

GUJARAT TECHNOLOGICAL UNIVERSITY

BE-5 SEMESTER – OLD PAPER – S22 TO S25 – QUESTION BANK

Subject Name & Code:

Soil Mechanics- 3150615 BE05006011

Unit 1: Slope Stability

This unit covers the analysis of soil slopes, factors of safety, and different failure mechanisms.

A. Repeated & Important Questions

1. **Explain different types of slope failures.**
 - **Appeared in:** Summer 2023 (Q3a-OR), Winter 2023 (Q5a), **Summer 2022 (Q1a).**
 - **Marks:** 03 Marks each time.
 - **Note:** A fundamental question, often asked as a short note.
2. **How is a slope analyzed using the Swedish circle method (method of slices)? Discuss the method and derive an expression for the factor of safety.**
 - **Appeared in:** Summer 2023 (Q3c-OR), **Winter 2022 (Q2c).**
 - **Marks:** 07 Marks each time.
 - **Note:** A core numerical and theoretical method for finite slopes.
3. **Explain Taylor's Stability Number.**
 - **Appeared in:** Summer 2023 (Q3b-OR), Summer 2024 (Q3c).
 - **Marks:** 04 Marks (Summer 2023), 07 Marks (Summer 2024 - applied in a numerical).
 - **Note:** A key concept for quick analysis of cohesive slopes.
4. **Discuss various methods to improve slope stability.**
 - **Appeared in:** Winter 2022 (Q4b), **Summer 2025 (Q2b).**
 - **Marks:** 04 Marks each time.

B. Other Questions from this Unit (Non-Repeated but Important)

1. **Enlist different types of factor of safety used in stability of slopes. (Summer 2022, Q2a, 03 Marks)**
2. **Write a short note on Friction circle method. (Summer 2025, Q3b, 04 Marks)**

3. **Explain Fellenius method for locating centre of slip circle. (Winter 2024, Q2b, 04 Marks)**
4. **A long natural slope in a C- ϕ soil is inclined at 12° to the horizontal... determine the factor of safety. (Winter 2024, Q2c, 07 Marks) - *Numerical on Infinite Slope***
5. **An Embankment 13 m high is inclined at 30° to the horizontal... Determine the FOS. (Summer 2022, Q2c, 07 Marks) - *Numerical on Method of Slices***
6. **An Road embankment... Find factor of safety available against slope failure for 12m and 15m height. (Summer 2025, Q4c, 07 Marks) - *Numerical using Stability Number***
7. **Define: Infinite and finite slope. (Summer 2025, Q1b, 04 Marks)**
8. **Differentiate the Infinite and finite slope. (Winter 2023, Q5b, 04 Marks)**

Unit 2: Stress Distribution in Soils

This unit deals with calculating the increase in vertical stress at any point in a soil mass due to applied loads.

A. Repeated & Important Questions

1. **Explain Newmark's Influence Chart and its application.**
 - **Appeared in:** Summer 2023 (Q3a), Summer 2022 (Q3a-OR), Summer 2025 (Q5b).
 - **Marks:** 03 Marks each time.
 - **Note:** A standard tool for stress calculation under irregular loads.
2. **Use Boussinesq's theory to calculate stress under a point/line load.**
 - **Appeared in:** This is a very common numerical problem.
 - **Summer 2024 (Q5c):** Stress under a point load at different points.
 - **Summer 2025 (Q5c):** Derive equation for a line load.
 - **Winter 2024 (Q1c):** Compute stress at different depths.
 - **Marks:** 07 Marks.
 - **Note:** Mastery of Boussinesq's equation is essential.
3. **Explain the concept of 'Pressure Bulb'.**
 - **Appeared in:** Winter 2023 (Q5b), Summer 2024 (Q1a), Winter 2024 (Q3b), Summer 2025 (Q4a).
 - **Marks:** 03 or 04 Marks.
 - **Note:** A conceptual question about stress isobars.

