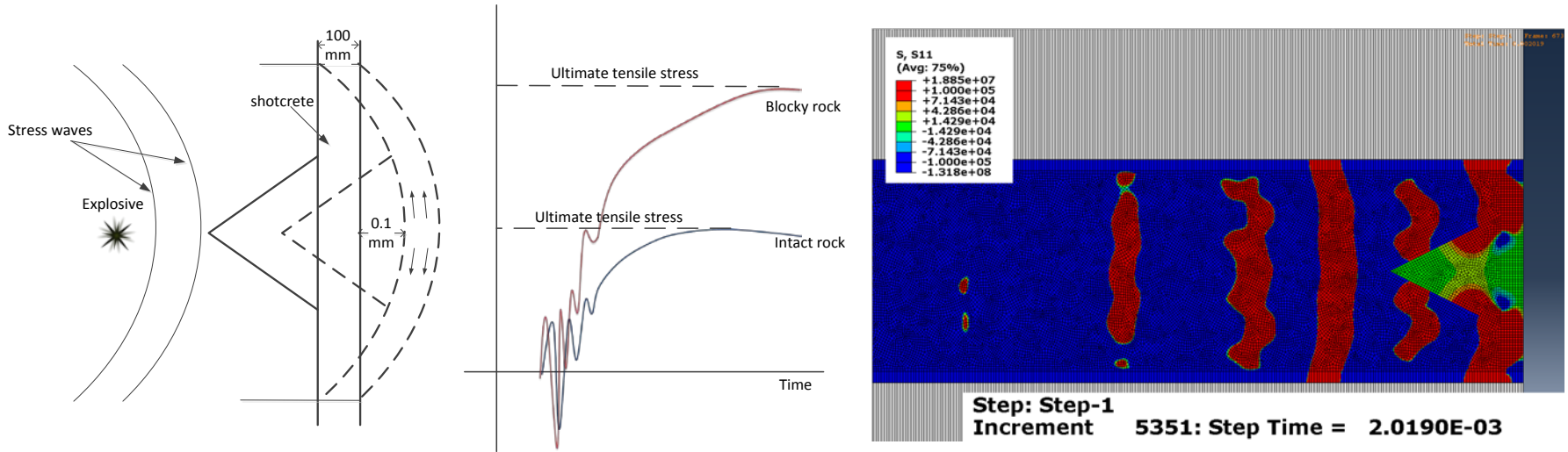


Failure modes of shotcrete on jointed rock subjected to impact-type loads



Lamis Ahmed, 2016

KTH Architecture and the Built Environment



BeFo Report 166, 2016

Introduction

Numerical modelling was performed to exam the behaviour of the shotcrete liner in moderately jointed hard rock under blasting loads. The dynamic analysis that realistically captures the characteristics of the blasting load was studied.

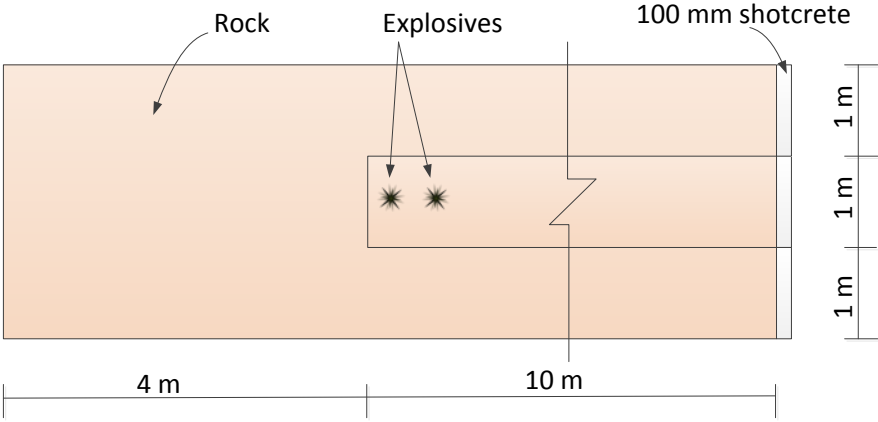
Aim of the research

The main goal is to recommend a finite element based analysis model, describing how the blasting load can be practically applied and how the resulting stress wave propagation can be modelled and described numerically.

The goal is also to interpreter for how criteria for multiple explosive charges should be formulated.

