Micropiles – sustainable and resilient?!

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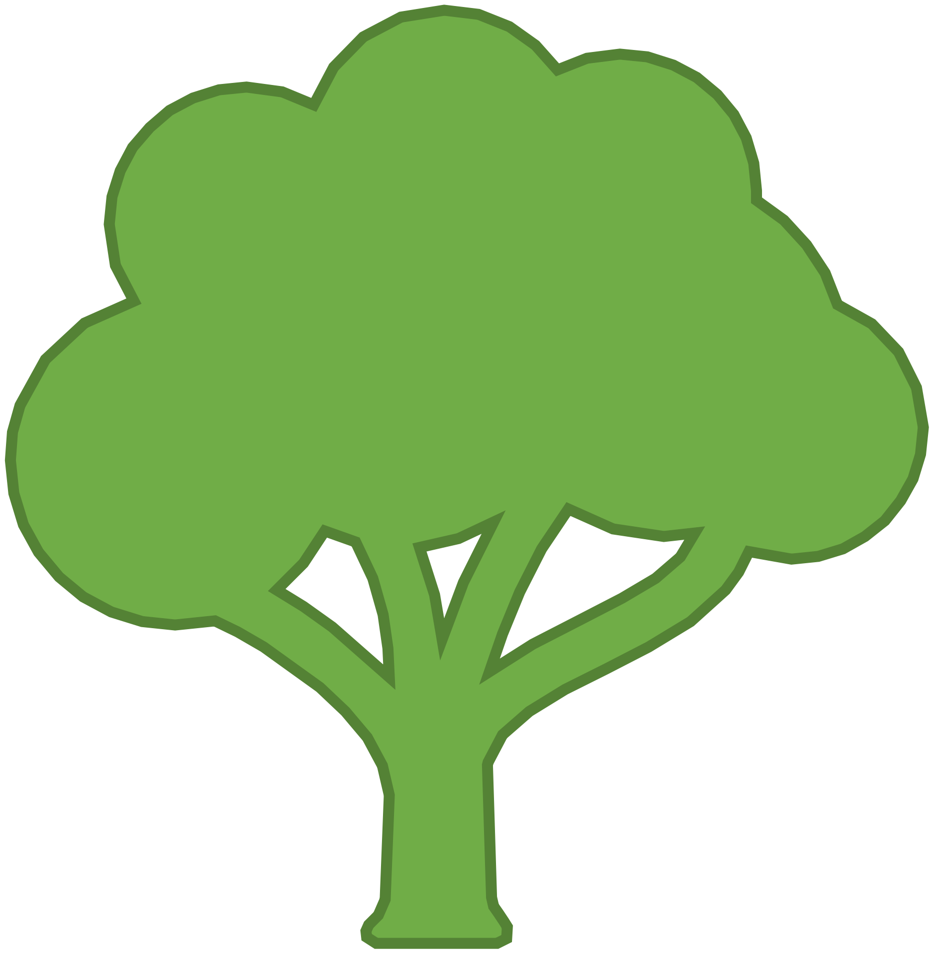
Overview

- Sustainablility
- Resilience
- Design and Material
- Execution
- Examples
- conclusion

Sustainability



History

- First mentioned in Middle Age in Venice – Italy
- „Sylvicultura oeconomica“ by Hans C. von Carlowitz, forest engineer in 1713
- Brundtland Report 1987 – UN World Commission
- Agenda 21 – Rio de Janeiro June 1992

Definition

Hans Carl von Carlowitz

Planned reafforestation = sustainable forest economy

Brundtland Report

Sustainable developement meets the needs of the present without compromising the ability for future generations to meet their own needs

Common meaning

- In nature -> Remaining of diverse biological systems

- In economy -> Long-term practices respecting the environment, the well-being of employees and prospect of future nations

Resilience

History

- In English material mechanics in the 19th Century – stress and resilience by Thomas Young
- In Psychology 1950 by Jack Block – *ego-resiliency*
- Since 10 years Stress and Resilience developed to key concepts in Psychology and Climatic Change research

Definition

engineering

Resilience in engineering sciences refers to the ability of technical systems not to fail completely in the event of faults or partial failures, but to maintain essential system services.

ecosystem

Ability of an ecosystem to return to baseline condition after disruption

psychology

Resilience or psychological resilience is the ability to cope with crises and to use them as an occasion for development by resorting to personal and socially mediated resources.

Energy sector

Resilience is defined as the ability of a system to maintain its ability to function under stress or to restore it at short notice. Resilience goes beyond the property of robustness.

