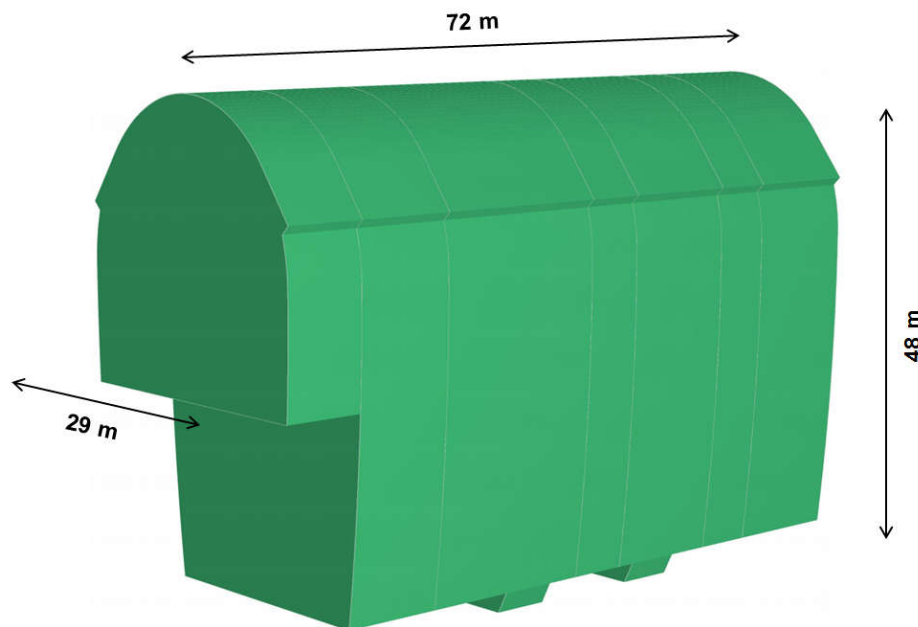


3D numerical stability analysis of a power plant cavern

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Michael Rudolf Henzinger, TU Graz
Wulf Schubert, TU Graz

1. Project overview

■ Cavern size

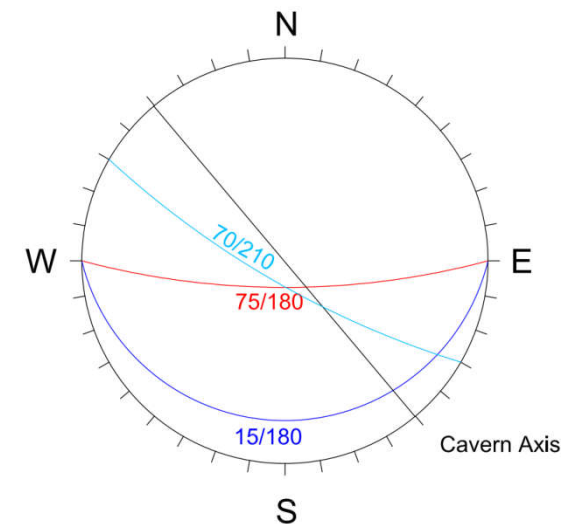
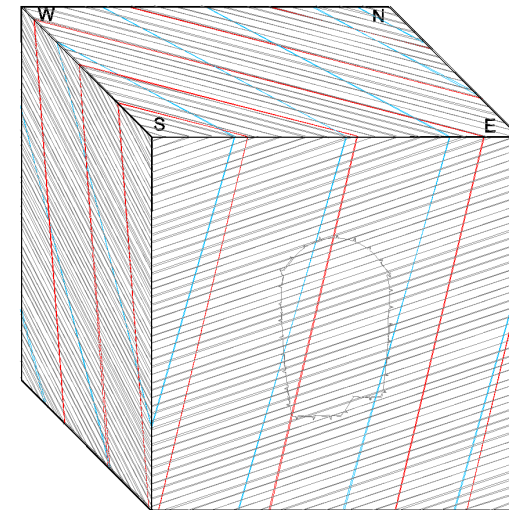


