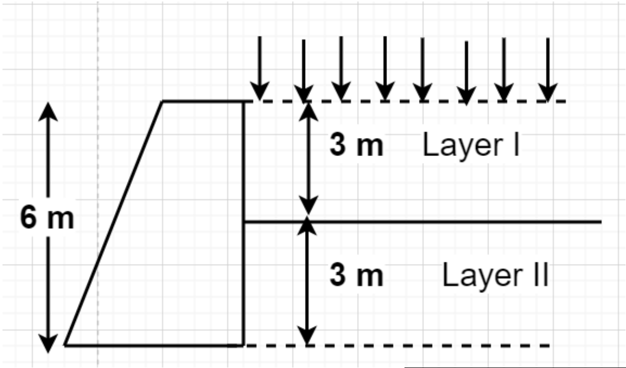
APPLIED GEOTECHNICAL ENGINEERING		CMRIT

Internal Assessment Test II – June 2022 Solution

1	(a) **Vertical wall 6 m high, backfill horizontal carrying uniformly distributed surcharge of 45 kN/m², ϕ_1=36° in top 3 m and ϕ_2=32° in bottom 3 m, $\gamma 1$ =19.8 kN/m³ in top 3 m and $\gamma 2$=19 kN/m³ in bottom 3 m. find the total active force and point of application.**	[08]	CO3	L3
	Coefficient - 1 Computation of pressure - 3 Computation of active thrust - 3 Position of thrust - 1			



q = 45 kPa

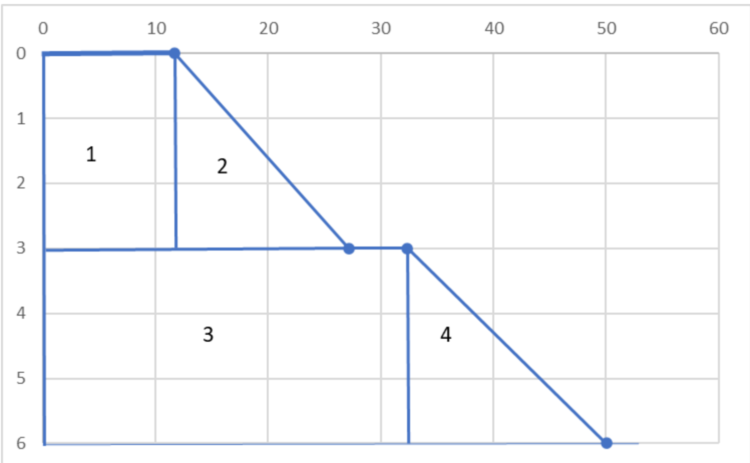
Layer I:
ϕ_1 **= 36°;** γ_1 **=19.8 kN/m³**

Layer II:
ϕ_2 **= 32° ;** γ_2**=19 kN/m³**

$$k_a = \frac{1 - Sin36}{1 + Sin36} = 0.26$$

$$k_a = \frac{1 - Sin32}{1 + Sin32} = 0.31$$

z	Vertical stress	
0	0.26 × 45	11.7
3 in layer I	0.26 × (19.8 × 3+45)	27.144
3 in layer II	0.31 × 104.4	32.364
6 m	32.364 + 19 × 3 × 0.31	50.034



Index No	Fi	xi	Fixi
1	35.1	4.5	157.95
2	23.166	4	92.664
3	97.92	1.5	146.88
4	26.505	1	26.505
Sum	182.691		423.999

x	2.320853		

	(b) Explain three types of lateral earth pressure with sketches.	[06]	CO3	L2
	At rest; Active and Passive condition – 2 × 3 = 6			

At rest pressure

- Soil mass is not subjected to any yielding / movement.
- This case occurs when the retaining wall is firmly fixed at its to and is not allowed to rotate or move laterally.
- Figure above shows a brdge abutment slabwhich is restrained at its top by the bridge slab. This at rest condition is in elastic equilibrium.

