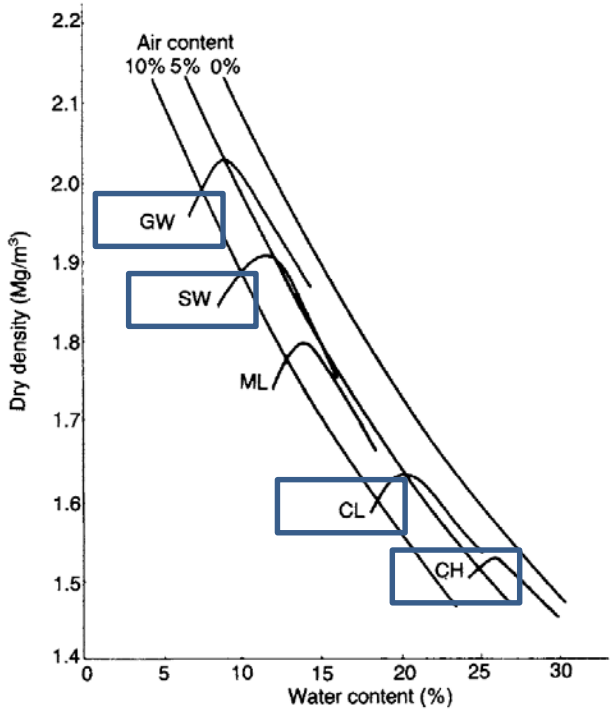
Q1: **(1 X 10 = 10 Marks)**

1	2	3	4	5	6	7	8	9	10
A	D	B, D	A	C	A	B	A, C	B	A

Q2: **(10 Marks)**

(a)



(1.5 X 4 = 6 Marks)

(b) Se = wGs, 0.8 = 0.3*Gs, Gs = 2.67 **(2Marks)**

$\gamma = \frac{W}{V} = \frac{(V_w + V_s G_S)\gamma_w}{1+e} = \frac{(Se + G_S)}{1+e}\gamma_w$ = 18.89 kN/m^3 **(2Marks)**

Q3: **(12 Marks)**

(a) Point A:

Total stress σ_a = 21*5 = 105 kPa (**2 Marks**)

Total head at A: 5/10 = 0.5m, Pressure head at A: hp = 0.5-(-5) = 5.5m, ua = 9.8*5.5 = 53.9 kPa (or 55 kPa if g = 10) (**2 Marks**)

Effective stress at A: σ_a' = 105 – 53.9 = 51.1 kPa (or σ_a' = 105 – 55 = 50 kPa if g = 10) (**2 Marks**)

(b) Point B:

Total stress σ_b = 5*9.8+21*5 = 154 kPa (or 155 kPa if g = 10) (**2 Marks**)

Total head at B: 5-(5/10) = 4.5m, Pressure head at A: hp = 4.5-(-5) = 9.5m, ub = 9.8*9.5 = 93.1 kPa (or 95 kPa if g = 10) (**2 Marks**)

