

# **A NON-DESTRUCTIVE PARAMETER IDENTIFICATION FOR AN EMBANKMENT DAM**

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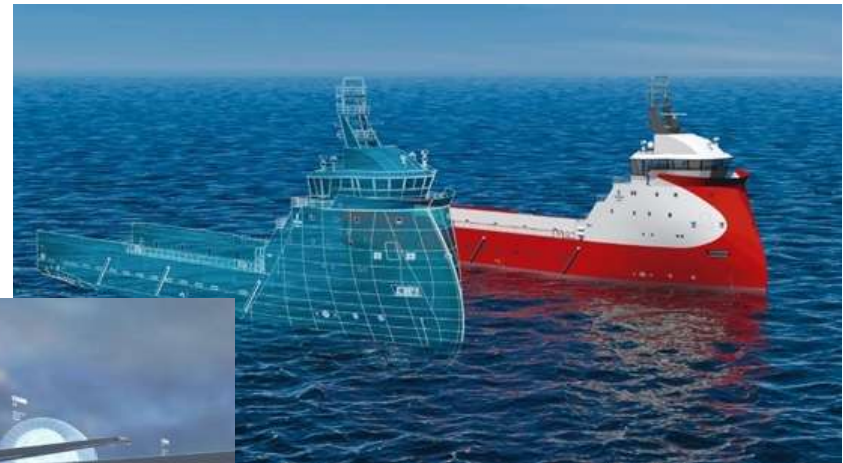


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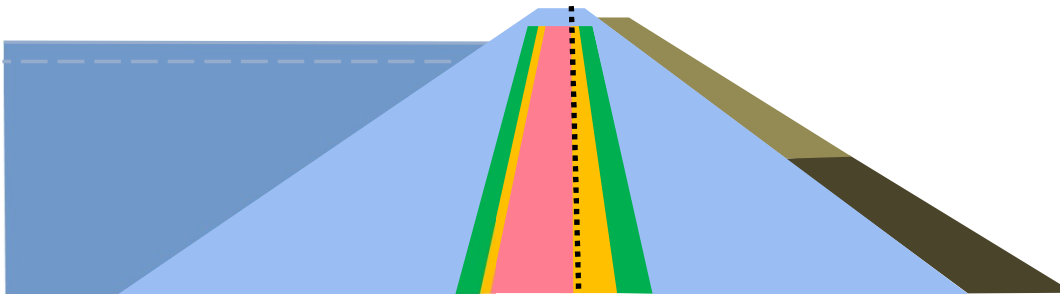
## DIGITAL TWIN

- Virtual copy of something that is real
  - Modelled to behave realistically
  - Mechanical behaviour
    - Measurements





- Difficulties to retrieve samples
  - Effects on the dam
- Dam in Northern Sweden
  - Ca. 45 m high
  - Deformations from inclinometer
  - Parameters for constitutive models
    - Moduli of core and shoulder most sensitive
    - Other parameters from documentation

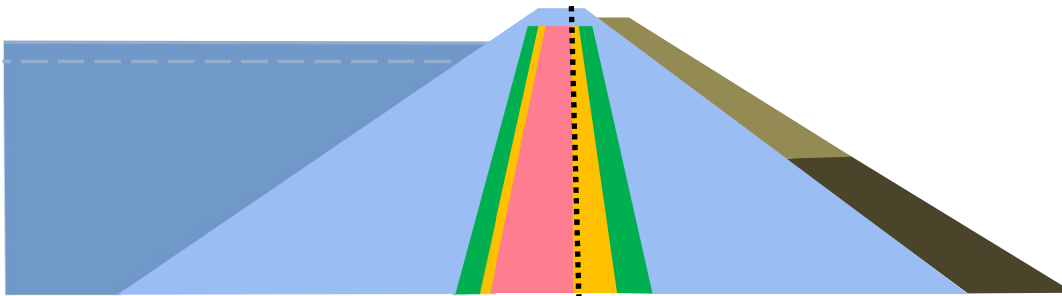


NUMERICAL MODEL → DIGITAL TWIN

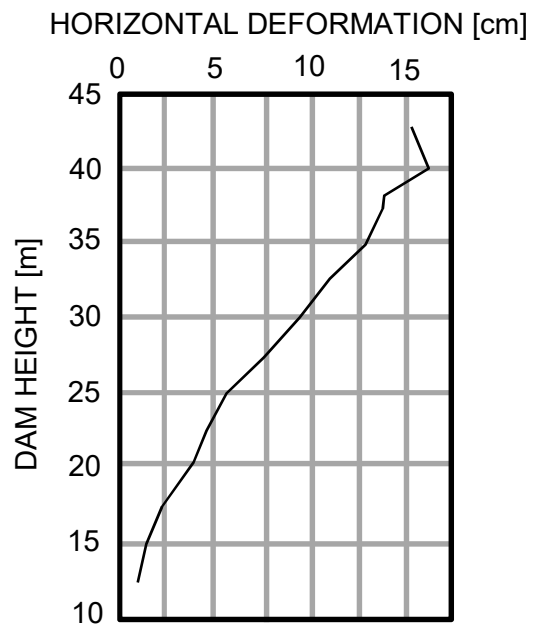
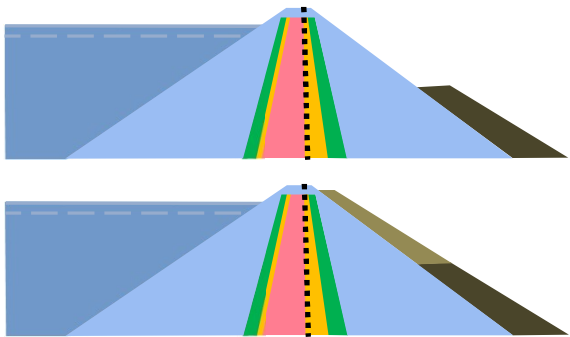


