FOUNDATIONS AND EARTH STRUCTURES

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Course Content

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Course Overview

This course covers the analysis and design of foundations, slopes, and earth-retaining structures. Students will learn to evaluate soil behavior under different loading conditions, apply stability theories, and design geotechnical solutions for real-world engineering challenges. The course combines theory with practical applications, including lab work and case studies, to prepare students for professional practice in civil and geotechnical engineering.

Prerequisites

A strong foundation in Strength of Materials 1 and Soil Mechanics 1 is required. These courses provide essential knowledge of stress-strain relationships, soil classification, and basic geotechnical principles, ensuring students are prepared for advanced topics like shear strength and slope stability analysis.

The content of course is organized around the following main area:

Chapter 1: Plasticity and Shear Strength of Soils: This chapter introduces Mohr's Circle for stress analysis and the Mohr-Coulomb failure criterion to predict soil behavior. Students will explore shear strength measurement techniques, including direct shear and triaxial tests, and examine differences between drained and undrained conditions. Practical exercises focus on interpreting lab data for design applications.

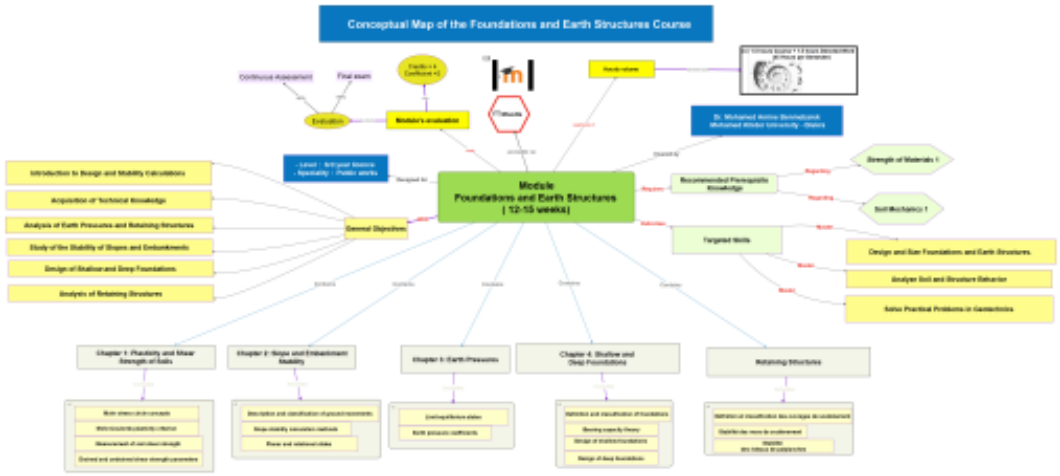
Chapter 2: Stability of Slopes and Embankments: This section analyzes landslide mechanisms, including rotational slips and planar failures. Stability methods like Fellenius' and Bishop's approaches are applied to compute safety factors, accounting for pore pressure and soil heterogeneity. Mitigation techniques, such as drainage and soil nailing, are discussed through case studies.

Chapter 3: Earth Pressures: Students learn to calculate lateral earth pressures on retaining structures using Rankine, Boussinesq, and Prandtl theories. The chapter covers at-rest, active, and passive states, emphasizing their role in designing walls, sheet piles, and excavations. Real-world examples demonstrate how pressure distributions influence stability.

Chapter 4: Shallow and Deep Foundations: Design principles for shallow foundations (bearing capacity, settlement) and deep foundations (piles, caissons) are covered. Students will use Terzaghi's theory and in-situ test data to size footings and estimate pile capacity, ensuring safe load transfer to the ground.

Chapter 5: Retaining Structure: The final chapter focuses on designing gravity walls, cantilever walls, and sheet piles. Stability checks against sliding, overturning, and bearing failure are emphasized, with practical examples illustrating design steps and material selection.

The conceptual map below offers a visual representation of the topics covered in this course and their interconnections, providing a clearer understanding of the course structure.



Conceptual Map of the Foundations and Earth Structures Course

Support for Students Missing Prerequisites

To ensure all students are prepared for the course content, we provide comprehensive review materials for those who need to strengthen their foundation:

[cf. Strength of Materials 1][cf. Strength of Materials 1]

General Introduction

II

The field of foundations and earth structures is a core branch of geotechnical engineering concerned with the interaction between soils and man-made structures. It encompasses the analysis, design, and stability evaluation of structural elements such as shallow and deep foundations, retaining walls, embankments, and earth slopes1.

Understanding the mechanical behavior of soils under various loading and drainage conditions is fundamental to ensuring the safety and durability of civil engineering works. The complexity of soil as a material—being heterogeneous, anisotropic, and affected by environmental factors—necessitates both theoretical and experimental approaches for assessing its strength, plasticity, and stability2.

Key aspects of this domain include the study of shear strength through laboratory testing, the application of limit equilibrium and plasticity theories, and the evaluation of slope stability using analytical and empirical methods. The discipline also integrates principles from soil mechanics, structural analysis, and hydrology to address challenges related to settlement, bearing capacity, and failure mechanisms..

Foundations and earth structures form the interface between engineered systems and the natural ground. As such, their proper design and assessment are essential for the integrity of buildings, infrastructure, and environmental protection works.

General Objectives

- Understand fundamental principles of soil mechanics and their application to foundation and earth structure design.
- Analyze slope stability using common calculation methods (Fellenius, Bishop).
- Evaluate different foundation types for various soil conditions.
- Apply earth pressure theories to retaining structure design.
- Assess geotechnical risks in construction projects.