FRACMAN®

Discrete Fracture Network-Based Slope Stability Analysis

Bringing Realism to Rock Slope Analysis

Golder, world leading specialists in Discrete Fracture Network (DFN) analysis of fractured rocks, brings a range of advanced slope stability tools based around this key technology. The DFN approach allows for a more explicit representation of rock mass fabric than is possible with a more conventional analysis. The DFN analysis takes borehole and mapping data and defines the geometric and spatial properties of the rock mass fracture system, allowing the construction of a validated three-dimensional (3D) network of fracture elements using a stochastic approach.

Using Golder's FracMan® software, probabilistic analysis of a range of geotechnical issues can be performed including:

- In situ block size distribution
- 3D probabilistic kinematic wedge analysis
- Step path failure analysis and rock bridge calculations
- Back break analysis for layer-controlled settings

In Situ Block Size Distribution

FracMan® allows for explicit mapping of blocks within a DFN model, including:

- Identifying block size and fragmentation distribution
- Developing a block shape description
- Conducting sensitivity testing to fracture size changes
- Applying blast pattern fractures to evaluate post blast fragmentation

3D Probabilistic Kinematic Wedge Analysis

Conventional kinematic analysis is predicated on unrealistic conservative assumptions aimed at identifying the largest possible rock wedge that may form within a certain bench geometry. In contrast, FracMan® DFN modeling methods allow the fracture network to be more realistically defined with reference to observed geometric properties, incorporating both observed large discontinuities and faults (deterministic features) and smaller stochastically generated features.

Using the same limit equilibrium approach but applied to realistically defined rock blocks results in a:

- Probabilistic assessment of wedge formation
- Description of block size distribution
- Determination of the distribution of the depth of wedge failure for the back break assessment
- 3D visualisation of block instabilities
- Monte Carlo analysis tools for multi-realisation modelling

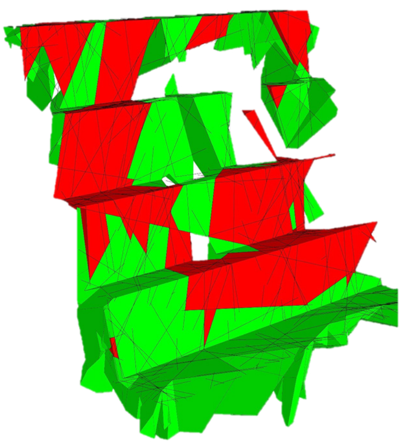

Figure 1: DFN based kinematic wedge stability analysis showing stable (green) & unstable (red) true blocks

Step Path Failure Analysis and Rock Bridge Calculations

Critical failure surfaces through slopes form partly along discontinuities and partly through the rock mass, and it is the magnitude of this rock 'bridging' that often governs the stability of the slope. Golder has developed a method for the automatic tracing of potential failure pathways through realistic DFN models with no limitations on fracture orientation, length scale, or spacing variations.

Key aspects of the approach are:

- The approach differentiates between rock bridges failing under shear and those failing under tension.
- It is a rule and weighting-based approach that has been validated against numerical analysis.
- Without the need for complex numerical simulations, the approach can automatically run through a large number of trace sections in order to return a probabilistic assessment of the rock bridge percentage for a potential geometry based upon a well-constrained description of the rock mass fabric.
- The approach has been verified against more complex geomechanical simulations, with the results showing good agreement. Thus, the DFN-based approach can be used to provide a more representative estimate of the factor of safety through structured rock masses.
- The DFN-based approach provides a more representative estimate of the factor of safety through structured rock masses by including the influence of rock mass failure along joint set orientations.

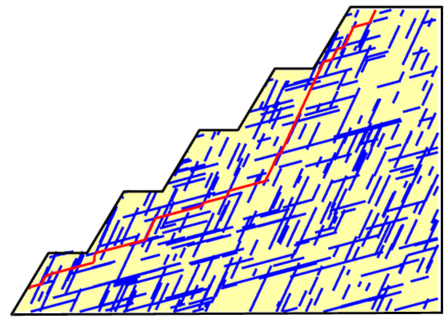

Figure 2: Step path failure analysis to determine rock bridge percentage

Back Break Analysis for Layer-Controlled Settings

The majority of bench stability analyses are aimed at massive jointed rock masses, and are not ideally suited to systems that are strongly geomechanically layered. To address this, Golder has developed an approach for assessing potential back break in highly layered rock mass in order to provide a probabilistic assessment of back break and, hence, a catch bench design.

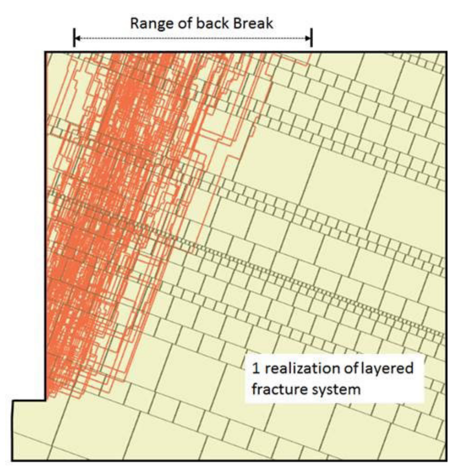

Figure 3: Stochastic determination of back break angle in layered rock mass

Contact us at: fracman@golder.com

Golder has FracMan expertise in the UK, USA, Canada and Sweden.