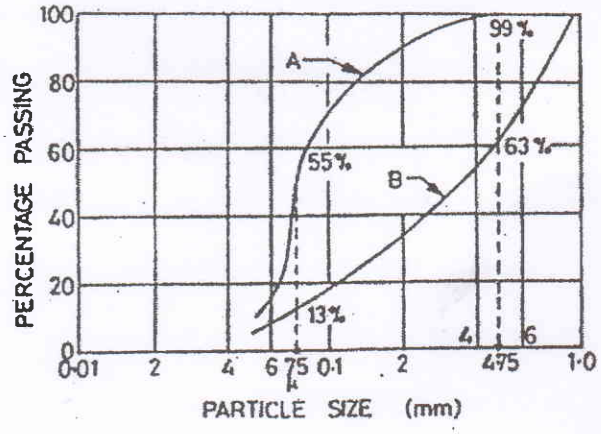
04 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2075 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Soil Mechanics *(CE552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. What are the different geotechnical problems in civil engineering and infrastructure development? What would be a solution of such problem? [1+1]
2. a) Define phase diagram. Draw the phase diagram for the saturated, partially saturated and dry soil. [3]
   b) Enlist the index properties and Engineering properties of soil. [2]
   c) Draw the stress strain curve for different consistency states of soil. [3]
3. a) Write down the names of soil classification systems based on particle size and plasticity of soil. Define plasticity chart of a soil based on ISSCS (Indian Standard Soil Classification System). [3]
   b) Particle size distribution curves for two types of soil; Soil A and Soil B are shown in figure below. Water contents measured at the boundaries between the liquid state-plastic state and plastic state-semi solid for soil A are 45% and 15% respectively. Similarly, for Soil B, they are 25% and 10% respectively. Classify these soil based on Unified Soil Classification System. Draw plasticity chart if required. [5]



4. What are the various minerals in the clay soil? Describe them. Define specific surface and diffuse double layer. [3+1]
5. a) What happens if soil is compacted? How does compaction affect engineering properties of soils? [2]
   b) Write down the names of different methods of compaction those are carried out in the field. Draw compactions curves for Standard Proctor Test and Modified Proctor Test. [2]
   c) The maximum dry density of a compacted soil mass is found to be 18 kN/m^3 with optimum water content being 15%. Find the degree of saturation of this compacted soil if specific gravity of soil of this soil is given as 2.65. What will be the value of the maximum dry density it can be further compacted to? [2]

6. State quick sand condition. A sand deposit consists of two layers. The top layer is 3.0 m thick ($\gamma = 17$ KN/m^3) and bottom layer is 4.0 m thick ($\gamma_{sat} = 21$ KN/m^3). The water table is at a depth of 4.0 m from the surface and zone of capillary saturation is 1 m above the water table. Draw the diagrams, showing the variation of total stress, neutral stress and effective stress. [2+8]

7. What is confined and unconfined flow in seepage flow? Why a filter is used on the downstream of earth dam? Prove that flow lines intersect the equipotential line at right angles. [2+2+4]

8. Write down the conditions for using Boussinesq's analysis and Westerguard's analysis. A ring footing of external diameter 8 m and internal diameter 4 m rests at a depth 2 m below the ground surface. It carries a load intensity of 150kN/m^2. Find the vertical stress at depths of 8 m along the axis of the footing below the footing base. Neglect the effect of the excavation on the stress. [2+6]

9. a) Explain the different methods of accelerating consolidations settlement. [3]

   b) Derive an expression for one dimensional consolidation theory suggested by Terzaghi. [7]

10. a) What are the differences between drained and undrained shear strength? [3]

    b) Define Mohr-coulomb theory. Draw the Mohr-Coulomb strength envelope for cohesive soil, Cohesion less soil and purely cohesive soil. [3]

    c) A sample of dry cohesion less soil was tested in triaxial machine. If the angle of Shearing resistance was 36° and the confining pressure, 100 KN/m^2, determine the deviator stress at which the sample failed. [4]

11. Differentiate between finite and infinite slope. What are the factors that cause the failure of the slope? Write down the types of slope failures and explain the measures that can be taken to prevent slope failure. [1+2+3]

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06 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2075 Baisakh

Exam.	Back		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Soil Mechanics *(CE552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
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1. Differentiate between residual and transported soils. What would be a solution of different soil engineering problem? [2]

2. a) How does Index property of a soil differ from its Engineering property?
   b) Mention Index tests those are generally done to find the properties of individual soil grains and soil mass as a whole.
   c) Draw stress strain behaviour of different consistency states of soils.
   d) An embankment is made by compacting the soil. For compaction, 1,00,000 m3 of the soil is excavated from the borrow pit having void ratio equal to 0.8. Calculate the volume of the embankment if its void ratio after compaction is 0.6. [1+2+2+3]

3. How is the plasticity chart useful for classifying fine-grained soils? a soil has the following characteristics:
   a) Percentage of soil passing No. 200 sieve = 55
   b) Percentage of coarse fraction passing No.4 sieve = 60
   c) Liquid limit = 68%
   d) Plastic limit = 22%
   Classify given soil according to ISSCS. [2+6]

4. a) Describe basic structural units of clay minerals. Point out the difference between Silica sheet, Gibbsite sheet and Brucite sheet.
   b) Briefly Describe flocculated and dispersed structures of soils in regard with compaction. [2+2]

