inter·noise 83

OPENCAST MINING AND QUARRYING AND OTHER ACTIVITIES USING EXPLOSIVES - AN ASSESSMENT OF HUMAN AND PHYSICAL IMPACT

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INTRODUCTION

This paper attempts to show that a reasonable approach is required by all sides when levels of noise and vibration from the use of explosives are being discussed. The paper does not describe a specific research project, but covers our every day experience over many years, with the help of people living in affected property.

Ground Vibrations

Blast Damage. The generation of ground vibration from blasting has been a continual problem for mineral extraction operators and also for civil engineering projects such as tunnelling, trenching and by-pass construction whenever rock is encountered. Much discussion takes place on the correct levels to be set.

Over the years many authorities have undertaken research with regard to cosmetic damage, and this is well documented, the latest being the United States Bureau of Mines Report (1) which gives varying peak particle velocities for cosmetic damage relative to frequency since Peak Particle Velocity is now accepted as the parameter for damage. Prior to this report particle velocities were being given irrespective of frequency, and these ranged from 5 to in excess of 50 millimetres per second for residential structures. In some parts of the world this parameter was changed to resultant from maximum any plane, although many people did not know how to calculate the true resultant.

It is important to make three points before completing this small resume on cosmetic damage.
In 1950 G. Morris (2) recommended levels based on amplitude which is relative to frequency. In transposing these into Peak Particle Velocity they are very close to the United States Bureau of Mines levels (19 mm/second - 50 mm/second).

From our knowledge of the working documents of the International Standards Organisation great emphasis is laid on the necessity to measure frequency.
Generally in civil engineering projects in the United Kingdom the usual figures quoted range from 12 mm/second - 50 mm/second with 25 mm/second being that most widely quoted.

Human Response. The tolerance and reactions of humans to vibrations are important when discussions take place on annoyance levels. Humans notice and react to blast produced vibrations at levels that are lower than the cosmetic damage thresholds.

Parameters critical to response are duration, peak level, vibration frequency and frequency of occurence. Each plays a part in the reaction, namely, startle, fright, fear of damage, and annoyance. Add to all these that people do not want the opencast coal site, the quarry extension or the by-pass, and with the "go and get it somewhere else" syndrome it becomes impossible to work without some level of complaint It is, therefore, the responsibility of engineers from industry and local government (being reasonable men) to agree some target figures.

It is our belief that there should be a different approach for civil engineering contracts than for mineral extraction.

Civil engineering target levels should be relative to a safe Peak Particle Velocity in respect of cosmetic damage. The reasons being that such contracts are normally of short term and essential to the well-being of the general area, i.e. sewers, etc. Also to set very low levels could multiply the cost of the contract four to five times which, in the end, is paid for by the tax payer.

It has been our experience that very few complaints are made with regard to damage at the levels previously mentioned and in many cases nuisance complaints are less than from say, opencast coal sites.

Mineral extraction workings are usually timed in years, therefore human response must be the criterion upon which levels are discussed.

Most studies of human tolerance to vibrations have been from steady-state sources or those of relatively longer duration than typical mineral extraction and civil engineering blasting.

In the absence of data on tolerance to impulsive vibrations these results have been assumed to be applicable to blasting. This cannot be so, due to one fact alone, duration time, which is usually less than one second from typical blasting in the United Kingdom.

Wiss and Parmalee (3) studied responses of forty people to transient vibration, Goldman (4) steady-state 2 - 50 Hz., and T.M. Murray (5) human reaction to vibration of concrete floors. These along with I.S.O. Standard 2631 will be presented.

The studies just discussed all involve people in a test situation rather than in their own home. None of the problems of fear, startle, house rattle, and other secondary effects were present.

Air Overpressure

General. In mineral extraction ground vibration is only part of the problem in respect of nuisance, the other being 'air blast'. A better description is air overpressure since the word 'blast' very often gives the wrong impression to non-users of explosives; also it is pressure that is the problem and not what people hear (infrasonic).

Prediction. As with ground vibration there are many well documented technical papers on air overpressure. Many papers also include formulae for prediction, and with present day computers it is said a model of the blast site can be made. Is this true? Three major difficulties exist in the real world. Firstly, variables in working conditions, such as :-
A mineral extraction unit does not always work in one direction.
Bench heights vary, therefore different maximum instantaneous charges are utilised.
Benches are at various depths.
Detonation of the explosive is not always in the same direction.
Secondly, predictions could well be made after which significant changes may occur in atmospheric conditions, such as :-
The wind direction changes.
The wind speed varies.
Other parameters, which may vary and be outside the control of the operator but that can have a slight effect are barometric pressure, atmospheric temperature, and the presence or not of temperature inversions.

Thirdly, what are the target levels? In the United States Bureau of Mines report on air blast (6) based on a minimal possibility of cosmetic damage and window breakage, the recommended safe air over-pressure levels are :-

0.1 Hz.	High pass system	134 dB.
2 Hz.	High pass system	133 dB.
5 or 6 Hz.	High pass system	129 dB.

These levels, however, would prove very annoying to people within the properties (in the United Kingdom it is very rare for levels to reach such peaks), therefore, as with vibration consideration must be taken of complaint levels. In a paper which the authors presented in 1978 (7) it was stated that windows could rattle at 106 dB. Recently on one site any recording above 106 dB caused complaints, although in our experience this is usually around 117 dB. Slides will be shown giving the relationship between ground vibration and air overpressure. Therefore, where do you pitch your target, and with the variables in working conditions and atmospheric conditions (beyond the control of the operator) which can make 15 dB. difference, how does one control it?

Finally, one paramount fact is the Mines and Quarries Act. If the shot firer deems that by leaving the holes charged for say, an hour, or overnight, the explosive or detonators could be affected thus generating a dangerous occurence, he must fire with no delay.

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