Design and Material

Incorporation in design process

Ecologic and economic effects + resource management + lifespan cost + resilience = overall view

Resource management

Carbon footprint of different materials + efficient material usage + efficient use of equipment

Lifespan costs

Erection cost + maintenance + recycling cost

Resilience

Ability to withstand or absorb assaults without complete failure

Execution

Incorporation in execution

Ecologic and economic effects + resource management + lifespan cost + resilience

Resource management

e.g. Carbon footprint of uses equipment + reduction of consumables + efficient material usage

Lifespan costs

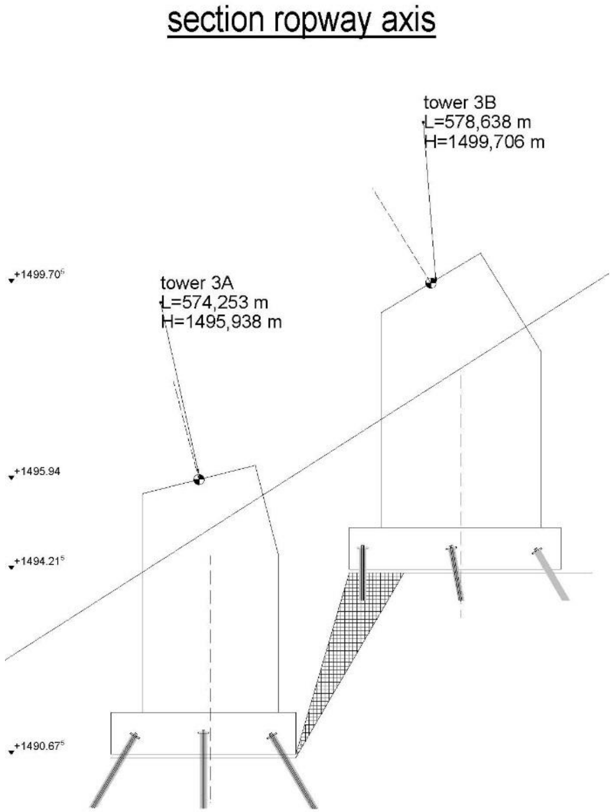
Erection cost + maintenance + recycling cost

Resilience

Ability to withstand or absorb assaults without complete failure

Some examples

1. Ropeway tower foundation



- Original design – shallow foundation
- Value engineering – deep foundation with Micropiles
- Reduction of carbon footprint earthworks 60%
- Reduction of carbon footprint concrete works 2%
- Reduction of erection cost foundation by 60%
- Improvement of slope stability at no additional cost

How do micropiles work in this case

- Deep foundation for the tower – like roots of a tree
- Reinforcement of soil – like roots of a tree
- Improvement of soil - adding the property, which soil actually does not have
- Minimizing excavation volume and concrete
- Sustainable solution

