Soil Mechanics

Course Objective:

This course is aimed at teaching the students the concepts of soil engineering, including the science and technology of soils and their application to problems in Civil engineering.

The course emphasizes the fundamentals and relevant principles of soil mechanics, gives an overall picture of the behaviour of soils and describes the nature of some of the soil problems encountered in Civil engineering.

1. Introduction (1 hour)
    a. Preview of Geotechnical problems in civil Engineering and infrastructure Development.
    b. Historical development of soil mechanics.
    c. Soil formation and soil type.
2. Solids- Water –Air Relations and Index properties of soils (5 hours)
    a. Phase diagram
    b. Simple definitions and their relationships
    c. Index properties of soils
    d. Determinations of various index properties
3. Soil Identifications and Classification (4 hours)
    a. Introduction
    b. Field Identification of soil
    c. Soil classification-Textural, ISSCS, MIT, BSCS, USCS and AASHTO soil classification system
    d. Application of soil classification system
4. Soil Structure and Clay Minerals (2 hours)
    a. Introduction
    b. Clay minerals
    c. Clay particle interaction
    d. Soil structure and fabrics
5. Soil Compaction (3 hours)
    a. Introduction
    b. Laboratory tests
    c. Factors affecting compaction
    d. Structure and Engineering behaviour of compacted cohesive soils
    e. Compaction specification and field control.
6. Principle of Effective Stress, Capillarity and Permeability (5 hours)
    a. Introduction
    b. Principle of effective stress
    c. Physical meaning of effective stresses
    d. Capillarity in soils
    e. Permeability of soils
    f. Determinations of coefficient of permeability: Laboratory and field methods.
    g. Types of Head, Seepage forces and quick sand conditions.
7. Seepage through Soils (4 hours)
    a. Introduction
    b. Two dimensional flow – Lap laces equation
    c. Flow nets
    d. Unconfined flow

e. Seepage in Anisotropic soil condition
f. Seepage through an earth dam on an impervious base
g. Flow through non – homogeneous sections
h. Prevention of Erosion- Protective filters

8. Vertical Stresses Below Applied Loads (4 hours)
    a. Introduction
    b. Boussinesq equation and Westergaard's equation
    c. Vertical Stress Distribution Diagrams
    d. Vertical stress beneath loaded Areas
    e. New marks influence chart
    f. Approximate stress distribution methods for Loaded Areas.

9. Compressibility of Soil (6 hours)
    a. Contact pressure and Settlement profile.
    b. Fundamentals of Consolidation
    c. One –Dimensional Laboratory consolidation Test
    d. Void Ratio – Pressure plots
    e. Normally consolidated and over consolidated clay
    f. Effect of Disturbance on Void Ratio –Pressure Relationship
    g. Calculation of Settlement from One – Dimensional Primary Consolidation
    h. Compression Index and Swell Index
    i. Secondary Consolidation Settlement
    j. Time Rate of Consolidation
    k. Coefficient of Consolidation
    l. Calculation of Consolidation Settlement under a Foundation
    m. Method of Accelerating Consolidation Settlement

10. Shear Strength of Soil (6 hours)
    a. Mohr-Coulomb failure criterion
    b. Inclination of the Plane of Failure caused by Shear.
    c. Laboratory Tests For Determination of shear strength Parameters.
    d. Direct Shear Test
    e. Triaxial Shear Test-General
    f. Consolidated drained Triaxial Test
    g. Consolidated undrained Triaxial Test
    h. Unconsolidated undrained Triaxial Test
    i. Unconfined compression Test on Saturated clay.
    j. Stress Path
    k. Vane Shear Test
    l. Empirical Relations between undrained cohesion and effective overburden pressure.
    m. Shear strength of unsaturated Cohesive Soils.
    n. Shear Strength of Sands.

11. Stability of Slopes (5 Hours)
    a. Introduction
    b. Infinite slopes and Translation slides
    c. Definition of factor of safety

d. Finite slopes- Forms of Slip surface
e. Ø = 0 Analysis (Total stress Analysis)
f. C – Ø Analysis – Method of Slices.
g. Location of the most Critical Circles
h. Friction Circle Method
i. Taylors Stability Number
j. Bishops method of Stability Analysis
k. Use of Stability Coefficients

Tutorials:

1. Introduction (0.5 hour)
2. Solids- Water –Air Relations and Index properties of soils (1.5 hour) : Numerical examples and derivation :: There can be tutorials for each sub-section
3. Soil Identifications and Classification (0.5 hour) :Practical examples :: There can be tutorials for each sub-section
4. Soil Structure and Clay Minerals (0.5 hour)
5. Soil Compaction (1 hour) : Practical and numerical examples
6. Principle of Effective Stress, Capillarity and Permeability (2 hours) : Practical example and numerical examples :: There can be tutorials for each sub-section.
7. Seepage through Soils (2 hours) : Numerical examples; Practical example :: There can be tutorials for each sub-section.
8. Vertical Stresses Below Applied Loads (1 hour) :Numerical examples type questions. :: There can be tutorials for each sub-section.
9. Compressibility of Soil (2 hours) :Numerical and Practical examples
10. Shear Strength of Soil (2 hours) : Numerical and Practical examples :: There can be tutorials for each sub-section
11. Stability of Slopes (2 hours) : Numerical and Practical examples :: There can be tutorials for each sub-section

Practical:

1. Sieve analysis of coarse and fine grained soils.
2. Determination of Atterberg limit of soils
3. Determination of In-situ density by Sand replacement method and Core Cutter Method.
4. Determination of OMC and maximum dry density
5. Unconfined compression test
6. Direct shear Test
7. Constant head permeability Test
8. UU Triaxial Test

References

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