

Construction Blasting and Alternative Non-Explosive Rock Breaking Techniques



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MALAYSIA is a fast developing country, therefore, there is an urgent need to open up more land for new industries and more areas for housing to cater for the movement of people from the villages to the cities. The Klang Valley, for example, has seen development encroaching into hilly areas as a result of the shortage of low lying areas for housing. Even the scarce flat land that is still available in Kuala Lumpur is now being developed into commercial districts.

As a result of the need to maximise the use of scarce land, there is a trend towards building high rise business centres and that requires going down further and deeper into the ground, not only to support the high rise building, but also to ensure there would be sufficient vehicle parking lots. Rock is often encountered in deep excavations and this would require the use of rock blasting or alternative means to break up the rock, such as using chemicals or expansive cements, or other methods now available in Malaysia.

Many of the areas slotted for development are already surrounded by high rise buildings and other amenities. It is up to the project manager, who is usually a civil engineer, to make the correct decision that is best suited to his budget or to consult a blasting consultant in order to choose an appropriate method to suit site conditions. This paper aims to provide some information to the engineer and help him decide on the most appropriate method, and is based on the author's 30 years of personal experience in explosives and rock blasting work, as well as alternative means to rock breaking.

ROCK BLASTING AND THE LAW

Rock blasting requires the use of explosives which is governed by the Explosives Act 1957 and the Explosives Rules 1923, and is administered by the Malaysian police. Only Malaysians who are free from criminal records are allowed to apply for a permit/licence. Those who are eligible to apply for the permit/licence must possess a Shotfirer's Certificate issued by the Mineral and Geosciences Department (DMG) or the police. However, the police have stopped issuing such certificates, and the DMG is now the sole department responsible for certifying the Shotfirer.

The Shotfirer's examination is actually tailored to those working in mines and quarries. As such, it is up to the manager to ascertain whether the chosen blasting contractor has the experience to carry out a blasting job at a construction site. Otherwise, he may need a qualified blasting consultant to advise him. There may be a need to

check on the qualification and experience of the blasting consultant. Professional engineers may learn about blasting while at university, but most do not have the relevant experience nor the required competency certificate.

From a legal point of view, construction blasting work is governed by Part XV (Blasting and the Use of Explosives, Regulation 135-146) of the Factories and Machinery Act 1967 and in respect of safety provisions by the Occupational Safety and Health Act 1994, even though under normal circumstances, the Department of Occupational Safety and Health (DOSH) seldom intervenes. The DMG has officers with some expertise in construction blasting, but they do not have the legal authority to intervene or oversee blasting work carried out on site.

The authority, in the author's opinion, lies with DOSH which has overall control of construction sites. The author believes that there is a need to have more detailed regulations or guidelines for blasting work at construction sites. This need for new regulations is actually not in conflict with the Explosives Rules 1923 because there is no such provision in the latter anyway. As explosive use is also regarded as a security matter, the licensing should stay with the police.

Applying for a licence may take weeks to process mainly because of safety and security requirements. Sometimes, the neighbour's interest will also need to be taken into account, especially when the proposed site is very close to residential areas, flats, condominiums and even industrial areas. If the neighbours protest, blasting work may not be permitted even though from a technical point of view it can be done safely.

Previous incidents involving flyrock, airblasts and high vibration at other sites which have been highlighted in the media may prompt the authority to reject the application. Even if permission is granted, the operational conditions may be so stiff or difficult to comply that it might be more appropriate to consider alternative means.

ROLES OF BLASTING CONSULTANTS

In many instances, blasting consultants are not engaged or even consulted by the authority especially when a construction site is far away from sensitive areas. Even though a blaster may not have the relevant blasting experience at construction sites, the project manager may mistakenly believe that the potential problem is minimal so he can afford to take the risk and thus save money by not

hiring a blasting consultant. It is quite normal for the authority to impose the requirement for engaging a consultant after a bad incident such as flying rock hitting houses, schools and other buildings, whereupon the project is suspended for months pending an enquiry and accident investigation.

Under the current practice, the consultant is normally hired by the blasting contractor. Sometimes, the project manager is the one who hires the blasting consultant. This is normally due to the fact that the project manager wants to oversee the blasting work but, in nearly every case, does not have adequate knowledge of explosives and blasting work. Sometimes, the project manager and the blasting contractor share the cost of hiring the blasting consultant.

A blasting consultant is normally a professional mining engineer or an engineer with a relevant engineering qualification. The trend nowadays is that the blasting consultant must also be a qualified Shotfirer who has attended related courses in blasting. Unfortunately, advanced blasting courses with emphasis on construction blasting are rarely held in Malaysia because of cost and demand factors. The engineer also needs to have experience in blasting work and also blast monitoring work.

The blasting consultant normally advises the blasting contractor on safe blast design and also assists the blaster in blast monitoring work. For example, if the vibration is high, he will have to adjust the various parameters in the blast design to ensure compliance with the operational conditions imposed by the authority. Besides advising, the presence of a blasting consultant is also needed for public relation purposes such as attending to complaints from the public and also to defend the project proponents in case of litigation due to allegations of property damage from blasting work. Here, proper records of the blast design and also blast monitoring work are essential and must be signed by a consultant. These are usually the first records the authority will want to sight in case of any complaints, or if there is a claim for damage in court.

