TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2079 Ashwin

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

Subject: - Soil Mechanics *(CE 552)*

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

1. Explain the importance of Soil Mechanics in relation to different Civil Engineering Problems. Briefly describe the how soils are formed. [1+1]
2. a) How does engineering properties of soil differ from Index properties? Mention different index tests done for coarse and fine grained soils. [3]
   b) Draw stress-strain curves for soil at different consistency states. [2]
   c) The in-situ field unit weight and water content of soil are 18 kN/m^3 and 10% respectively. Soil is excavated from this in-situ site is used for embankment construction. The dry unit weight and water content of the soil at compaction site are 19 kN/m^3 and 18% respectively. Determine the amount of soil to be excavated for 1 m^3 of compaction. Assume necessary conditions. [3]
3. a) Describe the soil classification according to MIT classification system. [3]
   b) The sieve analysis of a soil gave the following results:
   % passing 75 micron sieve = 4
   % retained on 4.75 mm sieve = 35
   Coefficient of curvature = 2
   Coefficient of uniformity = 5
   Classify the soil according to USCS system. [5]
4. Describe the different types of clay minerals with neat sketches. [4]
5. a) What is relative compaction? [1]
   b) Explain the effect of compaction on engineering behavior of soil. [2]
   c) The maximum dry unit weight of a compacted soil mass is found to be 17 kN/m^3 with optimum water content being 16%. Determine void ratio and degree of saturation of this soil after compaction. 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 2.65. [3]
6. a) State quick sand condition. [2]
   b) The water table in a deposit of uniform sand is located at 2m below the ground surface. Assuming the soil above the water table is dry,
      (i) Determine the effective stress at a depth of 5 m below the ground surface. Take bulk unit weight of sand as 18 kN/m^3.
      (ii) If the soil above the water table is saturated by capillary action, what is the effective stress at that depth?
      Also plot the variation of total pressure and effective pressure over the depth of 5 m in both the cases. [8]

7. Define flow net. Write its properties and uses. Prove that the discharge through an earth mass is given by $q = k \times h \times \left(\frac{N_f}{N_d}\right)$

where, k = coefficient of permeability; h = head; N_f = number of flow channels and N_d = number of equipotential drops [1+2+5]

8. a) How the scaling is done in Newmark's Analysis method? [2]

b) An excavation 3m × 6 m for foundation is made. The depth of foundation is at 2.5 below the ground surface. The bulk unit weight of the soil is 2 kN/m^3. Determine the effect of this excavation on the effective vertical stress at the depth of 6 m from the ground surface for (i) vertically below the center of the foundation and (ii) 6 m away from the center of the foundation. [6]

9. a) How does excess pore water pressure differ from hydrostatic pore water pressure? [2]

b) The soil profile of the ground shows that sand layer (3.5 m thick void ratio = 0.98, Specific gravity, Gs = 2.62) lies above the clay layer (3.5 m thick, void ratio = 0.62, specific gravity, Gs = 2.7, w_L = 50%). Ground water table lies 1.5 m below the ground surface. Assume impervious layer lies below the clay layer. If a uniformly distributed load, 110 kPa is applied on the ground surface of this soil, find the primary settlement of the clay layer. For compressibility index, use C_c = 0.0099 (LL-10). [5]

c) How does two way drainage and one way drainage affect the time of consolidation if degree of consolidation and coefficient of consolidation for that clay layer are same? [3]

10. a) State Mohr-Coulomb's failure criterion. [2]

b) A series of shear tests was performed on a soil. Each test was carried out until the soil sample sheared and the stresses for each test are as follows.

Test	Cell pressure σ3 (kN/m^2)	Deviator stress (kN/m^2)
1	300	875
2	400	1160
3	500	1460

Plot the Mohr circle of stress and the strength envelope and determine the angle of internal friction of the soil. [8]

11. a) Derive an equation for calculating factor of safety for infinite slope of dry cohesive soil. Assume necessary conditions. [3]

b) Find factor of safety of slope using $\phi = 0$ analysis method. Assume necessary conditions. [3]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2079 Jestha

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

Subject: - Soil Mechanics *(CE 552)*

- ✓ 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. Define Soil Mechanics. Explain the significance of fluid mechanics in soil mechanics. [1+2]
2. a) What are index and engineering properties of soil? Which property is significant for identification and classification of soil and why? [2+2]

   b) Define relative consistency. The values of liquid limit, plastic limit and shrinkage limit of a soil were reported as follows:

   $\omega_L = 60\%$, $\omega_P = 30\%$, $\omega_S = 20\%$

   If a sample of this soil at liquid limit has a volume of 40 cc and its volume measured at shrinkage limit was 23.5 cc, determine the specific gravity of the solids. What is its shrinkage ratio? Also draw the phase diagram for the soil at liquid limit and at shrinkage limit as per given reported values. [1+5]
3. What is the purpose of soil classification? A soil sample on laboratory test gives the following results. Classify the soil and give symbol as per USCS classification system. [2+6]

   Passing through 75-micron sieve = 8%
   Passing through 4.75 mm sieve = 42%
   Coefficient of uniformity = 6
   Coefficient of curvature = 4
   Plasticity index = 4
4. What are the building blocks of clay minerals? Explain the common group of clay minerals. [1+2]
5. What is compaction? How does it differ from consolidation? Describe briefly different methods of compaction with their relative merits and demerits. [1+2+3]
6. A layer of 6m thick fine sand is overlain by a clay deposit of 4m and water table is 2m below the surface. The unit weight of clay above and below the water level is 18kN/m^3 and 22 kN/m^3 respectively. The layer of fine sand has the porosity of 44% and specific gravity of 2.65. If there is capillary rise of 1m above the water table, draw total stress, pore water pressure and effective stress diagram. [8]
7. a) What is flow net? Explain the mechanism of piping in hydraulic structure. [2+2]

   b) The discharge through the pervious soil is 200 cc/day. The flow net shows 5 flow channels and 10 equipotential drops. If the net head causing the flow is 2.5m, calculate the permeability of the soil. [3]
8. The annular ring foundation of external and internal diameter 4m and 6m respectively transmits a pressure of 100kN/m^2. Compute the vertical stresses at the depth 0.5m, 1m, 2m, 4m and 8m below the center. Also draw stress distribution curve along depth. [8]

