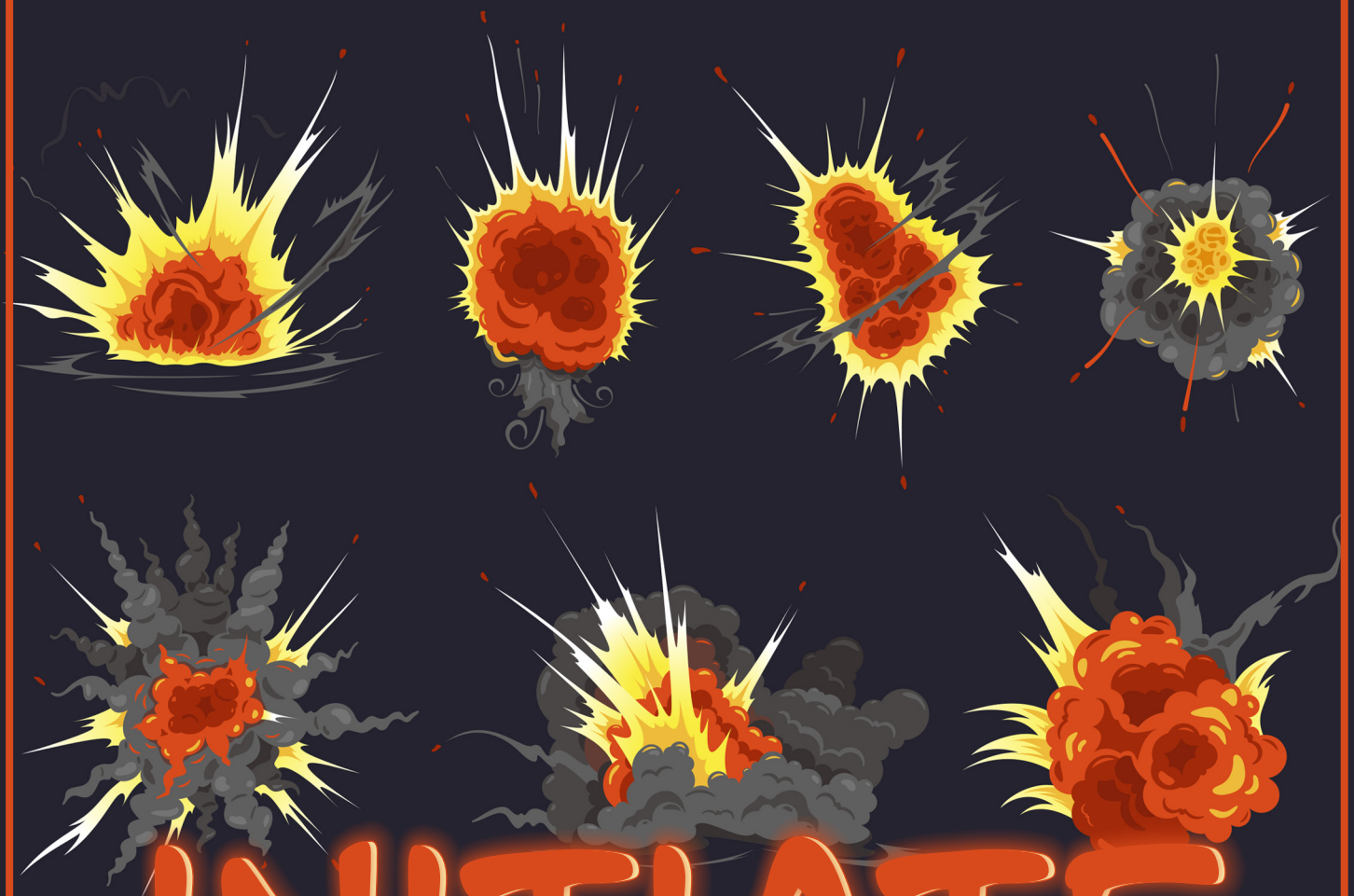

INITIATE BLAST!

Juan Carlos García, Dyno Nobel Mexico, reviews the benefits of implementing a hybrid detonator at a polymetallic mine in Mexico.

Since pyrotechnic initiators were invented, they have been the main initiation system used in Mexican underground mining, due to their ease-of-use and lack of requirements for investment in specialised equipment to perform blasting, such as: electronic initiation boxes, detonator taggers, and accessories necessary to make the connection.

