Guidance Note No. GN 9
Use of Decked Blasting

Mines Division, Geotechnical Engineering Office
Civil Engineering and Development Department

1. Scope

1.1 This note presents general guidance and recommended good practice on the use of decked blasting in surface and underground applications in Hong Kong. It also sets out the minimum requirements for submissions in support of an application for a blasting permit using decked blasting, and supplements information given in other Mines Division practice and guidance notes. The note draws upon local experience and input from local and overseas expertise in the industry. It will be reviewed and updated as more experience is gained.

2. Background

2.1 A deck is a portion of a borehole (or boreholes) loaded with explosives that is separated from other charges in the same borehole(s) by inert stemming material[1]. Decked blasting refers to firing multiple decks in a blast, with a different time delay between firing each deck.

2.2 Decked blasting is a common practice in the mining and civil construction industries in many countries. Decked blasting has been used for surface blasting in Hong Kong since 1991 and more recently in tunnel blasting, but there is relatively limited experience both locally and elsewhere using multiple decks for shaft blasting. Blasting in densely populated areas in Hong Kong is often restricted by the need to adopt a low maximum instantaneous charge (MIC) in order to keep the blast-induced ground vibrations below the allowable limits of the nearby sensitive receivers. The use of decked blasting, when properly designed, offers an effective solution to enhance production (excavation) rates while coping with the restriction of a low MIC.

3. Safety Concerns and Risks in Decked Blasting

3.1 The vast majority of decked surface and tunnel blasts carried out locally were completed without an adverse incident. Nevertheless, caution, as with all blasting works, must be exercised. Where multiple decks are used, there is potential for problems to occur more frequently and with greater severity. Local experience has shown that particular care is needed when using electronic initiation systems (i.e. electronic detonators) for blasting in shafts, especially when water is present, where incidents have occurred preventing detonators from being initiated. These incidents have resulted in serious problems in re-firing the blast and, in cases where the blast could not be re-fired, in recovering the explosives safely. In addition, misfires have occurred repeatedly when using nonel (non-electric) dual-delay detonators for tunnel blasts; the problem appears to relate to poor workmanship, rather than any inherent fault with the initiation systems.

3.2 Safety concerns/risks involved in decked blasting must be identified, well understood and addressed as part of the Blasting Assessment Report (BAR), and measures to

[1] *There is no local experience of using 'air-decking', i.e. separating the decks with an air gap. Until such time that it has been proven to be suitable for local use, air-decking is not recommended.*

mitigate the risks incorporated in the blast design and Blasting Method Statement (BMS) prior to the issue of a blasting permit.

3.3 Dealing with misfires or other incidents, which affect proper initiation of a blast, are always potentially very dangerous. Therefore, effective and robust contingency measures must be planned and ready to be implemented to deal with any such incident, without compromising safety.

3.4 Issues, concerns and risks that become more acute when undertaking decked blasting (in comparison with single-deck blasting) include:

(a) use of inexperienced, inadequately trained or inadequately supervised personnel unfamiliar with more complicated blast designs, loading and hook up arrangements, and related testing protocols,

(b) risk of damage to detonators, detonator harness wires, signal tubes and connection plugs (due to the large number of detonators used), particularly in shafts where space is tight and the blasting is loaded underfoot of the charging team,

(c) an overly ambitious loading schedule, which can lead to insufficient care being taken in loading the holes, placing stemming, checking the hook up, and, where possible, testing detonators and the blast circuit,

(d) poor blast design, which can result in desensitisation of explosives (dead pressing), damage to detonators, or sympathetic detonation of charges,

(e) inadequate attention to design details, such as the use of blasting accessories e.g. detonator sleeves and stemming plugs, which are incompatible with the detonators, or could result in damage during charging, and

(f) rectifying misfires[2], particularly if there is a need to remove part of the muck pile to check the integrity of the blast hook-up or where stemming needs to be removed in order to re-prime charges and, in cases where the blast cannot be initiated successfully, recovering the explosives safely.

4. Recommended Good Practices

4.1 Recommended good practices, which can help mitigate the risks when using decked blasting, include:

(a) ensuring that adequate time is allowed in the blast programme to load, check and fire the blast, including dealing with possible misfires, without compromising safety, taking full account of site constraints, the adequacy of plant and

[2] *The regulatory requirements for handling misfires are given in R 57 of the DG(G)R (Cap 295B). In surface and tunnel blasting, misfires can often be rectified by reconnecting the circuit in the misfired/unfired sectors, but misfires in a shaft are generally more difficult to deal with, as the explosives are located under the muck pile at the base of the shaft.*

equipment, and the number and experience of personnel involved in the blasting operation,

(b) ensuring that there is sufficient inter-deck stemming and adequate spacing between holes to avoid desensitisation or sympathetic detonation of charges. A minimum stemming length and hole spacing of 10 to 20 times the hole diameter should be adopted, but this can be varied, taking consideration of the borehole conditions, type of explosives, type of detonators and the blasting design, where it can be demonstrated that other limits are more appropriate and will not affect adversely the blast or compromise safety,

(c) checking for and taking appropriate account of any adverse geological features, such as open joints, discontinuities and voids, which could result in blast holes being interconnected and lead to under or overcharging of holes, premature detonation of explosives or damage of detonators, or, particularly in the case of surface blasting, inadequate burden which could result in flyrock,

