

ZOSTRICH GEOTECHNICAL

Zostrich Geotechnical was founded in August of 1995 as Ursa Engineering. Its focus is solely premium rock mechanics engineering and rock mass characterization work, primarily for the mining industry.

Areas of expertise include:

rock mass characterization

- photogrammetric imaging and mapping
- drillhole planning and interpretation
- geologic structure interpretation
- structural model construction
- domainal fabric spatial characteristics

rock slope design

- probabilistic bench design and optimization
- probabilistic interramp design and optimization
- statistical based rock slope design
- statistical based rock reinforcement
- rock slope reinforcement
- structural model construction

rock slope analysis

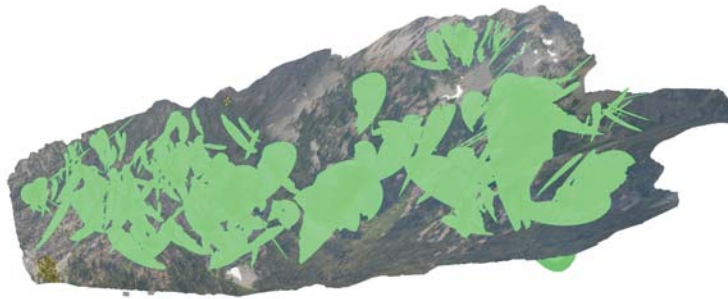
- evaluation of existing slopes/failures (physical and photogrammetric)
- determination of failure modes/remediation
- photogrammetric/structural model based rock slope reinforcement

underground design

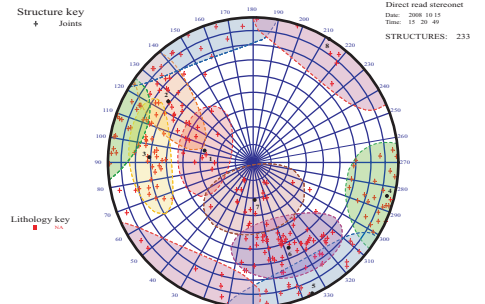
- portal design
- opening design optimization (size and orientation)
- rock support (access/stope)

rock fragmentation analysis (discontinuity model based)

Present and former clients companies of Zostrich Geotechnical include: BHP Minerals, BHP Billiton Diamonds, Kennecott, Barrick Gold, Kinross Gold, and many others.



Structural cloud (Adamtech 3DM Analyst)



Discontinuity set selection (Z-Fabric)

Rock mass characterization

Rock is a natural substance, created and modified over millions of years. Geotechnical engineers are unique amongst the engineering branches in that they must design their works utilizing the grab bag of properties that nature provides, rather than specifying design properties.

It is this concept that makes rock mass characterization so very important for any engineered excavation in rock. Without a detailed and accurate model of the material in which the design is conducted, engineering is wasted.

Rock mass characterization does not just involve measuring RQD, determining rock mass ratings from core, and measuring a few orientations. It is a complex job that requires dedicated a professional that specializes in the field.

We specialize in this unique area. Our statistical rock mass characterizations provide engineering descriptions of the rock mass, allowing a true engineering evaluation of the design in question to be conducted.

We conduct:

- **Statistical rock fabric characterization.** The rock mass contains innumerable discontinuities that impact design, this "fabric" is characterized using our proprietary techniques and software;
- **Rock mass quality analysis.** If the rock mass is highly altered and fractured, it becomes pertinent to describe it in terms of empirical rock mass characteristics;
- **Rock material property characterization.** This includes descriptions of design statistics for a variety of rock material properties, including discontinuity shear strength, rock mass strength, triaxial strength, etc. These are based on laboratory testing, field back analyses, and empirical analyses. Photogrammetric mapping of pre-existing failures can provide detailed information in this regard ;
- **Structural model creation/domain delineation.** In order to properly design a rock slope, a structural framework is required. The geologic structures included in the model are not only utilized in stability analyses, but are critical to structural domain delineation, proper assignment of material and discontinuity spatial characteristics, as well as assisting in delineating areas of low rock mass strength.

All concepts and methodologies presented herein are considered proprietary information and technology of Zostrich Geotechnical