2. Pile Foundation and Slope Stabilization

Micropile foundation for building in steep terrain

Slope slide

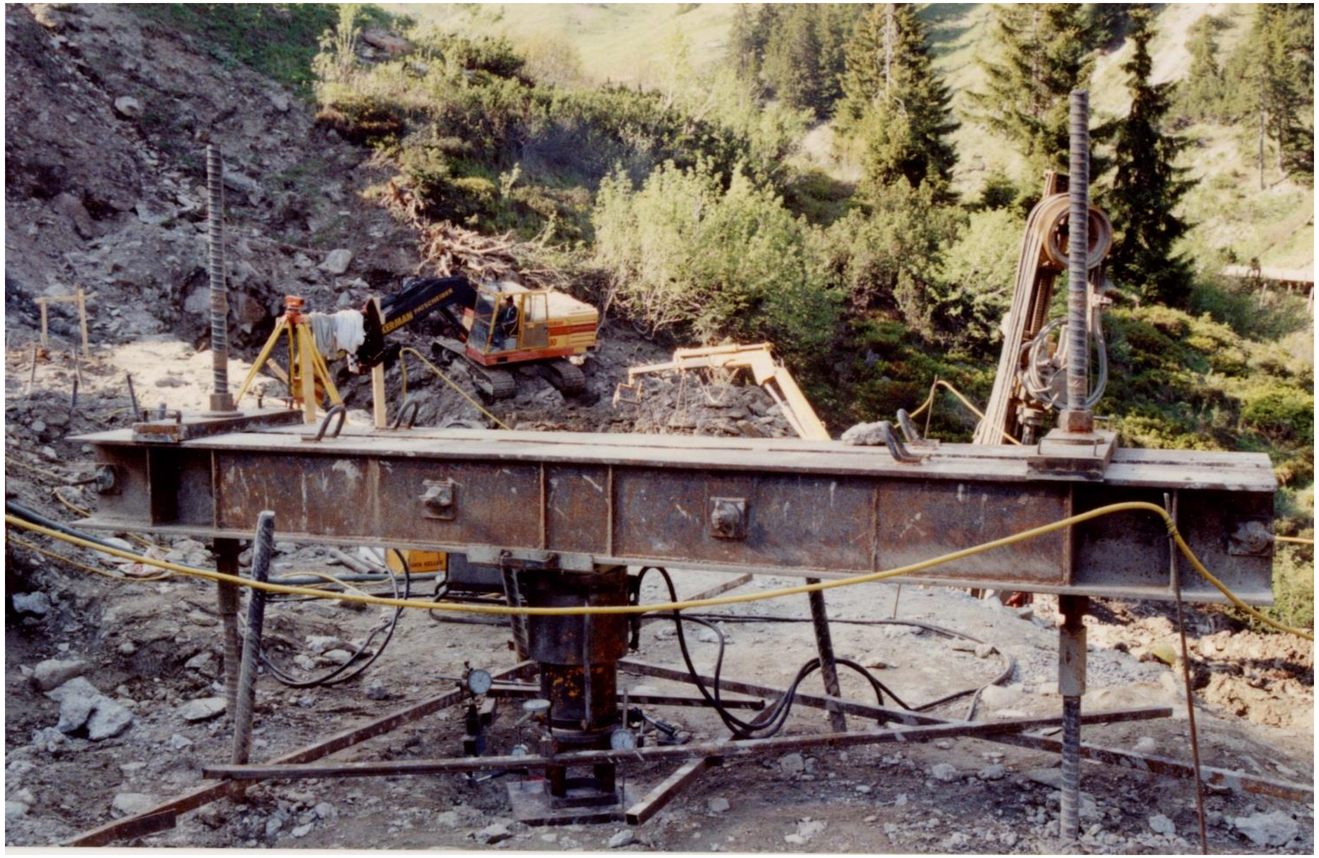
- Geotechnical survey
- Geodetic survey – speed of movement
- Risk assessment

Step by step solution

- Stability analysis – backclalculation
- Implementation of micropiles
- Stability analysis

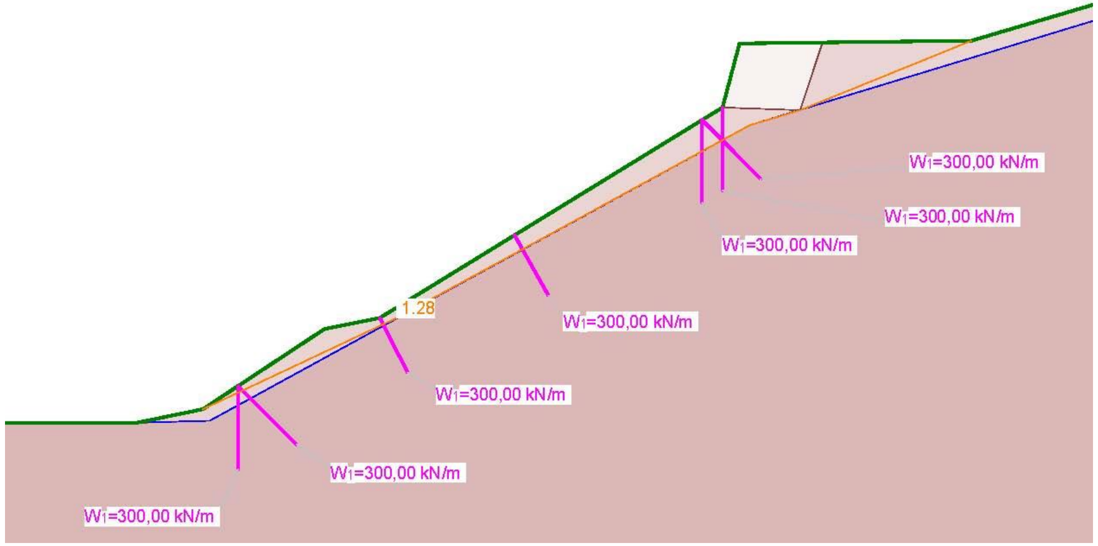
Foundation solution

- High foundation loads would have led to huge shallow slab foundations, which could not be realized due to steep terrain
- Due to steep inaccessable terrain a solution with piles of big diameter for the high loads of the foundation was not possible.
- A solution with micropiles was designed to bring the foundation loads to bearing ground

