NATIONAL CONFERENCE ON
FUTURE TRENDS IN MINING

(Tomorrow Mine - SAFE MINE) 25th & 26th May, 2018
J.N. Tata Auditorium, Indian Institute of Science
Bengaluru, Karnataka (India)

Programme

25.05.2018

Registration	:	8 AM to 9.00 AM
Inauguration & High Tea	:	9.15 AM to 10.30 AM
Technical Sessions		
Technical Session - I	:	10.30 AM to 12.30 PM
Technical Session- II	:	12.30 PM to 01.30 PM
Lunch	:	01.30 PM to 02.30 PM
Technical Session – III	:	02.30 PM to 04.00 PM
Tea Break	:	04.00 PM to 04.10 PM
Technical Session- IV	:	04.10 PM to 05.30 PM
Dinner	**:**	**8.00 PM**

26.05.2018

Technical Sessions – V	:	09.00 AM to 10.30 AM
Tea Break	**:**	**10.45 AM to 11.00 AM**
Technical Sessions – VI	:	11.00 AM to 12.15 PM
Technical Sessions – VII	:	12.15 PM to 01.30 PM
Lunch	**:**	**01.30 PM to 02.30 PM**
Technical Session – VIII	:	02.30 PM to 04.00 PM
Technical Session -XI	:	04.00 PM to 04.30 PM
Valedictory	:	05.00 PM to 5.45 PM

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a.	New Amendments In Mining Legislation To Improve Safety Standards In Indian Mines-	Shri Shyam Sundar Prasad
b.	Accident experience in Opencast Mines in India	Shri Manish E. Murkute
c.	Safety Management Plan – Documentation	Shri B. Arunachalam
d.	Employment of Contractual workers and Issues	Shri B.P. Singh
e.	Occupational Health Hazards in mines	Shri George John

TECHNICAL SESSION II : Advance Technology in Mining operation

1.	Controlled Blasting and Ground Vibration Analysis	Dr. H.S. Venkatesh
2.	Digital transformation in Mining Industry-	Shri G. Jayavelu & Suvendu Roy
3.	Application of Mine Planning software in open pit equipment scheduling	Shri Promod Kumar Sarangi & Shri Amjath Basha

TECHNICAL SESSION III : New Trends in Exploration in Strategic & Rare Earth Minerals

1.	Drone/ UAVs Surveys – Flying into 'Tomorrow's Mine'	Mr. Cyriac Joseph Dr. D.N. Gulhane & Mr. Gaius
2.	Rare Earth Minerals: Exploration and Strategy-	Dr. S.K. Bhushan
3.	Different geological settings of strategic and rare earth minerals and applicable exploration techniques in India & abroad	Dr. P. Krishnamurthy
4.	Exploration Scenario of Potash in India and the road map ahead-	Dr. Ranjit Choudhuri

TECHNICAL SESSION IV : Infrastructure development around Mining Stakeholder

1.	Mining at NMDC - an integrated approach towards value addition	Dr. N.K. Nanda, Shri Rajan Kumar & Shri G.E. Sreedhar
2.	Stakeholders' expectations of ethical mining and its responsibility towards Society-	Shri Samad Kottur
3.	CSR Activities at a Glance - Rajashree Cement Works Ultratech Cement Ltd	Shri D. P. Mukhopadhyay
4.	DMF/NMET Payments Proper utilisation	Shri Kamlesh V. Patel

TECHNICAL SESSION V : Processing of Strategic Rare Earth Minerals & Beneficiation of low grade bulk minerals

1.	Processing of Strategic Rare Earth Minerals and Beneficiation of Low Grade Bulk Minerals	Dr. Tapan Kumar Mukherjee
2.	Mineral inventory-Threshold values of Mineral Future trend of use of Bulk and other important minerals	Smt. Indira Ravindran
3.	Upgradation of Low Grade Ore- Strategies with Existing and New Technologies	Dr. (Prof) Rayasam Venugopal
4.	Gold Exploration and Mining Scenario In India-	Dr. Prabhakar Sangurumath

TECHNICAL SESSION VI : Sustainable Mining & Development

1.	Use of Mineral Resources and Sustainability-	Shri Deepak Vidyarthi
2.	Sustainable Mining-	Dr. Gurdeep Singh
3.	Waste Management at Mines-	Dr. MedaV enkataiah
4.	Accountability, Transparency & Credibility in Mining Sector	Shri A.R. Vijay Singh

TECHNICAL SESSION VII : Legislation, Amendments

1.	Amendment of Mineral Legislation, Impact on Mining/Mineral Industry and Way Forward	Dr. T.N. Venugopal
2.	Implementation of Sustainable Development of Framework (SDF) in the Mining Sector and Its Review-	Dr. Y.G. Kale
3.	Pros & Cons of Threshold values of atomic minerals	Shri Omprakash Somani
4.	A New Approach to Mining – Post Auction Scenario	Shri B P Pandey

TECHNICAL SESSION VIII : Alternative System of Transportation: Downhill Conveyors and Railway siding etc;

1.	"Single Flight Conveyor"- State-of-the-art technology	Shri B. Sahoo & Shri G. Ghorai
2.	Transportation Of Iron Ore Slurry Through Pipeline At Kudremukh Mine	Shri N. Vidyananda Shri K.V. Bhaskara Reddy
3.	Common Railway sidings: Improved Environment Vis Visa economics	Shri Y. Nagendra & Shri Ajai Kumar

TECHNICAL SESSION IX : Mining Education : Global Challenges and Prospects

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2.	HR practices	Shri Praveen George

Technical Session I

Safety Standards in Mining:
Present & Future

NEW AMENDMENTS IN MINING LEGISLATION TO IMPROVE SAFETY STANDARDS IN INDIAN MINES

Shri Shyam Sundar Prasad
Director of Mines Safety; Bilaspur Region
Directorate General of Mines Safety, Ministry of Labour & Employment.

Abbreviations - CMR, 1957: Coal Mines Regulations, 1957; CMR, 2017: Coal Mines Regulations, 2017; DGMS: Directorate General of Mines Safety; MMR: Metalliferous Mines Regulations, 1961; MVTR: Mines Vocational Training Rules, 1966; OMR, 1984: Oil Mines Regulations, 1984; OMR, 2017: Oil Mines Regulations, 2017; OC: Opencast; OSH: Occupational Safety & Health; UG: Underground.

ABSTRACT

Mining, being invariably associated with various potential hazards, is one of the most hazardous professions peace-time. Since inception of the Mines Act, the OSH in Indian mines has travelled a long journey of more than a century with immense improvement in working conditions, reflected by a marked decrease in the fatality and injury rates in mines. However, flattening of the decreasing trends in the said indicators during the recent decades was or is suggestive of the need to review the conventional system of prescriptive mining legislation to make suitable amendments for continuance of achieving improvement in mines safety.

During recent decades, the Indian mining industry has achieved phenomenal progress in production and productivity and even now, the industry is poised for revolutionary changes at an accelerated pace. Driven by the exponential rise in mineral demands, there has been vast development in the area of technology, scale of operation, working environment and work practices in coal, metal and oil mining sectors. To keep pace with the said technological advancement and changing scenario in mines, an initiative has been taken by the central government to review and amend various rules and regulations under the Mines Act, 1952. Under this initiative, a comprehensive amendment of the Coal Mines Regulations (CMR) and Oil Mines Regulations (OMR) has already been completed with publication of CMR 2017 and OMR 2017 in the official gazette vide GSR 1449(E) on 27th day of November, 2017 and GSR 1029(E) on 18th day of August, 2017 respectively, and the same in respect of MMR and MVTR is under active progress.

The CMR 2017 and OMR 2017 are a step forward towards "shift from a prescriptive to goal based legislation. These regulations have been made more enabling, flexible and dynamic. The concept of hazard identification and risk analysis based "safety management system" has been incorporated as a part of self regulatory approach, which will enable to effectively address changing and site-specific conditions in mines. Reduced number or replacement (in case of OMR) of prior permissions and approvals by adopting pre-existing standards, simplified

returns, provisions on responsibilities of contractors, manufacturers, suppliers & designers, provisions allowing maintenance of plans, sections & records in electronic form and dynamism in Forms for submission of various returns and notices are the other new features. The amended CMR also provides for statutory competency certificates restricted to opencast mines (in line with MMR), increased coverage for mechanized OC and UG Mining, man riding system in UG, "emergency response & evacuation plan" and a separate new chapter on extraction of methane. The above new features of regulations will not only be more effective in achieving improved OSH standards in mines but also facilitate the present government policy of "ease of doing business".

A comprehensive amendment in MMR in line with CMR is being taken up. Considering the change of training needs to match adoption of new systems and mechanisation, a draft for comprehensive amendment of MVTR has been formulated in active consultation with the coal, metal and oil mining industries. Amendment of the Mines Rescue Rules, 1985 is also on the agenda, which is in the initial stage of consultation.

The basic objective of this paper is to pinpoint the salient features of the recent and proposed amendments in mining legislations.

Acknowledgement

Author is grateful to Shri Prasanta Kumar Sarkar, Director General of Mines Safety, DGMS, Dhanbad, for according permission to present this paper in National Conference on "Future Trends in Mining", proposed to be held on 25th-26th May, 2018 at Bengaluru. The views expressed in the paper are that of the author and not of the organisation he belongs to.

ACCIDENT EXPERIENCE IN OPENCAST MINES IN INDIA

Shri Manish Murkute
Director of Mines Safety, Ballari Region

After agriculture, mining forms the second pillar for the development of the Society. Minerals constitute the backbone of economic growth of any nation and India has been eminently endowed with this gift of nature. A number of minerals of economic and commercial value abound in this country.

In the initial stages, mining was limited to outcrops and surface mining was started using manual labour and primitive techniques for breaking rock was deployed. With advent of time, when these methods could not go deeper, underground mining was resorted to.

However, with improvement in the various operations connected with rock breaking, transportation and mineral beneficiation, open cast mining has undergone a fast revolution. While earlier open pits could not go beyond depth of 30 to 50 meters, today we can think of pits of 200-300 meters depth and with this, the future of surface mining has become much brighter. The global scenario is thus undergoing a rapid change and as far as possible open cast mining technology is being evaluated first for any deposit before finally choosing the underground mining only in a very adverse cost situations.

In India, non-coal mining sector where the number of surface mines is predominating and underground mining is only for a very limited tonnage in Zinc, Copper, Manganese and Uranium.

Safety, health and welfare of workers employed in mines are administered by the Directorate General of Mines Safety (DGMS), under the Union Ministry of Labour & Employment.

While safety of men and machinery in general has been considered to be a problem area in underground mine, it is noted that very high degree of mechanization involving large size equipment and intensive operations, there are plenty of issues to be tackled as regards to safety of men and machinery in open cast mines also. Accident statistics of the Indian Mining both in coal mines as well as metalliferous mines indicates that the safety record of the open cast mining including operations connected with above ground require a special care since the earlier belief of open cast mining being very safe compared to underground mining does not really look to be correct.

Accident Experience

The trend in 10-yearly average number

of fatal accidents and that of fatality rates per thousand persons employed from 1901 to 2017 for coal mines indicated a consistent decline is observed in the 10-yearly average number of accidents per year. For non-coal mines, theaverage number of accidents and fatalities has remained more or less at the same levelduring the period from 1971-80 to 1991-2000. While the last ten yearly average during theperiod 2001-10 have slightly decreased in number of accidents and fatalities and the lastseven-yearly average have fallen significantly during the period 2017.

The number of fatal and serious accidents in the last ten years in separately for coal, metal and oil mines indicated that the number of accidents(fatal and serious taken together) in coal mines has decreased in 2017 in comparison to 2016.

In non-coal mines

In non-coal mines, although serious injury rate per 1000 person employed in opencast working came down significantly in last 6-7 years but death rate have been showing stagnant or rather increasing trend in opencast mining. The main causes being the HEMM specially the transport equipments such as tippers and dumpers engaged in mines. In the recent past accidents occurred in stone quarries have increased significantly.

During the year 2017, there were 61, 39 and 1 fatal accidents involving 67, 63 and 1 fatalitiesin coal, metal and oil mines, respectively. The number of fatal accidents during the previous year i.e. 2016 were 71, 31 and 9 for coal, metal and oil mines respectively.