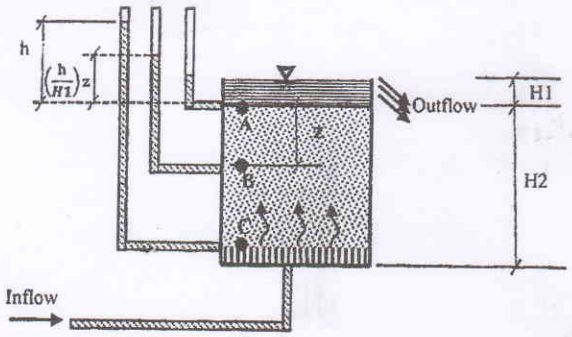
5. In the construction of a road, the compaction specification required was 95% of Proctor maximum dry density at a field moisture content within 2% of the optimum moisture content. The maximum dry density and optimum moisture content obtained in the laboratory from the Standard Proctor test were 1.95 Mg/m^3 and 13.5% respectively. A site engineer conducted sand cone test a two locations and obtained the following results.

Location No.	Mass of soil removed (gm)		Mass of sand used (gm)
	Wet	Dry	
1	43.86	38.46	39.51
2	37.38	32.21	32.39

   The density of sand used was 1.86 Mg/m^3. Check whether the specification was satisfied or not. [6]

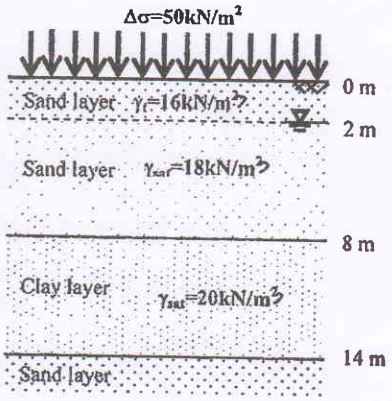
6. a) Explain the variation of effective stress due to the flow of water through the soil mass in downward and upward directions. What is discharge velocity? [2+1]
   b) In a variable head permeability test on a soil of length L_1, the head of water in the standpipe takes 5 seconds to fall from 900 to 135 mm above the tail water level. When another soil of length L_2 = 60 mm is placed above the first soil, the time taken for the head to fall between the same limits is 150 seconds. The permeameter has a cross sectional area of 4560 mm^2 and a standpipe area of 130 mm^2. Calculate the permeability of the second soil. [7]

7. a) What do you understand by Flow net in regard with seepage through soils?
   b) Derive a Laplace equation for Two-dimensional flow in the soil.
   c) In the figure below, upward seepage is shown. The rate of water supply from the bottom is kept constant. The total loss of head during upward seepage between points B and A is h. Keeping in mind the total stress at any point in the soil is solely determined by the weight of the soil and the water above it, draw the variation of total stress, pore water pressure and effective stress with depth. Take points A, B and C as reference. [1+4+3]



8. What is Isobar Diagram? Draw Isobar Diagram of 0.1Q. What is the limitation of Boussinesq's theory ? [1+5+2]

9. a) What is compressibility and what are the possible causes of compression in the soil?
   b) Define consolidation settlement, preconsolidation pressure (maximum overburden pressure), degree of consolidation and coefficient of consolidation?
   c) A soil profile is shown in below figure. If a uniformly distributed load 50 kPa is applied on the ground surface having preconsolidtion pressure, compression index and recompression index are 125 kPa, 0.36 and 0.06, respectively. Calculate the amount of settlement of the clay layer due to primary consolidation. Take γ_w = 10 kN/m^3.
   d) How can you accelerate consolidation settlement? [2+3+4+1]



10. What is stress path? What are the limitations of direct shear test? A specimen of fine dry sand, when subjected to a triaxial compression test failed at a deviator stress of 500 KN/m^2. It failed with a pronounced failure plane with an angle of 25° to the axis of sample. Compute the lateral pressure (σ_3) to which the specimen would have been subjected. [1+2+7]

11. What are the causes of the failure of earth slopes? A slope of very large extent of soil with properties c' = 0, e = 0.7, G = 2.7 and ϕ = 35° is likely to be subjected to seepage parallel to the slope with water level at the surface. Determine the maximum angle of slope for a factor of safety of 2.0. What will be the factor of safety if the water level were to come down well below the surface for this angle of slope? [2+4]

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06 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2074 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Soil Mechanics *(CE552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
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1. What do you understand by soil mechanics and why do you need to study this? What would be a solution of different soil Engineering problem? [2]

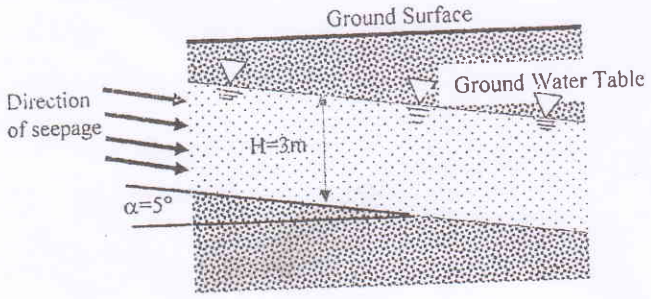
2. A relative density test conducted on a sandy soil obtained the following results: maximum void ratio = 1.25, minimum void ratio = 0.45, relative density = 40% and G = 2.65. Find the dry density of the soil in the present state. If a 3 m thickness of this stratum is densified to a relative density of 60%, how much will the soil reduce in thickness? What will be the new density in dry and saturated conditions? [8]