9. a) Explain the factors that affect the degree of consolidation. [4]

b) In one dimensional consolidation test the time required for 50% consolidation has been measure at 154 seconds (through the observation and measurement of pore water pressure). The settlement of the sample at the end of the test was 2.5 mm. [6]

$\sigma_0' = 60$ kPa, $\sigma_1' = 120$ kPa, $e_0 = 0.65$, $H_0 = 20$ mm, Take: $\tau_v = 0.197$ and 0.848 for 50% and 90% consolidation respectively. Determine:

(i) the time required for 90% consolidation
(ii) the coefficient of permeability in m/s
(iii) the compression index

10. a) Explain the advantage of triaxial shear test over direct shear test. [2]

b) On which type of soil unconfined shear test is conducted? Explain with the help of Mohr circles how shear strength parameters are determined using unconfined compressive strength test. [1+2]

c) The results of drained and consolidated-undrained triaxial tests on two samples of normally consolidated clay are shown below: [6]

Type of test	σ_3 (kPa)	$\sigma_3 - \sigma_3$ at peak (kPa)
Drained	300	650
Consolidated-undrained	200	250

Determine:

(i) ϕ' from the drained test,
(ii) ϕ from the consolidated-undrained test,
(iii) the pore pressure in the consolidated-undrained test at failure

11. What are the basic modes of the failure of the earth slopes? Briefly describe any two with sketch. What are the probable causes of increase in shear stress to trigger the instability of soil? [4+

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2078 Chaitra

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

Subject: - Soil Mechanics (*CE 552*)

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

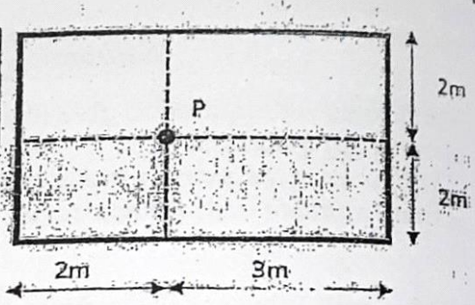
1. Define soil. What are the various soil engineering problems? [2]
2. a) Describe toughness index, coefficient of curvature, activity of soil and air content. [4]
   b) A mass of moist soil mass is 20 kg and its volume is 0.011 m^3. After oven drying, the mass reduce to 16.5 kg. Assume G = 2.70. Determine water content, dry density, degree of saturation and porosity. [4]
3. Describe the importance of soil classification. Classify the soil A and B with the properties as shown below according to unified soil classification soil. [3+5]

Soil	w_L(%)	I_p (%)	% passing through 4.75 mm sieve	% passing through 75μ sieve
A	45	29	100	59
B	55	15	100	85

4. a) Describe basic structural units of clay minerals. Point out the difference between Kaolinite, Illite and Montmorillonite clays structures. [3]
   b) Explain double diffuse layer in clay minerals. [1]
5. a) Discuss the factors affecting compaction of soil. [3]
   b) Describe the following: [3×1]
      i) Placement water content
      ii) Relative compaction
      iii) Theoretical Maximum dry density
6. a) Define the following: [4×1]
      i) Coefficient of transmissibility
      ii) Seepage pressure
      iii) Quick sand condition
      iv) Held water
   b) The following data were recorded in a constant head permeability test.
      Internal diameter of the permeameter = 7.5 cm, porosity of sample =44%
      Quality of water collected in 60s = 626 ml and head loss over a sample length of 18 cm = 24.7 cm. Calculate the permeability, flow velocity and seepage velocity. Also calculate the permeability of soil at porosity of 39%. [6]
7. Explain the flow net construction procedure of sheet pile. Describe the graded filter design method with the help of neat sketch. [8]

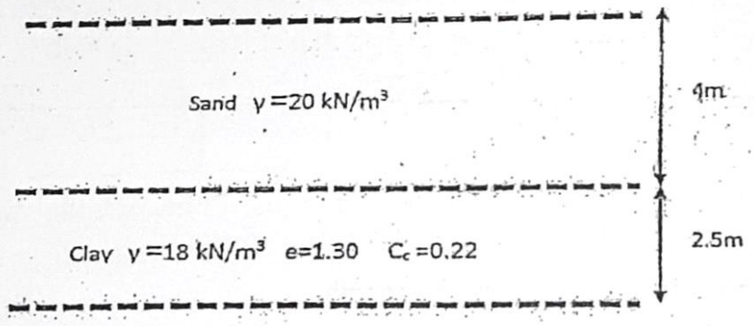
8. Describe the Boussinesq's limitations. A rectangular foundation 4 m by 5 m carries a uniformly distributed load of 200 kN/m^2. Determine the vertical stress at a point 'P' as shown in figure and at a depth of 2.5 m. [3+5]

m	n			
	0.6	0.8	1.0	2
0.6	0.1069	0.1247	0.1361	0.1533
0.8	0.1247	0.1401	0.1598	0.1812
1.0	0.1361	0.1598	0.1752	0.1999
2	0.1533	0.1812	0.1999	0.2325



9. a) With the help of neat sketch, describe the method of determination of coefficient of consolidation by square root of time method. [4]

b) Calculate the final settlement of clay layer as shown in figure below due to increases of pressure of 30 kN/m^2 at mid height of layer. [3]



c) A compressible layer whose total settlement under a given loading is expected to 20 cm, settles 4 cm at end of 2 months. How many months will be required to reach a settlement of 10 cm. Assume double drainage. [3]

10. a) State the Mohr's failure theory and derive the Mohr coulomb equation. [1+3]

b) The series of consolidated undained tests on undisturbed samples of an overconsolidated clay were as below. Determine the shear parameter in terms of effective stresses. [6]

Cell pressure (kN/m^2)	100	200	400	600
Deviater stress at failure (kN/m^2)	300	410	610	850
Pore water pressure (kN/m^2)	-45	-15	50	110

