GUJARAT TECHNOLOGICAL UNIVERSITY

BE 5 SEMESTER – OLD PAPER – S22 TO S26 – QUESTION BANK

Subject Name & Code: Soil Mechanics - 3150615

Chapter 1: Slope Stability

Repeated Questions:

1. Slope Types and Slope Failures (Theory):

- **Q.** Explain the difference between finite and infinite slope. **(WINTER 2023, 4 Marks; SUMMER 2025, 4 Marks)**
- **Q.** Discuss various types of slope failures / Discuss briefly, different types of slope failures / Explain types of slope failure with sketches. **(SUMMER 2023, 3 Marks OR; WINTER 2023, 3 Marks; SUMMER 2026, 4 Marks)**

2. Methods of Slope Stability Analysis:

- **Q.** How is a slope analyzed using a Swedish circle method (method of slices)? Discuss the method and derive an expression for the factor of safety. **(SUMMER 2022, 7 Marks OR; SUMMER 2023, 7 Marks OR; WINTER 2023, 7 Marks OR)**
- **Q.** Explain Taylor's Stability Number in relevant terms / Describe Taylor's stability number and its use in slope analysis. **(SUMMER 2023, 4 Marks OR; SUMMER 2026, 7 Marks)**
- **Q.** Write short note on Friction circle method / Explain friction circle method of analysing the stability of slopes. **(WINTER 2024, 4 Marks OR; SUMMER 2025, 4 Marks)**

3. Improving Slope Stability:

- **Q.** Discuss various methods to improve the stability of slope / Suggest methods to improve slope stability / What are the different methods to improve slope stability? **(WINTER 2022, 4 Marks; SUMMER 2025, 4 Marks; SUMMER 2026, 3 Marks)**

4. Slope Stability (Numerical):

- **Q.** A long natural slope in a C-ϕ soil is inclined at 12° to the horizontal. The water table is at the surface and the seepage is parallel to the slope. If a plane slip has developed at a depth of 4m, determine the factor of safety. Take C = 8 kN/m², ϕ = 22° and γ_{sat} = 19 kN/m³. **(WINTER 2024, 7 Marks; WINTER 2025, 7 Marks OR)**

Other Important Questions:

1. Slope Stability (Theory):

- **Q.** Explain causes of stress in soil. What is geostatic stress? What are different factors of safety used in the stability of slopes? Discuss briefly. **(SUMMER 2023, 7 Marks)**
- **Q.** Write a short note on types of slope failure according to extent of slip surface. **(SUMMER 2024, 3 Marks)**
- **Q.** Enlist different types of factor of safety used in stability of slopes. **(SUMMER 2022, 3 Marks)**
- **Q.** Derive the expression for the factor of safety of an infinite slope in a cohesionless soil. **(WINTER 2022, 7 Marks OR)**
- **Q.** Explain Fellenius method for locating centre of slip circle. **(WINTER 2024, 4 Marks)**
- **Q.** If the angle of friction is greater than angle of slope, the slope is always stable. (True/False) **(WINTER 2022, 3 Marks)**

2. Slope Stability (Numerical):

- **Q.** A 6 meter deep cut is to be made in cohesive soil with a slope of 1:1. The soil has C_u = 30 kPa, ϕ_u = 10° & γ = 18 kN/m³. Find the factor of safety with respect to cohesion. Take stability number, S_n = 0.108 **(SUMMER 2024, 7 Marks OR)**

- **Q.** An Embankment 13m high is inclined at 30° to the horizontal. A stability analysis by the method of slice gives the following forces per running meter. Sum of shearing forces = 600 kN, Sum of Normal forces = 1000 kN, Sum of neutral forces = 200 kN, The length of arc is 35m the value of effective stress parameter are 30 kN/m² and 25° resp. Determine the FOS w.r.t. (a) shearing strength (b) Cohesion. **(SUMMER 2022, 7 Marks)**
- **Q.** A vertical cut is made in a clay deposits. The soil properties are C = 30 kN/m², Φ = 0°, γ = 16 kN/m³. Find the maximum height of the cut which can be temporarily supported. Take S_n = 0.261. **(WINTER 2022, 4 Marks)**
- **Q.** An Road embankment is inclined on sides at angle of 30° to the horizontal. If the shear strength parameters are as c = 20 kN/m² and ϕ = 10°, Find factor of safety available against slope failure for 12m and 15m height. The unit weight of soil is 18 kN/m³. Take S_n = 0.07. **(SUMMER 2025, 7 Marks)**
- **Q.** A vertical cut is made in a clay deposit having c = 30 kN/m², ϕ = 0, γ = 17 kN/m³. Determine the maximum depth of cut so that the cut is stable. Take S_n = 0.26 **(SUMMER 2026, 4 Marks)**

