LASER SURVEYING FOR ROCKFACE PROFILING

Julia Reynolds explains why quarry owners, managers and blasting contractors should consider the use of 3D laser surveying techniques as an alternative to manual and visual face proiling surveys.

To precisely survey the rock face, it is imperative to determine the rock mass and the explosive energy needed to achieve objectives. Often geometrical errors occur in blast design because of incorrect face assessment and drill errors.

FACE ASSESSMENT

Poor face assessment errors can lead to poor yield, wasted explosive and prolonged drilling times. The common face profile assessment errors (see Figures 1 and 2) are the underestimation of face burden and face height and the overestimation of face burden and face height.

DRILLING ERRORS

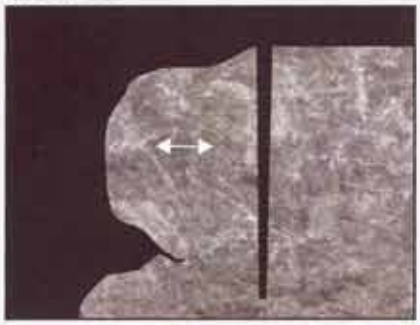
The failure to further consider and measure the effect of drilling errors can render good face assessment useless, as drilling errors have the same effect as poor burden estimation and add to the danger of boreholes encroaching too close to neighbouring hole positions. The common errors (see Figure 2 below and Figure 3 overleaf) are:

1. Incompatible face/drill.
2. Side angle on corner shots.
3. Crossed holes.
4. The drill rig is incorrectly set to the face line (the correct drilling direction should be 90 degrees to the face line).

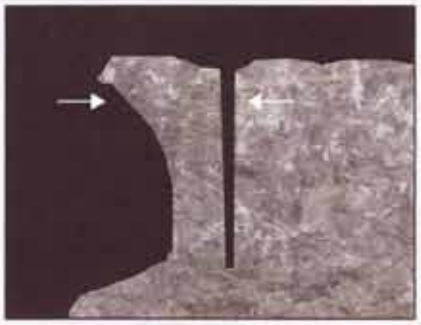
Traditional, but unpredictable survey methods can affect the results of the blast and lead to the following safety and environmental issues, eg:

- Uncertainties about rock face height and floor elevation can result in wasted explosive energy, uneven floors, oversize rocks and high vibration - all of which lead to production cost uncertainties and inventory calculation errors.
- Inaccurate borehole placement and borehole paths - which can create large variations in the distribution of explosive energy within the rock mass.
- Placing holes too close to the free face can result in dangerous fly rock, where rocks are sometimes propelled great distances, endangering lives and property.
- Excessive noise or "air blast" can create public relations problems with nearby homes and businesses.
- Excessive ground vibration can also cause environmental problems and, in extreme cases, damage property.
- While some vibration is created in every blast, the problem can be greatly exaggerated by sub-drilling, improper detonator timing selection and improper blast geometry.
- Sometimes the rock is subject to leaching

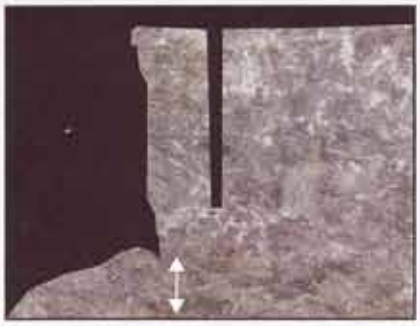
FIGURE 1



1. Under estimate of face burden



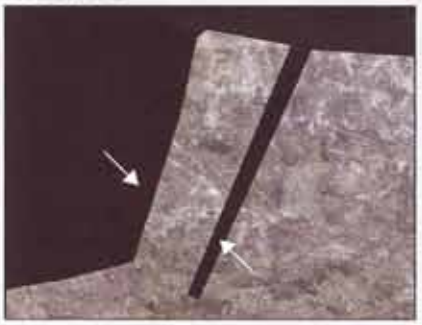
2. Over estimate of face burden



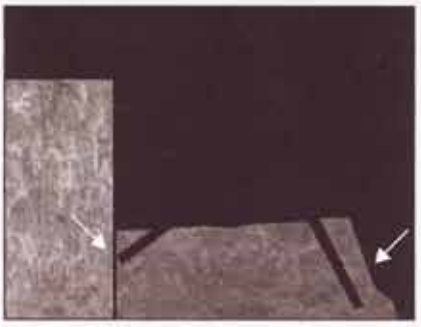
3. Under estimate of face height

4. Over estimate of face height

FIGURE 2



1. Incompatible face/drill



2. Side angle on corner shots

FIGURE 3

3. Crossed holes

Quarryman Pro is used to determine rockface geometry and 3D mapping of mine sites.

operations to remove desired minerals, which affects leaching efficiency.

