

# Constitutive Modelling in Practical Geotechnical Analysis

## Overview

This course brings together fundamental concepts, recent developments as well as some of the Singapore experience in the use of constitutive models in practical geotechnical analysis especially in underground construction works. Since 1989, finite element analysis has been used in Singapore to assess ground movement in underground construction. This has led to a proliferation in the use of numerical modelling in underground construction. At present, virtually every deep basement and tunnelling project in Singapore must be accompanied by numerical analysis. Finite element and constitutive modelling in a practical engineering setting is very different from that in a research setting. In the latter, the user typically develops his own constitutive model or use a highly sophisticated model with custom-measured parameters. This degree of sophistication is often unavailable in practice where the pressure of time and money means that standard models, such as Mohr-Coulomb, are used with parameters measured in standard laboratory and field tests. This is ironical since the consequences of modelling errors may be more serious in practical engineering than in research. The collapse of the Nicoll Highway in 2004 was a watershed event in the history of geotechnical construction in Singapore. It brought into focus the dangers of using sophisticated numerical software without in-depth understanding. Since then, there has been much greater emphasis on the engineer's understanding of soil behaviour and its modelling, both in the examination of professional engineers as well as post-graduate and continuing education. The objective of this course is to familiarize engineers using finite element and numerical software with the concepts and behaviours of commonly used constitutive models, with reference to the constitutive behaviour of soils, so that users acquire a clear understanding of the strengths and weaknesses of these models and use them in a knowledgeable and competent fashion. The topics to be covered include:

- Elasticity and effective stress principle in FE analysis.
- An overview on the basic concepts of plasticity, with emphasis on Mohr-Coulomb, including methods of compensating for shear strength over-estimation by Mohr-coulomb, stress path, flow rule and angle of dilation.
- Advanced soil models such as work-hardening plasticity and cap models (e.g. Cam Clay, soft soil model, hardening soil model etc.) and their advantages over Mohr-Coulomb.
- The stiffness issue: non-linear stiffness and what modulus to use e.g.  $E_0$ ,  $E_{50}$ .
- Modelling of natural and structured soils, including material characteristics and possible modelling strategies.
- Ground improvement and current approaches to modelling cement-improved ground in Singapore.

This course is being conducted as part of Continuing Education Programme (CEP), IIT Bombay ([www.cep.iitb.ac.in](http://www.cep.iitb.ac.in)).

<b>Course Dates</b>	<b>June 06 to 16, 2016</b>
<b>Host Institute</b>	<b>IIT Bombay</b>
<b>No. of Participants</b>	<b>50 (maximum)</b>
<b>You Should Attend If...</b>	<ul style="list-style-type: none"><li>▪ You are a geotechnical engineer or research scientist interested in geotechnical analysis of critical structures including foundations of high-rise buildings, tunnels and underground openings.</li><li>▪ You are a student or faculty from academic institution interested in pursuing research on soil behaviour and its modelling.</li></ul>
<b>Course Registration Fees</b>	<p>The participation fees for taking the course is as follows: Student Participants: Rs. 3,500/- Faculty Participants: Rs. 12,500/- Government Organisations: Rs. 17,500/- Industry Participants: Rs. 22,500/-</p> <p>The above fee is towards participation in the course, course material, computer use for tutorials and assignments, and laboratory equipment usage charges. Mode of payment: Demand draft in favour of "Registrar, IIT Bombay" payable at Mumbai.</p>
<b>Accommodation</b>	The participants will be provided with hostel accommodation on payment basis. Request for hostel accommodation may please be submitted at the time of registration.

# The Faculty

## Prof. Lee Fook Hou....

Dr. Fook-Hou Lee is a faculty member at the National University of Singapore (NUS). He developed and commissioned the NUS Geotechnical Centrifuge, which is the only geotechnical centrifuge in Southeast Asia. He has a strong interest in soil improvement, especially in the modelling of soil improvement processes and the characterisation of improved soil behaviour, as well as underground construction in urban areas. Dr. Lee is a registered Professional Engineer (Civil) as well as Professional Engineer and has consulted for more than 70 projects. He has published more than 100 papers, about 60 of which are in peer-reviewed journals. Dr. Lee has supervised and graduated more than 40 PhD students and Master of Engineering students. He has served as reviewer for all of the top journals in geotechnical engineering and received the Top 12 Reviewers award from Computers and Geotechnics in 2009, 2013 and 2014. He is currently an editorial board member for the ASTM's Geotechnical Testing Journal, Computers and Geotechnics and the Chinese Journal of Geotechnical Engineering. He is also the Managing Editor of Journal of Earthquake and Tsunami. Between 2005 and now, Dr Lee has been PI of 7 external research grants totally roughly \$11million.

## Dr. Subhadeep Banerjee....

Dr. Subhadeep Banerjee is Assistant Professor of Geotechnical Engineering of the Department of Civil Engineering at Indian Institute of Technology, Madras. He received his PhD in Civil Engineering from National University of Singapore. His research interests include cyclic behaviour of geomaterials, seismic soil-structure interactions, and finite element analysis of complex dynamic problems. Besides he is also an expert in constitutive modelling of soils special emphasis to the transient dynamic behaviour. At IIT Madras, he has formed three research groups, comprising a total of 6 PhD students, 1 MS by research student and 5 MTech students, to study the following attributes, (i) Cyclic characterization of various types natural soils, improved ground, landfills etc., (ii) Development of constitutive models of soils emphasizing on their performance under seismic loadings, and (iii) Application of fundamentals of dynamics to various complex soil-structure problems such as, tunnelling, base isolation techniques, plate anchors, retaining walls etc.

## Dr. Ashish Juneja....

Dr. Ashish Juneja is an Associate Professor at Indian Institute of Technology Bombay. He earned his doctorate from NUS, Singapore (2002), Master degree from IIT Delhi (1996) and Bachelor degree from University of Roorkee 1993 (now IIT Roorkee). Dr. Juneja worked intermittently in the industry for over 6 years in India and the UK, before returning to the academia in 2005. His research interests are in dynamic soil behaviour, numerical and physical modelling of underground structures and ground improvement works. He has published over 40 journal and conference publications and two book chapters. He has received research grant from DST, MoES, DRDO, Railways and a number of private organisations. He also serves as a consultant to Konkan Railways, Tehri Hydro Development Corporation, Samsung Engineering, Jan De Nul and John Deer. He is also a Reviewer for many International Journals. Dr. Juneja's teaching performance has consistently been evaluated as one of the best. Some of his popular courses have been transmitted live through ISRO's satellite to remote centres and other engineering colleges across India.



## Course Co-ordinator

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