AEG-ASCE SHORT COURSE

TUNNELS THROUGH FAULT ROCKS AND TECTONIC MELANGES

May 31 and June 1, 2002

Gunter Riedmueller and Wulf Schubert

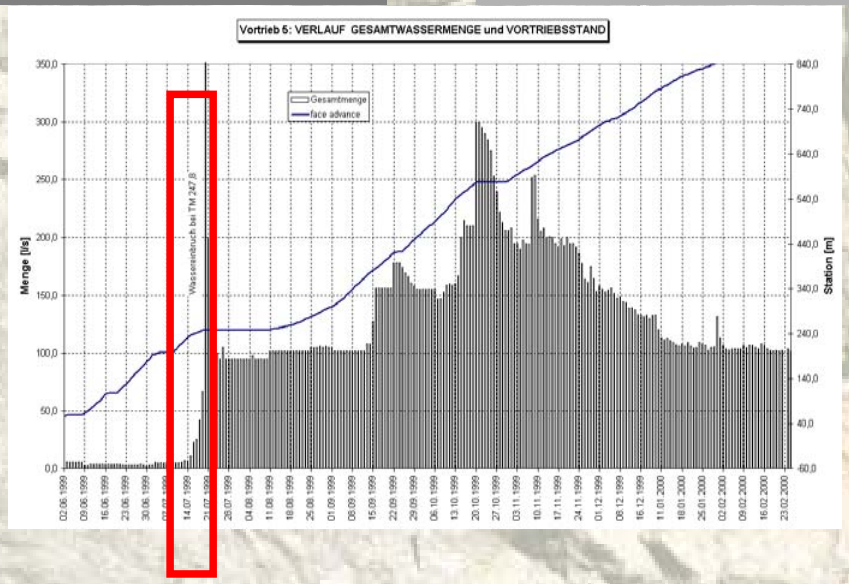
FROM AEG SHORT COURSE " Tunnels Through Fault Rocks and Tectonic Melanges: A Short Course for Engineering Geologists and Geotechnical Engineers", Oakland, California; June 1, 2002; Instructors: Prof. Gunter Riedmueller and Prof. Wulf Schubert, Technical University of Graz, Austria and Gruppe Geotechnik Graz

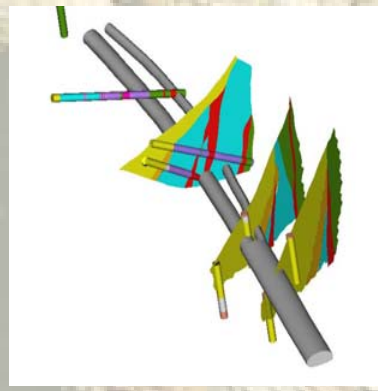
Course Outline

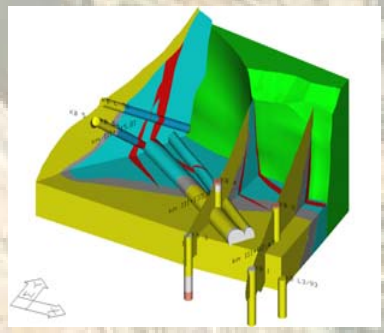
- **Introduction**
- **Characterization and Classification**
- **Investigation**
- **State-of-the Art Method in Engineering Geological Face Mapping and Displacement Monitoring**
- **Prediction Ahead of the Tunnel Face**
- **Solving Problems with Tunneling Through Faults**

