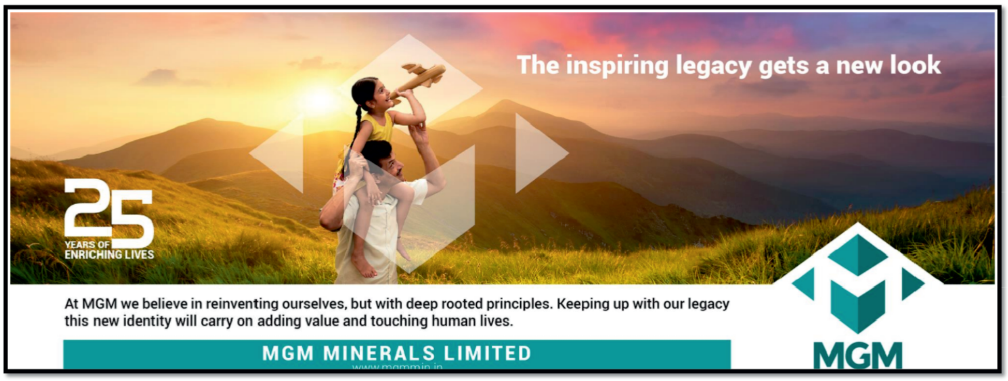

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LANJIBERNA LIMESTONE AND DOLOMITE MINE

Technical Article-13

The Journey of Explosive and its effect on Blasting

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Journey So far:

The development of explosives has experienced a long history. Greek fire was first used in around 17th centuries. It was probably a mixture of naphthalene, quicklime & Sulphur. The black powder/low explosive(gunpowder) was invented in China in 9th century. The Low explosive was sensitive to water ,evolving black smoke and was weak in effect. In spite of these properties, it was highly used among all the mining industries until the evolution of high explosive by the Italian scientist in 1846.The Swedish inventor in 1862 first developed a high explosive of Nitro-glycerine composition. Subsequently capsule loaded mercury fulminate named detonator was introduced in the market and became popular for control blasting. Gradually ANFO, NONEL and many other forms of explosive introduced in the market.

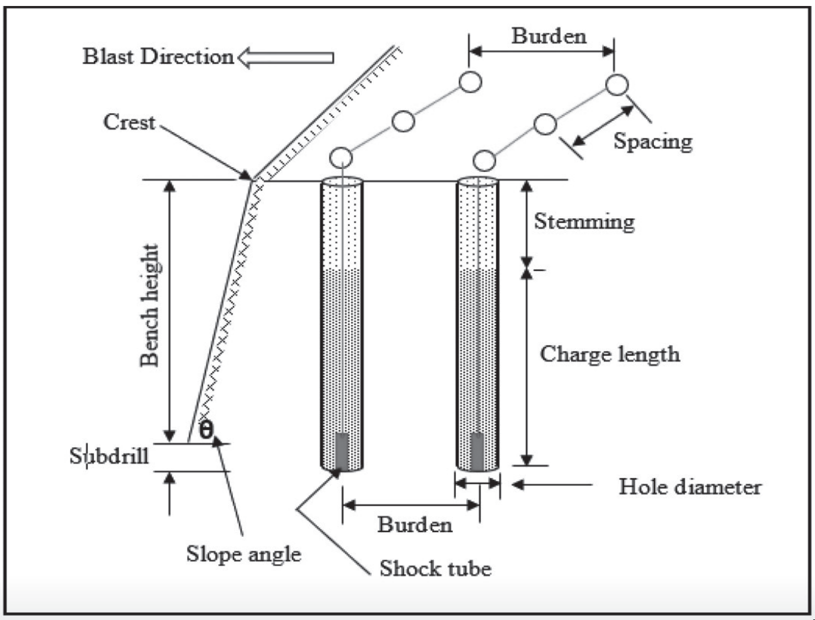
<u>Factors affecting the efficiency of Explosive:</u>

1. Design Factor
2. The Explosive in State Factor
3. The Rock and Environment Factor

Design Factor:

Rock Fragmentation requires some proceedings before the mass can be shattered into smaller sizes. The following factor influences the efficiency of the explosive usage and safety effect on the mine machines, nearby Building, Ground stability, Personnel safety to mention few:

- Drill hole geometry (Burden, Spacing, Stemming charge design, initiation technique, among others)
- Drill hole accuracy & direction into the rock mass. Several Debate on influence of the drill hole design was explored since decade. Poor hole design also influences the distribution of explosive energy during detonation as each burden distance has great impact on the shock front return time and disintegration efficiency during tensile slabbing. When available burden distance is inconsistent through out the drill hole column, the explosive energy tends to outperform in shorter distance and under perform in longer distance. This will result into undersize or oversize fragments.
- Explosive effect & environment. The Explosive state, including factors like type, quantity and initiation method, determines the release of energy. This in turn affects the size and velocity of the fragmentation generated during explosion. The blast environment such as confinement and proximity to structure can also can enhance the fragmentation due to reflection and interactions. Safety measures must consider these variables to mitigate the risks, including blast resistant structure, protective equipment and safe standoff distances.