3. a) How do you identify fine grain soils in the field?
   b) Write down the types of soil classifications.
   c) For finding the suitability of soils as subgrade for highways, which soil classification is generally used? Write down the name of each group according to that classification. Show the general rating of those groups as a suitability of subgrade.
   d) Draw the plasticity chart in corporated in an USCS and give the group symbols of the various region in the chart. [1+2+2+3]

4. What is specific surface area and what is its effect on fine grained soil? [3+1]

5. a) What is Zero Airvoid (ZAv)?
   b) Write down the factors that affect soil compaction.
   c) The maximum dry unit weight of a compacted soil mass is found to be 18 kN/m^3 with optimum water content being 15%. Find the values of porosity and degree of saturation of this compacted soil. Also, find the value of the maximum dry unit weight on the zero air void line at that optimum water content? Take specific gravity of soil solid as 2.7. [1+2+3]

6. a) Define the meaning of capillarity in regard with normal soil ground. Also, explain the effect of water table variation on the effective stress.
   b) As shown in below figure, an inclined permeable soil layer is underlain by an impervious layer. The coefficient of permeability of the permeable soil layer is equal to 4.8×10^{-5} m/sec. If seepage of water in this soil layer occurs in the direction shown in the figure below, then calculate (i) Hydraulic gradient and (ii) rate of water flow (seepage) for that soil layer. Take the thickness of soil layer, H =3 m and the angle of inclination of that soil layer, $\alpha = 5°$. Assume any other necessary conditions.



c) Write down the names of testing method for determining coefficient of permeability in the laboratory and field.
d) Differentiate between discharge velocity and seepage velocity. [2+4+2+2]

7. What are the properties of flow net? Prove that flow lines intersect the equipotential line at right angles. [2+6]

8. a) Vertical stress due to a point load can be calculated based on Boussinesq's and Westergaard's solutions. What is the basic difference between these two solutions?
b) Briefly explain Newmark's Influence Chart. What is the main use of this Chart?
c) Describe approximate stress distribution methods for loaded areas. [2+3+3]

9. a) What are the methods of accelerating consolidation settlement? What are the different causes of preconsolidation of soil? [1+2]
b) Derive a governing differential equation for one dimensional consolidation theory by Terzaghi? [7]

10. a) Write down the names of shear strength tests that can be performed in the laboratory? How do you calculate shear strength in direct shear test?
b) If direct shear is conducted for loose and dense sands, then plot graphs of Shear stress and Change in height of specimen versus Shear displacement.
c) Unconfined compression test is a special type of unconsolidated undrained triaxial test. Why?
d) Derive an expression for principal stresses at failure conditions. [2+2+1+5]

11. a) Explain finite slope and infinite slopes in regard with slope stability.
b) Find Factor of Safety of slope using $\phi = 0$ analysis method. Assume necessary conditions. [2+4]

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06 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2073 Magh

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Soil Mechanics *(CE552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. What are the different civil engineering problems related to soils? What would be a solution of such problems? [2+1]

2. a) Draw a graph showing different states of consistency of soil in reference to stress strain behavior.

   b) An embankment of 1,00,000 m^3 volume has to be constructed by compacting the soil brought from excavation site. After the compaction, dry unit weight of compacted soil (embankment) will be 16 kN/m^3. Also, bulk unit weight and water content of the soil at the excavation site are 12 kN/m^3 and 15%, respectively. Find the volume and weight of soil to be excavated from the excavation site. Take specific gravity of soil solid as 2.70. [3+5]

3. Give the grain size ranges of different soil types according to (MIT). Explain the different field identification methods for fine-grained soils. [3+5]

4. Explain double diffuse layer. Among Kaolinite, Montmorillonite and Illite clay minerals, which one swells the most and why? [4]

5. The following results were obtained from a standard compaction test. [6]

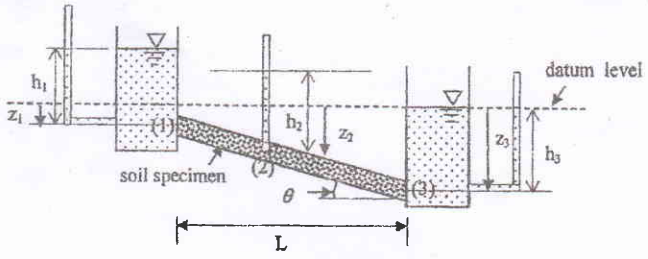
Test No.	1	2	3	4	5	6
Water content (%)	11.0	12.1	12.8	13.6	14.6	16.3
Mass of compacted soil (gm)	1920.5	2051.5	2138.5	2147.0	2120.0	2081.5

The specific gravity of solids is 2.7 and volume of the compaction mould is 1000 cm^3. A field compacted soil sample showed water content of 35% and unit weight of 2.318 Mg/m^3.

i) Draw compaction curve and determine the maximum dry unit weight and OMC.
ii) Find the relative compaction (RC)
iii) Find the degree of saturation at the maximum dry unit weight

6. a) In the figure below, water flows from point (1) to point (3) via the soil specimen which is inclined at an angle θ. Piezometers inserted at points 1, 2 and 3 show piezometric heights h_1, h_2 and h_3 respectively. In the figure below z_1, z_2 and z_3 represent the distance of points 1, 2 and 3 from datum level. [4+1]

   i) Find total heads at points 1, 2 and 3 from datum level.
   ii) Find the hydraulic gradient for this case when water enters the specimen from point (1) and exits from point (3).