Water Inflow

HEAVY WATER INFLOW
Station 247,8 m





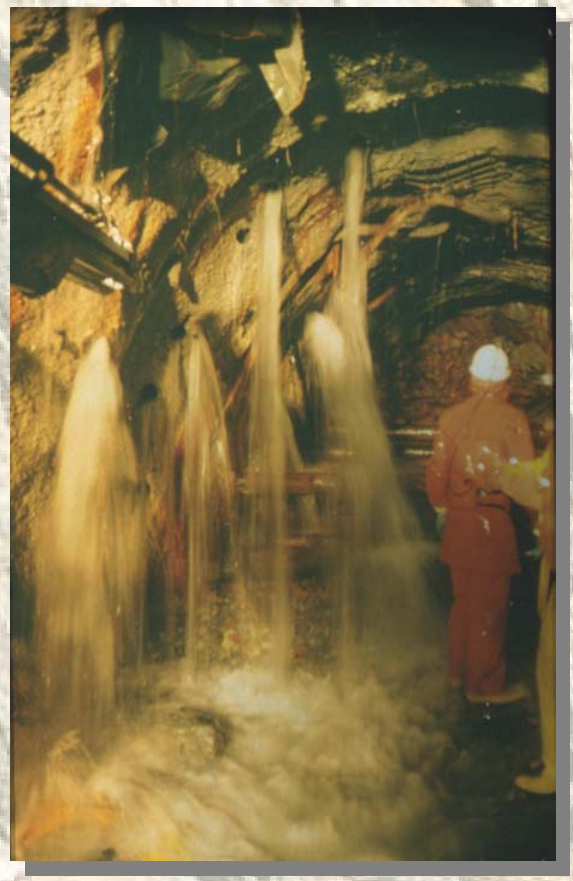


BLISADONA TUNNEL (Austria, 1999, 500l/s)

