2019

Application of plastic funnel in blast hole to improve blasting efficiency of opencast coal mine at West Bokaro

Ashutosh Bhaskar
Tata Steel Ltd

Alok Kumar Baranwal
Tata Steel Ltd

Praveen Ranjan
Tata Steel Ltd

Tapan Kumar Jena
Tata Steel Ltd

Manyank Shkhar
Tata Steel Ltd

See next page for additional authors

Publication Details

Ashutosh Bhaskar, Alok Kumar Baranwal, Praveen Ranjan, Tapan Kumar Jena, Mayank Shekhar and Debaprasad Chakraborty, Application of plastic funnel in blast hole to improve blasting efficiency of opencast coal mine at West Bokaro, in Naj Aziz and Bob Kininmonth (eds.), Proceedings of the 2019 Coal Operators Conference, Mining Engineering, University of Wollongong, 18-20 February 2019, 345-351.

Authors
Ashutosh Bhaskar, Alok Kumar Baranwal, Praveen Ranjan, Tapan Kumar Jena, Manyank Shkhar, and Debaprasad Chakraborty

APPLICATION OF PLASTIC FUNNEL IN BLAST HOLE TO IMPROVE BLASTING EFFICIENCY OF OPENCAST COAL MINE AT WEST BOKARO

Ashutosh Bhaskar[1], Alok Kumar Baranwal[2], Praveen Ranjan[3], Tapan Kumar Jena[4], Mayank Shekhar[5] and Debaprasad Chakraborty[6]

ABSTRACT: Blasting being one of the key activities of mining, its efficiency in terms of lower explosives consumption, improved rock fragmentation, decreased fly-rock, reduced noise and vibration level is very much desired for an effective mining operation which can be achieved by maximizing the utilization of explosive energy in the blast hole. Use of 'reverse plastic funnel' into the blast hole is one of the techniques for more utilization of explosives energy to improve blasting efficiency. The reverse plastic funnel is placed between explosive and stemming column in the blast hole which eliminates the contamination of explosive from drill cuttings (used for stemming), thus increases the Velocity of Detonation (VoD) of the explosive. Also, the conic shape of funnel creates a 'Wedge effect' guiding more of the explosive energy into the rock rather than upward out of the blast hole which helps in utilizing more explosive energy for rock breakage and reducing fly rock generation. In order to establish the benefit, trials were carried out in OB (overburden) benches of opencast coal mine at West Bokaro. In-hole VoD is measured by using Micro Trap VoD Recorder. It was found that the in-hole Velocity of Detonation (VoD) of the explosive is more in blast hole having funnel which means more strength of explosive. It was also observed that the fly rocks generation is negligible from blast holes in which funnels are placed.

INTRODUCTION

Blasting is one of the key activities of an opencast mining. A good blasting results in desired rock fragmentation, less noise and vibration, negligible fly rocks generation which ultimately improves the productivity of loading and hauling equipment and safety. Better blasting is resulted by proper utilization of explosive energy inside the blast hole. Over the years, many attempts has been made by different engineers globally to optimise explosive energy used for the given unit volume of rock. Powder factor (P. F. - tonnes of rock blasted /Kg of explosives used) used to be the measuring tools to evaluate explosives performance. This is basically the lagging indicator and attempts have been made to find out the leading indicator. "Energy Factor Concept" which is a step towards finding a "leading indicator" still today confined to theory and academics. Blasting performance has been a very much critical term for the economics of a mine but unfortunately does not have a yardstick for its measurements. Powder factor has always being used as a post-operative performance indicator of blast efficiency. As per the various literatures, only 18-20% of the explosives energy is being used for actual rock breakage of the 100% available explosives energy. Throughout the world,

1. Sr. Technologist Mining, Tata Steel Ltd. Email: ashutosh.bhaskar@tatasteel.com Tel: +91 7763807590
2 Technologist Mining, Tata Steel Ltd. Email: alok.baranwal@tatasteel.com Tel: +91 736806253
3 Sr.Manager- Drilling & Blasting, Tata Steel Ltd. Email: praveen.ranjanr@tatasteel.com Tel: +91 9263635355
4 Head Mining Technology, Tata Steel Ltd. Email: tapan.kumar@tatasteel.com Tel: +61 7763807858
5 Chief - Quarry AB & E Mines, Tata Steel Ltd. Email: mayank@tatasteel.com Tel: +91 7368801522
6 Chief - Raw Material Technology, Tata Steel Ltd. Email: d.chakraborty@tatasteel.com Tel: +91 9234554345

efforts have been made to increase the part of explosive energy which is being used in rock breakage.