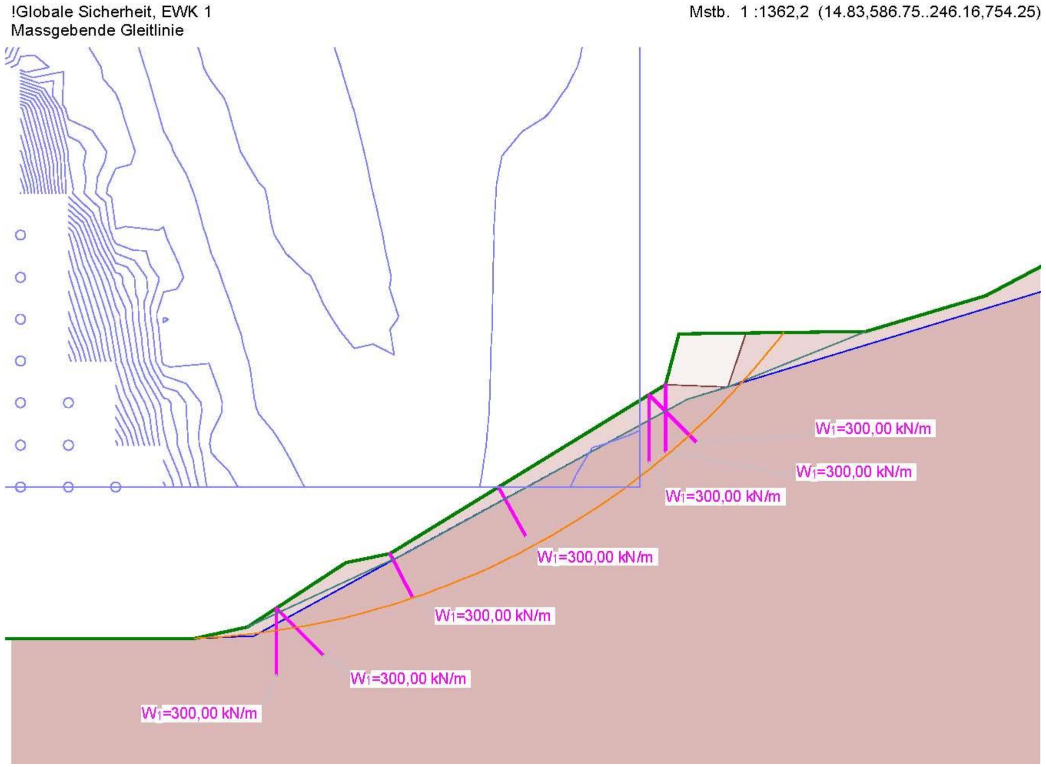


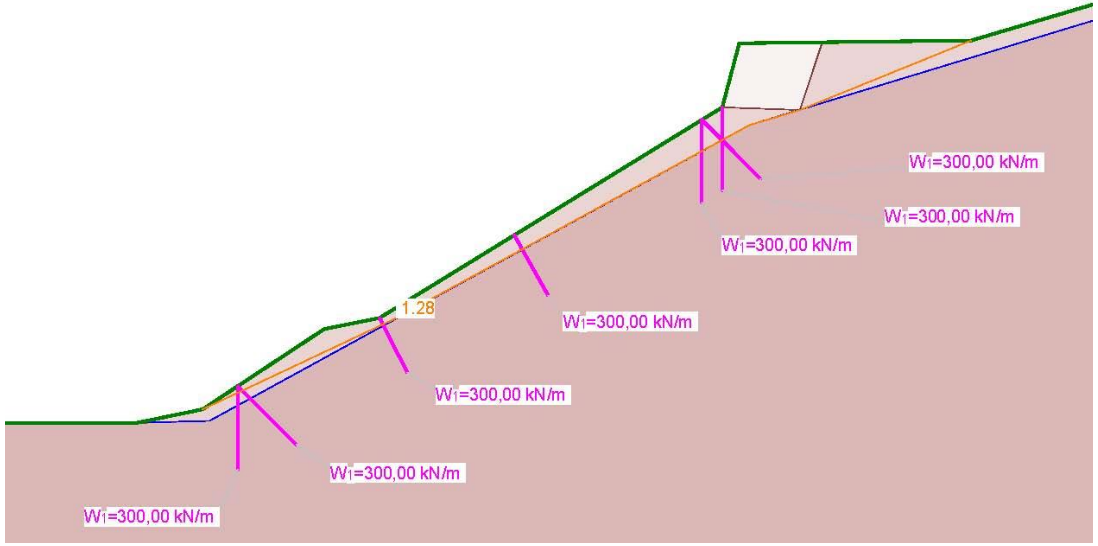
Drilling works

Slope stabilization 17 years later



Stability analysis – Krey versus Janbu





Stabilization works