- Overburden = 200 m
- Axis orientation = 140°
- Excavation volume = 87000 m³

2. Geological conditions

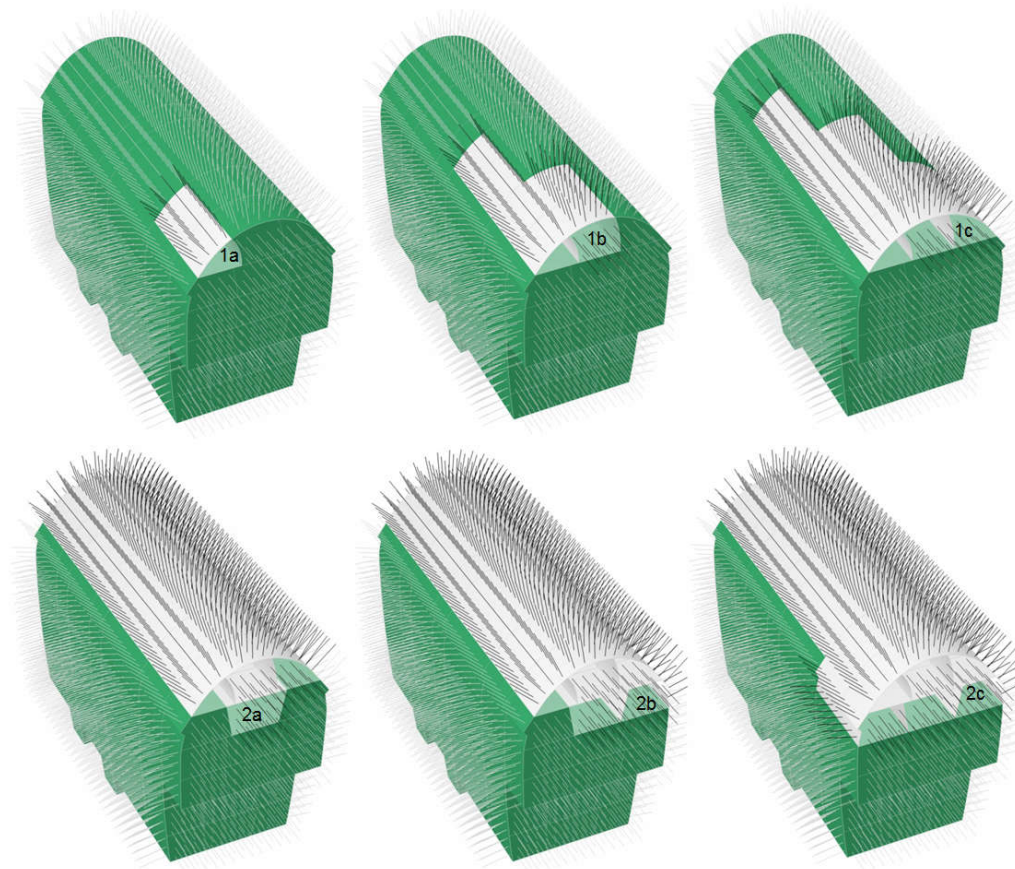
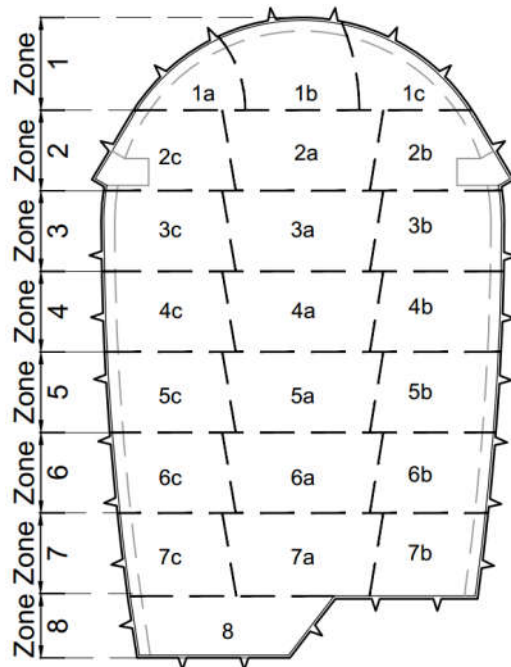
- Rock type
 - Plagioclasgneiss

- Joint orientation
 - Foliation SF= 15/180
 - Joint K1=75/180
 - Joint K2=70/210
 - Spacing between joints 60-to 200 cm



