ABSTRACTS

Keynote Speaker
Anthony Huey
Reputation Management, LLC

Perception is Truth: Communicating Effectively

Don't let 30 years of hard work get destroyed in 30 Seconds. Somewhere within every organization, a crisis is waiting to happen. Maybe tomorrow, maybe next year or even in five years; you can't be sure what the crisis will be or when it will strike. But you can be sure that a crisis will put your organization's hard-earned image and reputation up for grabs. The old adage, perception is reality, has never been more true than in today's superficial, hyper-critical and social media-driven world. This timely and highly-entertaining keynote offers actionable keys to swaying internal and external perception during a negative event.

Nate Skopak
Dykon Blasting Corporation

Origins of Air Overpressure

Determining the origins of air overpressure has been a long-debated topic within the explosives engineering community. Historically, it has been accepted that the initial face movement gave rise to air displacement, resulting in an air overpressure pulse. Later research proposed that the air overpressure pulse resulted from the shockwave rapidly propagating through and impacting the quarry face. Most recently, researchers have derived that air overpressure is associated with the gas phase from which a gaseous product from explosives rapidly pours out the quarry face under high pressure. Significant research has strongly indicated that the time at which the air overpressure pulse exits the face fails to coincide with either the arrival of the shockwave at the free face or the initial face movement. Research has consistently shown that the shockwave arrival at the face occurs before the air overpressure pulse leaves the face. Therefore, to best determine which blast mechanism contributed to the initial air overpressure pulse, testing was aimed at verifying the precise time at which the air overpressure exited the faces compared to when the face first moved. This research describes tests using scaled concrete blocks, which provided the ability to control the key parameters necessary for the research to be successfully concluded. Black powder was selected as the energetic material to eliminate the production of

the detonation wave while still inducing other gas-producing effects. The components evaluated were air blast arrival times in front of the face, the initial movement of the blast face, the precise initiation time of the blast hole, timing of pressurization within the rock mass (between borehole and face, or adjacent borehole), and the speed of sound in the air. A detailed timeline was created which portrays the actions within the blast to promote an understanding of the sequencing of events. The results showed that the initial face movement occurred at 17.57 milliseconds (ms) while the calculated time at which the air overpressure exited the face occurred at 7.07 ms. The large disparity continues to reaffirm the premise that the origin fails to coincide with the air pressure pulse. Average pressurization through the block occurred at a rate of 341.23 feet per second (104.15 meters per second) which resulted in the gas release pulse being calculated to exit the face between 4.41 and 6.21 ms. This pulse correlates more accurately with the air overpressure origin timing which will be the focus of continued research. Knowing the precise origin of blast-induced air overpressure will assist in being able to better control it through appropriate blast design.

Neal Lee
Nelson Brothers DBU

Varying Scaled Depth of Burial Depending on the Amount of Horizontal Relief Available to Each Hole

When any hole on the blast pattern has less than two HRPs (Horizontal Relief Planes, typically forward and to one side) available to it at the moment of firing, more of the energy is directed vertically into the stemming. Invariably, stemming ejection/flyrock is noted from the center of "box cut" patterns where the first hole to fire in each row has only ONE HRP, the amount of energy expended horizontally is increased significantly relative to other holes in the pattern which will typically have two HRPs. In many cases, blasters simply use the same stemming height for all holes, varying it only in the event of soft material on top, or reduced crest burden. This simplistic approach is generally successful, but leaves room for improvement when compared to a regime that includes utilizing the number of Horizontal Relief Planes (HRPs) available to each hole when determining stemming heights. When any hole on the pattern has only 1 HRP (see L side of Fig. I above, where holes @ 0ms, 84ms, 168ms, and 252ms are presented with only 1 HRP), 50% more energy is directed vertically upwards. It is therefore logical to increase the SDOB for these holes relative to holes with TWO HRPs. Conversely, SDOB can be reduced for holes with MORE than two HRPs (for example: The last hole to fire in each row when a three sided shot is initiated off BOTH corners). An empirical method of adjusting stemming height for holes with less than or greater than standard (defined as 2 HRP, or Two Horizontal Relief Planes) relief can improve blasting by increasing fragmentation at the collar while reducing airblast and flyrock. Rather than to develop procedures that are Diameter and Explosive Type-Specific, the author chose to vary the Scaled Depth of Burial (D.O.B./WT.^.333), this will encompass all hole diameters and product densities. This presentation will provide resources for the blaster in the field to adjust stemming heights on a hole-by-hole basis utilizing this knowledge.

