Sustainable Building Engineering L23

Geotechnical Engineering (9 ECTS)

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The course aims to provide a basic understanding of the mechanical behaviour of soils. To this end, the nature, composition and mineralogy of soils will be analysed in detail, with emphasis on the physical properties that mainly influence their response. Furthermore, the constitutive models used in practice are studied together with the laboratory tests used to define the physical, mechanical and hydraulic properties of the soils. Finally, the main characteristics of seepage flow in stationary and transient regimes and the basic theory for calculating the lateral pressure of the soil on retaining structures, the bearing capacity and the settlements of shallow foundations are studied.

Syllabus

1. **Origin, Description and Classification of Soils**
   - 1.1. Soil Formation
   - 1.2. Soil Classification: grain size distribution
   - 1.3. Phase Relations
   - 1.4. Atterberg Limits And Plasticity Chart
   - 1.5. State of Soil
   - 1.6. Exercises: Grain Size Distribution Curve and Plasticity Chart

2. **Continuum Mechanics**
   - 2.1. Stress and strain state
   - 2.2. Mohr Circle of Stress
   - 2.3. Stress and Strain Invariants
   - 2.4. Stress Path
   - 2.5. Exercises: Mohr Circle and Stress Path

3. **Basic Constitutive models**
   - 3.1. Elasticity
   - 3.2. Plasticity

4. **The Porous Medium**
   - 4.1. The Principle of Effective Stress
   - 4.2. Geostatic Stress
   - 4.3. Drained and Undrained Conditions: Relative Rate of Loading
   - 4.4. Pore Water Pressure Under Undrained Loading
   - 4.5. Exercises: Lithostatic Stress State in a Layered Soil Deposit

5. **Flow in Porous Media**
   - 5.1. Darcy's Law
   - 5.2. Steady State Flow Under Three-Dimensional Conditions
   - 5.3. Solution of one and two-Dimensional seepage
   - 5.4. Piping
   - 5.5. Transient Flow: One-Dimensional Theory of Consolidation (notes)

5.6. Exercises: One-Dimensional Seepage for Different Schemes

6. Soil Compressibility

6.1. Compressibility of fine-grained soils
  6.1.1. Oedometer test
6.2. Compressibility of coarse-grained soils
6.3. Exercises: Prediction of One-Dimensional Compression Settlements

7. Shear Strength of Soil

7.1. Soil Strength and Coulomb's Failure Criterion
7.2. Laboratory tests
  7.2.1. Shear Box Test
  7.2.2. Triaxial Tests: CD, CU, UU
7.3. Drained Shear Strength
  7.3.1. Cohesive soils
  7.3.2. Granular soils
7.4. Undrained Shear Strength for Cohesive Soils

8. Applications

8.1. Elastic solutions for the induced stresses in the soil
8.2. Earth pressure acting on retaining structures: Rankine's Theory
8.3. Bearing Capacity of Shallow Foundation
8.4. Settlements of Shallow Foundation: Oedometric Method
8.5. Exercises:
  8.5.1. Earth pressure acting on retaining structures
  8.5.2. Bearing Capacity of a Shallow Foundation
  8.5.3. Settlements for a Shallow Foundation

Suggested texts

- **Lancellotta** - Geotechnical Engineering, Spon Text (2nd Edition).
- **Budhu** – Soil Mechanics and Foundations, John Willey & Sons, (3rd Edition).