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Technological developments in underground mining technology in Tata Steel mines

Tata Steel Jharia division mines are operating mines of more than 100 years of legacy. The working is Jharia coalfield are in multi seam from seam 18 to seam 0 in various part of the coalfield. The mining spans from early 20's to 21st century. The mining method has gone under tremendous change and thus is evident from the various technologies used in this division of Tata steel. It has seen many successes and many failures in the century old life. The mines are still an active field for technology innovation and adoption from world best practices. The underground mines in this division are filled with many old workings whose even record is difficult to find. The workings are filled with water. The seams are gassy and evidently there is fire in seams. The safety in the mines is of paramount concern, but with the coal prices touching sky highs it is also of great importance to extract the coal in safe and productive manner. Tata Steel being a steel producer needs coal at lowest cost for maintaining the cost advantage over competitors. The coking coal supply is ensured from Jharia division of Tata Steel. It has five underground mines which are degree 2 or degree 3 mines. This paper deals with the various initiative and innovation. Tata Steel underground mines division is taking to improve safety and productivity.

Key Word: *Tata Steel, underground mines, safety, CMM, tele monitoring, road header, mine fire.*

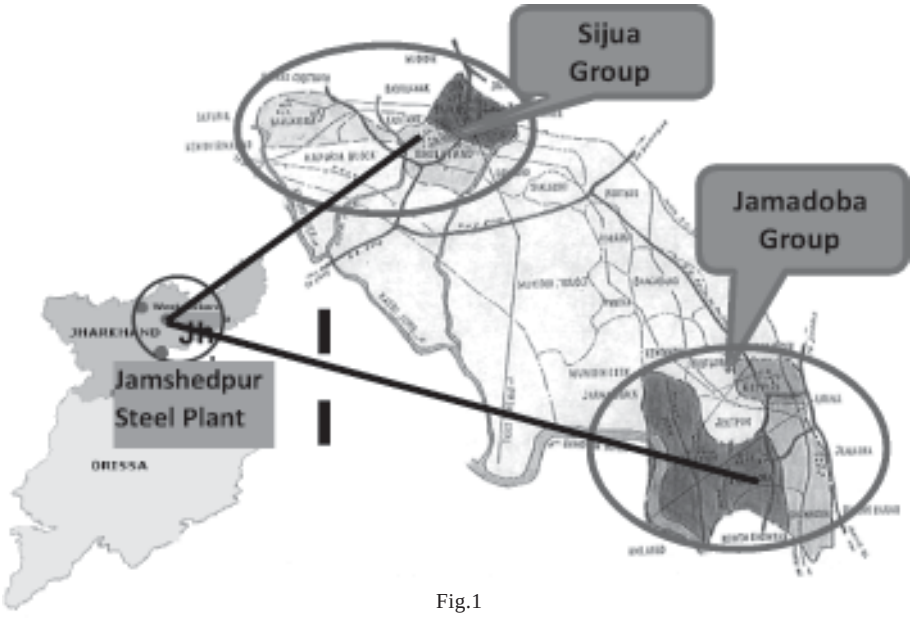

Fig.1

Introduction

A brief of Tata steel Jharia Mine (Fig.1)

Tata Steel mines started in 1912 with Bhelatand colliery to supply coal to its Jamshedpur steel plant. More coal mine were added to its fold and Jharia division started supplying 100% coking coal requirement to Jamshedpur. The requirement of Jharia coal in Jamshedpur works has ever increased with the expansion of its steelmaking capacity to 10 million tonnes.

Tata Steel has underground coal mines in Jharia division, which comprises two groups namely Jamadoba group and Sijua group. Jamadoba group of colliery comprises three collieries namely Digwadih colliery, Jamadoba colliery and 6&7 pits colliery, which are interconnected with each other by underground workings/goaves. Sijua group of collieries comprises two collieries namely Bhelatand A colliery and Sijua colliery.

Mine working

At present the mine is working at depth from 400 mts to 600 mts (Figs. 2 and 3). The lower seams are gassier in nature. Jamadoba group of mines is degree three and Sijua groups of mines are degree two. The deployed method of mining is bord and pillar with stowing. The coal breaking is done through blasting off the solid and loading is done through side discharge loader and load haul dump machine. The coal evacuated is filled with sand though hydraulic stowing method.

