STANDARD OF CARE FOR BLASTING NEGLIGENCE

By

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ABSTRACT: Blasters are usually strictly liable for injury or damage caused by flyrock (trespassory invasion) and blast-induced vibrations (non-trespassory invasion). The application of strict liability to non-trespassory invasions has resulted in significant litigation that has hampered the use of blasting and the blasting industry. Stark (2002) proposes that blasters should not be held strictly liable for non-trespassory invasions but should be liable only if their conduct is proven to be negligent. This change in legal standard was proposed because improvements in blasting technology over the last thirty years allow blasting to be conducted without substantial risk of harm to property and thus the amount of harm imposed by a blast can be related to the level of care exercised by the blaster. It is anticipated that a negligence standard will reduce the amount of litigation because a plaintiff will have a greater burden to overcome. To facilitate the acceptance of a negligence standard by a court of law, this paper summarizes the standard of care using the 1977 Surface Mining Control and Reclamation Act, extensive U.S. Bureau of Mines research, and current blasting techniques, such as blasting mats. It is important for the blasting industry to promulgate a standard of care so a judge can feel confident that blasting can be routinely and systematically controlled and if the legal standard is changed from strict liability to negligence a subsequent judge or jury will be able to evaluate the level of care exercised by the blaster. This paper also suggests that the industry and/or ISEE develop and disseminate a comprehensive standard of care that courts can use to further justify a change from strict liability to negligence and evaluate the standard of care.

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INTRODUCTION

Modern authorities, including case law and the Second Restatement of the Law of Torts (American Law Institute 1976), apply strict tort liability to trespassory (flyrock) and non-trespassory (ground vibration and air overpressure) blasting damages for construction (Spano v. Perini Corp. 1969), mining (Fantasy Valley Resort, Inc. v. Gaylord Fuel Corp. 1992), and quarry (Poe v. Atlas Powder Co. 1968) related blasting. Strict tort liability has been applied to damages caused by flying debris onto adjacent property as early as 1893 (Spano v. Perini Corp., 1960) and is justifiable based on the theory that a trespass has occurred. Stark (2002) proposes that blasters should not be held strictly liable for non-trespassory invasions but should be liable only if their conduct is proven to be negligent. A number of reasons are presented for raising the legal standard from strict liability to negligence including: (1) improvements in blasting technology that allow blasting to be conducted without substantial risk of damage and if damage does occur it is likely to be cosmetic, (2) establishment of conservative ground vibration and air overpressure damage limits for typical structures, and (3) established industry standards for construction blasting. To facilitate the acceptance of a negligence standard by a court of law, this paper summarizes existing information on the standard of care for blasting. This paper is not intended to serve as a sole source for the standard of care nor to serve in any legal capacity. The main purposes of the paper are to (1) explain why establishing a standard of care for blasting is important and (2) encourage the blasting industry to promulgate a standard of care so a judge can feel confident that blasting can be routinely and systematically controlled and if a judge changes the legal standard from strict liability to negligence a subsequent judge or jury will be able to evaluate the level of care exercised by the blaster.

STRICT TORT LIABILITY V. NEGLIGENCE

A strict tort liability standard for blasting makes a plaintiff's claim significantly easier to prove than a negligence standard because there are fewer elements that a plaintiff must prove to a jury before receiving a favorable verdict. The fewer elements and a burden of proof equal to the preponderance of the evidence make proving a strict tort liability claim fairly easy. As a result, plaintiff attorneys are drawn to situations in which the legal standard is strict tort liability and the burden of proof is only the preponderance of the evidence. For comparisons, the burden of proof in a criminal trial is beyond a reasonable doubt but in a civil trial the burden of proof is a preponderance of the evidence, which means that the plaintiff only has to prove 51% of the evidence favors their explanation of the injury or damage and thus only 49% favors the defendant. As a result, the preponderance of the evidence standard is frequently referred to as the "more likely than not" standard.

Under a negligence standard, there are four elements that a plaintiff must prove to prevail (see Table 1). However, under a strict liability standard, there are only two elements that a plaintiff must prove to prevail (see Table 1). It can be seen that both negligence and strict liability claims require proof of proximate cause and proof of the amount of personal injury or property damage inflicted by the blasting. The proof of damages is self-evident, e.g., cost to repair cracks, repaint the structure, and diminution in property value, and thus the only

element that a plaintiff might have difficulty proving under strict liability is that the blasting is the proximate cause of the damages.

