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Assessment of Blasting Quality of an Opencast Mine

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Abstract: The goal of this study is to assess the blasting quality of an opencast mine based on fragmentation analysis. Fragmentation of an opencast mine is one of the critical results of the blasting which is treated as the first quality demand in most types of blasting which affects all the downstream processes of mine to mill production like loading, hauling, crushing, and milling efficiency and also the cost involved in thesse processes. In this study, the fragmentation analysis of a chromite mine of Boula-Nuasahi Complex belt was conducted using WipFrag fragmentation analysis programming. Eight snap shots of blasted muck pile of the stated mine were investigated utilizing WipFrag photograph evaluation software. Both single and blended picture examination were done and the blended picture investigation was utilized to assess the top-quality fragmentation of blasting. The mean fragmentation of the impacted shake muckpile was anticipated from the investigation. Finding: Blasted muck pile contained the most proportion of fragments in the dimension vary 10mm to 100mm with a share of 47.37 and coefficient of curvature less than 1indicating blasted muckpile distribution is not very well graded. This study revealed the poor blasting quality of said mine which can be improved by observing and working on weak parts of blasting operation.

Key words: Blasting Quality, Fragmentation, Mean Fragment, Coefficient of Curvature, Blasted muckpile, WipFrag

I. INTRODUCTION

Blasting is the most important operation in entire mining processes and plays the pivotal role in the field of mine production and productivity where explosives are used for the liberating the rock from the ground [1], [2]. Although, there is an another alternative to loosen the rock from the bulk of rock mass where cutting machines are deployed directly to the rock face which was highly dominant method in early age of mining [3]. However, the development of explosives has given a new turn to the mining industries in their economic productions [4].Achievement of optimum fragmentation is the primary quality demand of most types of blasting operation which indicates the quality performance of blasting [5]. A good fragmentation increases not only the efficacy of loading and hauling equipments but also reduces the cost of crushing and milling and hence plays pivotal role in production and productivity of a mine [6], [7].

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Fragmentation evaluates also the quality planning of production of any surface mine. For example designing a proper blast, selection of appropriate explosives, application of suitable initiation system, appropriate delay pattern, direction of blasting, and the blast hole environment also affect the blasting performance and hence the optimum fragmentation [8]. In this study, fragmentation of a chromite mine Boula-Nuasahi Complex belt was analyzed through the analysis the five images of blasted muckpile taken from different angles and different distances using the WipFrag image analysis software. The WipFrag image analysis software is recently developed granulometry software [9]. It makes use of the technique of dimension of fragmentation with the assistance of advanced pictures of blasted muck pile.

II. METHODOLOGY

A. Image processing

Image processing transforms the fragment image into binary a image which consists of a net of block outlines.

B. Block Identification

Edge identification of block is done in a two stages process. Conventional image processing techniques are used in first stage of block edge identification, which involves the usage of thresholding and operators grade. The operators detect the faded or light shades between adjoining blocks of fragment, and then further work dependent on clean pictures with light finished rock fragments faces. A number of reconstruction techniques are used in second stage in order to further identify the edges of the blocks that are not completely (just mostly) delineated during the first stage. These incorporate both learning-based and subjective reproduction strategies, to finish the net.

C. Boundary Recognition Variables (BRV)

For each of the photograph processing stages, parameters called Boundary Recognition Variables (BRV) are accessible to the user, to optimize the edge detection process. The person has the choice of adjusting personal variables to optimize one stage of the process, or choosing one of 9 preset combinations of BRV. These combos are organized in arrangement to produce greater or fewer boundary, contingent upon the nature of the picture. . In this manner choosing more edges will lessen the quantity of missing edges in a given picture, while choosing less edges will diminish the quantity of false edges in that picture.

D. Improving constancy of the net

For higher accuracy,the constancy of the net is expanded via editing manually. There are a lot of intelligent altering instruments, to draw outlines, erase outlines, delete lines, or eradicate zones, which can be utilized to rapidly expel false edges and attract missing edges to finish the an appropriate net. The net is ordinarily shown as an overlay on the first pictures of shake, so the loyalty of the net can be assessed by the client precisely by the client.