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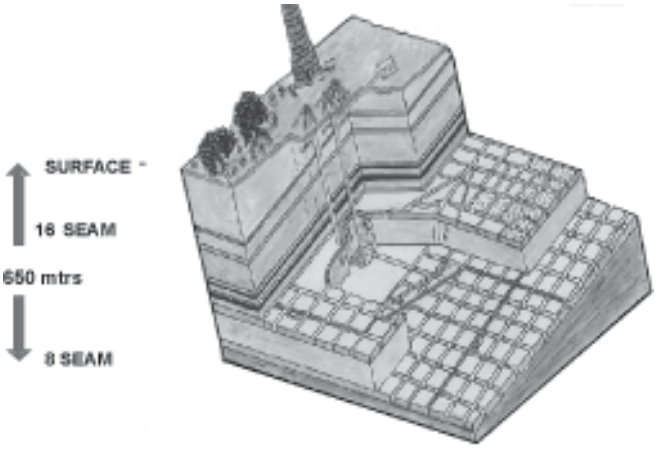

Fig.2 Isometric view of underground mines

The mines of TSL (Tata Steel Ltd.) have seams starting from 16 seam progressing downwards and now we are working in 14 seam, 11 seam, and 9 seam in various collieries.

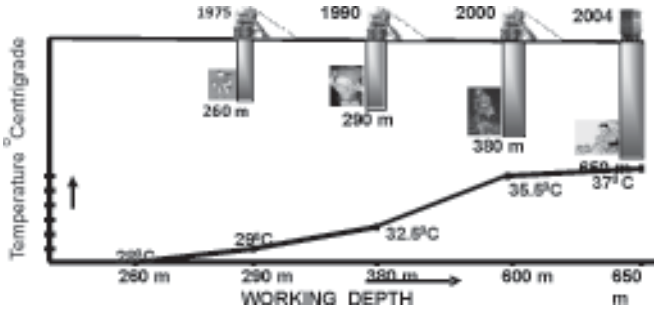

Fig.3

As we move downwards in the seams the depth of working is increasing which in turn is adding concerns to the safety, like high heat and humidity, high travelling distances causing fatigue to workmen, higher strata problem, high make of mine gases, poor ventilation etc.

The mines of TSL is a degree III gassy mines and has a working depth of up to 650 m from surface and three main safety hazards contributing to the maximum no. of accidents, namely mine gases, fractured strata and mechanization (i.e. workmen's exposure to the hazard).

The Tata Steel history is filled with many contemporary innovations in the mine. It has used plough technology for longwall, scraper

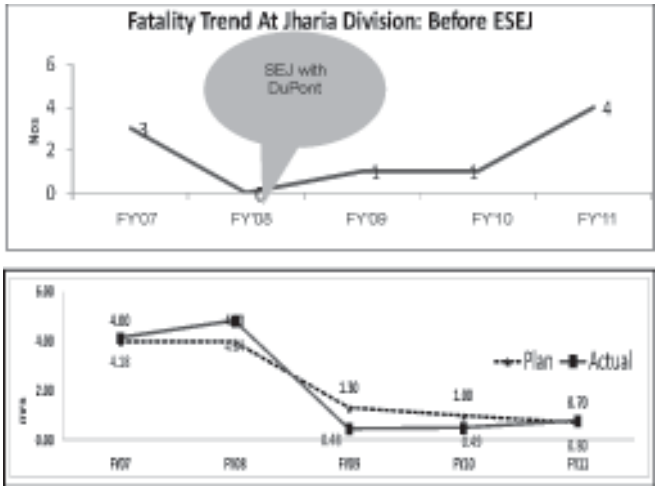

Fig.4

method of mining etc. At present the underground mines safety is a big concern in India. There are a very few companies who have capability to operate underground mining.

SAFETY CONCERN

The Jharia Division of TSL was facing the problem of continued LTIFR (loss time injury frequency rate) almost every year which could be seen in the below given graph of fatality. The level of LTIFR was also alarming and needed to be taken care of. Thus we launched safety excellence journey (SEJ) with Du Pont as our consultant in the year 2008 which reflected in decrease in LTIFR. But again it has increased. Based on this we have started safety excellence journey. There we have approached both engineering solutions and behavioural approach to mine safety. Thereafter the deeper analyses of the events were done to pin point the root causes (Figs. 4 and 5).