Table 1: Provable elements of negligence and strict tort liability claims (Epstein 2000)

Negligence	**Strict Tort Liability**
Duty of care	Assumed proven by plaintiff
Breach of duty of care	Assumed proven by plaintiff
Proximate cause of damage	Proximate cause of damage
Damages	Damages

The proximate cause element requires a plaintiff to show that the blasting is (1) the primary cause for the injury or damage, (2) the injury is reasonably anticipate or foreseen as a natural consequence of the blasting, and (3) without the blasting the injury or damage could not have happened. The last two elements of proximate cause are substantial hurdles in a blasting case. For example, under the second element it is fairly easy to show that cracking of a structure is a foreseeable consequence of blasting based on the numerous references on construction blasting and is usually presented by an expert witness. The third element is provable by showing that the cracks did not exist prior to the blasting and this can be accomplished by the owner of the structure or a pre-construction survey. The plaintiff usually tries to meet the first element of proximate cause by providing expert testimony that opines that the induced level of vibration and/or air overpressure could have caused the cracking. Therefore, the main hurdle, albeit a small hurdle, for a plaintiff to prove proximate cause is show that the level of vibration and/or air overpressure could have caused cracking in the structure.

Defendants usually try to refute a plaintiff's proximate cause evidence by (1) showing that the cracks existed prior to blasting and (2) if the cracking did not exist prior to blasting, the level of vibration is not sufficient to cause the observed cracking. This can be accomplished by carefully inspecting a crack usually with a magnifying glass or microscope to determine if the cracks are new, e.g., with sharp edges or paint hanging from the crack, or old, e.g., there is paint in the crack. Other techniques for rebutting plaintiff causation evidence is the lack of displacement of nearby loose objects, e.g., dishes, books on tables or in bookshelves, or ornaments, and/or non-disturbance of nearby liquids, both of which would disprove the presence of vibrations (Oriard 1999). In addition, the contractor can conduct a building condition survey prior to blasting to document pre-existing cracks. The performance of crack surveys usually results in significant cost because the surveys may be required for structures within approximately a one-mile (5000 feet) radius of the blasting to discourage fraudulent claims. Dowding (2001) suggests the use of a sensor to monitor the behavior of a crack before, during, and after blasting. This allows a graph of crack movement versus time to be developed, which usually shows that environmental factors have a larger impact on crack displacement than blasting.

The use of strict liability, and thus only really needing proof of causation, has led to damage awards for plaintiffs even though the cosmetic cracking was not caused by the blasting activities (Oriard 1999) and some dubious plaintiff and expert testimony. Oriard (1999) details 33 cases of questionable plaintiff claims from blasting.

These and other claims are facilitated by imposition of a strict tort liability framework on the blaster because the only debatable issue for a jury is whether or not the cracking/damage was caused by the blasting. The use of a negligence framework will require a plaintiff to establish the duty of care for a blaster, show the contractor was negligent, i.e., breached his/her duty of care, and that the blasting is the proximate cause of the damages (see Table 1). It is apparent that a blaster will have a duty not to damage adjacent structures.

Thus, before the legal standard will be raised from strict liability to negligence, courts probably will have to be convinced that plaintiffs will still be able to recover for legitimate claims even if a negligence standard is applied. This will require that a court be convinced that a plaintiff can prove that a blaster breached his/her duty of care.

IMPLEMENTING A NEGLIGENCE FRAMEWORK

Because the blaster essentially assumes a duty of care by undertaking the activity of blasting, the new obstacle that a plaintiff will have to prove under a negligence framework is that the blaster was negligent or breached his/her duty of care. A plaintiff can prove a breach of the standard of care using direct evidence or inferring negligence from circumstantial evidence. Direct evidence is discussed first and involves establishing a typical standard of care in the blasting industry and then comparing the blaster's level of care to this standard. If the blaster operated at or above the standard of care, he/she is not negligent. If the blaster operated below the standard of care, he/she is not negligent. Afterwards, the use of circumstantial evidence to prove negligence will be discussed.

