CASE STUDY

ELECTRONIC INITIATION AND WAVEFORM ANALYSIS IMPROVE OFF-SITE BLASTING EFFECTS

PROJECT SUMMARY

DIGISHOT® ELECTRONIC INITIATION SYSTEM IMPROVES THE OFF-SITE EFFECTS FROM BLASTING AND INCREASE QUARRY PRODUCTIVITY

Electronic initiation systems provide accurate delay timing for today's demanding blasting applications. Electronics also provide the explosive engineer with the ability to program precise delay times to further improve blast performance including reduced peak particle velocity (PPV) and increased frequencies (Hz) which minimizes ground vibration.

BACKGROUND

DEMANDING SEISMIC LIMITATIONS REQUIRES USING STATE-OF-THE ART TECHNOLOGY FOR BLASTING

In 2011, a central Vermont quarry converted from nonelectric detonators to Dyno Nobel's DigiShot electronic initiation system. This change was made to better comply with a 0.500 inches-per-second vibration limit mandated by the mineral rights holder, a global producer of industrial fillers and pigments.

PROJECT GOALS

IMPROVE VIBRATION READINGS AT SURROUNDING RESIDENTIAL STRUCTURES AND INCREASE BLAST PRODUCTIVITY

Following this stone producer's commitment to evaluate the performance of the DigiShot electronic initiation system, Dyno Nobel recommended the use of signature hole waveform analysis (SHA). This technology allows the user to select millisecond delay timing sequences that will reduce PPV and increase Hz for the different blast sites at the quarry and their specific seismograph monitoring locations.

TECHNOLOGY APPLIED

THE ELECTRONIC DETONATOR'S TIMING ACCURACY AND PROGRAMMABILITY IS USED IN CONJUNCTION WITH WAVEFORM ANALYSIS SOFTWARE

The process to determine the optimum delay timing sequence for each specific blast event starts with accurate seismic data collection. A series of seismographs are deployed at the quarry's regular monitoring locations, to capture seismic data from single test holes that are loaded and detonated on the active production benches.

Since only a single "signature" test hole is detonated, the shape of the captured waveform is based solely on the geology between the test hole and the seismograph.

The state-of-the-art waveform analysis software allows this single waveform to be used as a building block, evaluating multiple timing variables, to determine the best delay sequences to program into the DigiShot electronic detonators to reduce PPV and improve Hz, which reduces structural response.

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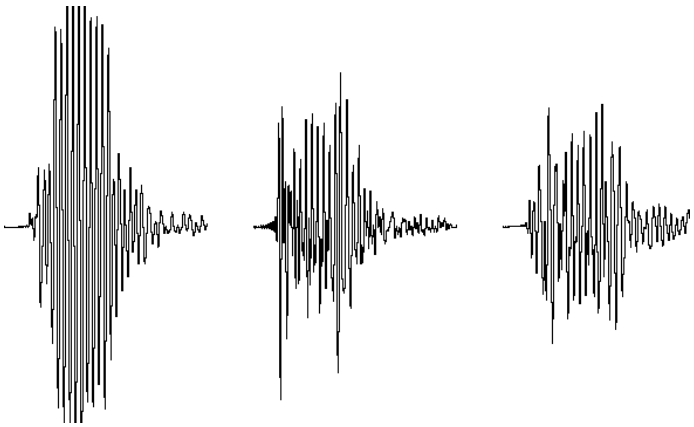
CASE STUDY



A single waveform is "stacked up" using different timing variables to simulate specific blast parameters.

VALUE ADDED

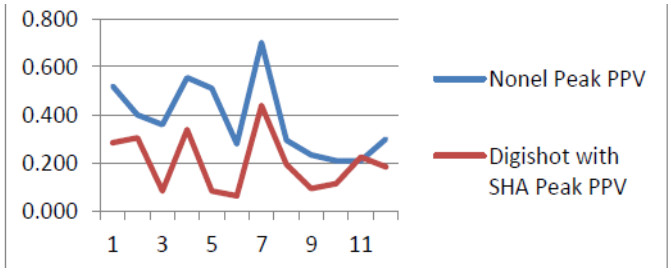
LARGER BLASTS, IMPROVED GROUND VIBRATION AND INCREASED PRODUCTIVITY ACHIEVED BY THE PROPER IMPLEMENTATION OF ELECTRONIC DETONATORS

Data collected from 107 separate events, comparing non-electric blasts detonated during 2010 and DigiShot initiated blast events with waveform analysis, detonated in 2011, indicate that average blast size increased by 18%. Total explosives detonated in these larger blasts increased by 34%, yet produced significantly lower vibration readings. The mineral producer's mandated 0.50 inch-per-second vibration limit is now consistently achieved. In 2010, blasts initiated with nonelectric detonators exceeded this limit on five separate occasions compromising their good neighbor promise. Due to reductions in ground vibration the quarry is now planning on drilling larger diameter boreholes. Originally the quarry used a 3.5-inch diameter borehole but due to these improvements an increase to 4-inch diameter hole will be made. This increased borehole diameter will also allow for an expanded pattern, further reducing drilling and blasting costs. Depending on bench height the average drill pattern used for the 3.5-inch diameter in borehole was 10x10. Using a 4-inch diameter borehole, borehole was also 10x10. Using a 4-inch diameter borehole, this limestone, should allow for an expanded pattern of 11x11.

The average PPV reading recorded at all monitoring locations and at all distances for nonelectric blasts was 0.278 inches-per-second compared to the DigiShot blasts averaging 0.163 inches-per-second: a 41% decrease in the recorded PPV. This, combined with an average of a 10 Hz increase in the frequency spectra has resulted in the virtual elimination of neighbor complaints at this quarry.

This stone producer also reports improved diggability, better fragmentation and improved highwall stability. These were a few of the unexpected benefits this producer and other quarries have experienced when new technologies are introduced and implemented as part of a better blasting program.

Dyno Nobel's Application Technology Team provides speedy turnaround when a request for waveform analysis timing is submitted by the quarry's blaster. A specific analysis is completed for each blast event depending on the number of boreholes, rows and decks in that specific blast design. In most cases the timing analysis is provided to the blaster on the same day as the submission so he can prepare for the next day's blast. This ensures the best chance to minimize off-site ground vibrations and maintain positive neighbor relations.



NONEL® vs. DigiShot & SHA

DYNO® Dyno Nobel