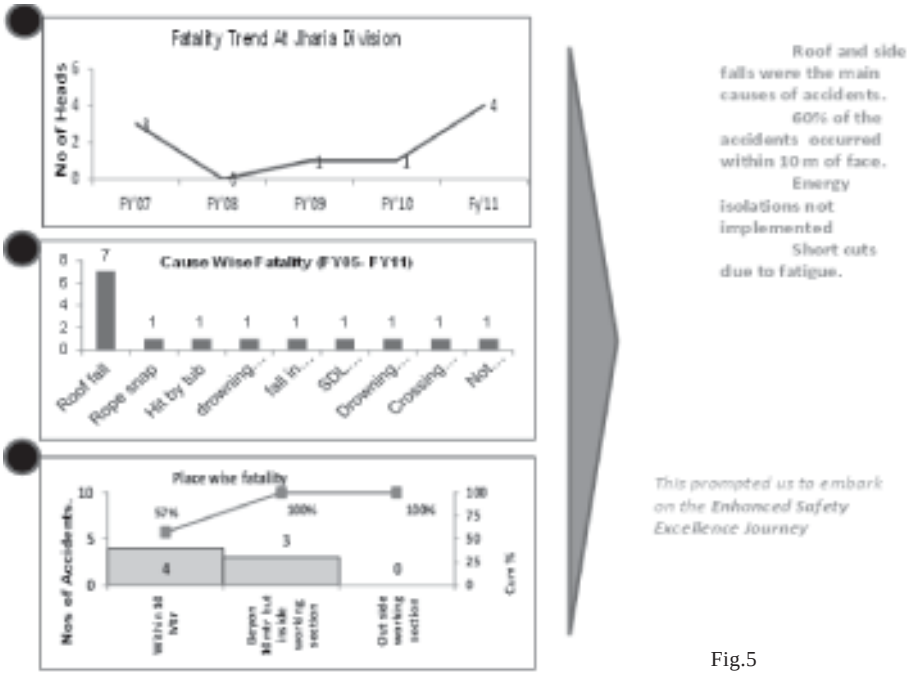

Fig.5

In this journey of higher productivity and increased safety concerns we faced many challenges, some of which are listed here:

1. High degree of gassiness in the mines (all mines are degree 3 or degree 2).
2. Incidence of fire in Sijua colliery, Digwadih and Other collieries are highly susceptible to fire.
3. Working at greater depth with drilling and blasting.
4. 100% stowing coal.
5. Arduous travel.

Innovative methods to counter challenges

In Tata Steel we take the problems head on and find adopt many engineering solutions to the problems. Some innovative methods were used for solving the problem (Figs. 6 and 7).

1. Use of coal mine methane for degassing of seam in advance of mining: Tata Steel started the project of degassing its 11 seam at Jamadoba. The first time in India the degassing is being done in active mine. The major challenge of drilling is through 5 number of water logged goafs. To counter this problem multi casing policy were used. The drilling was completed up to a depth of 670 meters up to 11 seam, where currently we are working. This project not only can reduce the threat but give an opportunity to harness the gas for some fruitful use.