B. Other Questions from this Unit (Non-Repeated but Important)

1. **Give the comparison of Boussinesq and Westergaard theory. (Winter 2022, Q1b, 04 Marks)**
2. **What are the basic assumptions in Boussinesq's theory? (Summer 2024, Q5a, 03 Marks)**
3. **A circular footing 1.5 m radius... Calculate vertical stress at point 3 m directly below its centre. (Summer 2024, Q1c, 07 Marks) - *Numerical on Stress under Uniform Load***
4. **A long strip footing of width 2 m carries a load of 400 kN/m. Calculate the maximum stress at a depth of 5 m below the centre line. (Winter 2022, Q3b, 04 Marks) - *Numerical on Stress under Strip Load***
5. **Derive equation for stress distribution of soil under a point load as per Boussinesq's theory. (Summer 2023, Q3b, part question)**
6. **Explain causes of stress in soil. What is geostatic stress? (Summer 2023, Q3c, part question)**

Unit 3: Subsurface Investigation

This unit covers the methods and objectives of exploring soil conditions at a site.

A. Repeated & Important Questions

1. **Explain Standard Penetration Test (SPT) in detail – its procedure, corrections, and application.**
 - **Appeared in:** Summer 2022 (Q1c), Winter 2023 (Q3c), Summer 2023 (Q1b).
 - **Marks:** 07 Marks (Summer 2022, Winter 2023), 04 Marks (Summer 2023).
 - **Note:** This is arguably the most important topic in this unit. Be thorough with the procedure and all corrections (dilatancy, overburden, etc.).
2. **List and explain various boring methods. Explain any one (e.g., Wash Boring) with a sketch.**
 - **Appeared in:** Winter 2023 (Q1c), Summer 2025 (Q1c), Summer 2024 (Q5a).
 - **Marks:** 07 Marks (Winter 2023, Summer 2025).
 - **Note:** Wash boring is a frequently asked method.
3. **Define soil exploration/subsurface investigation and state its objectives.**
 - **Appeared in:** Winter 2023 (Q1b), Summer 2023 (Q1c).
 - **Marks:** Part of 04 and 07 mark questions.
4. **What is a soil sampler? Explain terms like 'Area Ratio', 'Inside Clearance', and 'Outside Clearance'.**
 - **Appeared in:** Winter 2024 (Q1a), Winter 2024 (Q2c-OR) [Area Ratio numerical].
 - **Marks:** 03 Marks (Q1a), 07 Marks (Q2c-OR).
 - **Note:** Key for understanding sample quality.

B. Other Questions from this Unit (Non-Repeated but Important)

1. **Explain Bore log in detail. (Winter 2023, Q1a, 03 Marks)**
2. **Explain any one geophysical exploration method (e.g., Electrical Resistivity Method). (Summer 2023, Q1c; Summer 2024, Q4b; Summer 2025, Q5a)**
3. **Compute the area ratio of a sampler... Do you recommend this sampler? (Summer 2024, Q3c-OR, 07 Marks) - Numerical on Area Ratio**
4. **Determine the area ratio for the following soil samples and comment... (Winter 2024, Q2c-OR, 07 Marks) - Numerical on Area Ratio**
5. **A standard penetration test is conducted... find the corrected N value. (Summer 2024, Q2c, 07 Marks) - Numerical on SPT Corrections**
6. **The field N-value of Fully submerged Fine sand is 35... Calculated Corrected N-Value. (Summer 2025, Q2c-OR, 07 Marks) - Numerical on SPT Corrections**

Unit 4: Shear Strength

This unit covers the resistance of soil to shear deformation, described by parameters like cohesion (c) and angle of internal friction (ϕ).