11. a) Describe the process of determining the most critical circles in Swedish circle method. [3]

b) Analyse the infinite slope of cohesionless soil for a steady seepage condition. [3]

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INSTITUTE OF ENGINEERING
Examination Control Division
2078 Poush

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

Subject: - Soil Mechanics *(CE 552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
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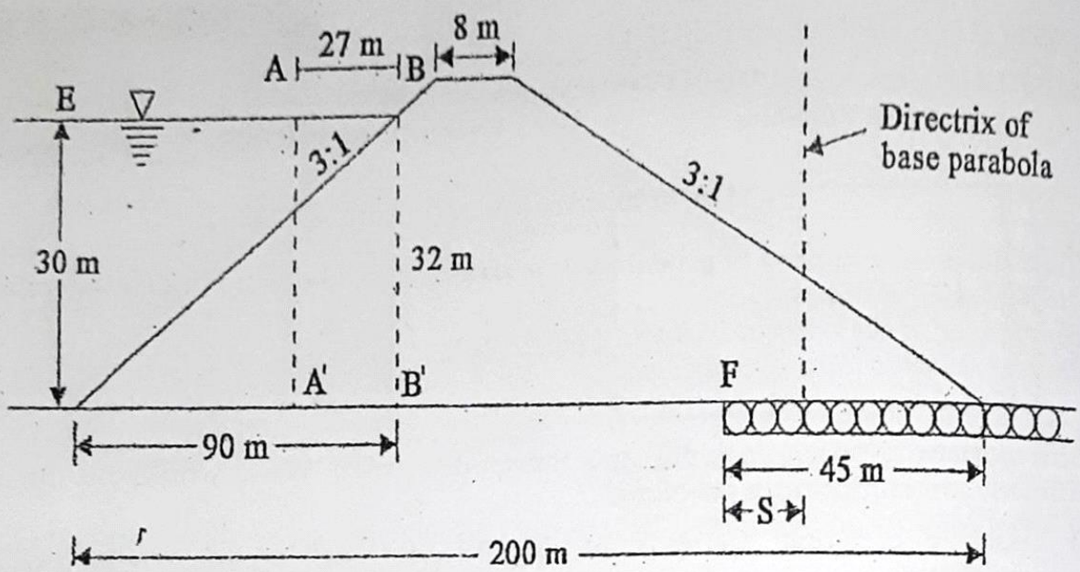
1. Differentiate between residual and transported soils. What would be the solution of different soil engineering problem? [2]
2. a) Describe different methods of determination of in-situ density based on site conditions. [4]
   b) Undisturbed sample of saturated clay has volume of 20cc and weighs 38 gm. After oven drying the weight reduces to 28 gm. Calculate the void ratio and specific gravity. [4]
3. How do you distinguish between clay and silt in the field? State the purpose of identification and classification of soils. List any three important engineering classification systems and describe one in detail, clearly bringing out its limitations. [2+2+1+3]
4. a) Define basic structural units of clay minerals and show the structure of Kaolinite, Illite and Montmorillonite minerals.
   b) Describe different types of soil structures. [2+2]
5. a) Mention the factors that affect the compaction. [1]
   b) Explain the effect of compaction on soil Properties. [2]
   c) A cylindrical specimen of a cohesive soil of 10 cm diameter and 20 cm in height was prepared by compaction in a mold. Taking the specific gravity of soil solid as 2.65 and the wet weight of this specimen as 30kN and water content as 15%, find the followings:
      (i) Dry unit weight, Void ratio and Degree of saturation of this cylindrical specimen.
      (ii) If 95% of relative compaction is to be achieved in the field, what should be the dry unit weight of compacted soil so same soil specimen in the field. [3]
6. a) Describe the effect of surcharge and capillary action in the effective stress. [4]
   b) A drainage pipe is clogged with the soil having coefficient of permeability 10 m/day. Due to clogging water level in the tank is raised to 20 m and discharge is reduced to 0.15 m^3/day. If the cross section of the pipe is 200 cm^2, what is the volume of soil in the pipe? [6]
7. a) With neat sketch describe the method to find top flow line for an earthen dam with horizontal filter. [3]
   b) An earth dam of homogeneous section with a horizontal filter is shown in figure below. If the coefficient of permeability of the soil is 3×10^{-3} mm/s, find the quantity of seepage per unit length of the dam. [5]



8. a) Describe approximate stress distribution methods for loaded areas.

   b) A ring foundation is of 3.60 m external diameter and 2.40 m internal diameter. It transmits a uniform pressure of 135 kN/m^2. Calculate the vertical stress at a depth of 1.80 m directly beneath the centre of the loaded area.

9. a) A structure built on a 3 m thick single drained clay layer settled 5 cm in 60 days after it was built. If this settlement corresponds to 20 percent average consolidation of the clay layer, plot the time settlement curve of the structure for a period of 3 years from the time it was built.

   b) Explain the different methods of accelerating consolidation settlement.

10. a) What are the advantages and disadvantages of a triaxial compression test? Briefly explain how you conduct the triaxial test and compute the shear parameters for the soil from the test data.

    b) Calculate the potential shear strength on a horizontal plane at a depth of 3 m below the surface in a formation of cohesionless soil when the water table is at a depth of 3.5 m. The degree of saturation may be taken as 0.5 on the average. Void ratio = 0.50; grain specific gravity = 2.70; angle of internal friction = 30°. What will be the modified value of shear strength if the water table reaches the ground surface?

11. An embankment 10 m high is inclined at an angle of 36° to the horizontal. A stability analysis by the method of slices gives the following forces per running meter:

    Σ Shearing forces = 450 kN
    Σ Normal forces = 900 kN
    Σ Neutral forces = 216 kN

    The length of the failure arc is 27 m. Laboratory tests on the soil indicate the effective values c′ and ϕ' as 20 kN/m^2 and 18° respectively.

