GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: Diploma

Branch: Civil Engineering

Course / Subject Code : DI03006051

Course / Subject Name : Soil Engineering

w. e. f. Academic Year:	2024-25
Semester:	3rd
Category of the Course:	PCC

Prerequisite:	Engineering Mechanics
Rationale:	After learning Mechanics of rigid bodies in 2nd semester, this subject "Soil Engineering" is introduced in 3rd semester, as it deals with the natural material "Soil" whose behaviour is somewhat intermediate between solids and fluids. Soil Engineering involves study of Soil, its behaviour and application as an engineering material. Design of foundation of building, dams, towers, embankments, roads, railways, retaining wall, bridges is mainly governed by characteristics and behaviour of Soil, hence this subject is very important for Civil engineering students.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Identify types of Soil according to mode of deposition and mode of transportation.	R,U,A
02	Determine the physical and index properties of soil to estimate behaviour and other important engineering properties for given construction activities.	R,U,A
03	Classify coarse grained and fine grained soil by IS method	R,U,A
04	Determine Coefficient of permeability and shear parameters of soil and apply results in foundation analysis and other construction activities.	R,U,A
05	Determine O.M.C. and M.D.D. values of soil and select suitable method of soil stabilization.	R,U,A
06	Compute bearing capacity of soil and earth pressure and interpret results.	R,U,A

**Revised Bloom's Taxonomy (RBT)*

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE (E)	PA (M)	PA (I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Overview of Soil Engineering** 1.1 Definition of Soil, Soil Mechanics, Soil Engineering, Importance of Soil engineering 1.2 History of Soil Engineering 1.3 Soil formation in Geological cycle 1.4 List of Structures where soil is used as construction material 1.5 Types of Soil according to mode of Transportation 1.6 Major Soil deposits of India.	03	7
2.	**Physical and Index properties of Soil** 2.1. Soil as a three phase system, assumptions for drawing two phase & three phase diagrams, 2.2. Fundamental definitions of physical properties- Water content, Bulk density, Dry density, Saturated density, Submerged density, Density of solids, Specific gravity-Absolute & Mass specific gravity, void ratio, porosity, Degree of saturation, Air content, Percentage air voids, Relative density 2.3. Derivation of following relations from phase diagrams and numericals on each : 2.3.1 e= n/n-1, n=e/1+e 2.3.2 w×G =e×Sr 2.3.3 ϒd=ϒb/1+w 2.3.4 ϒd=ϒb/1+w 2.3.5 ϒsat= (G+e)ϒw/(1+e) 2.3.6 ϒsub=(G-1)ϒw/(1+e) 2.3.7 ϒd= G ϒw/1+e 2.4. Methods to determine moisture content of soil. 2.5. Determination of Bulk & Dry density of soil by Core Cutter	08	16

	method and Sand Replacement method. 2.6. Determination of Specific Gravity of soil by pycnometer.		
3.	**Classification of Soil** 3.1 Classification of soil as per grain size by IS method. Basic criteria of classification of soils. 3.2 Difference between coarse grained and fine grained soil on the basis of their size and engineering properties. Mechanical Analysis of coarse grained soil. Sedimentation analysis of fine grained soil. 3.3 Particle size distribution curve. Nature of various grading Curves. Coefficients of uniformity and curvature. 3.4 Classification of soil on the basis of plasticity. Atterberg's limits of consistency: Liquid limit, plastic limit and shrinkage limit. Plasticity index, Liquidity Index and Consistency Index. 3.5 Determination of Liquid limit, Plastic limit and Shrinkage limit as per IS.	06	14
4.	**Permeability and Seepage** 4.1 Definition of permeability, permeable and impermeable soil, Darcy's law of permeability. 4.2 Factors affecting the permeability of soil. Coefficient of permeability, Difference between flow through pipe and flow through soil. 4.3 Laboratory Methods to determine Coefficient of Permeability- Constant Head Method and Falling Head method. 4.4 Field methods to determine Coefficient of Permeability: Pumping-out tests and Pumping-in tests. 4.5 Definition of Seepage and seepage pressure. Quick sand condition. Types of flow net. Characteristics and application of flow net.	06	14
5.	**Compaction and Stabilization of Soil** 5.1 Concept of compaction and its effect on various soil properties like density, permeability, shear strength & bearing capacity. 5.2 Factors affecting compaction like water content, types of soil, nature of soil, method of compaction, admixtures. 5.3 Optimum moisture content (O.M.C) and maximum dry density (M.D.D.) by IS standard compaction test- Light and Heavy compaction test(Proctor Test). Standard compaction curves. 5.4 Method of field compaction. Various compaction equipment, role of O.M.C. in field. 5.5 Concept and requirements of soil stabilization. Different methods of soil stabilization–Mechanical soil stabilization and Chemical	10	20

