Utveckling av dynamisk injektering Etapp 2
Development of dynamic grouting Stage 2

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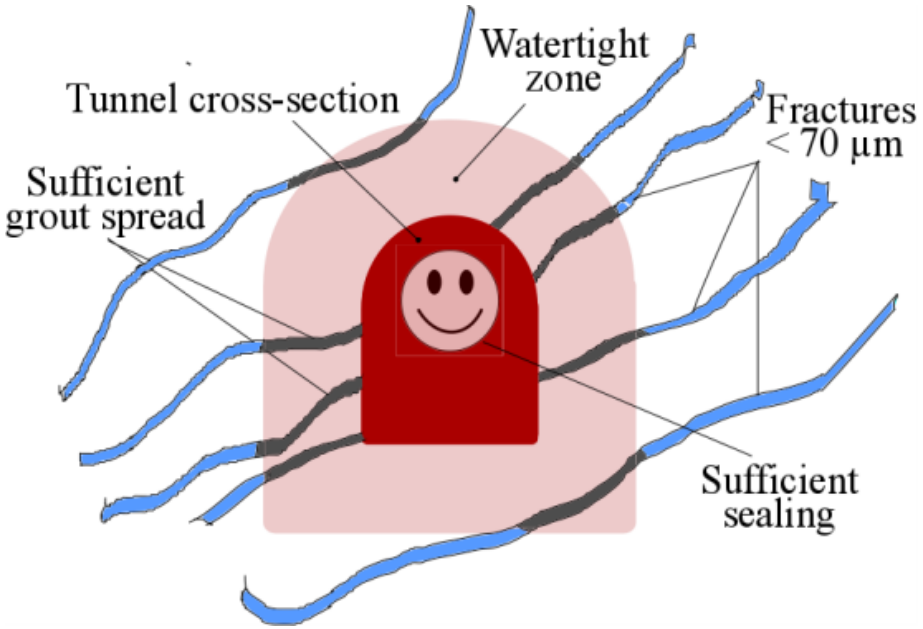
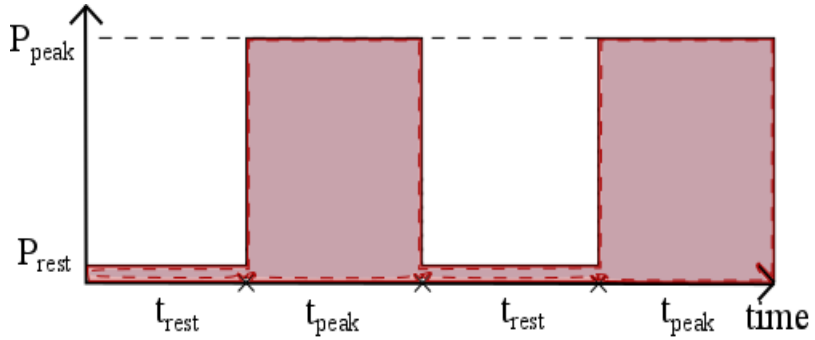
Background



Effective grouting in tunnel

Dynamic injection



Low-frequency rectangular pressure impulse

Mechanism of action

Erosion of the filter cakes due to continuous change of flow pattern.

Expected outcome

- Less dissipation of the pressure impulses along the fractures.
- Effective improvement of grout spread in fractures ≤ 70 µm

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Goals

Verification of the efficiency of the method in controlled condition in the lab.

Stage 1: Design, production, and pilot test of the distribution unit

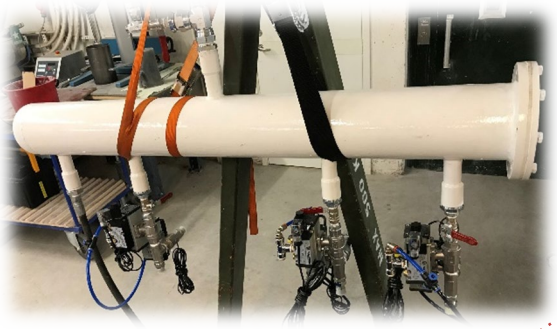
Distribution unit at laboratory

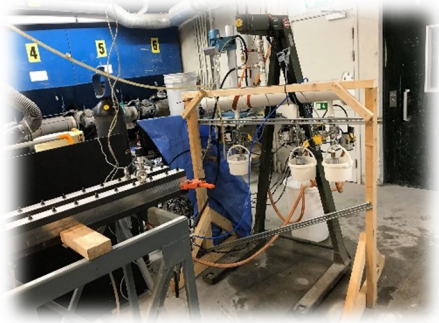
Demonstration of the effectiveness of the method to the stakeholder in the field.

