EXCAVATION AND SUPPORT CATEGORIES OF NATM

Prepared by Zeynep ŞEKER

January, 2012
About Me

- Studied at Hacettepe University
- **First Summer Practice:** Turkish Coal Enterprises Garp Lignites Establishment
- **Second Summer Practice:** Koza Gold Operations Company
- **e-Mail:** zeynep_seker@live.com
- **Phone number:** 0 555 706 61 53
New Austrian Tunnelling Method
THE NEW AUSTRIAN TUNNELLING METHOD (NATM), AN ALTERNATIVE AND CHEAPER WAY FOR TUNNELLING
OUTLINE

- History of NATM
- Philosophy of NATM
- Design Elements of NATM
- Excavation and Support Categories of NATM
- Conclusion
History of NATM

• **NATM** was developed between 1957 and 1965 in **Austria**.

• The main contributors to the development of NATM were Ladislaus von **RABCEWICZ**, Leopold **MULLER** and Franz **PACHER**.
• The main idea is to use the geological stress of the surrounding rock mass to stabilize the tunnel itself!
Philosophy of NATM

“Design as you go!!”

“Not too stiff. Nor too flexible
Not too early, Nor too late”
Seven Important Features

1) Mobilization of the strength of rock mass
2) Shotcrete protection
3) Measurement
4) Primary Lining
5) Closing of Invert
6) Rock mass classification
7) Dynamic Design
Design Elements of NATM

1. Theoretical excavation line
2. Immediate support
3. Foundation
4. Lateral drainage pipe covered with porous concrete
5. Waterproofing system
6. Final unreinforced concrete lining
7. Main tunnel drain pipe covered with porous concrete
8. Sidewalks with/without utility conduit
9. Precast gutter curb
10. Road surface
11. Ventilation fans
Excavation and Support Categories in Rock

Description

Intact Rock:
- Spot bolting
- Occasional sealing shotcrete
- Full face or top heading/bench excavation
- Example: Bergen Tunnels, NJ

Cross Section

- SPOT BOLT
- SEALING SHOTCRETE
- OUTLINE OF ORIGINAL TUNNEL
Bergen Tunnel
Excavation and Support Categories in Rock

Description

**Stratified Rock:**
- Systematic rock doweling
- Systematic shotcrete initial lining
- Top heading excavation
- Bench excavation follows distant
- **Example:** Zederhaus, Austria

Cross Section

[Diagram showing stratified rock excavation with labels for top heading, bench, rock dowels, and shotcrete.]
Zederhaus Tunnel
Excavation and Support Categories in Rock

Description

**Fractured Rock:**
- Systematic rock doweling
- Systematic shotcrete initial lining
- Top heading excavation
- Bench excavation follows any time
- **Example:** Devil's Slide Tunnels, CA
Devil’s Slide Tunnel; CA
Excavation and Support Categories in Soft Ground

Description

**Soft Ground - shallow cover:**

- Systematic pre-support
- Systematic shotcrete initial lining support with early ring closure
- Top heading excavation (with temporary invert), bench and invert excavation
- **Example:** Fort Canning Tunnel, Singapore

Cross Section

![Cross Section Diagram](image)
Fort Canning Tunnel
Excavation and Support Categories in Soft Ground

Description

Soft Ground - deep level:

• Systematic shotcrete support with early ring closure
• Top heading excavation closely followed by bench/invert excavation
• **Example:** London Bridge Station, London, UK
Excavation and Support Categories in Soft Ground

Description

Soft Ground - deep level:

• Systematic shotcrete support with early ring closure
• Sub-division into sidewall drifts
• Top heading excavation closely followed by bench and invert excavation

Example: London Bridge Station, London, UK
London Bridge Station
Face recently opened sealed with Shotcrete
Application of Primary Lining Shotcrete
Lattice Girder
Fixing of Wire Mesh and Pipe
Roofing/Forepoling
Shotcreting with CIFA Robotic Arm
Rock Bolting In Progress with Rocket Boomer
NATM support tubes installation (single layer)
NATM SUPPORT TUBES INSTALLATION (DOUBLE LAYER)
Placement of Support System
Face Development
• One of the ultimate advantages of the NATM is that complex underground structures can be built without the use of open cut.

• This is a major consideration when planning the construction of metros or underground rail systems in urban areas.
Pir Panjal Tunnel
Conclusion

The success of execution of the NATM is based on three premises:

- thoughtful, skilful design
- skilled execution
- competent supervision and interpretation of observation results
THANK YOU!
Any Question? 😊