Volume 2: Q2 2002

JUST FOR THE Record™

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Evaluating and Managing Construction Blasting Risk

Article provided courtesy of Gordon F. Revey, Revey Associates, Inc. - Highlands Ranch, CO, USA

ABSTRACT: *While representing owners at projects where explosives are used to excavate rock or demolish concrete, engineers participate in the management of blasting risk when they, a) design projects, b) develop contracting methods, c) write blasting specifications, and d) oversee fieldwork. In performing this work, the engineer assumes the responsibility of managing the many risks associated with blasting operations. Although rare, terrorist acts and incidents involving explosives create negative public perceptions. Despite these incidents, explosives are safely used to excavate rock at thousands of projects throughout the US each year. This article defines various forms of blasting risk, illustrates them with case histories, and offers practical guidelines for identifying and managing them.*

INTRODUCTION

Over ten million pounds of explosives are used daily to excavate rock by blasting in mining, and construction operations throughout the United States. Despite the immense volume of explosives used, serious incidents involving the legal use of explosive materials are rare. Unfortunately, when incidents involving explosives arise, they are well publicized, whereas the great majority of blasting projects—even the most challenging ones--quietly occur without incident or public recognition. Although unfair, media coverage focuses on those few incidents and/or accidents, and as a result skews the public's perceptions of our industry. Negative perceptions about blasting can profoundly affect construction work. Many projects have been halted or delayed by community groups concerned about the potential damage or environmental impacts of blasting. Other effects are more insidious and long lasting. For instance, planning engineers or government agencies often prohibit blasting to avoid the public's adverse reaction or because of general fear of blasting impacts. As regulations and specifications become increasingly more restrictive, the net effect is an increase in the cost of rock excavation.

Experienced blasting professionals acknowledge that blasting--even under the most challenging conditions--can be accomplished without incident if proper blasting controls are applied. In construction work, engineers and planners representing project owners and government agencies are jointly responsible for insuring that blasting is performed safely and with minimum financial risk.

This article defines the blasting industry's challenges, reviews public perceptions, explains types of blasting risk, presents a system for managing blasting risk, and offers a practical guide for identifying and managing various forms of blasting risk.

THE CHALLENGE

For engineers, blasters and project supervisors, managing risks associated with blasting is becoming an ever increasing challenge as work inevitably occurs in more populated areas. Not only is the work closer to people, structures and utilities, but environmental concerns about blasting effects on animals are also increasing. In some cases, owners and engineers simply avoid the risks of blasting by specifying that only mechanical methods be used for excavating rock. Unfortunately, this surrender to alternative methods usually increases the cost of the work. In a few cases, mechanical excavation methods are ultimately unsuccessful, necessitating the last-minute introduction of blasting methods. Without proper planning and controls, blasting at the eleventh hour is costly and increases risk because proper specifications have not been written and claim-prevention activities have not been done. At some large civil construction projects, blasting is often only a small part of the overall work. As such, blasting specifications and other controls are often not addressed as rigorously as they should be in project documents. Regardless of the scale of blasting work, when engineers or planners underestimate the importance of preparing adequate blasting controls and community relations programs, the consequences can be severe.

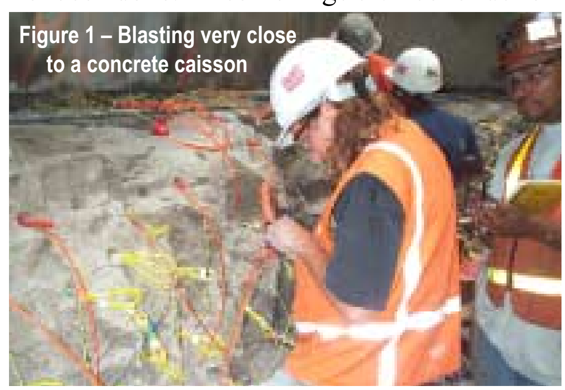

Figure 1 – Blasting very close to a concrete caisson

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Call us at 1-800-267-9111 (North America), or 1-613-592-4642, and we'll fax you the seven page article!

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APPENDIX. REFERENCES

Revey, G.F., (1999). Modern Blasting Technology and Risk Management, Published by GEOTEK & Associates, Inc.

Revey, G.F. (1996). "To Blast or Not to Blast," ASCE Practice Periodical on Structural Design and Construction, Aug. 1996, Vol. 1 No. 3.

Technical Services Manager

What about Bob?

Bob Turnbull, Technical Services Manager, started with Instantel's Engineering group in 1987 on a work placement. After graduating from the St. Lawrence College in 1988 as a Microcomputer Engineering Technologist, Bob joined Instantel full time. His first project was the design of the BlastMate series II product; this included the printed circuit board layout and the development of test criteria and specifications. He continued to develop products in the Engineering group until 1992 after which he assumed the role of Manager for the Service and Technical support groups. Bob still plays an active role in the development of Instantel's Instrumentation products.