Repeated Questions:

1. **Explain the Mohr-Coulomb failure theory.**
 - **Appeared in:** Summer 2024 (Q3b), (Implicitly covered in all shear strength questions).
 - **Marks:** 04 Marks.
 - **Note:** The fundamental theory behind shear strength.
2. **Explain the Triaxial Shear Test (UU, CU, CD conditions, advantages, disadvantages).**
 - **Appeared in:** Summer 2022 (Q3a), Summer 2022 (Q5a), Summer 2023 (Q5a), Summer 2025 (Q4a).
 - **Marks:** 03 Marks.
 - **Note:** A very common question focusing on its types and comparison with other tests.
3. **Explain the Direct Shear Test (Principle, procedure, advantages, limitations).**
 - **Appeared in:** Winter 2024 (Q1b), Summer 2023 (Q4a), Summer 2025 (Q5c).
 - **Marks:** 04 Marks (Winter 2024), 03 Marks (Summer 2023), 07 Marks (Summer 2025).
 - **Note:** Frequently compared with the Triaxial test.
4. **Explain the Unconfined Compression Test (Procedure, advantages).**
 - **Appeared in:** Summer 2022 (Q3c-OR), Winter 2024 (Q4a), Summer 2024 (Q3a).
 - **Marks:** 07 Marks (Summer 2022), 03 Marks (Winter 2024, Summer 2024).
5. **Numerical on determining shear parameters (c , ϕ) from Triaxial or Direct Shear test data.**
 - **Appeared in:** This is a very common numerical problem.
 - **Summer 2022 (Q3c):** Triaxial test numerical.
 - **Summer 2024 (Q4c):** Triaxial test numerical.
 - **Summer 2023 (Q5c):** Direct shear test numerical.
 - **Winter 2024 (Q4c):** Unconfined compression test numerical.
 - **Marks:** 07 Marks.
 - **Note:** Practice plotting Mohr's circles and determining parameters.

Other Important Questions:

1. **What are the shear tests based on drainage conditions? (Winter 2023, Q3a-OR, 03 Marks)**
2. **Explain importance of 'Laboratory Vane Shear Test'. (Winter 2023, Q3b-OR, part question)**
3. **Following are the results from a box shear test... determine c and ϕ . (Summer 2023, Q5c, 07 Marks) - Numerical on Direct Shear Test**
4. **Unconfined test is carried out on clay sample... Compute the shearing resistance. (Summer 2025, Q4c, 07 Marks) - Numerical on UCT**
5. **A clay specimen has unconfined strength of 100 kPa... Find its axial stress at failure. (Winter 2024, Q3c, 07 Marks) - Numerical on Triaxial Test**

Unit 5: Bearing Capacity of Shallow Foundation

This unit deals with the ability of soil to support the loads applied from a foundation.

A. Repeated & Important Questions

1. **Explain Terzaghi's Bearing Capacity Theory (Equation, Assumptions, Limitations).**
 - **Appeared in:** Summer 2022 (Q3b-OR), Winter 2023 (Q3a), Summer 2023 (Q4c).
 - **Marks:** 04 Marks (Summer 2022), 03 Marks (Winter 2023), part of 07 Marks (Summer 2023).
2. **Differentiate between General Shear Failure and Local Shear Failure.**
 - **Appeared in:** Winter 2023 (Q2b), Summer 2024 (Q4a).
 - **Marks:** 04 Marks (Winter 2023), 03 Marks (Summer 2024).
3. **What is the effect of the Water Table on bearing capacity?**
 - **Appeared in:** Summer 2023 (Q4b), Winter 2023 (Q4b), Winter 2022 (Q4b).
 - **Marks:** 04 Marks.
 - **Note:** A critical factor that is frequently tested.
4. **Numerical on calculating Ultimate/Safe Bearing Capacity using Terzaghi's equation.**
 - **Appeared in:** This is the most common numerical in the entire course.
 - Summer 2022 (Q4c), Winter 2022 (Q1c), Winter 2023 (Q2c-OR), Winter 2024 (Q4c), Summer 2024 (Q4c), Summer 2025 (Q3c)
 - **Marks:** 07 Marks.
 - **Note:** Practice problems for strip, square, and circular footings, with and without water table effects.