Introduction

3G
Gruppe
Geotechnik
Graz ZT GMBH

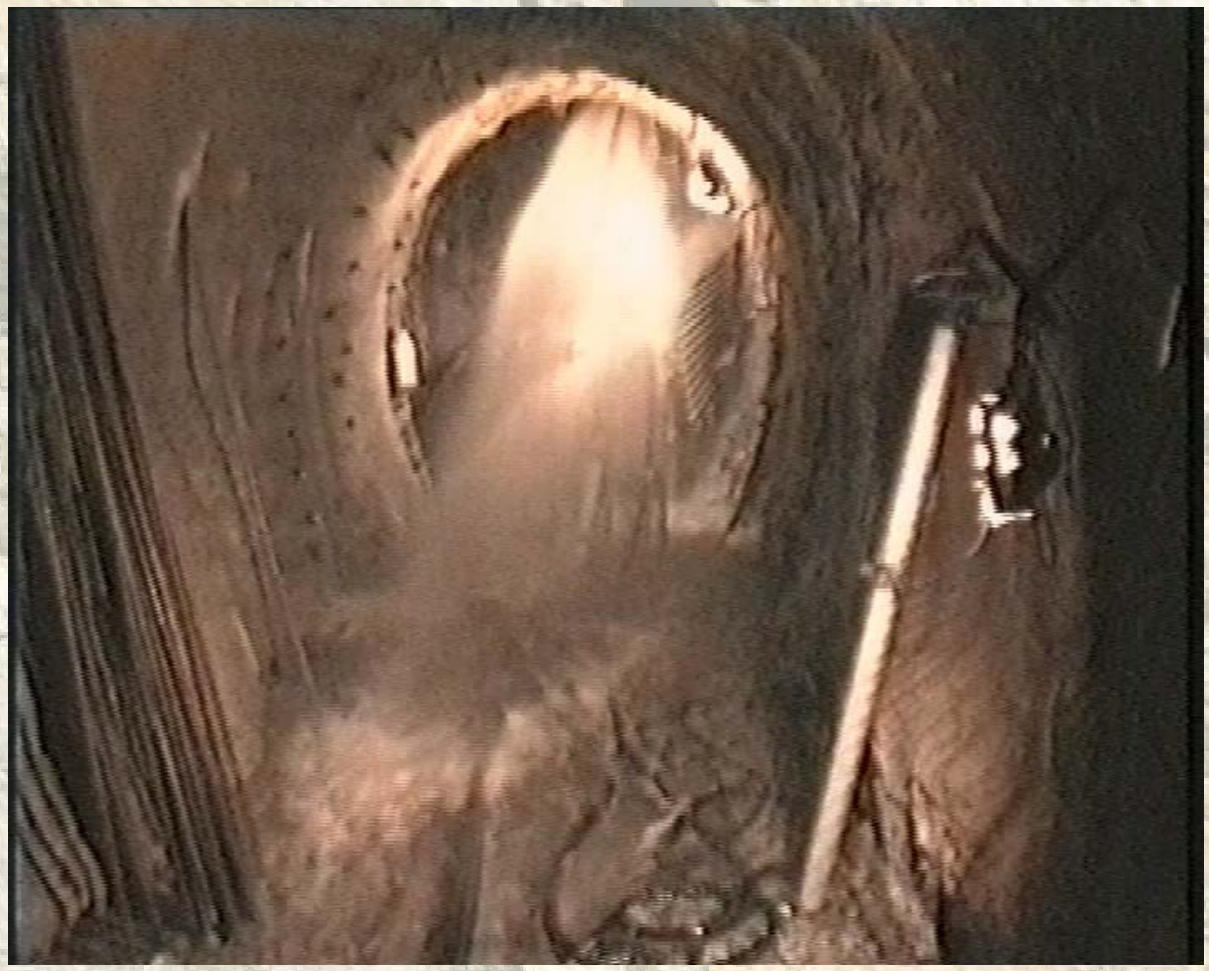
Water Inflow



KAPONIG TUNNEL (Austria, 1993, 300l/s)

3G
Gruppe
Geotechnik
Graz ZT GMBH

Water Inflow



BASO CHHU TUNNEL (Bhutan, 1999, 450 l/s)

Tunnel Collapse

Herzogberg Tunnel, Austria

3G
Gruppe
Geotechnik
Graz ZT GMBH

Tunnel Collapse

Herzogberg Tunnel, Austria

3G
Gruppe
Geotechnik
Graz ZT GMBH

Tunnel Collapse

Herzogberg Tunnel, Austria

3G
Gruppe
Geotechnik
Graz ZT GMBH

Tunnel Collapse

Herzogberg Tunnel, Austria

3G
Gruppe
Geotechnik
Graz ZT GMBH

Tunnel Collapse

Galgenberg Tunnel, Austria

3G
Gruppe
Geotechnik
Graz ZT GMBH

Case Studies