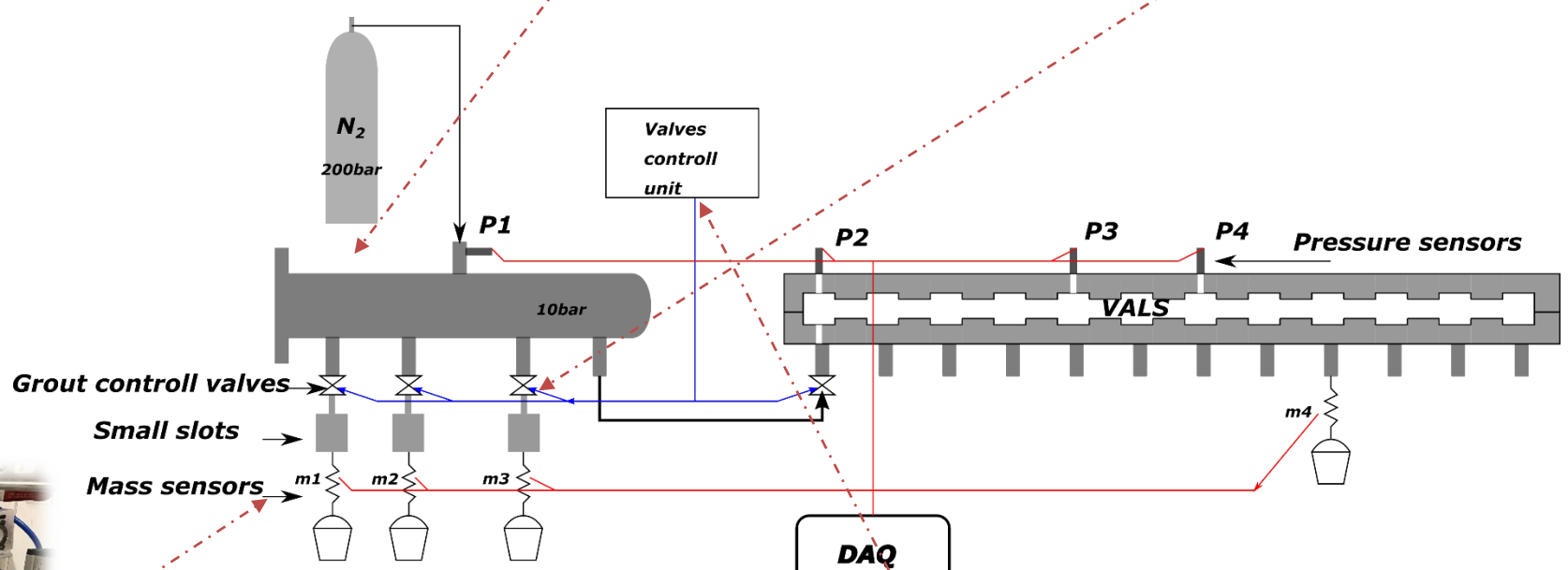
Stage 2: Field-scale experiments in Äspö HRL