During 2017, highest percentage of fatal accidents was due to fall of sides and explosives respectively and it was about 18% for each. It was followed by fall of person 15%, Fall of object about 10%, Dumper about 8% and Truck, tanker etc. about 2.5%.The main frequent causes of serious accidents in non-coal mines in 2017 was other machinery about 29%, fall of objects and fall of persons about 18% each.

SAFETY MANAGEMENT PLAN -DOCUMENTATION

Shri Arunachalam .B
Former Manager GVTC

Shiv kera said "Mere positive thinking does not guarantee success, positive thinking with positive efforts increases our probability of success

1.0 Introduction

Safety is guidance towards the understanding of what the true workings of fundamental protection is all about. The guise of risk is there in every act, those who know this will be safe, and those who practice with caution will be true safety leaders.

In the case of large mines the magnitude of operations will require the Safety management plan to be gone into the minutest detail with a document that is fundamental to the management of safety (plan), a flexible document detailing the procedure that isto be followed (manual) and a register that would detail the hazards and control measures (risk assessment and control register) as annexure to the plan.

In the case of manual or semi mechanized mines with the approval of concerned authorities, a brief plan and risk assessment and control register may be suffice. This could be done with the assistance of an outsider. This could cover a cluster of small manual mines with a total commitment that all will follow and will be independently responsible for implemen tation. Example, small limestone mines manually operated with jack hammers and tractors as the only machines.

In any establishment it would be in larger interests to cover all areas irrespective whether they fall inside or outside the purview of Mines act. This in turn will improve the organization's safety culture.

In this paper the documentation procedure details are discussed

2.0 Implementation Safety Management Plan

In the case of Coal mines Imple mentation Safety Management Plan (CMR2017 Regulation 37,104) has become mandatory and expected to be so in metal mines any time (Ref Draft MMR 2012, Regulation 115). Over and above mandatory needs it is in the interest of the industry as well as all miners.

Safety is a matter of health, safety and well being. Key factors for managing safety and to establish the safety culture within the organization are (1) The Commitments; (2) Workplace Awareness; (3) Method (4) Discipline.

3.0 Safety management plan

The most sort of issues which need to be addressed in the Safety Management Plan include:-

1. Safety policy - objectives/goals

2. Corporate structure - organizational charts - key personnel - reporting lines

3. List of persons responsible, their roles, responsibilities and accountability, including the relationship between these persons in the implementation of SMP

4. Outline of the risk management framework including processes for: -

a. Identification, analysis and evaluation of risks

b. Eliminating, or reducing the risks to safety caused by operations –

c. Managing risks including the use of audits, expertise, resources and staff –

d. Reviewing risks including monitoring the effectiveness of controls –

e. Developing risk assessment register associated with the operations

f. Training of personnel

g. Exhibiting evidence of the ability of senior management to make safety decisions, for example, relevant skills, knowledge and qualifications of key personnel and the processes in place to ensure key personnel maintain the required knowledge and skills.

h. Investigating of non compliances of preventive actions and dealing with repeated non compliances procedures in place

5. Important committee or safety related meeting dates

6. Review meeting schedule (Stating specific month and date)

7. Dates to review policies, manual or work procedures

8. Dates required for major hazard analyses to be completed

9. Outcomes or actions following review of hazards, accidents or statistics

10.Actions, dates and responsibilities to complete agreed actions

11. Achievement of actions

The roles of the following Key Staff in the Safety System should be clearly spelt out in the safety management system as well as in all the lower levels of the plan.

Owner, Agent, Manager, Supervisor, Safety Officer, Workman Inspector, Trade Union Representative, Mechanic, Operator, Worker, Contractor and Contractor's Management, etc

4.0 Annexure to safety management plan

The Safety Management Plan will have an annexure such as a manual, risk assessment and control register, formats needed for various situations. With the consent of owner/agent or manager, these would undergo changes as circumstances demand.

4.1.0 Safety Manual:- This manual will be an annexure to the plan and would outline the operational procedures to comply with the overall and specific hazard management. It is the document that would be available to all workers on site and should enable them to be aware of not only the framework within which they have to do their work but also what is expected from them to ensure a safe and healthy work environment.

Suggested contents and lay out of Safety manual

4.1.1 Abstract

- Manpower

• Geography, Water bodies, revenue land /forest/others

• Structures belonging to/not belonging to owner & distances,

• Geology -Details of intervening strata, etc

• Working hours limitations if any

• Machinery Details no, Size, capacity, Repair facility

• Pumping activities

• Brief of the SMP, how it was done , Number of major , medium & minor, hazards etc., at base risk level and at residual risk level ,

• List of risks above accepted rating levels that cannot be eliminated, emergency measures in place

4.1.2 Brief description of mine

• Location plan,

• Brief geology of formation , series ,Stratiography, structural features,fold, fault, dip, Strike, nature of weathering, fractures if any and general direction

• Nature of mineral mined, cutoff grade, ore characteristics, Nature of waste & characteristics

• Mine Top RL No of benches on ore/ waste, bottom RL, Bench slope, pit slope,

Rain fall, Ground water table if any in deposit, dumps etc.,

4.1.3 Flow sheet:- Flow sheet explaining List of major activities and detail of Sub activities under each major activity activities starting from exploration to final stage of Dispatch.

4.1.4 Definitions

• Hazard, Risk, risk assessment, Risk rating, risk management, Base& residual risk

• Consequence, probability, exposure, Control measure, etc (ref Circular)

• Specific words in SOP

• Any other specific activity /product having site specific terminology (eg) calibrated ore, classification etc.

4.1.5 Process of Hazard identification, risk assessment and control

a) Guide lines for determining skills of team members

b) Selecting team for hazard identification

c) Based on flow chart determine

• independent activities ,
• group activities,
• overlapping activities,
• seasonal activities
• one time activity

Assign manpower to cover such areas keeping in mind the team should cover all in the hierarchy and based on quantum of such activity weight given to workmen involved in such or similar activity by increasing numbers.

Prepare a hazard identification format for field use for each individual.

Prepare risk assessment format to assess base risk, existing controls rate the risk level, apply controls assess the residual risk.

Safety clearances for new equipment work method and material used should be in place.

4.1.6 Internal audits

4...1.6.1 the need for auditing

Safety management cannot be a fit and

forget scenario as there will be change in working conditions, machinery, environment etc...It is necessary that a system put in place is monitored at regularintervals,fine-tuned,and updated

Monitoring is better assigned to another set of officials to rule out bias or complacency. Careshould be taken against mudslinging. As far as possible roles should be interchanged to get intoapplicability of shortfall in monitoring.

• Where there is high residual risk mitigations could be by elimination.

• Monitoring process to also consider creation of new risk by earlier control measure.

DGMS Circular instructs audit by DGMS officials. But it is necessary that we conduct internal audits with our officials to go thread bare into the system, identify weak zones and implement additional controls

Competence to audit to be spelt, • Periodicity• Review by one up of audit reports should be done. Finally audit report to be discussed in open

Reviews to be documented with time bound corrective measures

4.1.6.2 Functions of auditor and the audited

• Auditors should undergo an in house training. Auditor should not audit his own department

• Fix days for audit and inform in advance

• Look into the document and see if all hazards are addressed

• Check efficiency of control measures by communicating with audited department at lower levels.

• check awareness

• Check display ,implementation and awareness of Safe Operating procedures

• Check if any mock drills were conducted and neutral observer's report on such drill

• On completion of audit inform finding to the concerned department head, send a copy of audit report to Mines manager

• Audited department head should send compliance action report within 15 days after receiving the report. However if the observation is of a major Hazard immediate action should be initiated

• In cases areas needing financial sanction where the mines manager may not have powers , he should inform the owner and if need be suspend activities or put in additional control measures.

4.2 Hazard reporting format:-This would detail Location of Hazard, description, action taken and is it permanent, controls that were in place. This can be filled and submitted by any who need not be member of the team.

4.3 Identification of trigger points: - Trigger points are incidents that occur where an accident could have occurred such as road turnings where trucks more or less run face to face etc. Repeated such instances will turn out to be an accident at some point of time. This happens more when the control measures are administration/training/ppe.. Control could be made and when these are the only controls triggers should be identified and measures taken

4.4.1 Emergency preparedness to cope with a hazard should it occur. Proactive /corrective measures to be taken in case of emergency situations like explosion, inundation, slope failure, Fall of vehicle /person, fire in machinery/plant/buffer zone. Dump Slide / Face Slide. Employees who are likely to be affected by the emergency are to be evacuated, those who are affected should be rescued and provide the first aid and medical assistance,

Investigation of cause emergency once brought under control, Corrective & preventive actions to be taken to prevent the reoccurrence of such situation.

Sending of written report to Safety department. Department head shall send the action report.

Conducting of Mock drill for each of the situation as per the schedule and recording observations

Suitable action for improvement on the basis of observation of Mock drills,

4.4.2 Disaster management procedures

• After all these exercise to handle unforeseen scenario a disaster management team should be in place listing out mode of communication, controllers, medical facilities available to take mitigate the disasters.

• Powers to handle such disaster should also be documented

4.5 Accident / Incident Reporting & Investigation

This would be a Standing Order to ensure compliance with Regulations and to inform mine personnel of responsibilities and reporting requirements. It should cover:

- Responsibility of those on the site
- Immediate response and Emergency backup
- Notifying Key staff of accident
- Securing the site
- Treatment of any injuries
- Investigation and Reporting
- Review of any recommendations and determining actions

The investigation should ultimately lead to finding out the root cause and measures to be adopted. Root cause analysis should be done without bias, lest the objective gets defeated. In case the corrective measure had not formed part of control measures earlier, the same should be incorporated. While doing so hazards need to be identified, base and residual risk rated. Such residual risk should bring things under tolerable level. Till it is implemented, if need be, elimination should be resorted to. E.g. Dumper over running the edge due to subsidence in waste dumps.

4.6 List of Safe operating Procedures

All new tasks where there are high to medium risks present should have safe operating procedures prepared before tasks are commenced. For existing processes, safe operating procedures for high risk tasks are prepared first, followed by medium and low risk tasks.

SOP is also needed for introducing new methods, equipment or materials etc The language in case of hazards of major nature SOP should be emphatic (Do not use may, can etc., but use word must)The message

should be clear and easily understandable. It should definepurpose, List out potential hazards with CONTROLS.

The sop would be based existing controls and new controls introduced to bring risk to as low as reasonably acceptable level

4.7 Training requirements:-

In the case of operating mines familiarity breeds contempt. In some cases the initial training and attitude play a major role in accepting the newer controls. Many a time there would be resistance. Therefore training is necessary. Also refresher training should be conducted. Manual should stipulate methods of identifying those who need training, the interval, training is needed after an accident, long absence etc.

5.0 Hazard identification, risk assessment and control register

Take into consideration Para 4.5.cabove and Split each activity in the process to as small nodes as possible

Based on the hazard identification, existing control, base risk, additional controls, residual risk a register is kept that would have additional columns for entering feedback, new hazards if any that crop up. There should be provision for adding hazards not identified but reported by shop floor. This will constitute a major back up in all review meetings

6.0 Safe operating procedures

While conducting hazard identification and base risk assessment existing controls will surface out, later while applying additional control to reduce the level of risk further control measures will come in. Also OEM gives some safe procedure. There will be some by way of DGMS circulars, compliance of environmental safety norms, etc. All these needs to be grouped put in sequentially and each act assigned responsibility. This would need review at each meeting additions made if necessary. Also ascertain if no new hazards have come up as result of such SOP.

6.0 Conclusion

Murphy's Law"If everything seems to be going well you have obviously overlooked something" though this is quoted on the lighter side, on many occasions this is true. Either due to ignorance we are sitting on a seemingly dormant volcano or we have a complacent attitude that we are well experienced and no harm will ever occur.

As we proceed further we need to fine tune to get closer to targets. System calls for continuous improvement. The function of team goes much more than just identifying hazards and getting into control measures the activity gets split into further sub activities to get closer to the goal.