- Pinglin Tunnel, Nangkan – Ilan Motorway, Taiwan
- Tunnels of the Malakasi section, Egnatia Motorway, Greece

Two spectacular examples showing that an inadequate geological understanding of fault rocks and tectonic melanges causes severe geotechnical problems during tunneling

Case Studies

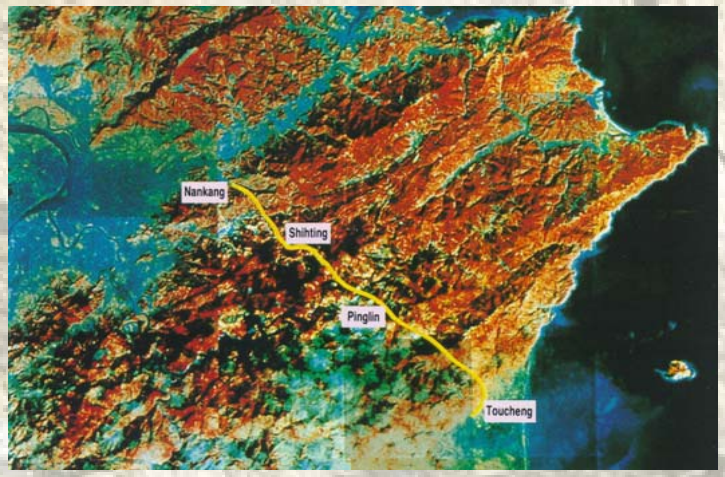
Project Summary

- Length: 12.9 km
- Twin-tube tunnel with tubes 60 m apart
- Outside diameter of tubes 11.8 m
- Pilot tunnel (diameter 4.8 m) between main tunnel tubes
- 28 cross connections between tubes
- Three ventilation shafts (diameters 6.0 m, 6.5 m, depths 355 m, 252 m, 459 m)
- Three interchange stations