    Determine the factor of safety of the slops with respect to (a) shearing strength and (b) cohesion

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1. Differentiate between physical and chemical disintegration process. [2]
2. a) What do you mean by index and engineering properties?. Why is it necessary to determine index properties of soil? [4]

   b) You are appointed as a supervisor for a road construction project. During the construction process, the contractor compacted the base course of the road and the average water content for the test samples was found to be 15%, the specific gravity of soil grains= 2.7 and unit weight of soil=18 kN/m. The specification requires that void ratio< 0.75. if you have to pass the bill for that task according to the specification, Would you pass the bill for that work? [4]
3. a) Point out similarities and differences between USCS system and AASHTO system of soil classification. [2]

   b) What are the basic requirements of soil classification? [2]

   c) Classify the given soil according to USCS classification system [4]

   % of soil passing through sieve no. 200 (0.075 mm) = 40%
   % of soil retained in sieve nno.4 (4.75 mm sieve) = 55%
   The grading characteristics of soil were: D_{10} = 1.2 mm, D_{60} =3.8 mm, D_{30} = 2.6 mm
4. What do you mean by adsorbed water? Describe double diffusive layer formation. [1+3]
5. a) Is it practically possible to maintain the optimum moisture content during compaction at field? Give reason. [1]

   b) The following results were obtained from a standard compaction test [3+2]

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 1000cm^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)
6. a) Sand deposit consists of two layers. Top layer is 3 thick with bulk unit weight 18 kN/m^3 and saturated unit weight of 21 kN/m^3 and the bottom layer is 4m thick with saturated density of 20 kN/m^3. Ground water table is at a depth of 4 m below the ground surface and zone of capillary saturation is 1m above the water table. Calculate and plot effective stress, total stress and neutral stress. [6]

b) What is quick sand condition? At a site, the initial investigation showed that the soil is cohesive (clay). If you have to determine coefficient of permeability of the soil, which method is most appropriate in laboratory and why? Also write the expression to determine the coefficient of permeability. [2+1+1]

7. a) A deposit of cohesionless soil with a permeability of 4×10^{-2} cm/s has a depth of 10 m with an impervious ledge below. A sheet pile wall is driven into this deposit to a depth of 7 m. The wall extends above the surface of the soil and a 3 m depth of water acts on one side. Sketch the flow net and determine the seepage quantity per metre length of the wall. [4]

b) Explain the filter requirements for controlling piping. Describe the properties and application of flow net. [2+2]

8. a) Define significant depth and its importance. Construct an isobar for significant depth. [4]

b) A strip footing of width 2m carries a load of 500kN/m. Calculate the maximum strees at a depth of 5m below the center of footing. Compare the result with 2:1 Distribution method. [2+2]

9. a) A 3m thick clay layer beneath a building is overlain by a permeable stratum and is underlain by a impervious rock. The coefficient of consolidation of the clay was found to be $0.025 cm^2/min$. The final expected settlement for the layer is 8cm.Determine [6]

i) How much time will it take for 80% of the total settlement
ii)The required time for a settlement of 2.5 cm to occur
iii) the settlement that would occur in 1 year

b) Discuss the limitations of Terzaghi's theory of consolidation. State the difference between primary and secondary consolidation. [2+2]

10. a) List out all the field and lab tests for determining the shear strength parameters of the soil. Also state which tests are appropriate for which type of soil. [3]

b) Point out the limitations Mohr-Coulomb theory. [2]

c) The following result were obtained from a consolidated – undrained test on normally consolidated clay. Plot the strength envelope in terms of total stress and effective stress and determine the strength parameters. [5]

Sample No.	Cell pressure (KN/m^2)	Deviator Stress (KN/m^2)	Pore Water Pressure (KN/m^2)
1	200	244	55
2	300	314	107
3	400	384	159

11. An infinite slope is made of clay with the following properties:
$\gamma_t = 18\ KN/m^3$, $\gamma' = 9\ KN/m^3$, $c = 25\ KN/m^2$ and $\phi' = 28°$. If the slope has an inclination of 35° and height equal to 12m, determine the stability of the slope, when [6]

i) The slope is submerged
ii) There is seepage parallel to the slope

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2078 Baishakh

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Year / Part	II / II	Time	3 hrs.

Subject: - Soil Mechanics *(CE 552)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
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1. a) Explain the importance of studying Soil Mechanics. [1]
   b) Point out the types of soil based on its formation, grain size and cohesiveness. [1]
2. a) Sketch the phase diagram for a soil and indicate the volumes and weights of the phases on it. Define 'Void ratio and Degree of saturation'. [2]
   b) A field density test was conducted by core cutter method and the following data was obtained.
   Weight of empty core-cutter = 22.80N
   Weight of soil and core-cutter = 50.05N
   Inside diameter of the core-cutter = 90.0mm
   Height of core-cutter = 180.0mm
   Weight of wet sample for moisture determination = 0.5405N
   Weight of oven-dry sample = 0.5112N
   Specific gravity of soil grains = 2.72
   Determine (i) dry density, (ii) void-ratio, and (iii) degree of saturation. [6]
3. a) Name the tests generally done to identify sandy soil and clayey soil in the field. [2]
   b) Name the soil classification systems which use both particle size and plasticity characteristics of soil. [2]
   c) Classify the following soil if the test results obtained from Sieve Analysis and Consistency Tests are given below:
   Percentage passing No. 4 Sieve (4.75 mm) = 70%, Percentage passing No. 200 Sieve (0.075mm) = 30%; Liquid limit = 33% and Plastic Limit = 11%. [4]
4. Define soil fabrics and soil structure. Explain with clear sketches the 1:1 and 2:1 types of clay minerals. [1+3]
5. Evaluate the construction of embankment if required degree of compaction is 95% and the dry density of the embankment was found as 1.78gm/cc. The result of compaction test performed in the laboratory for the same material using 950cc mould are as follows. [6]

w%	7.7	11.5	14.6	17.5	19.7	21.2
Mass of wet soil (kg)	1.70	1.89	2.03	1.99	1.96	1.92

