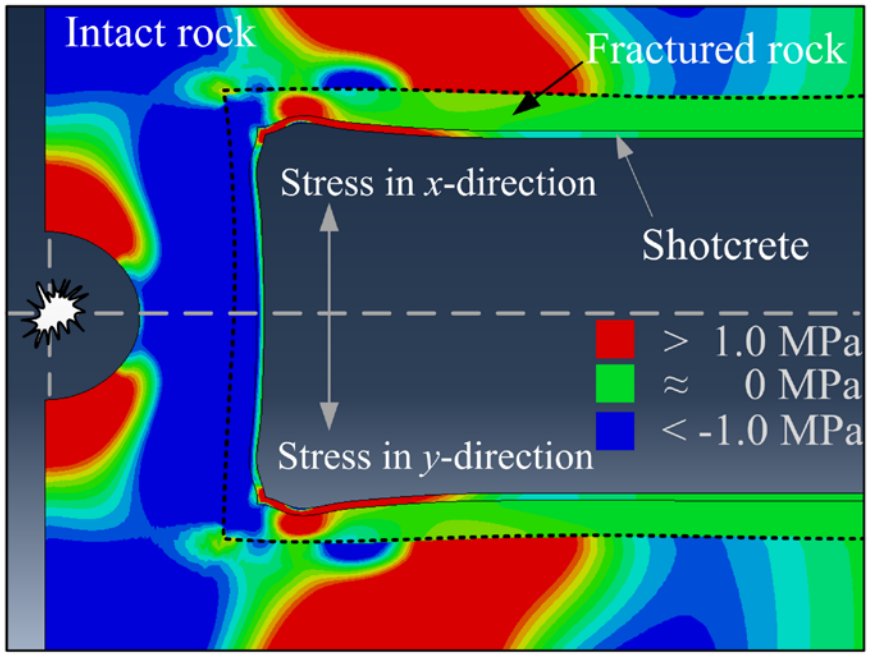
Impact-type vibration effects on young concrete for tunnelling



Lamis Ahmed, 2016

KTH Architecture and the Built Environment

BeFo rapport 147, 2016

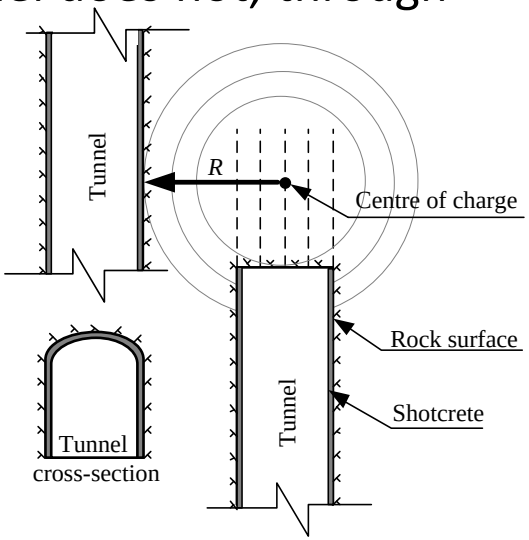
Introduction

Problem statement

- There are concerns over the effects from vibration at early age on the strength attained by shotcrete/concrete. And, because of the limited research and regulation on this topic, conservative vibration limits must be used for hardening shotcrete/concrete that will be exposed to vibrations.

- Engineers are limited on the timing and distance of shotcrete/concrete placement. This may contribute to longer construction periods and increased project costs.

- For example, the driving of two parallel tunnels that requires coordination between the two excavations so that blasting in one tunnel does not, through vibrations, damage the shotcrete in the other tunnel.



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Aim of the research

The aim of this study is to suggest a numerical analysis method that can be used in the work of determining practical vibration limits on young cast concrete and shotcrete. There are a number of important goals:

- Find a study case which deals with the effect of vibration on young cast concrete and shotcrete i.e. young or hardened.
- Identify the important factors and material properties that must be accounted for in the analysis.
- A comparison between analysis results and results obtained from the study case.

