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Risk and Reliability Analysis in Geotechnical Engineering

Presented by the Department of Civil Engineering, University of Pretoria

17 February 2023 **1 ECSA CPD Point**

The Reliability Methods in Geotechnical Engineering course comprises part of the taught component of a postgraduate subject, Analytical Soil Mechanics SGS 787, taught as part of the Honours Degree in Geotechnical Engineering at the University of Pretoria.

Analysis techniques used in geotechnical engineering typically estimate the collapse load or the factor of safety applicable to a boundary value problem. However, the magnitude of the collapse load or the factor of safety does not provide information on the probability of failure. It is often the probability of failure, more so than the actual factor of safety, that is important for engineers and their clients. In this course a number of techniques are introduced for the calculation of the probability of failure. A working knowledge of basic statistical principles is assumed, but important concepts will be briefly reviewed.

Postgraduates students registered for the Honours Degree in Geotechnical Engineering are required to attend the course and pass the examination for Analytical Soil Mechanics SGS 787. There is no formal evaluation of other course attendees.

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Course content

- An overview of basic statistical principles and reliability relevant to the course
- The Point Estimate Method
- Monte Carlo Analysis
- FORM optimisation technique for reliability analysis

Learning outcomes

After successfully completing this course, you should

Have a basic understanding of the statistical principles of reliability including

- an ability to plot probability density functions from data
- knowledge and understanding of the normal, log-normal, uniform and exponential distributions
- an ability to determine probabilities from abovementioned distributions
- understanding of the importance of correlation
- understanding of the principle behind a performance function
- ability to determine probabilities of failure from normally distributed capacity and demand functions
- understanding of the concept of a reliability index and how it relates to the probability of failure

Have an understanding and be able to apply the Point Estimate Method, including

- understanding how moments represent the properties of a statistical distribution
- understanding how a probability distribution can be represented by a system of point estimates
- determination of moments (and hence expected values, variances and probabilities) from point estimates
- application of the PEM to problems of one, two and three and multiple random variables

Have an understanding and be able to apply the Monte Carlo Analysis Method, including

- generation of sets of random numbers with specified statistical distributions and correlations
- implementation of the technique in a spreadsheet or computer program
- determination of the required number of analysis steps to obtain a convergent solution

Have a basic understanding and be able to apply the FORM optimisation technique for the determination of reliability, including

- understanding how the probability density of a performance function can be represented in multi-variate space
- expression of the reliability index for multi-variate problems using the Hasofer-Lind method
- implementation of the FORM technique in a spreadsheet and applying the solver function to solve practical multi-variate reliability problems

Who should enrol?

This course is ideal for you if you are

- an Honours student in Geotechnical Engineering (civil engineers and engineering geologists)
- a civil engineering and engineering geology practitioner who has completed undergraduate courses in soil mechanics, with some knowledge of statistics and you would like to expand your knowledge
- an engineer and engineering geologist from industry who wishes to expand their background in reliability analyses, and
- an engineer who does not necessarily satisfy the academic requirements to be admitted to the Honours Degree program.

Course fees

R5000.00 per delegate (VAT incl.) for in-person attendance. Course fees include all course material, refreshments and meals.

R2500.00 per delegate (VAT incl.) for online attendance.

R1250.00 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.

Admission requirements

Prospective delegates should ideally hold a degree in civil engineering or engineering geology. Undergraduate knowledge of soil mechanics and statistics is recommended.

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

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Email: info@enterprises.up.ac.za

Course presenter
Prof SW Jacobsz
Department of Civil Engineering

PLEASE TURN OVER FOR THE PROGRAMME

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Course programme

08:00–10:00 Overview of basic statistical principles and reliability

- Plotting probability density functions from data
- The normal, log-normal, uniform and exponential distributions
- Determination of probabilities from distributions
- The importance of correlation
- Introducing performance functions
- Probabilities of failure from normally distributed capacity and demand functions
- The concept of the reliability index and the relationship with to the probability of failure

10:00–10:30 Coffee/Tea Break

10:30–12:30 The point estimate methods

- The representation of the properties of a statistical distribution using moments
- The representation of a probability distribution with a system of point estimates
- Determination of moments (and hence expected values, variances and probabilities) from point estimates
- Application of the PEM to problems of one, two and three and multiple random variables

12:30–13:30 Lunch

13:30–14:30 Monte Carlo Analysis

- Introduction to the method
- Generation of sets of random numbers with specified statistical distributions and correlations
- Implementation of the technique in a spreadsheet or computer programme
- Determination of the required number of analysis steps

14:30–15:00 Coffee/Tea Break

15:00–17:00 FORM optimisation technique for reliability analysis

- Representing the probability density of a performance function in multi-variate space
- Expression of the reliability index for multi-variate problems using the Hasofer-Lind method
- Implementation of the FORM technique in a spreadsheet and applying the solver function to solve practical multi-variate reliability problems