Formwork and reinforcement of pile cap beam – ramp concreting

Inclinometer

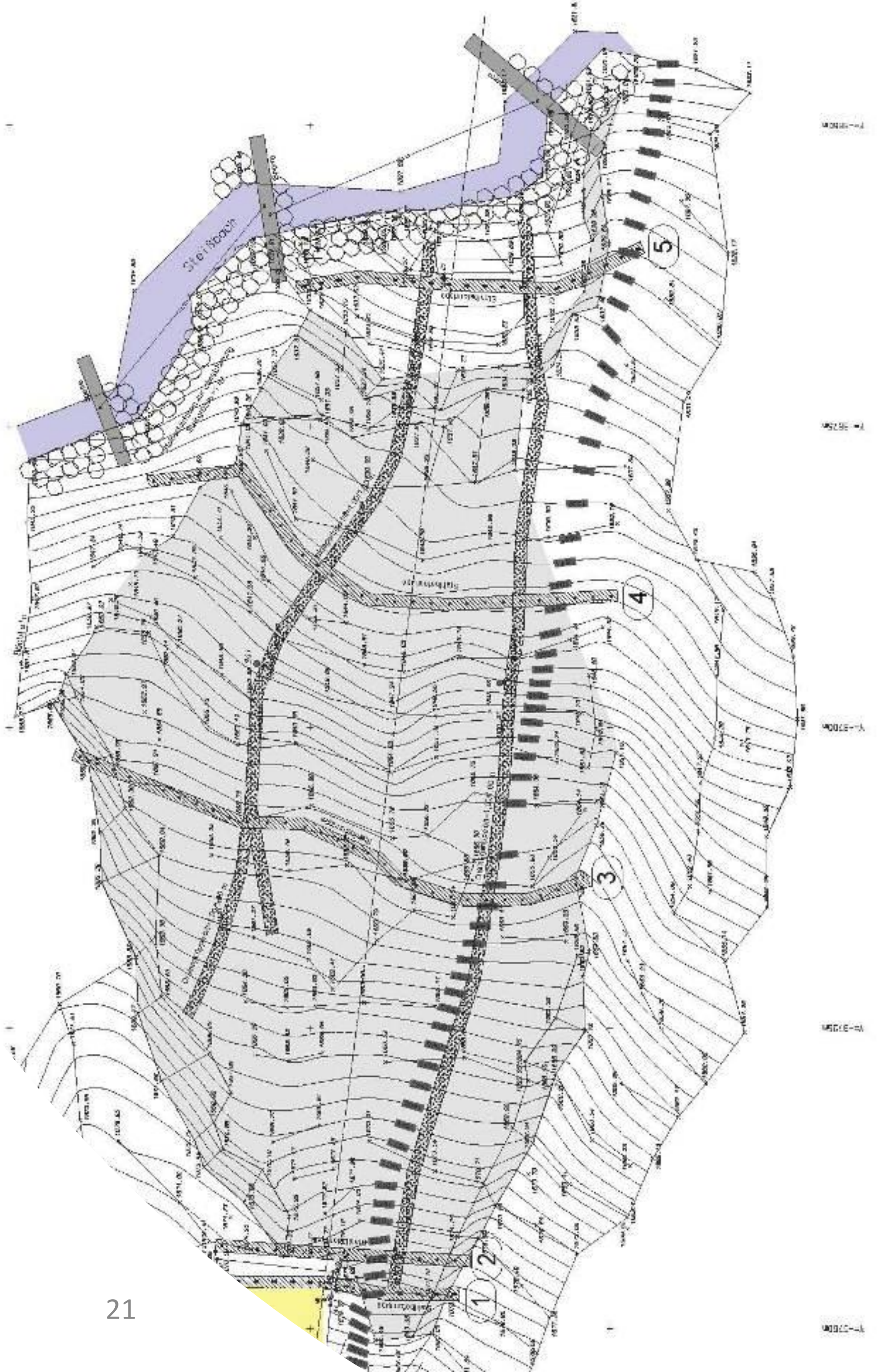
pile cap beam

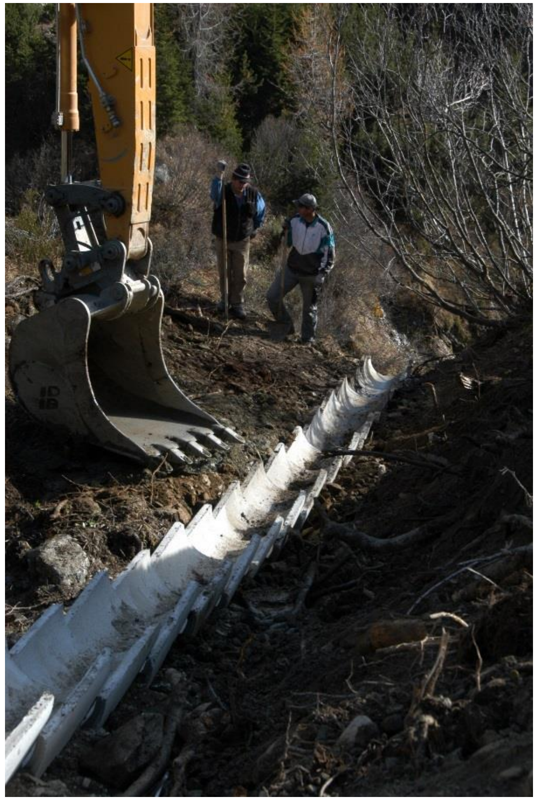
demand of client

- Stability of building longterm
- Slope stability longterm