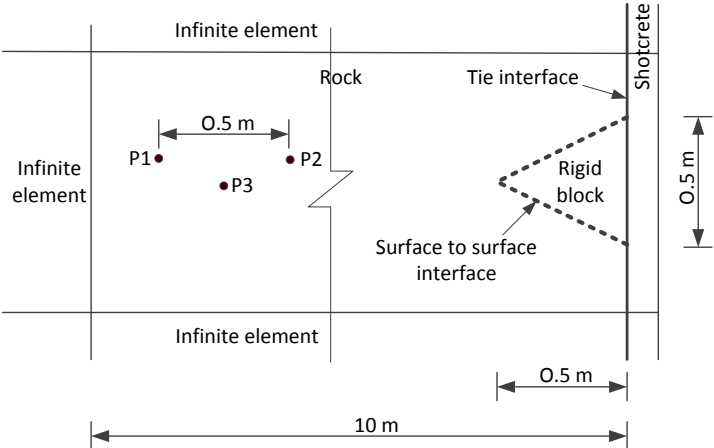
Research process

Dynamic finite element models of rock and shotcrete subjected to stress waves have been developed using the Abaqus/Explicit finite element program. The simulations were performed using two-dimensional (2D) plane strain elements.



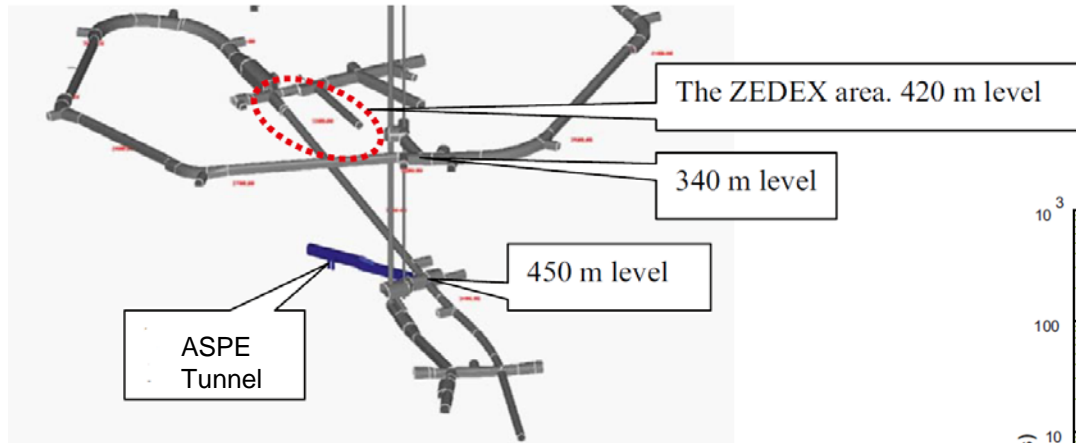
Configuration of the finite element model with only the rock

Including fractured rock

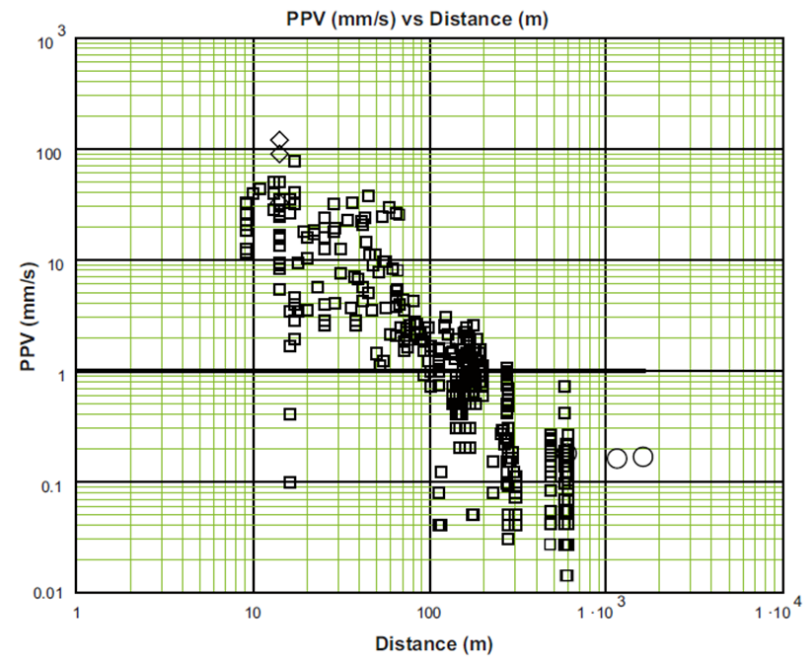


Measurements

A verification of the suggested finite element model was done by comparing numerical results with corresponding acquired measurements from APSE tunnel.