* * *

Safe operating procedures are the outcome as the control measures. They should have wider circulation, not cumbersome but practical ,acceptable to all concerned failing which it will just be a bunch of papers

1. Construction of Main Haul Roads
2. Dozer Operations
3. Excavators. Operations
4. Rock Breaker Operations

5. Grader Operations
6. Wheel Loader Operations
7. Drills Operations.
8. Blasting activities
9. Haulage
10. Waste Dump Management
11. Ore Stack Maintenance
12. Installation and commissioning and operation of DG set and electrical installations
13. Auto-electrical maintenance
14. Battery charging
15. Transformer oil testing and filtering
16. Maintenance of electrical over headline
17. Repairing of breakdown HEMM
18. Checking of brakes of wheeled equipments
19. Dismantling and assembling of buckets and hydraulic cylinders
20. Gas cutting and arc welding
21. Track removal of Dozer for repair work and refitting
22. Replacement of oils and filters
23. Working below vehicles/ HEMMs
24. Replacement of heavy duty tires from heavy duty equipments machineries
25. Replacement of hoses and spares
26. Inspection/Maintenance of Vehicles at site/mines
27. Towing of breakdown vehicles from mine to workshop
28. Washing of HEMMs at site
29. Loading
30. Weighbridge Operation
31. Transportation
32. Plant Operation
33. Field sampling
34. Laboratory Sampling
35. Chemical Analysis
36. Canteen

Salient points in the SOP should be prominently displayed at such Hazardous location. It should brief and local language with sketches, photo etc..

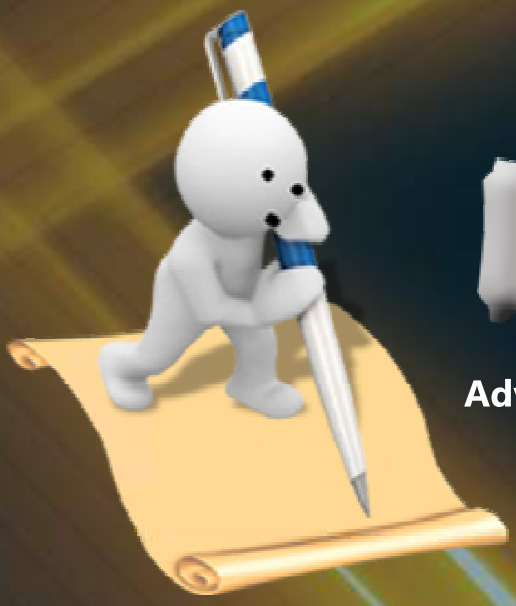
ABSTRACT: OCCUPATIONAL HEALTH HAZARDS IN MINES

Shri George John
Asst Director (OH), Director General of Mines Safety

The persons employed in the mines are exposed to a number of hazards at work, which adversely affect their health. Some of the important hazards are dust, noise, heat, humidity, vibration etc. In recent times, there has been increasing awareness among mining industry and the workers about occupational diseases such as Coal Worker's Pneumoconiosis, Silicosis, Hearing Impairment etc. caused by exposure to excess dust and noise etc., at work places.

A complete picture of the occupational health status in Indian Mines is not available and there is a strong need to undertake occupational health surveillance in a big way and as per the international standards and guidelines. This will help us in assessment of the situation and to identify the thrust areas in this regard.

Almost all the occupational diseases are known to cause permanent disablement and there is no effective treatment. However, most of the occupational diseases can be prevented by adopting proper precautionary measures and engineering controls at workplace.



Technical Session II

Advance Technology in Mining operation

CONTROLLED BLASTING AND GROUND VIBRATION ANALYSIS

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Dr. H S Venkatesh
Director, National Institute of Rock Mechanics, Bengaluru, Karnataka

Abstract

Study was conducted to find the frequency range of dynamic seismic waves induced due to blasting and its impact on the residential structures.Controlled surface blasting was carried out for accommodating various thermal power project components in varying geological condition. Blasting parameters were changed to collect various bands of particle velocity and its frequency. Analysis of blast induced ground vibration revealed that the frequency of monitored ground vibration was always greater than 14Hz in all the three directions. It was observed that blast vibrations changed due to change in rock strata and blastingin competent rock resulted in higher frequenciesand particle velocity. The results in this paper presented showthat blasting by small diameter holes (38 and 45mm) produces high frequency blast vibration even for very low particle velocity and the frequenciesgenerated does not fall in the natural frequency band of structure, which is a favorable condition for the residential structures.

Introduction

Blasting is always a major operation in any excavation related activity with its known advantages like user friendly and economically viability, whereas the concern is that the influence of blast vibration involved in the activity. Recent advanced technologies and its adoption have provided a wide range of acceptable results and also managed the prime factors like ground vibration and its frequency range that influence the structure stability. In this paper, the results of ground vibration produced by controlled blasting carried out for construction of thermal power project are discussed and the range of frequency that was produced for various blasting parameters are analysed.

Natural frequency of structures

The structure develops inertia force when it is excited by dynamic loads like blasting seismic waves. At higher frequency range, individual components of the structure tends to vibrate where as in low frequency range, the vibration may cause movement of entire structure due to high shear stress. If a structure is subjected to vibration at its natural frequency, the displacements at the structure will be maximum which leads to induced stress in the structure. Stiffer the building increases the natural frequency of the building and vise-versa. The natural frequency of any structure falls in the range of 4 to 16 Hz (Dowding et. al. 1980, Adhikari et. al. 1989, Pal

Roy, 1998, P K Singh, 1998, Siskind et. al., 1996).

Buildings surrounding the study area was not same as each other and each structure hadvarying span, height and nature of construction which defined its natural frequency. The structures surrounding the study area were of one to three stories building of different construction material (Figure 1). The natural frequencies were estimated by considering the physical characteristics of the structure which varied from 5Hz to 8Hz.

Figure1. Blast location and close by structure.

Blasting parameters

Blasting was carried out to accommodate various components for construction of thermal power project. The maximum depth of strata excavated is 5m from the surface level. The geological strength parameters of the strata was studied andthe strata in the excavation area falls inthe range of Class-IIIwith respect to geological strength index.Hard rock patches were observed in the excavation area.

Jack hammer (38mm diameter) and crawler mounted drillmachine (45mm diameter) was used to drill the holes to a maximum depth of 2.5m. Holes were charged with 25mm and 40mm diameter cartridges and initiated using non electric shock tube/nonelinitiation system. The details of blast parameters are given in Table 1.The charge factor maintained was about 0.4 to 0.5kg/m3. The bench was formed by removing the toe for almost all the blast and the blasts carried out was systematically designed, executed and monitored. Whenever the blasting was carried out in close proximity to the structures, blasting mats were used for muffling the blasting area (Venkatesh H S et. al., 2013).

Table1. Blasting parameters

Hole diameter	32/45mm
Hole depth	1.5/2.5m
Burden and spacing	0.7 to 1m/ 0.8 to 1.2m
Explosive	25mm/40mm cartridge
Initiation system	Non electric initiation system combination of 17/25/42ms, 250ms TLD
Charge factor Muffling	0.4-0.5kg/m3 Blasting rubber mats

Blast vibration

The blast induced ground vibrations were captured using standard tri-axialtransducer (Minimate plus model from Instantel). The main advantage of this instrument over the Micromate from Instantel is the low frequency response range (2Hz). The ground vibration wascaptured at different distances from the blast location. Transducer was fixed in the ground as per the guidelines provided by International Society of Explosive

Engineering (ISEE)(Anon, 1998). It was ensured that the geophone is buried inside the ground to get good coupling and with an intension that it shall capture actual ground vibration. Event trigger threshold limit was fixed at 0.51mm/s so that not to miss any small vibration data and the sensor check was performed prior to each blast data collection. For each blast, three peak particle velocity data and subsequent frequency was recorded in longitudinal, transverse and vertical directions. The monitored data wasanalysed and finally peak vector sum was derived for each blast.

Peak particle velocity and frequency analysis

Blast vibration involves ground vibration in the form of peak particle velocity. The main parameter that influence the peak particle velocity is frequency and is directly associated with the type of structure and its natural frequency (Singh P K et. al., 2010). It is universally know that the low frequency is the main root cause for structure instability and may lead to damage the structures. In more complex waveforms, the dominant frequency is not necessarily the frequency at the peak particle velocity but at the frequency at greater amplitude (Lighthill M J, 1980). In India, Director General Mines Safety (DGMS) has regulated the peak particle velocity with reference to frequency and the type of structures which is subjected to ground vibration (Anon, 1997) and most of the international standards consider peak particle velocity and frequency as main parameters for fixing the blast induced standards (Anderson D A, 1993). According to the regulations, the structures are allowed to subject to higher peak particle velocity with higher frequency (Anon, 1998).

The primary goal of the study was to verify the blast vibrations frequency so that they are not falling in natural frequency band of surrounding structures. The natural frequency of the surrounding structures were estimated using its physical characteristics. The blast vibrations waveform was analyzed using advanced Blastware software. Each blast was analysed for peak particle velocity and its subsequent dominant frequency in all the three perpendicular directions (Figure 2a). From the analysis it was found that the recorded particle velocity were very less for the natural frequency band of structures (Figure 2b).

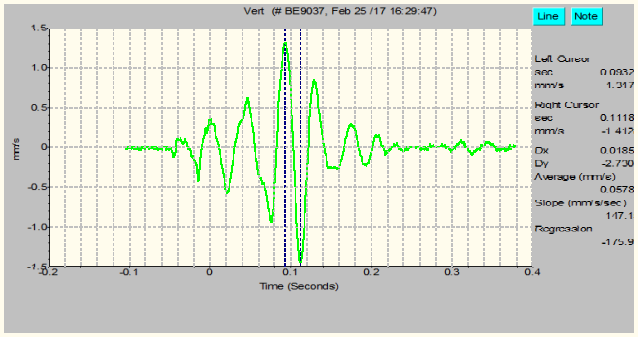

Figure 2 a. Analysis of blast vibration using advanced blastware software.

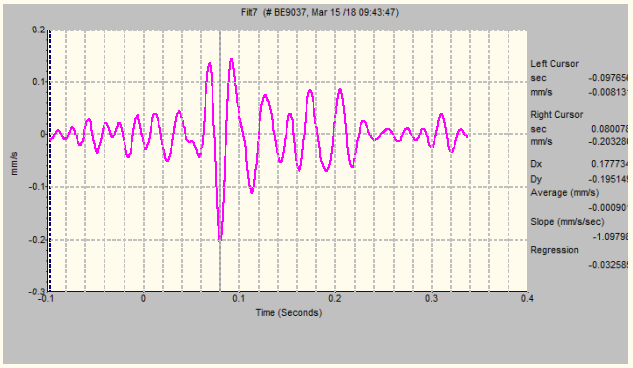

Figure 2b. Analysis showing particle velocity and frequency band.

The recorded frequencies were in the range between 14Hz to 170Hz in all the longitudinal, transverse and vertical directions (Figure3)

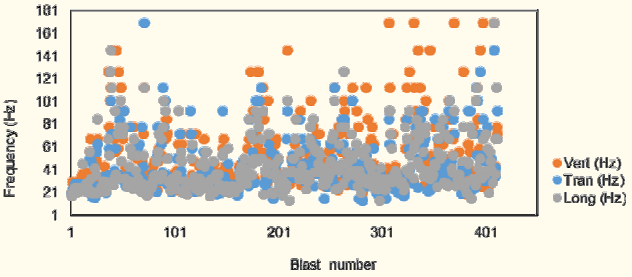

Figure3. Plot showing frequencies recorded for different blast.

The ground vibration is directly linked to the charge quantity (Blair D P, 2014). In line with this Siskindet. al. (1980b) states that the damage levels are directly related to the largest singlecomponent peak particle velocity and its dominant frequency. Form the study it was observed that evenlowest peak particle velocity of 0.55mm/s was associated with high frequency of 170Hz and linear trend of increase in frequency for increased peak particle velocity was noticed (Figure 4).

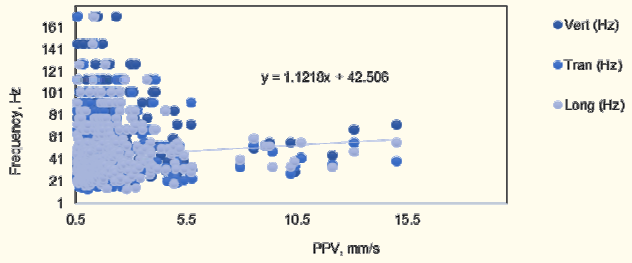

Figure4 Plot of Peak Particle Velocity vs Frequency.