Doug Rudenko, PG, Bronwyn Weaver, Maggie Archibald, Lance Griffin
Geosonics/Vibra-Tech, Q4 Impact Group, CEMEX

Community Relations of Operations: Inspiration, Managing With Good Data and Practical Approaches

The presentation will be tailored to those with operating responsibilities who may be in the midst of challenging situations (or are preparing for them). The panel will be sharing best practices and management strategies to create constructive dialog, prepare for negative public reaction, and overall work to de-risk projects such as expansions, rezoning and greenfield permitting. Topics explored will include: Community Assessment—creating connections with influencers, Complaint Procedures—addressing issues and looking for trends, Best Practices Using a Team Approach (time management)—looking at the program holistically and sustainably, Public Hearing Preparedness—both face to face and virtual, Advisory Councils—creating and maintaining, Meaningful Program Development—how to listen to the needs of the community.

Steven Carter
CRH America's Materials

CRH Managing Blasting Risk Through Process, Technology, and Performance Management

Drilling and Blasting applications have developed over the years utilizing proven fundamentals progressing to the current state of assessing scientific data, strategic process management, and implementing technological inputs to drive a continuous improvement performance management program. The process begins through effective mine planning and adoption of a sound strategy for generating optimized blast designs. Utilization of technology, understanding rock characteristics, utilizing tools and software to ensure accurate blast designs for economical plant productivity to deliver a saleable market driven product mix. To achieve this a culture of continuous improvement with objectives focused on safety first, creates an environment of exceptional cross functional collaboration to sustain a cost-effective balance between all stake holders for managing drilling and blasting success while limiting risk.

Doug Rudenko, PG and Brian Warner
GeoSonics/Vibra-Tech

3D Modeling of Blast Induced Ground Vibration Using Spectral Element Method

Advances in high-performance computing and numerical modeling schemes have made it possible to simulate seismic wave propagation more effectively at different scales: from small-scale models used in nondestructive testing to global scale seismological problems. Simulations have been done for many years in regional/global seismology, but not in blasting industry. This

research examines if the spectral element method used in the seismology codes could be used to model blasting.

During this study, an area 3.75 km (2.3 miles) by 2.25 km (1.4 miles) north of a large aggregate operation in Texas was selected where historical vibration measurements were abundant. Information was collected about the site geology and its material properties. Ambient vibration data were collected at 40 locations north of the quarry. The ambient data were processed using the horizontal-to-vertical spectral ratio (HVSR) method to determine the fundamental site frequency at each location.

Compressional and shear wave velocities of the subsurface layers were measured at 11 locations using seismic refraction and multichannel analysis of surface waves (MASW) methods. These velocities combined with fundamental site frequency data and site attenuation measurements made it possible to assign proper material properties in the model. Digital elevation data combined with the material properties defined the geometry of the model. Finally, the blast impulse was measured using two instrumented boreholes, each containing 2 triaxial geophones. Waveforms from two single hole blasts and one production blast were measured and their frequency content was examined. The borehole measurements were used to gain a better understanding of the type of source that was needed in the numerical simulation, especially when it comes to its frequency content and duration. Propagation of seismic waves was simulated through the computer model to produce synthetic seismograms at various locations for comparison to the measured field seismograms at the same locations. Due to the computationally demanding nature of this problem, high performance computing methods were required. Simulations were carried out on a computer cluster and the output synthetic waveforms were post-processed accordingly.

Catherine Aimone-Martin, PhD
Aimone-Martin Associates, LLC

Blast Vibration-Induced Structure Global Strains – A Better Approach to Cracking Potential

Global shear and tensile wall strains in structures resulting from near-by blasting operations provide a more realistic measure of material cracking potential compare with a ground velocity criteria such as that provided by the U.S. Bureau of Mines in RI 8507. Frequency-based velocity only tells part of the story whereas calculating structure global strains from differential displacements over structure wall dimensions provides a sound engineering basis for predicting cracking in plaster, drywall, mortar and concrete where failure strain limits are well known. This presentation provides simplified global strain calculations derived from seismograph geophones strategically mounted at structures. Examples of blast-induced strain measurements both well below and above material failure strains will be presented as well as details of a strain-based blasting criteria adopted for New York City.

Nick Lewis, PE
Vulcan Materials Company

The Challenges Encountered in Blasting Optimization in Aggregate Operations

This presentation will discuss the pros and Cons of increasing blast fragmentation in a typical aggregate operation. The process flow, drilling and blasting program and customer demand must have a cooperative approach in order to be optimum. Methods to increase or decrease finer material will be presented.

