

## ❖ BENCH FACE ANGLES

The determination of a distribution of attained bench face angles is critical to design. These will, together with the required catch bench width, determine the bench controlled slope angle.

Let us examine, in brief, the damage that occurs to a bench during excavation.

For most rock masses, backbreak will occur preferentially at the bench crest. This is due to the fact that the primary failure modes (plane shear, wedge, step-path, etc.) are of a sliding nature. Thus, a base condition for failure to occur is that a structure of sufficient length to transect (cut through) the bench must exist. As the distance from the bench crest increases, the probability a structure of sufficient length existing decreases (Figure B1). The face of most benches is therefore relatively vertical (at least if good blasting is practiced) with the crest being that most affected by structural failures. In addition, the crest generally gets hammered by blasting (sub-grade drilling above, high vibration and blast gas effects due to adjacent blast series), and excavator action.

The bench face angle is here defined as the angle from the toe of the bench to the maximum extent of backbreak on the catch bench above (Figure B1).

Given careful, well-planned, geotechnical data collection, a structural model can be constructed that allows calculation of the bench face angles that can be expected upon excavation. This distribution will be a function of many factors. However, the most common are:

- Bench height;
- Bench face bearing
- Shear strength of discontinuities;
- Intact rock strength;
- Discontinuity orientations by set;
- Estimate of joint persistence and spacing, and;
- Perceived purpose of the bench face
- Excavation practices (blasting, ripping, free-digging, etc.)

An example of the resulting diagram is given as Figure B2.

Note that these predictions, based upon mapping, can be quite accurate when compared to actual results. Some comparisons are given in Figure B3.