Higher frequency components in a signal will be attenuated more quickly than lower frequency components over a travelling distance (Blair, 1990). From the plot of distance vs frequency(Figure 5), it was observed that the frequency of vibration reduced with respect to increase in distance. Even though the matter is not a much concern in the present study due to higher frequency band when compared to natural frequency of the surrounding structure. The trend may influence on the stability of the structures at far distance where the frequency matches with the natural frequency of the structure for small peak particle velocity.

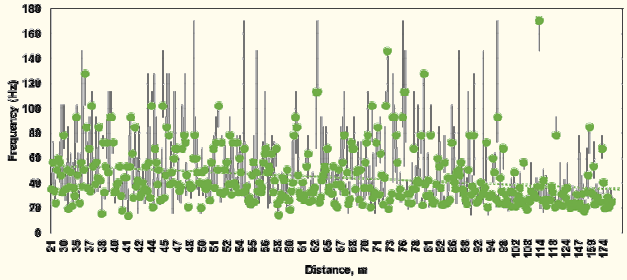

Figure 3. Plot showing frequencies recorded for different blast.

Influence of geological conditionson frequency

The results of this study found that the frequency of the peak particle velocity and its frequency also has an influence on energy released by the explosive charge and the transmitting media (Blair D P, 2014). Siskind et al (1989) suggests that as distance from the shot increases, the particular influence of blast design is filtered out by transmission through the ground. Low frequency ground vibrations were recorded when blasting was carried out in disintegrated rock strata and higher range of frequency was recorded for higher particle velocity when blasting was carried out in competent rock (Figure 6) thereby proving that damage from blasting competent rock is less when compared to blasting disintegrated rock strata.The

characteristic frequencies of the ground will tend to dominate the waveform since they propagate most efficiently. It was also observed that when the monitoring stations were located in disintegrated strata, the resistance to travel of seismic waves generated low frequency ground vibrations. It was also observed that the distance is not always related to the ground vibration whereas geological structures/failure planes also influence the frequency of the ground vibration.

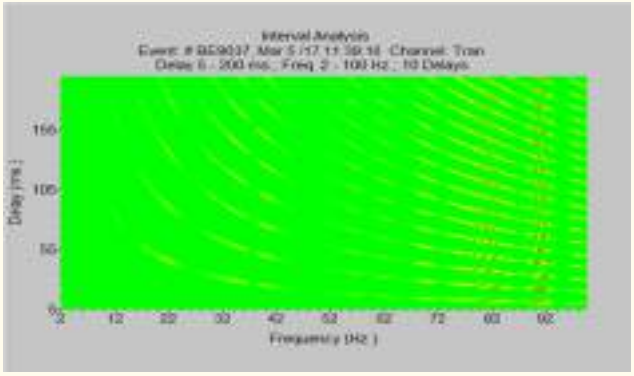

Figure6 Frequencyof ground vibration obtained when blasting in competent rock.

Conclusion

1. The findings of this study revealed that the frequency is mainly depended on the maximum charge per delay. Small quantity explosive detonated produced high frequency ground vibrations which was always greater than 14 Hz and not falls in the range of natural frequency of the structures.

2. The study also indicated that the blasting vibration changes numerously due to change in rock strata and also depends on direction of monitoring station. Higher frequency was recorded for higher particle velocity when blasting competent rock.

3. The general tendency of reduction in frequency with respect to increase in distance was observed. Very low particle velocity was recoded in lower frequency band which was not a concern in terms of structure stability.

4. Use of non-electric shock tube initiation have led to minimize the scattering effect of delay which is very much essential in avoiding the unexpected ground vibrationsand is more effective means to control the damage of the structures.

5. The outcome of the analysis made way to continue with the followed technique since the measured data was safer with respect to the structure stability. Even though the test results found to be more appropriate, case studies shall be carried in similar condition as the results are site specific.

Acknowledgments

The authors would like to acknowledge Director, NIRM for giving opportunity for taking up the studies at DSTPP, Odisha. The authors also acknowledge the contribution of MrA I Theresraj, former Sr. Scientist, NIRM for his technical support and Mr. K G Gowtham in data collection. The authors convey thankful regards to NTPC officers and management for their kind support during field studies.

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DIGITAL TRANSFORMATION IN MINING INDUSTRY

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Mining has witnessed tremendous technology driven changes in the recent past and today it is strongly focused on automation, integrated mining systems, and an improved utilization of assets by increasing machine performance.

- Mining industry leaders are increasingly using Centralized data repository with artificial intelligence and deep learning technology to give mine managements the capability to model, monitor and analyze the entire mining value stream, which includes:

- Environment, Health and Safety
- Prospecting & Mine Planning
- Mining Operations
- Drilling & Blasting
- Loading and Hauling
- Ore Processing
- Ore Transportation Logistics (Road, Rail etc.)
- Sales and distribution
- Enterprise Functions

In order to derive an appropriate solution to integrate these business activities and to focus on the measurable and relevant business outcomes, mining industry is moving towards a state-of–the-art Integrated Virtual Control Centre for Centralized monitoring of key KPI's of entire mining value chain. This integration is the amalgamation of the AI and Digital technologies, which provides professional remote management environment with an eagle eye. This can help the industry in increasing operational efficiency, equipment availability & utilization, and improvement in productivity, and other performance parameters by taking decisions at the right time based on right information. This enables miners to better understand the operation and embed productivity improvements through dynamic planning and scheduling, dynamic dispatch, and blending, based on customer order and market economics.

APPLICATION OF MINE PLANNING SOFTWARE IN OPEN PIT EQUIPMENT SCHEDULING

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Abstract:

During the last few years, most of the mining companies in India have been under enormous pressure to improve their top-line growth and bottom-line savings. As a result, many companies are turning to systems and information technologies that can help optimise their supply chain activities. In this paper, we discuss the application of Mine planning software in open pit equipment scheduling.. The objective is to generate a plan that meets the quality and tonnage targets by utilising the provided equipment and resources.

Introduction

Mining is a highly variable industry, starting with various uncertainty like nature of the deposit, commodity price and demand. In order to address the above issues digital technology are playing a great role to address the issues and guide the mines to acquire control on the mining operations.

Currently Indian mining industry are in the process of transition due to various initiative taken by Govt. of India. At this stage it is most important to adopt latest ditial technology to address the correct issues in order to maintain a global standard in the mining operation. Mining process start with identifying the depost followed by exploration , resource and reserve estimation , production and finally with mine closure.

In this paper we have addressed all the above required process through application of Mine planning software alone with major focus on the application efficient equipment scheduling.

Modeling of the deposit:

Geovia Surpac is an integrated geology, resource modeling, mine planning and production software. Surpac enables mining practitioners to quantify and evaluate mineral deposits and to plan the efficient extraction of reserves. Surpac has a important merit that it can build refined three-dimensional geological model using various estimation methods like inverse distance method, ordinary krigging, etc. The refined model can veritably correspond the stratum, lithological character, geological structure and material types.

Pit Optimisation:

Refined 3D resource model will be exported to Geovia Whittle (Strategic Mine Planning Software) to evaluate the financial viability and the optimal mine strategy for the

deposit. With Whittle, user will have all the strategic mine planning capabilities need to achieve mine optimisation like strategic scheduling, detailed cost, price and recovery modeling, stockpiles, multiple mines, blending and cut-off optimisation. Based on the revenue factor, cash flow results and other financial parameters in Whittle, a pit shell will be selected which defines the shape, size, stripping ratio and life of the pit.

Pit Design:

Based on the pit shell from Whittle, the ultimate pit/pushbacks can be designed with all-cut/circular ramp in Surpac software. Further, waste dump and stockpile can be designed in Surpac to accommodate the material exploited from the pit. These designs will be used to schedule the pit for short-term or long-term planning.

Scheduling:

Mining companies have moved from the use of mathematical models (excel spreadsheet) to a more sophisticated graphical and spreadsheet methods of scheduling as their operations have become more complex and the use of only spreadsheets may be risky as one cannot determine which portion within the flitch is being mined.

Geovia MineSched is the most innovative scheduling software for mining which puts the mining practitioners in the driver's seat to maximise productivity and profits.MineSched is employed by surface and underground mining operations of all types and sizes to produce long-term and short-term schedules that meet capacity and material quality targets.

Its benefits are follows:

- It operates in familiar environments as
- Microsoft excel
- Microsoft project interface
- 3D viewing, validation and animation
- Process is user controlled Priority and sequencing rules are easy to set
- Shortfalls or risks are brought to the fore for resolution.

In terms of the time horizon, there can be operational, short-term, medium-term, long-term planning (LTP), and LOM planning. The operational and short-term planning involve a very detailed scheduling of processes and equipment, where it is important to know what each piece of equipment should be doing during each day and even each hour.

The number of excavators and production rates, and capacities of wastedumps and stockpiles can be different across time periods. In addition, each time period has its targets (Tonnage and Quality) which can be understood as a milestone to be reached at the end of the period.

One powerful feature of MineSched is its ability to automatically create the graphical output that shows where mining has taken place for each scheduling time period, in the form of a three-dimensional solid. The mining sequence can be shown animated on-screen. Reports in minesched are generated with production tonnage and grade data output for each time period. These reports can be presented in Microsoft Excel and their formats are flexible and user-defined. Templates are generally created so that report quality tables and graphs directly linked to the Minesched raw results can be

studied and printed immediately upon completion of the Minesched scheduling run.

Open Pit Equipment scheduling:

MineSched assists all open-pit Mine Planning Engineers in their haulage planning to save time, especially on sites that involve long and complex haulage routes.

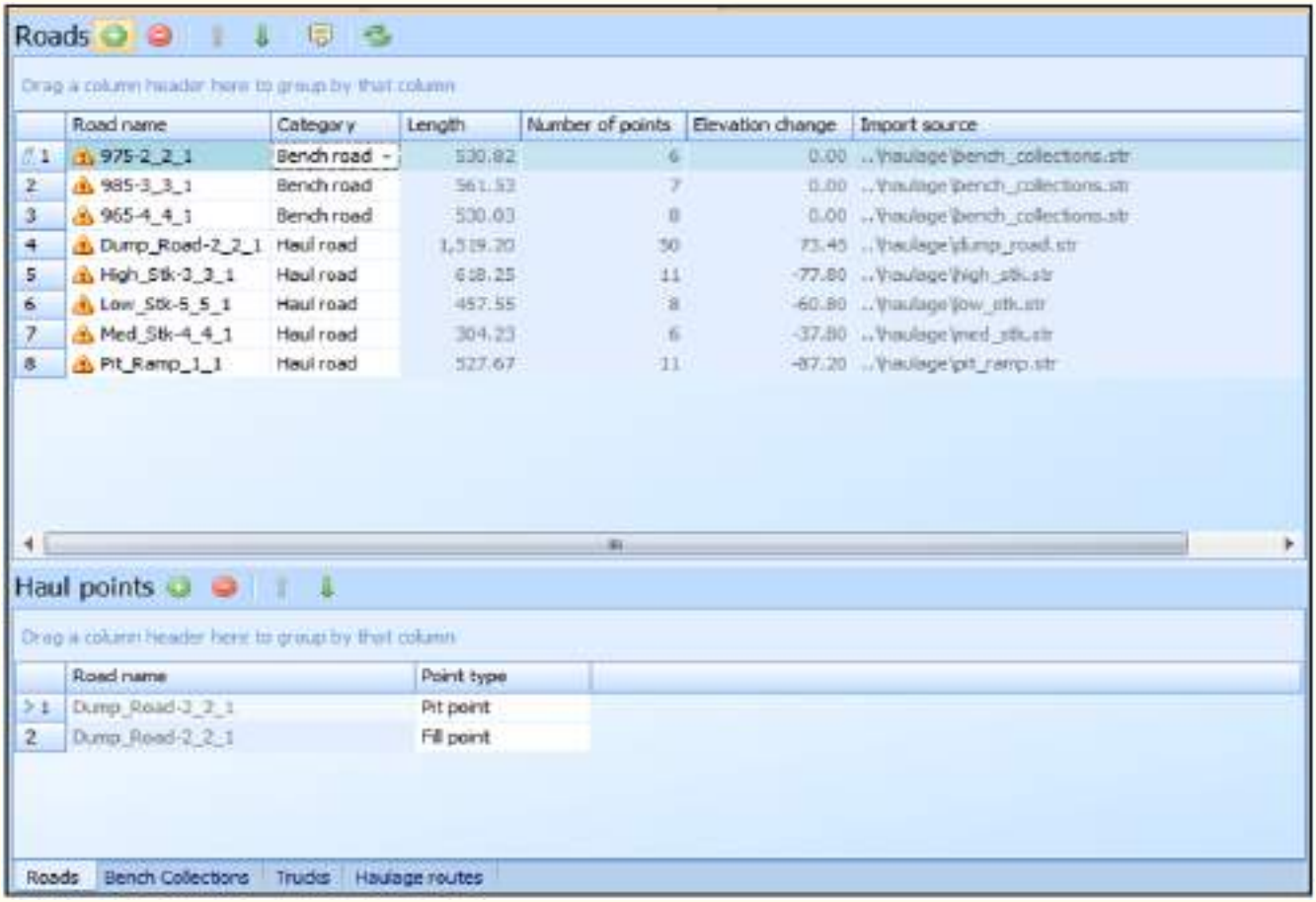
A Planning Engineer can:

1. Import individual haul roads and use these roads to build haulage routes. The benefit of this process is that each road is associated with any number of haulage routes, which removes the need to trace along a haulage route prior to importing data to MineSched.