- **Construction method:** two 750 m sections at the two portals should have been excavated by D&B method. The remaining 11.4 km (main tunnels and pilot tunnel) should have been constructed by using TBM
- **Construction schedule**: Construction of the pilot tunnel was commenced in July 1991. Completion of the whole project was expected by the end of 1999

Pinglin Tunnel

Case Studies



TAIPEI-ILAN - EXPRESSWAY

Pinglin Tunnel
(12.9 km)

Pinglin Tunnel

3G
Gruppe Geotechnik Graz ZT GMBH

Case Studies

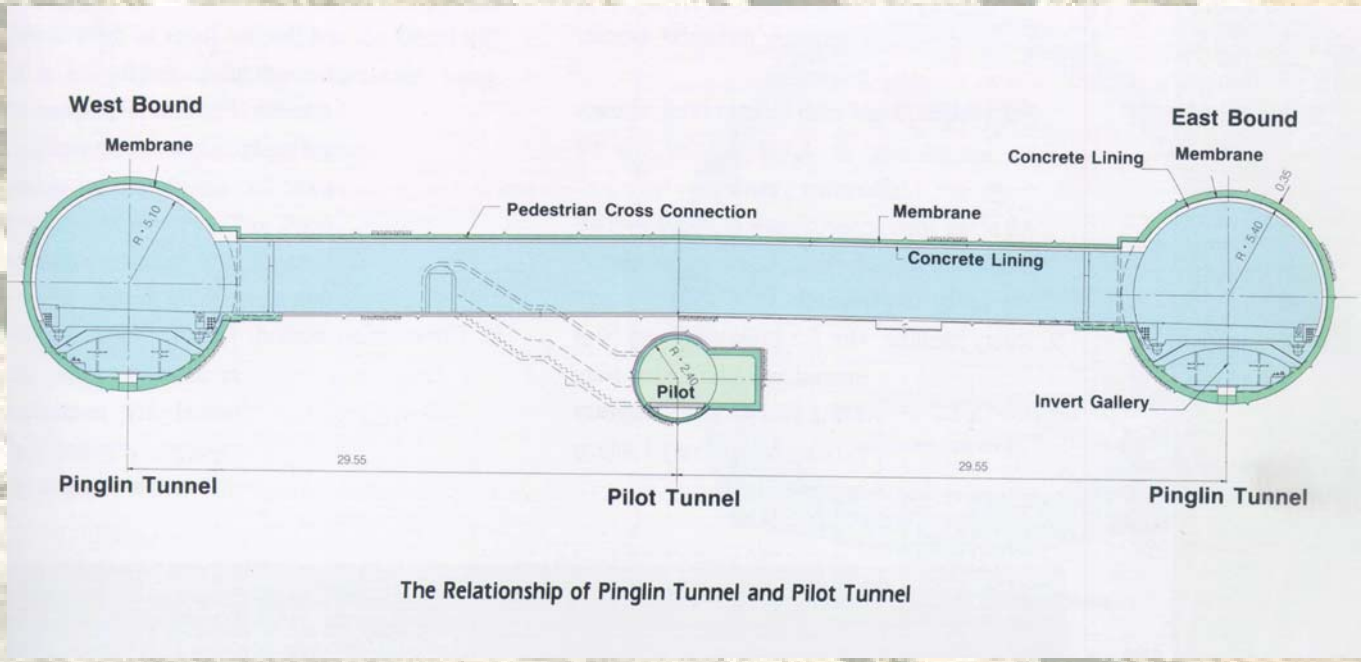
Artist's Perspective View

