

Course Code	Course Title	L	T	P	C
20SE022	DESIGN OF UNDERGROUND WATER STRUCTURES	3	0	0	3

PRE-REQUISITE COURSES: PRESTRESSED CONCRETE

COURSE OBJECTIVES:

The main objective of this course is to learn the designs of underground water structures. Familiarize students with types & classification of underground openings, methodology & codal provisions. Understand the material properties, deformation analysis using analytical & numerical methods. To carry out the complete design of hydraulic tunnels & shafts. To study about the design based wedge & key block theory. Student must be able to design underground water tanks & retaining walls.

Course Outcomes:

At the end of the course student will be able to

CO's	Course Outcomes	PO's
1	To understand the design methodology & codal provisions for underground structures.	1, 2
2	Understand the stress deformation analysis.	2
3	Design of hydraulic tunnels & shafts.	3
4	To understand the design based wedge & key block theory.	2, 3
5	Design underground water tanks & retaining walls.	3

SKILLS:

- ✓ Material Properties & Stress deformation analysis using analytical & numerical methods.
- ✓ Design of hydraulic tunnels & shafts.
- ✓ Design of underground water tanks & retaining walls.

UNIT – I:

INTRODUCTION - Types and classification of underground openings, Factors affecting design, Design methodology, Functional aspects, Size and shapes, Support systems. Codal provisions.

UNIT – II:

MODELLING & ANALYSIS OF UNDER GROUND STRUCTURES: Material Properties & Stresses- deformation analysis of openings - circular, elliptical, spherical, ellipsoidal and galleries with composite lining due to internal pressure, closed form solutions, BEM, FEM. Analysis of Tunnels & shafts using analytical and numerical methods.

UNIT – III:

DESIGN OF UNDER GROUND STRUCTURES: Design of underground structures using analytical methods, empirical methods based on RSR, RMR, Q systems. Design based on rock support interaction analysis. Observational method NATM, Convergence-confinement method. NATM Hydraulic tunnels, Shafts, Tunnel portals, Metro tunnels.

UNIT – IV:

DESIGN BASED ON WEDGE & KEY BLOCK THEORY: Design based on Wedge failure and key block analysis. Design of Shafts and hydraulic tunnels. Stability of excavation face and Tunnel portals. Use of appropriate software packages.

UNIT – V:

CASE STUDIES: Case Studies using design of underground water tanks – Circular & Rectangular. Analysis & Design of retaining walls, Counterfort retaining walls. Retrofitting of underground Structures.

TEXT BOOKS:

1. R. S. Sinha, “Underground Structures: Design & Construction”, Elsevier Science, 2nd December, 2012.
2. Rajendra Patel, “Concrete for Underground Structures”, Scitus Publisher, January, 2017.

REFERENCE BOOKS:

1. Cui, Z.-D., Zhang, Z.-L., Yuan, L., Zhan, Z.-X., Zhang, W.-K, “Design of Underground Structures”.
2. Punmia, B.C., Ashok Kumar Jain, “Design of reinforced concrete structures”. Code of practice for liquid retaining structures, IS 3370 – 2009.