Mechanics and Constitutive Modelling of Geomaterials - CE6350

Spring (Jan-May) 2024
Credits: L-3, T-1, O-6 - Total 10 credits

Instructor: Ramesh Kannan K and Robinson R G
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Slot: G (Mon-12 Hrs, Wed-17 Hrs, Thu-10 Hrs, Fri-9 Hrs)
Place: BSB

Course Objective:

1. Introduce the fundamental concepts on the mechanics of geomaterials through experimental evidences and critical state framework
2. Explain the basic tenants of elasticity and plasticity to model the continuum behaviour of geomaterials
3. Derive the classical critical state based continuum models (Cam clay models) and show the implementation of the models to predict the material response

Course Outline:

1. Revisiting fundamental tenets of soil behaviour
2. Elemental testing of geomaterials
3. Compression of soils
   - Behaviour of OC and NC soils
   - State boundary surfaces
4. Stress path and invariants
5. Critical state concepts, Roscoe and Hvorslev surface
6. Brief introduction to continuum mechanics
   - Vector calculus and indicial notation
   - Tensors
   - Kinetics and Kinematics
7. Linear and non-linear elasticity
   - Isotropic linear elastic stress-strain relations
   - Hyperbolic non-linear model
8. Constitutive laws (classical plasticity)
   - Yield function - (Tresca, Von-Mises, Mohr-Coulomb model and others)
   - Flow rule and plastic potential
   - Hardening law
   - Associated and non-associated plasticity
9. Ordinary Cam clay and Modified Cam clay models
10. Introduction to hypoplasticity and anisotropic critical state theory

Main References: The following are a restricted list of various interesting and useful books. Class notes and the books mentioned below will help you gain confidence in this course.

- Wood, D. M. (1990). *Soil behaviour and critical state soil mechanics.* Cambridge university press.
- Wood, D. M. (2014). *Geotechnical modelling.* CRC press.
- Atkinson, J. H. and Bransby, P. L. (1982). *The Mechanics of Soils- An Introduction to Critical State Soil Mechanics*, McGraw-Hill Book Company Limited, London
- Davis, R. O., and Selvadurai, A. P. (2005). *Plasticity and geomechanics.* Cambridge university press.

Additional References:

- Schofield, A. N. (2005). *Disturbed soil properties and geotechnical design.* Thomas Telford.
- Pietruszczak, S. (2010). *Fundamentals of plasticity in geomechanics.* Boca Raton, FL: Crc Press.
- Chen, W.F. and Han, D. J. (2007). *Plasticity for Structural Engineers* . J. Ross Publishing.
- Puzrin, A. (2012). *Constitutive modelling in geomechanics: introduction.* Springer Science.
- Borja, R. I. (2013). *Plasticity.* (Vol. 2, p. 1). Berlin: Springer.

Course Outcome: This course is primarily designed for graduate students. The course offers fundamental understanding of concepts used to model geo-materials. At the end of the course, students will be aware of various tenets of classical continuum models and how critical state soil mechanics framework acts as a basis for developing many advanced constitutive models.

Prerequisites: An undergraduate-level understanding of mechanics of materials and advanced geotechnical engineering is assumed.

Grading Policy: Home assignments/ term paper (30%), Quiz/ Questionnaire (30%), Final exam (40%).

Course Policy:

- Please sign up for Moodle at IITM. We will confirm your enrolment for the course, then you will be able to see the course page.

Term paper: Please submit before April 15:

- Bolton, M.D., 1986. Strength and dilatancy of sands. Geotechnique, 36(1), pp.65-78.
- Rowe, P.W., 1962. The stress-dilatancy relation for static equilibrium of an assembly of particles in contact. Proceedings of the Royal Society of London. Series A. Mathematical and Physical Sciences, 269(1339), pp.500-527.

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