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

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Unstable Failures – Rock Bursts and Coal Bumps

Stable failure

Unstable failure

Position of Last Remaining RocProp

Void Over Burst Pillar

Burst Pillar

View Accident Site

Coal Rubble From Burst Pillar
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)

Joint and Block Model

- Mohr-Coulomb strain softening (MCSS) model

![An example stress-strain curve of softening model.](image1)

![A conceptual representation of variations of cohesion, friction angle and dilation angle in the MCSS model.](image2)
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)

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