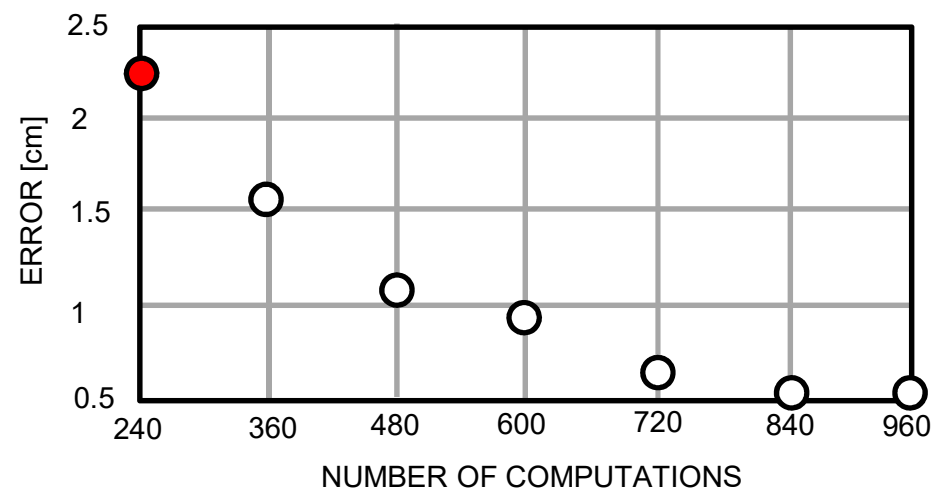
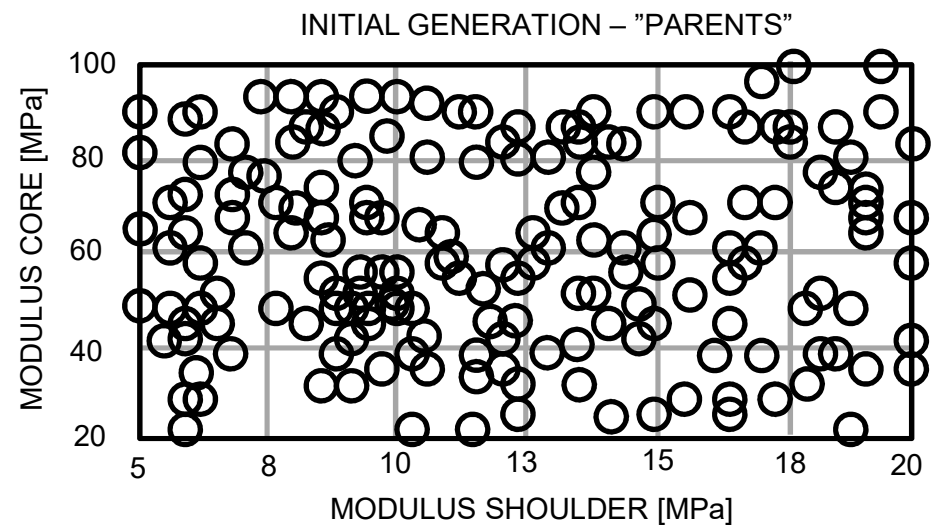
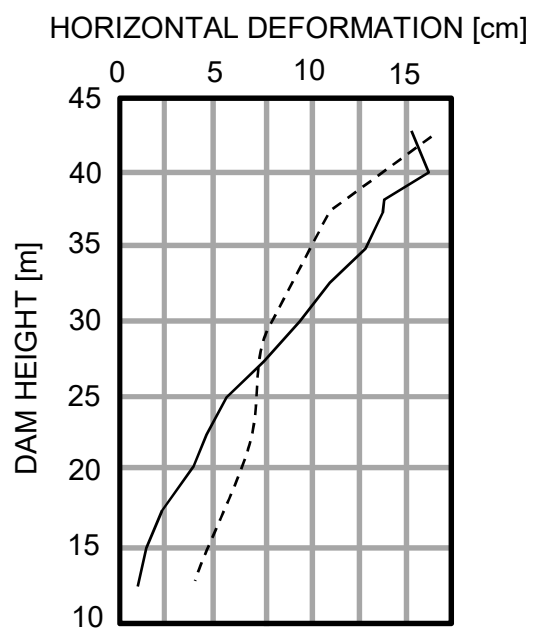
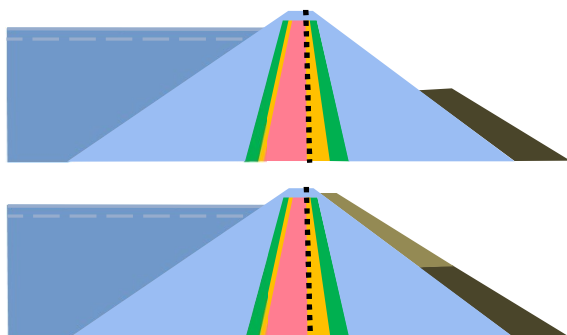
## INVERSE ANALYSIS – NON DESTRUCTIVE