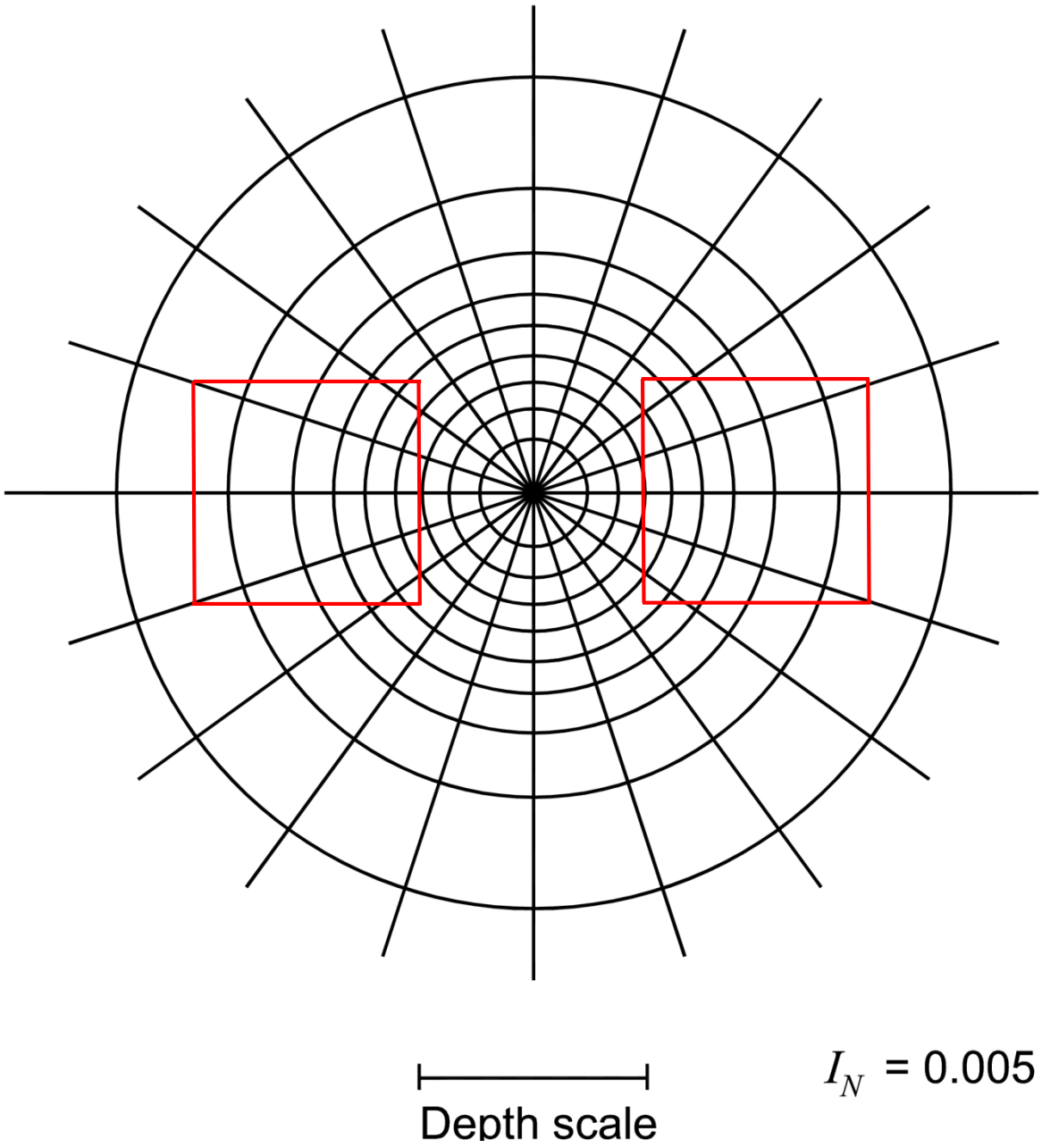
Effective stress at B: σ_b' = 154 – 93.1 = 60.9 kPa (or σ_b' = 155 – 95 = 60 kPa if g = 10) (**2 Marks**)

Q4 **(16 Marks):**

(i) n = 3/2 = 1.5, m = ½ = 0.5, Iqr = 0.135; n = m = ½ = 0.5, Iqr = 0.082;

Overal Iqr = 4*(0.135-0.082) = 0.212 (**5 Marks**)

$\Delta\sigma z$ = 30*0.212 = 6.36 kPa (**3 Marks**)