Richter Scale vs. PPV

Shakin' it Up with Wes Bender

Several times, when I have been going over a seismograph record with someone who is not familiar with blasting (let alone blast vibration), I have been asked how the peak particle velocity levels compare to the numbers on the Richter Scale. This may seem like a reasonable question, however, it shows that the individual asking the question either doesn't understand what the Richter Scale is or that they do not understand the difference between magnitude and intensity.

A number on the Richter Scale represents the total magnitude of an earth-motion event while the readings on the seismograph indicate the intensity of ground motion at a given location. The magnitude of a particular event will stay the same, but the intensity of vibration will vary depending upon how far from the epicenter you were taking readings. In other words, there would be no practical way that you could relate your seismograph readings (taken at one location) to the Richter Scale.

While we record blast vibration intensities in inches or millimeters per second of particle velocity, earthquake intensities are assigned a number on the Modified Mercalli Scale, a scale is used that relates the intensity to the apparent effects from the motion. In greatly simplified form, it ranges from MM I which is only detectable by very sensitive instruments to MM XII which represents total destruction of structures. One cannot readily assign particle velocities to the twelve different MM levels and it would not be technically correct to do so.

There is such a great difference in the characteristics between blast vibration and earthquake motion that it is not feasible to try to relate the two in any logical manner. The frequency of your blast vibration could range from several hertz (at greater distances) to 700 or 1000 hertz (in close proximity). Earthquake frequencies are so low that they are not normally measured in hertz but rather in the number of seconds for a full cycle or period. You might see rather high acceleration levels from your blast, but the displacements would be so low that they would not cause damage. On the other hand, an earthquake may cause damage at rather low acceleration levels because the displacements could be quite high. In California, bridges and other highway structures are designed to survive specific earthquake acceleration levels. These could be quite low, on the order of 2 to 4 Gs or so. You can see why a structural engineer might become concerned when you tell him that you expect acceleration levels from your blast to reach 4 or 5 Gs, measured on the ground at the base of his structure. Unless he can also understand that the displacements are only going to be on the order of a few ten thousandths of an inch and will not damage the structure, it isn't likely that you will be allowed to blast.

While we can't relate your seismograph reading to Dr. Richter's scale, we might try to relate the size of the entire blast to it. First we must disregard some of the differences between blasts and earthquakes such as energy release of the explosive, spatial separation of charges, frequency, time duration of energy release, depth to the source of energy, etc.

Let's see how many pounds of explosive it would take to reach various Richter numbers. Several years ago Doug Anderson presented a paper at the ISEE on the topic. Doug used information developed for nuclear testing and fully explained his calculations in his paper, hence (if we accept his cautionary notes and assumptions) we can use his calculations to reach an approximate magnitude based upon explosives weight. He indicated that the Richter magnitude would only relate to the total blast if all explosives were detonated simultaneously. We don't do that very often in conventional blasting. He also noted that it would not strictly relate to the charge weight per delay (unless there was an unusually large delay between charges making each an individual blast, which we also don't normally do.) The actual magnitude number would then fall somewhere between that calculated for the entire blast and that calculated for the largest charge weight per delay.

For purposes of the following table, we will assume that we are initiating one charge of the weight indicated. This will result in the highest possible Richter magnitude for the event. If you decide to break the event up into delays and calculate another Richter number for the largest charge weight per delay, as stated above, the actual Richter magnitude for the event would fall somewhere between the two. Doug made it abundantly clear that these were going to be rough approximations, so don't try to take them to court with you!

Richter Scale vs. PPV *(cont.)*

Shakin' it Up with Wes Bender

Magnitude	Pounds of Explosive
5	2,000,000,000
4	200,000,000
3	20,000,000
2	2,000,000
1	200,000
0	20,000
-1	2,000
-2	200
-3	20
-4	2

If you wish to calculate your own magnitude numbers using Doug Anderson's assumptions, the formula he used is as follows:

$$M_{ce} = (\log w) - 1$$

Where M_{ce} is Magnitude for chemical explosions, and w is the explosive weight in tons.

As you can see, it takes a lot of explosive energy to achieve a magnitude similar to that of an earthquake. As Doug points out in his paper, if the smallest earthquakes that can be felt are about magnitude 2 or 3, how come people are complaining about your blasts that may only have a few pounds loaded? Congratulations. You have just discovered the difference between magnitude and intensity. While the magnitude of your blast may be quite small, where you are locating it in relation to their residence makes the difference. The vibration intensities that you record with your seismograph next to their foundation is much more important than the overall blast size...but then I guess you knew that all along, anyway.