Chapter 2: Stress Distribution of Soils

Repeated Questions:

1. Boussinesq's Theory (Theory):

- **Q.** What are the basic assumptions in Boussinesq's theory of stress distribution in soils? / Explain Boussinesq's theory and its assumptions in detail. **(SUMMER 2024, 3 Marks OR; SUMMER 2026, 7 Marks)**
- **Q.** Derive as per Boussinesq's theory, expressions for vertical stress at any point in a soil mass due to (i) line load on the surface, and (ii) strip load on the surface. / Derive the Equation for Vertical stress under a line load using Boussinesq theory. **(SUMMER 2025, 7 Marks OR; WINTER 2025, 4 Marks OR)**

2. Boussinesq's Equation (Numerical):

- **Q.** A concentrated load of 50 kN acts on the surface of a homogeneous soil mass of large extent. Find the stress intensity at a depth of 5m; (a) Directly under the load, and (b) At a horizontal distance of 5m. Use Boussinesq's equation. **(SUMMER 2024, 7 Marks; WINTER 2025, 7 Marks)**

3. Newmark's Influence Chart:

- **Q.** Explain Newmark's influence Chart and its application / Write a short note on Newmark's influence chart. **(SUMMER 2022, 3 Marks OR; SUMMER 2023, 3 Marks; SUMMER 2025, 4 Marks OR)**
- **Q.** Derive the principle of construction of Newmark's chart. **(WINTER 2024, 4 Marks; WINTER 2025, 3 Marks)**

4. Pressure Bulb and Contact Pressure:

- **Q.** Explain the concept of 'Pressure bulb' and its use in soil engineering practice / Explain the concept of 'Pressure Bulb' in soils. **(SUMMER 2023, 4 Marks OR; WINTER 2023, 4 Marks OR; SUMMER 2024, 3 Marks; WINTER 2024, 4 Marks; SUMMER 2025, 3 Marks)**
- **Q.** Explain with figure about contact pressure & settlement distribution beneath rigid & flexible footing. / Draw contact pressure distribution diagram for flexible and rigid footings on sand and clayey soil. **(SUMMER 2023, 4 Marks OR; SUMMER 2024, 4 Marks)**

Other Important Questions:

1. Stress Distribution (Theory):

- **Q.** Enlist theories regarding distribution of stresses in soil. Derive equation for stress distribution of soil under a point load as per Boussinesq's theory. **(SUMMER 2023, 4 Marks)**
- **Q.** Give the comparison of Boussinesq and Westergaard theory for stress distribution analysis. **(WINTER 2022, 4 Marks)**
- **Q.** Briefly explain with sketch Boussinesq's equation. **(WINTER 2023, 3 Marks OR)**
- **Q.** Using Boussinesq's expression, derive the expression for vertical stress at depth h under the centre of a circular area of radius a loaded uniformly with a load q at the surface of the mass of soil. **(WINTER 2025, 4 Marks)**
- **Q.** Illustrate the vertical stress distribution on a horizontal plane at a given depth. **(WINTER 2025, 3 Marks OR)**
- **Q.** Explain the concept of isobars and pressure bulb. **(SUMMER 2026, 3 Marks OR)**
- **Q.** Newmark's influence chart can be used for the determination vertical stress under (a) Circular load area only (b) Rectangular load area only (c) Strip load only (d) Any shape of the loaded area **(WINTER 2022, 3 Marks)**

2. Stress Distribution (Numerical):

- **Q.** A circular footing 1.5 m radius transmits a uniform pressure of 100 kN/m². Calculate vertical stress at point 3 m directly below its centre. **(SUMMER 2024, 7 Marks)**

- **Q.** A long strip footing of width 2 m carries a load of 400 kN/m. Calculate the maximum stress at a depth of 5m below the centre line of footing. **(WINTER 2022, 4 Marks)**
- **Q.** Use Boussinesq's theory and compute vertical stress values on a vertical plane located at radial distance of 1m away from a 200 kN point load acting at ground level. Compute the vertical stress values at 2m, 3m & 4m depth. **(WINTER 2024, 7 Marks)**
- **Q.** A point load of 150 kN acting at ground surface. Compute the vertical stress at 4m depth along axis using Boussinesq's equation and Westergaard's equation. **(SUMMER 2026, 7 Marks OR)**

Chapter 3: Subsurface Investigation

Repeated Questions:

1. Exploration Methods (Theory):

- **Q.** Define subsurface investigation. Give various objectives and Planning for carrying out subsurface exploration. Explain any one type of geophysical exploration method used in field along with its applications / Define soil exploration and its objectives. Explain the stages of Site Investigations. **(SUMMER 2022, 4 Marks; SUMMER 2023, 7 Marks; SUMMER 2026, 3 Marks; SUMMER 2026, 7 Marks)**
- **Q.** Describe with a neat sketch how will you carry out the wash boring method of soil exploration / List out various boring method and Explain wash boring method with neat sketch in details. **(SUMMER 2024, 3 Marks; WINTER 2024, 4 Marks OR; SUMMER 2025, 7 Marks; WINTER 2025, 4 Marks)**
- **Q.** Write a short note on Geophysical exploration using electrical resistivity method / Describe geophysical exploration using electrical resistivity method. **(SUMMER 2024, 4 Marks; WINTER 2024, 3 Marks OR; WINTER 2025, 4 Marks OR)**

2. Standard Penetration Test (Theory):

- **Q.** Explain working principle of SPT test and its application / Explain with neat sketch SPT in detail - its working principle, corrections applied / Write step by step procedure to perform standard penetration test in the field. Also explain corrections for SPT value. **(SUMMER 2022, 7 Marks; WINTER 2022, 7 Marks; SUMMER 2023, 4 Marks; WINTER 2023, 7 Marks; WINTER 2024, 3 Marks)**

3. Soil Samplers (Theory):

- **Q.** Explain the terms 'inside clearance' and 'outside clearance' as applied to a sampler. **(WINTER 2024, 3 Marks; WINTER 2025, 3 Marks OR)**
- **Q.** Draw a split spoon sampler with details / Draw split spoon sampler with its notations. **(SUMMER 2025, 3 Marks; SUMMER 2026, 4 Marks)**

4. SPT Correction and Sampler Area Ratio (Numerical):

- **Q.** A standard penetration test is conducted at a depth of 5m in saturated fine sand having unit weight 20 kN/m³. If observed N value is 25, then the corrected N value / estimate the corrected N value. **(SUMMER 2024, 7 Marks; WINTER 2025, 7 Marks)**
- **Q.** Compute the area ratio of a thin-walled tube sampler having an external diameter of 100mm and wall thickness of 2mm. Do you recommend this sampler for obtaining undisturbed soil sample? / Evaluate the area ratio of a thin-walled tube sampler... [Data truncated in source – refer to the original question paper] **(SUMMER 2024, 7 Marks; WINTER 2025, 7 Marks OR)**

Other Important Questions:

1. Exploration Methods (Theory):

- **Q.** Explain Bore log in detail. Its prediction used in soil exploration. **(WINTER 2023, 3 Marks)**
- **Q.** Enlist the various methods of Exploration? Explain any one in detail with sketch. **(WINTER 2023, 7 Marks)**
- **Q.** Explain the working principle of wash boring. **(SUMMER 2026, 3 Marks)**
- **Q.** Define drift and shaft for direct method of exploration. **(SUMMER 2026, 3 Marks)**

2. Penetration Tests (Theory):

- **Q.** Write brief critical notes on standard penetration test. **(SUMMER 2024, 4 Marks OR)**
- **Q.** Explain in details Dynamic cone penetration test with neat sketch. **(SUMMER 2025, 7 Marks)**

3. Penetration Test and Sampler Calculations (Numerical):

- **Q.** The field N-value of Fully submerged Fine sand is 35 at 8m depth. The avg. Saturated unit weight of sand is 19.5 kN/m³ Calculated Corrected N-Value as per IS 2131-1981. **(SUMMER 2025, 7 Marks OR)**
- **Q.** Determine the area ratio for the following soil samples and comment on the nature of samples obtained in each of the samples. Table (Core cutter 165 150; Split barrel 51 35; Seamless tube 51 48) **(WINTER 2024, 7 Marks OR)**

4. Sampling and Geophysical Methods (MCQ):

- **Q.** Undisturbed samples are obtained by (a) Direct excavation (b) Augers (c) Thick wall sampler (d) Thin wall sampler **(WINTER 2022, 3 Marks)**
- **Q.** Elastic shock waves have different velocities in different material is the principle involved in (a) Electrical resistivity method (b) Seismic refraction method (c) Both (a) and (b) (d) Pressure meter method **(WINTER 2022, 3 Marks)**

Chapter 4: Shear Strength

Repeated Questions:

1. Direct Shear Test (Theory):

- **Q.** Explain the principle of the Direct shear test. What are the advantages of this test? What are its limitations? / Explain merits and demerits of Box Shear test. **(SUMMER 2023, 3 Marks; SUMMER 2023, 4 Marks; WINTER 2024, 4 Marks; SUMMER 2025, 4 Marks; SUMMER 2025, 7 Marks)**

