

# **EXCAVATION AND SUPPORT CATEGORIES OF NATM**

Prepared by Zeynep ŞEKER  
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# About Me

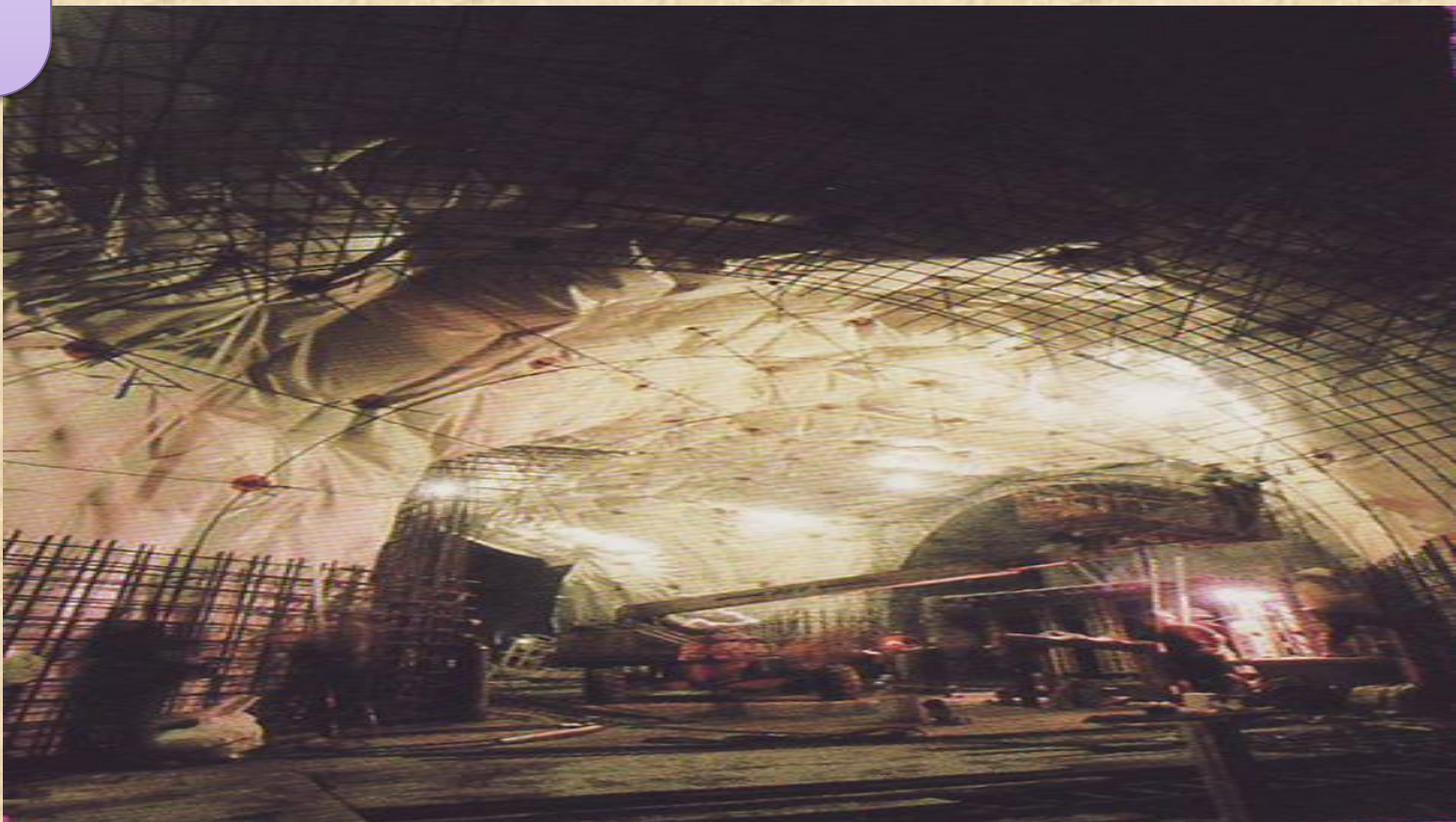
- Studied at Hacettepe University
- **First Summer Practice:** Turkish Coal Enterprises Garp Lignites Establishment
- **Second Summer Practice:** Koza Gold Operations Company
- **e-Mail:** zeynep\_seker@live.com
- **Phone number:** 0 555 706 61 53



**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**.



# MAIN IDEA!

- 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”



