Predictions of Rock Fall Trajectories Using Discrete Element and Lumped Mass Modelling Methods

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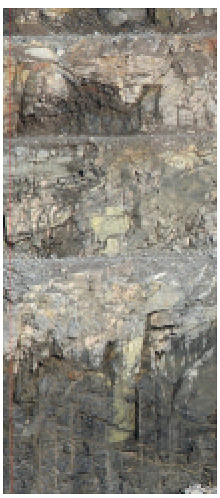
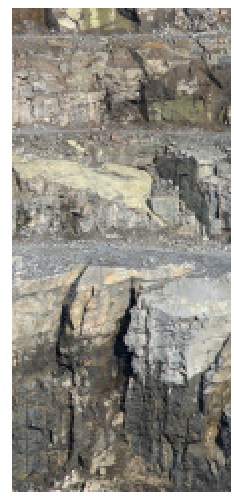
Rock fall analyses determine the likely paths and trajectories of unstable rocks. Key design parameters are path length, bounce height, rock velocity and kinetic energy during the fall. This information is needed to design protective measures.

Types of rock movement:
- Free fall
- Bouncing
- Rolling
- Sliding

A rock fall model should account for each of these movements. Models become complex when combinations of movement types occur or at sudden transitions from one type to another.



Slope profile obtained from
3D high-resolution digital photographs

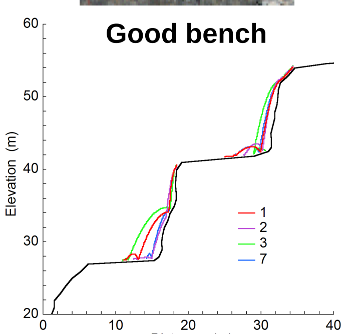


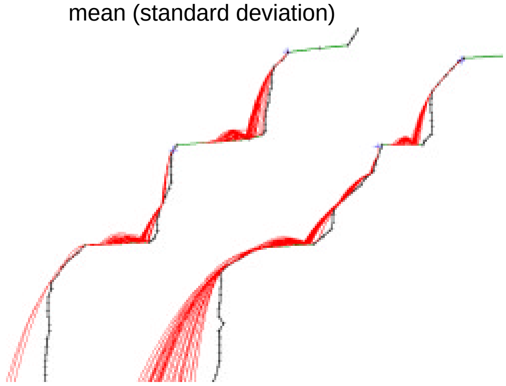
RocFall - lumped mass model

	R_N	R_T	Friction angle	Rough
Bench	0.3 (0.05)	0.75 (0.05)	45° (10°)	2°
Face	0.5 (0.05)	0.95 (0.05)	35° (10°)	2°

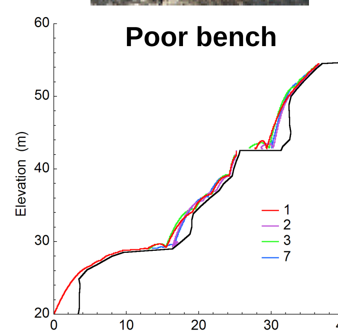
mean (standard deviation)

Good bench





Poor bench



PCF2D - discrete element model

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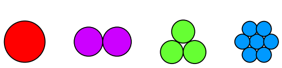

	Normal stiffness (N/m)	Shear stiffness (N/m)	Friction coefficient	Density (kg/m^3)
Bench	1E9	1E9	1	-
Face	1E10	1E10	1	-
Particle	1E10	1E10	1	2500

Damping coefficient = 0.5

Both methods can give similar rock fall trajectories. RocFall results depend on coefficients of restitution while PFC2D results depend on damping coefficient. PFC2D can simulate arbitrary rock shape. Future modeling with PFC2D will examine rock fragmentation and energy losses during impact.