3. Excavation and support measures

- Excavation sequences



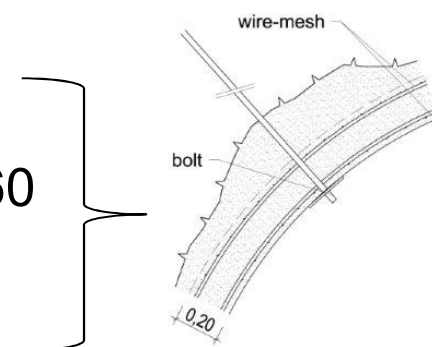
3. Excavation and support measures

- Support measures

- Cavern roof

20 cm shotcrete + 2 layers of wiremesh AQ60

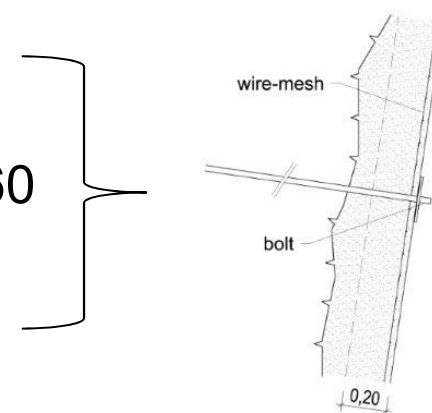
Systematic bolting (l=6 m capacity =250 kN)



- Cavern sidewalls and end walls

20 cm shotcrete + 1 layers of wiremesh AQ60

Systematic bolting (l=6 m capacity =250 kN)



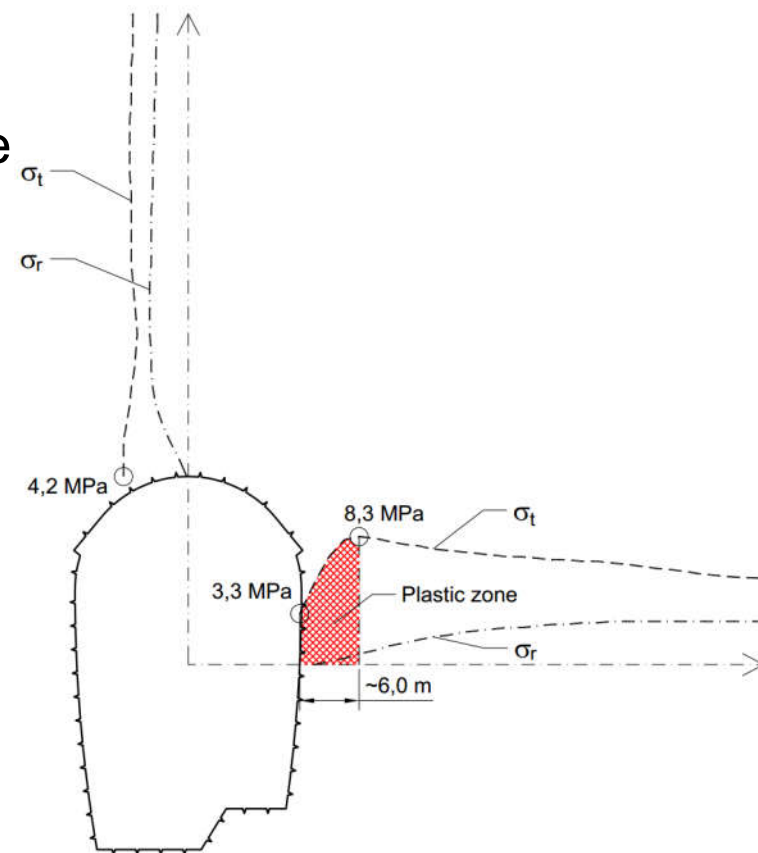
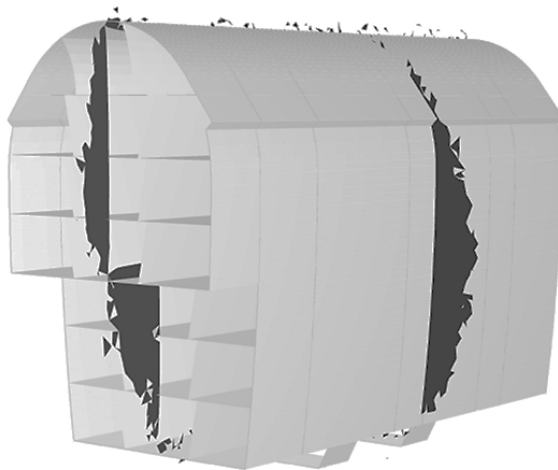
4. Numerical analysis



