4.4 SOIL MECHANICS AND FOUNDATION ENGINEERING

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RATIONALE

Civil Engineering diploma engineers are required to supervise the construction of roads, pavements, dams, embankments, and other Civil Engineering structures. As such the knowledge of basic soil engineering is the pre-requisite for these engineers for effective discharge of their duties. The subject covers only such topics which will enable the diploma engineers to identify and classify the different types of soils, their selection and proper use in the field for various types of engineering structures.

COURSE OUTCOMES

After undergoing the subject, students will be able to:

CO1: Identify and classify various types of soils
CO2: Select particular type of foundation according to loading of structure
CO3: Determine shear strength of soil
CO4: Carry out compaction of soils as per density
CO5: Calculate bearing capacity of soil
CO6: Calculate liquid limit and plastic limit of soil
CO7: Perform various tests of the soil

DETAILED CONTENTS

UNIT I

1. Introduction

1.1 Importance of Soil Studies in Civil Engineering

1.2 Geological origin of soils with special reference to soil profiles in India: residual and transported soil, alluvial deposits, lake deposits, local soil found in Punjab, dunes and loess, glacial deposits, black cotton soils, conditions in which above deposits are formed and their engineering characteristics.

1.3 Names of organizations dealing with soil engineering work in India, soil map of India

2. Physical Properties of Soils

2.1 Constituents of soil and representation by a phase diagram

2.2 Definitions of void ratio, porosity, degree of saturation, water content, specific gravity, unit weight, bulk density/bulk unit weight, dry unit weight, saturated unit weight and submerged unit weight of soil grains.

UNIT II

3. Classification and Identification of Soils

3.1. Particle size, shape, and their effect on engineering properties of soil, particle size classification of soils

3.2. Gradation and its influence on engineering properties

3.3 Relative density and its use in describing cohesionless soils

3.4 Behaviour of cohesive soils with change in water content, Atterberg's limit - definitions, use and practical significance

3.5 Field identification tests for soils

4. Flow of Water Through Soils

4.1 Concept of permeability and its importance

4.2 Darcy's law, coefficient of permeability, seepage velocity and factors affecting permeability

4.3 Comparison of permeability of different soils as per BIS

4.4 Measurement of permeability in the laboratory

UNIT III

5. Effective Stress: (Concept only)

5.1 Stresses in subsoil

5.2 Definition and meaning of total stress, effective stress and neutral stress

5.3 Principle of effective stress

5.4 Importance of effective stress in engineering problems

6. Deformation of Soils

6.1 Meaning, conditions/situations of occurrence with emphasis on practical significance of:

a) Consolidation and settlement
b) Creep
c) Plastic flow
d) Heaving
e) Lateral movement
f) Freeze and thaw of soil

6.2 Meaning of total settlement, uniform settlement, and differential settlement; rate of settlement and their effects.

6.3 Settlement due to construction operations and lowering of water table

6.4 Tolerable settlement for different structures as per BIS

UNIT IV

7. Shear Strength of Soil

7.1. Concept and Significance of shear strength

7.2 Factors contributing to shear strength of cohesive and cohesion less soils, Coulomb's law

8. Compaction

8.1 Definition and necessity of compaction

8.2 Laboratory compaction test (standard and modified proctor test as per IS) definition and importance of optimum water content, maximum dry density; moisture dry density relationship for typical soils with different compactive efforts

8.3. Compaction control; Density control, measurement of field density by core cutter method and sand replacement method, moisture control, Proctor's needle and its use, thickness control

9. Soil Exploration

9.1 Purpose and necessity of soil exploration

9.2 Reconnaissance, methods of soil exploration, Trial pits, borings (auger, wash, rotary, percussion to be briefly dealt)

9.3 Sampling; undisturbed, disturbed, and representative samples; selection of type of sample; thin wall and piston samples; area ratio, recovery ratio of samples and their significance, number, and quantity of samples, resetting, sealing and preservation of samples.

9.4 Presentation of soil investigation results

UNIT V

10 Bearing Capacity of soil

10.1 Concept of bearing capacity

10.2 Definition and significance of ultimate bearing capacity, net safe bearing capacity and allowable bearing pressure

10.3 Factors affecting bearing capacity.

10.4 Improvement of bearing capacity by sand drain method, compaction, use of geo-synthetics.

11. Foundation Engineering

11.1 Concept of shallow and deep foundation.

11.2 types of shallow foundations: combined, isolated, strip, mat, and their suitability.

11.3 Factors affecting the depth of shallow foundations, deep foundations,

11.4 type of piles and their suitability; pile classification based on material, pile group and pile cap**.**

PRACTICAL EXERCISES

1. To determine the moisture content of a given sample of soil
2. Auger Boring and Standard Penetration Test
   a) Identifying the equipment and accessories
   b) Conducting boring and SPT at a given location
   c) Collecting soil samples and their identification
   d) Preparation of boring log and SPT graphs
   e) Interpretation of test results
3. Extraction of Disturbed and Undisturbed Samples
   a) Extracting a block sample
   b) Extracting a tube sample
   c) Extracting a disturbed samples for mechanical analysis.
   d) Field identification of samples
4. Field Density Measurement (Sand Replacement and Core Cutter Method)
   a) Calibration of sand
   b) Conducting field density test at a given location
   c) Determination of water content
   d) Computation and interpretation of results
5. Liquid Limit and Plastic Limit Determination:
   a) Identifying various grooving tools
   b) Preparation of sample
   c) Conducting the test
   d) Observing soil behaviour during tests
   e) Computation, plotting and interpretation of results
6. Mechanical Analysis
   a) Preparation of sample
   b) Conducting sieve analysis
   c) Computation of results

d) Plotting the grain size distribution curve
e) Interpretation of the curve

7 Laboratory Compaction Tests (Standard Proctor test)
a) Preparation of sample
b) Conducting the test
c) Observing soil behaviour during test
d) Computation of results and plotting
e) Determination of optimum moisture and maximum dry density

8. Direct Shear Test
9. Permeability Test
10. Demonstration of Unconfined Compression Test
a) Specimen preparation
b) Conducting the test
c) Plotting the graph
d) Interpretation of results and finding/bearing capacity
11. Demonstration of Vane shear Test

RECOMMENDED BOOKS

1. BC Punmia, "Soil Mechanics and Foundations", Standard Publishers, Delhi.
2. Bharat Singh and Shamsher Prakash, "Soil Mechanics and Foundations Engineering", Nem Chand and Bros, Roorkee.
3. AK.Duggal, TR. Ramana, S Krishnamurthy, "Soil Sampling and Testing - A Laboratory Manual", Galgotia Publications, Delhi.
4. BIS Codes IS 6403 (latest edition) and IS 1498 (latest edition).
5. "Shallow Foundations" by NITTTR, Chandigarh.
6. Vinod Kumar, "Video films on Geo-technical Laboratory Practices", NITTTR, Chandigarh.
7 e-books/e-tools/relevant software to be used as recommended by AICTE/HSBTE/NITTTR.

SUGGESTED WEBSITES

1. http://swayam.gov.in

INSTRUCTIONAL STRATEGY

The teacher while imparting instructions are expected to lay greater emphasis on the practical aspects rather than theory and mathematical treatment. To bring clarity regarding concepts and principles involved, teachers should organize demonstrations in the laboratories and fields. It is necessary to create understanding that soils fail either under shear or settlement due to heavy loads. This can be shown by making use of photographs on working models of such failures. Efforts should be made in the practical classes that students perform practical exercises individually. Conduct of viva examination at the end of each practical work will develop clear understanding about the concepts and principles related to this subject. This subject contains five units of equal weightage.