Group	Class	Roll No.
G-1	BBX	101,102,103,104,105,106,107, 124,125,126,127,128,129,130,147, 148,149,150,151,152,153
G-2	BBX	108,109,110,111,112,113,114,115,131,132,133,134,135,136,137, 138,154, 155,156,157,158,159,160,161
G-3	BBX	116,117,118,119,120,121,122,123,139,140,141,142,143,144,145,146,162,163,164,165,166,167,168,169

Tutorial-1 Index properties of soil

1. An undisturbed soil sample has total weight of _____ grams, volume of 1000cc, water content = _____ and specific gravity =2.66. Compute (i) Void ratio, (ii) porosity, (iii)degree of Saturation, (iv) Water content to make sample fully saturated and (v)Efficient unit weight of soil sample

Group	Total weight of sample (gm)	Water content (%)
G-1	2000	10
G-2	2500	11
G-3	2690	12

2. A soil sample has a porosity of _____ percent. The specific gravity of solids is 2.70. Calculate (a) void ratio, (b) dry density, (c) unit weight if the soil is **S %** saturated and (d) unit weight if the soil is completely saturated.

Group	Porosity %	**S** (%)
G-1	40	40
G-2	30	50
G-3	35	60

3. A soil specimen has a water content of 10% and a unit weight of 20 kN/m^3.If the specific gravity of soil mass is 2.70, determine the dry unit weight, void ratio and degree of saturation.

4. If the bulk unit weight of a wet soil mass is 19.80 kN/m^3, find dry density, void ratio and degree of saturation of soil mass. Consider water content is 12%.

5. Sample of sandy soil has _____ porosity. Find density index if maximum and minimum dry unit weight of sample is respectively ____ kN/m^3 and ____ kN/m^3. Take specific gravity of soil as 2.6.

Group	Porosity %	Maximum dry unit weight kN/m^3	Minimum dry unit weight kN/m^3
G-1	30	17	12
G-2	33	18	13
G-3	35	20	15

6. The porosity of a soil sample is 35%. Calculate its void ratio, dry density, saturated density and submerged density. Take G = 2.7.

7. A soil sample has a liquid limit of ____ , plastic limit ____ and flow index of ____ . Natural water content of soil is ____ . Determine: (i) plasticity index (ii) liquidity index (iii) consistency index (iv) Toughness index (v) What would be the type of soil on a plasticity chart?

Group	Liquid limit %	Plastic limit %	Natural water content %	Flow index %
G-1	35	22	15	16
G-2	50	36	20	20
G-3	60	40	25	25

8. The consistency limits of clay are: Liquid limit=52 %; Plastic limits=30 % and shrinkage limit=18 %. If a specimen shrinks from a volume of 39.5 cm^3, at liquid limit; to a volume of 24.2 cm^3, at shrinkage limit. Calculate true specific gravity, and shrinkage ratio?

Tutorial-2 Permeability and Seepage

1. A soil sample of height 60 mm and cross sectional area of 100 cm^2 was subjected to constant head permeability test for time of 6 minutes, with head of 15 cm. Compute the coefficient of permeability of the soil sample if quality of water collected was 400ml.

2. A soil sample of height 60 mm and cross sectional area of 100 cm^2 was subjected to falling head permeability test. In a time interval of 6 minutes, the head dropped from 65 cm to 30 cm. If the cross sectional area of the stand pipe is 2 cm^2, compute the coefficient of permeability of the soil sample.

3. A soil sample of height 60 mm and cross sectional area of ___ cm^2 was subjected to falling head permeability test. In a time interval of ___ minutes, the head dropped from ___ cm to ___ cm. If the cross sectional area of the stand pipe is 2 cm^2, compute the coefficient of permeability of the soil sample. If the same sample is subjected to a constant head of ___ cm, calculate the total quantity of water that will be collected after flowing through the sample.

Group	Time interval (minutes)	Head drops from (cm)	C/s of sample cm^2	Constant head (cm)
G-1	6	60 to 35	100	30
G-2	10	75 to 40	110	20
G-3	13	55 to 30	102	25

4. Explain the procedure to find co-efficient of permeability of fine grained soil. Determine the average co-efficient of permeability in horizontal and vertical directions for a deposit consisting of three layers of thickness ___ m, ___ m and _ m and having the co-efficient of permeability of $\mathbf{k_1}$ mm/sec, $\mathbf{k_2}$ mm/sec and $\mathbf{k_3}$ mm/sec, respectively.