Pinglin Tunnel

3G
Gruppe
Geotechnik
Graz ZT GMBH

Case Studies

Cross Section of Main Tunnels,
Pilot Tunnel and Pedestrian Connection



The Relationship of Pinglin Tunnel and Pilot Tunnel

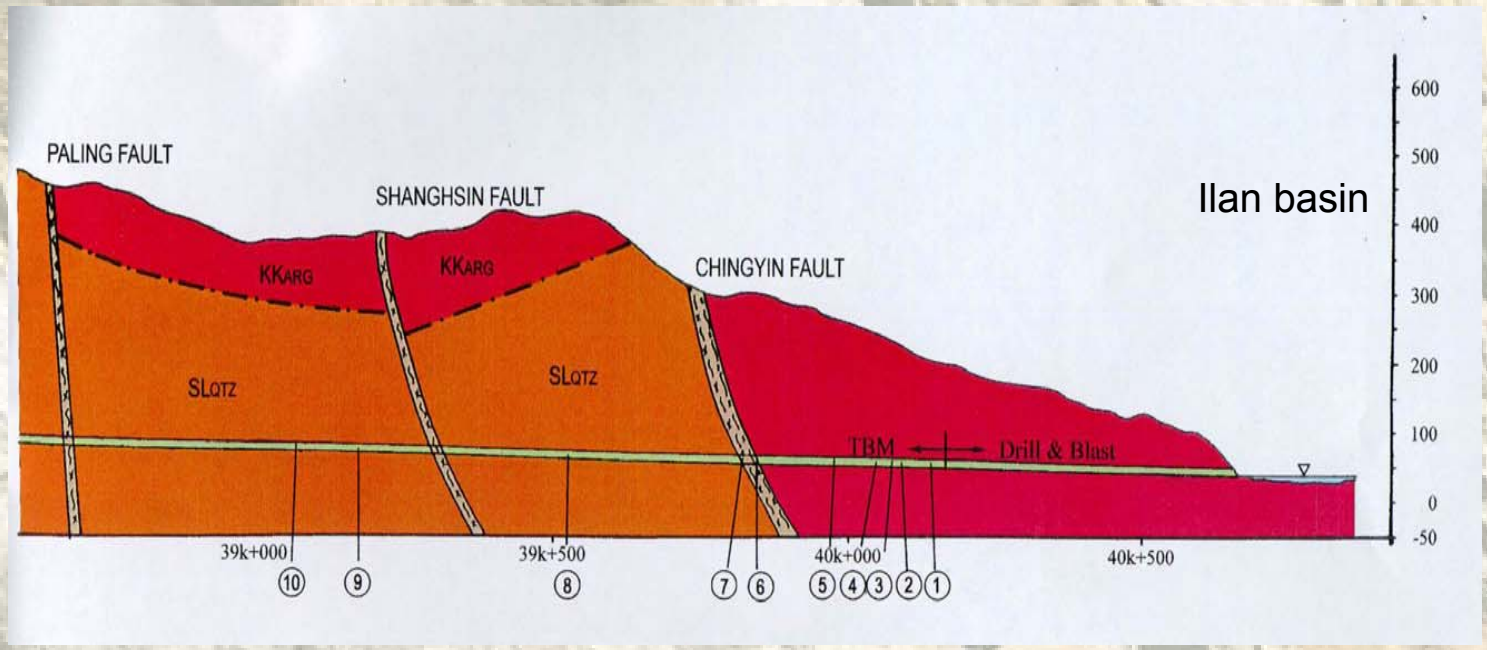
Pinglin Tunnel

3G
Gruppe
Geotechnik
Graz ZT GMBH

Case Studies

Pinglin Tunnel, East Section

Fractured, open jointed rock mass
due to extensional faulting

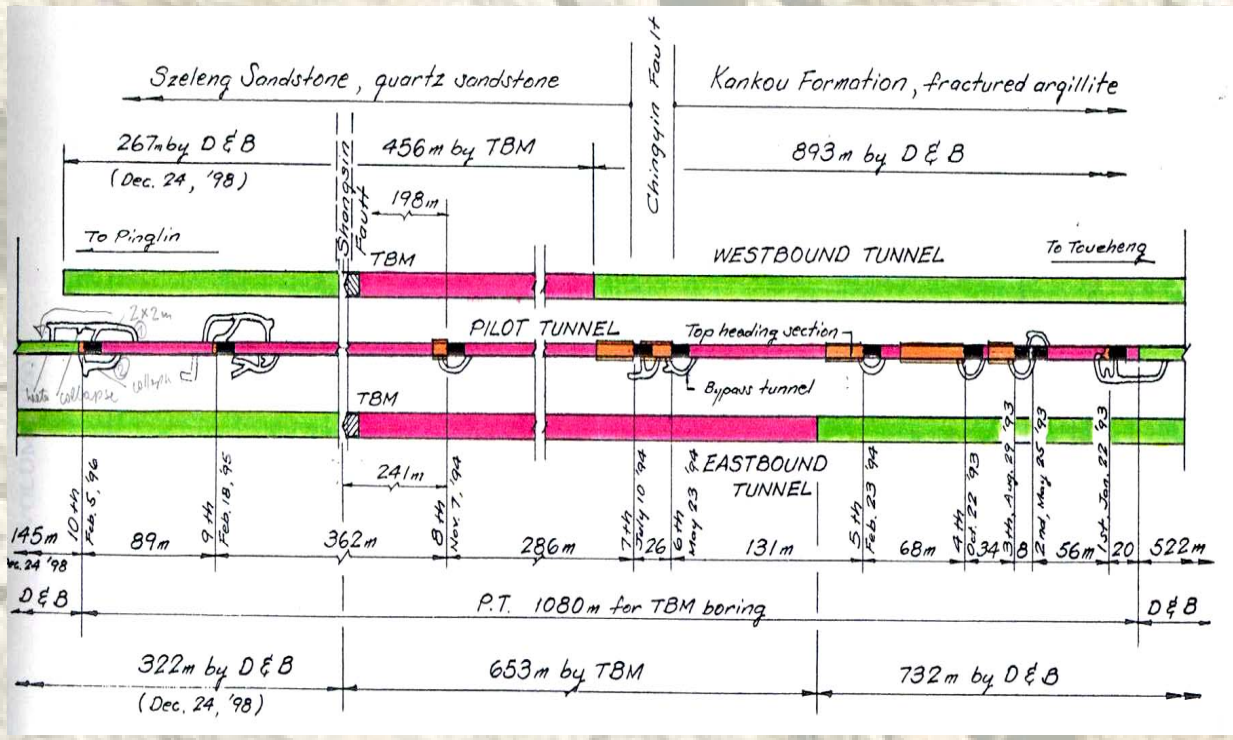


10 stoppages of pilot tunnel TBM

3G
Gruppe
Geotechnik
Graz ZT GMBH

Case Studies

Locations of TBM Stoppages (December 1998)

