Analyses of De-confinement Mechanisms of Unstable Failures in Underground Mining Conditions

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Prepared for the 33rd International Conference on Ground Control in Mining
July 29-31, 2014, Morgantown, WV

Presented by Ryan Garvey

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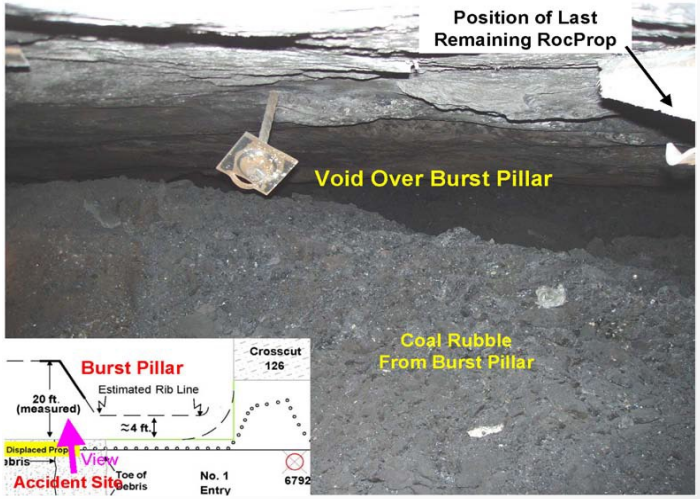
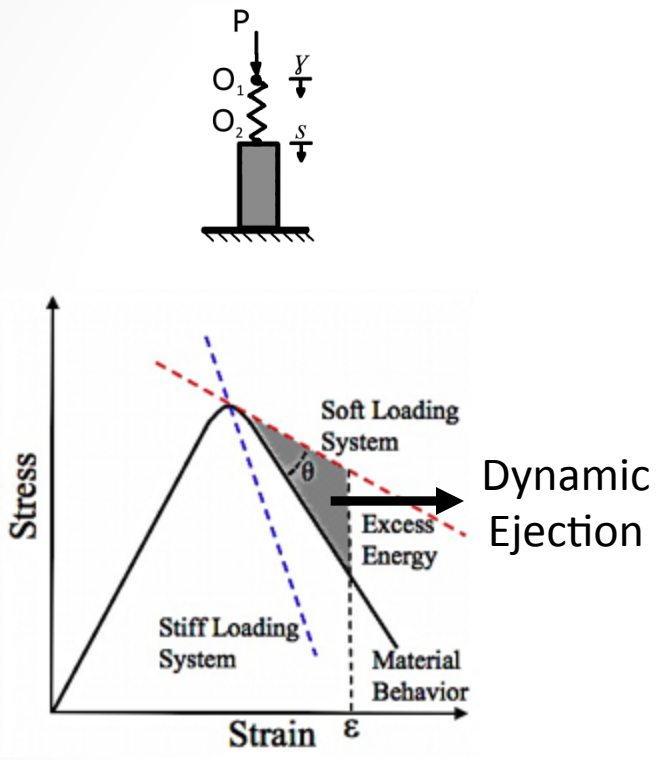
Unstable Failures – Rock Bursts and Coal Bumps