Group	k_1 mm/sec	k_2 mm/sec	k_3 mm/sec	Thickness (m)
G-1	3×10^{-2}	2×10^{-2}	5×10^{-2}	5, 2, 3
G-2	5×10^{-2}	3×10^{-2}	6×10^{-2}	4, 6, 2
G-3	7×10^{-2}	2.5×10^{-2}	2×10^{-2}	2, 4, 5

5. A coarse grained soil has a void ratio of 0.78 and specific gravity as 2.67. Calculate the critical gradient.

Tutorial-3 Shear strength of soil

1. Determine the shearing strength parameters from the Direct Shear Test results given below. The proving ring constant is 0.45 kg/Div. What would be shearing strength at the normal stress of 10 kg/cm^2?

Sr. no	Normal stress (kg/cm^2)	Shear Force (Div.)		
		G-1	**G-2**	**G -3**
1	1.0	110	100	160
2	2.0	150	120	200
3	3.0	200	210	240

2. In an unconfined compressive test, a sample of clay 8 cm long and 4 cm in

diameter fails under a load of 120 N at 10% strain. Compute the shearing resistance taking into account the effect of change in cross section of the sample.

3. A series of direct shear tests were conducted on a soil, each test was carried out till the sample failed. The following results were obtained.

Sample no	Normal stress (kN/m^2)			sheare stress (kN/m^2)		
	G-1	**G-2**	**G -3**	**G-1**	**G-2**	**G -3**
1	15	17	20	18	20	25
2	30	25	39	24	29	31
3	45	44	49	30	36	40

Determine the Cohesion and Angle of shearing resistance for the soil

4. The following results were obtained from a series of consolidated undrained (CU) shear tests on a soil, in which the pore water pressure was not determined. Determine the cohesion and the angle of shearing resistance.

Sample no	Confining pressure (kN/m^2)			Deviator Stress at failure (kN/m^2)		
	G-1	**G-2**	**G -3**	**G-1**	**G-2**	**G -3**
1	100	200	300	600	700	800
2	200	300	400	750	795	850
3	300	400	500	870	900	920

Tutorial - 4 Compaction of soil

1. The following data were obtained from Standard proctor test on a sample of soil. The volume of mould is 1000 ml. Plot the compaction curve and calculate maximum dry density and optimum water content.

G- 1						
Water content (%)	8	10.5	12	13.75	16	18
Weight of wet soil(kg)	1.8	1.97	2.08	2	1.88	1.75
G- 2						
Water content (%)	7	11	13	15	17.5	19.7
Weight of wet soil(kg)	1.6	1.8	2.0	2	1.75	1.65
G- 3						
Water content (%)	8	10.5	12	13.75	16	18
Weight of wet soil(kg)	1.8	1.90	2.20	1.95	1.88	1.75

2. The following data were recorded while performing the compaction test:-

Plot the MDD-OMC curve and obtain the optimum water content and maximum dry density. Volume of mould=1000 cc. Also plot zero air voids curve. Take G = 2.66

G- 1						
Water content (%)	7.71	11.5	14.6	17.50	19.50	21.25
Bulk density (kN/m^3)	17.55	19.50	21.0	20.55	20.30	19.80
G- 2						
Water content (%)	7	11	13	15	17.5	19.7
Bulk density (kN/m^3)	16.9	18.0	21.0	20.5	20.0	19.5
G- 3						
Water content (%)	8	10.5	12	13.75	16	18
Bulk density (kN/m^3)	17.9	19.8	22	21.20	19.25	18.9

Tutorial – 5 Consolidation of soil

1. In consolidation test, the void ratio of the specimen which was $\mathbf{e_1}$ under the effective pressure of 214 kN/m^3, changed to $\mathbf{e_2}$ when the pressure was increased to σ_2 kN/ m^3. Calculate the coefficient of compressibility, compression index and the coefficient of volume compressibility. Find the settlement of foundation resting on clay, if thickness of the layer is _____m and the increase in pressure is 10kN/m^2.