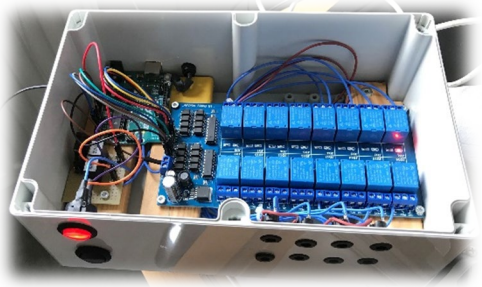
Distribution unit at Äspö HRL

Stage 1 R&D and pilot test of the distribution unit









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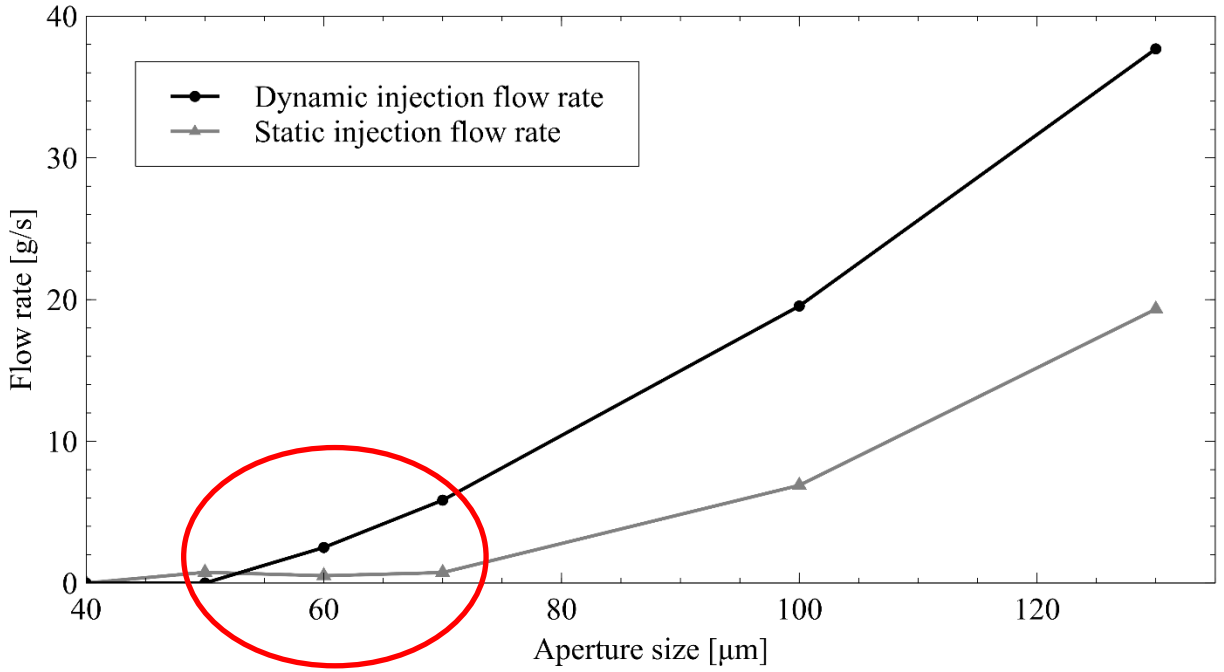
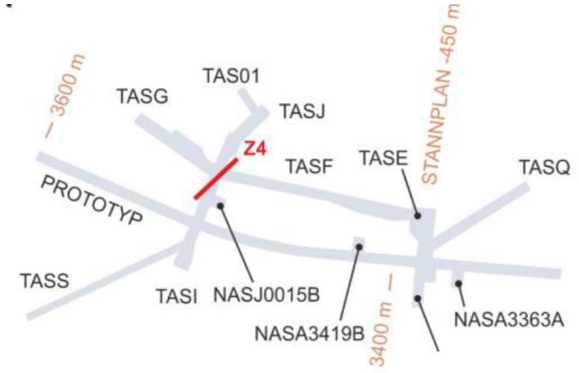
Stage 1 Important results and conclusion

- The average flow-rate was higher for dynamic injection at all apertures.
- The grout penetrated up to 60 µm aperture for dynamic injection.
- The grout flow stopped at 70 µm aperture for static injection.