- Numerical model
- Dimensions of the model $l=267$ m/ $w=152$ m/ $h=285$ m
- The failure criterion by Mohr-Coulomb is used
- The excavation is modeld in 80 stages
 - Stage 1 = primary stress
 - Stage 2-80 = excavation and installation of the support
- The bolts are implemented as fully bonded bolts
- The shotcrete lining is modelled with elastic beam elements

4. Numerical analysis

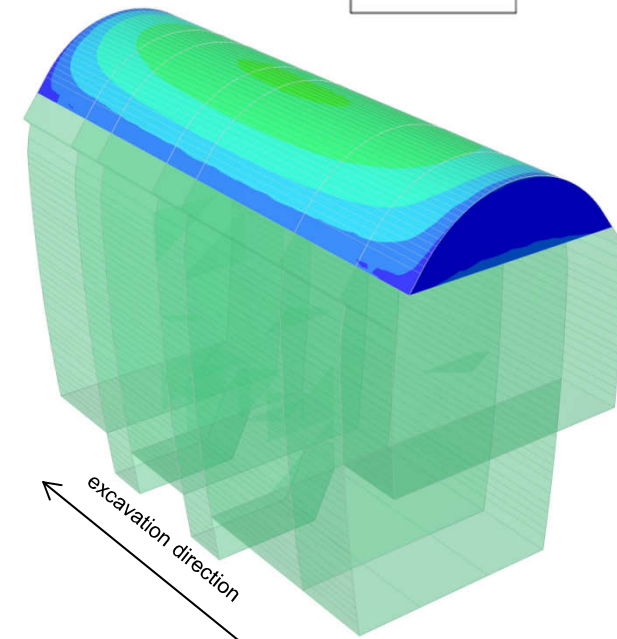
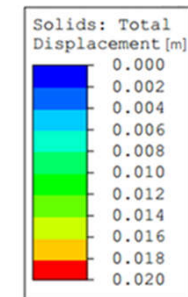
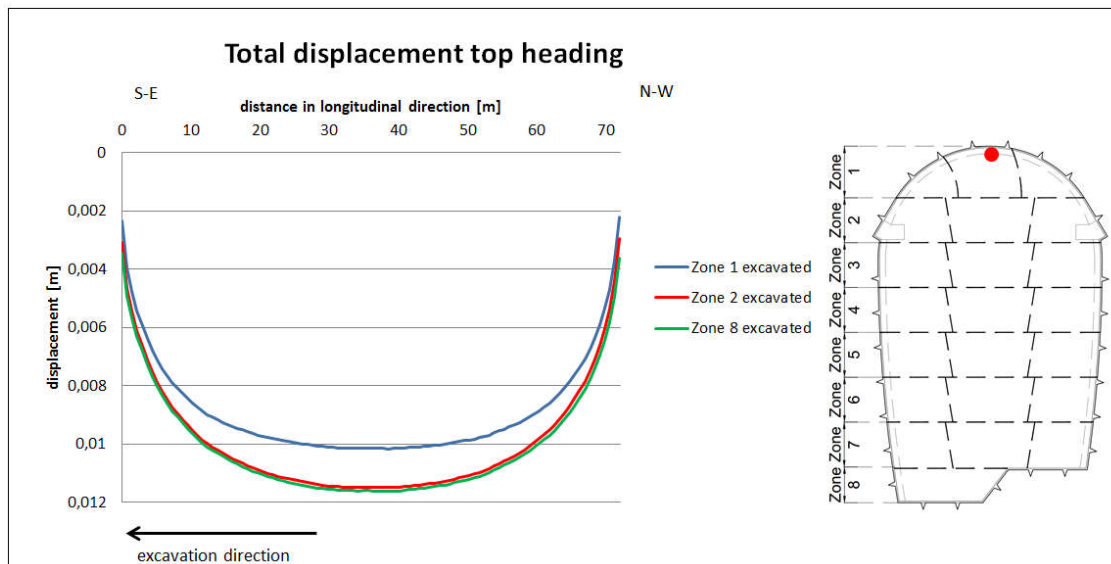
- Calculation results
- Stress distribution & plastic zone