(d) adopting similar charge weights in each deck and ensuring that the burden and/or spacing of the decks is sufficiently adequate to mitigate the risk of flyrock, but not excessive so that it results in large ground vibrations,

(e) as a rule of thumb, adopting a minimum 8 to 25 ms delay between charges in the same deck and between decks, to prevent the possible overlap of blast shock waves from the detonation of charges, which could result in large ground vibrations. For non-electric initiation systems, the time delay is intrinsically limited in precision and reference should be made to the manufacturer's recommendations in determining the minimum time window. For electronic detonators, the delay timing is generally very precise and, where appropriate, a smaller delay between charges may be viable,

(f) when using a non-electric initiation system, designing the blast to ensure that all the surface detonators fire before any of the down the hole detonators; otherwise there is a risk of cut-offs. For dual delay detonators, in particular, ensuring that the length of the shock tube between detonators is suitable for the blast design; excessively long lengths of shock tube have to be coiled up and can get in the way when hooking up and checking the blast, whereas if the shock tubes are too short, the connections may be too tight and not properly aligned, at right angles. Also, to avoid misfires, checking to ensure a minimum "run up" distance between surface connections (in accordance with the manufacturer's recommendations) so as to achieve a steady state velocity of detonation in the signal tube,

(g) when using an electronic initiation system:

(i) ensuring that the wiring harness and connection plugs are sufficiently robust to withstand damage during the loading operation,

(ii) maintaining and servicing regularly, in accordance with the manufacturer's requirements, all equipment e.g. bench box, tagger, and ensuring that any software is up-to-date (maintenance and service records must be kept and available on site for inspection),

(iii) checking each detonator to identify defects prior to charging,

(iv) checking to ensure that the connecting plugs are closed at all times when not being used,

(v) testing and monitoring current leakage throughout the charging operation, and

(vi) ensuring that there is adequate spare equipment on site e.g. fully charged blast box and taggers, to replace any equipment that becomes defective,

(h) not using detonator sleeves and stemming plugs, unless there is a specific need to use them and they are fully compatible with the initiation system,

(i) checking the condition and adequacy of tools and equipment before loading e.g. burred or damaged tamping rods or bulk emulsion dosing hoses must not be used and when dosing bulk emulsion into a blast hole,

(j) using only properly trained personnel and implementing adequate supervision. All personnel involved in the charging operation must be trained to ensure that they fully understand their roles and responsibilities, as well as the specific working procedures to be adopted, including the susceptibility of components to damage, the checking requirements and the testing protocols. Good workmanship is crucial in the charging and hook-up operations. Adequate supervision must be provided by the Blasting Competent Supervisor (BCS) (independent supervision), the Blasting Engineer (the contractor's supervision) and the registered shot firer(s), and hold points specified, to ensure the blast is carried out correctly as detailed in the BMS and in accordance with the approved blast design. The BCS must actively supervise all aspects of the blasting operation, and.

(j) all misfires must be handled with extreme care.

5. Submission Requirements in Support of Blast Permit Application

5.1 The BAR must include a comprehensive and detailed risk assessment, the proposed preventive and mitigation measures and a contingency plan to deal with misfires or other blasting incidents, taking into account the good practices recommended in Section 4, where applicable. The BMS, which forms part of the Blasting Permit conditions, must include all relevant requirements from the approved BAR which are necessary to ensure that the blast is properly executed in accordance with the agreed blast design, including hold points and supervision arrangements.

5.2 The risk assessment must identify the safety concerns and hazards in carrying out the blasting operation, covering all scenarios where problems might be encountered before, during and after firing, particularly with respect to dealing with current leakage, misfires and incidents involving unexploded explosives. The interaction of multiple factors affecting risk, e.g. design, experience, time, workmanship and supervision, must be addressed. The risk assessment must be reviewed regularly and updated whenever necessary by the blasting contractor and endorsed by the BCS.

5.3 Robust protective and risk mitigation measures to prevent problems during charging and the occurrence of misfires or other incident must be clearly specified. The blast design must take into consideration prevailing conditions and the design detailing and loading arrangements. The methodology for the proposed decked blasting and sequence of blasting must be comprehensive with clear working procedures.

5.4 Resource requirements and, in particular, training and site supervision requirements, and clear lines of authority and responsibility for the blasting works must be stated clearly.

5.5 A robust and effective contingency plan must be in place to enable safe and prompt recovery from situations arising from the blast, such as a misfire or an incident involving unexploded explosives. It must cover all possible scenarios, with plans and procedures to rectify problems, e.g. recovery of explosives mixed in the muck pile.

5.6 For unusual/new or high risk/consequence blasting, the project proponent (client) must be advised of the risks and acknowledge acceptance of the risk by signing off on the working procedures before blasting commences. Also, if necessary, the Commissioner of Mines may require an independent assessment of the blasting method and procedures before issuing a Blasting Permit.

Mines Division
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General guidance is provided in this Note. Specific requirements may be imposed by the Commissioner of Mines to suit the conditions and characteristics of the site. Any feedback on this document should be sent to the Chief Geotechnical Engineer/Mines, Geotechnical Engineering Office, Civil Engineering and Development Department.
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