- Affordable solution

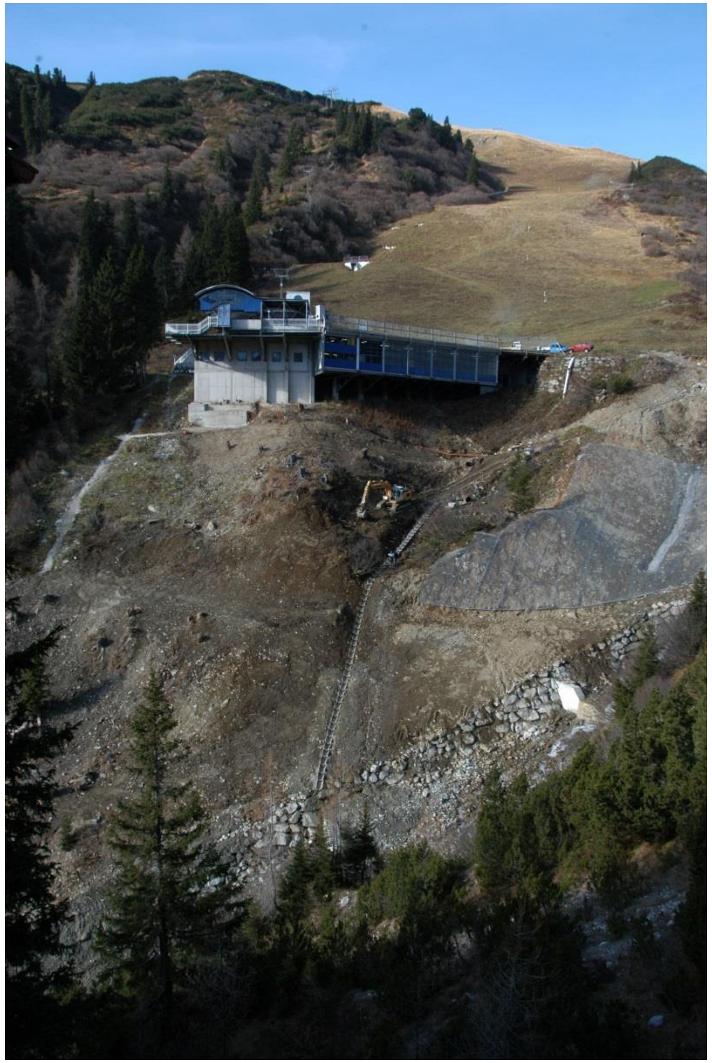
Output

- Stabilization project combined with drainage measures
- Riverbed stabilization by riverbed swells
- Riverbank stabilized by hard bank reinforcements

