

# **Full scale Investigation into the Origins of Air Overpressure from Quarry Blasting**

## **Aim**

The aim of this investigation is to establish the basic parameters that control the level of air overpressure produced during a blast. The two most likely, influential effects generated by a blast that governing air overpressure are thought to be:-

1. The arrival of the shockwave at the free face
2. Movement of the face which results in a large volume of displaced air.

Both will be fully investigated.

## **Equipment setup**

Initial testing has been performed to establish whether the vibrations along the face, caused by the arrival of the shockwave, are the source of the air overpressure in front of a blast.

To successfully test this, conventional bench blasts at three quarries, Whitwell, Thrislington, which are limestone quarries and Mountsorrel which is a granite quarry, have been monitored.

Monitoring involves placing a sensor down the blast face, directly in front of the first hole at the corresponding height of the primer charge. The sensor is designed to record the exact time at which the shockwave arrives at the face and then the first movement of the face.



*Figure 1 Face sensor encased in a rubber ball, positioned in front of the face*

The sensor is placed inside a rubber ball (in this case, a yellow ball) to protect it from the abrasive surface of the face as it is lowered into position (figure 1).

A second sensor is placed down a blast hole, behind the first blast hole to be detonated in the blasting pattern with the intention of recording the arrival of the shockwave from the first hole and therefore providing a basis to calculate the velocity of vibration in the rock. This is then used to confirm the exact arrival of the shockwave at the free face. The sensor is taped to an air bag which provides excellent coupling to the inside wall of the blast hole. This should ensure a cleaner signal is recorded. The air bag is placed above the charge and below the stemming.

The primary means of monitoring the air overpressure is via two low frequency response microphones set up at known distances from the blast face. These are placed in a straight line, directly in front of the first blast hole and perpendicular to the face so that the highest possible levels of air overpressure can be recorded.. All four sensors ( face sensor, in hole vibration sensor and two microphones) are linked to a micro trap data logger.



*Figure 2 Air overpressure microphones positioned directly in front of the first blast hole.*

This will then allow us, to gather a comprehension collection of air overpressure data and to predict highest possible levels of air overpressure from similar blasts.

In addition to this, the air overpressure is recorded by seismographs equipped with low frequency microphones. Two of these seismographs are located at the same position as the air overpressure microphones. Other seismographs are located on the blasting bench behind the blast in ordered to investigate the levels of Air overpressure generated in that direction

## **Burden Measurement**

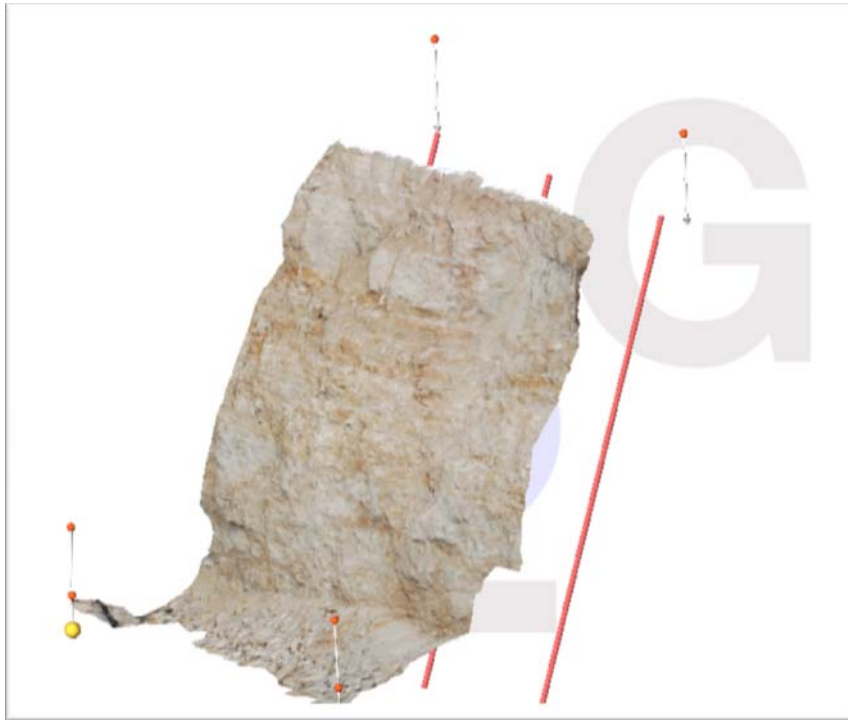
A factor likely to play a key part in controlling the air overpressure (applicable to whether it originates from the vibrations along the face or the face movement) is thought to be the burden. The burden is expected to be influential in controlling both the velocity of face movement and also the level of vibration at the face.

In order to measure the exact burden in front of the blast holes (the first hole in particular) a face profiling package known as Blast Metrix is used. This is an innovative system which is used for bench face surveying based on three dimensional images. The system involves placing two scaling rods, fixed with targets at the foot of the face and two smaller delimiter targets on top of the bench (see figure 3). Two digital photographs are taken of the face which are processed by the accompanying software package which then generates a three dimensional model of the face (an example in figure 4)



*Figure 3 Blast Metrix setup*

The blast specifications (burden, spacing, hole inclination etc) can then be entered into the program and the blast holes are then added to the generated model and from this, the exact burdens along the whole length of each blast hole can be analysed.



***Figure 4 Three dimensional model created by the Blast Metrix software of the same bench shown in figure 3***  
**Monitoring Equipment**

A piezoelectric wafer is used for each sensor. The wafer consists of two separate bars or wafers of piezoelectric material. As a force is applied to the wafer (for example, movement caused by vibrations), it bends and thus creating a voltage. This change in voltage is recorded and signifies the movement along the face (arrival of the shockwave or movement of the face). Each sensor is connected up to a four channel high speed recorder (MREL's Microtrap).





*Figure 3 An MREL Microtrap deployed to monitor a blast at Whitwell Quarry*

The 'Microtrap' is triggered by a VOD probe cable. The free end of the cable is strapped onto the primer charge containing the detonator so that as soon as the hole detonates, the Microtrap records the entire blast and enables precise arrival times of shockwaves and air overpressure to be recorded.



*Figure 4 VOD cable strapped to a primer charge*

Low frequency air overpressure microphones are connected to the remaining two channels on the Microtrap. These two microphones are placed perpendicular to the free face and directly in front of the first hole. The aim of this setup is to record the air overpressure on the same time base as the arrival of the shockwave at the face and the first movements of the face. It is necessary to use two microphones at a set distance apart to calculate the speed of the air overpressure wave in air. Once known, it can be used to determine the time at which the air overpressure leaves the face and whether it coincides with the arrival time of the shockwave or the initial movements of the face.

The seismographs which are placed around the blast are used to build up a database of air overpressure readings so that the rate of attenuation in front and behind a blast can be determined. Also the data can be utilised in predicting the levels of air overpressure at certain distances for similar blasts in the future.