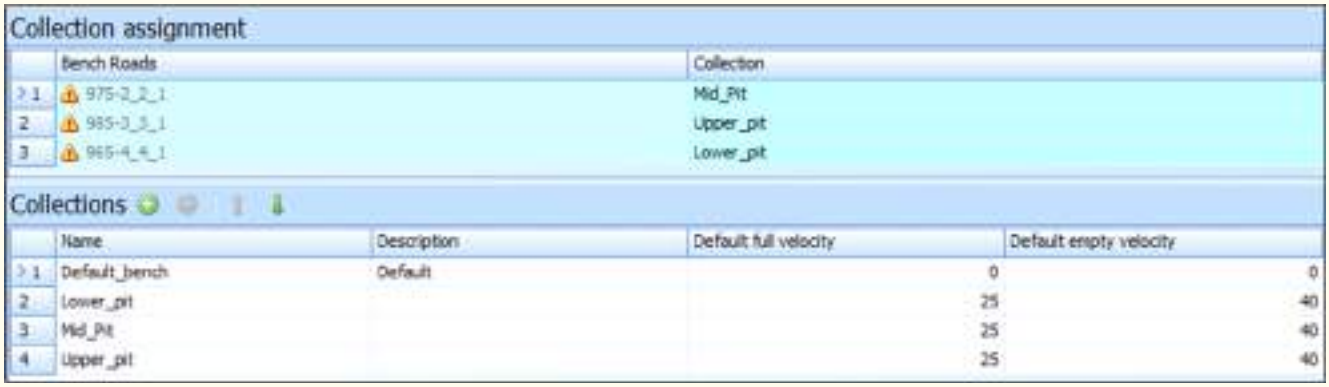
2. Define bench roads, which control the path of a truck from the working face through to the haulage route. This provides a more practical haulage route definition. Bench roads can be grouped into collections, so a large number of bench roads can be easily associated with a haulage route. The below image illustrates the defined haulage route with bench roads.

1. Haulage Canvas in MineSched

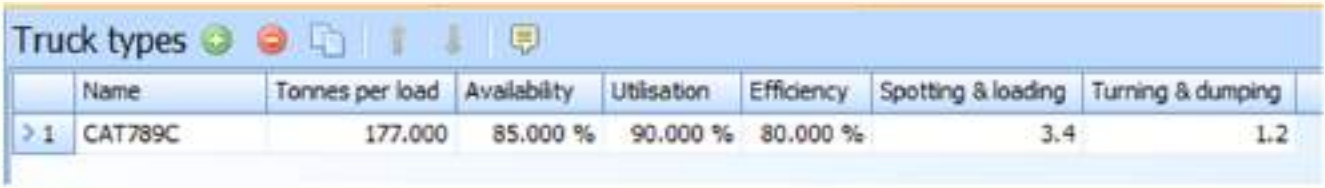
3. Link haul roads to the source data. If changes are made to the haulage design, or any haulage properties (e.g. full or empty velocities), the impacted roads are flagged in the Roads tab and a Refresh function has been created to update the haulage routes defined in MineSched. Different parameters are added in minesched to genates report on the utilization of the equipment as per tonnage and time etc



2. Adding Haul/Bench Roads and Haul Points



3. Assigning Bench road position and Truck Velocity (Full/Empty)

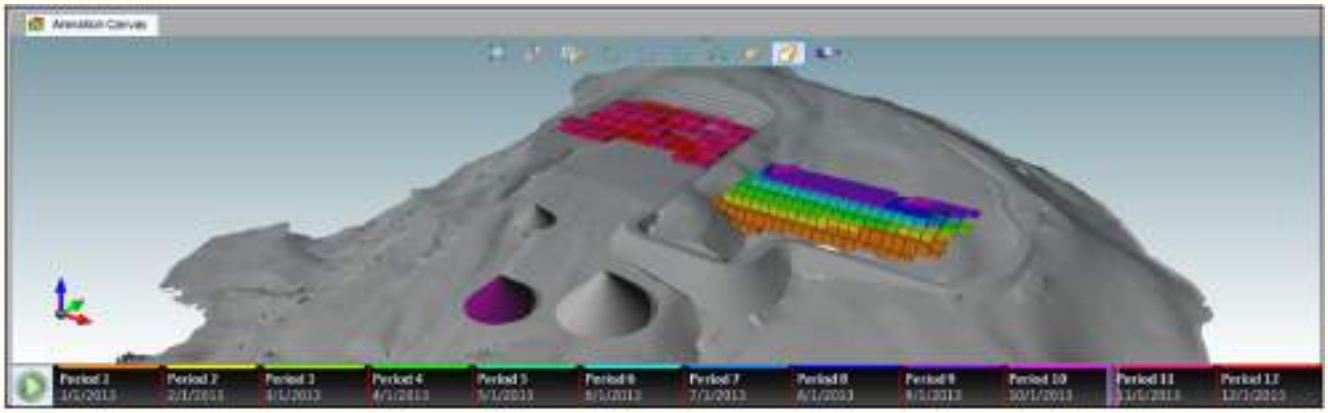


4. Adding Trucks and its parameters

Haulage routes

	Route name	Truck	In use
1	TO_DUMP	CAT789C	Yes
2	TO_LOW	CAT789C	Yes
3	TO_MED	CAT789C	Yes
4	TO_HIGH	CAT789C	Yes

5. Assigning Haul routes to Truck(s)



6. Blocks in Pit/Dump with Stockpile capacity at a period

Material Movement | TKM by Gradient | Truck Hours | Trucks Required (CAT789C)

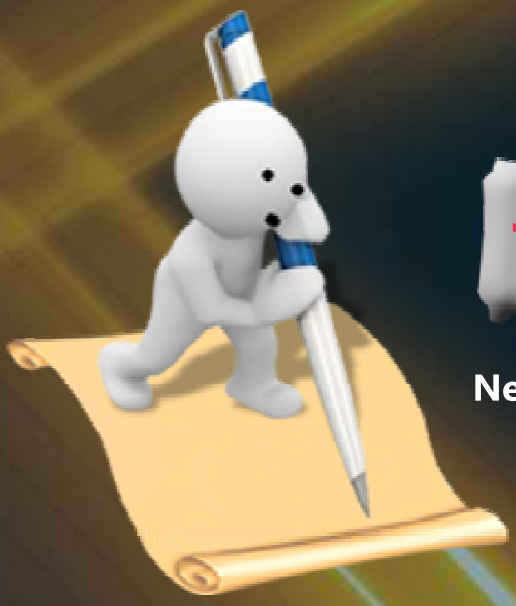
Period Number	TRUCKS removed from PIT	TRUCK_HOURS removed from PIT
1	4,907	2,234
2	3,981	1,637
3	4,017	1,829
4	3,997	1,761
5	3,745	1,705
6	3,909	1,722
7	3,880	1,767
8	3,758	1,711
9	3,510	1,547
10	2,776	1,264
11	2,868	1,264
12	2,184	994

7. Report showing Trucks required per period and Truck hours per period

Conclusion:

By deploying best practice mine planning, scheduling and process improvements, miners will reap direct and indirect cost savings, and become more productive, predictable and profitable. Each mine is different, but key to deploying best practices is the use of a modern integrated mine planning and scheduling solution that can keep pace with the incoming mine data, ensure accuracy, accelerate mine modelling and plan output, facilitate information sharing, enable the mining of complex geographic areas, and free up valuable human resources to focus on continual improvement and operational excellence.

Use of Mine planning software play a key role in the mining operation. It has the potential to make the production engineers and managers focus on exact utilization of the equipment involved in the production plan to modify as per the reqirement .Mine planning software can integrated with different other applications such as Truck dispatch system as well as ERP solutions for better monitoring of the production with quality and quantity wise.



Technical Session III

New Trends in Exploration in Strategic & Rare Earth Minerals

DRONE/ UAVS SURVEYS –FLYING INTO 'TOMORROW'S MINE'

Shri Cyriac Joseph, Dr. DN Gulhane, Partners
Shri Gaius TJ
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Introduction:

In today's world "Change" is the key. And this change is happening at a very rapid pace in all sectors, be it Scientific Research, IT, Manufacturing, Agriculture, Forestry, etc. So is the same in the Mining world, particularly at this moment when the Mining industry in India and the world over is transiting through a difficult period not only on account of the volatile prices of the mineral commodity, but also due to the change in environmental norms and the stringent Government policies. The Governments are making major changes in the policies to ensure mineral security, encourage exploration of new areas, development of new and virgin deposits and to bring about efficient, eco-friendly and sustainable development of the mining projects.

The current situation has seriously affected mining companies including the global majors like BHP Billiton, Rio Tinto, Vale, Anglo Gold, etc. The situation has prompted numerous Mergers and Acquisitions and also, Restructuring of existing businesses, based on the financial constraints, logistics and geographical reach of the various projects held by various companies. While some of the companies are moving into new arenas, there are a number of companies, switching back to their organic business based on their competence and reach.

Thus, the Mining industry is under tremendous pressure to beat this bottom of the cycle situation. In the meantime this adversity is also turning into an opportunity to find innovative ways and means to endure these hard times, triggering techniques, policies and technology to ensure cost effective operations, while enhancing, productivity, safety and working conditions at the mines.

Gone are the days where we could take ages to prospect, explore and develop mineral deposits. The Governments are making major changes in the policies to bring about efficient and sustainable development of the mining projects, as this sector is a major contributor to the GDP of the country, while providing large scale employment and socio-economic development of the backward regions in which these mineral deposits are situated.

The recent-Mines and Minerals (Development & Regulation) Amendment Act 2015 and The Coal Mines (special

provisions) Act, 2015, and the subsequent Rules and regulations, introduced by the present Government of India, has brought about a huge shift in the policy for the grant of Mining lease through the Auction process - a shift from the traditional allocation system of Mining Leases, in India. This policy/ system calls for quick and accurate data availability for the realistic evaluation and development of the mineral deposits and also to obtain the statutory clearances like Mining plan, Forest Clearances, Environment clearances, etc.,by the successful bidders.The traditional methods of survey and exploration and Mine development has to be fast tracked to make available timely and reliable data to ensure that the projects are delivered on time without cost overruns and, with due importance to safety, environment and sustainable development.

Thus the application of the latest technology and innovation is inevitable not only because of the need for the implementation of these technologies, but also on account of the formidable benefits these innovations and technologies brings into the industry.

The 'Takeoff':

Unmanned Aerial Vehicles (UAVs) / Drones are turning the mining sector into an emerging frontier for new technology. Flying these small drones and obtaining the output using Photogrammetry is gaining momentum. In recent years, these miniature helicopters have helped the industry find cheaper and safer ways to map deposit sites and explore for minerals viaRemote control.

Drones have proven themselves as an efficient platform for the replacement for traditional backbreaking ground based survey methods. They go beyond surveying, giving 3D (ortho) images and videos of the sites. LiDAR, Thermal sensors, Multispectral and Hyper spectral sensors capture images which have wide variety of uses, such as lineament mapping, topography, 3D modeling, geological feature extraction, volumetrics, mine planning & design, thermal anomalies, quantification of live vegetation (NDVI), land use land cover classification and its change detection,etc.