2. Triaxial Shear Test (Theory):

- **Q.** Discuss the UU, CU, and CD triaxial shear test conditions / Explain shear tests based on drainage condition / Name and explain the shear tests which may be performed based on the different drainage conditions. **(SUMMER 2023, 3 Marks; WINTER 2023, 3 Marks OR; SUMMER 2024, 4 Marks)**
- **Q.** What are the advantages and disadvantages of Tri-axial Compression Test? / Write advantages of Triaxial shear test / State the benefits of the triaxial test. **(SUMMER 2022, 3 Marks; SUMMER 2025, 3 Marks; WINTER 2025, 3 Marks)**

3. Unconfined Compression Test:

- **Q.** Write brief critical notes on unconfined compression test / Explain unconfined compression test. **(SUMMER 2022, 7 Marks OR; WINTER 2022, 7 Marks; SUMMER 2024, 3 Marks; WINTER 2024, 3 Marks; SUMMER 2025, 7 Marks)**

4. Shear Strength (Numerical):

- **Q.** Three specimens of clay having a small air void content were tested in the shear box. Shear loading was started immediately after the application of normal load and was completed in 10 minutes. The results obtained were as follows: Table (Normal stress 145, 241, 337; Shear stress 103, 117, 132). Find the apparent cohesion and angle of shearing resistance of the clay / Shear box test results for three clay specimens are provided as... Plot the failure envelope and analyze the soil's behavior. [Data truncated in source – refer to the original question paper] **(SUMMER 2024, 7 Marks OR; WINTER 2025, 7 Marks)**
- **Q.** Two identical specimens of a soil were tested in triaxial apparatus. First specimen failed at a deviator stress of 770 kN/m² when the cell pressure was 200 kN/m². While the second specimen failed at a deviator stress of 1400 kN/m² under a cell pressure of 400 kN/m². Determine the shear parameters of the soil. **(SUMMER 2022, 7 Marks; SUMMER 2024, 7 Marks)**
- **Q.** A clay specimen has unconfined strength of 100 kPa & is subjected to UU Triaxial test under a cell pressure of 100 kPa. Find its axial stress at failure / Using the appropriate relation, calculate the axial stress at failure. **(WINTER 2024, 7 Marks; WINTER 2025, 4 Marks)**

Other Important Questions:

1. Shear Strength Concepts (Theory):

- **Q.** Write the importance of Shear strength in Civil Engineering. **(SUMMER 2026, 4 Marks)**
- **Q.** Write a short note on Mohr-Coulomb strength theory. **(SUMMER 2024, 4 Marks)**
- **Q.** What is a stress path? Draw stress path for foundation loading and unloading condition. **(WINTER 2022, 4 Marks)**
- **Q.** Explain importance of 'Unconfined Compression Test' & 'Laboratory Vane Shear Test'. **(WINTER 2023, 4 Marks OR)**

2. Shear Test Procedures and Terms (Theory):

- **Q.** Discuss step by step procedure to perform Tri axial shear test in the laboratory. **(WINTER 2022, 7 Marks)**
- **Q.** Define following terms in relation to tri-axial test (i) Confining pressure (ii) Deviator stress (iii) major and minor principal stress **(SUMMER 2022, 4 Marks)**

- **Q.** Write down the Procedure for Shear strength determination using Direct shear test with neat sketch. **(SUMMER 2026, 7 Marks)**

3. Shear Strength (Numerical):

- **Q.** Following are the results obtained from box shear test on soil: Normal Stress (kN/m²): 25, 75, 150, 250, Shear Stress (kN/m²): 60, 80, 105, 145. Plot graph and determine the shear values C and ϕ of soil. If a specimen of same soil is tested in triaxial test, estimate the deviator stress (σ_d) at which the sample will fail when cell pressure (σ_3) is 100 kN/m² **(SUMMER 2023, 7 Marks)**
- **Q.** A direct shear test was carried out on a soil sample and following results were obtained. Table (Normal stress 150, 200; Shear stress 110, 120). Compute deviator stress if a triaxial test is carried out on the same soil with cell pressure of 150 kN/m². **(SUMMER 2026, 7 Marks)**
- **Q.** 4 cm in dia., fails under a load of 80N. Evaluate shearing resistance if failure occurs at 10% strain. [Data truncated in source – refer to the original question paper] **(WINTER 2024, 7 Marks OR)**