Stable failure

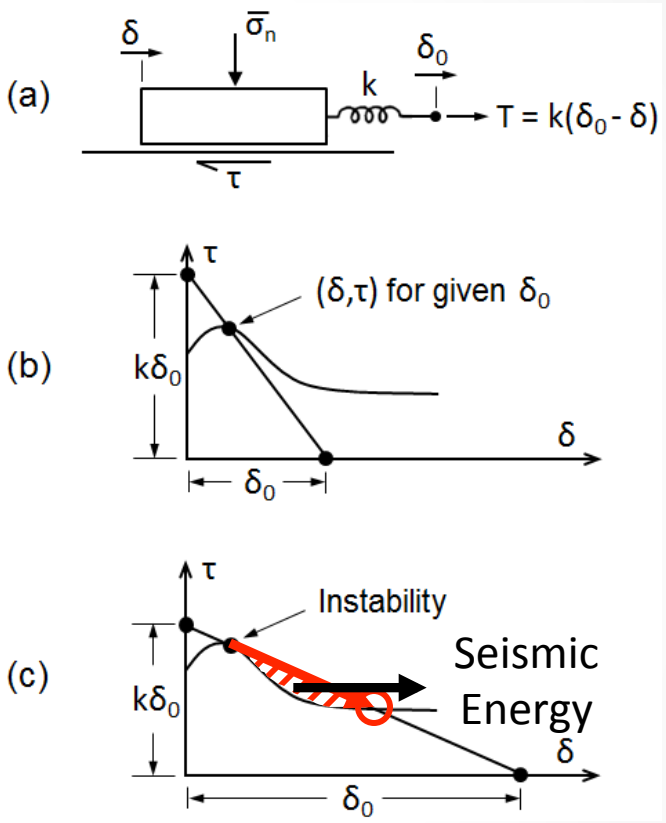
Unstable failure



Stiffness Criteria



Unstable and stable failures in compression, modified from Cook (1965)

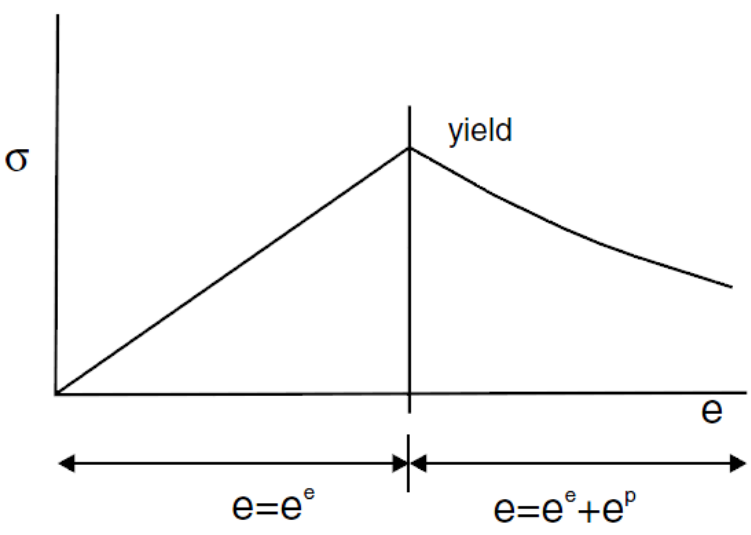


Stable failures (b) and unstable failure (c) in shear along discontinuity (Rice, 1983)

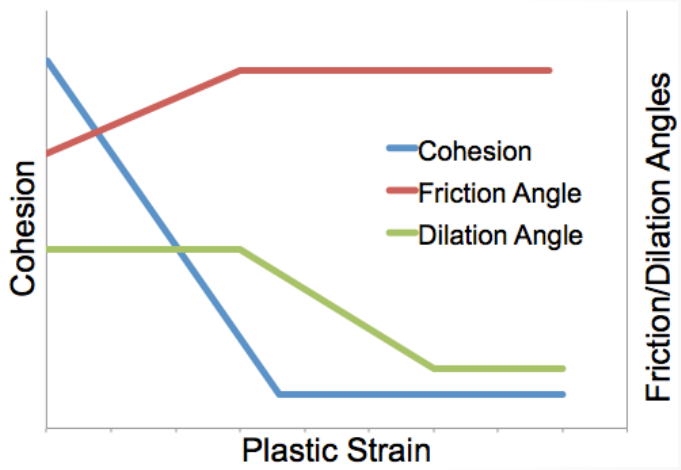
- Cook, N.G.W. 1965. A note on rockbursts considered as a problem of stability. *Journal of the South African Institute of Mining and Metallurgy* 65: 437-446.
- Rice, J.R. 1983. Constitutive relations for fault slip and earthquake instabilities. *Pageoph* 121(3): 443-475.