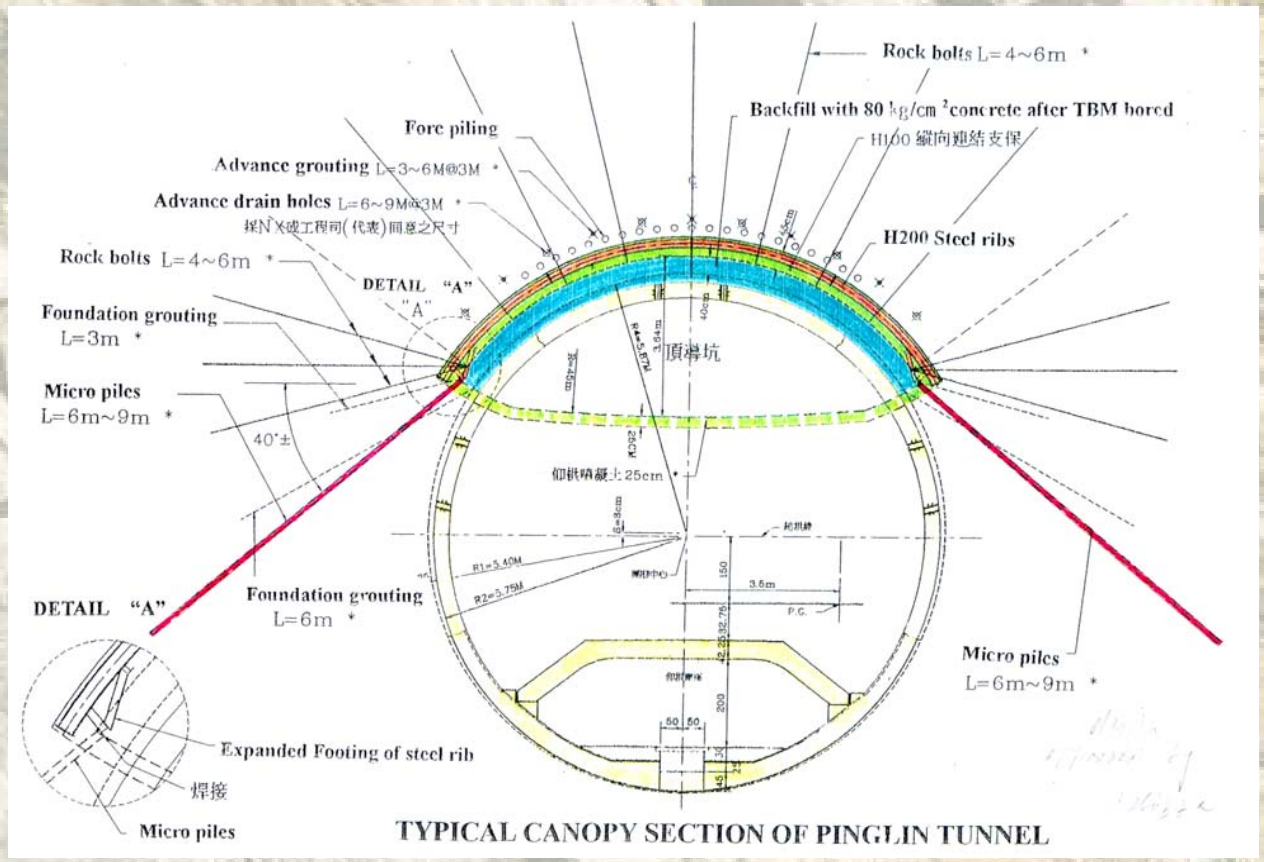


Westbound T.: 893 m D&B, 456 m TBM, 267 m D&B ahead of the face
Eastbound T.: 732 m D&B, 653 m TBM, 322 m D&B ahead of the face
Pilot Tunnel: 522 m D&B, 1080 m TBM, 145 m m D&B ahead of the face

Pinglin Tunnel

Case Studies

Design for Excavation Ahead of the TBM
("Canopy Section")

