

# A practical methodology to define geotechnical design sectors in structurally-controlled anisotropic environments

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The slope design process is widely utilized in a relatively standard format. Data from geological, structural, rock mass, and hydrogeological models is used to formulate and populate geotechnical models. The volume of interest is divided into geotechnical domains, wherein structural and rock strength information are key inputs to define the conceptual failure model(s). Subdivision of domains that contain structurally-controlled and/or anisotropic materials into design sectors should result in practical slope designs. However, it is often difficult to determine the size and extents of these design sectors prior to analysis. Furthermore, although available geotechnical drilling and structural mapping data in mined areas is used routinely, such data is typically sparse and/or focused only on a narrow volume around vertical 2D design sections, which are typically radially-oriented with respect to the centre of a pit or sub-pit.

This contribution augments the use of vertical 2D design sections. It shows the spatial variability in the apparent dip of anisotropic units, using standard mapping data and well-constrained, high-confidence 3D models. Major lithological contacts are generated by 3D modelling. Based on well-constrained mapping data, it may be established that, with the exception of volumes around tectonic or erosional unconformities, lithological contacts are parallel to bedding in their associated volume(s). Apparent dips of a given lithology, at either a mined or planned pit surface, may be derived from a combination of the dip and dip direction of individual triangles on triangulated lithological surfaces (*viz.* contacts), with the dip direction of individual triangles on pit surfaces. This produces the apparent dip of the main plane of anisotropy (in this example, bedding in banded iron formation and shale) for every coincident point.

Apparent dip is plotted spatially and binned into categories that show its inward- or outward-dipping attitude with respect to the pit. This binning may be arbitrary or guided by the friction angle of a given unit. As such, the need for prior definition and reliance on fixed, vertical 2D design sections is minimized as the analysis produces a laterally continuous map of apparent dip. In turn, this allows for a significantly improved early definition of design sectors without using possibly non-representative average or median orientations of planes of anisotropy for a whole sector. This is particularly important where the main plane of anisotropy shows significant changes in dip direction, which may warrant further domain subdivision. This technique overcomes the situation where the pit surface shows a dramatic change in orientation with respect to strike or dip direction in a given part of a domain. Improved design sector classification highlights possible areas of favourable or unfavourable interactions, of anisotropic lithologies, with slope geometries in current mining faces, future pushbacks, or on final/design faces. This guides focused data acquisition for practical sector- (or subsector)-specific design parameters as input for mine design. In turn, this leads to optimized designs and early risk mitigation.

## Introduction

The slope design process, developed over the past 25 years, is widely utilized in a relatively standard format (Figure 1). Data from geological, structural, rock mass, and hydrogeological models is used to formulate and populate geotechnical models. Based on these parameters, the volume of interest is divided into geotechnical domains. Structural and rock strength information are key inputs to define the conceptual failure model(s) within these geotechnical domains.