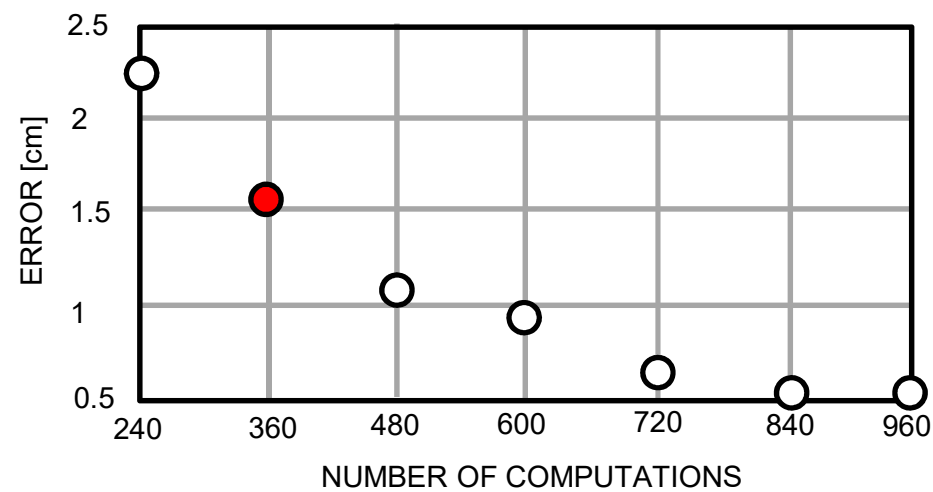
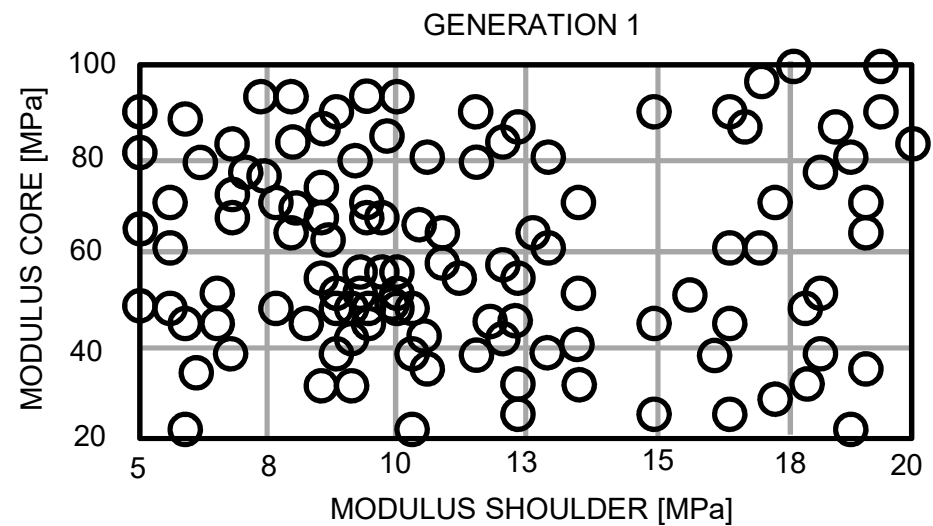
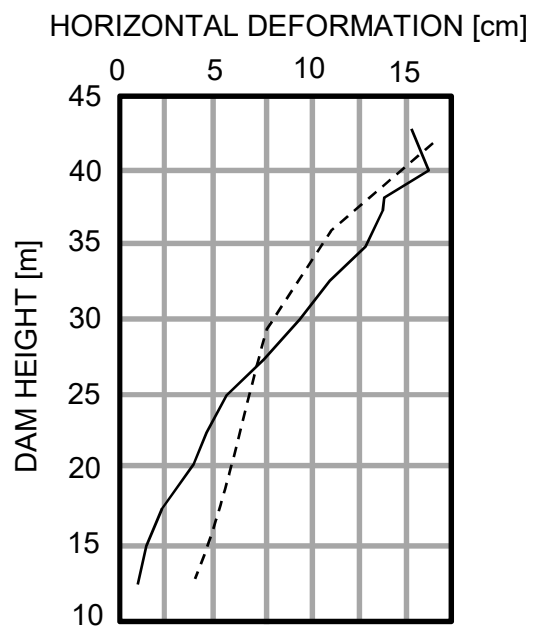
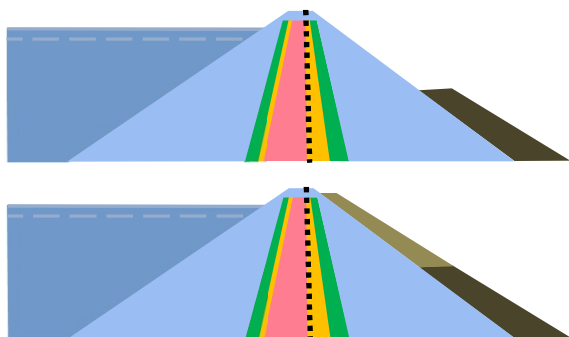
- Numerical model
  - PLAXIS 2D
    - Hardening soil
- Optimisation program
  - Objective function
    - Difference between the computation and measurement
  - Search strategy
    - Genetic algorithm based on evolutionary principles