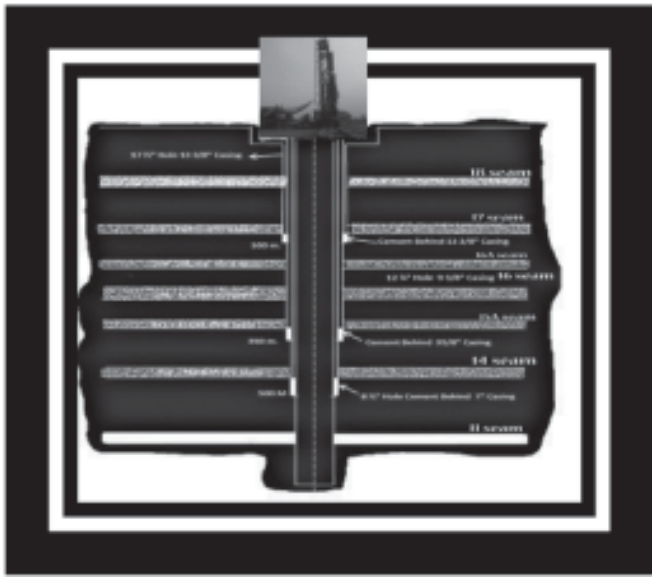

Fig.6

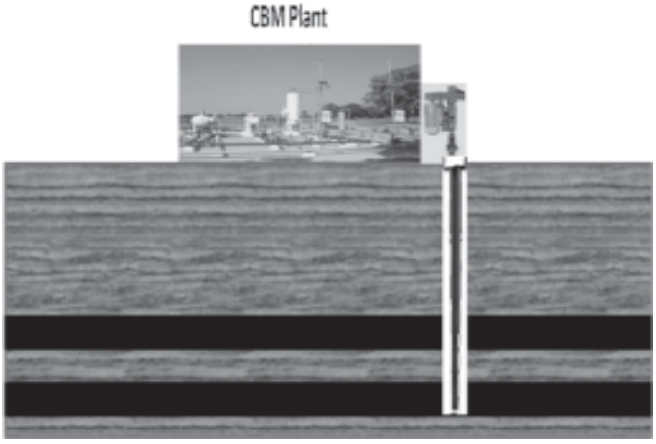

Fig.7

2. Use of UDM with LHD to reduce exposer within 10 meters of exposed roof. The roof and side fall within 10 mts of face is a major safety concerns for injury as well as fatality. Therefore the major thrust area is to reduce exposure in the green roof area of the working. In this our initiative is to use the equipment from the safe distance. In this series we have introduced UDM with LHD for working from the safe distance (Figs. 8 and 10).

Fig.8

Fig.9

3. Use of haulage type manriding systems for reduced travel: All the mines of working at greater depth and long distance from the shaft. In order to reduce this arduous travel we have introduced man riding system in Jamadoba colliery for distance of around 1 km from the shaft. We are also in the process of deployment in other mines. This is the first haulage based man riding system in India for degree 3 mines.
4. Use of nitrogen plant for control of fire: Jharia coal seams are very susceptible to mine fire. There incubation period is high. Since the method of mining prevalent in

Fig.10

underground coal mines leave around 70% coal inside. The chances of fire are very high. The big Jogta fire has entered into Sijua colliery in early 80's. The Digwadih has also shown the symptom of fire. Based on the experience, Jharia division mines are fully equipped with nitrogen plant for flushing of old isolated working with nitrogen plant for prevention of fire occurrence.

5. Implementation of positive isolation system for improved safety: The residual energy in electrical system and unattended power source can always play havoc and cause heavy damage in terms of loss of life injury and damage of equipment. The system of identification of each energy source and methods to isolate energy sources are adopted for complete safety has been implemented.

Fig.11

Fig.12

6. Use of tele-monitoring system at all mines of Jharia Division: This division has implemented remote operated tele-monitoring with central data capture system. This has inbuild early detection and advance warning system.

a. Raises audio-visual alarm and automatically trips the power when gas limit are exceeded.

b. Simultaneously display the information at pit bottom, districts and surface control room.

7. Use of road header for development: The blasting at greater depth comes with its own problem of strata control system. It eliminates the need of blasting, therefore reduces the damage to rock strata and therefore

a. Stable rock strata are ensured.

b. Improves productivity by reducing production cycle.

