Design, Construction, Maintenance and Operation of Tunnels

Time Period	Description of Topic
1st Day	
09.45 – 11:15	**General Requirement for Tunnelling Project** ➢ Techno-Economic Feasibility of Tunnels ➢ Classification of Road Tunnels based on Location, Shape, Construction Method, Length and Side Coverage ➢ Purpose of Tunnel& Traffic Characteristics ➢ General Requirements of Tunnel Projects ➢ Special Contractual clauses required for tunnels ➢ Specifications related to Tunnels (IRC,IS, BIS, CIE, PIARC, NFPA) ➢ MEP Parameters
11:30 - 13.00 & 14:00:15:30	**Planning & Geometrics Design of Road Tunnels** ➢ Conceptual Planning ➢ Requirements for Alignment ➢ Remote Sensing Applications for fixing Alignment ➢ Selection of Portal Location ➢ Selection of Tunnelling Method ➢ Environmental & Socioeconomic Impact Analysis ➢ Tunnel Geometry-Width, Height, Shape, Uni-directional/Bi-directional Cross Passage Between Two Tubes ➢ Statuary Clearances
15:45 - 17.15	**Geological, Geophysical and Geotechnical Investigations** ➢ Detailed Surface Geology Mapping ➢ Geophysical & Geological investigations ➢ Exploratory Boring and Tests on Core Samples ➢ Directional Drilling Techniques ➢ Hydrological, Drainage & Metrological data collection/investigations
2nd Day	
09.45 – 13:00	**Tunnel Specific Modification in MCA for Mode of Execution (BOT, HAM, EPC, BOQ etc.)** ➢ Basics of Contract Management in Tunnels ➢ Addressing Time & Cost impact ➢ Risk sharing strategy (in terms of statutory requirements & technical requirements) ➢ Principle of environmental considerations in contract ➢ Additional force majeure due to geological system ➢ Clauses pertaining to emergency response system ➢ Insurance clauses ➢ Clauses for monitoring and reporting ➢ Specifying machinery type and requirement ➢ Safety management ➢ Schedules for payments (G/H)
14.00-17:15	**Structural Design** ➢ Rock Mass Rating ➢ Rock Mass Quality ➢ Design of Tunnel Supports- Empirical, Analytical and Numerical Methods ➢ Tunnel Lining ➢ Case Studies and Examples
3rd Day	
09.45 – 13.00	**Tunnel Construction and Selection of Construction Equipment and Machineries** ➢ Types of Tunnel Construction

	○ Cut and Cover Tunnels ○ Drill & Blast method ○ Tunnel Boring Machines ○ Box Push ○ Boring without blast ➢ Surveying and Profile Marking ➢ Portals Construction ➢ Advancement of Tunnel Face by Excavation-No Blast Techniques, Conventional Technique of Drilling and Blasting ➢ Blasting pattern & Requirements ➢ Muck Disposal Management ➢ Alternatives of Support System ➢ Installation of Temporary and Permanent Support ➢ Tunnel Lighting, Ventilation & Drainage System during construction ➢ Methods of Tunneling ○ Immersed Tunnel ➢ Precaution of Tunneling in Urban Areas ➢ Prob Drilling
14.00-17.15	**Tunnel Construction and selection of Construction Equipment and Machineries (Contd..)** ➢ Selection of Construction Equipments & machineries ➢ Drilling Tools ➢ Cycle time analysis ➢ Typical situations & mitigation plan ➢ Quality Assurance ➢ Advancement in tunnel construction
4th Day	
09:45 – 11:15	**Geological Face Mapping & Determination of Support Requirement during Daily Construction** ➢ Geological surprises/features in tunnelling ➢ favourable/unfavourable dips/joints etc ➢ Daily assessment of rock parameters/Face mapping ➢ Over break a reality or controlable ➢ Quality tests ➢ Determination of support system ➢ Practical examples
11:30- 13:00	**Tunnel Monitoring, Safety during Construction and Operation** ➢ Requirements ➢ Various monitoring parameters ➢ Instrumentation ➢ Monitoring &Reporting ➢ Real time assessment & use of AI (warning system)
14:00-17:15	**Electro Mechanical Components (Ventilation, Fire Fighting & Electrical) Design** ➢ Type of ventilation system & advantages disadvantages ➢ Design parameters of ventilation& idea of CFD analysis ➢ Fire fighting needs, requirements, methods & system requirements ➢ Liner heat detection and fire alarm system ➢ Power requirements ➢ Electrical systems ➢ Tunnel lighting ➢ ELV system in tunnelling ➢ Emergency evacuation plan ➢ System Redundency
5th Day	
09:45-13:00	**Development of SCADA and Integration of Various Systems**

	➢ Communication systems ➢ Architecture of SACDA in tunnels ➢ Reliability factors ➢ System & control requirements ➢ Traffic Management System ➢ Air quality Monitoring and relevance ➢ Integration parameter (Ventilation, firefighting, TMS, Incident management, communication, power supply, lighting, entrance control system etc) ➢ Outputs & control systems ➢ Example of a system in tunnel in India/Abroad
14:00-17:15	**Operation, Maintenance & Upgradation of Tunnel** ➢ Operation maintenance management team ➢ System requirements for daily, routine, periodic maintenance ➢ Tunnel Parameter Monitoring ➢ Classical maintenance Schedule of contracts ➢ Safety drills ➢ Upgradation of equipment and SCADA system ➢ Ventilation, Communication &Fire fighting system maintenance
17.15 – 17:30	Feedback and Concluding of the Programme