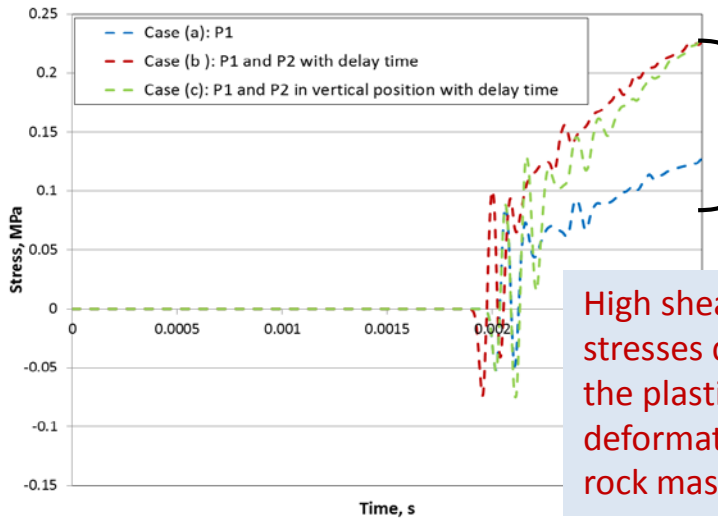
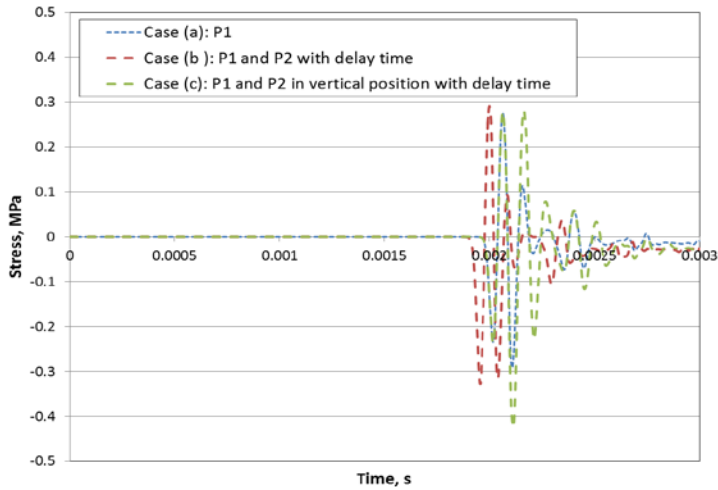


Layout of the ASPE Tunnel



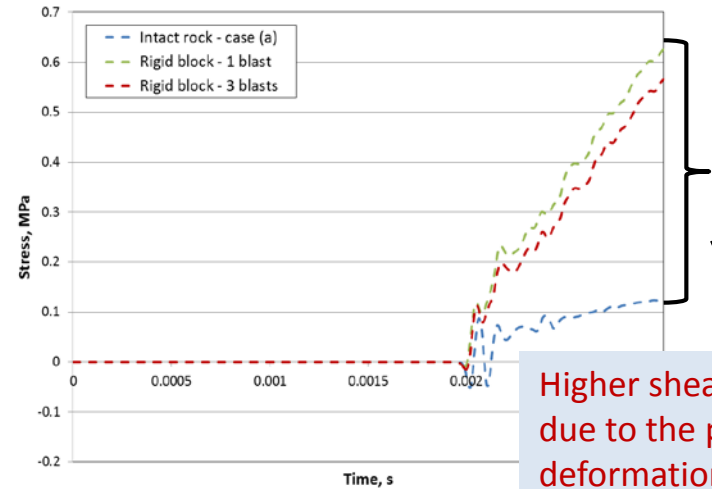
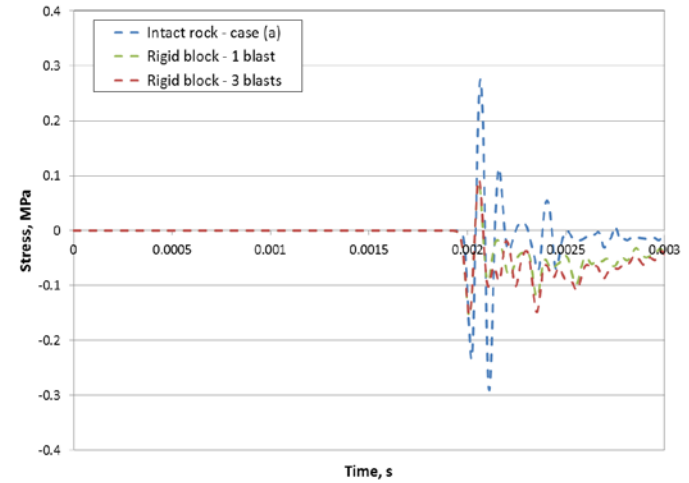
Maximum PPV for each round versus the distance.

Results



High shear stresses due to the plastic deformation in rock mass

Intact rock



Higher shear stress due to the plastic deformation in rock mass and the separation of rigid block

Fractured rock

Conclusions

- The comparison shows that the 2D models gives realistic results and can be used to investigate the vulnerability of shotcrete.

Intact rock model:

- From the view of tensile stresses at the shotcrete-rock interface, the vibration induced by delay time is less harmful to shotcrete than what was expected.

Fractured rock model:

- Compared with the shotcrete on the intact rock, a reduction of about 70% in the tensile stresses in the direction normal to the tunnel wall.
- In case of the fractured rock, the shear stresses are dominated.