6. a) Fluctuation of water level in the sea affects the effective stress of the soil lying in the sea bed. Do you agree with this statement? Answer the question with proper explanation. [2]
   b) A soil profile consists of 4m and 3m thick clay layer and sand layers, respectively. Clay layer lies above the sand layer and the ground water table is seen at 2m depth from the ground surface. Above the water table, there lies 1m thick capillary saturated

zone. Determine effective vertical stress at 0m, 1m, 2m, 4m, and 7m depths from the ground surface. Take bulk unit weight and saturated unit weight of clay as 20kN/m^3, and 20kN/m^3 respectively. Take saturated unit weight of sand as 19kN/m^3. [4]

c) Explain Darcy's law in regard with discharge velocity. Write down the names of different tests done to find the coefficient of permeability of the soil both in the laboratory and field. [2]

d) Explain Quick sand condition. [2]

7. a) What is flow net? Describe its properties and applications. [1+2]

b) Prove that the discharge per unit width of an earthen dam with a horizontal filter at its toe is equal to the coefficient of permeability times the focal length. [5]

8. a) A water tower (10^6kN including foundation) is supported by three columns in triangular pattern (each side 10m long). Calculate the stress 5m below the foundation level at the center of water tank and each footing. [6]

b) Describe the limitations of Boussinesq's and Westergaard's theory. [2]

9. a) Explain what is meant by normally consolidated clay stratum and over-consolidated clay stratum. Sketch typical results of consolidation test data to a suitable plot relating the void ratio and consolidation pressure in each case and show how pre-consolidation can be estimated. [2+2+1]

b) There is a bed of compressible clay of 4m thickness with previous sand on top and impervious rock at the bottom. In a consoliation test on an undistributed specimen of clay from this deposit 90% settlement was reached in 4 hours. The specimen was 20mm thick. Estimate the time in years for the building founded over this deposit to reach 90% of its final settlement. [5]

10. a) Define major and minor principle stresses. What happens if the value of major principle stress increases while minor principle stress remains constant? Draw Mohr circle of stresses at failure with Mohr-Coulomb Failure line for soil having only angle of internal friction. [3]

b) Name the laboratory and field tests conducted to find the strength parameters of a soil. [1]

c) Draw final test results of Unconfined Compression Tests and Direct Shear Test for the same soil so that strength parameters of the soil could be obtained. [2]

d) At confining pressure of 100kPa and deviator stress of 200kPa, a cohesionless soil sample was failed in a triaxial test. Determine the deviator stresses if the sample of same soil when failed under confining pressure of 200kPa. Also, Mohr circles of stress along with Mohr-coulomb failure envelop. [4

11. A cut 10m deep is to be made in a stratum of cohesive soil (c=35kN/m^2, γ=18.5kN/m^3 and $\varnothing$=0). The bed rock is located 15m below the original ground surface. [

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2077 Chaitra

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

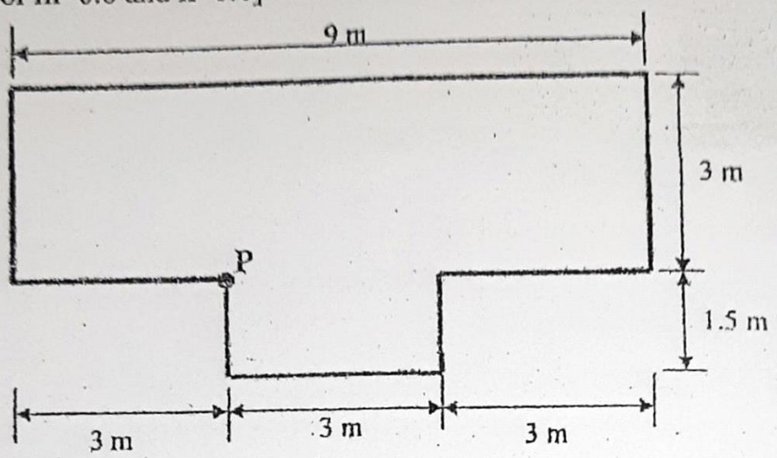
Subject: - Soil Mechanics *(CE 552)*

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

1. Briefly describe the process of soil formation. [2]
2. a) Draw phase diagrams for dry soil sample and saturated soil sample before and after the compaction and consolidation processes, respectively. [2]
   b) Explain the field tests generally done to find the dry unit weight of soil. [2]
   c) Dry sand is poured into a cylindrical container (internal diameter, 0.2m and height, 0.2m) and just filled up to its top. The weight of the dry sand in the container is found to be 10kg. By adding water, this dry sand sample is fully saturated with water. Let the void ratio of this sand sample be 0.54 which remains constant throughout the saturation process. Taking the value of specific gravity of soil solid as 2.65, find the followings:
      (i) The amount of water needed to fully saturate the dry sand sample and its water content at full saturation.
      (ii) Also, find the amount of water to be added in the dry sand sample to achieve 80% degree of saturation. Mention the assumed condition if any. [4]
3. a) Differentiate between cohesive and cohesion less soil with their uses in Civil Engineering field. [2]
   b) Describe field identification test to distinguish between clay and silt. [4]
   c) Draw neatly the IS plasticity chart and label the symbol of various soils. [2]
4. Compare the monitorillonite and kaolinite minerals of clay in the basis of chemical and physical characteristics and how they affect the geotechnical behavior of soil. [4]
5. A soil in the borrow pit is at a dry density of 17kN/m^3 with a moisture content of 10%. The soil is excavated from this pit and compacted in an embankment to a dry density of 18kN/m^3 with a moisture content of 15%. Compute the quantity of soil to be excavated from the borrow pit and the amount of water to be added for 100m^3 of compacted soil in the embankment. [6]
6. Define 'neutral' and 'effective' pressure in soils. What is the role of effective stress in shear strength of soil? The discharge of water collected from a constant head permeameter in a period of 15 minutes is 500ml. The internal diameter of the permeameter is 5cm and measured difference in head between two guaging points 15cm vertically apart is 40cm. Calculate the coefficient of permeability. If the dry weight of the 15cm long sample is 4.86N and the specific gravity of the solids is 2.65, calculate the seepage velocity. [2+1+7]
7. Draw a flow net diagram for the given earthen dam data and compare the discharge with the theoretical calculation.
   Top width = 15m upstream and downstream slope = 2H:1V, height of dam = 30m, free board = 5m, length of drain = 30m and coefficient of permeability = 40m/day. [6+2]
8. a) Using Boussenisq's equation for point load, determine the increment in vertical stress below the center of the uniformly loaded circle. Assume all necessary conditions. [3]

b) Name different methods used to determine the increment in vertical stress at any point below the ground surface due to external load applied on the ground surface. [1]

c) A T-shaped foundation as shown in figure is loaded with a uniform load of 120kPa. Determine the vertical stress at the point P at a depth of 5m. [4]
[Take I_N=0.0629 for m = 0.6 and n=0.3; I_N=0.1431 for m=0.6 and n=1.0; and I_N=0.1069 for m=0.6 and n=0.6]