There is a need to know how close, in time and distance, to shotcrete/concrete, blasting can be allowed to take place.

Establish reliable guidelines

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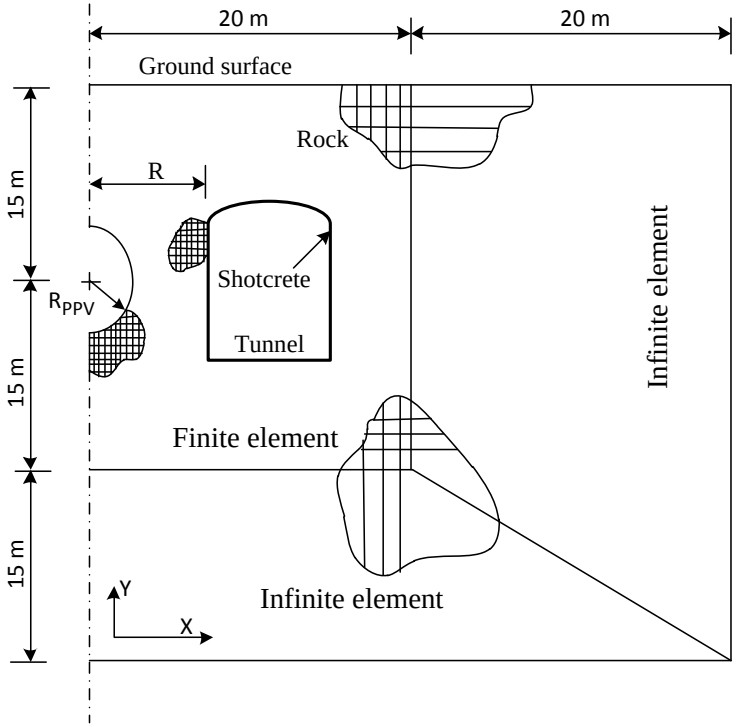
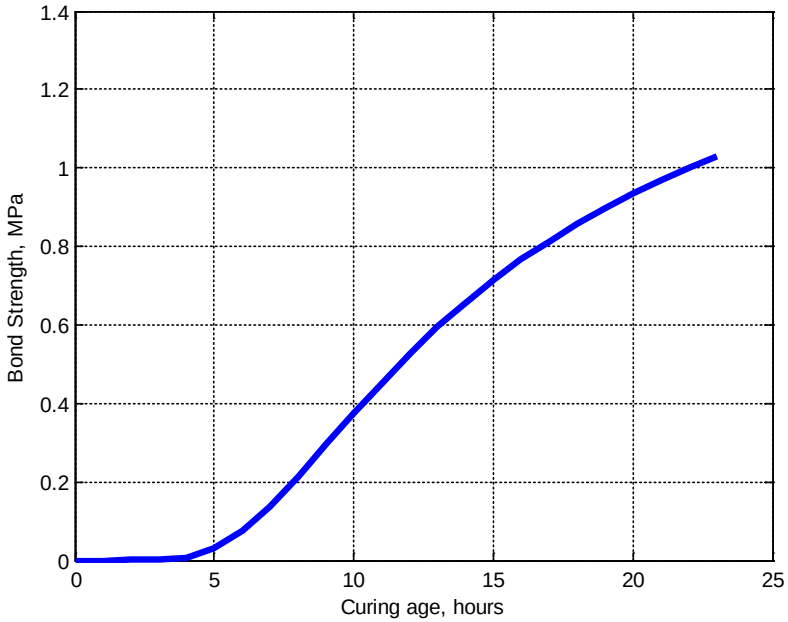
Research process

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.





