MP-Fundation for a suspension bridge in high alpine
General Description

- Geology – geotechnical parameters
- Climatic conditions
- Structural and Geotechnical Design
- Challenges
- Site infrastructure
• Northern lime alpine – Dachstein Kalk
• Weathered rock by frost heap
• Karst
• Huge cracks and partly permafrost
Climatic conditions - situation

- Nearly 3000 m above sea level – glacier north of ridge – frost all over the year
- Strong westerly winds up to 250 km/h
South wall

Situation of western abutment

Situation of eastern abutment
Structural and geotechnical design

**structural**
- Standard EN 1990
- EN 1991-2 Action on structures - Bridges
- EN 1992-2 Design of concrete structures - Bridges
- EN 1993-2 Design of steel structures – Steel Bridges
- HiVoSS Human induced Vibrations of steel Structures - Design of Footbridges

**geotechnical**
- EN 1997-1 Geotechnical design
- EN 1537 – Ground anchors
- EN14199 - Micropiles
challenges

- Weathered rock with cracks up to 20 cm width
- Difficulties with prestressed anchors – failure of rock
- Tension forces per abutment 2*950 kN from ropes
- Frost all over the year – in summer during the day 10-15°C, night below 0°C
- Situation of abutments – partly in vertical rock wall
General drawing suspension bridge
Cross section eastern abutment

Foundation of abutment on a huge bloc – lying on falling rock-slope – which had to be secured against sliding
Cross section western abutment

Rockline survey with laser scan and additional detailed survey in place – e.g. western abutment
Fixation of abutment bloc with tension and bearing piles
Site infrastructure

- Site elevation 2980 m
- Dachstein Ropeway – capacity 6 to – not available due to regular person transport
- Material ropeway – capacity 2 to – station 500 m apart
- Transport and erection 95% per helicopter
- Bridge mounting with an additional material ropeway along bridge axis
Bridge works
General site view with material ropeway for bridge mounting
Drilling works west abutment
Securing of eastern abutment
Drilling works
access bridge
Stocking against injection loss

Due to several gaps and wide cracks we chose a stocking system to limit injection mortar loss.
Bridge foundation in carst - high alpine

- Carst rock – wide gaps up to 30 cm
- No anchoring possible – failure of rock due to gaps
- Pile foundation and tie piles for suspension bridge
- Permanent tie piles GEWI with different diameters according to load
- Ready for concrete
Severe conditions
Access bridge works
Access bridge works

Rock securing with rock bolts

View on access bridge and tunnel entrance
Dachstein suspension bridge

East abutment
Dachstein suspension bridge

View from east abutment to west abutment

Securing work of bloc east abutment still in progress
Dachstein suspension bridge

- Including access bridge
- Additional view point
Dachstein suspension bridge

- Span 90 m,
- designed for live load of 7.5 kN/m²
- wind speed 250 km/h
Lessons to learn

• Micropiles proved an outstanding method for foundation in karst rock
• Suitable for difficult geological and geotechnical conditions
• Suitable for difficult and extreme climatic conditions
• Low maintenance cost
Thank you for your attention!

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