design of such wall under active and passive state of earth pressures respectively and why? Show all necessary and relevant results using figures which can be adopted directly at a design office.

******** END ********

1) Here, $L_t = 2\text{ m} = 2000\text{ mm}$.

Recovered Length $L_r = (150+220+75+185+235+250+265)$
$= 1380\text{ mm}$

$\therefore$ Recovery ratio $= \frac{L_r}{L_t} = \frac{1380}{2000} = 0.69$ or 69%.

& L_a (for RQD) $= (1380 - 75) = 1305\text{ mm}$.

$\therefore$ RQD $= \frac{L_a}{L_t} = \frac{1305}{2000} = 0.6525$ or $\approx 65\%$

$\therefore$ As per Peck et al. (1974), as RQD is within 50–75% range, hence in-situ Rock quality is FAIR. Ans.

2) Area ratio $= \frac{D_o^2 - D_i^2}{D_i^2} \times 100\% = A_r$

$\therefore$ For Sampler tube 1, $A_r = \frac{75^2 - 72^2}{72^2} \times 100\% = 8.5\%$

For Sampler tube 2, $A_r = \frac{110^2 - 107^2}{107^2} \times 100\% = 5.7\%$

For Sampler tube 3, $A_r = \frac{50^2 - 35^2}{35^2} \times 100\% = 104\%$

Among these, Samper tube 1 is best as $A_r < 10\%$ and sensitivity for $D_o = 75$ mm which is desired in terms of undisturbed soil sample.

For SPT, Samper tube 3 is used. Ans.

3) Given, $\sigma_3 = 25\text{ KN/m}^2$, $\sigma_d = 35\text{ KN/m}^2$ $\therefore \sigma_1 = \sigma_3 + \sigma_d = 60\text{ KN/m}^2$

Now failure plane, $\alpha = 45 + \frac{\phi}{2} = 52^\circ$ $\therefore \phi = 14^\circ$

and, $\sigma_1 = \sigma_3 \tan^2(45 + \frac{\phi}{2}) + 2c\tan(45 + \frac{\phi}{2})$

$\therefore 60 = 25\tan^2 52^\circ + 2c\tan 52^\circ$ $\therefore c = 7.44\text{ KN/m}^2$ } Ans

4) SPT measured = $(15+16) = 31$ $(=N)$

Here Dilatancy correction is reqd.

$\therefore N' = 15 + \frac{1}{2}(N-15) = 23.$

For overburden Correction, $C_N = \left(\frac{P_a}{\sigma'_{vo}}\right)^{0.5}$

Here, $P_a = 100$ KPa & $\sigma'_{vo} = [(17\times2) + (17-9.81)\times3]$ KN/m^2

$= 55.57$ KPa

$\therefore C_N = \left(\frac{100}{55.57}\right)^{0.5} = 1.34$ (which is between 0.4 & 1.7, hence can be used)

& For borehole diameter = 15 cm,

Correction, $C_B = 1.05$

Here, Energy ratio, $R_e = \frac{E_m}{E_t} = \frac{\frac{1}{2}mv_m^2}{\frac{1}{2}mv_t^2} = \frac{v_m^2}{v_t^2}$

Now, theoretical velocity of impact $v_t = \sqrt{2gh}$

for SPT, $h = 760$ mm $= 0.76$ m

$\therefore v_t = \sqrt{2\times9.81\times0.76} = 3.86$ m/s

& Actual $v_m = 2.5$ m/s.

$\therefore R_e = \left(\frac{2.5}{3.86}\right)^2 = 0.42$ i,e, 42%.

$\therefore$ Energy correction, $C_E = \frac{42}{60} = 0.7$

$\therefore$ Corrected SPT value,

$(N_1)_{60} = N' \cdot C_N \cdot C_B \cdot C_E$ (assuming other correction factors $= 1.0$, as no information is given)

$= 23(1.34)(1.05)(0.7)$

$= 22.65$

Ans

Taking Wolff (1989) relationship,

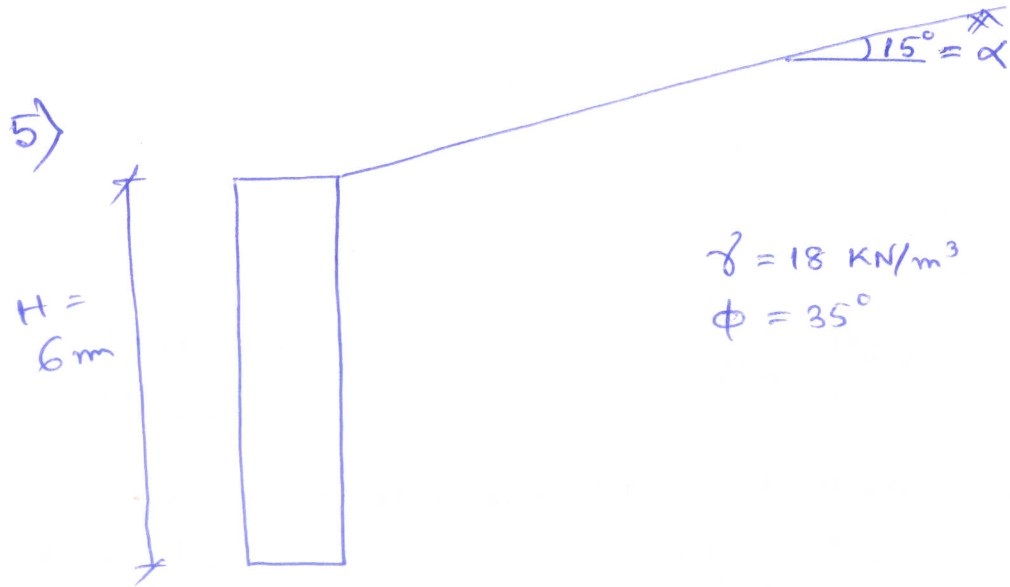
$\phi'(\text{deg}) = 27.1 + 0.3N_{corr} - 0.00054N_{corr}^2$