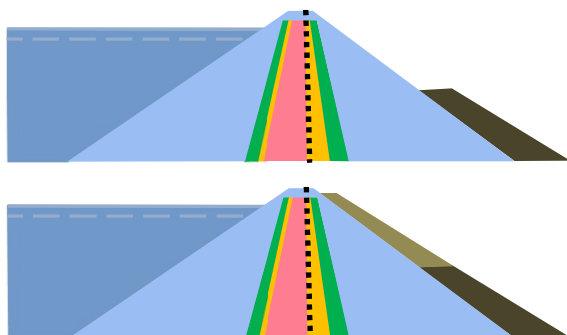


NUMERICAL MODEL → DIGITAL TWIN

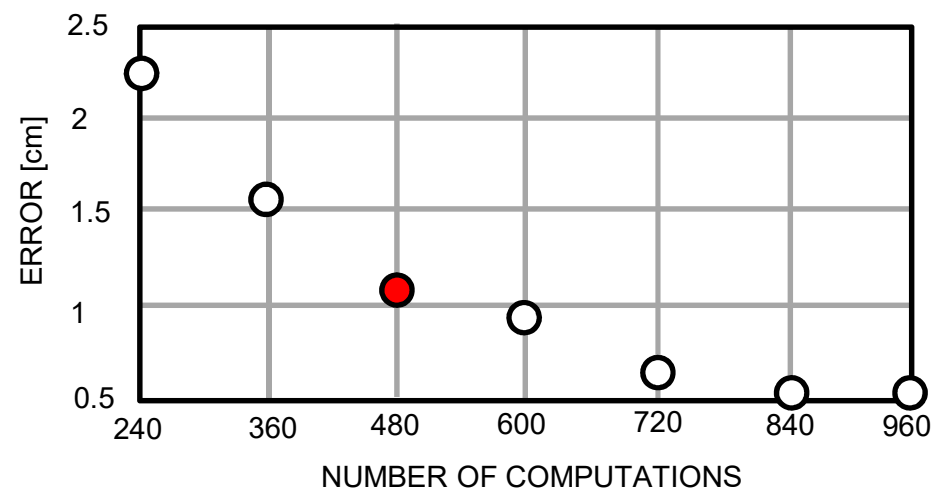
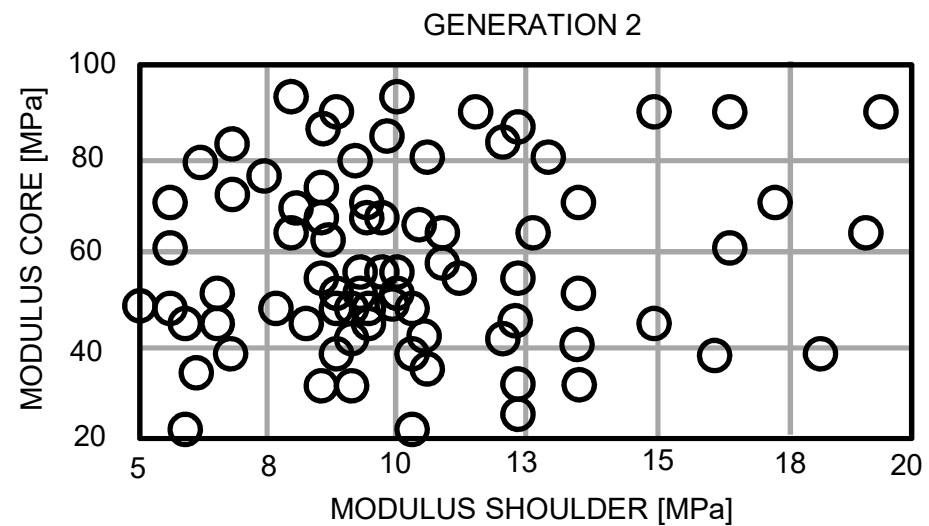
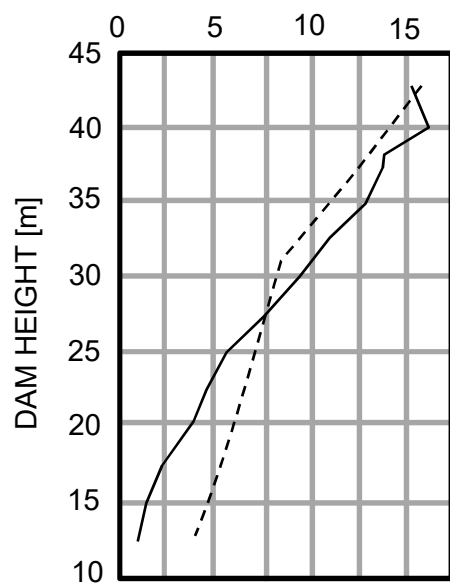