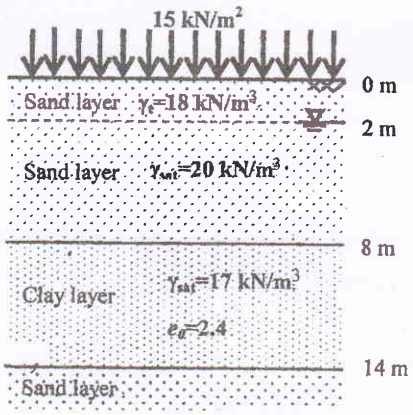


   b) Obtain the expression for the critical hydraulic gradient necessary for quick condition to develop. Why there is more likelihood of quick conditions in sand than in clay? [4+1]

7. What are the basic requirements for the design of protective filters? Is the flow through an earth dam confined flow or unconfined flow? Prove that flow lines intersect the equipotential line at right angle. [2+1+5]

8. State the assumptions of Boussinesq's equation. A water tower has circular foundation of diameter 10 m. Total weight of tower including foundation is 1800 tonnes. A very weak stratum having bearing capacity of 10 t/m^2 lies 3 m below the foundation level. Calculate the stress due to foundation load at the top of the weak stratum and as certain whether it will be safe to construct the water tower at that place with given foundation size.

9. a) A surcharge load of 15 kPa was applied on the ground surface having the soil profile as shown in figure below Consolidation settlement took place in the clay layer. Consolidation test was done for the clay layer and following results were obtained: Coefficient of consolidation, $c_v = 3.25\times10^{-7}$ m^2/s, Compression index, $C_c = 1.2$ and Coefficient of permeability, $k = 3.5\times10^{-9}$ m/s. Assume that the consolidation of clay layer is solely due to the change in stress at the center of the clay layer. Also, consider that there is no change in ground water level before and after the consolidation Take $\gamma_w = 10$ kN/m^3.



Determine total, effective and pore water pressure at the center of the clay layer (i) before applying the surcharge load, (ii) immediately after applying the surcharge load and (iii) sufficiently after a long time of applying the surcharge load.

b) What will be the final settlement of the clay layer after the primary consolidation? Also, determine the settlement of clay layer after 0.5 year. [For $U = 70\%$, $T_v = 0.403$, for $U = 80\%$, $T_v = 0.569$, for $U = 90\%$, $T_v = 0.848$] [5+4]

10. How are the drainage conditions adopted in a triaxial shear test realized in the field? Derive the general formula that gives the value of the major principal stress σ_1 as a function of minor principal stress σ_3, the cohesion and angle of internal friction. 3+7]

11. a) What are the probable types of failure of slope?

b) Write down the possible causes of increase in shear stress or decrease in shear strength of soil in regard with slope instability.

c) Explain remedial measures that can be used to prevent slope failure. [2+3+1]

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06 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2073 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Soil Mechanics *(CE552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
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1. What are the various field of application of soil mechanics? Write the factors that determine the characteristics of a residual soil. [1+1]
2. Define thixotropy and flow index. A sample of saturated clay has a volume of 97 cm^3 and mass of 202 gm. When completely dried, its volume is 87 cm^3 and mass of 167 gm. Determine: [2+6]
   i) Initial water content
   ii) Specific gravity of soil solids
   iii) Shrinkage limit
3. Classify the following soils a, b and c as per unified soil classification system: [3+3+2]
   i) Soil passing form 75μ sieve = 4%, soil passing from 4.75mm sieve (Coarse fraction) = 62%, coefficient of uniformity = 5, coefficient of curvature = 2.6
   ii) Soil passing from 75μ sieve = 62%, liquid limit = 54%, plastic limit = 23%
   iii) Soil passing from 75μ sieve = 39%, liquid limit = 33%, plastic limit = 18%
4. What is isomorphous substitution? Compare between 1:1 and 2:1 minerals. [1+3]
5. a) Draw compaction curve for a soil showing maximum dry density, optimum water content, zero-air void line, dry side and wet side of optimum water content.
   b) Compare the compaction characteristic curve for sand and clay. [3+3]
6. What are the factors that influence the height of capillary rise in soils? Establish the relationship between seepage velocity and superficial velocity. A soil stratum having thickness of 1.15 m, porosity = 30% and G = 2.7 is subjected to an upward seepage head of 1.95 m. Determine the thickness of coarse material required above the soil stratum to provide a factor of safety of 2 against piping assuming that the coarse material has the same specific gravity and porosity as the soil and head loss in the coarse material is negligible. [1+3+6]
7. a) Derive the relationship for the seepage discharge through anisotropic soil.
   b) If the upstream and downstream heads of an impervious dam are 8 m and 1 m repectively, then find the seepage discharge when seepage of water takes place from upstream to downstream via the isotropic soil lying below the impervious dam. Take total number of flow channels and equipotential drops as 9 and 12, respectively. Also, take coefficient of permeability of the soil layer, $k = 3\times10^{-4}$ cm/s. [4+4]
8. What is Newmarks influence chart? A water tank is supported by a ring foundation having outer diameter of 10 m and inner diameter of 7.5 m. The ring foundation transmits uniform load intensity of 160kN/m^2. Compute the maximum vertical stress induced at a depth of 4 m below the foundation using Boussinesq's theory. [2+6]