8. Advance strata management system: The roof and sides are the major hazard in the underground mines. We have

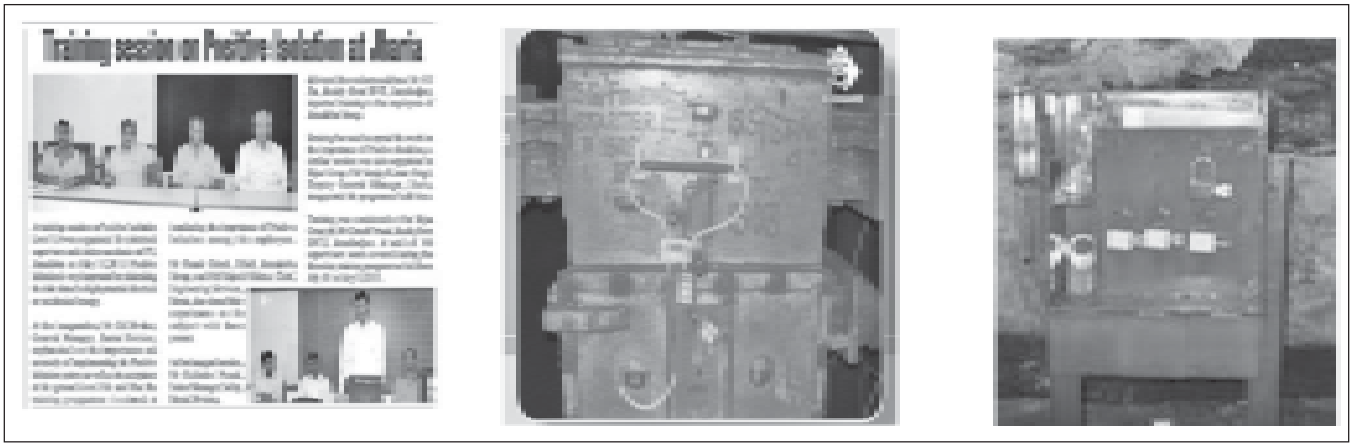

Fig.13

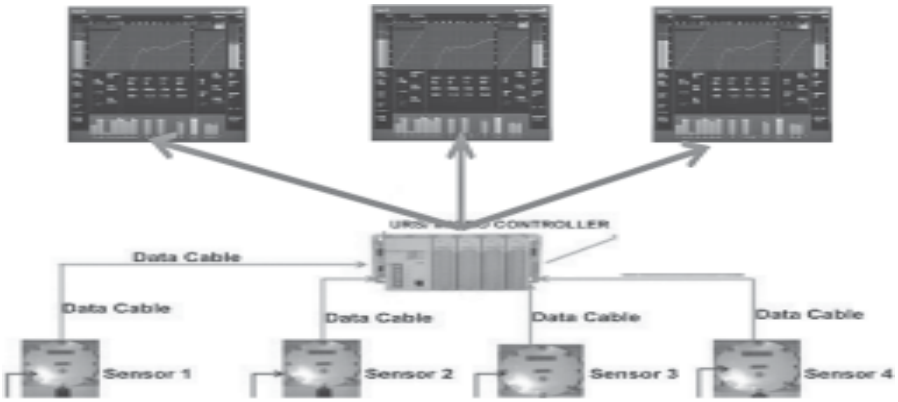

Fig.14

taken several initiatives for addressing such problems.

a. Joint project with Central Institute of Mining & Fuel Research (CIMFR) for revising the support systems.
b. Use of resin capsule to replace cement capsules for roof bolting.
c. Change the design of roof bolts.
d. Manual roof bolting replaced by mechanized drilling with extended handle for ensuring verticality of roof bolts.