Blasting and its effect:

Every mining operation which comprises of hard and soft rock requires blasting operation. The blasting operation makes the production smooth and rehandling of the material easily, but there are many consequences of the blasting on the environment which we need to address properly. Drilling and Blasting operation leads to form cloud of dust which may go to several meters before Settling and continue to move in the atmosphere for minutes. Other mining operations like dispatch leads to unsettle the Settled dust again. Due to this dust natural vegetates and environments. get polluted. Water pollution, air pollution land pollution is of the major impacts.

Some of the estimations for the quantity of dust produced have been either based on the area of the blast (EPA Report, 1932) or based on the quantity of explosive (Prasad 1995; Mukherjee 2001).

In one investigation, drilling operations produced 3.62 g/ton and blasting operations were measured to procure 72.5 g/ton of dust (NTIS 1976).

With the high production targets on mines, use of explosives Charge per hole increased tremendously which ultimately increase the amount of dust generation. Now, it is highly demanded to reduce the dust generation in the atmosphere and to study the process of dust generation and dispersion and steps that needed to be taken to reduce its generation and the dispersal of fines and dust. A research effort was initiated to Stimulate blast dust dispersal in different meteorological conditions and software were developed to predict dust plume movement-in and around times (Kumar & Bhandari, 2001, 2002).

Measurement is during, dust results from blasting very difficult and not many presentations / are research done for dust measurements after blasting. to US. EPA (1996) reports. dust measurements. Using ad blasting balloon sampler.

In order to reduce blasting dust some these parameters must be taken my consideration. Such as Burden spacing, stemming hole diameter, hole length, column charge, stemming length. effective sub-grade drilling, initiation Sequence, priming and ratio to blasthole diameter of charge dimeter.

- ❖ In Drilling process, one must design a blast pattern which is effective.
- ❖ Sub grade drilling helps in relieving the toe formation of the benches.
- ❖ Before Selecting explosive. One must study the lithology of the rock or benches to be" blast.
- ❖ Proper burden and Spacing help in controlling the and ground vibration will ultimately dust formation Class of Explosive and its amount also helps in this process. Dimensions of blast hole must be monitored as blast must move forward. Delay time plays a major role in As the Smooth muck mineral need bee fast to move.
- ❖ Powder factor must be monitored in order to reduce dust generation. PF is less than production of fines and dust also increases.
- ❖ Proper stemming materials and stemming length is also play vital role in dust control.
- ❖ Water filled ampoule in stemming is considered as safe stemming material and very much helpful in reducing dust and
- ❖ Water Sprinkling before blasting by inserting hole plug will also reduce the dust formation.

<u>BLASTING OPERATION:</u>

- ❖ PRIMING: The process of inserting the DTH into the cartridge.
- ❖ CHARGING: The process of inserting the cartridge into the hole.
- ❖ STEMMING: The process of covering of short hole with stemming material.
- ❖ 1st Siren (single): Before 30 minutes.
- ❖ CLEARANCE: Withdrawal of men and machinery outside the danger zone
- ❖ 2nd Siren (single): After area clearance.
- ❖ Deployment of safety guards at each entry point
- ❖ CONNECTION: Connecting the shot holes with TLD
- ❖ 3rd Siren (3times): Before firing the shot hole.
- ❖ SHOTFIRING: After final intimation from blasting in-charge Blaster blast the hole.
- ❖ After 5 min of blasting Blaster will inspect all the holes for checking any misfire.
- ❖ 4th Siren (single): After blasting final clearance.