4. Shear Strength Tests (MCQ):

- **Q.** Pore pressure coefficient B is a function of (a) Over consolidation ratio (b) Degree of saturation (c) Under consolidation ratio (d) None of the above **(WINTER 2022, 3 Marks)**
- **Q.** In-situ Vane shear test is used to measure the shear strength of (a) Soft clayey soil (b) Sandy soil (c) Gravelly soil (d) All types of soil **(WINTER 2022, 3 Marks)**

Chapter 5: Bearing Capacity of Shallow Foundation

Repeated Questions:

1. Bearing Capacity Failure Modes:

- **Q.** Differentiate between general shear failure and local shear failure (with neat sketch). / Differentiate between general shear and punching shear failure. **(WINTER 2022, 3 Marks OR; WINTER 2023, 4 Marks; SUMMER 2024, 3 Marks; WINTER 2025, 3 Marks; SUMMER 2026, 4 Marks)**

2. Factors Affecting Bearing Capacity:

- **Q.** Explain the effect of water table on bearing capacity of soil / Explain how the water table effects on bearing capacity / Critically explain effect of G.W.T. on bearing capacity of soil. **(WINTER 2022, 4 Marks OR; WINTER 2023, 4 Marks OR; SUMMER 2024, 4 Marks OR)**
- **Q.** Enumerate / Enlist / Discuss the various factors affecting the bearing capacity of a shallow footing (with sketch). **(SUMMER 2022, 4 Marks; WINTER 2023, 7 Marks; WINTER 2024, 4 Marks; WINTER 2025, 4 Marks)**

3. Terzaghi's Theory and Definitions:

- **Q.** Write the assumptions and limitations of Terzaghi's bearing capacity theory / Describe Terzaghi's theory of bearing capacity of foundation soil under strip footing. What are the assumptions and its limitations? **(SUMMER 2022, 4 Marks OR; WINTER 2023, 3 Marks; SUMMER 2024, 3 Marks; WINTER 2024, 3 Marks)**
- **Q.** Define the following: (i) Ultimate bearing capacity (ii) Net safe bearing capacity (iii) Safe bearing capacity (iv) Allowable bearing capacity / Gross pressure intensity. **(SUMMER 2023, 7 Marks; WINTER 2023, 4 Marks; SUMMER 2025, 3 Marks)**

4. Safe Bearing Capacity (Numerical):

- **Q.** Determine the safe bearing capacity of a strip footing 1.5 m wide & 1.5 m depth, resting on a deep sand bed, consider $\gamma = 18$ kN/m³, and bearing capacity factors $N_c = 35.5$, $N_q = 23.2$, $N_\gamma = 22$ corresponding to $\phi = 38°$ and factor of safety = 3. Use Terzaghi's equation. **(SUMMER 2024, 7 Marks; WINTER 2024, 7 Marks; WINTER 2025, 7 Marks OR - extended with net safe bearing capacity and economic comparison)**
- **Q.** Compute the safe bearing capacity of a square footing 2.0 m × 2.0 m, located at a depth of 1.5 m below ground level in a soil of unit weight 19 kN/m³, $\phi = 20°$, $N_c = 17.7$, $N_q = 7.4$, $N_\gamma = 5.0$. Take factor of safety = 3. The water table is very deep. If the water table touches the base of the footing, find the reduction in safe bearing capacity. Use Terzaghi's equation. **(WINTER 2024, 7 Marks OR; WINTER 2025, 7 Marks)**

5. Foundation Types, Plate Load Test and Contact Pressure:

- **Q.** Explain in detail Plate load test / Discuss merits and demerits of Plate load test / Write the limitation of Plate load test. **(SUMMER 2023, 7 Marks OR; WINTER 2023, 7 Marks OR; SUMMER 2025, 4 Marks; SUMMER 2026, 3 Marks)**
- **Q.** Write short note on Floating Foundation. **(SUMMER 2022, 3 Marks; SUMMER 2025, 3 Marks OR)**
- **Q.** Differentiate between shallow foundation and deep foundation / Explain the basic difference in the bearing capacity computation of shallow and deep foundations. **(SUMMER 2023, 3 Marks OR; WINTER 2024, 3 Marks OR)**
- **Q.** Explain with figure about contact pressure & settlement distribution beneath rigid & flexible footing / Draw contact pressure distribution diagram for flexible and rigid footings on sand and clayey soil. **(SUMMER 2023, 4 Marks OR; SUMMER 2024, 4 Marks)**

6. Pavement Basics (Miscellaneous):

- **Q.** Difference between Flexible and Rigid pavements / What are the basic requirement of a good pavement? **(WINTER 2022, 3 Marks; WINTER 2023, 3 Marks)**

Other Important Questions:

1. Bearing Capacity Concepts (Theory):

- **Q.** Describe various types of failure with sketch. **(SUMMER 2022, 3 Marks)**
- **Q.** What is the effect of increase in width of a footing on bearing capacity of a footing resting on (a) sand and (b) clay? **(SUMMER 2023, 3 Marks OR)**
- **Q.** What are the criteria for deciding the depth of foundations? **(WINTER 2024, 3 Marks)**

2. Bearing Capacity (Numerical):

- **Q.** A square footing has dimensions of 2 m × 2 m and depth 2 m. Determine its ultimate bearing capacity in pure clay with UCS of 0.15 N/mm², $\phi = 0°$, $\gamma = 1.7$ g/cm³. Assume Terzaghi's factor for $\phi = 0°$ as $N_c = 5.7$, $N_q = 1.0$, $N_\gamma = 0$. **(SUMMER 2023, 7 Marks OR)**
- **Q.** Determine the allowable gross load and net allowable load that can be carried out by a square footing of size 2 m × 2 m, placed at a depth of 1.0 m below ground level. The water table is at a great depth. Foundation soil has the properties: $\gamma_d = 18$ kN/m³, C = 15 kN/m². Use Terzaghi's theory. For $\Phi = 25°$, $N_c' = 14.8$, $N_q' = 5.6$, $N_\gamma' = 3.2$. Assume F.S. = 3. **(WINTER 2022, 7 Marks)**
- **Q.** Determine ultimate bearing capacity using Terzaghi's theory. A strip footing 1.5 m wide resting on a saturated clay at a depth 2 m below ground level. ($\Phi = 0$, $\gamma_{sat} = 20$ kN/m³, C = 30 kN/m²) The water table is also at a depth of 2 m from the ground level. If the water table rise by 1 m, calculate the reduction in ultimate bearing capacity. **(WINTER 2023, 7 Marks OR)**
- **Q.** A 2.5 m wide strip footing is founded at a depth of 2.0 m below the ground level in a homogeneous bed of sand, having the following properties: $\Phi = 35°$, $\gamma = 18.0$ kN/m³. Determine the ultimate, net ultimate and net safe bearing capacity of the footing. For $\Phi = 35°$, $N_c = 57.8$, $N_q = 41.4$, $N_\gamma = 42.4$. Assume a factor of safety of 3.0. Use Terzaghi's analysis. Water table is at 2 m from G.L. **(SUMMER 2022, 7 Marks)**
- **Q.** Determine the safe bearing capacity of a square footing 2.0 m × 2.0 m located at a depth of 1 m below ground level in a soil of density 17.5 kN/m³, $\Phi = 30°$, $N_c = 30.4$, $N_q = 18.4$, $N_\gamma = 22.4$ if the water table rises upto G.L. what is reduction in SBC. Take FOS = 3. **(SUMMER 2022, 7 Marks OR)**
- **Q.** A strip footing of 3 m wide and founded at 2.5 m depth below GL, in a soil having cohesion is 35 kN/m² and angle of internal friction is 35°. The water table is at a depth of 5 m below GL. The moist weight of soil above water table is 18.00 kN/m³. Determine Safe bearing capacity and safe load per m length. Take FOS = 3. Use Terzaghi's theory and general shear failure. Take $N_c = 57.8$, $N_q = 41.4$ and $N_\gamma = 42.4$. **(SUMMER 2025, 7 Marks)**
- **Q.** A strip footing of 3 m width is placed at 3.5 m depth below Ground Level. Determine ultimate bearing capacity using (i) Terzaghi's Equation ($N_c = 5.7$, $N_q = 1$, $N_\gamma = 0$) and (ii) IS Code method ($N_c = 5.14$, $N_q = 1$, $N_\gamma = 0$). Take $\gamma = 18$ kN/m³ and c = 15 kN/m², $\Phi = 0$. **(SUMMER 2026, 7 Marks OR)**

3. Expansive Soils:

- **Q.** Define (i) Free swell index (ii) Swelling pressure. **(SUMMER 2025, 3 Marks)**
- **Q.** Give characteristics of Black cotton soil. **(SUMMER 2026, 3 Marks OR)**
- **Q.** Explain how expansive soil can be identified in the laboratory? **(SUMMER 2022, 4 Marks OR)**

Chapter 6: Pile Foundations

Repeated Questions:

1. Pile Types and Pile Driving (Theory):

- **Q.** Write critically note on Pile classification / Enlist various classification of pile. **(SUMMER 2023, 3 Marks; WINTER 2023, 3 Marks)**
- **Q.** Differentiate between End bearing pile and Friction pile. **(SUMMER 2026, 3 Marks)**
- **Q.** Elaborate the conditions where a pile foundation is more suitable than a shallow foundation. **(WINTER 2023, 3 Marks OR)**
- **Q.** Explain in detail "Under Reamed Pile Foundation" / Draw an under reamed pile with detailed configuration / Write short note on Under reamed pile in expansive soil. **(SUMMER 2022, 4 Marks; WINTER 2023, 4 Marks; SUMMER 2024, 4 Marks OR; SUMMER 2025, 4 Marks)**
- **Q.** Enlist various pile driving hammers and explain any one / any two in detail. **(SUMMER 2022, 3 Marks; SUMMER 2026, 4 Marks OR)**

2. Pile Capacity – Formulae and Load Test (Theory):

- **Q.** Write brief critical notes on the Engineering News formula / Explain Engineering News formula. **(SUMMER 2024, 4 Marks; WINTER 2024, 3 Marks OR)**
- **Q.** Discuss various dynamic pile formulae with meaning of each term in it. What are their limitations? / Write dynamic formulae to estimate pile capacity. **(SUMMER 2022, 3 Marks OR; SUMMER 2024, 7 Marks OR)**
- **Q.** Explain pile load test for determining load carrying capacity of a pile with neat and clean sketch. **(SUMMER 2024, 7 Marks OR)**

3. Skin Friction and Group Action (Theory):

- **Q.** Explain Negative skin friction for Cohesive Soil and Cohesion less Soil / Define negative skin friction. What is its effect on the pile? **(SUMMER 2022, 4 Marks; SUMMER 2023, 7 Marks)**
- **Q.** Explain the Feld rule to determine efficiency of a pile group. **(SUMMER 2024, 3 Marks)**
- **Q.** "The settlement of a group of pile is more than the settlement of a single pile." Comment on the statement. **(WINTER 2022, 3 Marks; SUMMER 2024, 3 Marks OR)**
- **Q.** Define adhesion factor. State its purpose in the design of piles in clay. **(SUMMER 2026, 4 Marks OR)**

4. Pile Capacity (Numerical):

- **Q.** A 30cm diameter pile is driven into a homogeneous clay (C = 40kPa, $\alpha = 0.7$) If the embedded length is 10m estimate the safe load (FS = 2.5) **(SUMMER 2024, 7 Marks)**

5. Pile Foundation (MCQ):

- **Q.** Answer the following (MCQs): The piles which are used to protect water front structures are called (a) Load bearing piles (b) Sheet piles (c) Tension piles (d) Fender piles; Negative skin friction is predominant in (a) Friction piles in sand (b) Friction piles in soft clay (c) Piles resting on hard soil (d) Bearing pile; The group efficiency of driven piles in sand at a close spacing may be (a) Equal to 100% (b) Greater than 100% (c) Well below 100% (d) Can not be said. **(WINTER 2022, 3 Marks OR; SUMMER 2024, 3 Marks OR)**

Other Important Questions:

1. Pile Foundation (Theory):

- **Q.** Explain the functions of (i) Batter pile (ii) Fender pile (iii) End bearing pile (iv) Friction pile **(SUMMER 2023, 4 Marks)**
- **Q.** Write procedure for estimate the group capacity of piles in sand. Also explain negative skin friction and its effects on the pile? **(WINTER 2023, 7 Marks)**

- **Q.** Explain the function of pile foundation and show how the bearing capacity of the foundation can be estimated for granular soils. **(WINTER 2025, 3 Marks OR)**
- **Q.** What is group effect and how will you estimate the capacity of a pile group in cohesive soil? **(WINTER 2025, 4 Marks OR)**