Joint and Block Model

- Mohr-Coulomb strain softening (MCSS) model



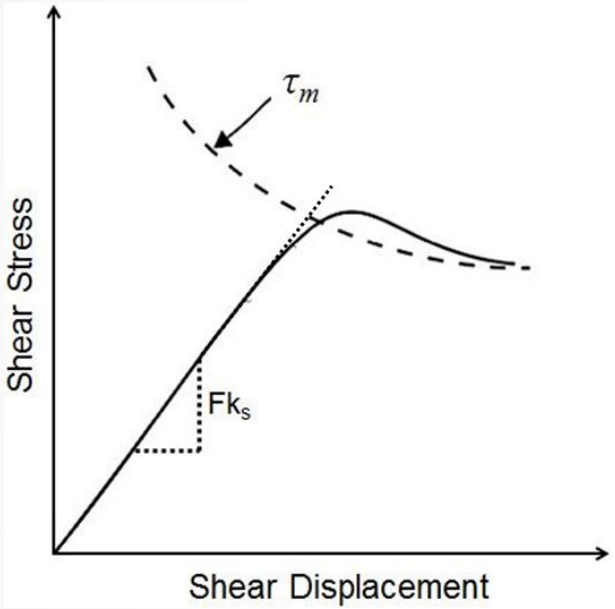
An example stress-strain curve of softening model.



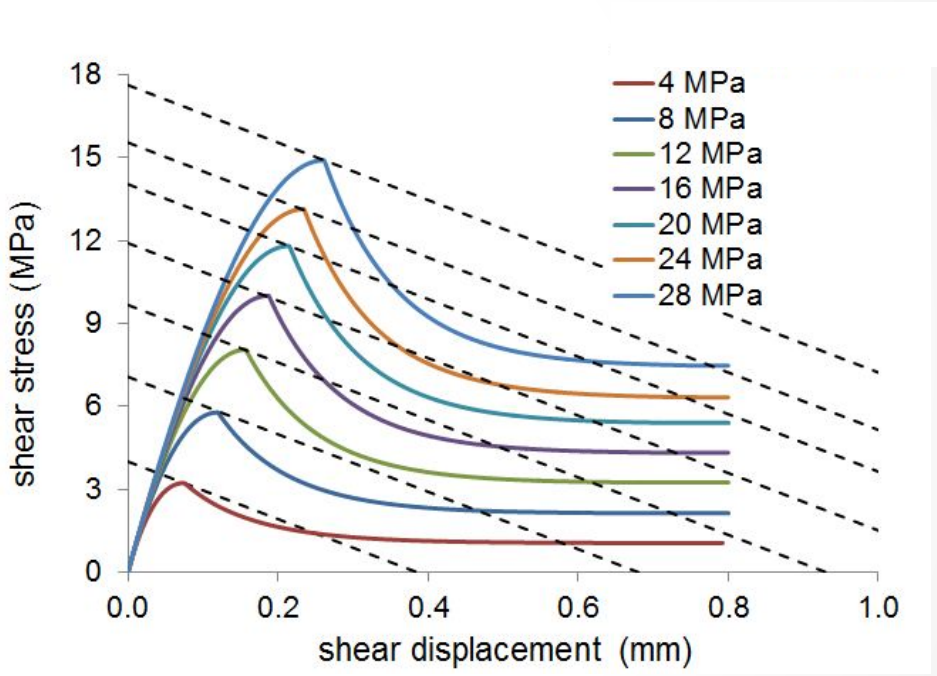
A conceptual representation of variations of cohesion, friction angle and dilation angle in the MCSS model.

