**Introduction**

Zero Group has successfully completed numerous high profile Bulk Excavation contracts across Gauteng’s CBD and has gained extensive insight and experience on how to deal with Rock encountered within these bulk excavations.

The objective of this information sheet is to provide clarity regarding some of the limitations, restrictions and design considerations in dealing with rock conditions. Furthermore, ground vibration, air blast, fly rock, as well as the control measures required to properly conduct blasting operations within the confinements of an urban developed area relative to the position on site are briefly addressed hereafter.

**Blast Parameters**

Blast parameters are based on the maximum allowable charge mass per delay needed to maintain the recommended peak particle velocity (PPV) limit. Explosives in blast holes provide the required energy to conduct the work. Ground vibration, air blast and fly rock are a result of the blasting process and their respective impact needs to be considered beforehand. To address these concerns, “Blast zones” are identified according to the specific limitations and influences applicable to blasting in these confined areas.

Zones are generated by carefully analysing the design and the distances away from neighboring properties and structures. Where rock profiles are shallower than anticipated, the rock cannot be blasted according to its predetermined zone, thus a more restricted alternative will have to be chosen, resulting in an increase in cost. Areas where rock geology varies (e.g. either much harder or softer) aspects of the design will change and hence the burden and spacing will also have to be adjusted accordingly.

It is recommended that Hydraulic Rigs (larger hole diameters) be used on blast holes deeper than 3.0 m, especially if fly-rock is an expected issue. Hydraulic rig holes are initiated with shock-tube or electronic delay systems to achieve single hole firing. For holes shorter than 3.0 m deep, Jackhammers (small holes diameter) should be used. Jackhammer holes are initiated using either a shock-tube (daisy chain) or detonating cord with shock-tube clusters.
Blast Restrictions / Limitations

The limitations on the blast area, usually requested from either the contractor or the engineer, are based on the guidelines and safe blasting criteria set out and defined by the following internationally accepted standards:

- United States Bureau of Mines (USBM) (Applicable to residential structures);
- German Standard on Structural Vibrations - DIN4150-3 (Applicable to high-rise / office buildings);
- Vibration Amplitude and Frequency Analysis (Applicable to services, pipelines, retaining walls, freshly poured concrete and server / data centres); &
- Code of Practice (1989) for Lateral support in surface excavations.

Additional factors like the curing time of recently poured concrete, both above and below ground (e.g. pads, bases, foundations, retaining and lateral support walls) have a huge impact on these restrictions, especially when concreting and blasting activities are occurring in close proximity to each other. Another factor that requires consideration is the presence of water. This causes adverse effects that are not easily controlled during detonation, as the pressure generated results in the displacement of the water in the area.

Civil Blast Zone / Blast Type Classifications

Based on the restrictions, limitations and variables mentioned thus far, it is evident that one simply cannot rely on the conventional method of “Bulk Blasting” within built-up areas, as the proximity of the blast to its surroundings, as well as the impact on other nearby structures and substructures, dictate the method of blasting to be used. Therefore, we have identified the need to specifically highlight some of the different types of blasting methodologies found within the industry by differentiating between the four (4) most commonly used methods in dealing with rock in urban areas. The four condition are listed below:

**Enclosed/Restricted Blasting - Red Zone**
- Jackhammer holes (88 mm diameter)
- Initiated with detonating cord and shock tube clusters / shock tube
- Blasted with cartridges
- Blast hole lengths / depths varying from 0.6m to 2.4m
- Covered Blasting

**Restained Blasting - Yellow Zone**
- Hydraulic Rig holes (51 / 64 / 76 mm diameter)
- Initiated with shock tube or electronic systems
- Blasted with cartridges
- Blast hole lengths / depths varying from 3.0m to 6.0m
- Narrow blast hole pattern (Burden and Spacing)

**Bounded / Composed Blasting - Blue Zone**
- Hydraulic Rig holes (51 / 64 / 76 / 89 mm diameter)
- Initiated with shock tube or electronic systems
- Blasted with Emulsion
- Blasted hole lengths / depths varying from 4.0m to 6.0m
- Narrow blast hole pattern (Burden and Spacing)

**Unbounded/Bulk Blasting - Green Zone**
- Hydraulic Rig holes (89 / 102 mm diameter)
- Initiated with shock tube or electronic systems
- Blasted with Emulsion
- Blast hole lengths / depths varying from 6.0m to 8.0m
- Wider blast hole pattern (Burden and Spacing)

Conclusion

In summary, when rock is encountered during the excavation process and blasting is required to break up the in-situ material, multiple design and safety considerations must be taken into account before the method of blasting can be decided upon. A site specific blast design will be done by an independent blast consultant for each project, and every blast will be monitored and reported on.

The main factors around blasting are to remain within the recommended ground vibration levels at the areas of concern, while controlling fly rock by maintaining the minimum stemming while insuring proper covering. Water logged areas must be identified and managed properly. Lastly, as the geological consistency is not always known or evenly distributed, this too will influence how ground vibration manifest and propagate within the in situ rock profile.