There are various techniques available globally like stem plug, ball plug, air bag, paraplug etc. to increase utilisation of explosive energy for rock breakage, but these are costly and not being manufactured in India. However, plastic funnel is available in local market and having low cost. So, usage of reverse funnel (Figure 1) is identified as one of the techniques to utilize the explosives energy for more breaking of the rock.

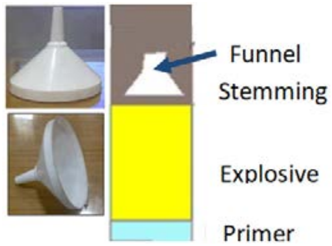

Figure 1: Plastic funnel

D. Karakus *et al.* has studied the impact of stemming plug to maximize the utilization of explosive energy to improve blasting efficiency and he has found that there was an increase in explosive energy transmitted to rock mass, resulting in better fragmentation. Rampura Agucha opencast mine of HZL, India and Aditya Limestone mine of Aditya Birla Group, India are also practicing the usage of plastic funnel in blast hole (between explosive and stemming) to improve their blasting efficiency.

THEORY OF PLASTIC FUNNEL

Two main purpose of using 'reverse plastic funnel' in blast hole between explosive and stemming are as follows:

- Eliminates contamination of explosive from drill cuttings, thus increases the Velocity of Detonation (VOD) at upper portion (near to stemming) of the explosive in blast hole.

Its conic shape creates a 'Wedge effect' (Figure 2) guiding more of the blasting energy into the rock rather than upward out of the blast hole. The result is lower explosives consumption, improved rock fragmentation, decreased fly-rock and reduced noise and vibration levels and savings in drilling costs. Hence, to realize the benefit of plastic funnel, a pilot trial was taken at Q SEB, West Bokaro of Tata Steel.

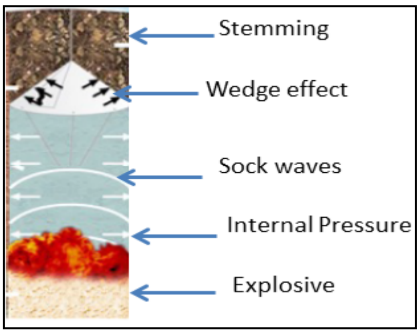

Figure 2: Wedge effect of plastic funnel

WEST BOKARO - TATA STEEL LTD

West Bokaro is a Division of Tata Steel Limited. It is a producer of coking coal. The mine came into existence as M/s Bokaro and Ramgarh Ltd in 1947. Coal was initially produced from a small underground mine, which was opened in 1948. In 1972 West Bokaro became a Division of the company. West Bokaro produces raw coals from two opencast mines Quarry-AB and Quarry South Eastern Block (SEB). These are beneficiated in two washeries to produce clean coals which is transported to steel plant at Jamshedpur.

West Bokaro is located about 200 km NW of Jamshedpur in Hazaribagh district. It is about 35 km SW of Hazaribagh town and 26 km NE of Ramgarh town. Geographically, it is located west of Lugu Hill. There are several other coal mines, owned by M/s Central Coal Fields Ltd around West Bokaro. The rain-fed Bokaro river flows through the property. Total area of the leasehold is 4300 acres and contains an estimated mine area reserves of about 180 million tons of coal. The loading station at Chainpur is situated 4 km to the South.

The rock encountered here consists of intercalated beds of sand stone, shales and coal seams belonging to Barakar stage of Damuda series of lower Gondowana system, the age of this coalfield are permo-carboniferous. The general dip of the beds is 2-5 degrees towards southeast but it undergoes great variation locally due to faulting, warping thickening and thinning of the strata. There are total ten shale bituminous medium cocking coal seams.

PILOT TRIAL AT Q-SEB COAL MINE OF WEST BOKARO, TATA STEEL LTD

The pilot trial was taken in one of Overburden (OB) bench of Q SEB. The details of the blasting parameters are as follows:

- Total number of holes – 89 Nos (22 holes with funnel)
- Average hole depth -10.8 m
- Hole diameter – 165 mm,
- Funnel diameter (larger diameter of funnel) – 155 mm
- Average burden – 5 m
- Average spacing – 6 m
- Average stemming length – 4 m
- Explosive used – Flexigel

The funnel of size 155 m (dia. of larger circle of funnel) is selected so that it can be easily taken down into the blast hole. Funnel specification is shown in Figure 3.