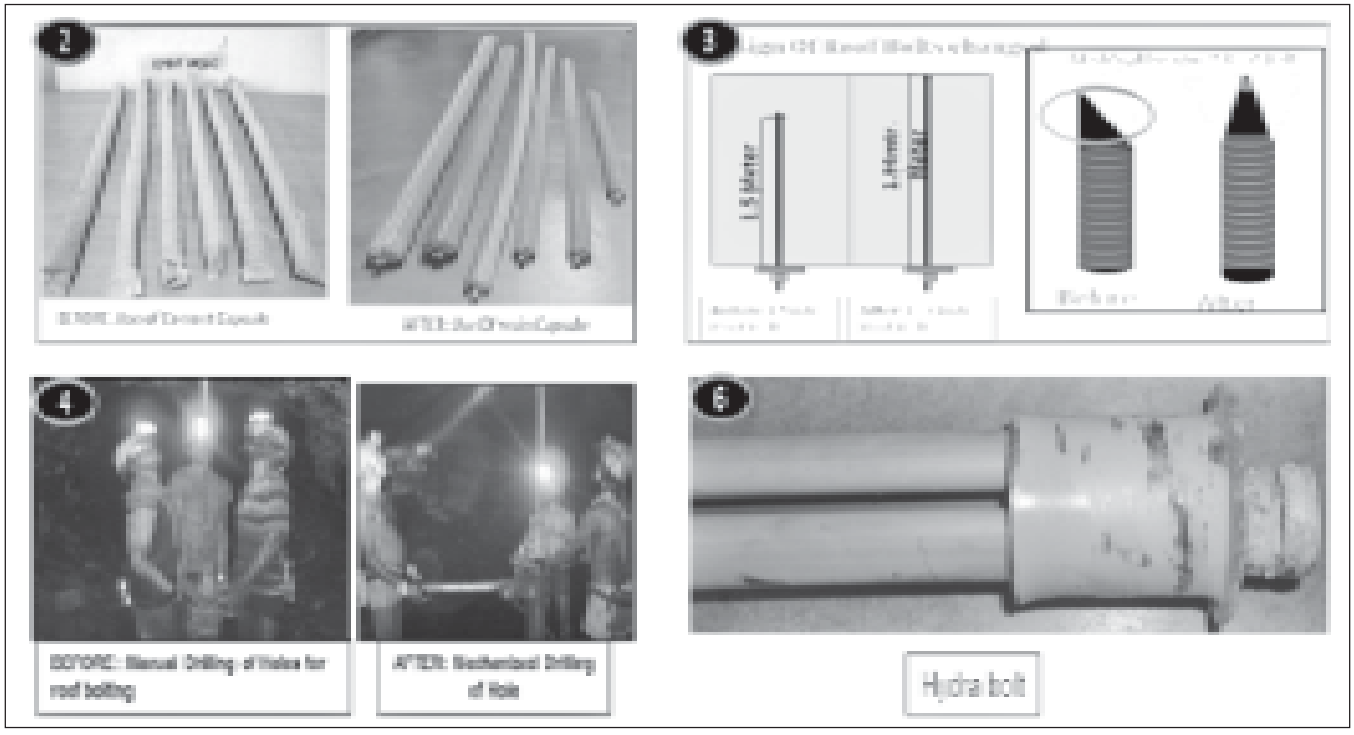

Fig.15

e. Introduction of side bolting at depth of more than 300 meters.
f. Use of hydra bolt started first time in India.

RESULTS ACHIEVED

Various initiatives has resulted in some great results so far, one of which being our LTIFR has reduced and fatality has dropped to zero from fy11 to fy13 and is continuing and it is evident from the following graph (Fig.16).

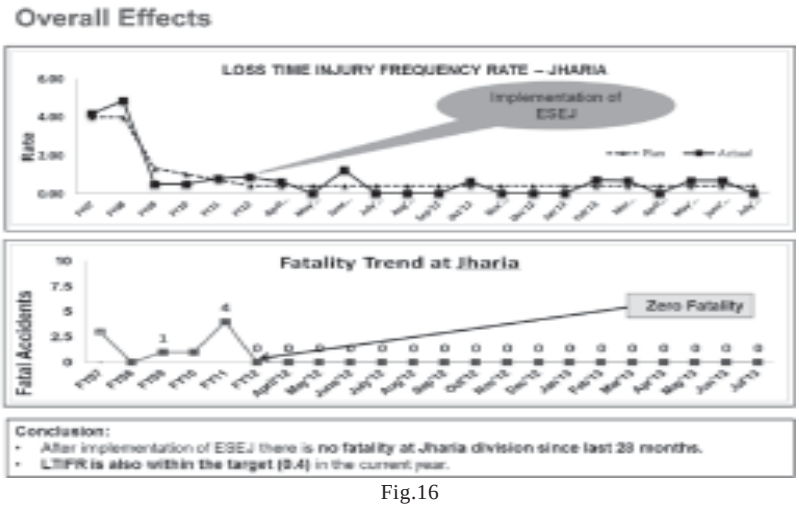

Fig.16

PATH FORWARD AND CONCLUSION

Improvement is a continuous journey. More improvement and innovations are always on the horizon. With the improvements we have achieved good safety indices. But the ever

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Fig.12 Compact, less spread muck loaded by FEL and dozer for support

loaded by loaded by shovel (Fig.10). The fragment distribution was uniform and the mean fragment size was within the optimum fragment sizes of the excavator bucket (0.24 – 0.32cm). The average cycle time for uniform fragment sizes was lower in this case {shovel (20 sec), backhoe (15sec)}. The cycle time for loading such muckpile using front end loader (Fig.11 and 12) was higher (55 sec) and also it was supported by dozer to spread the tight muckpile, which remained very close to the final wall during the loading. Therefore, deployment of proper excavator is essential to load the blasted muck.

Conclusions

The following conclusions may be drawn from the present study:

1. Front end type loader can be a good choice for loading loose muck having more lateral spreading and low height.
2. Shovel or backhoe can be a good choice for loading less lateral spread muck having less throw and proper height.

Acknowledgements

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TECHNOLOGICAL DEVELOPMENTS IN UNDERGROUND MINING TECHNOLOGY IN TATA STEEL MINES

(Continued from page 18)

increasing depths will consciously pose hazard which needs to be taken care of. The ever increasing hazardous condition also warrants continuous improvement and new initiatives. Some of our initiative which is under planning and consideration phase are:

1. Use of air conditioning system in degree III mines will be first in India. We have finalized design and will be implemented soon.
2. Use of continuous miners/short wall technology with stowing. All the continuous miners/short wall technology are being done in conjunction with caving but first time in India we will be using the method with stowing. For this, the studies are in progress for high rate paste filling technology to be used with continuous mines/short wall for higher productivity at higher depth.

We are exploring all the possibilities currently present in the market in addition to it so that we can sustain our performance and improve continuously in the field of high production and productivity with high level of safety.