Face and Borehole Surveying

Another performance aspect in primary blasting

Some years on from its first widespread use in the quarrying industry, there is now little doubt that laser profiling of free rock faces in quarrying operations has been a major step forward in the prevention of uncontrolled rock projections during primary blasting. Parallel to this, the incidence of remedial secondary blasting of toes has dramatically decreased.

As is often the case this is not the whole picture, since borehole angle and alignment measurement systems have equally played a role and, indeed, added the final essential part of the control equation.

Consequence and opportunity

Today any uncontrolled event resulting in injury, damage or even distress to neighbours can result in massive unwelcome costs to an extractive operation and may even threaten the viability of that production unit as a business entity.

It is perfectly clear that the exertion of control in any process is paramount to safe and efficient working. With the primary blast, the measurement of true burden and borehole interaction is the shotfirer's contribution to the avoidance of an uncontrolled event, but at the same time this is also a contribution to a cost-effective and efficient downstream process.

While safety and legislative compliance are essential, there are more subtle benefits arising downstream of this key safety tool which can impinge markedly on the overall cost of the rock winning and processing operation.

Since the inception of Handibulk bulk emulsion explosives in UK quarrying in 1992 by Orica Europe (then ICI Explosives Europe), the company has been a strong exponent of laser surveying and borehole tracking using both its own integrated software systems and off-the-shelf proprietary products.

The mould-breaking concept of 'rock on the ground', where the explosives supplier is paid for broken mineral on the quarry floor rather than for 'energetic' materials, brought new demands for surety in both safety and performance. This meant exerting critical control over the quality of blastholes provided by both clients and contractors alike.

Performance and the dynamic relationship

It has been demonstrated elsewhere that there is a critical relationship between the three key elements of a primary blast, these being: the explosives themselves; the initiation system and its sequencing; and the geometry of the blastholes in the shot. Of these, the explosives, paradoxically, exert the least influence, followed by the initiation system and then the geometry, which exerts the greatest influence.

Considering these elements individually, for the explosives category, the use of bulk emulsion explosives plays a key role. This is because pumped emulsion completely fills the cross-section of the hole and any negative effects from water are minimized. This may seem like a minor point, however in the process of creating hot and rapidly expanding gases the presence of water is bad news; the heat-sink effect in converting water to steam at around 30 atmospheres of pressure is massive.

Quite simply, the use of pumped bulk emulsion explosives offers the operator a degree of consistency of performance that was not available in the past, when operators were obliged to change between packaged water-resistant explosives and ANFO as conditions in the quarry varied.

Arguably, this advance in technology sterilized an existing industry variable and imparted a performance benefit factor which, to some extent, remains unrecognized and undervalued.

For the second most important element, namely the initiation system and its sequencing, the benefits and importance of delay firing are well known. Certainly the consequences of getting it wrong are patently obvious.

Perhaps one important feature which is often overlooked is the inherent accuracy of the shock-tube-type detonators, such as Exel, which are used today. These have been proven to be significantly more accurate than their predecessors, the short-delay range of electric detonators. This can be easily explained since the latter system relied on some 30 different pyrotechnic elements, each individually timed, while the former relies on only two. But this is not quite the end of the story. In delivering this accuracy, the shock-tube system is constrained in its blast-design capabilities, particularly for large multi-row or multi-deck shots where inter-period delays can be as low as 8 milliseconds.

Today, however, with the new 'ikon' electronic detonator, ➤

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unprecedented accuracy and design capabilities will open up new opportunities for the operator.

Finally, and most importantly, is the geometry element. For any particular explosive, in rock fragmentation terms, the more it is asked to do the coarser will be the fragment size achieved, and similarly the converse will also be true. In reality this is a simple dynamic energy equation. The degree to which the work parameters can be controlled, ie the burden and spacing, is obviously paramount to consistent performance. This last category is perhaps the area which offers the greatest variance but equally the best and most influential area for exploitation of control and effect manipulation. Today's profiling systems, measuring tools and software both enhance and allow this opportunity.

Expanding the benefits

From the primary blast viewpoint, what do operators really want? Safety, obviously! But Utopia for any quarry manager must be mineral which digs easily and can be processed to offer the required balance of products consistently, particularly at the higher value-added end of the product spectrum.

Admittedly, downstream benefits tracking is difficult to pinpoint in true financial terms, however dig rates and cycle times are easily measured, as is fragmentation from any particular blast, albeit with some cost. Nevertheless, tools are available and it is imperative that today's quarry manager obtains maximum benefit from them.

Developing a specification

In developing a specification true performance-predictive software programs such as Sabrex are essential. This allows the risk to be taken on the office desk and not on the quarry bench where mistakes can be costly and may expand the time frame of finding the ideal solution. With such software the essential parameters of change can be explored and the solution(s) pinpointed with some degree of confidence.

Having established a theoretical solution, real-time parameters can start to be applied on the bench and indeed added to the model as the operation develops. It is important to realize that as each real piece of data is validated and added to the model, it becomes infinitely more specific to that particular quarry and its circumstances.

Exerting control and developing a quality plan

The old saying that once the holes are in then that's what you've got, and that the blast should be planned accordingly, is totally wrong. The true planning cycle ensures that this does not happen and that holes are delivered to the specification as required and developed in the aforementioned analytical process.

The pre-blast survey using laser-profiling techniques in conjunction with a developed quality plan used in the placement of holes is a prerequisite of consistent blasting. The checking of the planar alignment of holes to each other and within plan is of equal fundamental importance.

Conclusion

Quarrying is about to about to enter an era when the exertion of control will determine its destiny. This is not a new concept for the industry but it will be infinitely more demanding than ever before. However, the tools are there and they should be used to the industry's best benefit.

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