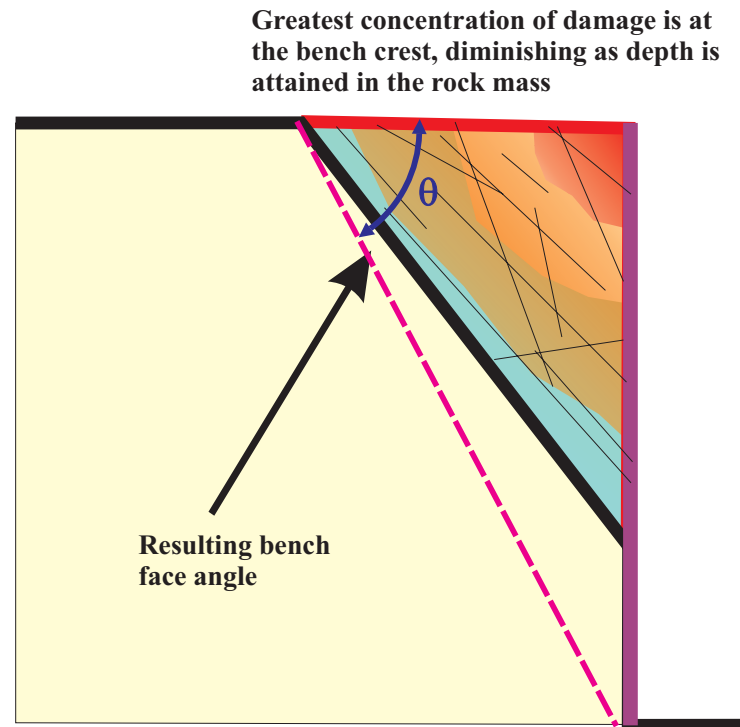
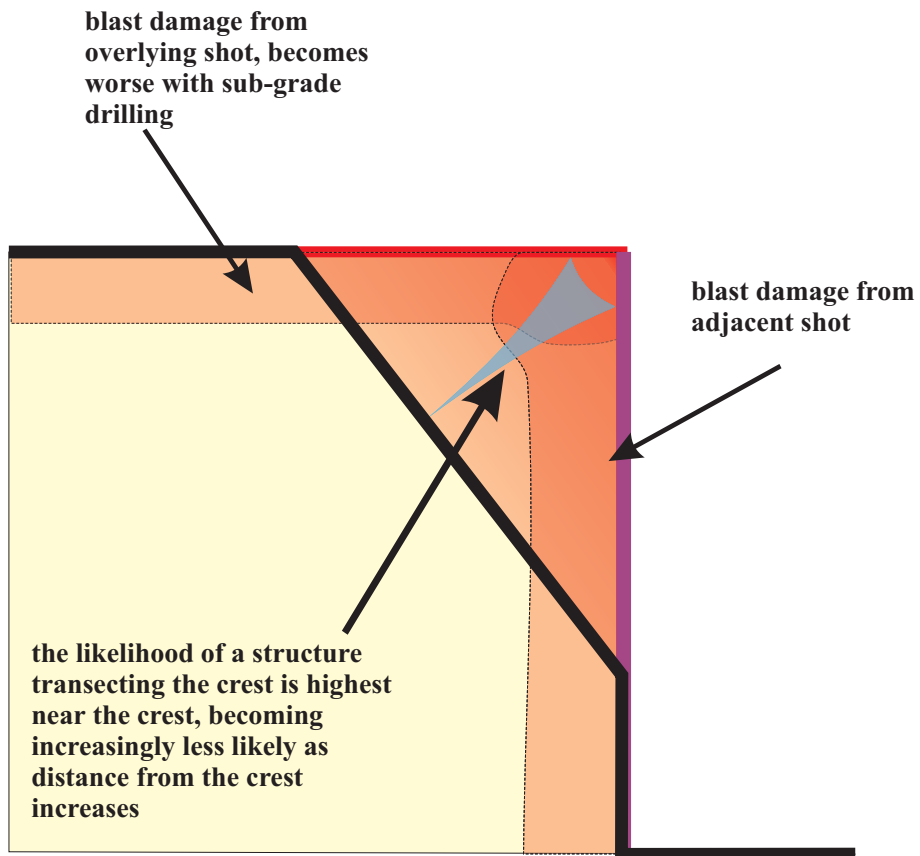
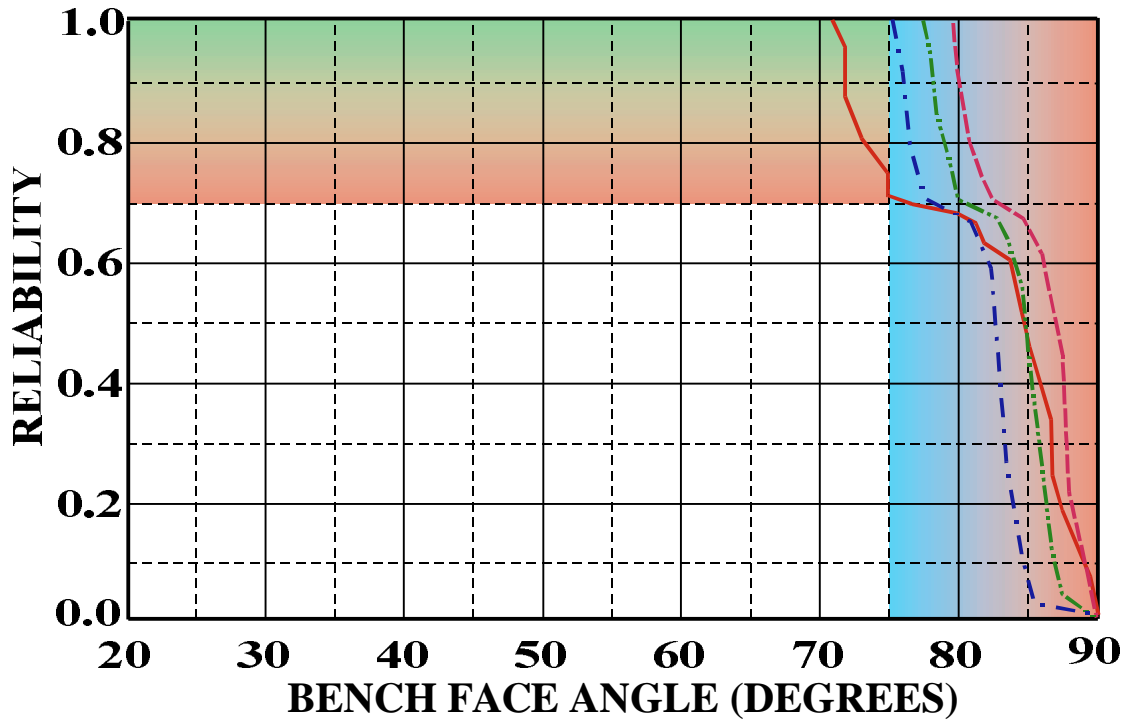