THE REQUIREMENT FOR COMPETENCY CERTIFICATION

Currently, only the Institute of Quarrying, Malaysia, with the cooperation from the DMG, conducts a Shotfirer Course on a regular basis. The course syllabus is based on the United Kingdom Shotfirer Course with amendments to suit local conditions. It has been tailored for the quarrying industry and, as such, there is little emphasis on construction blasting. Apparently, the certificate issued is also recognised in neighbouring countries and quite a number of participants from these countries have attended the course. Since many of the blasters are employed in the construction sector and are involved in tunnelling work, the Institute, with the cooperation of the DMG, may soon introduce a Professional Development Course to cater for this particular need.

CONSTRUCTION BLASTING WORK

Compared to blasting work at quarries and mines, construction blasting needs to be more precise. The blaster needs to take more care because, in most cases, the blasting work is carried out near areas accessible to the public such as residential areas, factories, major roads, railways, etc, where flyrock is not tolerated at all. Other environmental concerns such as airblast, ground vibration and dust may not cause any damage, but may result in annoyance to the public. Public protests alone could force the authorities to disallow blasting work altogether at a particular location. The project proponent may then need to consider alternative means to break rock.

The volume of rock that can be blasted at any one time is also limited due to the need to control the effect of blasting on to the surrounding area. Instead of tens of thousands of cubic metres per blast achievable in mining and quarrying, the blaster may only decide to blast just a few hundred, or sometimes a few thousand cubic metres per blast. As such, the cost of blasting at construction sites is very much higher than at quarries or mines, or the cost of earthworks. The nearer the blasting area is to a sensitive site, the higher the cost due to the need to take additional safety measures, design for lesser volume per blast and also the need to monitor the blast at multiple locations.

Sometimes, even method statements from blasting consultants and the promise of full supervision by the latter are not enough to convince nearby residents that the proposed blasting method is safe. This is when alternative means need to be considered.

WHAT ARE THE ALTERNATIVE NON-EXPLOSIVE TECHNIQUES AVAILABLE IN MALAYSIA?

There are other means of breaking rock boulders using pyrotechnics or propellant material such as boulder buster where a cartridge of propellant material is inserted into a borehole filled with water and fired from a distance of about seven metres. Being an explosive material (Class 1.4S), the use of this material also requires a licence under the Arms Act 1960 and proper training to handle this equipment.



Boulder buster in use

However, it is very difficult to obtain a licence to use this equipment quickly because of the need for security vetting unless the contractor is willing to subcontract the work out to the few specialists in Malaysia who already possess such licenses. This equipment can also be used in demolition work, concrete breaking, quarrying and other construction work where a sensitivity issue may arise. The noise, airblast and flyrock created by the use of the equipment are minimal if any. However, this equipment may not be suitable for use in softer rock.

EXPANSIVE CEMENTS (NON-EXPLOSIVE SILENT DEMOLITION AGENT)

The other available method already in use in some Malaysian construction projects is expansive cement.

This material has already been available for quite a long time in Malaysia; however, very few engineers outside the mining and quarrying industry know about its availability. Previously, the material used to be imported from Europe, but due to the high cost, the current source of material is mainly from China.

In fact, some of this product is rebranded and exported to the United States. The author had a chance to test this cement from a Malaysian supplier at several locations in Langkawi and Kelantan. The material was chosen because the location was too near a sensitive building and also because of concern of flyrock. The owner of the land also objected to the use of blasting using explosives for the same reasons.



The boulders broken into small pieces using expansive cement

The advantages of using expansive cement are:

- a) Noiseless
- b) No flyrock
- c) No ground vibration
- d) No licence required to use it.

The biggest advantage of using expansive cement is that there is no need to apply for any licence. Hence, it can be used almost immediately when there is a requirement for it. The time saved as compared to using explosives in blasting work or the use of pyrotechnic-based boulder busters can be substantial and may range from days to weeks. No specialised equipment is needed and little training is required to use it. Similar to blasting and rock breaking using boulder busters, it can be used for demolition jobs such as concrete breaking.

The use of expansive cement requires the drilling of boreholes (40mm diameter) which is then filled with expansive cement mixed with water at a certain proportion to the top of the boreholes. The boreholes are drilled at about 600mm burden and spacing.

The cement reacts with water and the mixture expands and exerts enormous stresses (1,000 to 3,000 tonnes per square metre) onto the rock, causing it to crack in several directions. After about 24 hours, the cracks connect between the boreholes and the rock can be pulled out using an excavator. In fact, small cracks can be seen in about four hours.



An excavator removing a broken rock outcrop

CONCLUSION

Engineers actually have many choices of possible methods to break rock at a construction site. The normal methods of using rock breakers, rock splitters, etc, are actually commonly employed at construction sites. However, the adjacent property owners or residents will have to suffer from the continuous noise and ground vibration which could extend over long periods. For a big project, it will take a

long time to break the rock to make way for development. While rock blasting is an obvious choice when the site is far away from sensitive areas, other alternatives must also be considered, including the use of chemicals such as expansive cements. It is expensive but at least it will keep the neighbours happy and they will feel secured. The expansive cements are also very suitable for use in areas with limited accessibility. ■

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