E. Analysis

Subsequent to having distinguished net of blasted parts diagrams, WipFrag programming begins with the examination of the estimation which includes 2-D estimation on the picture, remaking of the 3-D appropriations of the fragmentations and after that the generation of graphical yield.

- **Single analysis of images**

All the 5 images are analyzed one by one using above said image analysis software. The size appropriation acquired from the single picture evaluation cannot deliver the highest quality size distribution because they can't signify complete area.

- **Merged(combined) analysis of images**

The aftereffects of the single picture examination are merged together and analyzed with the same software in order to obtain the optimum size distribution and correct parameters.

F. Measurement of Fragment Areas

In In the last activity on the computerized picture processing, the block profile territories and shape elements are estimated on the layout net of block boundaries. All activities are performed successively on all individual advanced pictures in the PC principle memory. At any phase of the examination, the picture or net can be saved on the disk for impending reference (total with data, for example, scaling variables) or printed out on a laser printer so as to get a printed version for reference.

Now the rundown of block profile territories is saved to a disk document. Ensuing tasks should be possible quickly, or later, utilizing each or a few records in turn, including combining numerous information documents into a solitary investigation.

G. 2-D to 3-D Reconstruction

At the underlying advance of this phase, the measured 2-dimensional distributions are divided into 40 dimensions or bin. The 2-D to 3-D transformations is done by the ideologies of geometric probability[10], and is carried out on each bin. At first, the appropriation is changed over into a 3-D recurrence distribution, and afterward to weight percent basis. At long last the dispersion is changed over into a combined weight percent distribution.

H. Graphical and Other Output

WipFrag images analysis software gives outputs in the form of graphs and printed versions of examination results. The client has the choice to acknowledge the default diagram consequently during the investigation, or select a few.

III. RESULTS AND ANALYSIS

A. Single image analysis results

Following the strategy of picture examination in WipFrag framework, the aftereffects of single picture from 1 to 5 are given with their pictures. The picture investigation demonstrates the size appropriation. The various notations appeared in the picture investigation curves are portrayed underneath.

Dn: Equivalent spherical diameter,
D10: Ten Percentile sizes
D50: Fifty percentile size
Mean: Average fragment size
Mode: The Most common sized particle,
N: Uniformity Coefficient of Rosin-Rammler criteria of size distributions
Xc: Characteristic Size, the intercept of the Rosin-Rammler straight line fitted to the WipFrag Dn data in log-log co-ordinates. This is proportional to the D63.2.
Where notations are described above