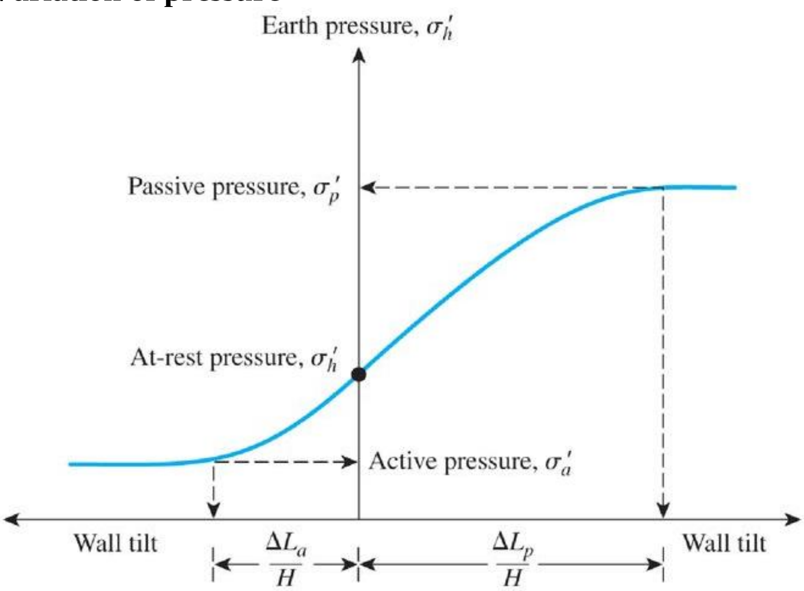
Active earth pressure

- Soil mass yields such that it starts to stretch horizontally.
- This is in a state of pastic equilibrium.
- Soil mass is on the verge of failure
- This happens on the right hand side when the wall moves towards the left.
- An increase in weight of thevreatined soil cause a substaintial increase in horizontal reaction.

Passive earth pressure

- When the movement of the wall is such that it tends to compress horizontally
- Condition of limiting equilibrium
- Develops on the left side of the wall below the ground level
- Because the soil in this zone is compressed when the movement of the soil is towards left.

Variation of pressure



	(c) Explain components of total settlement with sketches	[06]	CO2	L2
	Immediate settlement, Consolidation settlement; Secondary settlement - – 2 × 3 = 6			

Foundation settlement can be classified into three types

- Immediate settlement
- Consolidation settlement
- Secondary settlement

Immediate settlement

- Takes place immediately after construction of the structure

- Called as distortion settlement because it is due to distortions/rearrangements within the foundation soil

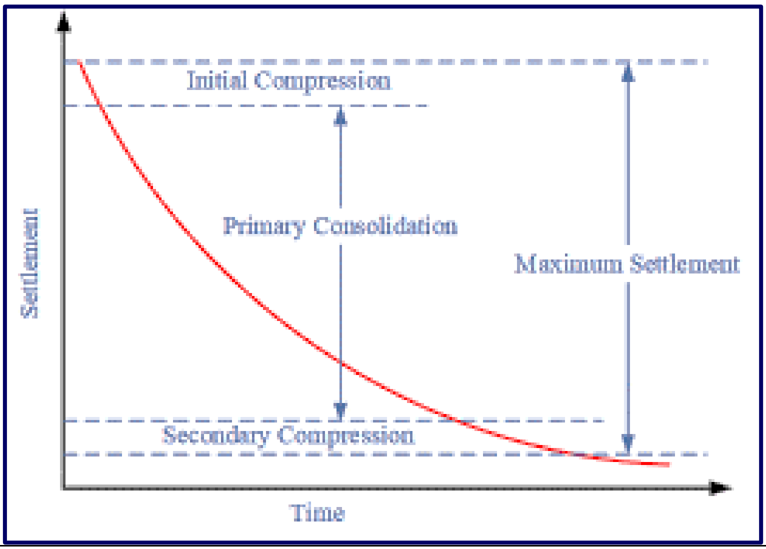
Consolidation settlement

- This is due to gradual expulsion of water from the voids of the soil
- Because of the hydraulic gradient water starts flowing out and decrease in volume occurs
- This depends upon the permeability of the soil and its time dependent

