JACKING OF ROCK FRACTURES DURING PRE-GROUTING IN SCANDINAVIAN TUNNELING PROJECTS
-A CASE STUDY OF THE EFFECTS FROM CHOSEN GROUTING PRESSURE

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Objectives:

- To investigate the effect of the choice of injection pressure in the pre-grouting of rock tunnels
- To give an insight to the practicing engineers about the benefits and disadvantages of using low or high pressures

Scope:

- Defining requirement for successful grouting
- Discussing current grouting practices
- Examining different parameters, which may be affected by a change in the pressure
- Analyzing grouting in a tunnel in Sweden and a tunnel in Norway and comparing the results

Requirements on pre-grouting

- Obtaining the required sealing efficiency
- Completing grouting in one round
- Managing grouting time to get the desired sealing in shortest time
- Take attention to environmental considerations
- Consider safety issues

Current Practices:

- Norwegian practice: the permissible grouting pressure will vary from a few bars up to 100 bars and it depends on the in-situ stresses and the position of the grouting hole
- U.S. practice: Characterized by Monitoring of the grouting process, reduce the Apparent Lugeon value to zero, and low grouting pressure
- Swedish practice: the pressure is determined based on the geological properties and the flow of grout. New theoretical developments are applied
- GIN method: Set certain maximum limit for pressure and grout volume as well as combination of them. Ambiguities are connected to this method

Analysed case studies

- Two case studies were analyzed with respect ot grout spread and jacking: The Stockholm City Line Project in Sweden and the Holm – Nykirke Line project in Norway

- The Swedish project used a grouting pressure of 2 MPa (with rock cover 15-30 m) and the Norwegian project a pressure of 8 MPa (with rock cover 50-170 m).

- By using the theoretical approach of the Real Time Grouting Control Method, together with developed theory for analysis of jacking, the grout spread could be estimated when no jacking occur and when jacking actually occurs.

- Several signs of jacking were observed in the Norwegian project, while only few cases of jacking were observed in the swedish project.

Conclusions:

- RTGC application provides a tool that gives essential information about the spread of the grout and the state of deformation of the fracture
- The estimated values of spread distance and deformation are valuable if they are examined against the recorded and observed data and events
- The extended application for the calculation of the consequences of elastic jacking works well, and it can be implemented in an online application
- A combination of high pressure and long grouting time in the Norwegian project could lead to unnecessarily long spread of grout and injection of a large volume of grout and large deformations
- It seems that possible hidden consequences of these deformations can have a significant impact on the sealing requirements as well as on the economy of the project.
- The theoretical approach can provide essential information by quantifying consequences of elastic jacking that can be used for an optimizing of the injection pressure and stop criteria in the design phase