A10 motorway – refurbishment Reitdamm stabilization of a longtime creeping landslide of a hillside embankment

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Situation

- 450 m long
- 40 m high
- 500,000 m³ excavation material from the Reit tunnel
- Construction time: April 1978 – September 1979
Underground Conditions

Dam is based on an inclined surface consisting of silty sand and gravel layers with layers of glacial lake clay beneath.

The crystalline basement existing below is composed of phyllite and sedimentary moraine material.

The behaviour of the glacial lake clay is a main factor to be considered.

In any case an increase of the pore water pressure in the glacial lake clay should be avoided.

Breymann (2009)
Start of construction works in **April 1978**

Rapid construction of the fill → displacements of 5-6 mm/day in August 1978

First steps for stabilizing:
→ Stopping the works for 14 days
→ Reduce the advance of filling to 0.4 m per level
1979 First constructive steps for stabilizing:

T-bar shaped diaphragm wall elements

Drainage pile walls at the hill and valley side of the embankment

Fountain shaft S1
1980 Second constructive steps for stabilizing:

Anchors in fountain shaft S1

15 back anchored fountain shafts in the area of the embankment toe between the T-shaped diaphragm walls
1986:
Extension of the monitoring instruments by installation of 5 Inklinometer
1987: Repairing cracks in the pavement of traffic lane to Salzburg with pressure less water-cement slurry

1993: oblique crack in the sprayed concrete lining of the fountain shaft S1
1998:
Deep vacuum wells in the area of the construction roads

4 water pressure sensors

9 Extensometer

Reinforced concrete ring in fountain shaft S1
2012/2013:
geological exploration of the whole dam

13 Inklinometer
3 extensometer
2 pore water pressure sensors
2 ground water gauges
3 testing anchors
Refurbishment solutions

- Solution A: Stabilisation of the dam with additional anchors

- Solution B: Construction of a bridge for the valley side carriageway and reduction of the dam's height by one third.
Definition of safety concept

- For both Solution A and Solution B, the following safety concept was defined for the dimensioning:
  - Design situation: quasi-permanent design situations - BS1
  - Failure consequences: consequences class CC2
- The analyses for Solution B assume a lower safety level than required by current standards for the area of the embankment dam underneath the highway. This approach is only feasible if based on the observational method in accordance with Eurocode 7.
Solution A – stabilisation with additional anchors

- The concept for the protection against slope failure consists of:
  - Reinforced concrete ribs, which are back anchored with sufficient dimensioned tie backs and situated mainly between the upper construction road and the motorway.
  - Additional the current provided monitoring system and the existing deep vacuum wells have to be maintained to observe the occurring displacements and to keep the pore water pressure in the glacial lake clay layers in balance.
Solution A – stabilisation with additional anchors
Öhlinger und Partner (2014)
Solution B – construction of a bridge

- The concept for the protection against slope failure consists of:
  
  - The hillside carriageway is protected with a back anchored discontinuous bored pile wall.
  
  - The existing valley side carriageway is substituted by a bridge and, in addition, the topmost third of the dam (approx. 60,000 m³) will be excavated afterwards.
Solution B – construction of a bridge
A 10 Tauern Autobahn

aufgelöste Bohrpfahlwand
Bohrpfähle Ø1,20m, e=2,50m, l=20,00m
Kopfbalken 1,60/0,80 und
mit Spritzbetonsicherung d=25 cm
2x Ankerbalken 0,75/1,00

*Berme Aushub

2 Pfladen e= 6,0 m
je 7 Bohrpfähle Ø1,20m, e=1,00m, unbewehrt, l= 20,00m
je 6 Bohrpfähle Ø1,20m, e=1,00m, bewehrt, l=33,30–42,10m

Anker - 15,0° - lg=48,0m, e=2,50m
Anker - 20,0° - lg=49,0m, e=2,50m

bestehende Steinentfussicherung Dräht=0250
best. obere Baustraße
best. untere Baustraße

Öhlinger und Partner (2014)
Comparison of the two Solutions

- Solution A

- Solution B

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IGT (2014)
Choice of a solution and realisation

- Key characteristics of both solutions:

Solution A
- Flexibility of the measure
- Gradual extension of the solution possible, if observation is guaranteed

Solution B
- Solution in one step
- Decouple the deformations of the remaining dam from the highway itself
Choice of a solution and realisation

Aims for the client ASFINAG:

- Find the best solution for a general long-term refurbishment
- Avoid settlements of the road at all
- Reduce costs for maintenance of the highway as much as possible
Choice of a solution and realisation

- **Main advantage of solution B:**
  - Further movements of the dam will not affect the road itself
  - Further actions, if required, can be performed without affecting the traffic of the motorway

- **Main disadvantage of solution A:**
  - It cannot be guaranteed that the displacements of the dam will be stopped
  - An intensive observational program has to be initiated

- In face of this and the fact that both solutions were estimated to be quite the same in terms of costs the clients decision was to tender only solution B.
Impressions of the building site

IGT, Pyöry (2015)
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IGT, Pyöry (2015)
Thank you for your attention