Joint and Block Model

- Continuously Yielding (CY) joint model



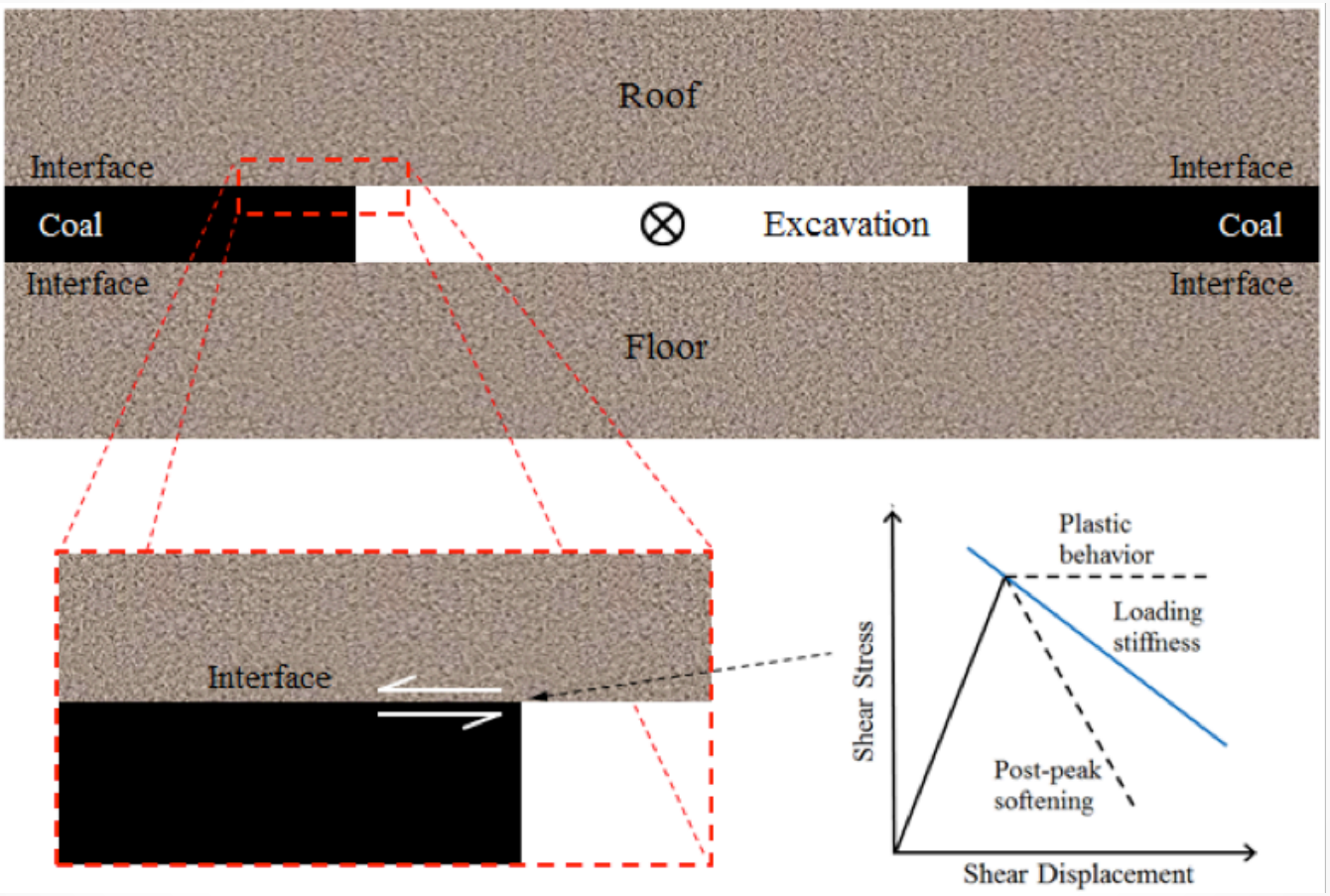
The typical shear stress-shear displacement curve of the CY joint model (Itasca Consulting Group, 2010)



Shear stress-shear displacement curve of the CY joint model under increased normal loading (Gu and Ozbay, 2014)