9. Distinguish between normally consolidated and over consolidated soil deposits. A 5 m thick saturated soil layer has a compression index of 0.25 and coefficient of permeability 3.2×10^{-3} mm/s. If the void ratio is 1.9 at vertical stress of 0.15 N/mm^2, calculate the void ratio when the vertical stress is increased to 0.2 N/mm^2. Also calculate settlement due to above stress increase and time required for 65% consolidation. [2+8]

10. a) Write down the names of shear strength tests. [2]

    b) Consolidated undrained triaxial test was performed for a normally consolidated saturated clay and cell pressure, $\sigma_3 = 200\text{kN/m}^2$, axial stress, $\sigma_1 = 550\text{kN/m}^2$ and pore water pressure, $u_w = 80\text{kN/m}^2$ were measured. Answer the followings: [2+2+2+2]

    i) Plot the Mohr circle of stresses in regard with Total stress.

    ii) Plot the Mohr circle of stresses in regard with effective stress.

    iii) Assume the condition of normal consolidation and c'=0. Then obtain the value of ϕ'.

    iv) If Mohr-Coulomb's failure criterion is assumed to be valid, then determine the direction of failure plane that might occur within the specimen

11. An infinite slope is made of clay with the following properties: [6]

    $\gamma_t = 18\text{kN/m}^3, \gamma' = 9\text{kN/m}^3, c = 25\text{kN/m}^2$ and $\Phi' = 28°$. If the slope has an inclination of 35° and height equal to 12m, determine the stability of the slope, when (a) the slope is submerged and (b) there is seepage parallel to the slope.

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2075 Bhadra

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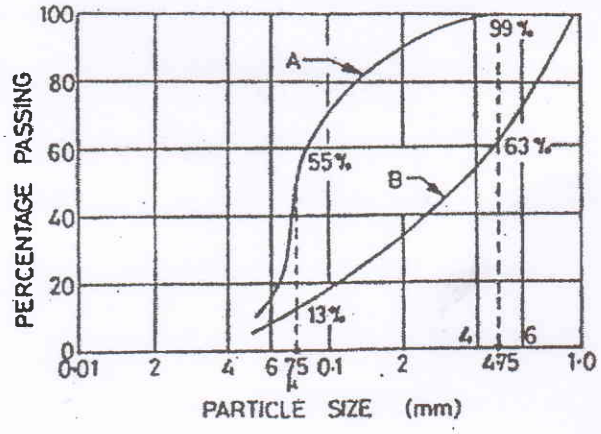

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06 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
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2075 Baisakh

Exam.	Back		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Soil Mechanics *(CE552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. Differentiate between residual and transported soils. What would be a solution of different soil engineering problem? [2]

2. a) How does Index property of a soil differ from its Engineering property?
   b) Mention Index tests those are generally done to find the properties of individual soil grains and soil mass as a whole.
   c) Draw stress strain behaviour of different consistency states of soils.
   d) An embankment is made by compacting the soil. For compaction, 1,00,000 m3 of the soil is excavated from the borrow pit having void ratio equal to 0.8. Calculate the volume of the embankment if its void ratio after compaction is 0.6. [1+2+2+3]

3. How is the plasticity chart useful for classifying fine-grained soils? a soil has the following characteristics:
   a) Percentage of soil passing No. 200 sieve = 55
   b) Percentage of coarse fraction passing No.4 sieve = 60
   c) Liquid limit = 68%
   d) Plastic limit = 22%
   Classify given soil according to ISSCS. [2+6]

4. a) Describe basic structural units of clay minerals. Point out the difference between Silica sheet, Gibbsite sheet and Brucite sheet.
   b) Briefly Describe flocculated and dispersed structures of soils in regard with compaction. [2+2]

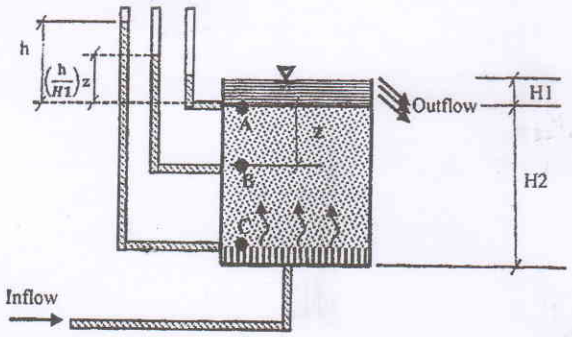
5. In the construction of a road, the compaction specification required was 95% of Proctor maximum dry density at a field moisture content within 2% of the optimum moisture content. The maximum dry density and optimum moisture content obtained in the laboratory from the Standard Proctor test were 1.95 Mg/m^3 and 13.5% respectively. A site engineer conducted sand cone test a two locations and obtained the following results.