1. ESTABLISHING THE STANDARD OF CARE FOR BLASTING NEGLIGENCE

This section investigates the standard of care typically utilized in the blasting industry to show that a deserving plaintiff can prove that a blasting contractor breached his/her duty of care in the blasting operation. It is proposed that the standard of care can be delineated to some degree by compiling typical recommendations for the procedures that should be followed on a blasting project. There are many sources of information for typical blasting procedures but this paper is not intended to serve as a state-of-the-practice review of blasting procedures. The main objectives of this paper are to convey the importance of establishing a standard of care for the blasting industry to facilitate implementation of a negligence standard, demonstrate that references exist that present suitable guidelines for blasting, and to encourage the industry to develop a standard of care. As a result, a few sources of information are reviewed below to highlight the extent of the information available, which may help convince a court that blasting is a controllable activity and there is a typical level of care applied to blasting projects.

a. Acceptable Blast-Induced Vibrations and Air Overpressures

The standard of care can be reflected in the allowable levels of blast-induced vibrations and air overpressures. Evidence of whether or not the standard of care was breached can be obtained using the allowable blasting limits in Tables 2 and 3 and comparing the recorded or estimated peak particle velocities and air overpressures to these limits. If the induced vibrations and air overpressures exceed the recommended values, the plaintiff has prima facie evidence of negligence. Conversely, defendants can utilize compliance with the limits in Tables 2 and 3 as mere evidence of non-negligence. The blasting limits in Tables 2 and 3 are designed to prevent the

onset of hairline cosmetic cracking and thus damage to adjacent structures is not likely to occur unless the blasting contractor was negligent.

Table 2: Allowable Peak Particle Velocities as a Function of Distance from the Office of Surface Mining (OSM) Regulations (Office 1983)

Distance from Blast (feet)	Permitted Peak Particle Velocity (inches per second)	Scaled-Distance Factor to be applied without seismic monitoring ($ft/lbs^{1/2}$)
0 - 300	1.25	50
301 - 5000	1.00	55
Greater than 5000	0.75	65

Table 3: Typical Air Overpressures, Office of Surface Mining (OSM) value, and Potential Damage (Oriard 1999)

Air Overpressure	Potential Damage
0.0145 psi (134 dB)	OSM overpressure limit for no damage
0.029 psi (140 dB)	Safe limit and project specification value
0.1 psi (151 dB)	Occasional window breakage
1.0 psi (171 dB)	General window breakage
3.0 psi (180 dB)	Possible structural damage

b. Federal Mining Related Blasting Regulations

In 1977 the Federal Surface Mining Control and Reclamation Act (Federal 1977) was passed and set forth initial regulatory procedures, permit requirements, and performance standard governing the use of explosives in surface mining operations. Initial and permanent rules implementing the procedures, requirements, and performance standards of this Act were published by the Office of Surface Mining Reclamation and Enforcement (OSM) in 1977 (Office 1977) and 1979 (Office 1979), respectively. The OSM under the Department of the Interior prepared these rules and regulations. In 1983 these rules and regulations were amended to reflect comments and court interpretations of the initial and permanent rules (Office 1983). The 1983 rules revise the general requirements relating to blasting, preblasting surveys, air overpressures, ground vibration, monitoring of blasts, and blast design. These rules apply to surface mining activities (Section 816) and underground mining activities (Section 817) and are current through 19 July 2001. The requirements in Section 816 and 817 are similar with the differences being limited to the blasting conditions covered, notice of blasting, and scheduling of blasting. For example, Section 816 covers only surface mining activities while Section 817 covers surface and subsurface blasting incident to underground mining, such as coal mining. Section 816.64 requires more notification before blasting, e.g., publishing the blasting schedule in the local newspaper and distributing the schedule in writing to local government, utilities, and residents, while Section 817.64 requires only written notice to local governments and residents. Finally, Section 816.64 requires notice of the blasting

schedule to be distributed at least 10 days but not more than 30 days before blasting whereas Section 817.64 only requires notice at least 24 hours before blasting.

The common provisions in Sections 816 and 817, i.e., general requirements, preblasting survey, signs, control of adverse effects, and records of blasting, are briefly summarized in the following paragraphs. Sections 816.61 and 817.61 require, inter alia, blasters to obtain state certification/license before blasting, the responsible certified blaster must be present at the time of blasting, and a blast design must be submitted if blasting will be conducted within 1,000 feet of any dwelling, public building, school, church, community building, or institutional building outside the permit area or 500 feet from an active or abandoned underground mine.