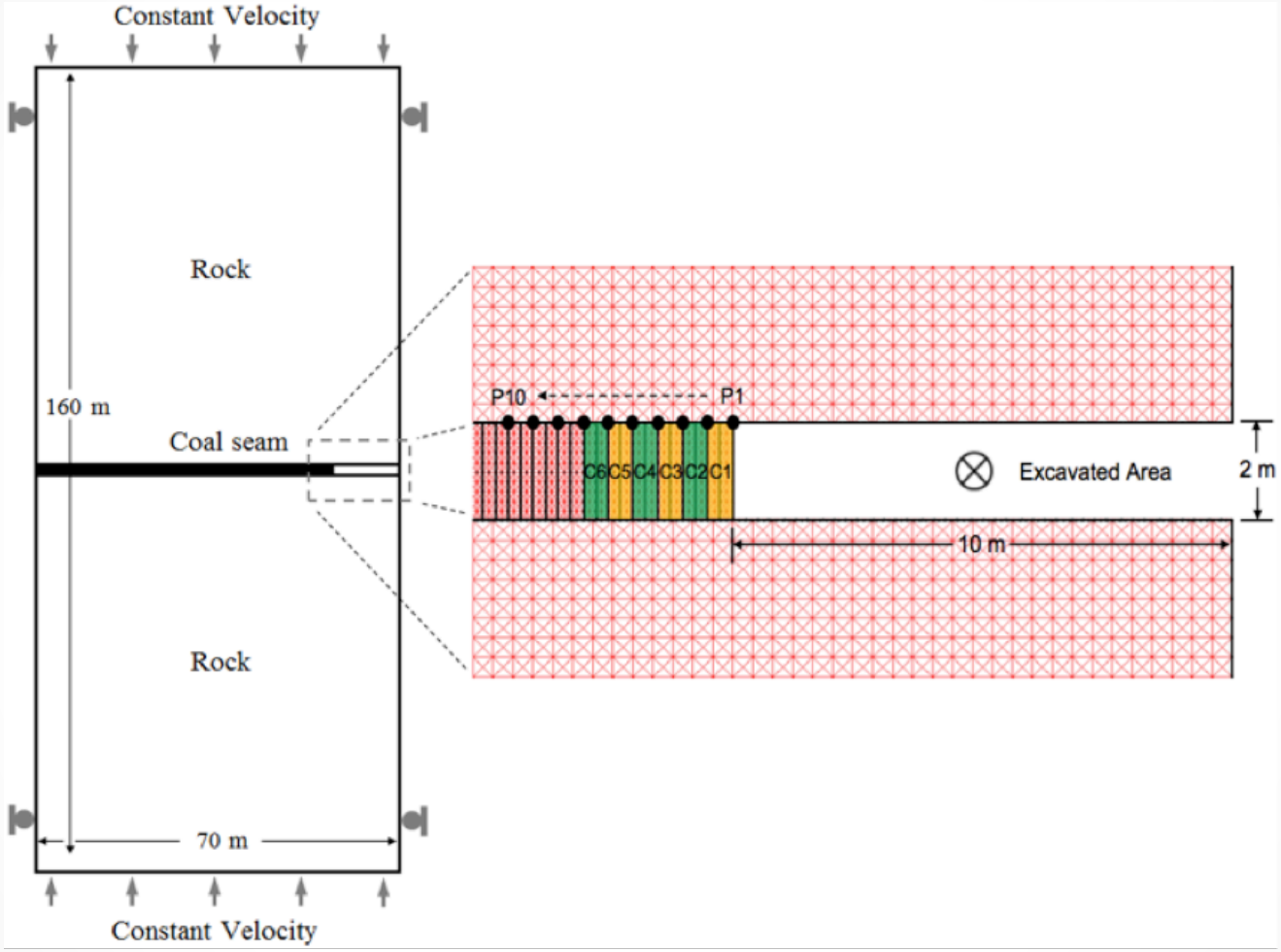
- Itasca Consulting Group. 2010. UDEC manual, version 4.0. Minneapolis, MN, USA.
- Gu, R and Ozbay, U. 2014. Distinct element analysis of unstable shear failure of rock discontinuities in underground mining conditions. *International Journal of Rock Mechanics and Mining Sciences*, 68: 44-54.