Location No.	Mass of soil removed (gm)		Mass of sand used (gm)
	Wet	Dry	
1	43.86	38.46	39.51
2	37.38	32.21	32.39

   The density of sand used was 1.86 Mg/m^3. Check whether the specification was satisfied or not. [6]

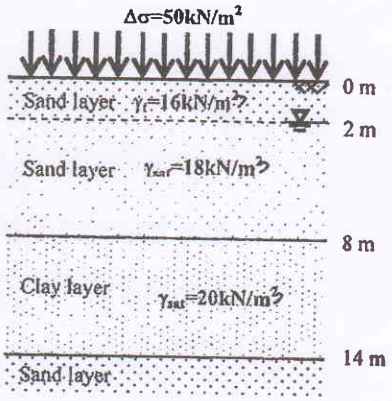
6. a) Explain the variation of effective stress due to the flow of water through the soil mass in downward and upward directions. What is discharge velocity? [2+1]
   b) In a variable head permeability test on a soil of length L_1, the head of water in the standpipe takes 5 seconds to fall from 900 to 135 mm above the tail water level. When another soil of length L_2 = 60 mm is placed above the first soil, the time taken for the head to fall between the same limits is 150 seconds. The permeameter has a cross sectional area of 4560 mm^2 and a standpipe area of 130 mm^2. Calculate the permeability of the second soil. [7]

7. a) What do you understand by Flow net in regard with seepage through soils?
   b) Derive a Laplace equation for Two-dimensional flow in the soil.
   c) In the figure below, upward seepage is shown. The rate of water supply from the bottom is kept constant. The total loss of head during upward seepage between points B and A is h. Keeping in mind the total stress at any point in the soil is solely determined by the weight of the soil and the water above it, draw the variation of total stress, pore water pressure and effective stress with depth. Take points A, B and C as reference. [1+4+3]



8. What is Isobar Diagram? Draw Isobar Diagram of 0.1Q. What is the limitation of Boussinesq's theory ? [1+5+2]

9. a) What is compressibility and what are the possible causes of compression in the soil?
   b) Define consolidation settlement, preconsolidation pressure (maximum overburden pressure), degree of consolidation and coefficient of consolidation?
   c) A soil profile is shown in below figure. If a uniformly distributed load 50 kPa is applied on the ground surface having preconsolidtion pressure, compression index and recompression index are 125 kPa, 0.36 and 0.06, respectively. Calculate the amount of settlement of the clay layer due to primary consolidation. Take γ_w = 10 kN/m^3.
   d) How can you accelerate consolidation settlement? [2+3+4+1]



10. What is stress path? What are the limitations of direct shear test? A specimen of fine dry sand, when subjected to a triaxial compression test failed at a deviator stress of 500 KN/m^2. It failed with a pronounced failure plane with an angle of 25° to the axis of sample. Compute the lateral pressure (σ_3) to which the specimen would have been subjected. [1+2+7]

11. What are the causes of the failure of earth slopes? A slope of very large extent of soil with properties c' = 0, e = 0.7, G = 2.7 and ϕ = 35° is likely to be subjected to seepage parallel to the slope with water level at the surface. Determine the maximum angle of slope for a factor of safety of 2.0. What will be the factor of safety if the water level were to come down well below the surface for this angle of slope? [2+4]

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06 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2074 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Soil Mechanics *(CE552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. What do you understand by soil mechanics and why do you need to study this? What would be a solution of different soil Engineering problem? [2]

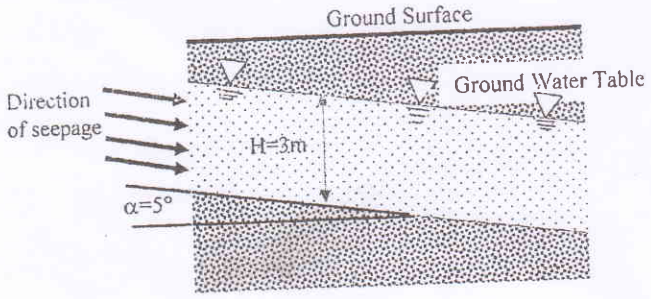
2. A relative density test conducted on a sandy soil obtained the following results: maximum void ratio = 1.25, minimum void ratio = 0.45, relative density = 40% and G = 2.65. Find the dry density of the soil in the present state. If a 3 m thickness of this stratum is densified to a relative density of 60%, how much will the soil reduce in thickness? What will be the new density in dry and saturated conditions? [8]

3. a) How do you identify fine grain soils in the field?
   b) Write down the types of soil classifications.
   c) For finding the suitability of soils as subgrade for highways, which soil classification is generally used? Write down the name of each group according to that classification. Show the general rating of those groups as a suitability of subgrade.
   d) Draw the plasticity chart in corporated in an USCS and give the group symbols of the various region in the chart. [1+2+2+3]

4. What is specific surface area and what is its effect on fine grained soil? [3+1]

5. a) What is Zero Airvoid (ZAv)?
   b) Write down the factors that affect soil compaction.
   c) The maximum dry unit weight of a compacted soil mass is found to be 18 kN/m^3 with optimum water content being 15%. Find the values of porosity and degree of saturation of this compacted soil. Also, find the value of the maximum dry unit weight on the zero air void line at that optimum water content? Take specific gravity of soil solid as 2.7. [1+2+3]

6. a) Define the meaning of capillarity in regard with normal soil ground. Also, explain the effect of water table variation on the effective stress.
   b) As shown in below figure, an inclined permeable soil layer is underlain by an impervious layer. The coefficient of permeability of the permeable soil layer is equal to 4.8×10^{-5} m/sec. If seepage of water in this soil layer occurs in the direction shown in the figure below, then calculate (i) Hydraulic gradient and (ii) rate of water flow (seepage) for that soil layer. Take the thickness of soil layer, H =3 m and the angle of inclination of that soil layer, $\alpha = 5°$. Assume any other necessary conditions.



c) Write down the names of testing method for determining coefficient of permeability in the laboratory and field.
d) Differentiate between discharge velocity and seepage velocity. [2+4+2+2]