2. Pile Capacity and Pile Group (Numerical):

- **Q.** A square pile group of 9 piles passes through a recently filled up material of 4 m depth. The diameter of the pile is 0.3 m and pile spacing is 0.9 m center to center. If the UCS of soil is 60 kN/m² and unit weight is 15 kN/m³. Compute the negative skin friction. **(WINTER 2023, 7 Marks)**
- **Q.** A pile group consists of 9 piles of 30 cm diameter and 10 m length driven in clay. The soil properties are C_u = 100 kN/m², γ = 20 kN/m³. Calculate the safe load for the pile group. Take factor of safety = 3 and α = 0.6. **(SUMMER 2024, 7 Marks)**
- **Q.** A group of 16 piles of 0.45 m diameter is arranged in a square pattern with centre to centre spacing of 1.5 m. The piles are 10 m long and embedded in soft clay with cohesion 30 kN/m². Bearing resistance may be neglected for the piles. Adhesion factor is 0.6. Determine the ultimate load capacity of pile group. **(SUMMER 2022, 7 Marks)**
- **Q.** A concrete pile, 35 cm diameter, 15 m long is driven through a 6 m thick layer of silty sand (ϕ = 25°, γ = 18 kN/m³) overlaying a dense layer of sand (ϕ = 40°, γ = 16.5 kN/m³). If the water table is at great depth, estimate the safe load the pile can carry. Take F.S. = 3, k = 1.0 and δ = 0.75ϕ. N_q = 140 for ϕ = 40°. **(SUMMER 2022, 7 Marks OR)**
- **Q.** A 60 cm diameter pile is driven into a homogeneous clay having, C = 50 kPa, α = 0.7. If the embedded length is 10 m, estimate the safe load. Take FOS = 2, and N_c = 9. **(WINTER 2024, 7 Marks)**
- **Q.** A concrete pile of 45 cm diameter was driven into sand of loose to medium density to a depth of 15 m. The following properties are known: Average unit weight of soil along the length of the pile, $\bar{\gamma}$ = 17.5 kN/m³, average ϕ = 30°, average K_s = 1.0 and δ = 0.75ϕ. Calculate the allowable load with FS = 2.5. Take N_q = 16.5. **(WINTER 2024, 7 Marks OR)**
- **Q.** A square group of 16 piles was driven into soft clay extending to a large depth. The diameter and length of the piles were 50 cm and 9 m respectively. If the unconfined compression strength of the clay is 60 kN/m², and the pile spacing is 1 m centre to centre, estimate the ultimate capacity of the group. Assume adhesion factor of 0.6. Neglect bearing resistance. **(WINTER 2025, 7 Marks)**
- **Q.** A 30 cm diameter pile is driven into a homogeneous clay (C = 45 kPa, N_c = 9). If the embedded length is 6 m, estimate the safe load (FS = 3). Assume the adhesion factor α = 0.7. Also analyze how changes in α, would affect the safe capacity. **(WINTER 2025, 7 Marks OR)**

3. Dynamic Pile Formulae (Numerical):

- **Q.** A pile is driven with a single acting steam hammer of weight 45 kN with a free fall of 1.5 m. The average penetration of the last 20 blows is 30 mm. Find the safe load using ENR formula. **(SUMMER 2025, 4 Marks OR)**
- **Q.** A drop hammer weighing 40 kN and having free fall of 75 cm drives an RCC pile of 30 kN. The average settlement per blow was 1.5 cm. The total temporary elastic compression is 2.0 cm. Assuming coefficient of restitution as 0.25 and FOS is 2.5, determine ultimate bearing capacity and allowable load on pile. **(SUMMER 2025, 7 Marks OR)**
- **Q.** A 25 kN weight pile is inserted using single acting steam hammer with a free fall of 1.2 m. The avg. penetration of last 20 blow is 20 mm. Find the safe load using the ENR formula. **(SUMMER 2026, 7 Marks)**

Chapter 7: Introduction to Geosynthetics

Repeated Questions:

1. Classification and Types of Geosynthetics:

- **Q.** Define 'GEOSYNTHETICS'. Classify the geosynthetic materials and explain any two of them with neat sketch / Describe different types of Geosynthetics and its application with sketch in various domain of civil engineering. **(SUMMER 2023, 7 Marks OR; WINTER 2023, 7 Marks OR)**

2. Functions of Geosynthetics:

- **Q.** Explain in brief about any two types of geosynthetics / Explain various functions of geosynthetics with suitable applications / Write the functions of geosynthetic materials and explain any one of them. **(SUMMER 2024, 4 Marks; SUMMER 2024, 4 Marks; WINTER 2024, 4 Marks OR; SUMMER 2026, 7 Marks OR)**

3. Applications of Geosynthetics:

- **Q.** What are the different applications of geotextile, and geocell / Describe the different applications of geogrid, geomembrane, and geocell / Enlist various application area of Geosynthetics. **(SUMMER 2024, 3 Marks OR; WINTER 2024, 4 Marks; SUMMER 2025, 3 Marks OR; WINTER 2025, 4 Marks)**

Other Important Questions:

1. Properties and Functions of Geosynthetics (Theory):

- **Q.** Name important hydraulic and mechanical properties of geosynthetic materials. **(SUMMER 2024, 3 Marks OR)**
- **Q.** Classify geo-textile materials. What are the basic functions performed by geotextiles? **(SUMMER 2022, 4 Marks OR)**
- **Q.** Summarize the separation and drainage functions of geosynthetics. **(WINTER 2025, 3 Marks)**
- **Q.** The function which is not served by geotextile material is (a) Filtration (b) Drainage (c) Reinforcement (d) Dynamic loading. **(WINTER 2022, 3 Marks OR)**

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