Sections 816.62 and 817.62 require that blasters allow all residents or owners of dwellings or structures within ½ mile of the blast permit area to request a preblasting survey at least 30 days prior to blasting. If a preblasting survey is requested, the blaster must conduct the survey and submit a written report of the survey to the resident and regulatory agency. If the person requesting the survey disagrees with the blaster's report, he or she may submit to the blaster and regulatory authority a description of the areas of disagreement. Blasting cannot proceed until all surveys requested at least 10 days prior to the planned blasting are completed.

Sections 816.66 and 817.66 require similar blasting signs around the blasting area, similar warnings to people with ½ mile radius of the blast, and access control to the blasting area. Sections 816.68 and 817.68 require that blasters make and keep records of all blasts for at least three years. The records are required to be available upon request by regulatory authorities or the public for inspection. This requirement could facilitate plaintiff's in proving a negligence claim because the records must contain sixteen different categories of information including types of explosives used, total weight of explosives detonated in an 8-millisecond period, blasting mats or other protections used during blasting, seismograph locations and records, and location of the blasts

Sections 816.67 and 817.67 are most relevant provisions to the issue of physical damages induced by flyrock, ground vibrations, and air overpressures because these Sections control the adverse effects of blasting. Sections 816.67(c) and 817.67(c) state that flyrock can't extend more than one-half the distance to the nearest dwelling or other occupied structure or the permit boundary, which greatly reduces, if not eliminates, the risk of trespassory physical damages. Sections 816.67(d) and 817.67(d) use the peak particle velocity to regulate ground vibrations and states that all structures in the vicinity of the blast including water towers, pipelines, and other utilities, tunnels, dams, impoundments, and underground mines shall not be subjected to vibrations greater than the regulatory limits. These two Sections provide three options to mining blasters to control ground vibrations:

1. The blast cannot induce a peak particle velocity that is greater than the limits presented in Table 2 and seismographs must be installed to monitor the vibrations to ensure that the vibrations do not exceed the regulatory limits.

2. If seismic monitoring will not be conducted, the blaster cannot use an explosive weight that exceeds the amount calculated for the scaled-distance factors presented in Table 2.

3. The blaster can use peak particle velocities that vary with the frequency of the blast as shown in Figure 1. These peak particle velocities are the highest values that are allowed and thus the blaster must install "sophisticated seismic monitoring which records the frequency content of the ground vibrations" in Section 816.67(b) and peak particle velocity.

Compliance with any one of these three options will "provide protection to structures including residences, based on an analysis of the damage recorded by the RI8507 study (Siskind et al., 1980)."

In summary, the vibration limits presented in Table 2, i.e., peak particle velocity and scaled-distance factor based on the distance from the blast, are extremely conservative so Sections 816.67 and 817.67 also allow the use of the peak particle velocity limits in Figure 1. A comparison of Table 2 and Figure 1 shows that the maximum allowable peak particle velocity in Table 2 is 1.25 inches/second whereas the less conservative limits in Figure 1 allow a peak particle velocity of 2.00 inches/second. The increase peak particle velocity is allowed because the regulatory limit reflects the importance of frequency and thus the different responses of structures at different frequencies. For example, a residential structure consisting of drywall can withstand a higher peak particle velocity (0.75 versus 0.5 inches/second) than a plaster at a frequency between 2.5 and 15 hertz. However, at other frequencies, drywall and plaster construction can sustain the same peak particle velocity, e.g., 2.0 inches/second at a frequency greater than 30 hertz. However, to utilize the higher peak particle velocities the blaster must install seismographs that record both peak particle velocity and frequency for each blast and include this information in the blasting records.