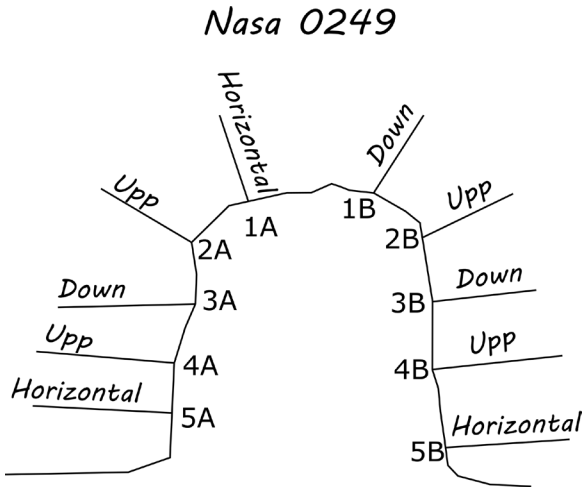


Average grout flow rate for static and dynamic injection

Stage 2 – Preparation



Location search at Äspö HRL



Drilled 10 boreholes at site NASA 0249A

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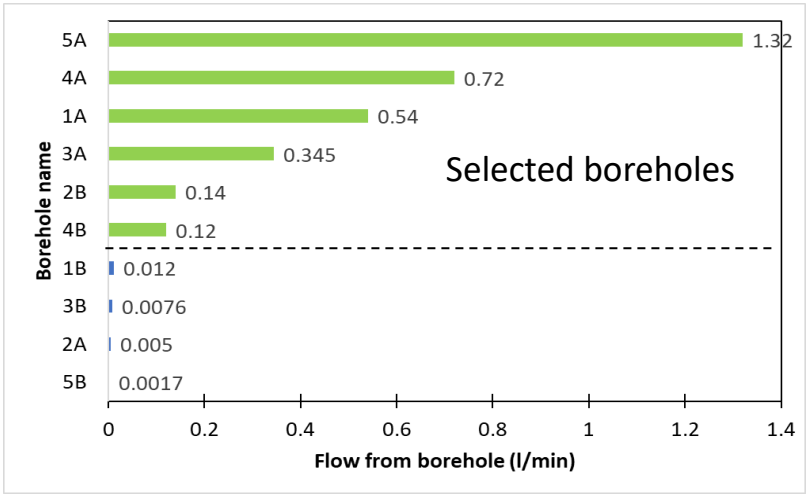
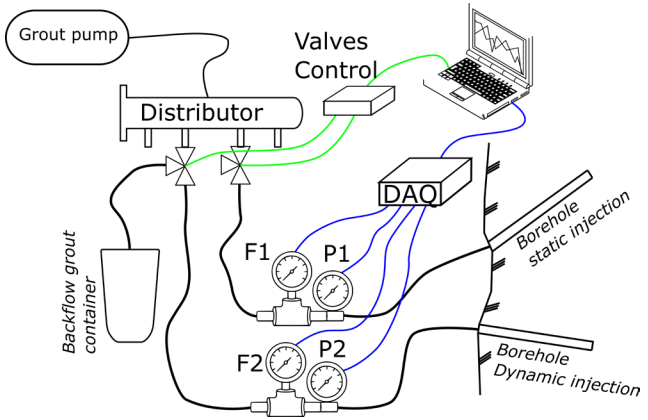