Eventually this would reshape the future of mining operations.

Unmanned Aerial Vehicles (UAVs) / Drone

There are different type of drones currently used for different applications, such as fixed wing system, multirotor system, and so-called hybrid systems, which have both multirotor and fixed-wing systems. Based on that purpose of aerial survey we can decide the payload and type of drone to be used. The main existing drone types are explained below.

Fixed Wings:

More like small airplanes they use their fixed wings in combination with forward speed to generate the lift (Fig.1), which need a small open space for take-off and landing; Used for land survey in large areas, also in agriculture, mining with high cruising speed as high as 80km/hour;Longer flight lengths and wind resistance is higher.

Fixed-Wing (Fig.1)

Multi-rotors:

More like a helicopter multi rotor drones uses their rotary wings to generate lift (Fig.2), vertical takeoff and landing, which can hover around; does not need a runway; Can be stopped mid-air and more accurate photography is possible; Speed is low at 50 km/hour, but speed is further lowered to 25 km/hour to get better aerial photos; Shorter Flight lengths, and wind resistance is quite lower.

Multi-rotors (Fig.2)

These devices are safe, easy to use and carry anywhere. Alongside, cost is one of the biggest benefits of drones as they are relatively cheaper than traditional helicopters andcan provide better results for a fraction of the cost for surveying new areas for mining companies.Surveying projects, using traditional land surveys, particularly in tough terrains, that used to take days and weeks are completed in few hours, facilitating faster collection of data enabling, quick decision making and investments.

The Sensors and Technology:

1. Photogrammetry:

The Drones capture high resolution photographs from multiple angles that are overlapped. By knowing the focal length, flying height and vertical exaggeration of the image it is possible to calculate all the spatial aspects on the ground with high degree of accuracy and precession. In the beginning of an aerial survey it is very vital to plan the flight line and set the interval of photography. Each adjacent image in same flight line should have minimum of 60-80% of overlap and 20% of side lap between the photos in the adjacent image (top and bottom flight line). In order to geo-reference and improve the accuracy of the geographic locations in each aerial photos sufficient number of GCP (ground control points) are marked on the groundby DGPS (Differential Global Positioning System). The latest drones are fitted with Rovers to accurately geo-reference the surveys without the GCPs.

These aerial images are stitched together to form a big mosaic of the Area of Interest (AoI). Finally themosaicsis processed using various software's to obtain 3D images and DEMs, DSMs, DTMs, etc. at very short time period. The accuracy of the digital imagery could be as close as 25mm to150mm.

2. LIDAR sensors:

A LIDAR (Light Detection and Ranging) sensor produces light energy in the form of a pulsed laser which is transmitted toward the ground surface and measures the time of return of the return pulse of light. The return time of each light pulse combined with other data recorded by the airborne system—generates precise, three-dimensional information of the surface characteristics. The output of these LIDAR surveys is known as LIDAR Point cloud data. These Lidar point cloud data can have a spatial resolution of few millimeters. Light is not a governing factor and could be taken even in the dark. Drones have proven them self as a effective platform for acquiring LIDAR data quickly and with great precision.

3. Thermal imaging Cameras:

All object in the world will absorb electromagnetic energy and re-emit in the thermal region. Thermal sensors will capture the re-emitted electromagnetic radiation by the object and record it. The infrared cameras measures and dispalays a 'thermal profile of objects in relation to the temperature of the surrounding objects. The thermal imaging cameras are independent of light, the surveys can be undertaken even in the dark.

4. Optical Sensor:

Optical sensors make use of visible, near Infrared and short wave infrared region of electromagnetic spectrum. This type of Aerial survey will help us in the creation of 3D models of earth terrain, Landuse, Land cover classification, calculation NDVI (Normalized vegetation Index), producing DEM (Digital Elevation Model) and so on. Most commonly these types of sensor are passive so they need solar radiation in order to carry out the survey operations. These are expensive and are used for specific and high-end surveys.

The Application:

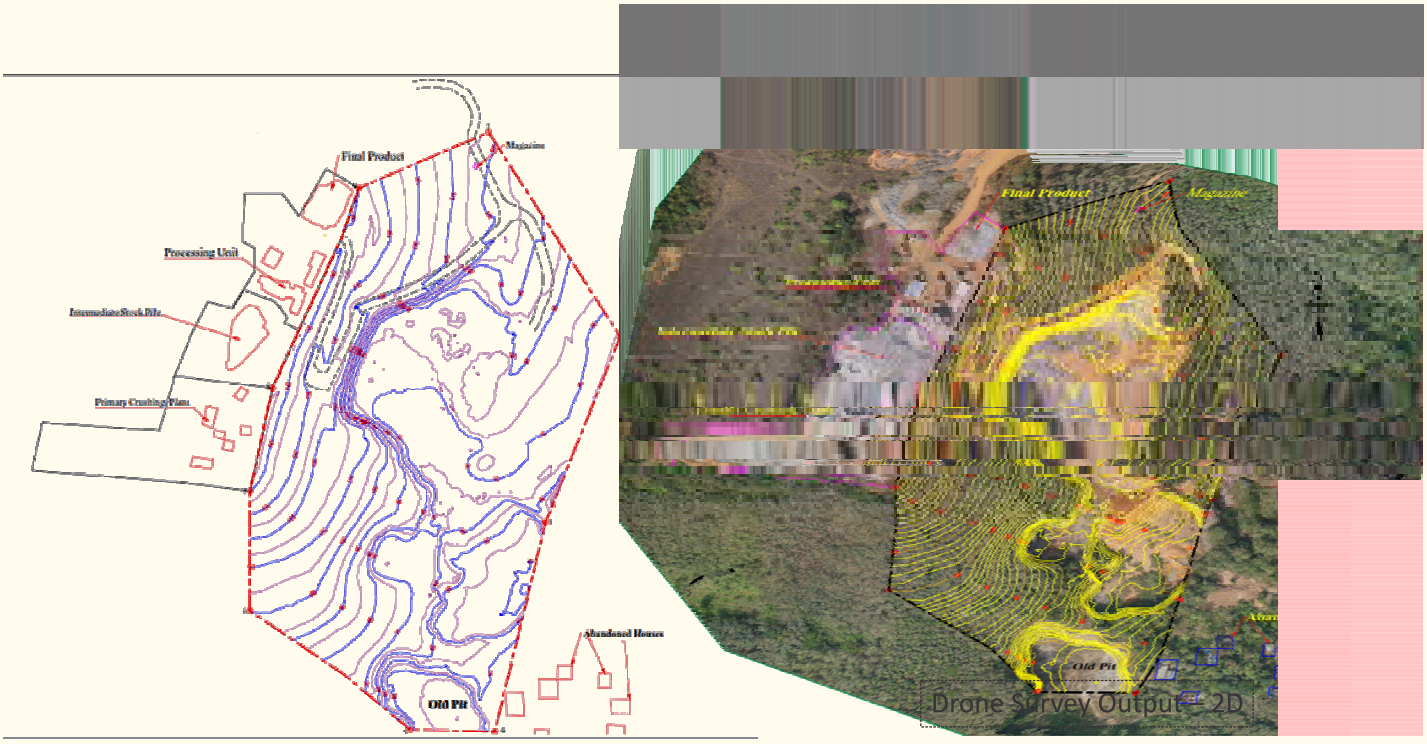
Drone-based data collection can boost safety, productivity, efficiency and cost effective operations. Surveying projects that once took days or weeks using traditional surveying techniques are now possible in just a few hours.

These are fantastic tools that not only fast tracks the process but also provide 3D outputs of the target area and may be processed to give a real-time hold of the projects for the surveyors, geologists, geophysicists, mine planners and environmental engineers. Thus, assisting in development of these projects quickly, safely and efficiently, bringing down the costs while providing the realistic and techno-economic situation of the projects.

Most importantly, drones can provide access to areas that are hard to reach and/or dangerous, such as old dumps during or after monsoon, unstable areas, survey of tailing ponds, marshy areas, below recent collapses, dense forest, vertical cliffs or hills, etc.

Plus, thanks to the drone's ability to collect data from above, there is no downtime required while surveyors move around a pit, as can be the case when using terrestrial surveying instruments.

Comparison of Traditional Survey Output and Drone Survey Output:



Traditional Survey Output

Drone Survey Output – 3D

The 3-D ortho-images and videos would give a 'Birds eye view' as well detailing, which will help the top management of the mining companies to understand the physical position of each and every inch of the mining lease. This would give an accurate image and a better understanding of the operations. Thus, monitoring and decision making by the top management becomes lot more easily, without being dependent on the reports and output from down below.

The Drone technology has started flying forward into the mining industry, the newly adopted technology can be utilized for a wide array of mining activities:

1. Topographic Surveys and 3D Models:

- Generating topographic and contour surveys in very difficult terrain and to easily &

quickly obtain 3D models – DEMs, DSMs, DTMs, of the Mining area.

• Details of every inch of the Mining lease area could be captured and reviewed any time. There would not be frequent necessity to return to the site even in case of any missed data.

• The high spatial resolution aerial images of the Mining lease area would provide the surface features, tree growth, Outcrops, Minerals stocks, drainage patterns and other surface details that includes the details of the terrain, boundary pillars, bench positions, haul roads, dumps and all other surface features of the mine.

2. Volumetric Calculations and Stockpile Management

• Volume calculations and reconcilia tion of ore and waste movement is a difficult task at most mine sites. Ground based survey techniques require surveyors to climb over and around stockpiles while being subject to weather and dust hazards

• Aerial surveying with drones completely removes the person from the work place and allows the surveying to take place without interrupting the mining process.

• Aerial surveys can take place on a regular schedule, allowing for accurate updates on the mining company's valuable assets.

3. Geological features and Mapping:

• The up-close, highly detailed images of outcrop, 3D surface models and the actual image of the entire mineral deposit area/ mining lease, including all surface geological features, gives the geologists a very handy tool for mapping, planning and execution of detailed exploration and ore reserve estimations.

• Prospecting and searching for mineral resources and deposits through the identification of spectral signatures of outcrops, rocks, vegetation and terrain

• Mapping of steep inaccessible slopes.

4. Mine Construction / Development:

• Development of detailed maps to assist the phases of planning and design of new mining sites and their infrastructures

• Production of Digital Terrain Models for the purposes of alignment of infrastructures in new projects, visualization of hydrographic networks of the site, deposits, and other hidden topographic information.

• Support and consultation for planning and designing infrastructures on mining sites

• Topography and terrain exploration with the aim of determining the appropriate mining method and technologies

• Assessment of the progress of mine construction and development and Project monitoring &reporting.

5. Short-term planning

• Pit & dump management according to the slope stability.

• Communication of daily/weekly mining plans

• Haul route surface optimization

• Multi temporal data can help in the Storm damage assessment & control.

6. Long-term planning

• Haul road, dump and pit design

• Geotechnical

• Surface stability monitoring

7. Environmental

• Identification of flora and fauna present in the mining area.

• Identification of landuse, land cover

and the quantification of total lie vegetation present in the mining area.

- By acquiring regular aerial survey data the mining operation can ensure environmental compliance to local regulations.
- Land use can be monitored and any encroachment on company property quickly detected
- Erosion detection
- By the help of multi-temporal data the year wise afforestation can be monitored. Reduction in the NIR reflectance of the afforested area indicates the diseased vegetation so that we can give proper precautions before it's too late.
- Inundation tracking
- Surrounding community tracking

8. Mine Inspections:

- Mining companies are required to inspect: Tailing Dams, Waste dumps, old workings and benches, unused roads, unstable areas particularly during monsoon, etc.
- Previously inspections had to be carried out by people in often hazardous conditions. By using drones to capture video and images, regular inspections can be carried out safely and cheaply.
- Compliance of a large number of IBM, DGMS, R&R and other statutory guidelines can be observed and archived aerially using the technology.

9. Mine Safety and Risk Assessment:

- The drone surveys could be of great advantage in capturing, identifying and assessing the risks of hazardous areas and workingsin the mines.
- This would be of great assistance in the meticulous planning and the development of the safety systems and in inspecting/monitoring the hazardous areas and the safety systems in the mines.
- The ortho-images and the real-time monitoring would give good insight and data of the areas that are not easily approachable mentioned above, and are not regularly captured by traditional survey techniques.