Group	**G-1**	**G-2**	**G-3**
$\mathbf{e_1}$	1.068	1.070	1.025
$\mathbf{e_2}$	0.994	0.998	0.990
σ_2 (kN/m^3)	429	450	410
Thickness of layer (m)	8	10	6

2. During consolidation test, the void ratio decreases from ____ to ____ under the stress increment of _____ kg/cm^2 to _____ kg/cm^2. Compute coefficient of compressibility, coefficient of volume compressibility and compression index.

Group	Decrease in void ratio	Increment in stress (kg/cm^2)
G-1	0.8 – 0.5	2 – 4
G-2	0.7 – 0.4	3 - 6
G-3	0.6 - 0.3	4 -7

3. A soil sample 20 mm thick takes 20 minutes to reach 20% consolidation. Find the time taken for a clay layer 6m thick to reach 40% consolidation. Assume double drainage in both cases.

Tutorial – 6 Stress Distribution

1. For a point load of ___ KN, compute the vertical stress at ____ m depth along the axis by using Boussinesq and Westergaard's theories. Consider Poisson's ratio as zero.

Group	Point load KN	Depth m
G-1	200	6
G-2	150	3
G-3	300	7

2. A raft of ___ m × ___m carries a load of _____ KN/m^2. Determine vertical stress increment at a point ____m below the centre of the loaded area using equivalent point load method.

Group	Load (KN/m^2)	Raft (m×m)	Depth (m)
G-1	200	4×4	4
G-2	300	6×6	6
G-3	500	5×5	8

3. For a point load of ____ kN acting at the ground level, compute the vertical stresses developed on a horizontal plane located at ___ m depth. Use Boussinesq's theory & compute the stresses for radial distances of ___ m, ___ m, ___ m & ___ m.

Group	Load (KN/m^2)	Radial distances (m)	Depth (m)
G-1	200	0.0, 2.0, 4.0, 6.0	4
G-2	300	0.0, 1.0, 2.5, 5.0	6
G-3	500	0.0, 1.5, 3.0, 6.0	8

Tutorial – 7 Earth pressure and Stability of soil

1 Compute the intensities of active and passive earth pressure at depth ____m in dry cohesionless sand with angle of internal friction of ϕ° and unit weight of γ kN/m^3. What wiil be the active and passive earth pressure if the water table rises to the ground level? Take saturated unit weight of sand as 22 kN/m^3.

Group	Unit weight γ (KN/m^3)	ϕ°	Depth (m)
G-1	18	30	10
G-2	18.5	32	12
G-3	19	28	8

2 A retaining wall retains a 12m high backfill, γ = ____ kN/m^3, ϕ = ___$^\circ$ with uniform surface. Assuming the wall surface to be vertical, determine the magnitude and point of application of the total active pressure. If the water table is at a height of ____ m, how far do the magnitude and point of application of total active earth pressure changed?

Group	γ (KN/m^3)	ϕ°	Water table height (m)
G-1	17.7	25	6
G-2	18.5	28	7
G-3	19	30	8

3. A rigid retaining wall, ____ m high is restrained from yielding. The backfill consists of cohesionless soil having ϕ=____°. And γ=____ kN/m^3. Calculate the total earth pressure per meter length of the wall.

Group	γ (KN/m^3)	ϕ°	Height of retaining wall (m)
G-1	17	25	6
G-2	18	28	7
G-3	19	30	8

4. Calculate the factor of safety with respect to cohesion of a clay slope laid at **1 in** ___ to a height of _____ m, if the angle of internal friction ϕ=____°, C=____ kN/m^2 and γ=19 kN/m^3. What will be the critical height of the slop in this soil? Take stability number as 0.064.

Group	**slope**	ϕ°	Height (m)	C (kN/m^2)
G-1	1 in 2	25	6	25
G-2	1 in 4	28	7	28
G-3	1 in 3	30	8	29

5. A vertical cut is made in clay deposit having C = 30 KN/m^2, ϕ = 0, ɣ = 16 KN/m^3. Determine the maximum depth of cut so that the cut is stable. Take Sn = 0.261.

6. A concentrated load of ____ kN is applied at the ground surface. Determine the vertical stress at a point **P** which is ____ m directly below the load. Also calculate the vertical stress at a point **R** which is at a depth of ____ m but at a horizontal distance of ___ m from the axis of load.