It is well known that the dispersion produced by a pyrotechnic initiator generates significant damage to the boxing rock that will withstand all the efforts caused by the imbalance, generated by altering its natural state and resulting in a gap in an area that had been in harmony for millions of years. Studies have been carried out on this, and the tests that were undertaken on the insecurity exposed by workers and the existing over-excavation in the various units have indicated that an average over-excavation of 25 – 27% is maintained, but that there are mines where the over-excavation exceeds 50%.

Due to problems in the mining industry, as well as in its specific sector, one mine in Mexico decided to promote testing

Figure 1. EZshot Electronic Detonator.

Table 1. Use of NONELs and EZshot implementation at the mine in Zacatecas, Mexico

Delay	NONEL LP Serie	Quantity
200 msec.	1	1
400 msec.	2	1
600 msec.	3	1
1000 msec.	4	1
1400 msec.	5	1
1800 msec.	6	1
2400 msec.	7	1
3000 msec.	8	1
3800 msec.	9	2
4600 msec.	10	2
5500 msec.	11	2
6400 msec.	12	2
7400 msec.	13	2
8500 msec.	14	2
9600 msec.	15	5
	EZshot	
11 000 msec.	P1	4
11 050 msec.	P2	4
11 100 msec.	P3	3
11 150 msec.	P4	4
	Total	40

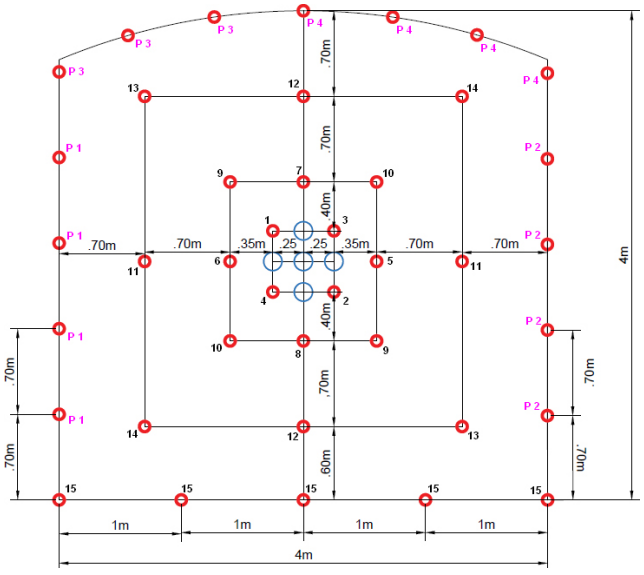

Figure 2. Firing sequence (4 m x 4 m). NONEL + EZshot used in limestone.

with the EZshot® hybrid, as there was no need to train employees or buy additional equipment whilst still generating the benefits of an electronic detonator.

Work abastract

Dyno Nobel Mexico carried out 10 trial blasts with the EZshot system for perimeter blasts in a polymetallic underground mine located in Zacatecas, Mexico (Figure 1).

The system combines the precision of electronic timing with the ease of the NONEL shock tube. This easy to use electronic detonator comes in factory programmed delay times, ranging from 1100 – 20 000 msec., making it well-suited to underground perimeter blasting.

The customer provided blast designs specific to the rock they were working on (skarn and limestone), and from there a firing sequence was created in order to reduce over-break and the associated over-excavation. The goal was also to produce a stable tunnel ceiling to reduce the scaling and the risk factor involved in this activity.

The NONELs used at the mine follow the Mexican delay series comprised of 15 periods, ending at 9600 msec. (Table 1).

With the EZshot implementation, the series was increased in four periods:

- P1 (11 000 msec.).
- P2 (11 050 msec.).
- P3 (11 100 msec.).
- P4 (11 150 msec.).

This allowed the mine to use 19 delays in total, and the benefits obtained included:

- Reduction of over-excavation and overbreaking of the rock, which improved tunnel quality by reducing the operations of scaling on the crown and walls.
- Better granulometry of the rock improved fragmentation, due to better energy distribution.
- Increased safety by reducing overbreak of the rock and the time spent in scaling. This meant that the risk of falling rock was lower and the exposure time was reduced.