10. Mine Rescue Operations:

- The application of the drone surveys is incomparable during Mine accidents and Rescue operations, particularly when these accidents pose serious threat to the Rescue personnel.
- Planning and executing of the rescue operations and undertaking immediate precautionary/ control measures to avoid any further damage or causalities.

11. Greenfield Project– Monitoring of Land Acquisition and Rehabilitation Work

- To capture high-quality images of the land being acquired and integrate data (social metrics) onto the land-category (forest, revenue, private) and individual houses, etc.
- Spatial summary for each village.

12. Ground Research for R & R

- High resolution Drone-Data for the villages will help in archiving the on-ground–information about the area before and after the R&R activities.
- Total area under tree cover/canopy
- Classification of land area of Government lands, farmlands, private lands, etc.
- House count - ID allocation, information about area of the houses along with census data

• Infrastructure in the villages: community wells, places of worship, schools, etc.

• Land use change pattern.

13. Monitoring illegal mining and activities by Regulatory Authorities and Government Agencies:

• Surveillance of Mining areas, by periodic surveys using this technology by Government Agencies and Statutory authorities could check and control illegal mining/activities areas surrounding Mining areas.

• Quick assessment of the violation and illegal activities surrounding mining areas.

Conclusion:

Drones are beginning to take flight into the mining industry in India and the world over.

This technology would be a key player in making "Tomorrow's Mine a Digital and Safe Mine".

With the economic realities facing the mining industry right now, and given the formidable benefits that this technology brings into the mining industry, UAV/ Drone surveying is a step that mining properties cannot afford skip, else it would definitely be a missed flight!!

Finally, a major boost for the drone industry in India, Shri. Piyush Goyal, Honorable Minister of Railways and Coal, has in January 2017, asked all state governments and the public sector mining units "explore the usage and deployment of drone technology" in their respective organizations."

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RARE EARTH MINERALS : EXPLORATION AND STRATEGY

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Rare earth bearing minerals are broadly represented either by light rare earth elements (LREE) starting from lanthanum to europium(including scandium) or heavy rare earth elements (HREE) covering gadolinium to lutetium (including yttrium) with the divide falling between the unpaired and paired electrons in the specific 4f shell. Global REE resources are dominant of the LREE and a study indicated that the ratio of LREE to HREE of such resources is about 13:1 The REE minerals are found in nature in the form of oxides, carbonates, phosphates and silicates.

The rare earth minerals occur in magmatic, hydrothermal and supergene environments. Rare earths are found in pegmatites, alkaline complexes, bauxite / laterites, phosphorite, ionic adsorption clay, placers, IOCG (iron oxide-copper-gold) and heavy mineral beach sands. There are only a few minerals like bastnaesite, ancylite, lanthanite, monazite, parisite, carbocernaite, apatite, britholite, burbankite and ionic adsorption clays, that are commercially mined for rare earths. Prior to discovery of carbonatite-hosted REE deposits, the entire production was from monazite within beach-sand operations from India and Brazil, as leading producers. Since monazite is also source of thorium, the potential radioactivities of tailings have rendered it unacceptable as commercial ore in most parts of the world. Carbonatite, a mantle derived magmatic rock with >50% carbonate minerals, is the dominant host rock for REO (rare earth oxide). Globally there are 527 carbonatite occurrences with 49 of these being extrusive, ranging in age from Archean to present. Most of the extrusive carbonatite are pyroclastic in nature. There are 140 REE deposits being explored out of which only 12 deposits have >1% REO. About 70% of REO is globally extracted from bastnaesite due to low risk of radioactive waste management.

China is the largest producer (>97% export of world) and has currently >50% of total global resource of REO. USA has 11.8% and India 2.8% resource (mostly from beach sands). The resource estimate of monazite from beach sand in India is 10.7 million

tonnes. The REE are characterised by high melting point, conductivity and thermal conductance. Due to their unique magnetic, fluorescent and chemical properties, REE are key components in hybrid rechargeable batteries, catalyst converter, glass, polishing, magnets, laser, components of colour TV, superconductors, ceramics and high end defence systems.

India has endogenic (carbonatites, pegmatites, alkali granites / syenites) and exogenic (beach sands and offshore placers) type rare earth deposits. There are 29 occurrences of carbonatites from India, out of which, Kamthai in Rajasthan has potential of world class deposit. At Kamthai, there is a bimodal distribution of rare earth minerals. The voluminous ore has carbocernaite (unique in world) as the dominant rare earth mineral, whereas subordinate reserves contain bastnaesite with ancylite / synchysite minerals.

DIFFERENT GEOLOGICAL SETTINGS OF STRATEGIC AND RARE EARTH MINERALS AND APPLICABLE EXPLORATION TECHNIQUES IN INDIA AND ABROAD

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Abstract

Strategic and rare earth minerals are found in specific rock types (e.g. carbonatites, alkali granites, rare-metal pegmatites and peralkaline-syenites) and distinct secondary environments (e.g., beach and riverine placers, specific clay horizons). The rare-earth carbonates (basnaesite, parisite, synchysite and others) along with pyrochlore (Nb-bearing) are mostly confined to carbonatites, whereas complex multiple oxides (columbite-tantalite, betafites and others) and silicates occur in peralkaline granites and syenites. Monazite-bearing placers along with other heavy minerals such as magnetite, ilmenite, garnet, sillimanite and zircon constitute the main REE mineral of interest. Columbite-tantalite, beryl, lepidolite and spodumene occur in rare-metal pegmatites related to alkali granites. Xenotime has been found as an important riverine placers derived from xenotime-bearing granitoids besides vein-like material in chlorite schist in shear zones.

Both these contrasting group of rocks and placers occur in fairly well defined geological and tectonic settings such as the deep continental rift zones, terrain boundaries and beaches with Archean and Proterozoic shield areas in the hinterland (e.g. Peninsular Indian shield and other shields of the world). Radioactivity due to U and Th-bearing minerals such as uraninite, thorianite, zircon, monazite, pyrochlore, betafite and others present in these rocks enable both air-borne and ground radiometric techniques as an important tool for exploration and discovery besides other conventional geophysical and geochemical methods. Some case studies from India and other countries are provided.

EXPLORATION SCENARIO OF POTASH IN INDIA AND THE ROAD MAP AHEAD

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Presented in the DGMS Karnataka Chapter Hosted Seminar/Workshop on Future trend of Mining Held in ISSC Bengaluru, 25-26 May 2018

Abstract

India's is dependent on total Import of potash. The country imported about 25 million tonnes of Murate of potash (MOP) during the period2010-2016.

In India, the only known occurrence of some relevance of potash deposits happens to be in the Nagaur-Hanumangarh-Ganganagar (NHG) Evaporite basin in NW Rajasthan. The existence of potash deposits in this evaporite basin was identified by GSI and they explored a vast evaporite basinal tract of almost 50000 sq km and brought their exploration results successfully to a stage of establishing exploration potential through their historical work which lasted for almost two decades (1973-1991)

The above work comprising of 72 boreholes and 60000 meterages of drilling allowed GSI to compute a broad reserve base of 404 million tonnes of probable and about 2000 million tonnes of possible reserves having an average grade projection of 4.7% K or about 5.2% K2O in the three subbasins. However, the above holistic and significant potash reserve projection notwithstanding and which rendered the probable and possible reserve apparently quite attractive yet on account of the leaner K2O grade profile, these potash resources of NWG basin of NW Rajasthan, till the present time remained techno commercially un-attractive for consideration of their eventual development

The reserve and grade projection data of GSI exploration work would merit significant complementary exploration efforts, particularly from the resource optimisation angle to render the latent potash resource potential of the sub basins attractive. The above need is primarily because of the erratic depositional pattern of the deposits particularly In regard to the potash bed thickness, their lateral continuity both in terms of the thickness and grade persistency.

In the present paper an attempt has been made to revisit the historical work of GSI and on the basis of the limited due diligence of the work and taking into cognisance the current techno commercial issues prevailing the potash project development scenarios globally and which are considered for their eventual fruition as successful projects have been reviewed and a complementary exploration model has been considered and elaborated.

Incidentally under the agies of the Special Committee of Promotional Projects-(SCPP) sponsored by Ministry of Mines, Government of India, MECL has been currently carrying out exploration work in some of the Depocenters (Jaitpur, Bharusari and Lakhasar). Similarly GSI is also currently engaged in revisiting one of the Depocenters in the potash bearing evaporite sub basin (Satipura) in the NW Rajasthan

Preamble

In a highly populated country like India, ensuring food security of its populace on a sustainable basis represents an area of major concern. One of the priority considerations therefore has been to enhance agricultural production keeping pace with the population growth of the country. In this respect the role of potash as a fertiliser nutrient and its application in a balanced form along with Nitrogenous and Phosphatic fertilisers in enhancing agricultural produce assumes enormous significance

Unfortunately India as on date is poorly placed on the potash front and is 100 percent reliant on the import of this commodity. India imported during the years 2015-16 a quantity of-3.243 million tonnes of MOP having 60% K2O content, a figure which by itself represents a relatively lesser import figure than the peak import figure of 6.357 million tonnes of MOP made during the year 2010-2011. Further during the period spanning from 2010-16, a total of 25.458Mt of MOP was imported (Source Fert Statistics-FAI)

Potash which is a generic term representing any salt of potassium mostly gets represented by the minerals like Sylvite/ Sylvinite/Polyhalite /and Carnallite. In view of the total dependence on import , potash constitutes a strategic mineral for India, and it is unfortunate that there is no indigenous exploitable potash resources to even compliment the partial requirement of this commodity.

The only potash occurrence of some relevance but of para marginal type deposit in N-W Rajasthan is currently being reinvestigated by GSI and MECL It is in the above context, re-evaluation of the historical exploration work of GSI on potash occurrences in the Nagaur-Hanumangarh –Ganganagar (NHG) evaporite basin in NW Rajasthan assumes significance

Brief narration of GSI exploration work in NHG evaporite basin

The potash bearing evaporite basin in the Rajasthan was explored in considerable details by GSI for about two decades (1974-91). The above historical exploration work of GSI in the NHG evaporite basin of Rajasthan remains till date as the only indigenous potash resources endowment of promise.

The sickle shaped NHG evaporite basin delimited by 1% K iso grade extends over an approximate distance of 130 km along the longer axis and about 25 km across. Within this evaporite basin occurs several relatively more concentrated zones of potash, defined as depocenters or subbasins, as have been shown in the map below

Fig 1 Map showing sickle shaped potash bearing evaporite basin incorporating several depo- centres of potash mineralisation

The Historical exploration work conducted by GSI can be briefly summarized as under. GSI drilled 72 drill holes involving about 60000m of drilling.The above investigation was complemented by Geophysical and Geochemical Survey

GSI's historical work enabled establishment of potash exploration potential in several sub-basins. Further in the three subbasins of Satipura, Bharusari and Lakhasar the exploration work was considered as detailed enough by GSI to upgrade some of the potash reserves in these three sub basins into Probable category from possible one. Together these three subbasins account for the entire probable reserve of 404 million tonnes and out of which half of total reserves are exclusively confined in the Satipura Basin.

The spatial extension of these subbasins, unlike their major global counterpart are however very small in dimensions with basin diameters ranging from 1 km to3 km. The potash mineralized sections in these

subbasins are generally restricted to the upper portion of halite cycles with a depth of burial of potash bearing beds ranging from around 470 to 750meters.

GSI projected a total reserve of 2474 million tonnes having 4.60% as the average K content including a probable reserve of over 404 million tonnes. The average grade of the probable reserve estimated was pegged at 4.7% K. The historic estimates of GSI reckoned a minimum bed thickness of 1.5 meters and a cut of grade of 3% K. The main potash mineral suits encountered are Polyhalite K2SO4, MgSO4, 2CaSO4,2H2O, Sylvite (KCL) Sylvinite, (KCL. NaCl), Carnallite (KCL,MgCl2,6H2O) Langbeinite (K2SO4M,2gSO4)

Potash, like phosphates, also has an episodic formational history over geological ages. Incidentally the Rajasthan potash, considered as of Eocambrian age reflects a geologically old age of the deposits. Because of this geological antiquity there could be possibilities that some of the contained potash got leached/dissolved/washed away partly or significantly

The stratigraphic column of the evaporite bearing basin is characterized dominantly by clastic and carbonate formations .In the middle of the stratigraphic column, a thick evaporite sequence ascribed as Hanseran Evaporite Group of Eco Cambrian age of (940-600) million years old has been encountered. Further GSI could identify and establish existence of seven halite cycles in the Hanseran Evaporite sequence.

