

# *Introduction to Tunnel Design and Construction*

## **Purpose and Background**

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Tunnels are key elements of the nation's infrastructure. Mostly invisible and out of sight, they play a key role in urban transportation, water and sewerage transportation, and in hydro electric power and many other sectors.

The seminar will cover an introduction to all forms of tunneling in a coherent and systematic approach. Particular emphasis will be placed on the attendees understanding both the full range of tunneling techniques available and their applicability in various soils and physical constraints. The seminar will also emphasize understanding and mitigating the inevitable risks involved in tunneling. A comprehensive review will be provided of techniques for subsurface investigation and characterization for soft ground, hard rock tunneling, microtunneling and shaft construction and how this subsurface information is then used in both designing and specifying for tunnels and in the selection of an appropriate tunneling method and tunneling equipment.

The full range of tunneling methods currently available will be presented and discussed in detail including hand and simple mechanical excavation, NATM, various forms of soft ground and rock mechanical excavation, drill and blast tunneling, pipe and box jacking and microtunneling.

The course also includes the selection and installation of various tunnel lining methods, the selection and construction of various shafts for tunneling, and key aspects of tunnel design, specification, cost and construction management with particular emphasis on risk management and mitigation during the design and construction process. New trends in tunneling and innovative techniques will also be discussed.

The seminar includes numerous case studies and provides practical applications of the various techniques discussed, including three comprehensive case history group workshop sessions in soft ground, hard rock and microtunneling forms of tunneling, as well as the presentation of seven videos of various aspects of tunneling.



## Summary Outline

### DAY ONE

#### Introduction

- Seminar Overview
- Participants background
- Review of tunnel sizes and principal uses
- An explanation of trenchless techniques

#### Sub Surface Characterization for Soft Ground

- Geotechnical investigation for soft ground tunneling
- Soils classification of soils for tunneling

#### Tunnel Construction in Soft Ground

- A brief historical overview of soft ground tunneling
- Hand excavation and simple tunnel machines
- Excavator shields in competent ground
- NATM (New Austrian Tunneling Method)
- Soft Ground Slurry Tunneling
- Soft Ground Tunneling using EPB systems
- Other shield types for soft ground
- Compressed air tunneling

#### Tunnel Lining Selection and Design for Soft Ground

- Soft ground tunneling ground support system selection
- Two pass linings (Rib & Lag linings)
- One pass linings
- Segmental linings
- Jacked pipe linings

*Case History: Soft Ground Tunneling Group Workshop Session*

### DAY TWO

#### Sub Surface Characterization for Rock

- Geotechnical site investigation for rock tunneling
- Rock classification of rock mass for tunneling

#### Tunnel Construction in Rock

- A brief historical overview of rock tunneling
- Review of rock excavation methods
- Drill and Blast tunnels
- Road headers in competent ground
- Hard rock tunneling with TBMs
- Other techniques for hard rock tunneling
- Tunnel excavation performance evaluation

#### Tunnel Lining Selection and Design for Rock Tunnels

- Rock tunnel support system selection
- Supports to hard rock tunnels (rock bolting etc.)

#### Shaft Construction for Tunneling

- Review of all available techniques and their suitability
- Rib and lag and steel supports
- Sheet piles
- Jet grouting
- Caissons
- Slurry walls
- Ground freezing

*Case History: Hard rock tunneling Group Workshop Session*

### DAY THREE

#### Pipe Jacking and Microtunneling

- Pipe jacking capabilities, equipment and techniques
- Microtunneling capabilities, equipment and techniques
- Jacking pipe for pipe jacking/microtunneling
- Specialist techniques for microtunneling  
*Case histories Case History: Micro tunneling Group Workshop Session*

#### Potential Problems in Tunneling and Shaft Construction for Tunneling

- Ground improvement (grouting methods for ground improvement)
- Groundwater control
- Obstructions and mixed face tunneling
- Case histories

#### Tunnel Planning and Minimization of Risk

- Investigation and pre planning
- Method and equipment selection
- Performance envelopes for various tunnel methods (settlement/alignment noise etc.)
- Specification preparation for tunneling
- Contract document preparation for tunneling
- Risk mitigation and management techniques for tunneling
- Tunnel construction management, inspection, monitoring and control
- Tunnel and microtunnel cost influences and costs levels

#### Tunnel Management and Safety

- Tunnel design management and safety
- Tunnel and shaft operation safety
- QA/QC for tunneling

#### New Developments, Trends and Techniques

- Investigation techniques (prior to and during tunneling)
- Hard rock tunneling
- Soft ground tunneling
- Pipe jacking and microtunneling
- Pipe roofing techniques
- Jacked Boxes

A bibliography of suggested books, manuals and trade journal reading

## Seminar Benefits

- Select and specify suitable investigation techniques for tunneling
- Analyze ground conditions for tunneling
- Assist in making informed decisions regarding tunnel and tunnel shaft construction methods and tunnel lining selection
- Select and properly specify the most suitable equipment for tunneling
- Develop a better understanding of the application and use of microtunneling techniques
- Write better contract documents and specifications for tunneling
- Develop techniques to mitigate risk in tunneling due to anticipated and unanticipated tunneling problems
- Develop tunnel construction schedules more accurately
- Manage and monitor tunnel construction projects to improve productivity, quality, and safety
- Develop comprehensive monitoring plans for tunnel construction

## Who Should Attend?

- Construction and project managers
- Design and project engineers (both field and design office)
- Construction supervisory personnel
- Construction cost estimators
- Graduate geotechnical engineers
- Individuals in the construction industry, either wanting a better grounding in modern tunneling techniques and practices or an update on current technical and contractual tunnel management techniques

## Seminar Instructor

**Andy Robinson** has a B.Sc Civil Engineering degree from Aston University in Birmingham, UK and has over 30 years experience in the underground utility installation sector. His primary experience is in the fields of tunneling, underground space and trenchless technologies including tunneling, pipe jacking & microtunneling, Horizontal Directional Drilling, shaft works and jacked underground structures.

Andy specialises in underground design, construction management and Expert analysis and prior to entering the engineering services field had roles with both a tunneling contractor a tunneling plant manufacturer. His expertise covers all aspects of project development and support, from project evaluation and feasibility study through conceptual and detailed engineering design to equipment and materials selection, project construction and operations management, and dispute resolution. He has a strong practical understanding of geotechnical and geological conditions and their impact on the underground works and how they are constructed.

His international experience is extensive having worked on projects in Europe, SE and Far East Asia, North, South and Latin America, The Caribbean, the Middle East and Australasia. He has been at the forefront of developments and innovations in the trenchless technology, microtunneling and tunneling field and has been a team member on two projects that have previously been recipients of the Trenchless Technology "Project of the Year" award.

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**Email: [jwyrick@asce.org](mailto:jwyrick@asce.org)**

