DIFFERENTIAL ENERGY™ TECHNOLOGY IMPROVES FRAGMENTATION BY 52.7%

Background

PROBLEM FOUND AND BASELINE DATA COLLECTED

Using an optimization study that covered a 20-month period in 2014 and 2015, the client found a high percentage of fines in the blasted stone. The client called in DynoConsult to help study the reasons and find a cost effective solution.

Before the study began, an audit was conducted to validate sound loading practices and the precision of drilling. Also, a standard blast was conducted to determine the baseline data on particle size and speed of the primary crusher.

The approach was to make one change at a time in the blasting parameters to measure the impacts on variation in particle size and crushing.

Goal

IMPROVE AND REDUCE FINE PARTICLES

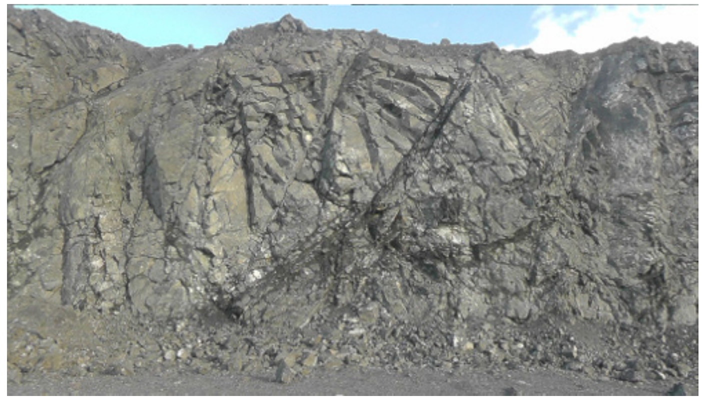
The project's aim was to improve and reduce fine particles smaller than 31.5mm. The 0.08mm passing size was not to exceed 11% of the range from 0.08mm to 31.5mm. Otherwise, production was rejected. A secondary goal was to improve overall fragmentation of blasting, improving the optimal range of 31.5mm to 1m.

The sampling methodology consisted of taking a portion of stones after the primary crusher at every 7,000 tonnes crushed from the blast under the study. After that, the sample was sent for analysis to an outside laboratory.

Technology Applied

DIFFERENTIAL ENERGY, A POSSIBLE SOLUTION

The technology involved in the study was DIFFERENTIAL ENERGY technology (TITAN®ΔE), which allows alteration of the segment gasification rate (max. 4 segments) in a single hole and in a single loading phase.



For this study, more than 15 blasts were required to determine the parameters best suited to meeting the project's goals.

The benchmark blasting was done based on the quarry's conventional parameters (blast no. 2014-08). In examining this blast, it was possible to determine the distribution curve of the fines. It was found that the 0.08mm passing size came to 10.8%, close to the 11% limit (see Figure 1).

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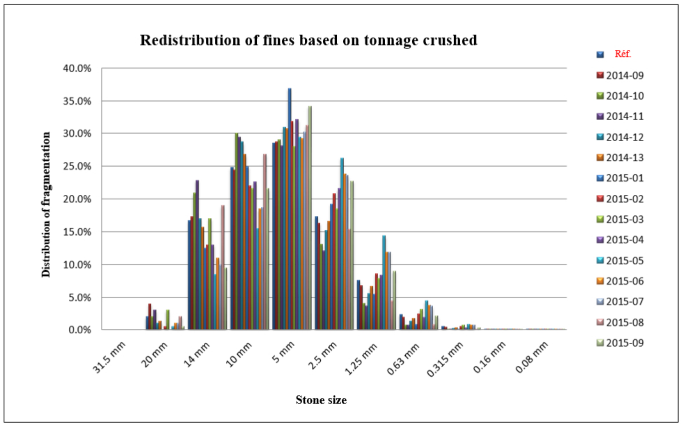
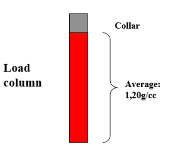


Graph 1: Distribution of fines from 0.08mm to 31.5mm

In blast 2014-12, the drilling parameter was retained and the loading level was much the same: 0.90kg/m3 for blast 2014-08 and 0.92kg/m3 for blast 2014-12. The use of two-segment differential energy allowed the average load density of 1.2g/cc to be maintained in the hole (see Figure 2: bottom segment 1.26g/cc and upper segment 1.15 g/cc).

After blasting, an improvement in the 0.08mm passing level was observed, from 10.8% to 6.5% (see Figure 2).

After several trials, blast 2015-08 enabled the best overall result to be achieved. The drilling diameter was lower, at



Passing percentage										
31.5 mm	20 mm	14 mm	10 mm	5 mm	2.5 mm	1.25 mm	0.63 mm	0.315 mm	0.16 mm	0.08 mm
100	98	83	69.5	49.5	38	29	22.5	18	14	10.8

Blasting parameters	
Depth (m) includes sub-drilling	15.54
Drilling diameter (mm)	121
Sub-drilling (m)	1.21
Collar (m)	1.83
Spacing (m)	3.35
Burden (m)	3.96
Pattern tye	rectangulaire
Product density(g/cc)	1.20
P.F. (kg/m³)	0.90
Zone	P2-E4

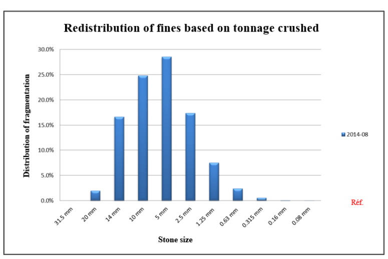
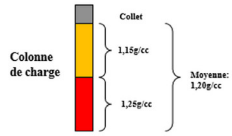