Hydrology tests



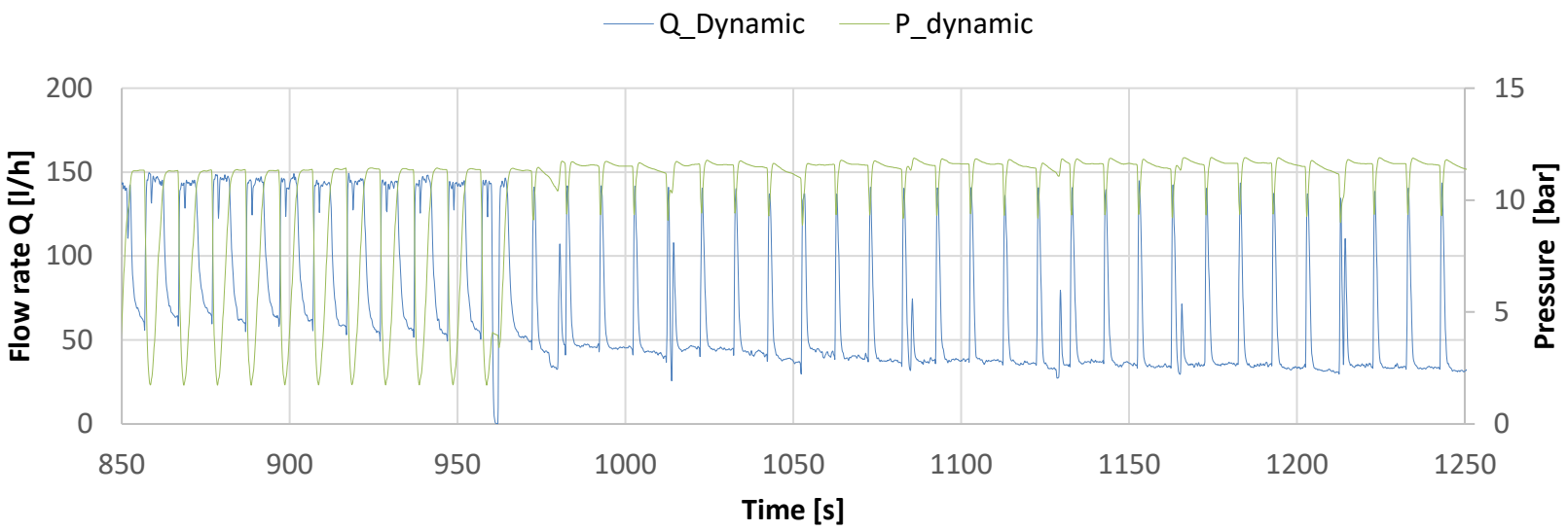
Schematic of setup

Full set up

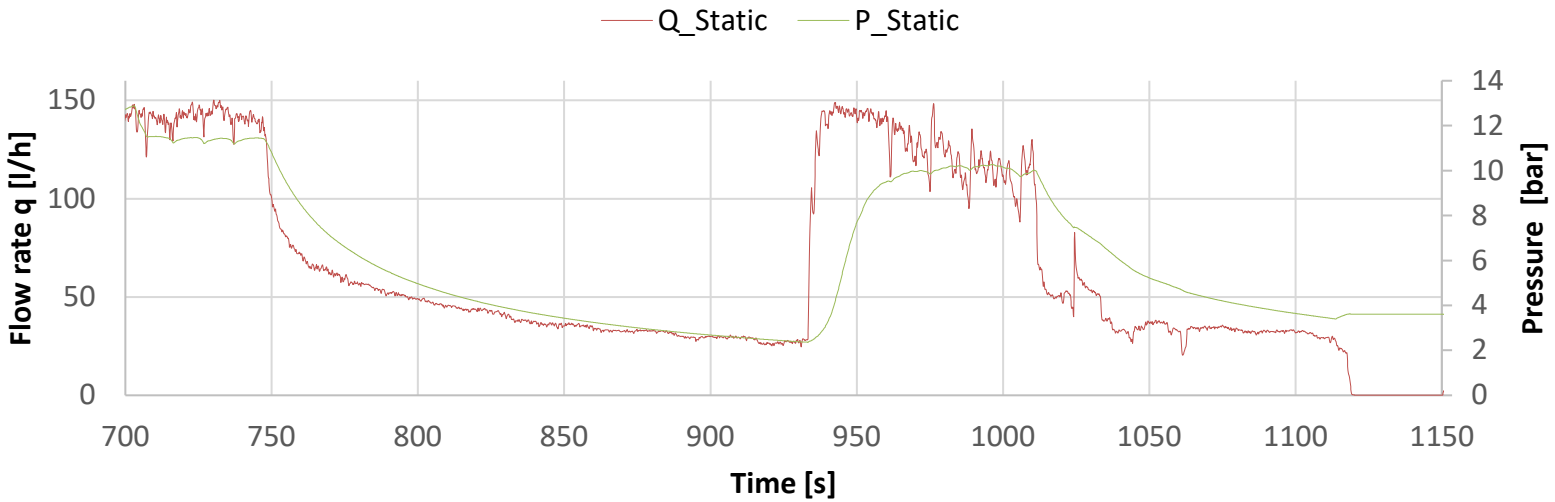
Flow meters

Stage 2 – Results

- Field test graphs for borehole 1A and 3A indicated that the dynamic injection helps to maintain maximal injection pressure at small flow rates.
- The dynamic approach even increases the injection pressure when the injection period was increased from 4 sec to 10 sec, and the pressure release period was also increased.
- For boreholes with possible bigger apertures (refer Hydro test I flow results), the reduction of grout flow rate was resulted in reduction of injection pressure, which shows that in current field test dynamic injection approach was not sensitive to change in the flow rate and maintained high pressure during injection of grout.



Borehole 1A dynamic injection



Borehole 3A static injection

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Summary

- During this project dynamic injection approach was tested in laboratory and field conditions.
- At the laboratory tests the dynamic injection showed large flow rate at all apertures and a flow was recorded down to 60 µm size aperture, while for static injection grout flow was stopped at 70 µm aperture.
- In field test, the dynamic injection helped to maintain maximal injection pressure also at small flow rates. This was applicable for both types of boreholes: with high ground water inflow and low ground water inflow.
- In the field test, the unique experience was gathered by combining experimental apparatus, laboratory sensors with industrial injection system to perform successful dynamic injection grouting.