Fig. 1.Image of muck pile sample 1

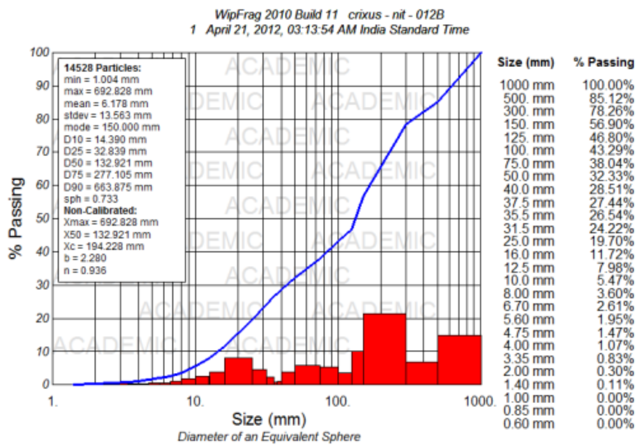

Fig. 2.Graphical representation of fragmentation distribution for sample 1

Fig. 3.Image of muckpile sample 2

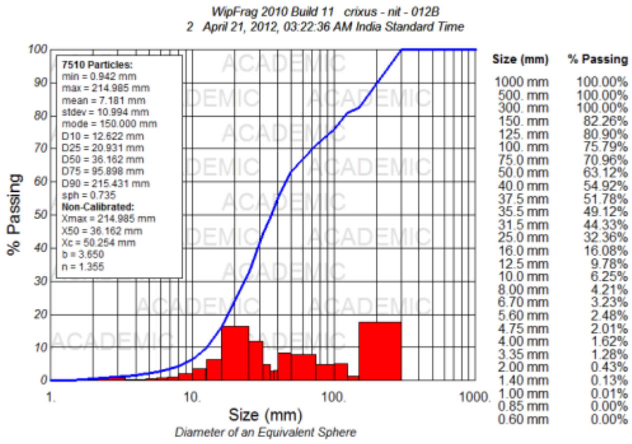

Fig. 4.Graphical representation of fragmentation distribution for sample 2

Fig. 5.Image of muckpile sample 3

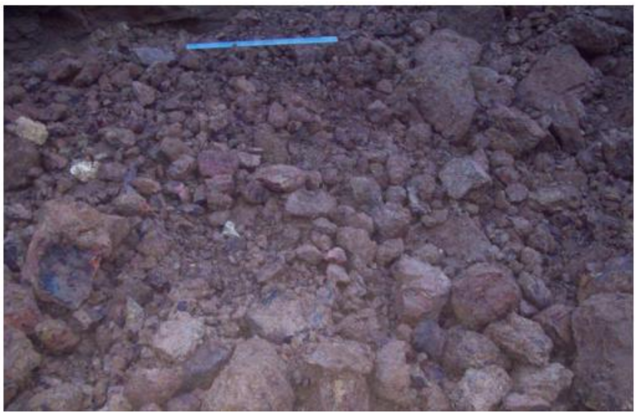

Fig. 6.Graphical representation of Fragmentation Distribution for sample 3

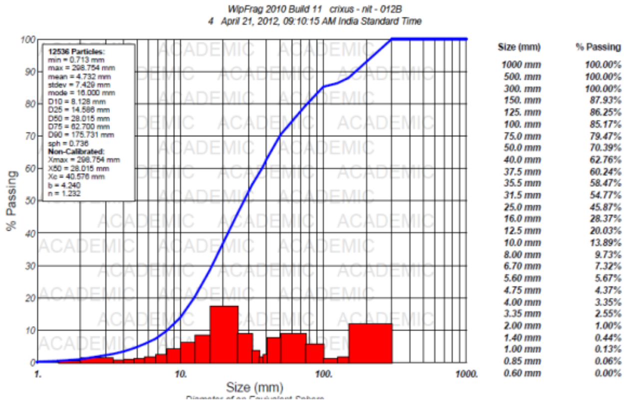

Figure 7. Image of muckpile sample 4

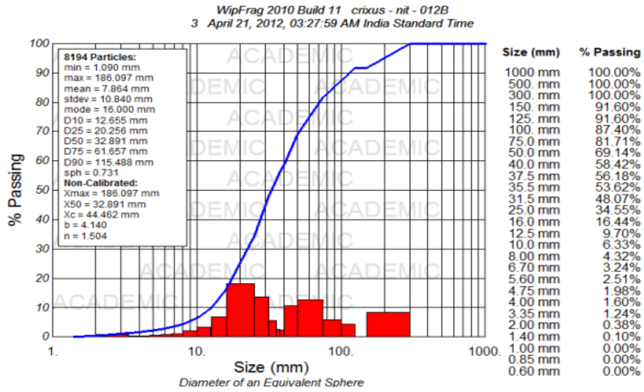

Fig. 8.Graphical representation of fragmentation distribution for sample 4

Fig. 9. Image of muckpile sample 5

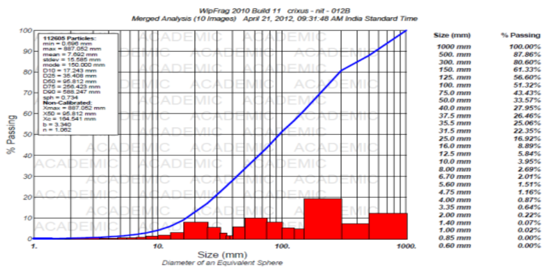

Fig. 10. Graphical representation of Fragmentation Distribution for Sample 5

B. Merged image analysis

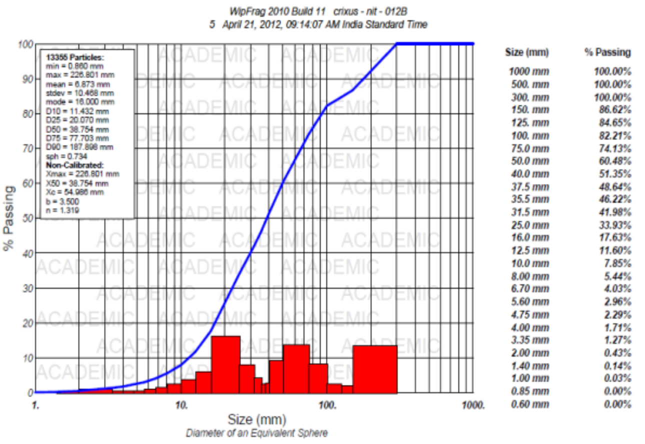

Fig. 11. Graphical representation of fragmentation distribution obtained from combined (merged) image analysis of all 5 samples