Group	Load (kN)	Location of point **R** (m)		Location of point **P** (m)
		depth	Horizontal distance	
G-1	1000	6	5	6
G-2	1500	8	7	7
G-3	2000	10	10	8

7. Calculate the vertical stress at a point **P** at a depth of ____ m directly under the centre of the circular area of radius ___ m. and subjected to a load ___ kN/m^2. Also calculate the vertical stress at a point **Q** which is at the same depth of 2.5 m, but _____ m away from the centre of the loaded area.

Group	Load (kN/ m^2)	Location of point **R** (m)		Location of point **P** (m)	Radius of circular area (m)
		depth	Horizontal distance		
G-1	100	2.5	2.5	2.5	2
G-2	150	2.5	3	7	2.5
G-3	200	2.5	3.5	8	3

Tutorial – 8 Introduction to Foundation & Bearing Capacity

1 A strip footing of **width** ___ m is founded at a **depth** of ____ m below the ground surface in a c-φ soil having **cohesion** ____ kN/m^2 and angle of internal friction 32°. The **water table is at a depth** of ___ m below ground surface. The moist soil above the water table has unit weight of 17.7kN/m^3. Determine the safe bearing capacity and safe load per m length of the footing. Consider factor of safety is 3 and take bearing capacity factor Nc = 57.8, Nq = 41.4 and Nγ = 42.4.

Group	Width of footing (m)	Depth of footing (m)	Cohesion (kN/ m^2)	Water table depth (m)
G-1	3.0	2.2	30	5.0
G-2	3.5	4.0	28	6.0
G-3	4.0	3.5	31	6.5

2. Determine the depth at which a circular footing of ___ m diameter is provided with a factor of safety 3. It carries a safe load of ____kN. The soil properties are: Φ= 30º, γ = 18 kN/m^3, C = ___ kN/m^2. For Φ= 30º Nc= 37.2, Nq= 22.5,Nr = 19.7. Use Terazaghi's analysis.

Group	Diameter of footing (m)	Safe load (kN)	Cohesion (kN/ m^2)
G-1	2.0	1500	10
G-2	3.0	1600	12
G-3	2.5	1800	15

3. Determine the allowable gross load and the net allowable load for a square footing of ___ m side and with a depth of foundation of ___ m. Use Tarzaghi's theory and assume local shear failure. Take factor of safety of 3. The soil at the site has γ = 18 kN/m^3, **C kN/m^2** and Ø' = 25°. Take Nc' =14.8 ; Nq' = 5.6 ; Nγ' = 3.2

Group	Size of footing (m)	Depth of foundation (m)	Cohesion (kN/ m^2)
G-1	2.0	1.5	10
G-2	3.0	1.0	12
G-3	4.0	2.0	15

4. Calculate the minimum depth a foundation required to transmit a load of ___ kN/m^2 in a cohesion less soil having γ = 17 kN/m2 and ϕ =___°. Also calculate the bearing capacity if the depth adopted is ____ m using Rankine's formula.

Group	Load (kN/m^2)	Depth of foundation (m)	ϕ°
G-1	50	1.5	20
G-2	75	1.0	25
G-3	100	2.0	28

5. Calculate the ultimate point resistance of a pile, if the pile is embedded in a deep clay stratum. Take cohesion C=____ t/m^2.

Group	Cohesion (t/m^2)
G-1	5.0
G-2	10
G-3	15

6. Calculate using Skemption's equation, the ultimate bearing capacity of a square footing on the surface of standard having unconfined compressive strength of 60 kN/m^2 .

7. A drop hammer weighing 55kN and having an effective fall of 0.70m drives an RCC pile weighing 35kN. The average settlement per blow is 1.3cm. The total temporary elastic compression is 1.7cm. Assuming coefficient of restitution as 0.25 and factor of safety 3.0, determine ultimate bearing capacity and allowable baring capacity.

8 An RCC pile of 18 m overall length is driven into a deep stratum of soft clay having an unconfined compressive strength **(UCS)** of ____ kN/m^2.The diameter of pile is ____ cm. Determine the safe load that can be carried by the pile with a factor of safety = 3, α = 0.95.

Group	UCS (kN/m^2)	Length of pile (m)	Diameter of pile(cm)
G-1	50	18	30
G-2	75	22	35
G-3	100	25	28