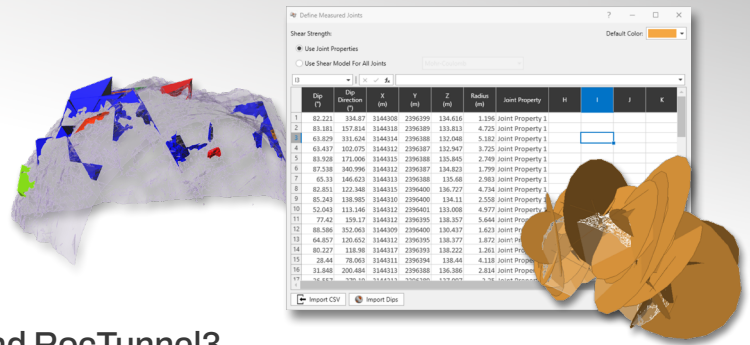




Q1: What is the difference between the two models generated? One model applies a factor to structures, and the other uses joint sets with their extent. Both show events that occur.

A1: In the forecasting portion of the demo, we showed two ways to analyzing the joint sizes:

- 1) a sensitivity analysis was conducted for the structure sizes by gradually increasing the factor applied;
- 2) Identify critical, select joints that may affect a failure, and use a large persistence.

Q2: What type of model is recommended to use?

A2: The type of model that can be constructed often depends on the available data. If remote sensing techniques are used (i.e., photogrammetry or LiDAR), then the model may consist of the as-built geometry, with the option to generate the 3D model and to map joints in ShapeMetriX. Without remote sensing, a design geometry may be used instead.

Q3: How can I apply cable bolts in this model?

A3: Anchors of various types, including cable bolts, may be applied in RocTunnel3 via the Support menu > Add bolts. The Cablebolt type can be defined as a bolt property.

Q4: Where can I contact a representative in Brazil?

A4: Please contact: latam@rocscience.com

A5: Can you please explain again how to import the ShapeMetriX model into RocTunnel3?

A6: The 3D geometry model generated in ShapeMetriX can be imported into RocTunnel3 as a .obj. ShapeMetriX allows exporting the surface mesh as .obj file. The imported geometry would be in the form of an excavation surface, but you can use built-in tools within RocTunnel3 to generate the

rockmass volume and excavation volumes.

Joints mapped in ShapeMetriX are imported into RocTunnel3 in a .dip file (Dips file format), and the joints would be modelled as Measured Joints with data for the dip, dip direction, location (x, y, z), and size. Extrapolated large structures from ShapeMetriX can be imported into RocTunnel3 as .dxf, then assigned with a Joint Property (shear strength) in RocTunnel3. The latter can be planar joints but also uneven (e.g. undulating) joints or folds.

Q5: Grace, what is the benefit of predicting failures? The face failure will be removed in the excavation process anyway. The crown failure, on the other hand, seems harder to stabilize before the next tunnel advance unless you drill inclined dowels.

A7: The forecasting process shown is meant to explore the possibility of using mapped joint data to help inform/manage risks in the staged construction, and to reconcile field data with design. It can also be used to calibrate the sizes of structures that affect the excavation. As example practical use cases:

- 1) Unstable (but not yet failed) blocks in the face may pose a risk to personnel and equipment and would call for an adjusted safety protocol.
- 2) Forecasting potential overbreak allows adjusting support and excavations sequences. The applicability certainly depends on the objectives and the contract. A goal of the case study was also to highlight workflows for on-site geotechnical engineers to provide basis for informed decisions.

Q6: Is any weighting function used for data collected based on the mapped surface orientation?

A8: In the case study, we did not apply any weighting function. However, this may be done in Dips to account for observational bias. If synthetic joint sets were generated in RocTunnel3, which are joint sets generated based on set statistics, then either the weighted or unweighted values could be imported from Dips.

Q7: Does RocTunnel3 use the stress state as an input for evaluating rock wedge failure (e.g., from EX3 or RS3)?

A9: Currently, RocTunnel3 does not take stress state, though this is a very good suggestion for future implementation of field stress.

Q8: Are fracture frequency and fracture length analyzed by your software?

A10: Variations in fracture characteristics are often derived from field data, which could be analyzed in Dips. Dips is interoperable with ShapeMetriX and RocTunnel3, meaning that the user could map joints in ShapeMetriX, analyze any joint set statistics in Dips and perform preliminary kinematic assessment, then a full limit equilibrium analysis in RocTunnel3 as informed by the fracture assessment in ShapeMetriX and Dips.

Q9: Instead of assigning values to fracture size, can the trace length of joints in a specific joint set be analyzed to determine its length distribution?

A11: Joint sizes can be analyzed in Dips, which consumes borehole data as well as mapped data from ShapeMetriX. The user could analyze for the distributions in joint persistence, trace length, etc.

Q10: Can the forecasting of failures in RocTunnel3 be automated?

A12: Forecasting is currently not an automated process in RocTunnel3. In the case study, we had to apply judgement on the relevant joints and joint sizes to model.

Q11: Is this model applicable for square tunnels?

A13: The tunnel or excavation can be any shape or geometry in RocTunnel3.

Q12: Can ShapeMetriX directly extract the as-built data from photos, or must it be entered manually for modeling in RocTunnel3?

A14: The 3D model generated in ShapeMetriX can be imported into RocTunnel3 via a .obj. ShapeMetriX is capable of generating the as-built geometry from photos (not a single photo, but from a series of overlapping photos as indicated in the presentation)

Q13: What is the difference between UnWedge and RocTunnel3?

A15: (1) UnWedge uses an extruded 2D excavation geometry; RocTunnel3 uses a 3D geometry that could be non-standard, such as those found in tunnel junctions or at larger, more complex scales. (2) UnWedge uses 3 joint sets that are ubiquitous and infinite; RocTunnel3 can accommodate any number of joints, with the option to model the location and size of joints. (3) RocTunnel3 can calculate for blocks daylighting during staged excavation (including staged support and loads), whereas UnWedge cannot model staging.

Q14: Will the recording be available on the Rocscience website?

A16: A recording of the webinar will be available on the 3GSM Youtube shortly.

Q15: How would the results differ if RocTunnel 2D were used instead?

A17: In 2D analysis, such as in UnWedge, the user would not be able to use mapped joints with location data and the as-built geometry. Instead, a design geometry may be used, as well as the mean orientations for 3 joint sets (with option to vary the joints statistically). The results would assume that blocks can form anywhere around the excavation because the joints are assumed to be ubiquitous and infinite.

Q16: How long does it take to analyze one section in Tunnel3, including face mapping?

A18: The examples used for the presentation take about ~1 minute to compute in RocTunnel3, just that the computation process was skipped during the demo. For reference, the first model consisted of an as-built geometry using 395 mapped joints. Digital mapping of principal structures in ShapeMetriX may be a task of some minutes. The time for elaborating a detailed map depends on its complexity but may take from a dozen of minutes up to an hour.

Q17: Does RocTunnel3 use the same computation engine as RocSlope3? Is it based on Block Theory?

A19: Yes, RocSlope3 and RocTunnel3 calculate blocks and block kinematics the same way. Both are based on the Block Theory by Goodman and Shi (1985).