Figure 1: Parameters for blast no. 2014-08



Pourcentage passant										
31.5 mm	20 mm	14 mm	10 mm	5 mm	2.5 mm	1.25 mm	0.63 mm	0.315 mm	0.16 mm	0.08 mm
100	98	83	69.5	49.5	38	29	22.5	18	14	10.8
100	97	74.5	57.5	36	25	18	13.5	11	8.5	6.5
	1.0	8,5	12	13,5	13	11	9	7	5,5	4,3

Paramètre de sautage	
Profondeur (m) Inclut sous-forage	15.84
Diamètre de forage (mm)	121
Sous-forage (m)	1.21
Collet (m)	1.83
Espacement (m)	3.35
Fardeau (m)	3.96
Type de patron	Équilatérale
Densité du produit (g/cc)	1.19
Taux de chargement (kg/m³)	0.92
Zone	P2-G4

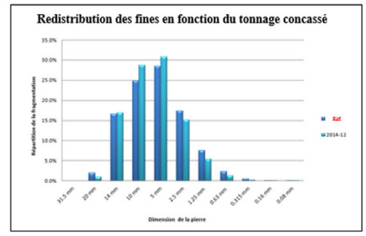
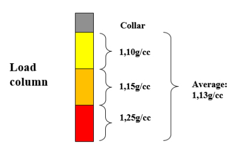


Figure 2: Parameters for blast no. 2014-12

114mm to 121mm, the drilling pattern was reduced by 7.8%, from 3.35m x 3.65m to 3.35m x 3.96m, and the loading level was higher, at 0.97kg/m3 instead of 0.90kg/m3.

Also, the average density in the hole was altered, from 1.20g/cc to 1.13g/cc. This lower average density in the hole was achieved by using three-segment DIFFERENTIAL ENERGY (bottom segment 1,26g/cc, middle segment 1.15g/cc and upper segment 1.10g/cc)

A decrease in 0.08mm passing fines from 10.8% to 5.7% was observed in comparison to the benchmark blast and from 6.5% to 5.7% in comparison to blast 2014-12.



Passing percentage										
31.5 mm	20 mm	14 mm	10 mm	5 mm	2.5 mm	1.25 mm	0.63 mm	0.315 mm	0.16 mm	0.08 mm
100	98	83	69.5	49.5	38	29	22.5	18	14	10.8
100	98	81	66	40	26	17	12	9	7	5.7
		2,0	3.5	9.5	12	12	10.5	9,0	7,0	5.1

Blasting parameters	
Depth (m) includes sub-drilling	13.5
Drilling diameter (mm)	114
Sub-drilling (m)	1.21
Collar (m)	1.5
Spacing (m)	3.35
Burden (m)	3.65
Pattern tye	Rectan.
Product density(g/cc)	1.13
P.F. (kg/m³)	0.97
Zone	P1-XX

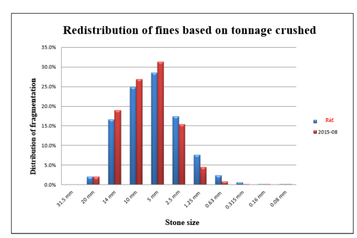


Figure 3: Parameters for blast no. 2015-08

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Value Added

DIFFERENTIAL ENERGY TECHNOLOGY HELPS IMPROVE FRAGMENTATION

DIFFERENTIAL ENERGY played a major role in improved fragmentation. In Figure 4 on particle size analysis of fines, the effects can be seen. Among other things, in curves 2014-12 and 2015-08, an improvement in 0.08mm passing fines can be analyzed, from 10.8% to 5.7% passing stones, representing a 52.7% improvement.

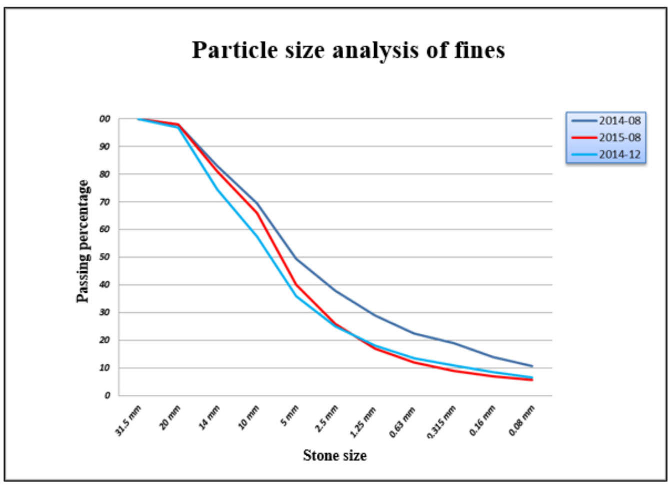

Figure 4: Fine passing percentage (0.08mm to 31.5mm)

In overall blasting, several other positive improvements were obtained in fragmentation (see Figure 5).

1. A lower proportion between 0mm and 31.5mm, from 21.02% to 15.56%, a 26% improvement.
2. The optimal fragmentation range, between 31.5mm and 1m, is maintained, marking an increase from 76.97% to 81.31%, a 5.33% improvement.

Blast no.	Number of blocks ≥ 1 m^3	1 m > à ≥ 31.5 mm	31.5 mm > à ≥ 0 mm
2014-08	2.02%	76.97%	21.02%
2014-12	3.72%	74.41%	21.87%
2015-08	3.13%	81.31%	15.56%

Figure 5: Distribution of fragmentation based on complete blasting

To conclude, it was shown that the use of DIFFERENTIAL ENERGY (TITAN ΔE) helps improve fragmentation to obtain a desired particle size, due to energy being distributed in the right places.