9. a) Define consolidation, degree of consolidation, pre-consolidation pressure and over-consolidation ratio. [2]

b) At a certain depth below the foundation of a building there exists a clay layer of thickness 10m. Above and below the clay layer there are incompressible permeable soils. In a consolidation test on the clay sample with drainage at top and bottom, a sample with initial thickness 2.54cm was compressed under a steady pressure. Half of the final settlement value? Take Time factor, T_v=0.196 for 50% degree of consolidation. [5]

c) Draw isochrones for a clay layer of thickness, H under one-way drainage and two way drainage conditions at different elapsed times after loading (t=0, t=t and t=∞). Assume necessary conditions. [2]

d) What are the possible methods for accelerating consolidation process? [1]

10. a) What is the shear strength of soil along a horizontal plane at a depth of 4m in a deposit of sand having ∅=35° γ_d=17kN/m^3, G_s=2.7. Assume the ground water table is at a depth of 2.5m from the ground surface. Also find the change in shear strength when the water table rises to the ground surface. [7]

b) Describe briefly the practical application of UU, CU and CD triaxial test. [3]

11. Carry out the stability analysis for an infinite dry slope with strength properties of c=10kPa and ϕ=25°. Assume the plane failure surface lies at a depth of 5m from the slope surface. Take the unit weight of soil above the failure plane as 16kN/m^3 and the inclination of the slope as 10°. What happens if the cohesion of the soil reduces to zero? [6]

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TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2076 Baisakh

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

Subject: - Soil Mechanics *(CE 552)*

- ✓ 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. Briefly describe the historical development of soil mechanics. [2]

2. a) Name the Index tests which are generally carried out to find the index properties of the soil. [1]

   b) Draw phase diagram of soil for different degree of saturation. Name different types of unit weights those are used in soil mechanics and express them in terms of weights and volumes of soil solid, void water and void air. [2]

   c) Draw the stress strain curve for different consistency states of soil. [2]

   d) From the pycnometer test, specific gravity of soil solid of the soil specimen is found to be 2.65. Also, the dry unit weight of this soil specimen is found to be 15 kN/m^3. If one cubic meter of this soil specimen weighs 18 kN/m^3, determine (i) water content, (ii) degree of saturation, and (iii) submerged unit weight of this soil specimen. [3]

3. a) A sample of inorganic soil has the following grain size characteristics

Size (mm)	Percent passing
0.075 (No. 200)	58
0.425mm (No. 40)	80
2mm (No. 10)	100

   The liquid limit is 30% and PI is 10% percent. Classify the soil according to the AASHTO classification system. [6]

   b) What are the basic requirements of soil classifications? What are common classification systems? [1+1]

4. a) Explain different types of clay minerals based on Silicate sheet, Gibsite sheet and Brucite sheet. [2]

   b) Describe the types of soil structures based on compaction process. Also, define double diffuse layer in regard with clay minerals. [2]

5. Define zero air void. What are the necessary precaution that is needed during field compaction in different environment? For homogeneous earth dams and subgrades for highways. Would you prefer to compact the soil on dry side of omc or wet side of omc? [1+3+2]

6. a) Write down Darcy's Law if Q amount of water flows per unit time through an inclined soil length 'L' of cross section 'A'. Take the hydraulic head difference at the entry and exit points of soil as 'h'. Draw neat figure and explain each term used in the law. [2]

   b) Differentiate between discharge velocity and seepage velocity when water flows through the soil. [2]

   c) When water flows through layered soils, average permeability, k_{avg} depending on the flow direction with bedding plane is considered. Find the value of k_{avg} for the composite soil shown in figure 2 when water flows in the vertical and horizontal directions. Here k_1, k_2, and k_3 are coefficient for permeability of respective soils. [3]

   d) What are confined and unconfined aquifers? Write down the equations for finding coefficient of permeability in these aquifers. [3]

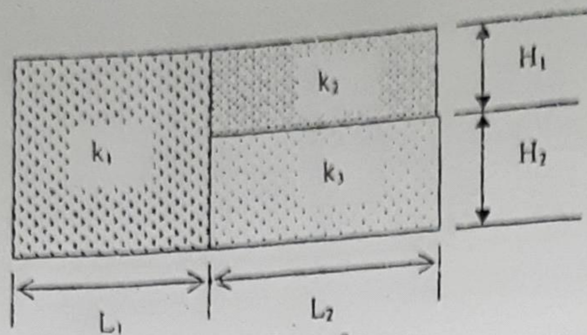

Figure 2

7. a) Define Flow lines and Equipotential lines in relation with flow net diagram. Write down the application of Flow net. [2]

   b) Draw a flow net for the flow of water under Sheet Pile wall. Write down the steps to draw this flow net and find the discharge, q for this flow. [4]

   c) Explain Quick sand condition during upward seepage flow. [2]

8. a) A water tower has circular foundation of diameter 10m. The total weight of the tower including the foundation is 18000 KN. A very weak foundation of bearing capacity of 100 KN/m^2 lies below the foundation level. Calculate the stress due to foundation load at the top of the weak stratum. Give your comment with regard to the feasibility of the foundation construction at the top surface of the weak layer. [6]

   b) Newmark's Influence Chart and Westergaard's analysis are also used for finding the vertical stress within the soil deposits. Write down the conditions for using them. [2]