4. Numerical analysis

■ Calculation results

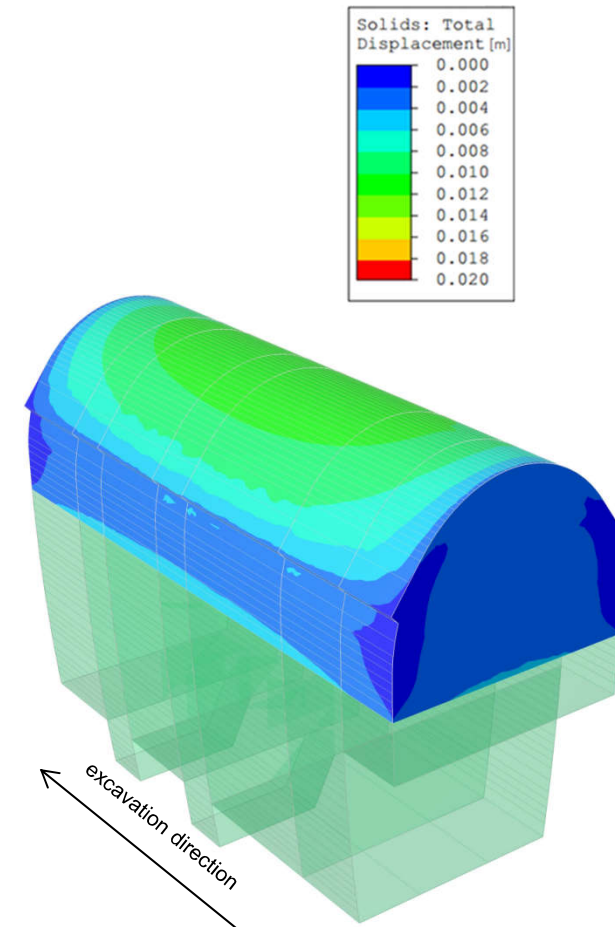
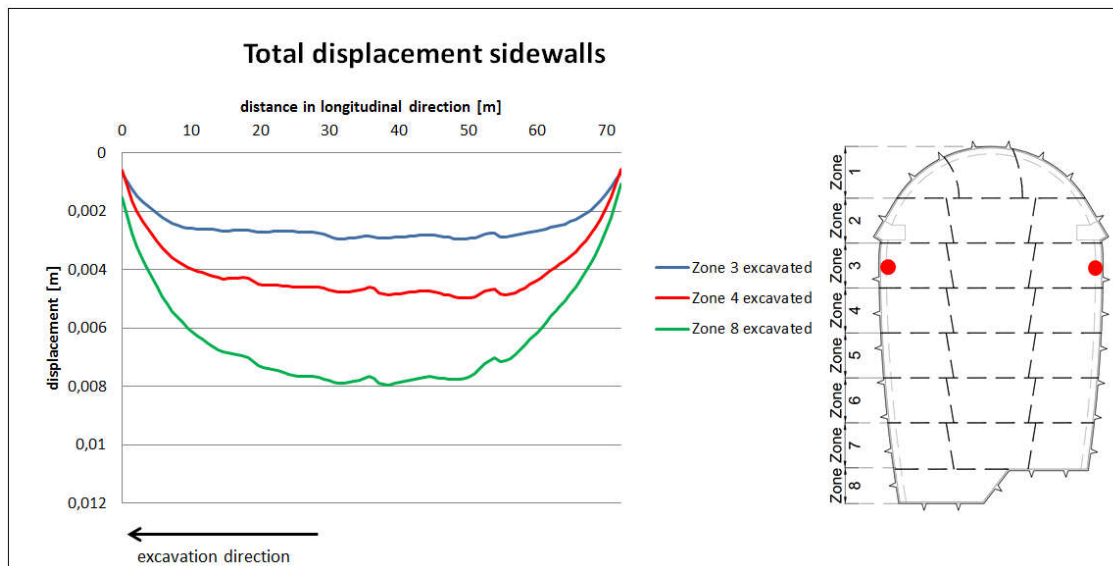
➤ Displacements top heading