N = 38 to 44 **(5 Marks)**

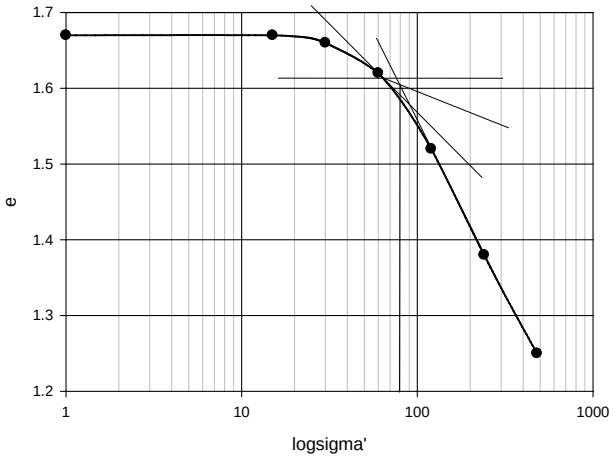
$\Delta\sigma_z$ = 30*0.005* (38 to 45) = 5.7 to 6.75 kPa **(3 Marks)**

Q5 **(20 Marks)**:

(a) $e_1 = w_1 G_s = 0.46 \times 2.7 = 1.242; \frac{\Delta e}{\Delta H} = \frac{1+e_0}{H_0} = \frac{1+e_1+\Delta e}{H_0}; \frac{\Delta e}{3.15} = \frac{1+1.242+\Delta e}{20}$

$\Delta e = 0.42; e_0 = e_1 + \Delta e = 1.25 + 0.42 = 1.67; \frac{\Delta e}{\Delta H} = \frac{1+e_0}{H_0} = \frac{2.67}{20}; \Delta e = 0.1335(\Delta H)$ **(3 Marks)**

σ'	ΔH (mm)	Δe	e
0	0	0.000	1.67
15	0.01	0.001	1.67
30	0.11	0.015	1.66
60	0.4	0.053	1.62
120	1.13	0.151	1.52
240	2.17	0.290	1.38
480	3.15	0.421	1.25



(5 Marks)

$C_c = \frac{1.38 - 1.25}{\log\left(\frac{480}{240}\right)} = 0.433$ **(2 Marks)**

(b) Preconsolidation stress: σ_p' = 80 kPa **(3 Marks)**

For sand layer: Se = wGs, e = 0.34; $\gamma = \frac{(Se+G_S)}{1+e}\gamma_w$ =9.8*(0.4*0.34+2.7)/1.34=20.77 kN/m^3 **(2 Marks)**

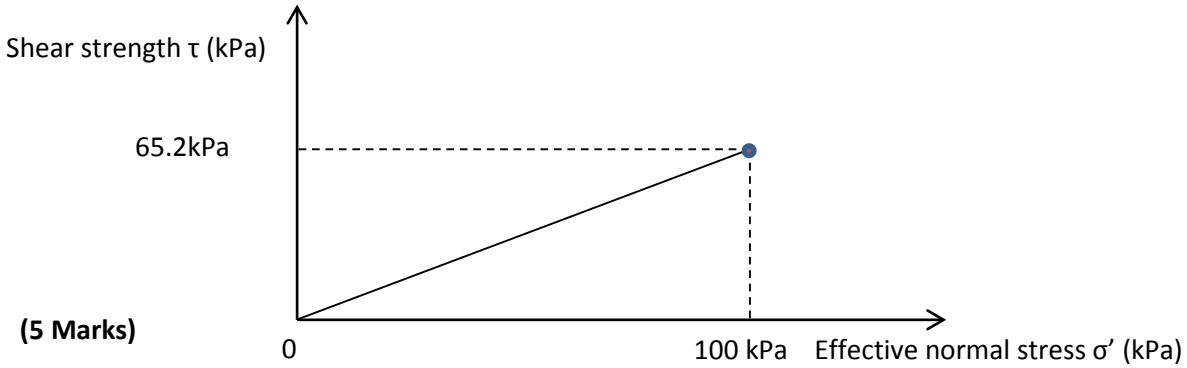
For clay layer: e = 1.67, $\gamma = \frac{(Se+G_S)}{1+e}\gamma_w$ =9.8*(1.67+2.7)/2.67=16.04 kN/m^3 **(2 Marks)**