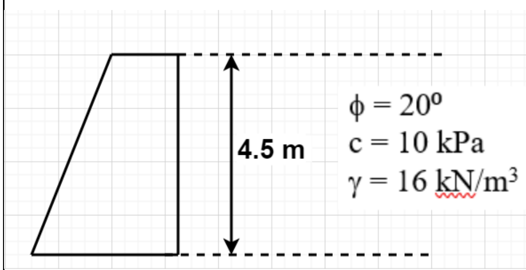
Secondary settlement

- This is due to secondary consolidation
- Excess pore water if its there gets dissipiated when the primary consolidation is complete.
- Plastic readjustment of particles takes place and change in volume occurs which is very minimal

Total settlement = Si+Sc+Ss



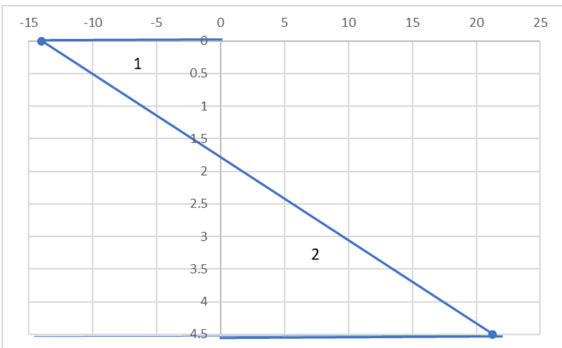
2	(a) A 4.5m high retaining wall retains a cohesive soil whose properties are c = l0 kN/m^2, ϕ=20°, γ=16 kN/m^3. Calculate the depth of tension cracks and also calculate the total active earth pressure on the wall, neglecting the tension zone. Draw the earth pressure diagram.	[08]	CO3	L3



ϕ = 20⁰
c = 10 kPa
γ = 16 kN/m^3

$$k_a = \frac{1 - Sin20}{1 + Sin20} = 0.49$$

$$\sigma_z = k_a.\gamma z - 2c\sqrt{k_a}$$



z	Vertical stress	
0	$-2 \times 10\sqrt{0.49}$	-14
4.5	$0.49 \times 16 \times 4.5 - 14$	21.28

Depth of tension crack

$$z_c = \frac{2c}{\gamma\sqrt{k_a}} = \frac{2 \times 10}{16 \times \sqrt{0.49}}$$

$$z_c = 1.79\ m$$

Index	F_i	x_i	$F_i x_i$
2	0.5 × 21.28 × (4.5 - 1.79) = 28.83	(4.5-1.79)/3 = 0.90	25.95

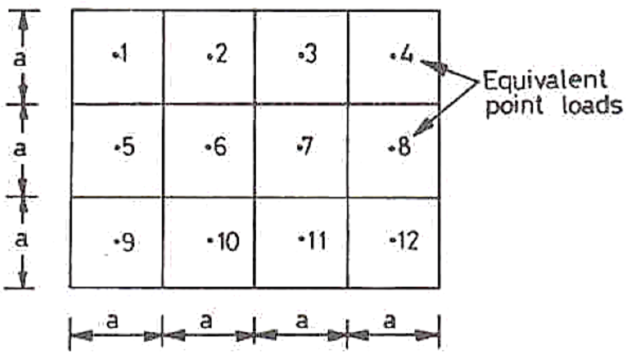
$$\bar{x} = 0.90\ m\ from\ base$$

Resultant is 28.83 kN acting at a distance of 0.9 m from base

(b) Explain equivalent point load method for determining vertical stress at any point within the loaded area.	[06]	CO2	L2

Explanation, Fig, Equation – 3+2+1

Vertical stress at a point under a loaded area of any shape can be determined by dividing the loaded area into small areas and replacing the distributed load on each small area by an equivalent point load acting at the centroid of the area. Hence Q = $q.a^2$ will be the load acting on each area. The total load is thus converted into a number of point loads. The vertical stress at any point below or outside he area is equal to the sum of the vertical stresses due to these equivalent point loads.



$$\sigma_z = \frac{[Q_1.(I_B)_1 + Q_2.(I_B)_2 + \cdots + Q_n.(I_B)_n]}{z^2}$$

$$\sigma_z = \frac{1}{z^2}\sum_{i=1}^{n} Q_i.(I_B)_i$$

This equation gives fairly accurate results if the side a of the small area unit is equal to or less than 1/3 of the depth z of point P at which vertical stress is required.

