



## Introduction to Critical State Soil Mechanics

Presented by the Department of Civil Engineering, University of Pretoria

6 -7 February 2023

2 ECSA CPD Points

The aim of the **Theoretical Soil Mechanics** short course is to provide practicing engineers with a sound understanding of critical state soil mechanics. 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. Concepts such as a yield surface, hardening law and flow rule will be introduced before presenting the Cam Clay and NorSand models.

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.

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## 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 and NorSand models.

## 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 and NorSand models,
- 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.

## 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

**R6500.00 per delegate (VAT incl.) for in-person attendance.**

Course fees include all course material, refreshments and meals.

**R3250.00 per delegate (VAT incl.) for online attendance.**

**R1 625.00 per delegate for online attendance by attendees from Lower-Middle income and Low-Income economies only**

(<https://datahelpdesk.worldbank.org/knowledgebase/articles/906519>)

**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](mailto: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 ECSA and SACNASP accredited.

## Registration and enquiries

### Client Information Centre

Tel: +27 (0)12 434 2500  
Fax: +27 (0)12 434 2505  
Email: [info@enterprises.up.ac.za](mailto:info@enterprises.up.ac.za)

### Course presenters

Prof Gerhard Heymann and Prof Eben Rust  
Department of Civil Engineering

PLEASE TURN OVER FOR THE COURSE PROGRAMME 

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## Course programme

### Day 1

- 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

- 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
- 13:30–16:00 Modified Cam Clay  
Stress-dilatancy  
Nor-Sand Model

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