De-confinement Mechanism



Mining geometry used for modeling de-confinement induced unstable compressive failures in sidewalls (mining advances perpendicular to the plane causing shear stress increases at the interfaces close to the sidewalls).

Numerical Model and Results



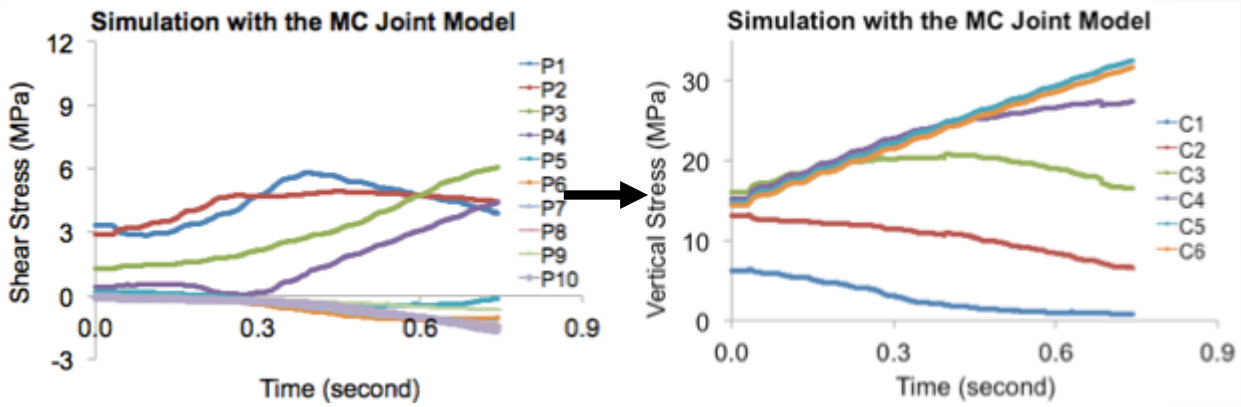
Model for the studies of de-confinement resulted from unstable shear failures at the interfaces.

Numerical Model and Results

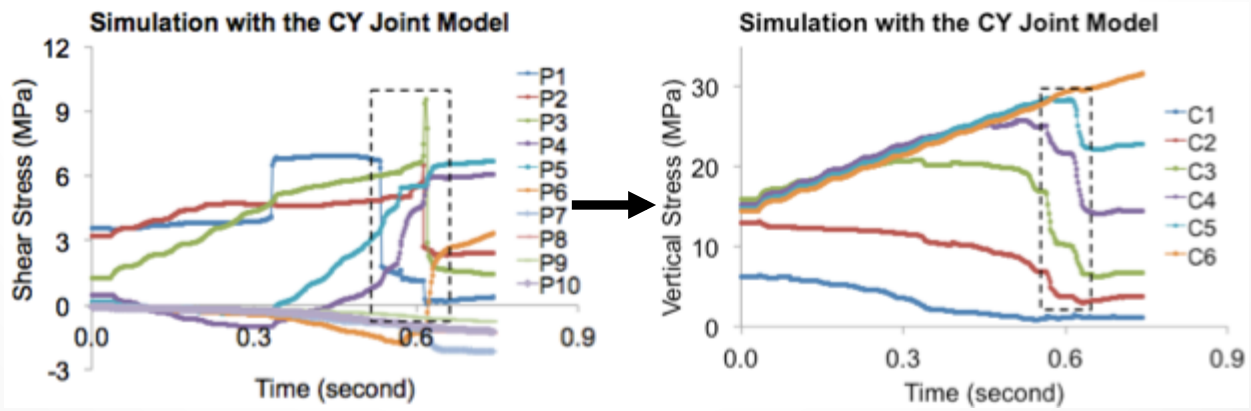
Shear stress-time curve of the interface measurement points