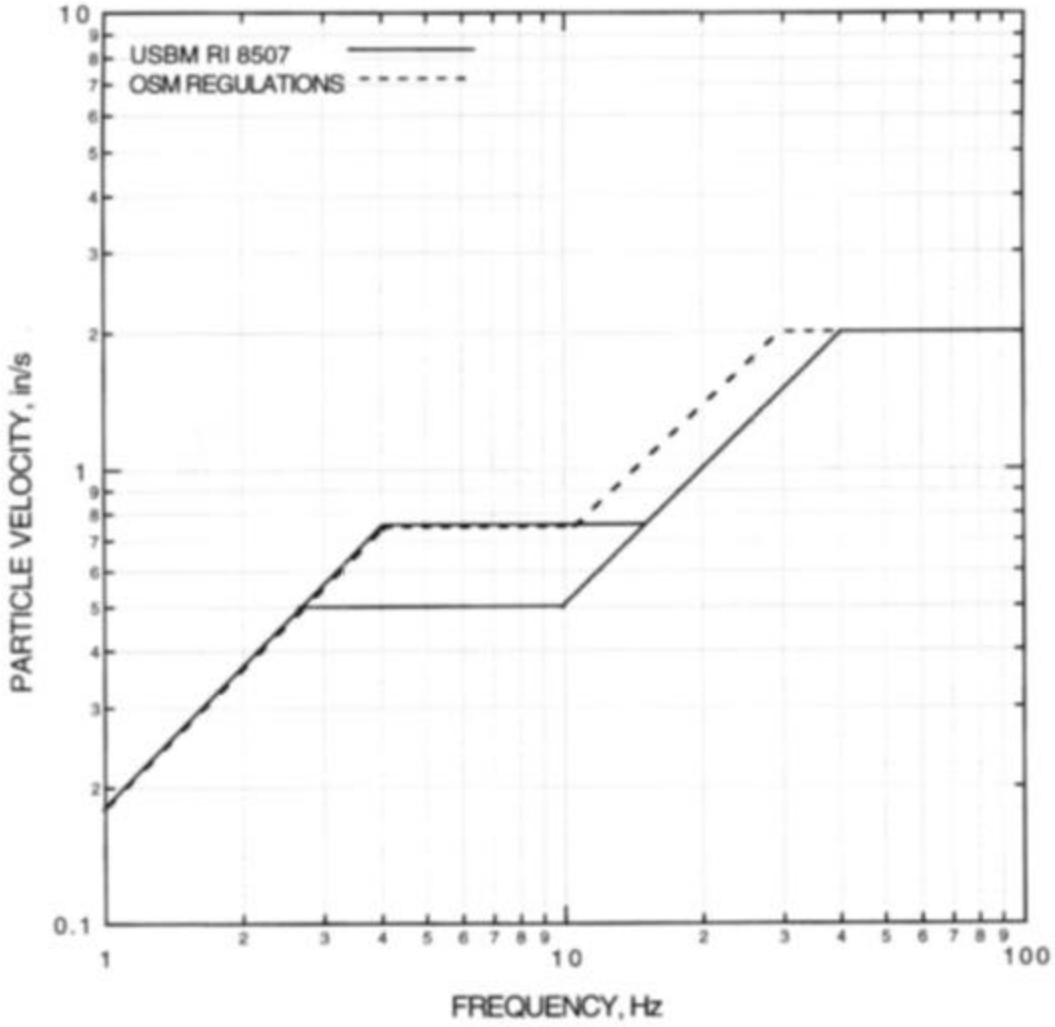

Figure 1: Safe Levels of Blasting for Houses from USBM RI 8507 and the Office of Surface Mining surface coal mine regulations that differ slightly between Frequencies of 10 and 30 hertz (Siskind 2000)

b. Typical Specifications for Control of Construction Vibrations

Dowding (1996) presents typical specifications for the control of blasting vibrations to ensure the safety of adjacent structures based on a number of references. The specifications are similar to the OSM recommendations presented above but focus on construction blasting and not surface or underground mining related blasting. Each section of the typical specification is briefly described as above to provide the reader with a sense of the scope of the specification. The entire of the specification can be read in Chapter 26 of Dowding (1996). Dowding (1996) also presents specifications for close-in blasting in Appendix B.

The first section of the specification pertains to the procedure for production blasting. The main provisions of this section include specifying the time, type of explosives, the qualifications of the blaster, a blasting plan that

details the drilling and blasting patterns, the blasting controls the contractor proposes to use, the production blasting procedures/techniques which includes the use of blasting mats being placed over the entire loaded area, a description of the test blast program and analysis of the results of the test blast(s), the blast warning procedures including signage and audible warnings, the details of the public awareness program including the letters and personal contacts that will be made with residents, institutional operators, and business establishments, and muck and rock removal procedures.