$= 33.62° \simeq 34°$

(i,e, Medium dense to dense sand)

Ans

5)



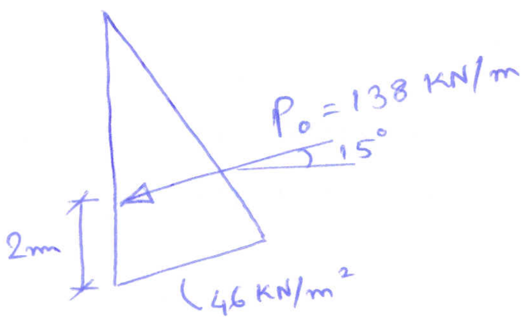
$\gamma = 18\ KN/m^3$

$\phi = 35^\circ$

$K_o = 1 - \sin\phi = 0.426$

∴ Total earth pressure at rest,

$$P_o = \frac{1}{2}\gamma H^2 K_o = (46)\frac{1}{2}(6) = 138\ KN/m$$



Rankine's method.

$$K_a = \cos\alpha \frac{\cos\alpha - \sqrt{\cos^2\alpha - \cos^2\phi}}{\cos\alpha + \sqrt{\cos^2\alpha - \cos^2\phi}}$$

$$= \cos 15^\circ \frac{\cos 15^\circ - 0.5118619}{\cos 15^\circ + 0.5118619}$$

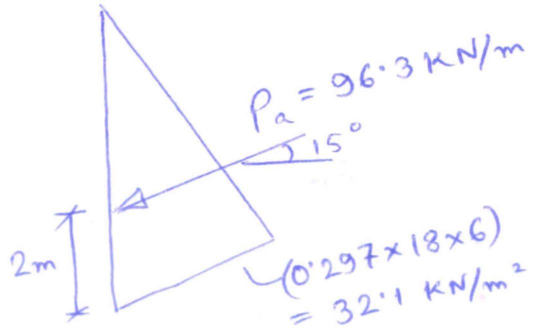
$$= \cos 15^\circ \times 0.3072592$$

$$= 0.297$$

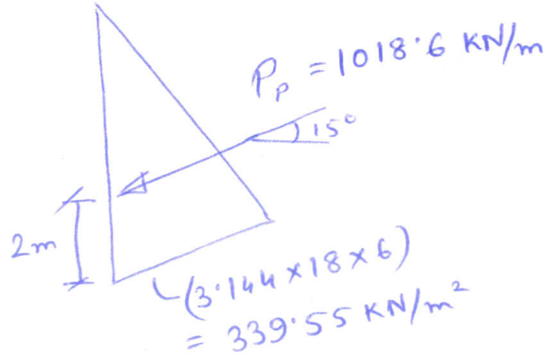
& $$K_p = \cos\alpha \frac{\cos\alpha + \sqrt{\cos^2\alpha - \cos^2\phi}}{\cos\alpha - \sqrt{\cos^2\alpha - \cos^2\phi}}$$

$$= \cos 15^\circ \times \frac{1}{0.3072592}$$

$$= 3.144$$



&



Coulomb's method → (Assume for concrete. $\delta = \frac{2}{3}\phi = 23.3°$)

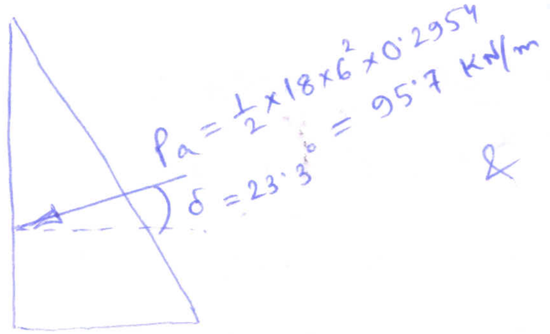
$$K_a = \frac{\sin^2(90+\phi)}{\sin^2 90 \sin(90-23.3)\left[1+\sqrt{\dfrac{\sin(35+23.3)\sin(35-15)}{\sin(90-23.3)\sin(15+90)}}\right]^2}$$

$$= 0.2954$$

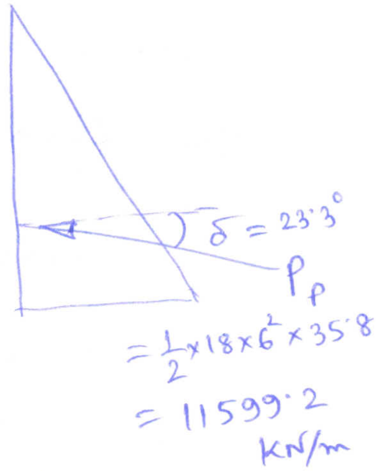
$$K_p = \frac{\sin^2(90-35)}{\sin^2 90 \sin(90+23.3)\left[1-\sqrt{\dfrac{\sin(35+23.3)\sin(35+15)}{\sin(90+23.3)\sin(90+15)}}\right]^2}$$

$$= 35.8$$

∴



&



∴ Recommended values for design,

$P_a = 96.3$ kN/m (Rankine) [Max^m]

& P_p = ~~339.55 kN/~~ 1018.6 kN/m (Rankine) [Min^m]

Ans