9. a) Differentiate between normally consolidated and over consolidated. Derive the general equation for the calculation of settlement from one-dimensional primary consolidation. [2+3]

   b) A 5m thick saturated soil stratum has a compression index of 0.25 and coefficient of permeability 3×10^{-3} mm/sec. If the void ratio is 1.9 at vertical stress of 0.15N/m^2, compute the void ratio when the vertical stress increased to 0.2N/mm^2. Also calculate settlement due to above stress increase and time required for 50% consolidation? [5]

10. a) What is shear strength of the soil? Draw Mohr's circle of stresses along with Mohr Coulomb Failure Criterion line. Also, find the relationships between the major and minor principal stress and failure angle and internal friction angle. [4]

    b) Drainage condition plays important role in the measurement of shear strength of the soil. Write down the names of triaxial shear strength tests depending upon the drainage condition. Differentiate unconfined compressive strength from undrained shear strength for unconfined compression test. [2]

    c) Consolidated Undrained triaxial test was performed for the normally consolidated saturated clay. During consolidation stage, cell pressure of 200 kN/m^2 was applied and drainage was allowed. In the shearing stage, deviatoric stress of 350 kN/m^2 was applied in vertical direction and pore water pressure of 80kN/m^2 was measured. [4]

    Answer the followings:

    i) Draw Mohr's circle for total and effective stresses.
    ii) Find the value of internal friction angle in total and effective stress conditions. Take the value of cohesion equal to zero for normally consolidated soil.
    iii) Determine the direction of failure plane that might occur within the specimen.

11. a) Write down the types of slope failures and explain the measures that can be taken to prevent slope failure. [2]

    b) Derive the equation of Factor of Safety for the infinite slope with cohesionless soil without water table. What happens if water table rises to the surface of the slope? [4]

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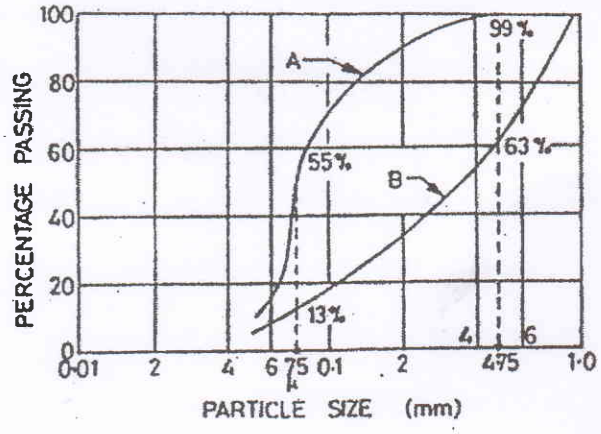
04 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2075 Bhadra

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.*
- ✓ *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]

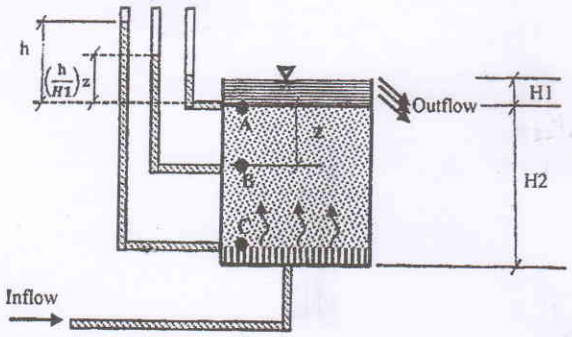
5. In the construction of a road, the compaction specification required was 95% of Proctor maximum dry density at a field moisture content within 2% of the optimum moisture content. The maximum dry density and optimum moisture content obtained in the laboratory from the Standard Proctor test were 1.95 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]

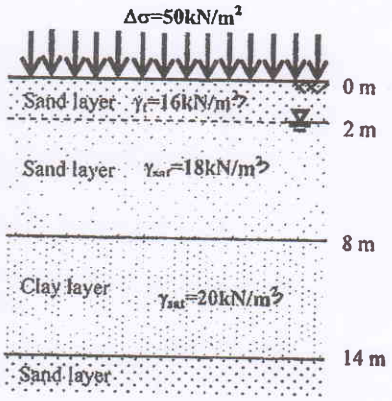
6. a) Explain the variation of effective stress due to the flow of water through the soil mass in downward and upward directions. What is discharge velocity? [2+1]
   b) In a variable head permeability test on a soil of length L_1, the head of water in the standpipe takes 5 seconds to fall from 900 to 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]

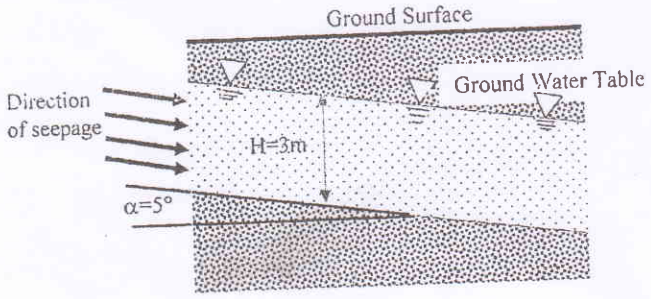
2. A relative density test conducted on a sandy soil obtained the following results: maximum void ratio = 1.25, minimum void ratio = 0.45, relative density = 40% and G = 2.65. Find the dry density of the soil in the present state. If a 3 m thickness of this stratum is densified to a relative density 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]

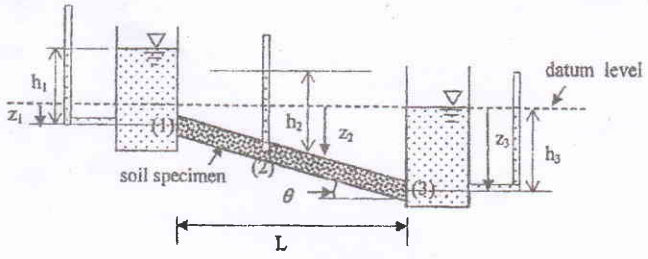
Test No.	1	2	3	4	5	6
Water content (%)	11.0	12.1	12.8	13.6	14.6	16.3
Mass of compacted soil (gm)	1920.5	2051.5	2138.5	2147.0	2120.0	2081.5

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).