The second section of the specification details the controls that the contractor will institute to ensure the safety of adjacent structures. The provisions of this section include specifying the scope of the pre-construction survey. For example, the pre-construction survey should survey all building within a radius of 400 ft (120 m) of future blasting activities or to a distance at which the peak particle velocity of 0.1 in./sec (2 mm/s) occurs. Based on the results of the pre-construction survey, classify the buildings into different categories depending on their susceptibility to cosmetic cracking. The pre-construction survey should also identify sensitive equipment, operations, or buildings and geologic conditions that may be adversely impacted by the blasting. A geologic condition that may be adversely impacted is loose granular materials that can undergo settlement in the presence of vibration.

The second section of the specification also includes performing line and grade surveys of adjacent buildings, measuring the peak particle velocity, frequency of vibration, and air over pressures. Dowding (1996) allows two options for specifying the maximum peak particle. One option is independent of frequency while the second option is a function of frequency as discussed above. The application of the peak particle velocity controls occurs when the ground vibration exceeds 80% of the ground vibration control limit. This section also requires monitoring of the blaster's progress, filing of shot record reports, type of instrumentation and results reports, weather conditions, and the necessary recording keeping for the project.

c. ISEE Blaster's Handbook

Another excellent source of information for determining the standard of care for a negligence standard is the Blaster's Handbook (ISEE 2001). The Blaster's Handbook also presents guidance for conducting blasting most of which is similar to Dowding (1996) and not repeated herein.

2. INFERRING NEGLIGENCE FROM CIRCUMSTANTIAL EVIDENCE

Another technique for assisting plaintiffs in proving negligence, and thus a breach of the standard of care, involves the use of circumstantial evidence. In some cases all of the information described under the mining regulations and/or the typical specifications presented by Dowding (1996) are not available to a plaintiff. This may occur when the defendant/contractor has exclusive control over the activity that allegedly produced the harm, e.g., a doctor during medial surgery when the plaintiff is unconscious. In this situation, courts allow the use of an evidentiary rule termed Res Ipsa Loquitur (RIL) to infer negligence from circumstantial evidence. Courts developed this evidentiary rule because in many situations a defendant can withhold useful information that a plaintiff cannot obtain, such as manufacturing and design information for a defective product, which can impede a plaintiff's case. A plaintiff can use RIL to infer negligence of a blaster if:

a. the damage ordinarily does not occur without a blaster being negligent,

b. the blasting was conducted under the exclusive control of the blaster so no one else could be the cause of the negligence, and

c. the damage could not be caused by another activity besides the blasting.

The second and third elements could be proven by showing that the blaster was in control of the blasting and relating the date of the blasting or other relevant activity to the occurrence of the damage, respectively. Therefore, the most problematic element for a plaintiff is probably showing that the observed damage does not occur without negligence. A plaintiff could use allowable peak particle velocities or air overpressures in Tables 2 and 3 and comparing the recorded or estimated peak particle velocities and air overpressures to these conservative limits. If the induced vibrations and air overpressures exceed the allowable values, the plaintiff has some evidence, not dispositive evidence, of negligence because these limits have been promulgated for mining blasting and not construction blasting.

If the plaintiff can satisfy these three elements, the court will assume that the plaintiff has met their burden of proof concerning the blaster's negligence and thus only needs to prove causation and damages, both of which are required under strict liability. Therefore, the proposed negligence framework and the existence of the RIL doctrine will allow meaningful claims to be proven with only slightly more evidence than under the strict liability framework. However, it is anticipated that this increase in proof will be sufficient to reduce the number of unwarranted claims.

Before the court awards a verdict to the plaintiff under negligence, the use of RIL allows the defendant to rebut the plaintiff's circumstantial proof that he/she was negligent during the blasting. This is justified because the plaintiff proved the defendant was negligent only by showing the three circumstantial elements shown above. The defendant can now introduce evidence to rebut the presumption that he/she was negligent during the subject blasting. This evidence can consist of the following:

a. using industry standards or customs that have developed under the strict liability regime and thus are conservative for use under a negligence framework. These customs include typical explosive weights, spacings, depths, and delays, use of blasting mats, time of blasting, types of explosive, types of monitoring equipment, typical experience of a blaster, the particular site and blasting application, etc., as described in the surface mining rules and regulations (Office 1983), Dowding (1996), or the ISEE Blaster's Handbook (2001).