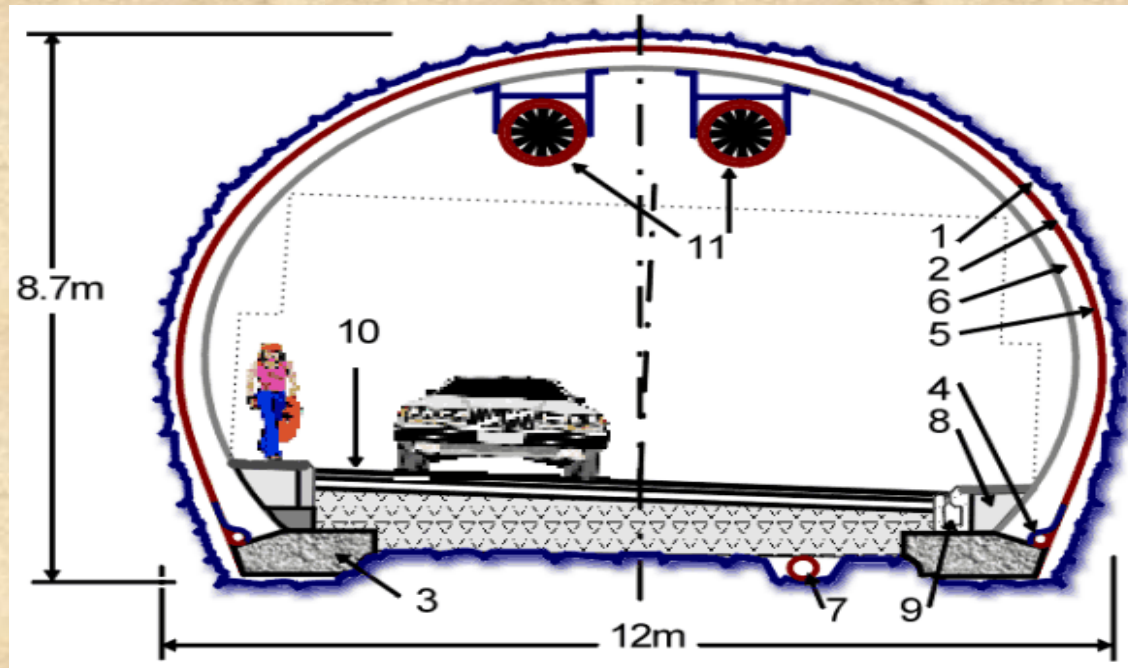


# Seven Important Features

- 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                        | 5. Waterproofing system                                | 8. Sidewalks with/without utility conduit |
| 2. Immediate support                                  | 6. Final unreinforced concrete lining                  | 9. Precast gutter curb                    |
| 3. Foundation   | 7. Main tunnel drain pipe covered with porous concrete | 10. Road surface                          |
| 4. Lateral drainage pipe covered with porous concrete |  | 11. Ventilation fans                      |



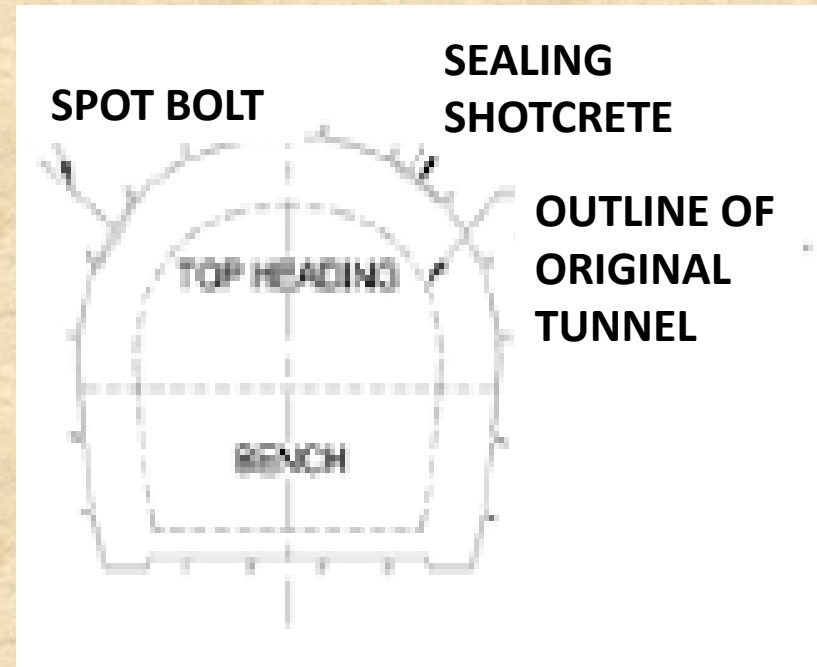
# Excavation and Support Categories in Rock

