ENTERPRISES
University of Pretoria



Introduction to Critical State Soil Mechanics

Presented by the Department of Civil Engineering, University of Pretoria

The aim of the **Introduction to Critical State Soil Mechanics** course is to provide practicing engineers with a sound understanding of critical state soil mechanics and its application in geotechnical engineering. The theory of consolidation and shear behaviour of soil can be unified within the framework of critical state soil mechanics. Important aspects such as stress invariants and stress paths will be revised before developing the concept of a state boundary surface and its application to describe the behaviour of normally and over-consolidated soil. Themes that will be covered include the critical state line, Roscoe surface, Hvorslev surface, drained and undrained planes and elastic walls. Critical state soil mechanics also provides a framework for the development of plasticity models for soils, often applied in finite element analysis. Concepts such as a yield surface, hardening law and flow rule will be introduced before presenting the Cam Clay model.

An overview of Finite Element (FE) analysis will be presented with special reference to the unique challenges of FE analysis in geotechnical engineering. Continuum mechanics will be introduced in terms of the relevant constitutive models to develop a set of equations in matrix form that satisfies compatibility of stresses and strains. Special properties of the three phase material, soil, in a continuum will be discussed. The introduction of Critical State models and associated challenges will be discussed. Lastly, Drucker's stability postulate and special implications and pitfalls regarding FE analysis will be discussed. Practical guidance will be given on the preparation of an analysis by applying the pre-processor of a specific FE code and evaluation of the outcome using the post-processor of the code.

Postgraduates students registered for the Honours Degree in Geotechnical Engineering are required to attend the course and pass the examination for Theoretical Soil Mechanics SGS 788. There is no formal evaluation of other course attendees.

NEXT PAGE

Introduction to Critical State Soil Mechanics

Presented by the Department of Civil Engineering, University of Pretoria

Course content

- Stresses and strains in soil. Stress invariants and strain invariants.
- Stress paths.
- Compression and shear behaviour of soils.
- The Roscoe and Hvorslev surfaces.
- The Critical State concept.
- The behaviour of sands and development of a flow rule.
- Introduction to plasticity theory, the Cam Clay model.
- Continuum mechanics, constitutive models, compatibility of stresses and strains and development of matrix that satisfies these constraints.
- Implications of applying soil mechanics principles such as effective stress and stiffness to FE analysis.
- Biot coupling and Terzaghi-Rendulic consolidation.
- Drucker's stability postulate.
- Implementing FE code in geotechnical engineering.

Learning outcomes

After successfully completing this course, you should

- have a thorough understanding of the critical state concept and its application in geotechnical engineering, including an understanding of:
- stress invariants, stress paths and the state boundary surface
- plasticity theory and the Cam Clay model, and
- understand the unique implications and difficulties of applying soil mechanic principles in a finite element analysis.
- be able to plot stress paths for drained and undrained loading of soil and calculate the deviatoric stress, mean effective stress, void ratio and pore pressure at failure
- be able to use plasticity theory to calculate elastic and plastic strains of soil during shear
- be able to carry out a finite element analysis in the context of soil mechanics and geotechnical engineering, and
- be able to model the input and judge the output of a specific FE code.

Who should enrol?

This course is required if you are a postgraduate student studying towards your Honours Degree in Geotechnical Engineering at the University of Pretoria. In addition, the course is aimed at civil engineering and engineering geology graduates who have completed undergraduate courses in soil mechanics, as well as senior engineers interested in improving their knowledge of Theoretical Soil Mechanics.

Course fees

R7 500.00 per delegate (VAT incl.)
Course fees include all course material, refreshments and meals.

Course fees must be paid in full 14 days prior to course start dates. Proof of payment can be submitted to enrolments@enterprises.up.ac.za.

Admission requirements

Prospective delegates should ideally hold a degree in civil engineering or engineering geology. An undergraduate knowledge of soil mechanics is required.

Accreditation and certification

Enterprises University of Pretoria (Pty) Ltd is wholly owned by the University of Pretoria. As a public higher education institution, the University of Pretoria functions in accordance to the Higher Education Act 101 of 1997. Enterprises University of Pretoria offers short courses on behalf of the University and these short courses are not credit-bearing, and do not lead to formal qualifications on the National Qualifications Framework (NQF) – unless stated otherwise. Delegates who successfully complete a short course and comply with the related assessment criteria (where applicable) are awarded certificates of successful completion and/or attendance by the University of Pretoria.

This course is currently in the process of ECSA accreditation.

Registration and enquiries

Course coordinator
Nocwaka Combo
Tel: +27 (0)12 434 2690
Email: nocwaka.combo@enterprises.up.ac.za

Course presenters
Prof Gerhard Heymann and Prof Eben Rust
Department of Civil Engineering

PLEASE TURN OVER FOR THE COURSE PROGRAMME

ENTERPRISES
University of Pretoria

Introduction to Critical State Soil Mechanics

Presented by the Department of Civil Engineering, University of Pretoria

Course programme

Day 1: Monday, 22 January 2018

08:00–10:00	Introduction Mohr circles and stress invariants Stress paths The octahedral plane and triaxial stress space
10:00–10:30	Coffee/Tea break
10:30–12:30	Ideal elastic soil Uncoupled elastic constitutive model Compression of soil Behaviour of soil during shear
12:30–13:30	Lunch
13:30–16:00	The critical state concept The Roscoe surface The Hvorslev surface

Day 2: Tuesday, 23 January 2018

08:00–10:00	The behaviour of sand Dilation and the development of a flow rule
10:00–10:30	Coffee/Tea break
10:30–12:30	The Cam Clay model Calculation of elastic and plastic strains
12:30–13:30	Lunch
13:30–15:30	Continuum mechanics, constitutive models, compatibility of stresses and strains and development of a matrix that satisfies these constraints
15:30–16:00	Coffee/Tea break
16:00–17:00	Implications of applying soil mechanics principles such as effective stress and stiffness to FE analysis

Day 3: Wednesday, 24 January 2018

08:00–10:00	Biot coupling and Terzaghi-Rendulic consolidation
10:00–10:30	Coffee/Tea Break
10:30–12:30	Drucker's stability postulate
12:30–13:30	Lunch
13:30–16:30	Implementing FE code in geotechnical engineering

Shifting knowledge to insight

www.enterprises.up.ac.za

+27 (0)12 434 2500 +27 (0)12 434 2505 info@enterprises.up.ac.za Private Bag X41, Hatfield, 0028

For quotations on in-house training, email **quote@enterprises.up.ac.za**