

Indian Institute of Technology Kanpur
Department of Civil Engineering
Proposal for a New Course

Course No.	CE73X
Title	Design and Analysis of Underground Excavations
Credits	3-0-0-0 [9]
Semester	I or II
Instructor	Dr. Gaurav Tiwari
Other faculty members interested in teaching the course	Dr. JP Sahoo, Dr. Arghya Das
Department	Civil Engineering (CE)
Departments to which the proposed course could be of interest	CE
Pre-requisites	Soil mechanics, Rock mechanics
Estimated Student Enrolment	50

Background: Underground excavations are frequently constructed structures in soil, along intact rocks and rock masses. The analysis and design of underground excavations are quite challenging depending on the soil and rock conditions. This requires the subject to be extensively studied.

Objectives: The students would learn the analysis of underground structures in rocks and soil of different qualities considering the elastic and elastoplastic stress-strain behaviour of geomaterials. The implementation of different design methods, including empirical, analytical and numerical approaches, would be covered in this course. Further, the use of codes and standards in the design of underground structures and the practical aspects of tunnelling including instrumentation and support design will be covered.

Course Contents (number of lectures in brackets):

Introduction: Review of soil and rock mechanics concepts, types and classification of underground openings, planning and exploration for various underground projects, functional aspects, size and shapes, support systems, codal provisions. [6]

Elastic stress distribution around tunnels: Stress distribution for different shapes and under different in-situ stress conditions, Greenspan method, design principles, multiple openings, openings in laminated rocks, Daemen's theory. [5]

Surface settlement analysis: Settlement effects of bored tunnels in soft soil, volume loss analysis, Transverse and Longitudinal settlement, Gaussian curve analysis. [5]

Rock mass-tunnel support interaction analysis: Ground response and support reaction curves, design of support systems including concrete and shotcrete linings, steel sets, rock

bolting and rock anchoring, combined support systems, design of TBM segment lining, Muir-Wood method. [8]

Empirical and observational methods: Analysis and support design based on RSR, RMR, Q systems, New Austrian Tunnelling Method (NATM), Norwegian Tunnelling Method (NTM) [6]

Structurally Controlled Failures: Stereographic projection method, principle and its application in underground excavation design, wedge failure and key block analysis. [5]

Special Topics: Deep excavations, concepts of CWFS, DISL criteria, implementation in softwares, stability of excavation face and tunnel portals, instrumentation [5]

References:

1. Hoek, E., Brown, E. Underground excavations in rock, CRC Press, 1980.
2. Leonard Obert, Wilbur I. Duvall, Rock mechanics and the design of structures in rock, Wiley, 1967.
3. Poulos, H.G. and Davis, E.H., Elastic solutions for soil and rock mechanics. John Wiley & Sons, 1974.
4. Bieniawski, Z.T. Rock mechanics in mining & tunnelling. A.A. Balkema, 1984.
5. Szechy, K. The art of tunnelling, Akadémiai Kiadó, 1973.
6. Goodman, R.E. Introduction to Rock Mechanics. John Wiley, 1980.
7. Ramamurthy, T. Engineering in Rocks, PHI Learning, 2008.
8. Guglielmetti et al. Mechanized tunnelling in urban areas”, Taylor and Francis, London, UK, 2007.

Proposer: Dr. Gaurav Tiwari: July 23, 2024

Convener DPGC (CE):

Chairman, SPGC