4. Numerical analysis

■ Calculation results

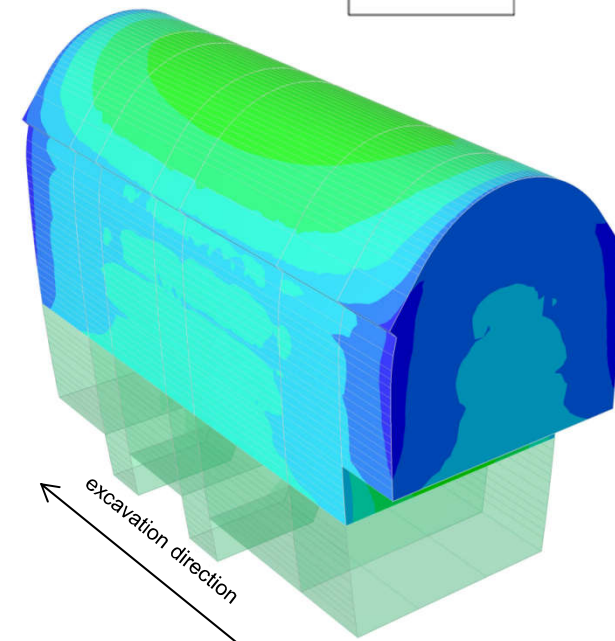
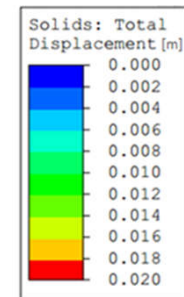
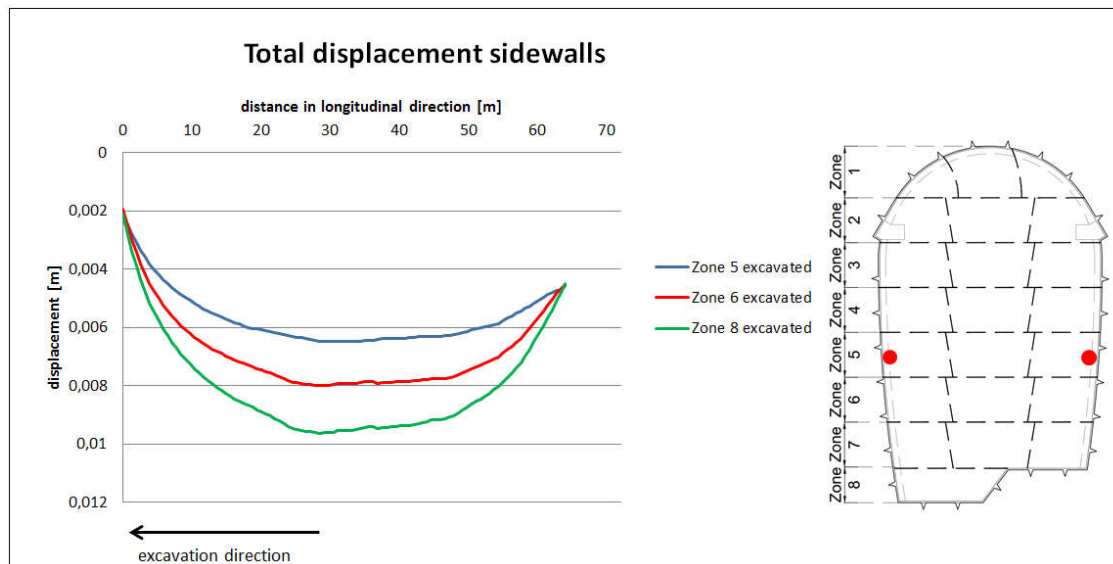
➤ Displacements upper bench