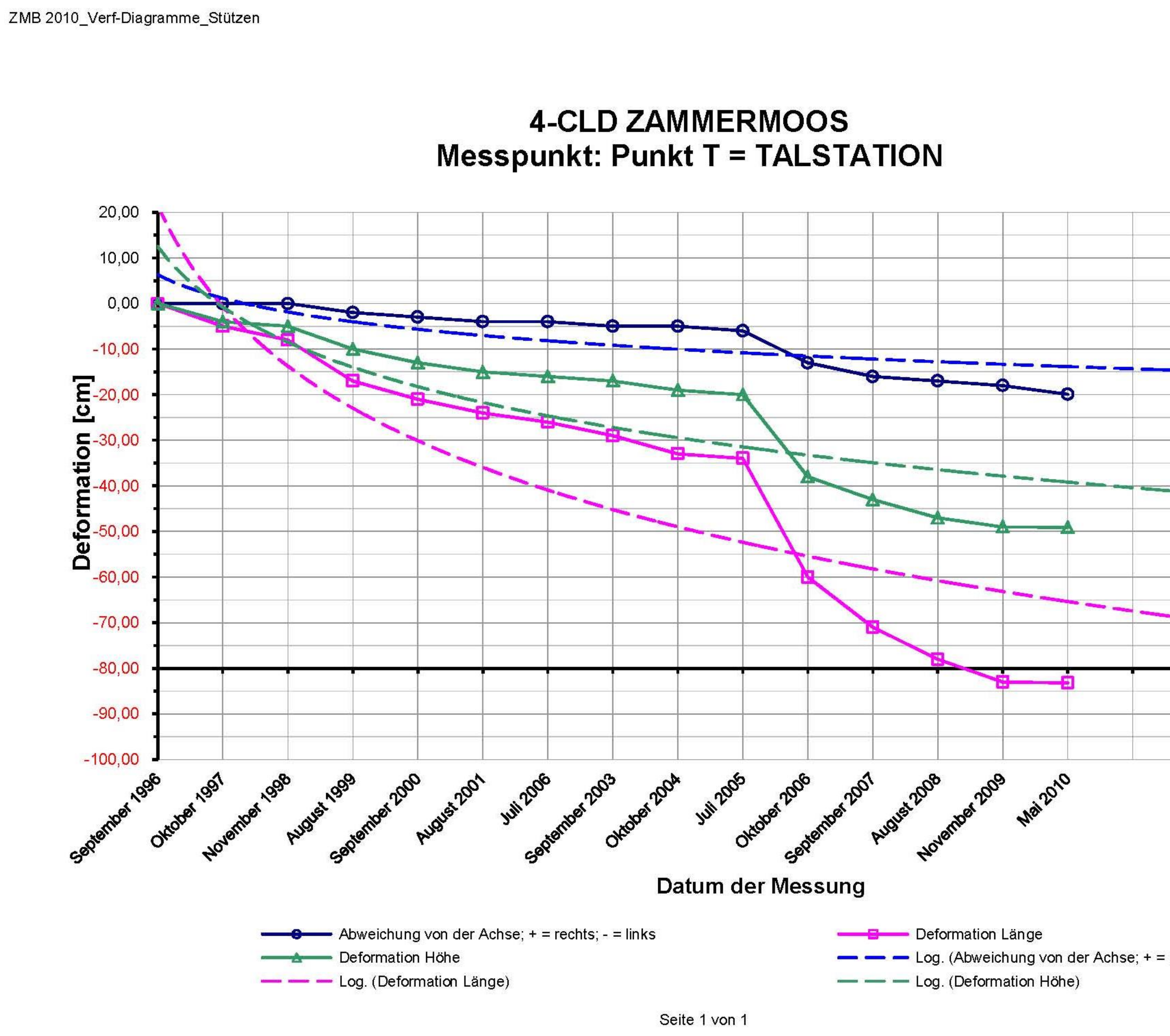




Finalizing works



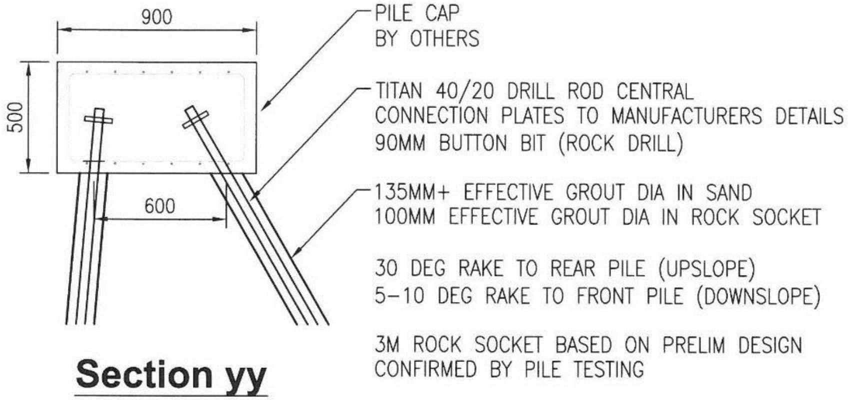
Result of stabilization after 4 years – movement decrease obvious



