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INSTRUMENTATION FOR OVERPRESSURE MEASUREMENTS

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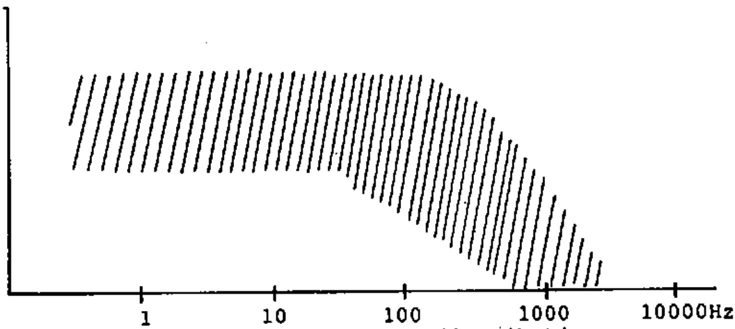
This paper describes our instrumentation system put together for a university research unit embarking on an investigation of blasting overpressure phenomena, their propagation and subjective reacton to them.

Explosive blasting, whether in quarrying or construction or demolition, has been creating environmental problems. For a long time the ground borne vibration was considered the culprit and was held responsible for building damage and as the main source of complaints from local residents. In recent years, the overpressure became recognised as frequently the main reason for complaint and sometimes the cause of damage.

Literature relating to building damage caused by vibration goes back many years, while there is still not much written regarding the overpressure. There appear to be no official criteria or standards which cover this form of noise nuisance, no universally recognised methods of measurement and quantification. The work of the U.S. National Bureau of Mines lead the way to the recognition of the unweighted maximum peak value, measurement from 2Hz upwards.

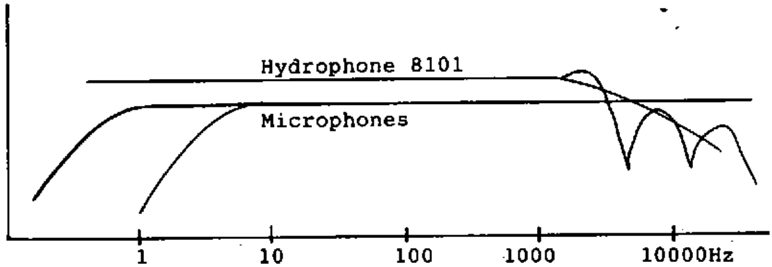
Some researchers have made and reported careful measurements of overpressure caused by explosive blasting or gunfire from canon. They have shown these to be mainly low frequency phenomena as per fig. 1. The spectra are a function of the method of detonation and charge location in the rock, as well as a function of the distance from the source of explosion, the terrain and the atmospheric conditions.

The very low frequency end appears strongly pronounced but its importance as a source of nuisance still needs looking into.



1. Typical 1/3 octave spectral distribution

An investigation of systems used in some reported research and in some attempts at local government monitoring has shown much of the instrumentation with unspecified or ambiguous or totally unknown low frequency performance, perhaps leading to a situation where it is not possible to compare results with any degree of confidence.



Transducer frequency responses

Some commercially available systems supplied for the monitoring of overpressure were found not only lacking in frequency response, but used a variety of weightings and time weightings, to make any comparison of results completely impossible.

It was interesting to note that some sound level meters offering linear response to 2Hz were found to have quite a spread in response to acoustic signals below 7 or 8Hz.

Most measurement standard microphones offer excellent performance from a few Hz upwards, but they are usually made to have much reduced response towards the DC end in order to avoid high sensitivity to wind induced noise.

Special microphone systems were developed years ago to comply with the requirements of ISO 2249 (and later BS 5331) for the measurement of physical characteristics of sonic booms. Serious investigation of physical characteristics of blast overpressure demands instrument performance similar to that of ISO.2249.

In considering the transducer, the choice was between a microphone carrier system, (to ISO 2249) and a piezo-electric hydrophone with high sensitivity. The latter was chosen for this application, as it offered a flat frequency response from 1Hz to 3kHz, sufficient sensitivity to give clear signals from 95dB upwards and a degree of robustness plus the ability to withstand snow and rain and dust, frequently encountered at measurement locations.

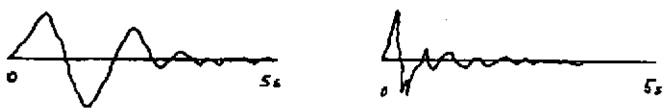
The good low frequency response made it necessary to use a large foam rubber windscreen in order to minimise sensitivity to wind generated noise. This also had the effect of eliminating possible thermal transient response problems, which may be caused by passing clouds on a sunny day.

It is interesting to note that a microphone or hydrophone system with linear response to 1 or2Hz may give output equivalent to 120dB (peak) or more when subjected to strong gusts of wind.

The instrumentation system was designed to perform the following functions:

1) Allow the capture and storage of the time function.
2) Measure the max. peak value of unweighted signal
3) Give value of SEL
4) Give constant bandwidth spectrum of overpressure signals for instant viewing.
5) Print date and time of occurrence, print max. peak value and SEL value.

The hydrophone was connected to a modified environmental analyser type 4426, which had an adjustable level trigger system. Type 4426 offered the facility of computing LEQ (or SEL) of the signal within a period of 5 seconds from trigger point and of giving the max. peak value within this period. On completion of the computation, - the date and time of occurrance was printed on a digital printer, plus the two values measured.



Typical time functions

The output from the hydrophone was also fed in parallel to a digital FFT analyser, also with single even trigger facility. This analyser (2033) was used as a digital data capture device and 'instant' analyser if required. The stored data was automatically fed into a digital cassette recorder.

Use of this recorder enabled many events to be stored for eventual replay into the analyser in a laboratory for spectrum analysis and other forms of analysis if required.

The instrument system has been in use for some years now and the hydrophone has proved itself to be a stable and reliable device for such an application.