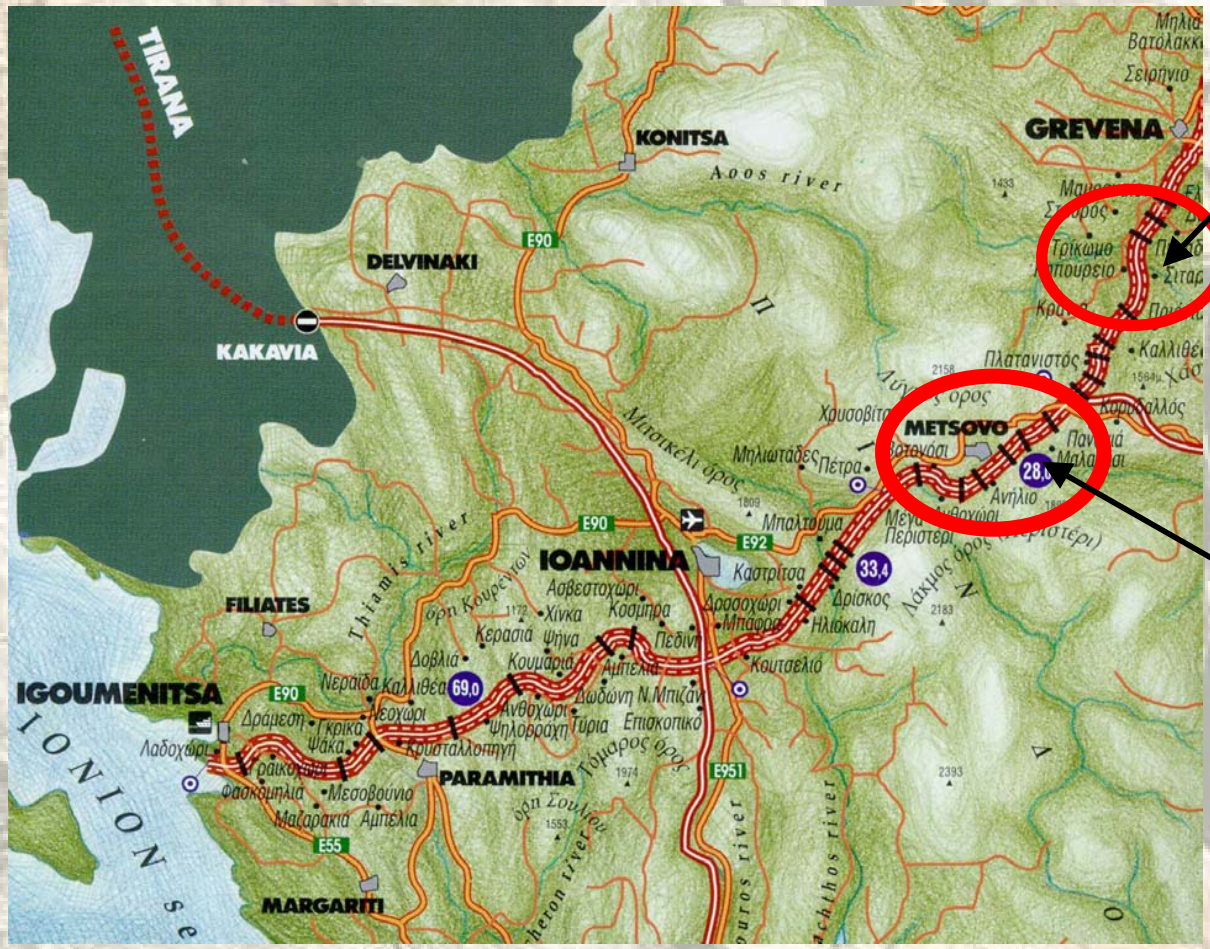


Pinglin Tunnel

3G
Gruppe
Geotechnik
Graz ZT GMBH

Case Studies

Location



Tunnels in a tectonic melange and olistostrome

Tunnels in thrust duplexes

Egnatia Motorway

Case Studies

Malakasi Section

- Alpine forearc region, containing **chaotic rock mass** of predominantly shale, sandstone, siltstone, limestone and ophiolitic lithologies
- The chaotic deposits include **olistostromes** and **tectonic melanges**, which characteristically contain a chaotic arrangement of competent blocks (limestone and ophiolitic olistoliths and/or phacoids) in an irregularly sheared weak matrix consisting of shale, sandstone, siltstone and gouge
- This chaotic rock mass from different geological environments can be characterized from the engineering perspective as **„block-in-matrix rocks“**

Egnatia Motorway

Case Studies

Damaged West Portal Pre-Cut of Tunnel M2

Egnatia Motorway