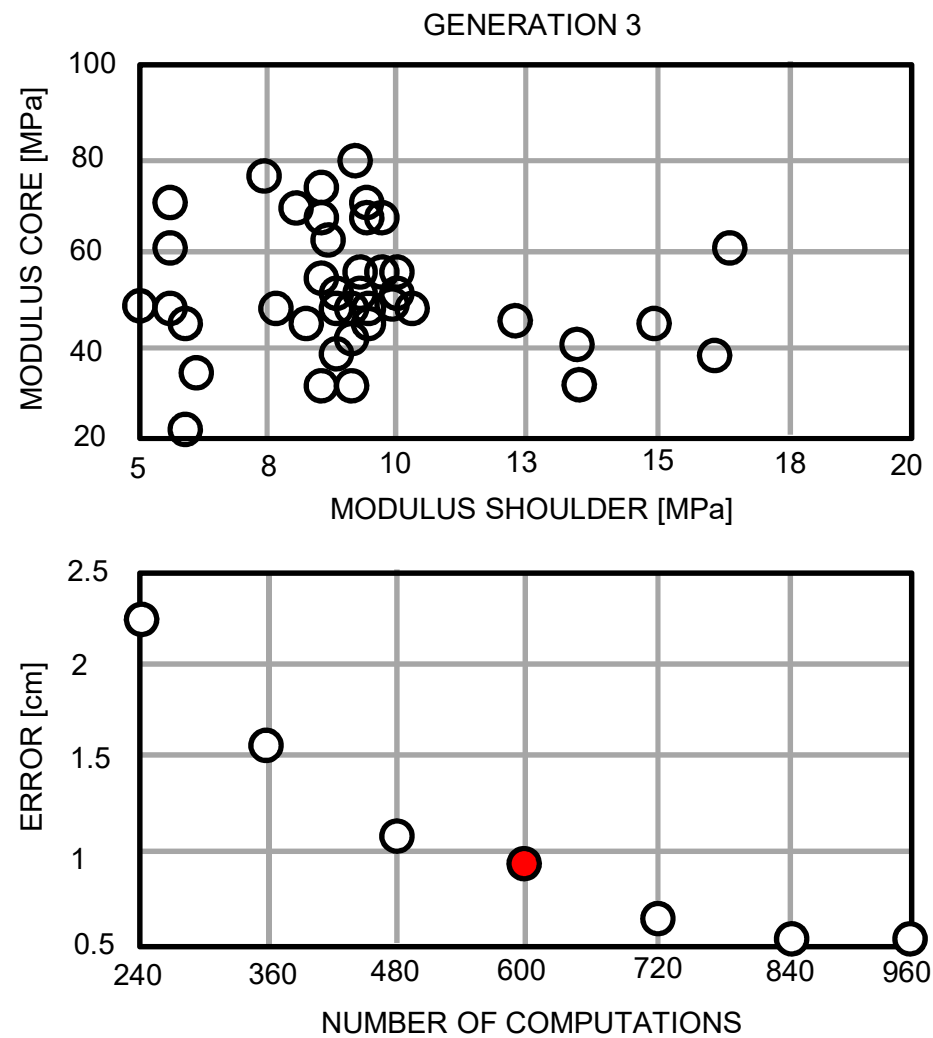
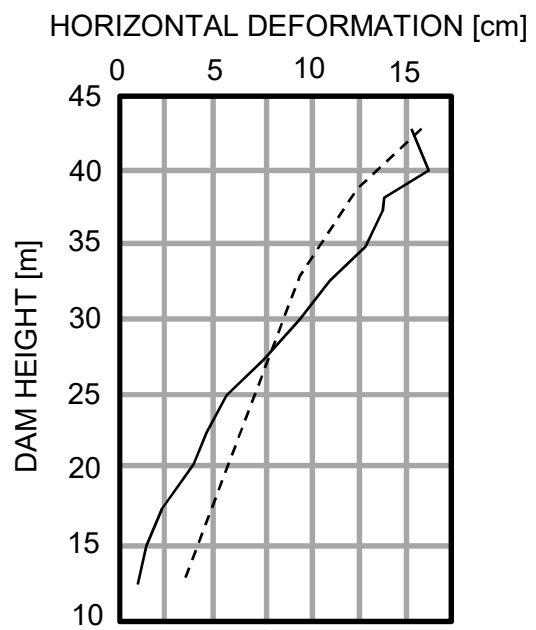
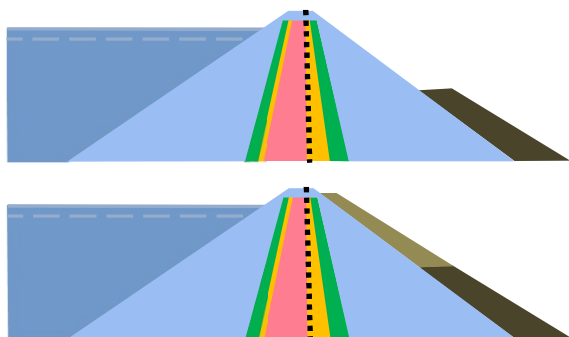


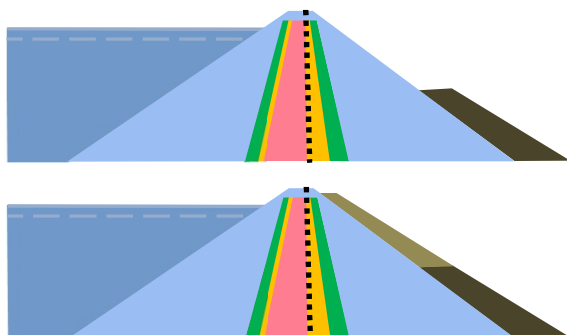


HORIZONTAL DEFORMATION [cm]