Vertical stress-time curve of the coal measurement regions

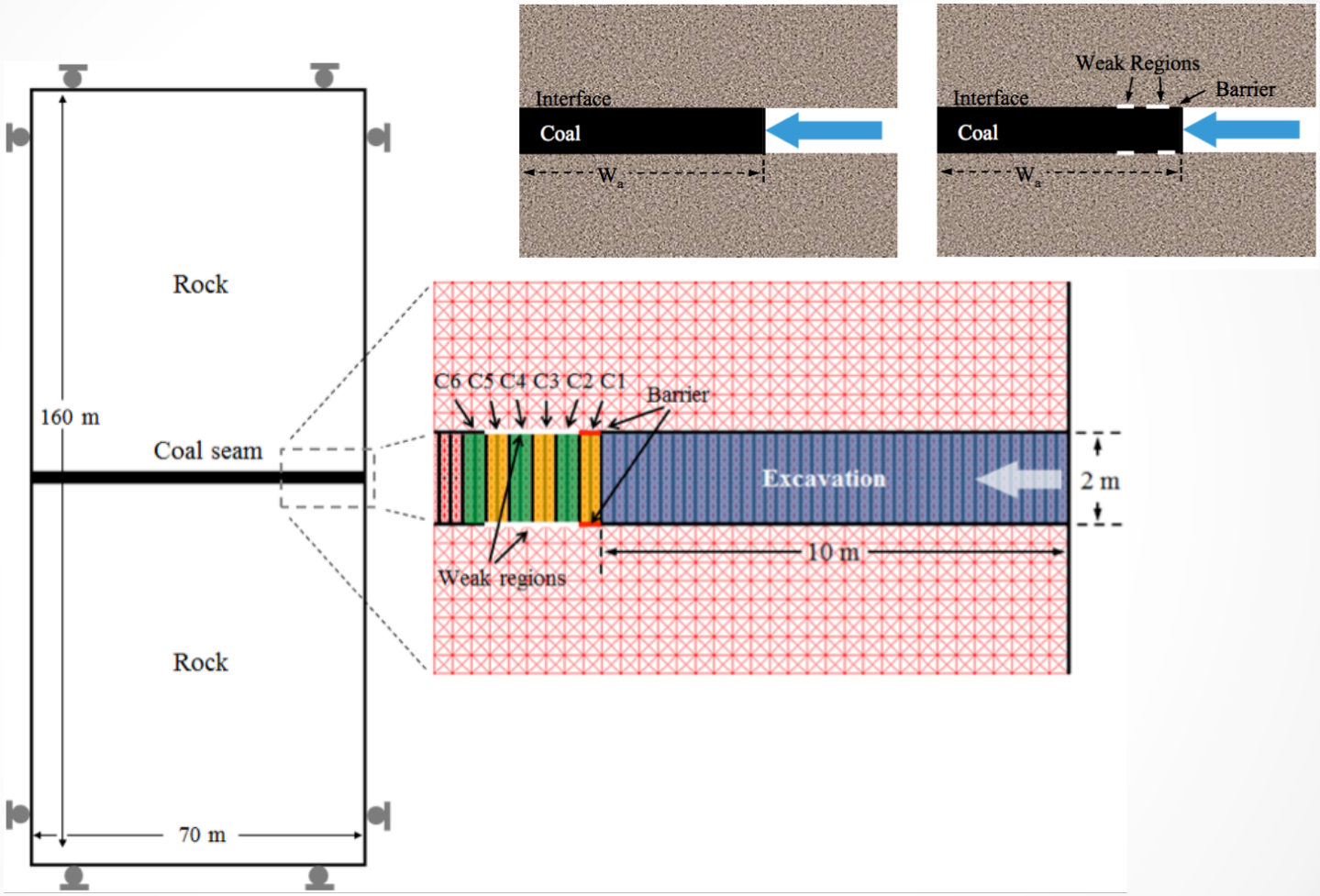
MC interface (stable)