b. using compliance with vibration and airblast limits developed for residences near mining related blasting (see Tables 2 and 3) as some evidence of non-negligence in construction blasting. In mining related blasting, non-compliance with these limits can be proof of negligence, not just evidence of negligence, because the limits pertain directly to mining blasting. However, there are no legal standards for construction blasting so these limits are only considered to be mere evidence of negligence or non-negligence depending on whether there is non-compliance or compliance, respectively. These mining related limits may be problematic for close-in construction blasting

where vibrations and air overpressures can safely exceed these limits (Oriard 2001). This should not present an insurmountable problem for the blaster because (1) the limits were developed for mining related blasting, which is usually not close to structures and thus should be considered as only some evidence of possible negligence and (2) they have not been adopted into any law or ordinance pertaining to close-in construction blasting. The blasting industry should consider developing vibration and air overpressure limits for close-in construction blasting to overcome this information void.

c. accepted vibration and air overpressure limits for construction blasting developed by experts and endorsed by an industry group such as the ISEE.

After the defendant presents their evidence that demonstrates that he/she was not negligent, a jury, not the judge, decides whether or not the blaster was negligent, and thus breached his/her duty of care. If the blaster is found to have breached his/her duty of care, the jury then will decide whether or not the blasting was the cause of the damage. If the jury concludes that the plaintiff did not prove that the blaster was negligent, the jury will not have to consider proximate cause of the cracking/damage. Thus if a blaster is not negligent, a claim could be dismissed prior to a jury weighing any evidence of proximate cause.

In summary, under a negligence framework a plaintiff will have to convince a jury, not the judge, that the blaster was negligent and caused the damage. This still may be favorable to plaintiffs because juries may be sympathetic to property owners but at least the blaster gets an opportunity to show that he/she conformed to industry standards and is not presumed to have breached a duty of care. The use of the negligent standard will also allow the blaster to more thoroughly question the credentials of expert witnesses because the expert will have to be knowledgeable about industry standards, blasting analyses that allow prediction of induced blast vibrations and air overpressure limits, safe vibration and air overpressure values for a particular site and structure, and typical blasting techniques such as the use of blasting mats, charge delays and spacing, and explosives weight. Under a strict liability framework the plaintiff expert only has to opine that the blasting probably caused the cracking and thus does not have to be well versed in blasting technology and practices. However, the effectiveness of the plaintiff's expert will still be somewhat dependent upon the inquisitiveness of the defendant's attorney. For example, in Ballard v. Buckley Powder Co. (1999) Ballard v. Buckley Powder Co. (1999) the plaintiff's expert received a Bachelors Degree in Architectural Engineering in 1983 and his current occupation involved inspecting homes for structural problems and making recommendations for repair. The expert "had no training or education in blasting, has never worked for a blasting company, has never given advice to a blasting company, has never designed a blast, and has never operated any seismic recording devices to record the effect of a blast." Between his first and second depositions, the plaintiff's expert "obtained information on blasting from the Internet, spoke briefly with Alcohol, Tobacco and Firearms personnel, and learned from the Kansas state fire marshal that a license is required to conduct blasting in Kansas." The expert also "is not familiar with blasting logs such as those used by the defendant, nor is he familiar with the formulas or the measurements found on those logs." .

The use of a negligence framework can be illustrated using a seminal case for imposing strict liability on construction blasting in New York in 1969 (Spano v. Perini Corp. 1969). Prior to this case blasting was considered under a negligence framework. Spano was the owner of a garage in Brooklyn that was damaged by

construction blasting on November 27, 1962. The undisputed blast involved a total of 194 sticks of dynamite at a construction site that was only 125 feet away. The blasting was conducted to facilitate construction of a water supply tunnel. Each stick of dynamite contained one-half pound of dynamite and thus the blast had a charge of 97 pounds of dynamite. A lessee of a portion of the premises testified that there was "no damage on or to the premises prior to November 27." This witness also testified that he heard the explosion on November 27 around noon while he was working "some three blocks away" and when he returned to the property a few hours later, "the building was cracked in the wall, the window broke, and the cement floor all pop up" (Spano v. Perini Corp. 1969). This evidence would be sufficient to satisfy the three element of RIL namely

a. the damage ordinarily does not occur without a blaster being negligent, which is evident because damage to a wall, window, and concrete floor usually does not occur without negligence based on many years of successful blasting,
b. the blasting was under the exclusive control of the blaster so no one else could be the cause of the negligence, which should be easily proven by identifying the contractor for water tunnel, and
c. the damage could not be caused by another activity besides the blasting, which should be proven because the damage was not present before the November 27 blast.