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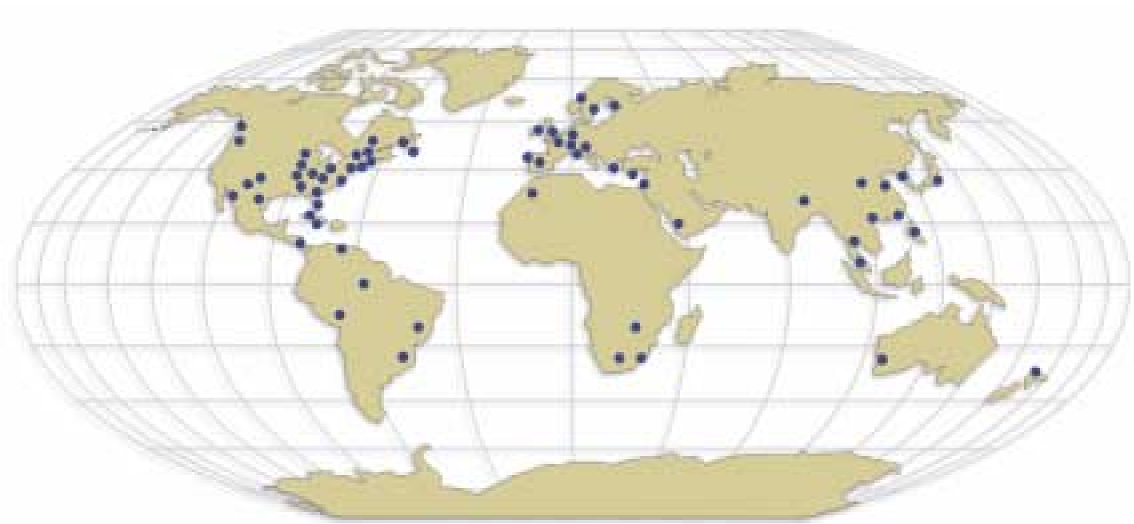

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ISEE 2001 Show Report

Wireless communications are the talk of the show

Each year Instantel participates in approximately 20 tradeshows and conferences worldwide, and we continue to look forward to the International Society of Explosives Engineers (ISEE) annual conference. This year's event was in Las Vegas, Nevada, U.S.A., and drew 1300 attendees, representing 32 countries. In addition to the 125 exhibitors displaying explosives-related products, services and technologies, the conference also featured a Blaster's Training Seminar, daily technical sessions, and a unique opportunity to network and exchange information with blasting professionals from all over the world.

Instantel showcased how our Representatives and Customers have taken advantage of the E-link™ communication tools to create a diverse set of wired and wireless data exhange solutions with multiple instruments. This included wired short-haul modems, GSM, cellular, RF, and satellite modems. Visitors were shown how the power and flexibility of E-link™ features could be used to implement various communications platforms to satisfy any remote monitoring application. The highlight of the booth, and the talk of the show, was the demonstration of Instantel's short-range wireless upload and download capability. Instantel demonstrated how data from a MiniMate-Plus could be downloaded to a PDA handheld computer without the use of a cable – up to a distance of 300 ft (100 m)! Needless to say, a lot of people suggested interesting applications and requirements for this capability in their day-to-day monitoring work.

Sunday night, over 300 of Instantel's closest friends joined us for our annual "Friends of Instantel Reception." Many thanks to all who dropped by making it a huge success again!

Wireless with BlastMate® Series III

Two-way wireless data transfer using a PDA, laptop or PC

Instantel has included a Bluetooth™ communications option for their Series III vibration monitors. Wireless technology now makes it possible to connect any compatible portable and stationary communications device as easily as switching on the lights, but without a single inch of cable.

You can copy event files from your Instantel® Series III vibration monitor and either download data directly to a PDA (Personal Digital Assistant - e.g. iPAQ from Compaq), laptop or PC, without a cable connection, providing flexible and reliable data acquisition. An upcoming release of BlastWare® software for the PDA allows you to view the event file summary data. Also, view waveforms, scale, and perform a cursor scan analysis of the events. Setup files that have been created on the PDA, laptop or PC can be wirelessly uploaded to the instrument.

For more information about the release of this exciting communications tool, call us at: 1-800-267-9111 (North America), or at 1-613-592-4642; Email - sales@instantel.com.

Article Submissions Requested

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April 28 - 30, 2002
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Explosives Engineers (Annual Conf. of UKIEE)
April 11, 2002
Leicestershire, UK

Expomin 2002 - CAMESE
May 7 - 11, 2002
Santiago, Chile

7th Intl. Symposium on Rock Fragmentation by Blasting (Fragblast 7)
August 12 - 15, 2002
Beijing, PR China

Electra Mining 2002 - CAMESE
September 30 - October 4, 2002, Johannesburg, South Africa

Queens University Blasting Technology Course
September, 2002
Kingston, Ontario, Canada

ISEE Pomatac Chapter
November, 2002

ISEE Marlboro - New England Chapter
October 18, 2002

IMEE 2002 International Mining & Machinery Exhibition
November 6 - 9, 2002
Calcutta, India