It was seen that most extreme rate at 47.37 % of fragmentation materials lie between 10mm to 100mm followed by material sizes between 100mm to 500mm at 36.54%.

It is likewise discovered that

D10 = 17.239 mm

D90 = 588.199 mm

XC = 159.988 mm

Table-I:. Size distribution attained from combined (merged) photographs investigation

Combined (image) examination results	Fragmentation distribution (%)			
	500-1000mm	100-500mm	10-100mm	0-10mm
	12.13	36.49	48.12	4.32

IV. CALCULATION OF UNIFORMITY COEFFICIENT AND COEFFICIENT OF CURVATURE

A. Uniformity Coefficient, Cu

Cu is additionally called Hazen Coefficient.

Hazen located that the sizes littler than the compelling size influenced the working of channels more than did the last ninety percent of the fragment sizes. To decide if a material is uniformly graded or well graded he proposed the following:

$$C_u = \frac{D_{60}}{D_{10}}$$

Cu < 5 indicates fragmentation is Very Uniform

Cu = 5 - 15 indicates fragmentation is Medium Uniform

Cu > 15 indicates fragmentation is Non uniform

From the combined (merged) Image investigation graph (figure 11), we observed that D60 =149mm

D10 = 17.239 mm

So, $C_u = \frac{149}{17.243} = 8.64$

In this way, it demonstrates that the fragment size distribution is Medium uniform.

B. Coefficient of Gradation or Coefficient of Curvature, Cg

$$C_g = \frac{(D_{30})^2}{(D_{60}\ X\ D_{10})}$$

Cg from 1 to 3 shows the distribution is well graded or desired sizes. From the combined (merged) Image investigation graph it is found that D30 = 45mm

Substituting D60 =149 mm, D10=17.239mm and D30 = 45mm in the above given formulae we get the value of Cg = 0.79 which is less than 1. So, the fragmentation is poorly graded.

V. DISCUSSION

The study was performed to investigate the blasting efficiency of the mine taken into study through fragmentation analysis using WipFrag software. Both single image analysis and merged image analysis were performed and results were used to calculate the Uniformity Coefficient (C_u) and Coefficient of Curvature (Cg) which are the measures of the particle size distribution range and the shape of particle size curve respectively and indicate the uniformity of particles size distribution and graded distribution of the particles respectively. Uniformity coefficient and graded distribution of the particles were obtained from the analysis of the results respectively 8.64 and 0.79 which indicate the medium uniform and poorly graded particles size distribution respectively and hence production and productivity of can't be honored.

VI. CONCLUSIONS

In order for the mine to be productive, fragmentation should be very uniformly distributed and well graded because fragmentation affects all the downstream processes like loading and hauling efficiency, crushing and milling efficiency. In order to make the concept "from Mine to Mill production" efficient, there is an urgent need to revisit the blasting technology used in the mine and find out the causes of poor fragmentation. There requires to investigate the accuracy of the blast design, proper explosives selection, explosives loading method, system of initiation, delay patterns and direction blast as per the availability of equipments and infrastructures.

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Mithilesh Kumar Rajak* graduated and post graduated from Indian Institute of Technology and is currently working in Amet University, Chennai as assistant professor. He has significant acdemic experience. He is a Ph.D research scholar as well. His area of research are explosives and blasting in surface & underground mines. He has done extensive researches in relation to industrial oriented works. His research works related production & productivity improvement in underground coal mine and and opencast mines have been commended. He has published several technical research articles various in national/internation journal, conference and syposium. The author has recently become a member of Institutions Innovation Council (IIC) – MHRD Innovation Cell.
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