Road Stabilization works

Problem to solve

- Original project – borepiles of big diameter
- Execution problem – one lane to be kept open + drilling machinery to heavy causes stability issues
- Value engineering -> micropile solution with A-frame
  - Sound solution – sucessfully used on many road kilometers in Austria
  - Unknown solution led to longer discussions and convincing efforts



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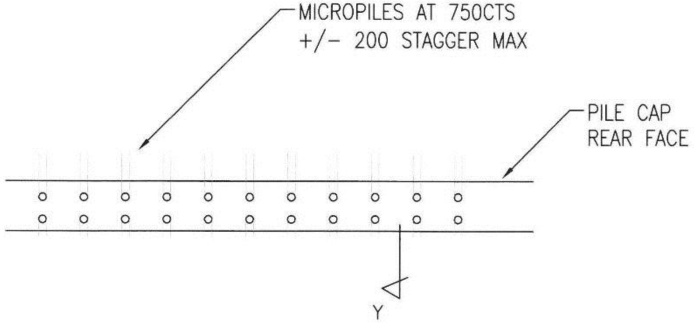
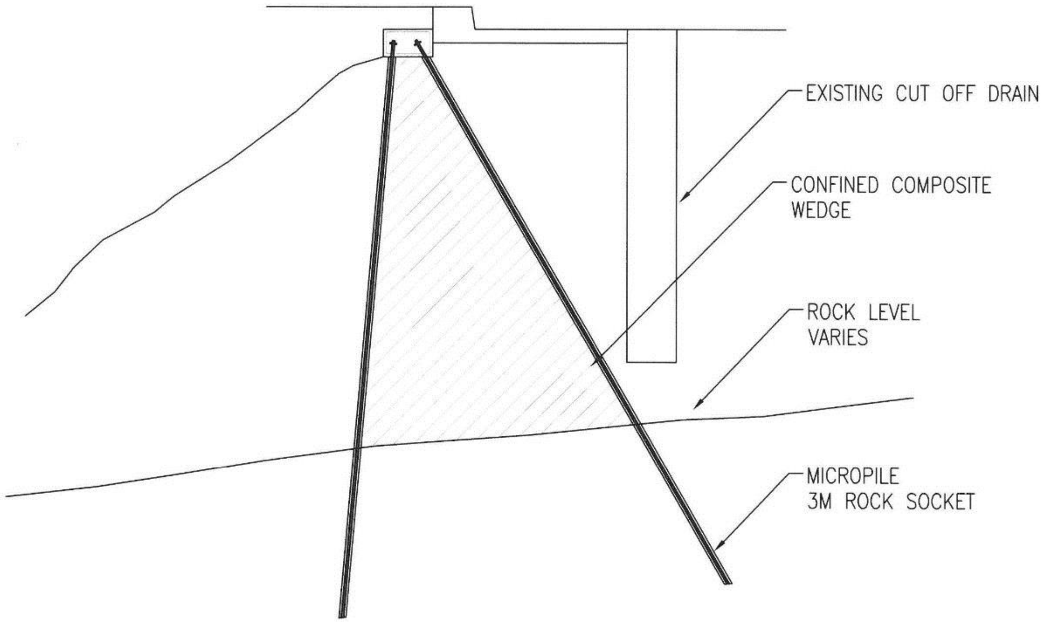


Plan View



Typical Section

NOTE
EROSION PROTECTION TO BE PROVIDED AND
MAINTAINED TO DOWNSLOPE FACE

Exectuion of value engineering

Drilling works with excavator mounted rigg

Pile testing

Exectuion of value engineering

Drilling of TITAN Hollow bar piles

Reinforcement cage of pilecap beam

Sustainability - conclusions

- carbon footprint -> small
- long lasting
- Works as part of natural environment – not against
- Idea comes from nature – roots = root piles
- Resource caring
- Micropiles are high capacity and versatile means of foundation

Conclusions resilience

Robust

Resistant to disruption

act as collective

Transfers ground to another system – chamge of properties

Are Micropiles sustainable and resilient?

After more than 30 years of working with micropiles - my answer is **yes**

Questions?

Thank You for your attention

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