Mohammad Sharif, PE
GeoSonics/Vibra-Tech

Blast-Induced Ground Vibration Effects on Integrity of Mine Infrastructure

The utilization of explosives in the mining industry is essential in rock excavation. Often this activity must occur in close proximity to mine infrastructure. The detonation of explosives near some infrastructure can cause excessive ground vibrations that may cause severe damage, production delays, or safety concerns. The level of impact on the integrity of such structures depends on the proximity to blast holes, charge loading, and relative confinement. These critical structures include but are not limited to electrical substations, transmission towers, exhaust ventilation fans, hoist houses, mine portals, and underground concrete service shafts. This presentation illustrates the mechanism of applied dynamic loads caused by blasting and how the structures will respond to these loads. The development of practical vibration criteria and monitoring solutions will be discussed to prevent damage, production delays, or safety performance issues.

Jonathan Ferdinand
GeoSonics/Vibra-Tech

Measurement of Ground Vibration and Pore Water Pressure in a Sand Embankment During Under Water Explosive Detonation

A 147-home lakeside residential housing development was planned along the banks of the old ponds left behind at the site of a former Sand and Gravel dredging operation. As part of the site remediation, the steep slopes of the ponds needed to be smoothed to a more gradual grade. The use of cast boosters detonated underwater near the shore was proposed to move the sand to its natural angle of repose. As part of this process, there was a concern that underwater blasting may result in the buildup of excess pore water pressure in the soil, especially during repeated detonations over short intervals. This increase in pore water pressure could result in soil softening, soil liquefaction, and settlement of a nearby overhead electrical transmission towers 75 feet from the water's edge, as well as a nearby BNSF railroad line, a State Highway,

and a small development. In addition, blast induced ground vibration may also directly damage these nearby structures of concern.

A protective ground vibration limit for the site was developed based upon the results of a shear wave velocity profile developed through Multichannel Analysis of Surface Waves (MASW) and the dynamic pore water pressure measurements were used to understand the excess pore pressure dissipation rate. Vibration attenuation measurements were used to verify compliance with the vibration limit at specific distances to adjacent structures.

Robert McClure
R.A. McClure, Inc.

Blast Optimization Using Smart Drill and Loader Technology

Blast optimization has many challenges. One of the key components is accurate blast design. Getting the "As-Designed" blast pattern from the software to the bench with a high degree of accuracy is critical to benchmarking and further optimizing the blast performance. Smart Drill integration into an operation brings the drilling accuracy on the bench by providing angle, azimuth and depths with subdrill. Post blast, the challenge is maintaining designed bench heights and managing floor elevation. The use of Smart Loader technology assists the operator to maintain pre-established floor elevations. The combination of this smart technology coupled with accurate blast design software provides the tools to a successful optimization program.

Spencer Kerdock
Martin Marietta

Advanced Blast Design and Blast Evaluation

Sometimes challenged with atypical bench conditions, a creative approach is required to not only maximize the fragmentation of the blast, but also to improve the conditions of the subsequent face behind it. Using the 3D design approach, Martin Marietta has seen tremendous success in more efficient and safer blasts across the enterprise. Blasts have become more controlled, drilling and loading safety has improved, layouts have become more efficient, production has increased, all while reducing secondary breakage costs. This presentation will review the steps included in the 3D design process, related technology, benefits and results, as well as how this process can be used for shot performance evaluation.

Shimin Liu, PhD
Pennsylvania State University

Blasting Induced Ground Vibration and Its Implication on Pillar Loading and Its Stability

Large opening mines account for roughly half of the metal/non-metal mines in the United States. Recent massive limestone pillar collapses highlight a need for in-depth studies of pillar loading and failure mechanisms. Since October 2020, four massive pillar collapses have occurred. For large opening mines, pillar design theories use a factor of safety which is defined as pillar strength to maximum average pillar load. This approach does not account for mine-induced variations such as water and its associated elevated pore pressure, or the effects of blasting and ground vibration. This study analyzed mine induced stresses variations of underground workings through both time dependent static strain and blasting induced dynamic strain. A comprehensive field monitoring strategy has been developed to monitor the stress/strain relationship. Research of this caliber can offer baseline data for developing pillar stability factors based on dynamic peak stress, rather than the tributary area method. The numerical model was developed to analyze the stress variation during the blasting events and the pillar stability was evaluated with repetitive blasting. This study will provide the mining community with better tools for the design of pillars with considering the repetitive blasting.

Chuck Jaworski, MSPS
GeoSonics/Vibra-Tech

Do's & Don'ts of Responding to Blast Complaints

Blasting generates complaints from adjacent property owners because blasting shakes their homes. Given there is a considerable difference between the levels of vibration that can cause damage to structures and the levels of vibration that people can feel and most will tolerate, it is important to have a sound response plan in place for when blasting complaints arise. This talk will outline considerations for a response plan based on our experience in seeing blasting complaints handled both well and poorly.