Therefore, the court would presume that the blaster was negligent and assuming that the plaintiff can prove causation and damages, which appears extremely likely in this case, the case would not be dismissed. The blaster then would have an opportunity to rebut the presumption of negligence. In this case it appears that the blaster was probably negligent given the substantial damage to the garage and thus the plaintiff would still be able to recover under a negligence framework. In the actual case, the trial judge awarded damages based on a strict liability framework without proof of negligence.

In summary, a plaintiff should be able to prove negligence in meritorious blasting cases and still gain recovery with little additional proof if the legal standard is raised from strict liability to negligence. However, the use of a negligence framework may make marginal and frivolous cases more difficult because the burden of proof and level of expertise required is greater. This may stem the numerous unwarranted claims that the blasting industry must defend, reduce the number of experts that choose to participate in litigation , and increase the use of blasting as a cost-effective excavation technique while protecting the interests of the public. However, a blaster will still have to mobilize an expensive defense to combat a blasting claim but the increased legal standard may provide some justification for a blaster to pursue a court appearance instead of simply settling and paying some damages.

CREATING A NEGLIGENCE FRAMEWORK

In one respect law is similar to civil engineering in that a new idea must be tested or tried to determine its feasibility. For the problem at hand, blasting must be tried to determine whether or not a judge will interpret the six abnormally dangerous factors in the same manner as described above, i.e., that blasting is not an abnormally dangerous activity when the conservative limits in Tables 2 and 3 are followed. To change the current strict tort liability standard to a negligence standard, it is anticipated that the blasting industry will have to reverse the imposition of strict tort liability in at least one of the thirty-five states that currently imposes strict tort liability. It

is recommended that New York be considered for overturning the use of strict tort liability because in 1969, New York abandoned a negligence framework for strict tort liability in the landmark case of Spano v. Perini Corporation (1969). Prior to 1969, New York did not award a plaintiff damages unless the plaintiff showed that the blaster was negligent, i.e., proved the four elements presented in Table 1. Therefore, a new defendant could argue that blasting technology has greatly improved since 1969, e.g., USBM research (Siskind 2000) and new blasting techniques, and allows reversion to a negligence framework especially in public works projects where adjacent property owners may be benefiting from the project and blasting may facilitate construction or provide a cost-effective and possibly less disruptive excavation technique.

To facilitate implementation of a negligence framework by a judge instead of strict liability, contractors could agree to create a remediation fund for adjacent property owners that would provide a nominal amount of money for repair of cosmetic damage if the damage exceeds a threshold value but is less than a maximum amount. If the damage does not exceed the threshold value, it can be alleviated during routine maintenance of the structure and thus the contractor would not provide remediation funding. However, if the damages exceed the threshold value and the blasting causes the damage, the property owner could request assistance from the contractor's remediation fund. This would provide some certainty to the contractor in regards to their foreseeable loss and also provide the property owner with a mechanism for recovery without litigation. (Presently, a contractor cannot predict the number of claims or the dollar value of the claims against his/her operation even if the conservative blasting limits in Tables 2 and 3 are followed.) If the damages exceed the maximum amount allotted by the remediation fund, the plaintiff can file a negligence claim. In addition, a negligence judgment frequently yields a larger recovery than a strict tort liability judgment (Henderson and Twerski 2000), which can reduce a plaintiff's concern about recovery and imposition of a negligence framework.

SUMMARY

The application of strict liability to non-trespassory invasions has resulted in significant litigation that has hampered the use of blasting and the blasting industry. An important issue in having a court change the legal standard from strict liability to negligence is to ensure that a deserving plaintiff can recover the damages induced by blasting. To facilitate the acceptance of a negligence standard by a court of law, this paper summarizes the standard of care using the 1977 Surface Mining Control and Reclamation Act, extensive U.S. Bureau of Mines research, and current blasting techniques, such as blasting mats. It is important for the blasting industry to promulgate a standard of care so a judge can feel confident that blasting can be routinely and systematically controlled and if the legal standard is changed from strict liability to negligence a subsequent judge or jury will be able to evaluate the level of care exercised by the blaster. This paper also suggests that the industry and/or ISEE develop and disseminate a comprehensive standard of care that courts can use to further justify a change from strict liability to negligence and evaluate the standard of care.

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