## Description

### Intact Rock:

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

## Cross Section



# Bergen Tunnel



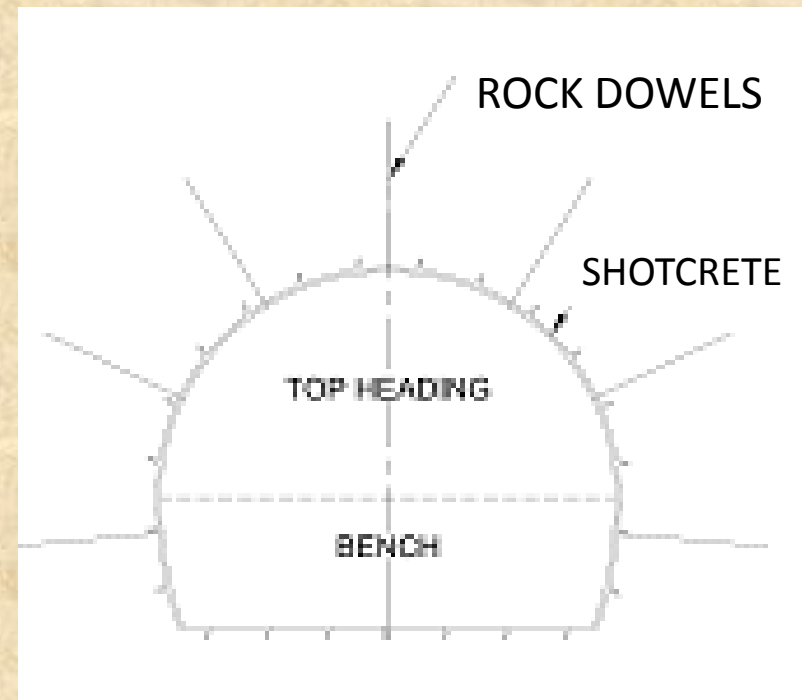
# Excavation and Support Categories in Rock

## Description

### Stratified Rock:

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

## Cross Section



# Zederhaus Tunnel



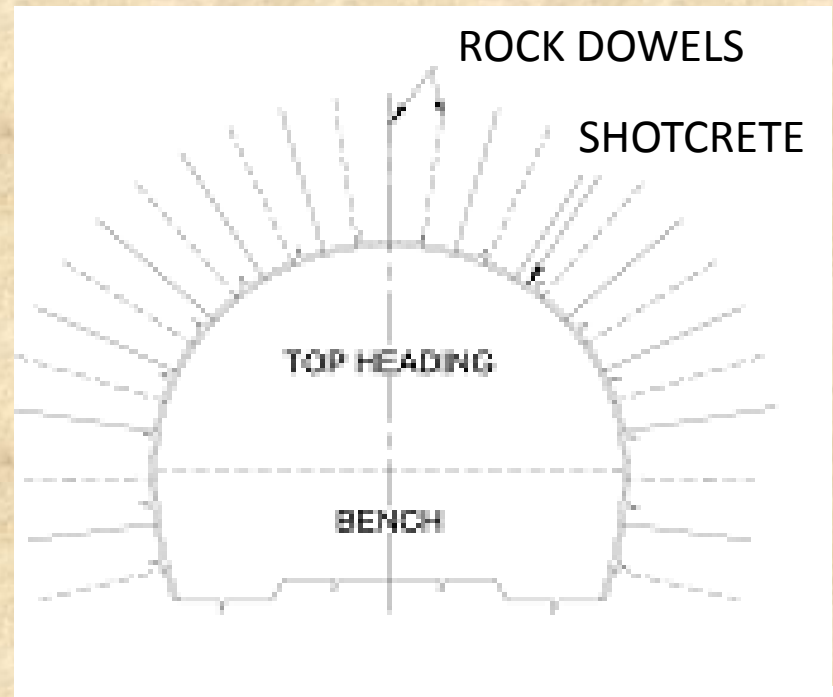
# Excavation and Support Categories in Rock

## Description

### Fractured Rock:

- Systematic rock doweling
- Systematic shotcrete initial lining
- Top heading excavation
- Bench excavation follows any time
- **Example:** Devil's Slide Tunnels, CA