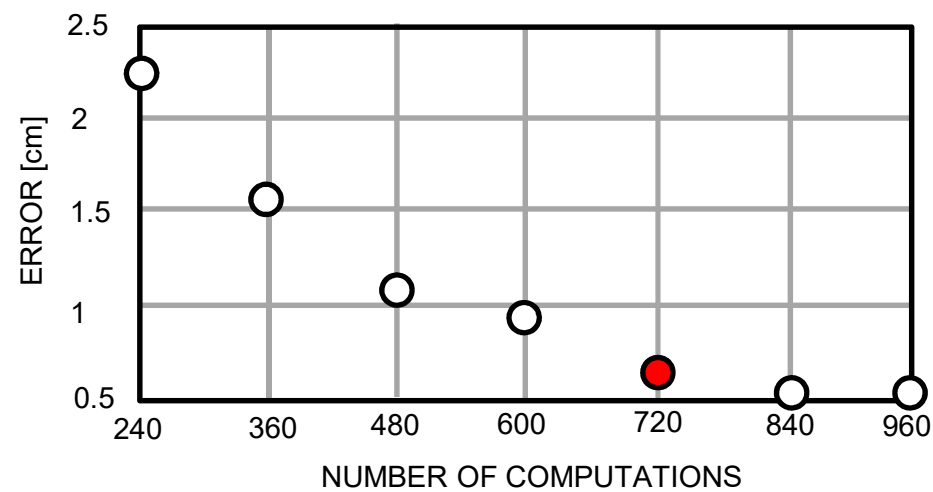
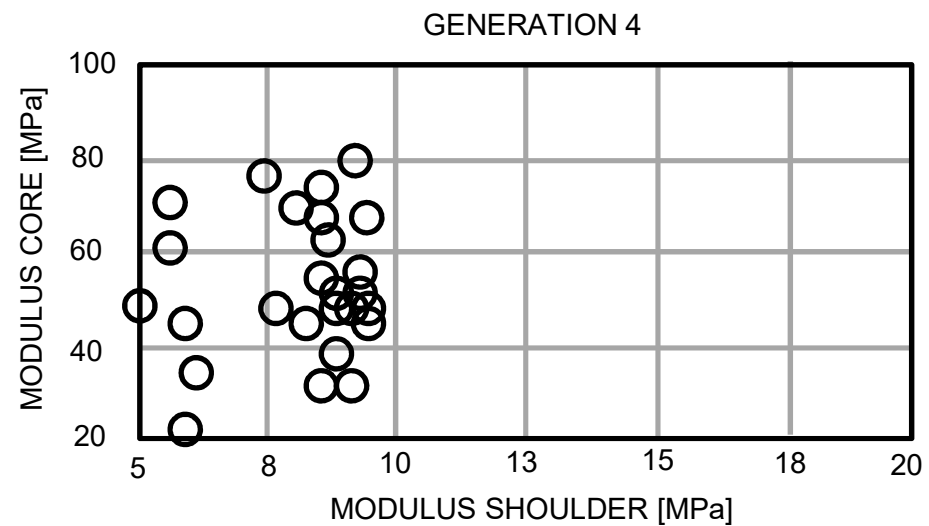
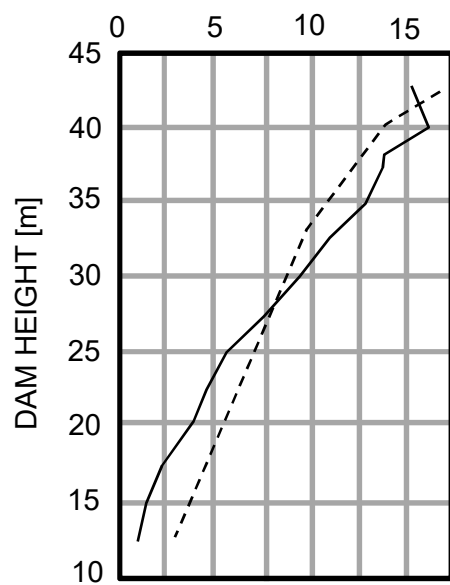