Effective stress at sampling point: σ' = 20.77*2+2.25*16.04-9.81*(2.25-1.5) = 70.27 kPa **(2 Marks)**

OCR = 80/70.27=1.14 **(1 Mark)**

Q6: **(7 Marks)**

(i)



(5 Marks)

(ii) Determine the effective friction angle

$\tau = \sigma' \tan\phi' + c'$; $c' = 0$;

$$\sigma' = \frac{250 \times 10^{-3}}{50 \times 50 \times 10^{-6}} = 100kPa$$

$$\tau = \frac{150 \times 10^{-3}}{50 \times 46 \times 10^{-6}} = 65.2kPa$$

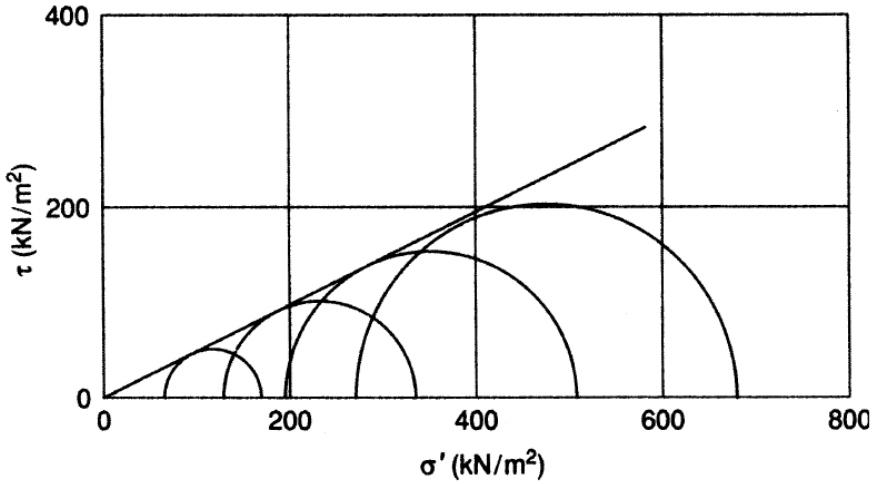
$\phi' = \tan^{-1} 0.652 = 33°$ **(2 Marks)**

Q7 **(25 Marks)**:

(ai)

σ_3 (kN/m^2)	$\sigma_1 - \sigma_3$ (kN/m^2)	σ_1 (kN/m^2)	u (kN/m^2)	σ'_3 (kN/m^2)	σ'_1 (kN/m^2)
150	103	253	82	68	171
300	202	502	169	131	333
450	305	755	252	198	503

The Mohr circles and failure envelope are drawn in Figure Q4.5, from which $c' = 0$ and $\phi' = 25\frac{1}{2}°$.



Or

$$\sigma'_1 = \sigma'_3 \tan^2\left(45 + \frac{\phi'}{2}\right) + 2c'\tan\left(45 + \frac{\phi'}{2}\right)$$

$$171 = 68 \times \tan^2\left(45 + \frac{\phi'}{2}\right) + 2c'\tan\left(45 + \frac{\phi'}{2}\right)$$

$$333 = 131 \times \tan^2\left(45 + \frac{\phi'}{2}\right) + 2c'\tan\left(45 + \frac{\phi'}{2}\right)$$

$\phi' = 26.1°,\ c' = 0kPa$

(aii)

Af = $\Delta u/\sigma_d$ **(2 Marks)**

A_f = 0.8 (for Specimen A), 0.84 (for Specimen B), 0.83 (for Specimen C) **(2 Marks)**

So, normally consolidated **(1 Mark)**

(b)

σ_3 (kN/m^2)	$\sigma_1 - \sigma_3$ (kN/m^2)	σ_1 (kN/m^2)
200	222	422
400	218	618
600	220	820

The Mohr circles and failure envelope are drawn in Figure Q4.3, from which $c_u = 110\,\text{kN/m}^2$ and $\phi_u = 0$.