7. What are the properties of flow net? Prove that flow lines intersect the equipotential line at right angles. [2+6]

8. a) Vertical stress due to a point load can be calculated based on Boussinesq's and Westergaard's solutions. What is the basic difference between these two solutions?
b) Briefly explain Newmark's Influence Chart. What is the main use of this Chart?
c) Describe approximate stress distribution methods for loaded areas. [2+3+3]

9. a) What are the methods of accelerating consolidation settlement? What are the different causes of preconsolidation of soil? [1+2]
b) Derive a governing differential equation for one dimensional consolidation theory by Terzaghi? [7]

10. a) Write down the names of shear strength tests that can be performed in the laboratory? How do you calculate shear strength in direct shear test?
b) If direct shear is conducted for loose and dense sands, then plot graphs of Shear stress and Change in height of specimen versus Shear displacement.
c) Unconfined compression test is a special type of unconsolidated undrained triaxial test. Why?
d) Derive an expression for principal stresses at failure conditions. [2+2+1+5]

11. a) Explain finite slope and infinite slopes in regard with slope stability.
b) Find Factor of Safety of slope using $\phi = 0$ analysis method. Assume necessary conditions. [2+4]

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06 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2073 Magh

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Soil Mechanics *(CE552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. What are the different civil engineering problems related to soils? What would be a solution of such problems? [2+1]

2. a) Draw a graph showing different states of consistency of soil in reference to stress strain behavior.

   b) An embankment of 1,00,000 m^3 volume has to be constructed by compacting the soil brought from excavation site. After the compaction, dry unit weight of compacted soil (embankment) will be 16 kN/m^3. Also, bulk unit weight and water content of the soil at the excavation site are 12 kN/m^3 and 15%, respectively. Find the volume and weight of soil to be excavated from the excavation site. Take specific gravity of soil solid as 2.70. [3+5]

3. Give the grain size ranges of different soil types according to (MIT). Explain the different field identification methods for fine-grained soils. [3+5]

4. Explain double diffuse layer. Among Kaolinite, Montmorillonite and Illite clay minerals, which one swells the most and why? [4]

5. The following results were obtained from a standard compaction test. [6]

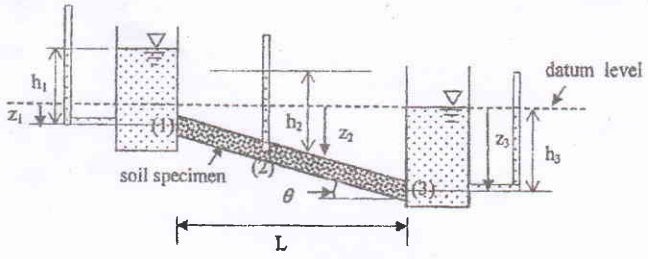
Test No.	1	2	3	4	5	6
Water content (%)	11.0	12.1	12.8	13.6	14.6	16.3
Mass of compacted soil (gm)	1920.5	2051.5	2138.5	2147.0	2120.0	2081.5

The specific gravity of solids is 2.7 and volume of the compaction mould is 1000 cm^3. A field compacted soil sample showed water content of 35% and unit weight of 2.318 Mg/m^3.

i) Draw compaction curve and determine the maximum dry unit weight and OMC.
ii) Find the relative compaction (RC)
iii) Find the degree of saturation at the maximum dry unit weight

6. a) In the figure below, water flows from point (1) to point (3) via the soil specimen which is inclined at an angle θ. Piezometers inserted at points 1, 2 and 3 show piezometric heights h_1, h_2 and h_3 respectively. In the figure below z_1, z_2 and z_3 represent the distance of points 1, 2 and 3 from datum level. [4+1]

   i) Find total heads at points 1, 2 and 3 from datum level.
   ii) Find the hydraulic gradient for this case when water enters the specimen from point (1) and exits from point (3).

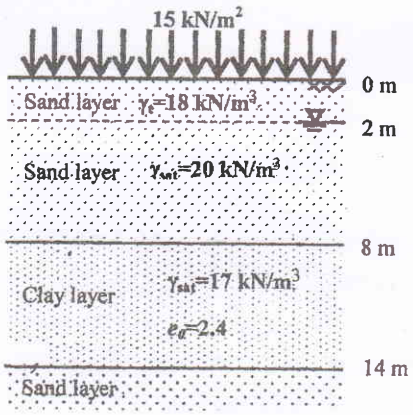


   b) Obtain the expression for the critical hydraulic gradient necessary for quick condition to develop. Why there is more likelihood of quick conditions in sand than in clay? [4+1]

7. What are the basic requirements for the design of protective filters? Is the flow through an earth dam confined flow or unconfined flow? Prove that flow lines intersect the equipotential line at right angle. [2+1+5]

8. State the assumptions of Boussinesq's equation. A water tower has circular foundation of diameter 10 m. Total weight of tower including foundation is 1800 tonnes. A very weak stratum having bearing capacity of 10 t/m^2 lies 3 m below the foundation level. Calculate the stress due to foundation load at the top of the weak stratum and as certain whether it will be safe to construct the water tower at that place with given foundation size.