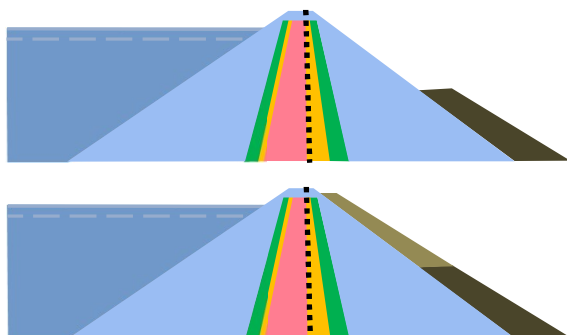




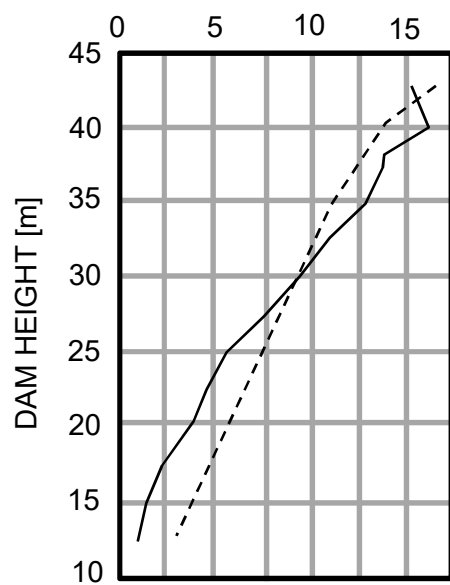


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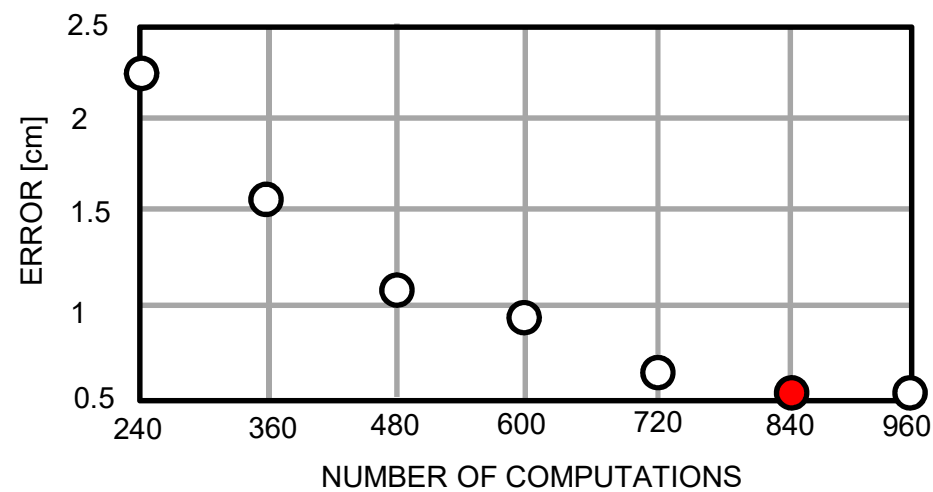
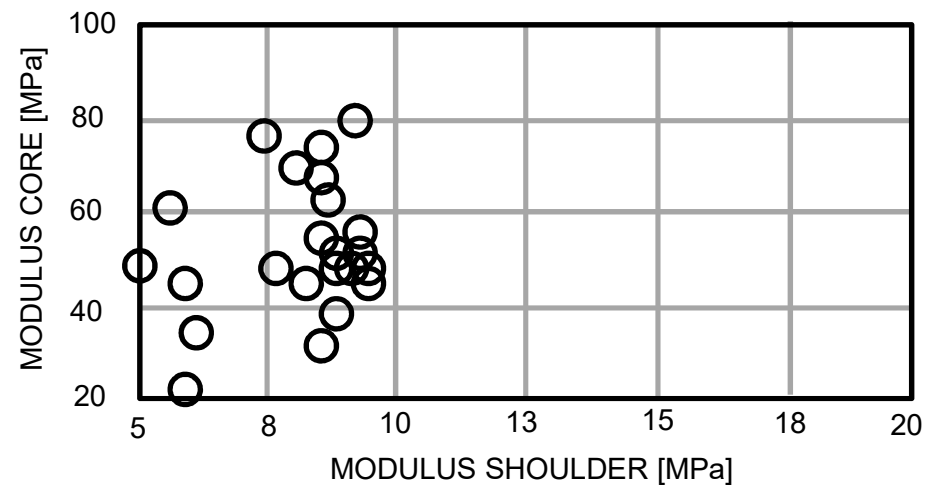


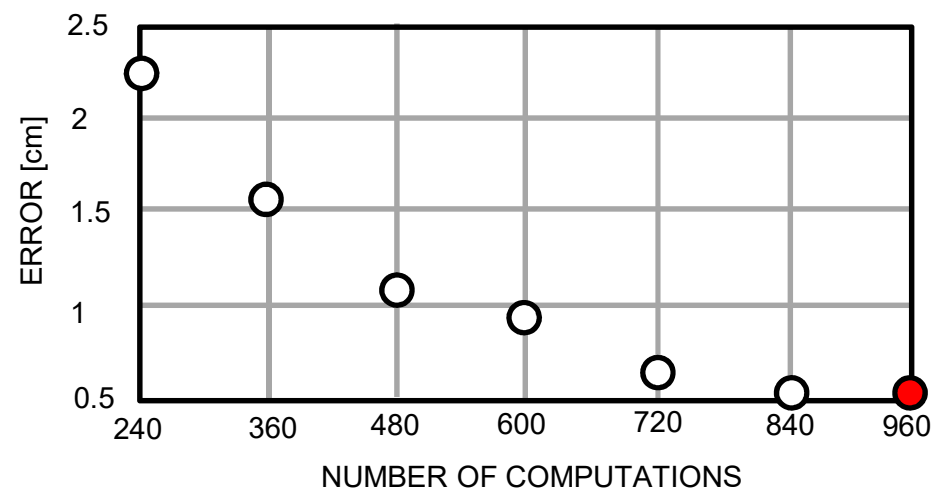


HORIZONTAL DEFORMATION [cm]



GENERATION 5



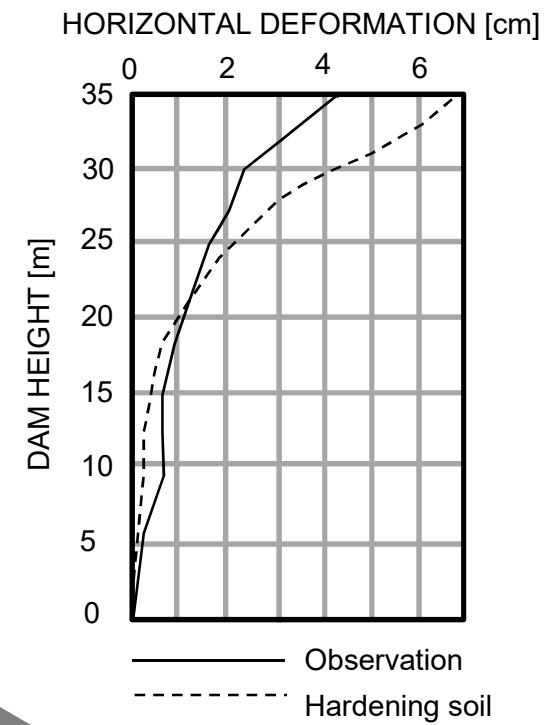
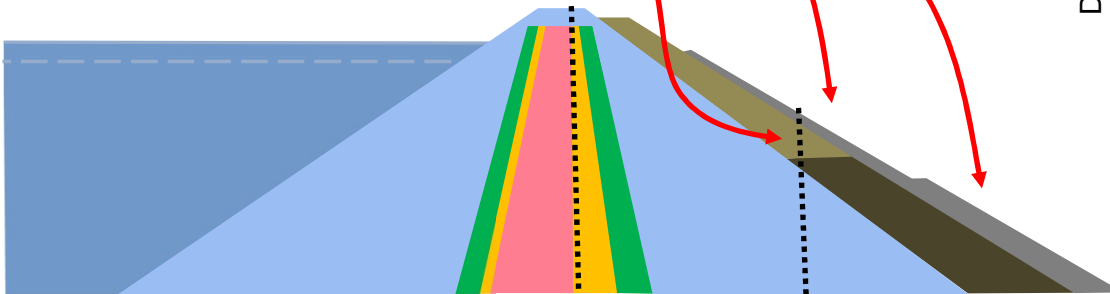