FIGURE B1





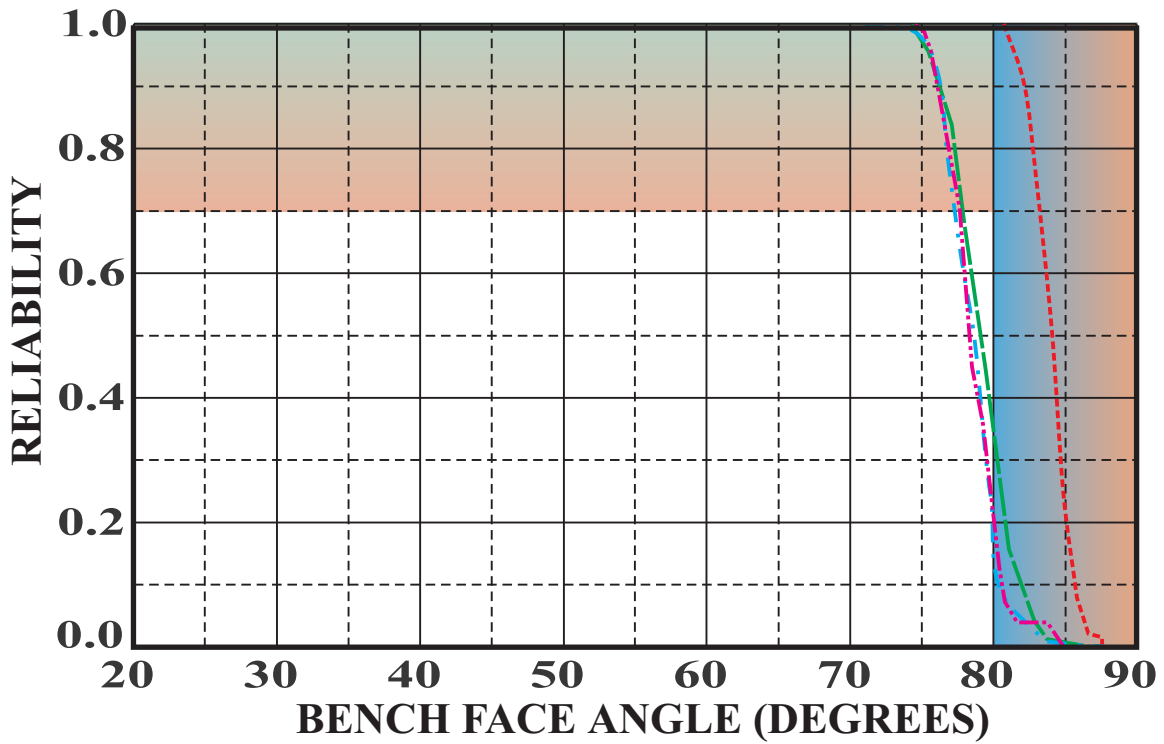
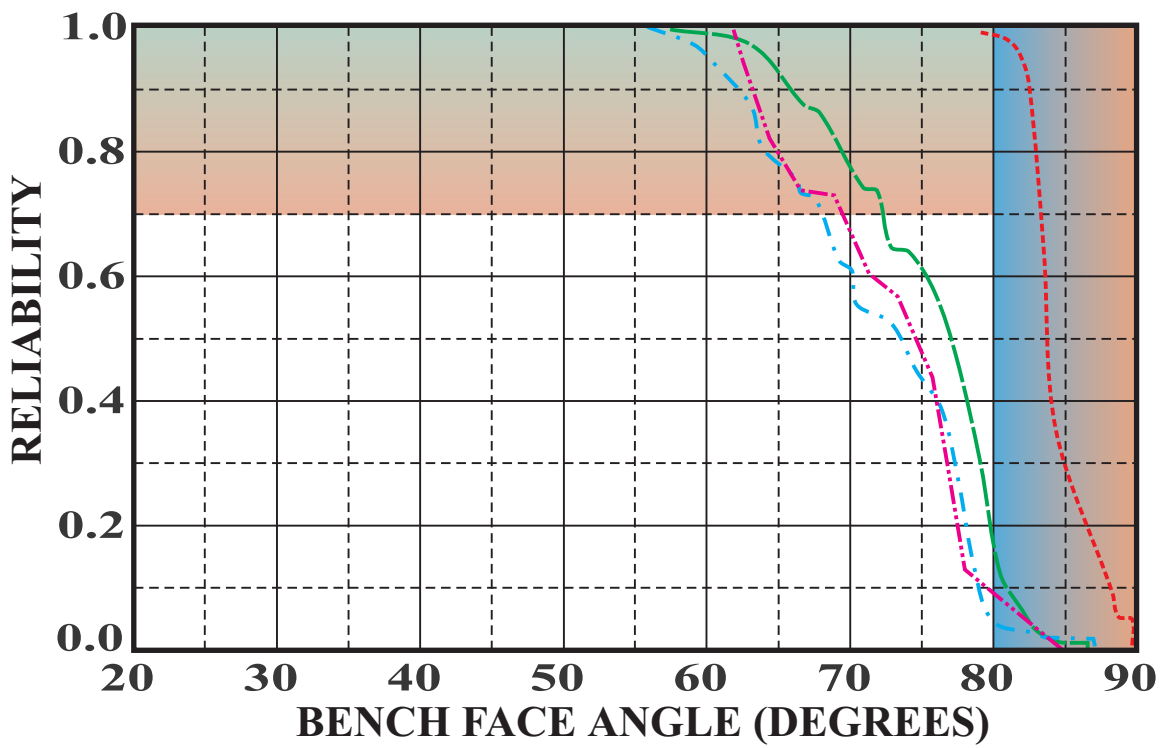
Amphibolite schist, cross foliation  
 Bench dip direction = 075 degrees (range 20 degrees)

- Measured distribution, bench height = 15m
- · - · - Expected distribution, bench height = 30m (double bench)
- - - Realistic maximum distribution, bench height = 30m (double bench)
- · - · - Realistic minimum distribution, bench height = 30m (double bench)

TYPICAL BENCH FACE ANGLE RELIABILITY CURVES

FIGURE B2





- Calculated face angle (best case)
- \_\_\_\_\_ Calculated face angle (expected case)
- . - . Calculated face angle (worst case)
- ..... Measured face angle

ATTAINED vs. THEORETICAL BENCH FACE ANGLES

FIGURE B3