## Cross Section



# Devil's Slide Tunnel;CA





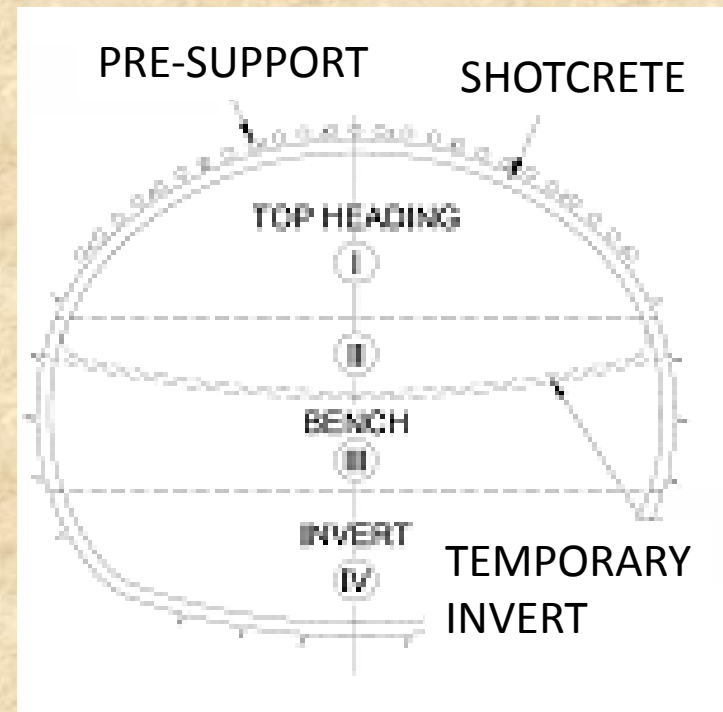
# Excavation and Support Categories in Soft Ground

## 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



# Fort Canning Tunnel



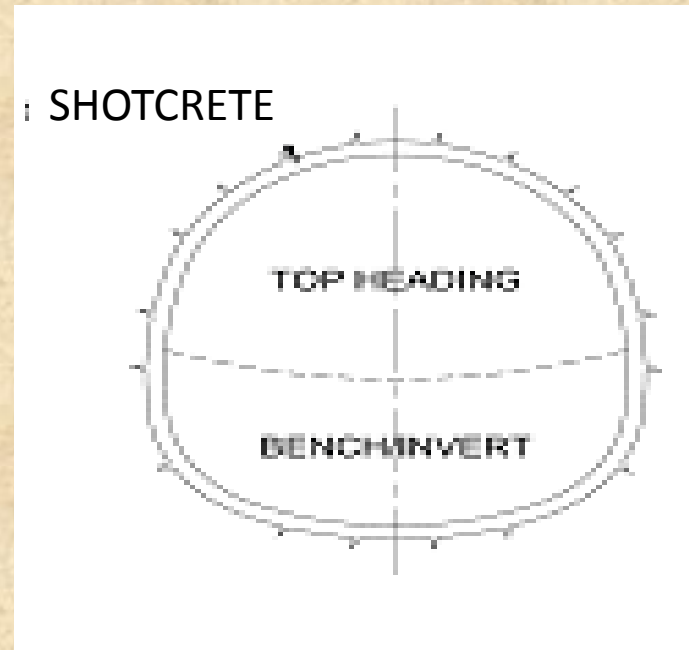
# Excavation and Support Categories in Soft Ground

## 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

## Cross Section



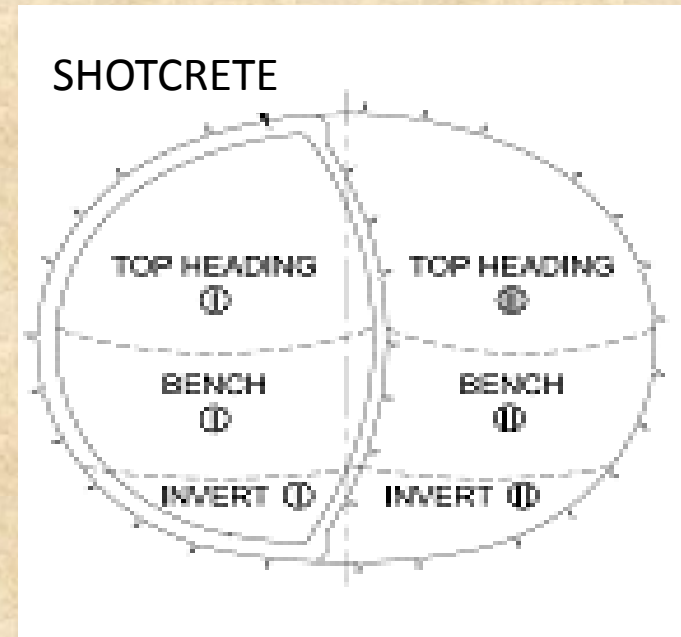
# Excavation and Support Categories in Soft Ground

## 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

## Cross Section



# 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? 😊