## PREDICTIONS

### ■ Strengthening measures

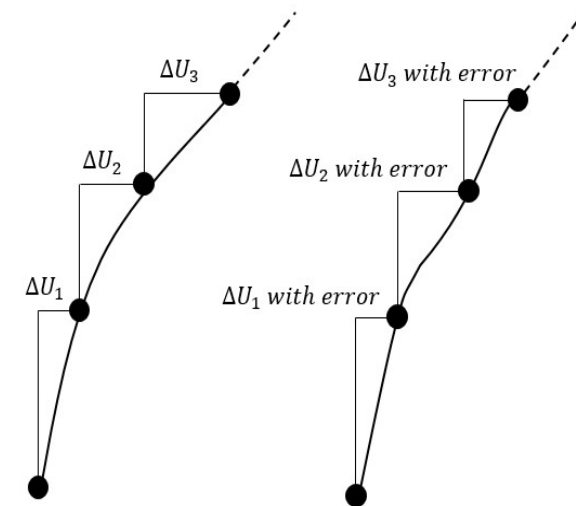
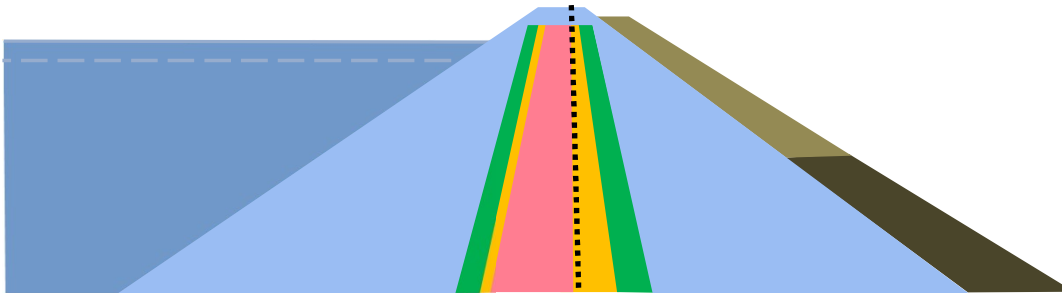
- Predict with data from previous studies
- Adding downstream berm
- New inclinometer installed
- Deformations from the new inclinometer





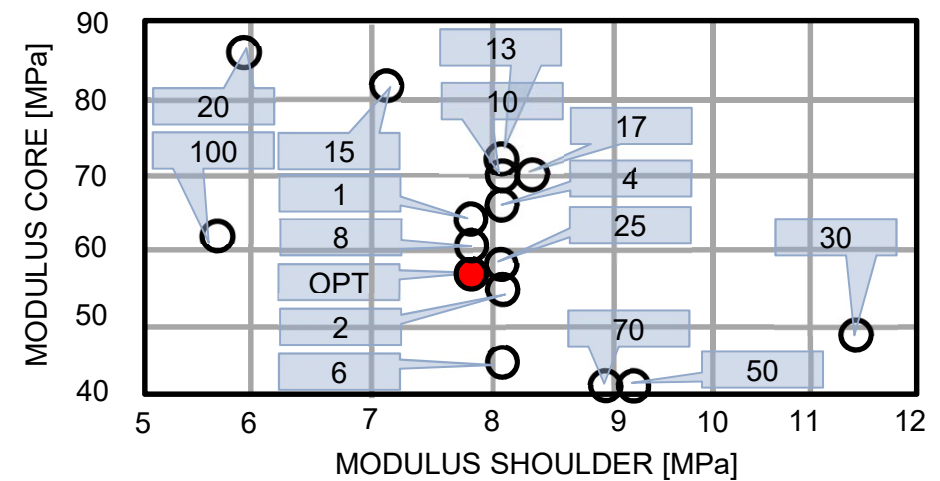
## CAN THE SEARCH ALGORITHM HANDLE ERRORS?

- Occurrence of errors
  - Equipment precision, installation, readings etc.
- Synthetic inclinometer data
  - Numerically generated data based on the optimum solution
- Add errors to the inclinometer data
  - Generated randomly within an interval





- Optimum solution ●
  - Base for the synthetic inclinometer data
- Solutions for inclinometer data with errors
  - Solutions found





## CONCLUDING REMARKS

- INVERSE ANALYSIS:
  - A non-destructive method, suitable to apply on existing embankment dams in order to provide mechanical properties. These properties can later on be used in predictions.
  
- MEASUREMENT ERRORS:
  - The genetic algorithm is robust.





## FUTURE WORK

- Include other types of measurements
  - Ongoing collaboration with Vattenfall R&D
  - Test embankment dam
- Increase the number of optimization parameters
- Test other search algorithms
- Verify against laboratory tests
  - Collaboration with LKAB, mining company
    - Tailings dam

**THANK YOU FOR LISTENING!**

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