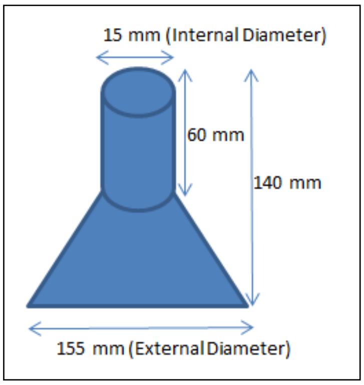

Figure 3: Specification of plastic funnel

After charging the blast holes with emulsion explosive, two funnels jointed together were inserted (shown in Figure 4) in the blast holes (larger diameter of funnel touches the explosive). The reason behind putting two funnels is to provide strength of the funnel to withstand the explosion pressure. After placement of funnel, stemming is carried out with drill cuttings to pack the remaining length of blast hole. Reverse plastic funnels are placed in 22 blast holes and remaining 67 blast holes are without funnel (shown in Figure.5).

Figure 4: Inserting reverse plastic funnel in blast hole

Figure 5: Blasting face at Q SEB, West Bokaro

Blasting Results

A. Velocity of Detonation (VOD)

In-hole VOD of the explosive of two holes (one hole with funnel and one hole without funnel) were measured by using Micro Trap VOD Recorder (Figure 6).

Figure 6: MicroTrap VOD recorder

The MicroTrap VOD Recorder is a portable, high resolution and explosives continuous VOD recorder. The VOD data were captured in the field by Microtrap instrument and the then it is connected to computer to download the data by using software to generated the VOD of the explosive. The VOD results are shown in Figure7.

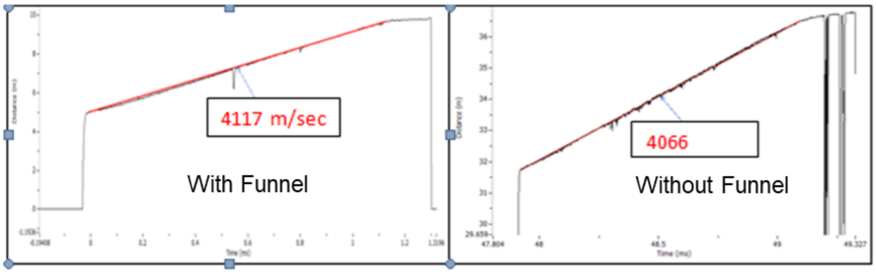

Figure 7: In-hole VOD results

It was observed that the in-hole explosive VOD is slightly greater in blast hole with funnel compare to hole without funnel which means more strength to explosive

B. Fly Rocks generation

It was observed that the fly rocks were negligible (Figure 8) from holes in which funnels are placed.

Figure 8: Fly rock generation

TRIAL AT Q-AB COAL MINE OF WEST BOKARO, TATA STEEL LTD

Initial pilot trial with plastic funnel in blast hole has shown the promising results in terms of more VOD and lesser fly rock generation. Hence another trial is carried out in OB bench at Q SEB, West Bokaro. The details of the blasting parameters are as follows:

- Total Number of holes – 64 Nos
- Average Hole Depth – 14 m
- Hole Diameter – 165 mm,
- Funnel Diameter (larger diameter of funnel) – 155 mm
- Average Burden – 5 m
- Average Spacing – 6 m
- Average Stemming length – 4.2 m
- Number of row - 3
- Explosive used – Bulk Explosive

Funnels are placed in all blast holes. Blast face is shown in Figure 9. It was observed that, fly rocks generation was very less (shown in Figure 10).

Figure 9: Blasting face

Figure 10: Blast results

CONCLUSIONS AND WAY FORWARD

Utilisation of explosive energy maximization is essential to get good blasting results and to avoid unwanted things like vibration, noise, fly rocks and air over pressure generation. Usage of reverse plastic funnel in blast hole is identified as one of the techniques to maximize the explosive energy utilisation. The two main benefit of using funnels are:

- To eliminate the explosive contamination
- To create wedge effect and hence guiding more explosive energy toward the rock rather than upward.
- Trials with plastic funnel in blast hole have shown the promising results in terms of more VOD and lesser fly rock generation. More trials are planned in overburden benches at West Bokaro to establish the benefits.

ACKNOWLEDGMENTS

The author would like to thank the West Bokaro mining team of Tata Steel Limited for their support and guidance to conduct trials. Thanks are also to the management of the Tata Steel Limited for their support and granting permission to publish the paper.

REFERENCES

Glenn Tobin, 2013. *The Importance of Energy Containment to the Blast Outcome and Justification for use of Stemming Plugs in Ove Burden Removal* (Oresome Products Pty Ltd: Australia)

Paraplug Brochure, Available from: http://www.paraplug.com/Downloads/brochure_en.pdf

Microtrap operational Manual, Available from: http://mrel.com/blasting_instrumentation/files/manuals/MicroTrap_Operations_Manual.pdf