Work procedures

Mine operations were observed and surveys were carried out with a Void Scanner (provided by Oviedo, a Dyno Nobel Mexico distributor), prior to the implementation of EZshot. This allowed for a comparison of over-excavation with NONEL vs EZshot.

Before EZshot was implemented, the way crews worked on preparation and development works was observed. This made it possible to identify parameters that needed adjustments. However, when starting to utilise EZshot, the decision was made not to modify them, and instead to identify the benefit that the product can provide on its own. For example, it was identified that the parallelism and symmetry of the drill template had considerable variations, but it was not modified to identify how much overbreaking could be diminished without correcting the lack of symmetry and parallelism.

When EZshot was first used, the drill template was marked to serve as a guide to the distribution of the holes, mainly on the perimeter, although the workers did not respect the marking. Large boards and spacings were generated and

made it difficult to break the rock – this could also be observed in the quality of the work.

The effective drilling depth varied from 3.5 m to 4.4 m (the length of the bar was 4.9 m). Despite the poor drilling accuracy, good results were obtained with the shots that were made, mainly in terms of the quality of the perimeter, since the half barrels were marked and scaling labour was reduced.

By obtaining the results from the modelling produced by the Void Scanner while the blasting was being carried out, the overbreak generated when using EZshot was calculated and compared with what was generated without using EZshot (Figure 2). The section width, section height, and the volume extracted with each blast were considered.

With all the data obtained, the necessary calculations were carried out to determine whether the product provided any benefits in safety, stability, and/or control.

Figure 3 shows the improvement after starting to implement EZshot in the production and development works. The half barrels marked can be observed, without overbreak in the upper part of the tunnel and in the upper area of the walls.

Table 2. Estimated values based on costs provided by different clients. 4.1 m advance is being considered in a 6 m x 4.5 m section. Units: L (labour), p (piece).

	Without EZshot	With EZshot	Reduction	Unit cost	Saving
Scaling (Labour)	3 L	1 L	2 L	US$11.22	US$22.44
Anchor	52 p	44 p	8 p	US$9.40	US$75,20
Labour (per anchor)	52 L	44 L	8 L	US$2.30	US$18.40
Shotcrete	9 m^3	7 m^3	2 m^3	US$127.79	US$262.23
Wire mesh (2 x 3 m)	14 p	11 p	3 p	US$29.98	US$93.21
Labour (per m^3)	9 L	7 L	2 L	US$4.60	US$9.44
Transportation cost	215 m^3	151 m^3	63 m^3	US$13.08	US$829.91
		Estimated savings from use of EZshot			US$1310.84

Figure 3. Quality of the work after implementing EZshot.

Results

The over-excavation was reduced, on average 63 m^3 in large section works, generating the following estimate of savings:

- Using volume as a base, it was found that when using EZshot, the over-excavation on average was reduced to 8 – 9%, while it was previously 45 – 50%.
- It can be observed that the indirect savings generated were significant, based on a single blast (Table 2). When considering that the unit on which the tests were carried out performs an average of three blasts per shift on works with section of 6 m x 4.5 m, and accounting for three shifts a day, a daily saving of US$11 797 can be calculated.
- Although there are still areas of opportunity in drilling (symmetry and parallelism), with the implementation of EZshot it was possible to decrease the over-excavation. With the support of the mine, work will continue to improve the areas of opportunity in the aforementioned points to seek to get the maximum potential from utilising EZshot.
- The quality of the work improved considerably – the half barrels marked on the perimeter are observed without overbreak of rock in the areas where the drilling was adequate, and in areas where the spacing was greater than that established in the template (caused by the lack of symmetry and parallelism between holes). However, it can be further improved by correcting the drilling parameters.
- The scaling labour was reduced, including receiving comments from mine personnel about the excellent results and the minimum scaling required in the area. The workers placed a lot of emphasis on this point, commenting that they had to perform scaling because it is part of the mining cycle established by the mine procedures, but that the scaling task was now minimal.
- It was found that the use of EZshot had a positive effect on blasting, generating less scaling, improving the stability of the work, improving the fragmentation of the material, generating vibrations that are below the regulations, and, most importantly, reducing the risk factor and improving worker safety.

Conclusion

After the trials were carried out, it was concluded that the use of hybrid detonators, such as the EZshot, can be of great benefit in improving the perimeter blasting of mining works, thus helping to achieve safer workplaces for personnel who carry out mining activities. GMR

Note

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