	soil stabilization (Use of cement, lime, fly ash, bitumen). Use of Geo-Synthetic as a stabilizing material. 5.6 Necessity of site investigation and sub soil exploration. Types and purpose of exploration. Basic field identification test of soil.		
6.	**Shear Strength of Soil** 6.1 Cohesion, Angle of internal friction, shear strength. 6.2 Coulomb's law for shear strength. 6.3 Different methods to find shear strength of soil in the laboratory. Procedure to find shear strength using Box shear test. 6.4 Types of soil- C-soil, ø-soil and C-ø soil. Mohr's circle method to find shear envelope and shear strength parameters.	06	15
7.	**Bearing capacity of Soil and Earth Pressure** 7.1 Concept of bearing capacity. Types of Bearing capacity- Ultimate bearing capacity, Safe bearing capacity, Net bearing capacity and Allowable bearing pressure. Influence of water table on bearing capacity. 7.2 I.S. method to determine bearing capacity of soils. Different theoretical methods to determine bearing capacity of soils. Introduction to Terzaghi's analysis. Assumptions and limitations of Terzaghi's theory. Different field methods for determination of bearing capacity – Plate load Test and Standard Penetration Test. 7.3 Different types of footings. Types of shear failure of footings. Methods to improve bearing capacity of soils. 7.4 Define Earth Pressure. Active and passive earth pressure for no surcharge condition. Rankine's formula to determine coefficient of earth pressure. 7.5 Liquefaction: Definition, Causes, Effect and Remedy of Liquefaction.	06	14
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
20	**30**	**50**	**-**	**-**	**-**

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Eval6uate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Soil Mechanics and Foundations	Dr. B.C.Punamia	Laxmi Publications Pvt. Ltd. NewDelhi ISBN: 81-700-808-19
2	Soil mechanics and Foundation Engineering	Dr. P.N.Modi	Standard Book House, New Delhi ISBN: 978-81-89401-30-6
3	Soil Mechanics and Foundation Engineering	S.K.Garg	Khanna Publishers, Delhi ISBN: 81-7409-104-1
4	Soil Mechanics and Foundation engineering	Dr. K.R. Arora	Standard Publishers ISBN-13: 978-8180141126
5	A Textbook of Soil Mechanics and Foundation Engineering	Murthy V.N.S.	CBS Publishers & Distributors Pvt. Ltd., New Delhi ISBN : 9788123913629

(b) **Open source software and website:**

1) NPTEL Course :-Soil Mechanics by IIT, Guwahati https://nptel.ac.in/courses/105103097
2) NCTEL Video series for Soil Mechanics laboratory Tests : https://www.youtube.com/results?search_query=nctel+soil
3) Virtual Lab by Ministry of Education, Government of India www.vlab.co.in

Suggested Course Practical List:

Sr. No.	Practicals	Unit No.	Approx. Hrs. required
1	Determine moisture content of soil by oven drying method	2	02
2	Determine field density and dry density of soil by Core cutter method	2	02
3	Determine field density and dry density of soil by Sand replacement method	2	02

Sr. No.	Practicals	Unit No.	Approx. Hrs. required
4	Determine specific gravity of soil by pycnometer/density bottle	2	02
5	Classification of soil by sieve analysis method	3	04
6	Determine Liquid limit, Plastic limit and Shrinkage limit of soil	3	06
7	Determine Permeability of soil by constant head method	4	02
8	Determine Permeability of soil by falling head method	4	02
9	Determine OMC & MDD of soil by standard proctor test [Light compaction Test]	5	04
10	Determine Shear parameters of soil by Direct Shear test	6	04
	Total hours		**30 Hrs.**

List of Laboratory/Learning Resources Required:

Sr. No.	Equipment Name with Broad Specifications	Practical. No.
1	Assembly of Core cutter for In-situ density determination.	02
2	Assembly of Sand replacement for In-situ density determination.	03
3	Sieve set & sieve shaker for mechanical analysis of soil.	05
4	Standard Proctor test apparatus for OMC & MDD determination of soil.	09
5	Density bottles/ Pycnometer for specific gravity determination.	04
6	Direct shear test apparatus.	10
7	Permeability test apparatus for constant water head.	07
8	Permeability test apparatus for falling water head.	08
9	Casagrande apparatus for Liquid limit determination.	06
10	Shrinkage Limit test apparatus.	06
11	Hot air oven with temperature control	01 to 10
12	Electronic weighing balance.	01 to 10

Suggested Project List:

a) Determine void ratio of soil by performing necessary tests in the laboratory.
b) Compare specific gravity of fine grained soil, coarse grained soil and Aggregate.
c) Compare OMC and MDD values of two different types of soil available nearby.
d) Prepare spreadsheet or computer program to calculate the OMC and MDD of given soil sample by standard compaction method.

e) Prepare spreadsheet or computer program to determine type of soil using particle size distribution curve and mechanical sieve analysis.
f) Prepare spreadsheet or computer program to determine Liquid Limit and Plastic Limit of given soil sample.
g) Compare coefficient of permeability values of two different types of soil available nearby.
h) Classify the soil from one source by performing necessary tests in the laboratory.
i) Prepare spreadsheet or computer program to calculate shear parameters of soil by performing direct shear test in the laboratory.
j) Prepare a working model of liquefaction of soil.
k) Calculate Bearing Capacity of Soil performing necessary tests in the laboratory.
l) Prepare and Compare working models of embankment filling with and without geo-synthetics.

Suggested Activities for Students: If any

a) Collect different photographs of a nearby soil deposit by natural formation.
b) Collect the photographs of different types of footings/foundations being constructed nearby with their primary details.
c) Collect different photographs of structural members where compaction of soil is being done before construction.
d) Collect the photographs of five different types of soil wrt classification of soil.
e) Collect the information with photographs of structural failure due to issue of soil stability.
f) Collect the information with photographs of soil improvement by different methods available in field.
g) Collect the information with photographs of structural members having excessive settlement of soil nearby.
h) Collect the information with photographs of failure of soil due to liquefaction.
i) Collect the information with photographs of different geo-synthetics.

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