(c) Explain contact pressure distribution in soils	[06]	CO2	L2

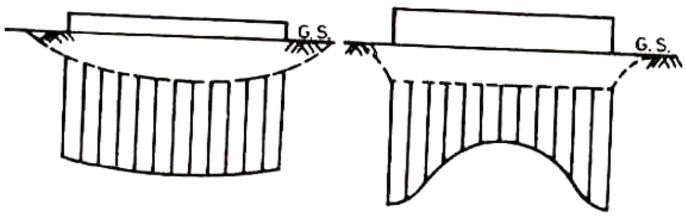
Pressure on saturated clay – Rigid and flexible footing – explanation + Fig - 3
Pressure on cohesionless infill – Rigid and flexible footing – explanation + Fig - 3

The upward pressure exerted due to soil on the underside of the footing is termed as contact pressure. In the previous theories it is termed as contact pressure. In the previous theories it is assumed that the footing is flexible. But actual footings are not as flexible as assumed.

The contact pressure distribution depends upon a number of factors such as

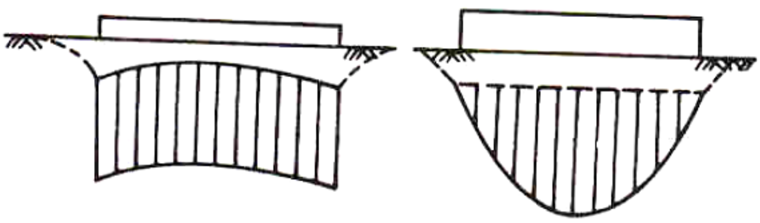
- Poisson's ratio of soil and footing material
- Modulus of elasticity
- Width of footing, thickness of footing etc

Contact pressure on saturated clay	
Flexible footing	Rigid footing
Settlement is max at the centre Contact pressure is uniform	Settlement is uniform Pressure is max at edges and min at centre
for rigid footing plastic flow occurs and the pressure becomes finite	



FLEXIBLE FOOTING RIGID FOOTING

Contact pressure on sand	
Flexible footing	Rigid footing
Edge of the footing undergoes a larger settlement than at the centre. The soil at the centreis confined and therefore has a high modulus of elasticity and deflects less for the same contact pressure. Contact pressure is uniform	Settlement is uniform Contact pressure increases from 0 at edges to a maximum at the centre. If the footing is embedded, there would be finite contact pressure at the edges. If the footing is embedded, contact pressure is maximum.



FLEXIBLE FOOTING RIGID FOOTING

3	(a)	A new construction is planned on a layer of 8 m thick saturated compressible clay on a hard rock bed. Estimate the settlement if the existing overburden pressure of 250 kPa at the centre of clay layer is increased by 150 kPa due to the new construction. The water content, compression index and specific gravity of clay are 40%, 0.3 and 2.7 respectively.	[06]	CO2	L4

	Computation of e, settlement calculation – 2+4			
	$eS = wG$ $e = 0.4 \times 2.7 = 1.08$ $S_c = \frac{0.3}{1 + 1.08} . 8. \log_{10}\left[\frac{250 + 150}{250}\right] = 235.5\ mm$			
	(b) Estimate the immediate settlement of a footing of size 2 m × 3 m resting at a depth of 2 in insandy soil whose compression modulus is 10 N/mm^2 and the load due to a new building increases the pressure by 160 kN/m^2 at the base of the footing (footing is expected to transmit a unit pressure of 160 kN/m^2). Assuming μ = 0.28 and I_f= 1.06.	[04]	CO2	L2
	Selection of B - 1 Calculation of S_i - 3			
	Always first dimension is taken as B B= 2; L = 3 m $S_i = qB\left[\frac{1 - \mu^2}{E_s}\right].I$ $S_i = 160 \times 2 \times \left[\frac{1 - 0.28^2}{10000}\right] \times 1.06 = 0.0313\ m$			

Signature of CI — Signature of CCI — Signature of HoD