Bond strength of the shotcrete-rock interface obtained from tests

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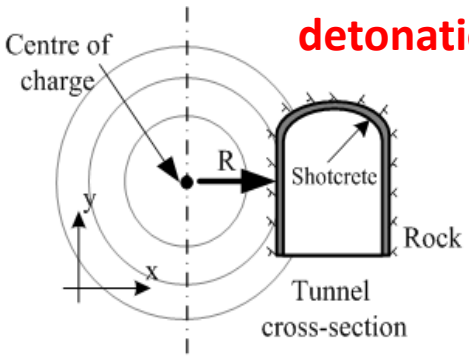
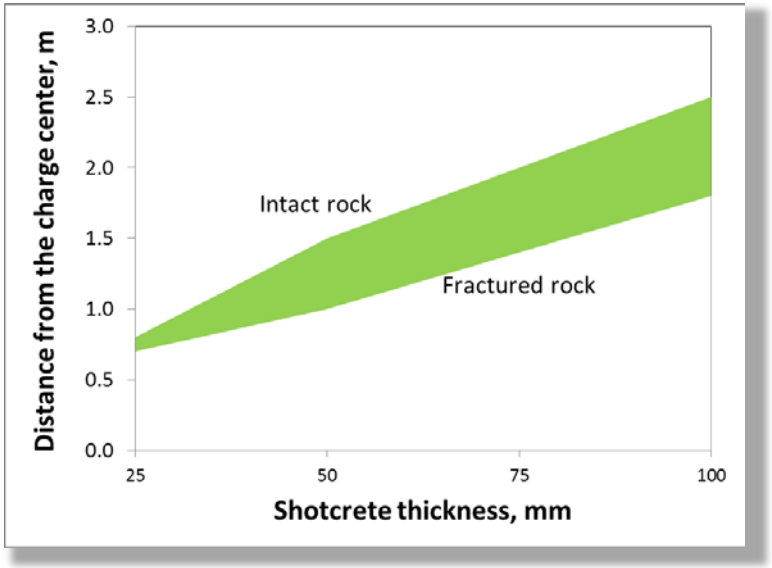
Recommendations

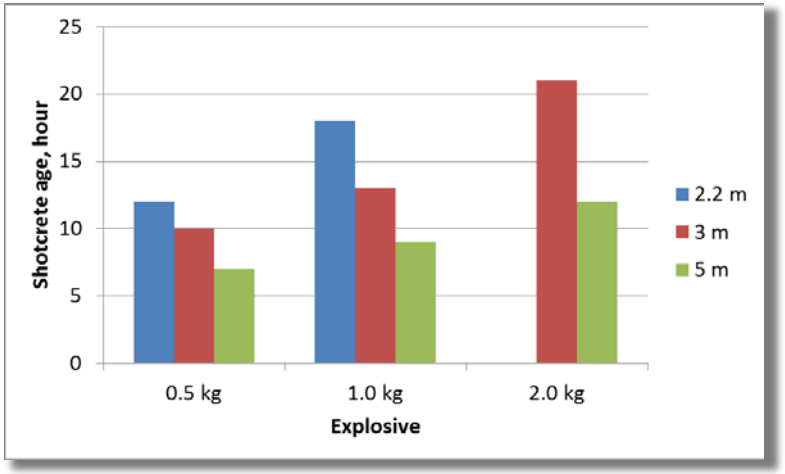
Hardened shotcrete

Safe distance from the detonation





Young shotcrete



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Recommendations

Mass concrete

Concrete age, hours	Concrete class C25		Concrete class C50	
	PPV lower limits, mm/s	PPV upper limits, mm/s	PPV lower limits, mm/s	PPV upper limits, mm/s
4	< 30	†	30	†
6	40	†	50	90
8	50	80	70	100
12	60	110	100	200

† Not possible to obtain upper limits

PPV: allowed peak particle velocity

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Conclusions

- The comparison shows that the 2D models gives realistic results and can be used to investigate the vulnerability of shotcrete, aiming at compiling recommendations and guidelines for practical use.

- The given recommendations emphasize that blasting should be avoided during the first 12 hours after shotcreting and that distance and shotcrete thickness are important factors for how much additional time of waiting is possibly needed.