CALCULATION & PROCESS FLOW CHART OF DRILLING OPERATION :

- Length of hole: 11m.
- Sub grade drill: 1 m (10% of hole).
- Diameter of hole: 102mm.
- Length of Cartridge: 0.45m.
- Diameter of cartridge: 83mm.
- Weight of cartridge: 2.78 kg.
- Stemming: 3.3m (30% of hole length).
- Booster length: 2.695m (35% of the remaining hole length).
- No. of booster: 6 (2.695m/0.45m).
- Length of column charge: 5.005m (65% of remaining hole length)
- No. of column charge: 11 (5.005m/0.45m)
- Burden: 2.5m
- Spacing: 3m
- No. of rows: 3
- Drill pattern: Staggered pattern
- Charge per hole: 47.26 kg
- Charge per delay: 330.82 kg

- **ASSUMPTION:**
- No. of rows: 3
- No. of holes in a row: 7
- Total no. of hole: 21
- Charge per delay: 330.82kg
- Total explosive used: 992.46kg
- Magazine location: Blleipuda.

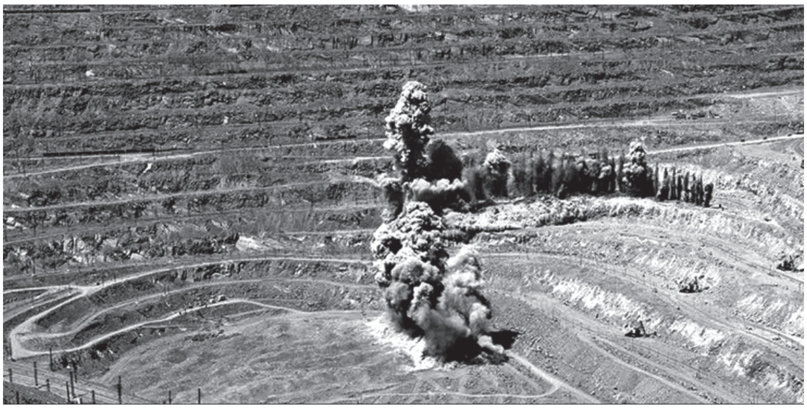
Power factor = 6.2 $\frac{\text{Ore produced (ton)}}{\text{Explosive used (kg)}}$

Ore produced = 2.5*3*21*11
= 1732.5 cu.m
= 6063.75 te

Charge factor = $\frac{\text{Volume (cu.m)}}{\text{explosive used (kg)}}$
= 1732.5 cu.m
992.46 kg
= 1.7456

Detonation factor = $\frac{\text{Ore produced (ton)}}{\text{No. of detonator used}}$

<u>LITERATURE REVIEW</u>:



In recent years open pit mines have developed rapidly with advantages such as high production efficiency, how input cost, and good safety. however, with the development of open pit mines towards green elaborate environmental pollution has become the biggest disadvantage of open pit mines (Gao and Liu 2010; Xie, 2014; Song et al, 2016; song, 2020).

In open pit mine the dust in the pit is not easy to disperse due to the influence of natural conditions and geographical environment which negatively impacts the operation efficiency, health and safety of the workers (Gen, 2010; Bai et al, 2013; Gao 2013).

Dust is produced in all links during operation, but the link with the largest dust production is the blasting operation before mining (Yan and Xue 2004).

According to the field measurements performed in this study, the instantaneous dust concentration during blasting must be as high as 4000 milligram per cubic metre exceeding the maximum allowable concentration of mine dust i.e.,10mg/m3 (Kissel ,2003; Barnewold and Lattermoser,2020).

Some experts and scholars use numerical simulations or laboratory experiments to analyse and summarise dust migration rules and provide theoretical basis for dust control (Bhandari et al,2004; Huang et al,2019; Jia et al,2021).

CONTROL MEASURES:

1. When magnesium chloride and calcium chloride mixed with water, it holds the dust firmly to the ground and do not allow to unsettle easily.
2. We can huge chemical demolition agents such as KATROCK, DEXPAN and FRACTAG as an alternative to blasting. As these are non-toxic chemicals and environmentally friendly, safe controlled demolition agents.
3. We can use water balloons within the stemming part resulting in formation of less dust
4. We must avoid blasting for soft rocks.
5. use of explosives must be calculated by studying rock type.

CONCLUSIONS:

1. Elimination - We should avoid blasting method for soft rocks but for the hard rocks we must practice blasting.
2. Substitution - We can substitute the type of explosive by studying the rock lithology and its quantity.
3. Engineering control - We can apply different methods to suppress the dust formation like
   - Water sprinkling throughout the area to be blasted.
   - Water ampules can be used as streaming materials.
   - Water balloons or plastic filled with water is placed between the stemming portions.
4. PPE (Personnel Protective Equipment) - We provide all necessary PPE to all the workers which helps in dealing in the hazards like face mask, gloves, goggles, ear plugs, earmuffs.

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