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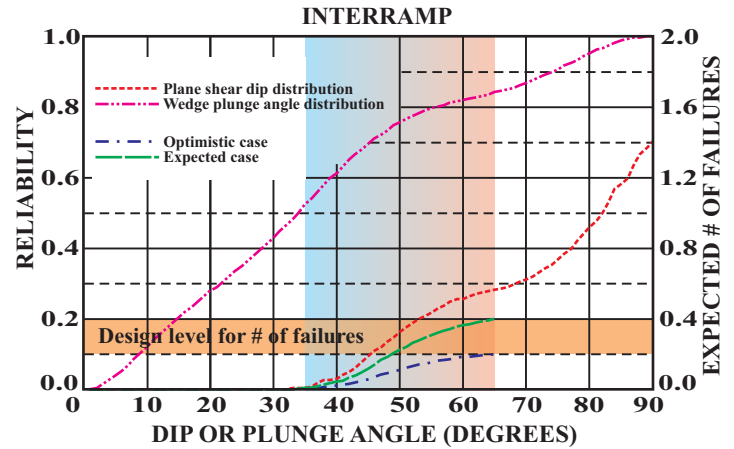
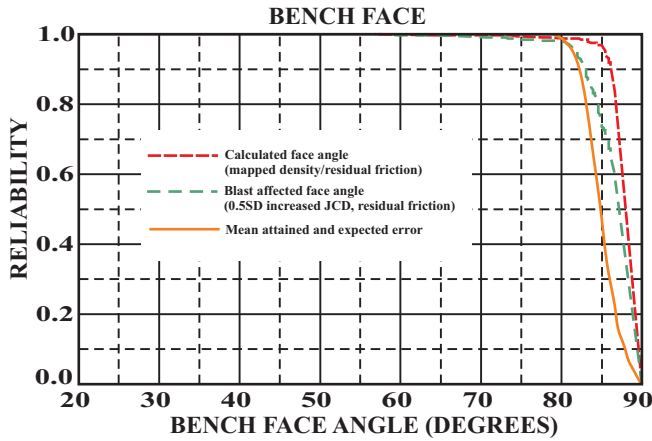
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Probabilistic rock slope design

Zostrich Geotechnical specializes in probabilistic, statistically based, rock slope design. The detailed models created during the rock mass characterization phase of the project provide a solid foundation for design.

Statistical evaluation of the spatial characteristics of rock fabric discontinuity sets, coupled with statistical analysis of discontinuity sets provides input to Z-Fabric. This results in detailed bench face angle distributions. It also can be utilized to provide realizations of face profiles, and associated variations, as input for rock fall models.

Evaluation of the major structure model provides detailed information for interramp design, both for individually identified geologic structures as well as statistically predicted structures. This, together with statistical descriptions of structural shear strengths allows a robust physical model to be mathematically analyzed.

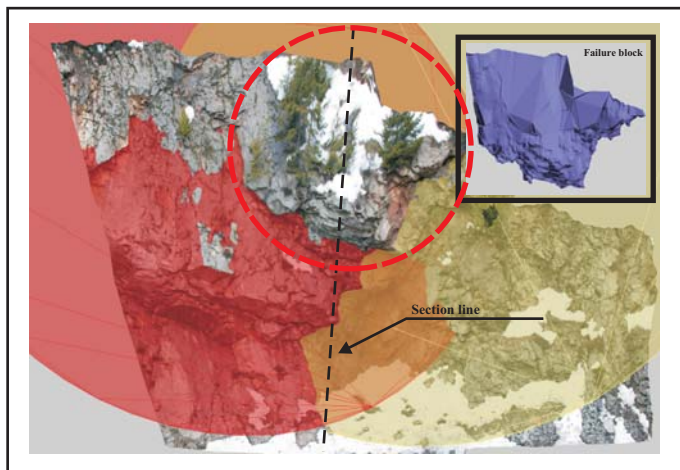


Failure analysis/rock support

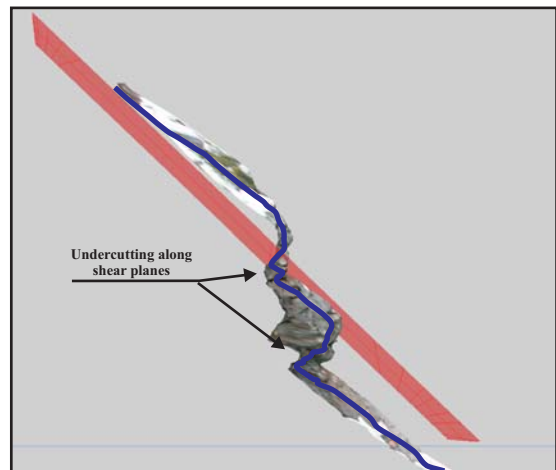
Photogrammetry, together with field mapping, monitoring, and an assessment of the variation of the discontinuity shear strength can be a powerful tool for rock reinforcement design/remediation/back analysis.

As can be seen in the example below structural "halos" define the local geologic structures. The DTM model of the slope can be cut by the constructed halos, resulting in a three dimensional solid model of the potential failure block. This is useful for driving force calculations for rock support design.

Sections can be cut through the created surface for aid in visualization and design. These sections, as well as the DTM, are scale correct. The accuracy of the DTM is an engineered parameter, and is normally within 1-4 centimeters (0.5 to 2 inches) for rock work.



Highway cut - discrete block analysis - failure block defined



Highway cut - vertical section

Shown above are just a few of the many tools at our disposal. Detailed rock mass characterization, including photogrammetry, drilling, material property testing coupled with the proper statistical tools for evaluation provide sound solutions to any rock mechanics problem. What's more, is that the use of statistical evaluation allows the variation of the problem, and the impact on the situation at hand, to be quantified.

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