4. Numerical analysis

■ Calculation results

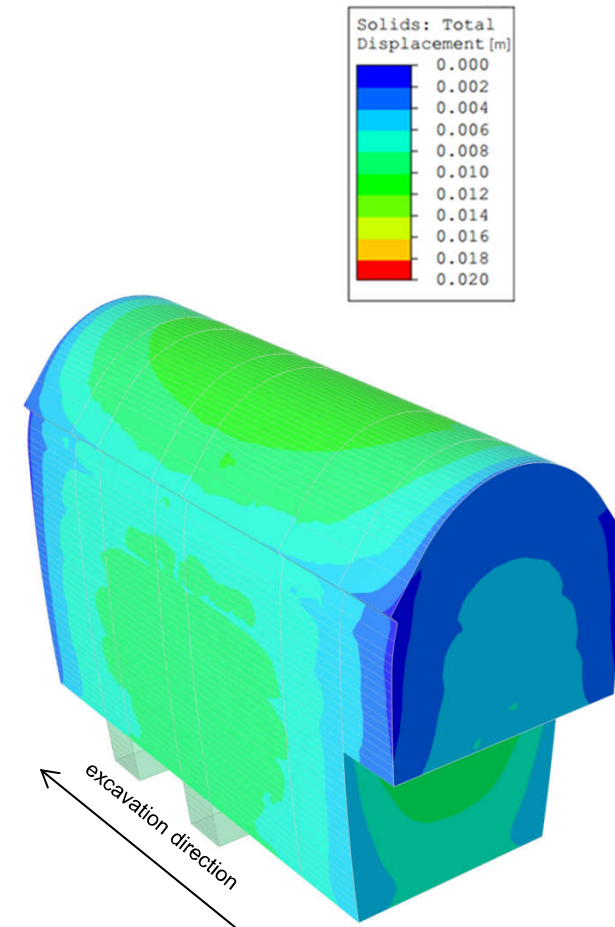
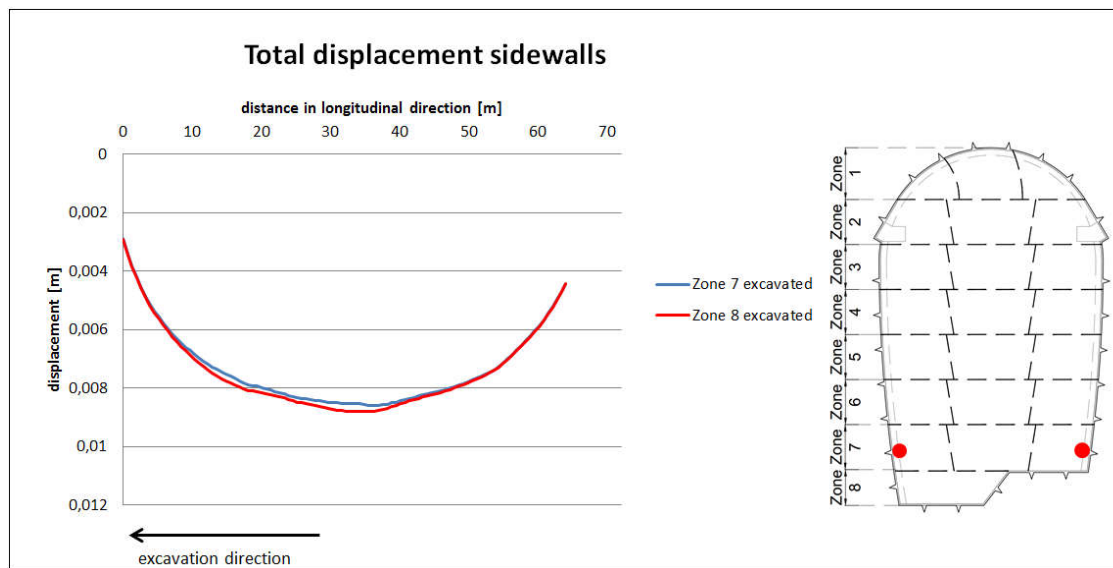
➤ Displacements central bench



4. Numerical analysis

■ Calculation results

➤ Displacements lower bench



4. Numerical analysis



- Calculation results

- Utilization of support measures

- Shotcrete

- Max. axial stress in the shotcrete lining 24,0 MN/m²

- Max. shear stress in the shotcrete lining 0,45 MN/m²

- Bolts

- Max. axial bolt load 245 kN

5. Conclusion

- Deformations of up to 1,2 cm during the excavation
- The extension of the plastic zone is about 6 m
- No unfavourable stress redistribution during the excavation
- Due to the depth of the plastic zone, the bolt length at the side walls and at the end walls should be increased from 6 to 8 m
- The shape and orientation of the cavern as well as the excavation sequences and support measures are suitably selected for the given conditions

Thank you for your attention