APPLICATION OF AUTO SCANNING LASERS TO ROCK FACE SURVEYING

The worldwide method of mining hard rock is to bench drill and blast terraces; rocks are repetitively drilled and explosives used to cut slices of rock into manageable pieces. The size of the rock pieces depends on the use to which the rock product is to be put, eg large stones for coastal armour or small stones for grinding to dust and used in talcum powder or cement.

The key to precision blasting is to know the amount of rock or burden in front of each drill hole to be charged with explosives. Armed with this information the engineer can optimise the ratios of explosive energy to rock.

The first stage is to produce an accurate survey of the rock face. This is not easy. A typical rock face may be 25m high and 100m long. The crest or tip of the face is often cracked and fissured, uneven and unsafe. Over the last 20 years, MDL has worked closely with the mining and quarrying industries to develop safe, practical techniques to survey these difficult faces, process the information and present it in an easily understood way.

In response to the changes in regulations and growing concern for blasting safety and its direct correlation with blast geometry measurement, MDL has presented Quarryman Pro, an industry standard, reflectorless 3D laser scanner that can be used for 3D rockface profiling to determine rockface geometry, blast hole burdens, stockpile volume measurement and 3D mapping of entire mine sites. The scanner can record up to 250 points per second without sacrificing its ease of use and rugged reliability.

THE QUARRYMAN TECHNIQUE

The "Quarryman technique" sets two reference point markers on the top of the rock face close to the edge that are visible from the floor below. The Quarryman is set up central to the face at a distance roughly twice the height of the face, from the toe of the face and the base of the rock terrace. The Quarryman firmware prompts the operator to enter survey file reference data such as day, date, face number, etc.

Further prompts request the operator to take manual shots to the hall markers and specific points or features of interest on the face. The "scan" mode prompts the operator to shoot points at the upper right and lower left of the rock face, creating a "scan window".

Two choices are available:

a. To scan by constant increment or arc, minimum increment 0.1°.

b. To scan by constant subtended distance, minimum entry being 1cm.

Upon completion of instruction entries, the Quarryman automatically scans the face, collecting 250 points per second. A 25m x 100m face is scanned at half-metre intervals in just a few minutes.

Where rock faces are complex and heavily fractured, two or more scans can be taken to the face from different locations to avoid an "observation shadow". Simple survey routines are used to inter-relate the scans and merge the data at the processing.

FACE 3D PRO

The software allows for usual data formatting, archiving and peripheral configurations prior to data download. After sorting the data logically, face measurements can be observed randomly and a wire graphics model of the rock face created.

Closely related is the Rodded Boretrak, a non-magnetic borehole deviation technology which is a unique, cost effective and portable surveying system. As the equipment is not affected by magnetic influences, flooded holes or casing, the Boretrak can be used during or immediately after drilling to assess deviation.

The Boretrack features lightweight alignment rods which are connected by a single-axis hinge system used to lower the measurement head into a borehole.

A sensor head calculates the borehole's deviation from the vertical at fixed intervals using inclinometer sensors within the measurement head. The output is compiled on a data logger in the field and transferred to a PC for post processing.

The Boretrak 3D software is used to process the data and produce a hard copy of the results. The data from a laser scanner, together with the borehole deviation measurements, gives a comprehensive overview of the area of rock face to be blasted.

The data is modelled in a software package for more accurate evaluation of burden. Once planned or trial borehole positions are entered, the blast engineer can optimise the amount of rock in front of each borehole by experimenting with various borehole layouts, drill angles and explosive products. Each time a new set of borehole parameters is entered, the programme re-interpolates the survey information from the model and outputs the new information. This method has enabled some quarries to save between 30 and 40 per cent in overall drilling and blasting costs.

The results achieved include:

- Full analysis of the entire face.
- Profiles extracted in true hole direction.
- A dynamic change in drill angles and azimuths to optimise burden.
- A true minimum burden for every point - all weak points were found automatically.
- Output for the driller and shot firer.
- Reduced explosive costs and fly rock control.
- Better face yields and fragmentation.

Over 800 systems are already in use worldwide, which include several earlier versions of manually operated Quarryman models. •

Julia Reynolds is the marketing executive for MDL Australia. This article incorporates reference material from Stephen Ball, managing director of MDL UK.