B. Other Questions from this Unit (Non-Repeated but Important)

1. **Define: Gross, Ultimate, Safe, Net, and Allowable Bearing Capacity.** (Winter 2023, Q3b; Summer 2023, Q4c; Summer 2025, Q2a)
2. **Enlist factors affecting bearing capacity.** (Summer 2022, Q4b; Summer 2023, Q4b; Summer 2025, Q5a)
3. **Write a short note on Floating Foundation.** (Summer 2022, Q4a; Summer 2025, Q3a-OR)
4. **Explain with figure contact pressure distribution beneath rigid & flexible footing.** (Summer 2024, Q5b)
5. **Discuss merits and demerits of Plate Load Test.** (Summer 2025, Q4b)
6. **Explain in detail plate load test.** (Summer 2023, Q2c-OR)

Unit 6: Pile Foundations

This unit covers deep foundations used when soil at shallow depth is not competent to support the load.

Repeated Questions:

1. **Classify piles and explain the functions/types of different piles (End Bearing, Friction, Batter, Fender, etc.).**
 - **Appeared in:** Winter 2023 (Q4a), Summer 2023 (Q2a, Q2b).
 - **Marks:** 03 Marks (Q4a, Q2a), 04 Marks (Q2b).
 - **Note:** A fundamental question to understand the purpose of piles.
2. **Explain Negative Skin Friction (Concept, effects, calculation).**
 - **Appeared in:** Summer 2022 (Q3b), Summer 2023 (Q2c), Winter 2023 (Q2c).
 - **Marks:** 04 Marks (Summer 2022), 07 Marks (Summer 2023, Winter 2023).
3. **Explain Dynamic Formulae (Engineering News Formula, Hiley's Formula) for pile capacity.**
 - **Appeared in:** Summer 2022 (Q5a), Winter 2022 (Q4c), Summer 2025 (Q3b, Q3c).
 - **Marks:** 03 Marks (Summer 2022), 07 Marks (Winter 2022, Summer 2025 Q3c).
 - **Note:** A common topic for both short notes and numerical problems.
4. **Numerical on calculating the Ultimate/Safe Load Capacity of a Single Pile.**
 - **Appeared in:**
 - **Static Formula (Clay/Sand):** Winter 2024 (Q5c), Summer 2024 (Q5c).
 - **Dynamic Formula:** Summer 2025 (Q3c).
 - **Marks:** 07 Marks.
 - **Note:** Practice using both the static (α , β methods) and dynamic formulae.
5. **Numerical on calculating the Ultimate Load Capacity of a Pile Group.**
 - **Appeared in:** Summer 2022 (Q5c), Winter 2022 (Q5c).
 - **Marks:** 07 Marks.

Other Important Questions:

1. **Write a short note on Under-reamed Pile. (Summer 2022, Q5b; Winter 2023, Q4b; Summer 2025, Q5b)**
2. **Explain the Pile Load Test procedure. (Winter 2022, Q5c; Summer 2023, Q2c-OR)**
3. **Explain the conditions where a pile foundation is more suitable than a shallow foundation. (Winter 2023, Q5a-OR)**
4. **Explain Feld's rule for pile group efficiency. (Winter 2022, Q5a)**
5. **"The settlement of a group of pile is more than the settlement of a single pile." Comment. (Winter 2022, Q4a)**

Unit 7: Introduction to Geosynthetics

This unit introduces polymer-based materials used in geotechnical engineering for functions like separation, filtration, and reinforcement.

Repeated Questions:

1. **Classify Geosynthetics and explain any two types in detail.**
 - **Appeared in:** Winter 2023 (Q3c), Summer 2024 (Q4b), Summer 2023 (Q5c).
 - **Marks:** 07 Marks (Winter 2023), 04 Marks (Summer 2024), 07 Marks (Summer 2023).
2. **List the functions/applications of Geosynthetics in Civil Engineering.**
 - **Appeared in:** Summer 2022 (Q5b), Winter 2022 (Q5b), Winter 2024 (Q5b), Summer 2025 (Q5a).
 - **Marks:** 04 Marks (Summer 2022, Winter 2022, Winter 2024), 03 Marks (Summer 2025).

Other Important Questions:

1. **Name important hydraulic and mechanical properties of geosynthetic materials. (Winter 2022, Q5a)**
2. **The function which is not served by geotextile material is... (Winter 2022, Q3a-MCQ)**