CY interface (unstable)

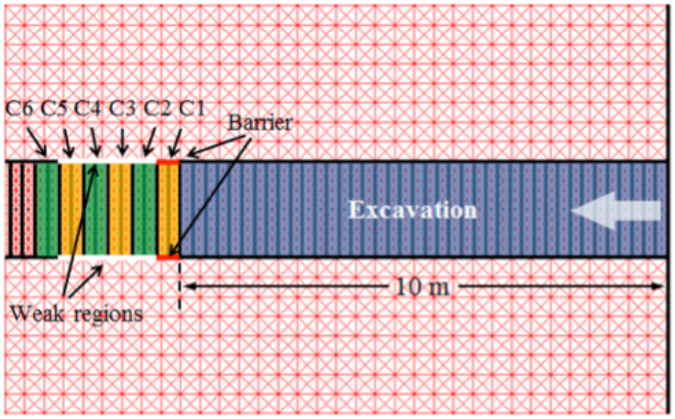


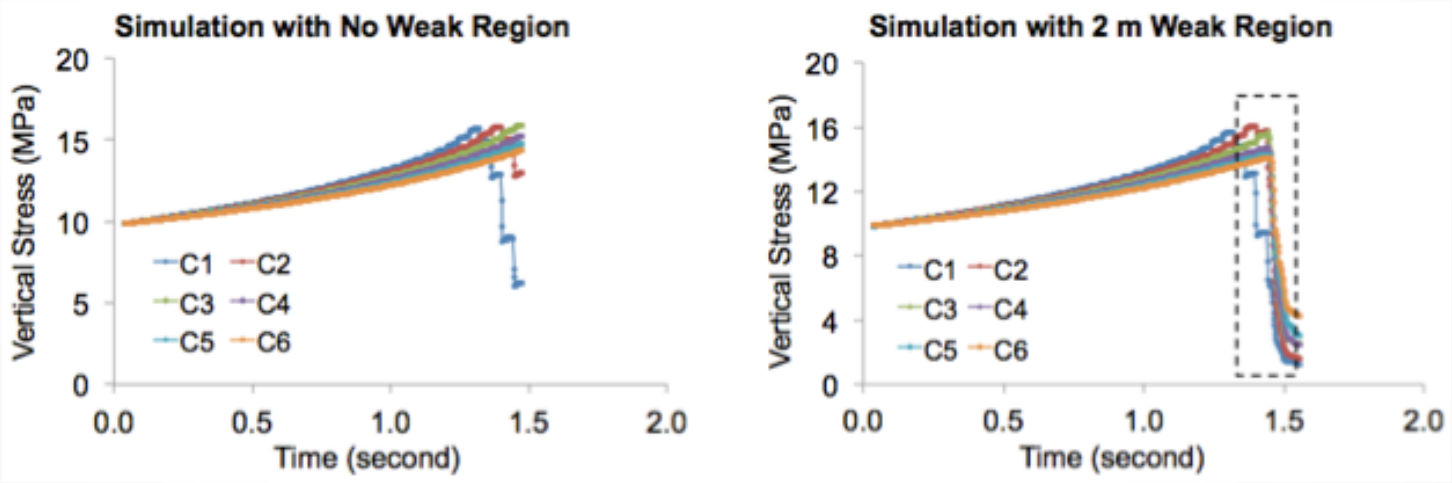
De-confinement Mechanism and Model



Model for the studies of de-confinement resulted from the existence of weak regions at the interfaces.

Numerical Model Results





Vertical stress-time curves of the measurement regions in the simulation.

Conclusions

- Unstable failures signified by sudden losses of load while stable failures follow a relatively smooth and gradual reduction in load.
- Sudden slip along interface led to rapid de-confinement and strength reduction of coal -> coal bump conditions
- Weak portions in rock-coal interface could lead to greater volumes of affected coal and larger magnitude compressive failures