9. a) A surcharge load of 15 kPa was applied on the ground surface having the soil profile as shown in figure below Consolidation settlement took place in the clay layer. Consolidation test was done for the clay layer and following results were obtained: Coefficient of consolidation, $c_v = 3.25\times10^{-7}$ m^2/s, Compression index, $C_c = 1.2$ and Coefficient of permeability, $k = 3.5\times10^{-9}$ m/s. Assume that the consolidation of clay layer is solely due to the change in stress at the center of the clay layer. Also, consider that there is no change in ground water level before and after the consolidation Take $\gamma_w = 10$ kN/m^3.



Determine total, effective and pore water pressure at the center of the clay layer (i) before applying the surcharge load, (ii) immediately after applying the surcharge load and (iii) sufficiently after a long time of applying the surcharge load.

b) What will be the final settlement of the clay layer after the primary consolidation? Also, determine the settlement of clay layer after 0.5 year. [For $U = 70\%$, $T_v = 0.403$, for $U = 80\%$, $T_v = 0.569$, for $U = 90\%$, $T_v = 0.848$] [5+4]

10. How are the drainage conditions adopted in a triaxial shear test realized in the field? Derive the general formula that gives the value of the major principal stress σ_1 as a function of minor principal stress σ_3, the cohesion and angle of internal friction. 3+7]

11. a) What are the probable types of failure of slope?

b) Write down the possible causes of increase in shear stress or decrease in shear strength of soil in regard with slope instability.

c) Explain remedial measures that can be used to prevent slope failure. [2+3+1]

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06 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2073 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	II / II	Time	3 hrs.

Subject: - Soil Mechanics *(CE552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. What are the various field of application of soil mechanics? Write the factors that determine the characteristics of a residual soil. [1+1]
2. Define thixotropy and flow index. A sample of saturated clay has a volume of 97 cm^3 and mass of 202 gm. When completely dried, its volume is 87 cm^3 and mass of 167 gm. Determine: [2+6]
   i) Initial water content
   ii) Specific gravity of soil solids
   iii) Shrinkage limit
3. Classify the following soils a, b and c as per unified soil classification system: [3+3+2]
   i) Soil passing form 75μ sieve = 4%, soil passing from 4.75mm sieve (Coarse fraction) = 62%, coefficient of uniformity = 5, coefficient of curvature = 2.6
   ii) Soil passing from 75μ sieve = 62%, liquid limit = 54%, plastic limit = 23%
   iii) Soil passing from 75μ sieve = 39%, liquid limit = 33%, plastic limit = 18%
4. What is isomorphous substitution? Compare between 1:1 and 2:1 minerals. [1+3]
5. a) Draw compaction curve for a soil showing maximum dry density, optimum water content, zero-air void line, dry side and wet side of optimum water content.
   b) Compare the compaction characteristic curve for sand and clay. [3+3]
6. What are the factors that influence the height of capillary rise in soils? Establish the relationship between seepage velocity and superficial velocity. A soil stratum having thickness of 1.15 m, porosity = 30% and G = 2.7 is subjected to an upward seepage head of 1.95 m. Determine the thickness of coarse material required above the soil stratum to provide a factor of safety of 2 against piping assuming that the coarse material has the same specific gravity and porosity as the soil and head loss in the coarse material is negligible. [1+3+6]
7. a) Derive the relationship for the seepage discharge through anisotropic soil.
   b) If the upstream and downstream heads of an impervious dam are 8 m and 1 m repectively, then find the seepage discharge when seepage of water takes place from upstream to downstream via the isotropic soil lying below the impervious dam. Take total number of flow channels and equipotential drops as 9 and 12, respectively. Also, take coefficient of permeability of the soil layer, $k = 3\times10^{-4}$ cm/s. [4+4]
8. What is Newmarks influence chart? A water tank is supported by a ring foundation having outer diameter of 10 m and inner diameter of 7.5 m. The ring foundation transmits uniform load intensity of 160kN/m^2. Compute the maximum vertical stress induced at a depth of 4 m below the foundation using Boussinesq's theory. [2+6]

9. Distinguish between normally consolidated and over consolidated soil deposits. A 5 m thick saturated soil layer has a compression index of 0.25 and coefficient of permeability 3.2×10^{-3} mm/s. If the void ratio is 1.9 at vertical stress of 0.15 N/mm^2, calculate the void ratio when the vertical stress is increased to 0.2 N/mm^2. Also calculate settlement due to above stress increase and time required for 65% consolidation. [2+8]

10. a) Write down the names of shear strength tests. [2]

    b) Consolidated undrained triaxial test was performed for a normally consolidated saturated clay and cell pressure, $\sigma_3 = 200\text{kN/m}^2$, axial stress, $\sigma_1 = 550\text{kN/m}^2$ and pore water pressure, $u_w = 80\text{kN/m}^2$ were measured. Answer the followings: [2+2+2+2]

    i) Plot the Mohr circle of stresses in regard with Total stress.

    ii) Plot the Mohr circle of stresses in regard with effective stress.

    iii) Assume the condition of normal consolidation and c'=0. Then obtain the value of ϕ'.

    iv) If Mohr-Coulomb's failure criterion is assumed to be valid, then determine the direction of failure plane that might occur within the specimen

11. An infinite slope is made of clay with the following properties: [6]

    $\gamma_t = 18\text{kN/m}^3, \gamma' = 9\text{kN/m}^3, c = 25\text{kN/m}^2$ and $\Phi' = 28°$. If the slope has an inclination of 35° and height equal to 12m, determine the stability of the slope, when (a) the slope is submerged and (b) there is seepage parallel to the slope.

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