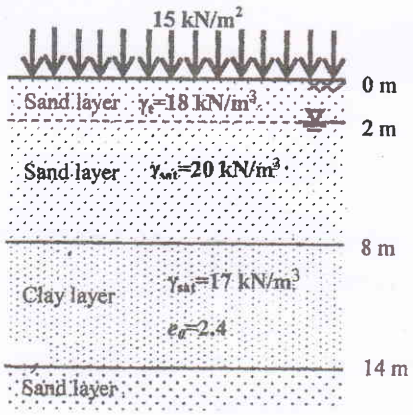


   b) Obtain the expression for the critical hydraulic gradient necessary for quick condition to develop. Why there is more likelihood of quick conditions in sand than in clay? [4+1]

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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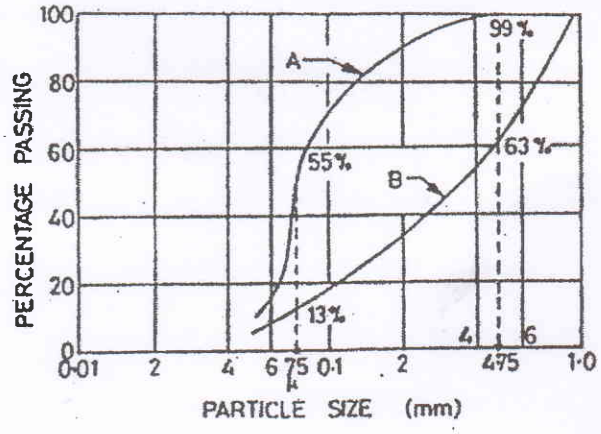
04 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2075 Bhadra

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.*
- ✓ *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]

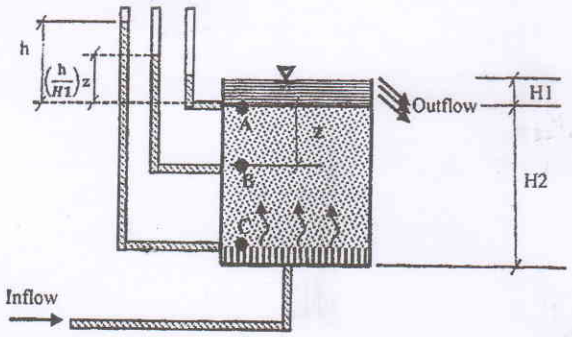
5. In the construction of a road, the compaction specification required was 95% of Proctor maximum dry density at a field moisture content within 2% of the optimum moisture content. The maximum dry density and optimum moisture content obtained in the laboratory from the Standard Proctor test were 1.95 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]

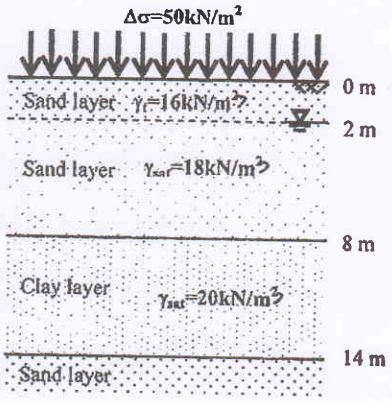
6. a) Explain the variation of effective stress due to the flow of water through the soil mass in downward and upward directions. What is discharge velocity? [2+1]
   b) In a variable head permeability test on a soil of length L_1, the head of water in the standpipe takes 5 seconds to fall from 900 to 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]

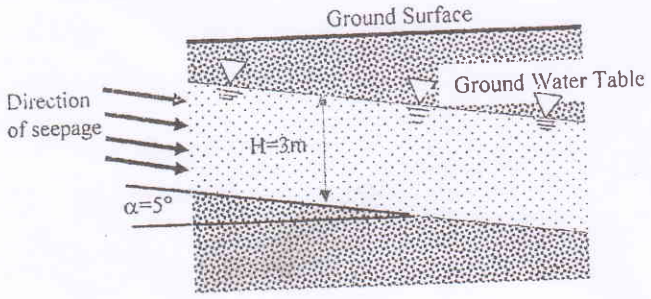
2. A relative density test conducted on a sandy soil obtained the following results: maximum void ratio = 1.25, minimum void ratio = 0.45, relative density = 40% and G = 2.65. Find the dry density of the soil in the present state. If a 3 m thickness of this stratum is densified to a relative density 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]

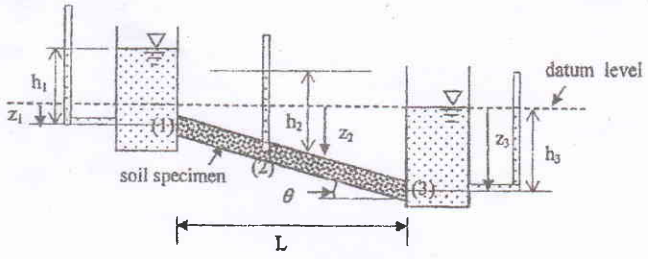
Test No.	1	2	3	4	5	6
Water content (%)	11.0	12.1	12.8	13.6	14.6	16.3
Mass of compacted soil (gm)	1920.5	2051.5	2138.5	2147.0	2120.0	2081.5

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).

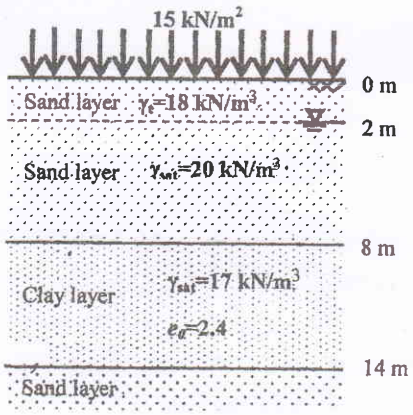


   b) Obtain the expression for the critical hydraulic gradient necessary for quick condition to develop. Why there is more likelihood of quick conditions in sand than in clay? [4+1]

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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