The relevance of GSI Historical work

- Could etch out the existence of Potash bearing zones in a small curvilinear basin measuring 130 kmx25km approximately with one percent iso-grade line delimiting the outer limit of the potash bearing basin

- Establish the fact that the basin is characterized by existence of smaller sub-basin with relatively higher K concentration

- In absolute term however, the Rajasthan evaporite basin unfortunately as per the available exploration data has been inadequately profiled by nature in terms of Potash concentration in comparison to their global counter parts

Table given below are the historical potash resource estimates in summarized form in the three more propitious sub basins namely Satipura, Bharusari and Lakhasar assuming 3% K as cut-off grade and a minable bed thickness of 1.5 m

Name of the Sub Basins	Area(km2)	Reserves in Million tonnes		Grade as K%
		Probable	Possible	
Satipura	245.61	202.30	1429.95	4.80
Bharusari	71.00	88.16	300.15	4.68
Lakhasar	29.00	113.73	342.29	4.39

It will be apparent from the above table that while the historical reserve projection are not so insignificant , particularly in the backdrop of country's poor potash endowment status , the grade projections are at best can be reckoned as of Para marginal type. Further the uneven drill spacing based on which GSI projected the reserves would remain questionable on account of their NI 43 -101 non- compliant nature. It may not be out of context to mention that the above instrument is reckoned as the globally accepted yardstick to measure various stages of exploration progression particularly involving potash. It is a quasi-techno- legal instrument

Limiting factors acting in the way to attract investment for development of the only known potash occurrences in NWRajasthan.

Relatively leaner potash grade endowment, erratic behavior of the deposit –impersistant lateral continuity of the potash horizon, rapid lateral thickness and grade variation in the potash bearing beds, low potash content bearing Polyhalite being the dominant potash mineral phase and the evaporite basin being structurally disturbed with potash sub basins generally localized in the fault controlled troughs, are some of the general attributes of the sub-basins hosted potash resources

The independent Depocenters hitherto delineated in NHG evaporite basin are not only spatially localised but also do not show the features that normally characterise the major potash deposits globally .It is not without the reasons that the NHG basin hosted potash resources of India have not yet been found techno commercially attractive enough for consideration of their development by competent developers

Desirable Action plans for comple mentary exploration measure

Based on the critical review of the historical GSI data, working out a comprehensive study of the more propitious sub-basin for reinterpretation to consolidate the reserve grade projections in Satipura, Bharusari and Jaitpur and Lakhasar sub-basin will be an unavoidable necessity and would be the starting point of any complementary study.

The contemplated revalidation study should be geared to

- Ensure approaches that would allow for resource estimation by current industry standards of historical work of GSI through limited probing drill holes

- Find out the true reflection of the K2O profile in the sub basins as indicated in the historical GSI study.The current aim of any complementary exploration at the first instant would be to revalidate the GSI BH data by closed spaced check drills- particularly for defining the lateral continuity of K2O values in the bed as well as the bed thickness with the aim to work out a critical mass of the deposit that can be considered for their eventual development and exploitation feasibilities techno commercially

• Identify the distribution of potash mineralization pattern in the Rajasthan evaporite and explore the feasibility to develop the sub-basins as exploitable blocks(Auctionable)

The prime tool to effect the above mission is to be effected primarily by drilling whose radius of influence(ROI) may be limited even upto 500m aided by appropriate type of down the hole geophysical logging and surface geophysical survey

The revalidation study on a selective basis to reconfirm the accuracy of historical drill core potash values will be an unavoidable need and may have to be implemented on a mirror image close spaced drilling concept. The suggested approach gains further ground on account of the reported concern expressed even in certain GSI quarters about the possible dissolution of some more soluble potash salts in the drilling fluids. Such possibilities are to be eliminated since if even they are partially true, then they would have a significant impact resulting in under reporting of the true in situ potash values in the mineralized section encountered in the drill holes and consequently they would impact any follow up techno economic studies also

Difficulties of dovetailing the Historical exploration data within UNFC frame work

There have been some recent attempts to retrofit the pre UNFC phase exploration data e.g. possible and probable reserve in terms G4 and G3 category which has gained good level of acceptance in the Geo policy formulating bodies in the country. It is felt that the approach is fraught with significant element of difficulties. UNFC scheme is essentially applied in a prescriptive mould and the natural endowments like the one in the present case are not always inclined to tread the path of such prescriptions .As such drill spacing design involving the evaporite sub basins of NHG basin with highly erratic trait has to be considered on a deposit specific need basis and not by pre-conceived prescriptions

The fallacy of fixing numbers of drill holes requirements on a preconceived notion for a bedded deposit like potash can be highly misleading. Thus in the Elk point evaporite basin in the state of Saskatchewan, Canada, extending over a basin length of 600 Km and 200 km across, there are instances that based on very limited no of Bore Hole data say 20 numbers or so, investment running over2-3 billion US dollars have been committed. On the other hand the Holbrook evaporite basin in Arizona in USA having a potash bearing areas of 2000 sq km in a salt bearing basin areas of about 8000 square km It has taken over 150 number of Bore Holesto bring three tenements to stages of feasibility level investigation.

Conceivable resource optimisation module

Resource optimisation study based on historical bore holes and complemented by suitably located close spaced drill holes will yet be another unavoidable exploration module. The inherent under lying concept

would be to extend the sphere of influence or (Radius of influence of BH –ROI) from Known to Unknown potash value direction and in a much calibrated way

• The Historical results of 14 BH in Satipura, 10 BH in Bharusari and 4 BH in in Lakhasar areas indicated island of potash concentrated zones which would merit definitional drilling approach to delineate the subsurface extent of such zones. To start with 30 drill holes are anticipated as immediate requirement as infilling drill hole in the three subbasins of Satipura, Bharusari and Lakahsar

• On the above line of consideration of extending radius of influence (ROI) premise and with the purpose of delimiting the known zones of higher K% values in a calibrated way, some in-house exercise has already been initiated both by MECL and GSI

• The underlying philosophy of optimisation would be to pick up the more propitious and contiguous areas e.g. areas yielding over 5% K as indicated in the historical exploration work of GSI and ascertain with infilling probing bore holes about the lateral continuity of such propitious zones. It was also felt that with reducing the radius of influence of the probing bore hole data, the mineral resource position can be optimised appreciably and meaning fully

Mineralogy and processing angle

• Optimisation study should also take into consideration minimum average K or K2O content and the cut-off grade and also the potash mineralogy of the deposits since these elements along with ore body model will determine the future mining and processing module beside development of a preliminaryeconomic module.

• In the case of Rajasthan Evaporite basin, the dominant potash bearing mineral is polyhalite which is least K2O bearing salt mineral having K2O content of about 16% .This value virtually represents one fourth of the K2O content present in a pure sylvite mineral. It implies that as against one tonne of pure sylvite bearing potash ore, 4 tonnes of Polyhalite ore equivalent have to be mined and processed with their consequential bearings on mining and processing costs and also on the project economics .

Consideration of Bore hole requirement for complementation

The historical work of GSI premised on the indicated 72 nos of BH effectively had to cover a very large target area measuring over 50000 sq km and with the scout drilling approach, could successfully etch out a relatively small localised sickle shaped potash bearing areas. The drill hole spacing pattern deployed was uneven and not in a grid based manner. Thus there are areas in the NHG evaporite basin where the bore holes were relatively closely spaced with intervening distance of 1 to 2 km while in other areas the drill hole were driven at a much wider spacing more than 5 to 6 km apart

It needs to be appreciated that in a situation where the very sizes of the subbasins are ranging in diameter of 1-3 km, there will be an unavoidable necessity to have

very close spaced drilling - may be at 300-500m interval to etch out the true sub basin configurations and to get a better idea about the contained potash(K) resources. To that extent historical potash reserve position needs to be complemented with the desired number of infilling drilling

Necessity to render the NHG evaporite basin hosted resources National Instrument 43-101 Compliant

Potash exploration is a tricky and highly specialised business and therealised expertise is restricted to very limited entities globally. For GSI the historical exploration work in the NHG basin was their first time potash exploration venture and they had to overcome lot of challenges. Their scout drilling approach backed by geophysical and geochemical survey was effectively geared to establish the existence of exploitable potash resources and delimiting their sub surface extensions. To the credit of GSI it must be said that they were not only successful in establishing the presence of potash in the NHG evaporite basin of Rajasthan but also effectively indicated the potash exploration potential of the defined subbasins

In retrospect it would be worthwhile to consider introduction of some measures that would render the GSI's historical work more meaningful

In the domain of exploration of potash in virgin areas, the deep large diameter and costly drilling exercise extending in some cases upto 2km depth is mostly preceded by geophysical exercise involving seismic and followed by down hole radiometric surveys .Reflection seismic methods have been invariably used to delineate salt structures and layers on the basis of the seismic signatures. Further the high gamma radiation signatures from the natural isotope potash 40 (K 40) are used to map the potassium content of the salt quiet precisely. In case of historical exploration of GSI, however gravity and magnetic surveys were the more reliant modes of geophysical surveysadopted ,perhaps on cost consideration

Suggested line of action for the next phase of exploration

Further exploration work by core drilling (targeted in-fill drilling) to confirm grade continuity andfurther define and expand the current exploration potential in the three subbasins will have to take note of following activities including

- Definitive density determinations from core samples;
- Mineralogical studies of core samples;
- Re-model the geology incorporating lithological units through detailed petrographic studies and determination of core log densities of the potash mineralized zones
- Detailed structural analysis to identify potential fault offsets of mineralized units;
- Detailed comparative evaluation of historical data and current explored MECL/GSI bore hole derived K/K2O data toverify the compatibility of both the datasets

• Construction of a block model for resource estimation for the Satipura, Bharusari and Lakhasar blocks

• Faithful implementation the QA/QC program for sample handling and sample analyses

Road Map ahead

The consolidation exercise in the NHG evaporite basin should include comprehensive optimisation studies of the available historical data complemented by infilling data.The underlying philosophy of optimisation would be to pick up the more prospective areas as indicated in the historical exploration work of GSI including

• Resorting to optimization study involving Satipura, Bharusari, Jaitpur and Lakhasar sub basins and incorporating the recent MECL/ GSI exploration data

• Working out the inter-se merit of the respective blocks in terms areal spread, grade, thickness and type of mineralization factors under the agies of MECL/GSI and accord relative priorities

• Attempting a scope level study under the agies competent agencies including MECL/GSI which will take into consideration preliminary processing, mining and economic aspects commensurate to the requirement of Scope level study

• It is felt as a desirable necessity during the "scope level study" study stage the involvement of a backup potash consultancy firm of international repute

Eventual objective

• To target generation of a minimum indicated reserve say about 50-100 million tonnes each in the Satipura, Bharusari and Lakhasar blocks to brighten their development prospects

• The envisaged optimisation study would reckon physical and chemical factors like bed thickness ,parting thickness, lateral continuity of bed/beds, mineralogy, sp.gr ,K values of the mineralized zone and their permutation and combination

• Attempt to create a barest potash resource base in each of the above three subbasins with a minimum K content of + 5 or+ 6% and evaluate their techno economic compatibility with other developing potash projects through various trade of studies

• While carrying out the above exercise, the approach would also be to keep in the hind sight the prevalent techno economic scenario of potash projects under development.

Initiative by GSI and MECL in the current potash exploration in the NHG evaporite basin

Till date no holistic study, even at the preliminary level such as scope level study has been made on any of the sub basins of NHG Evaporite. MECL/GSI are currently engaged in the re-evaluation exercise of the 4 more relatively promising sub basins and are expected to come out with some definitive answer about their development feasibilities .

The task is challenging and in this exploration mission of national relevance, both these premier National Institutions need to be extended all possible Governmental support both financial and technical (in areas where indigenous expertise/facilities are inadequate). At the same time they on their part have an obligation to discharge their onerous responsibility to undertake such multidisciplinary studies in a defined time frame. There is hardly any room for treating this vitally important project in a routine manner

In potash exploration successful drilling by itself is a challenging task but it is equally important to urgently precipitate all the desired sequential follow up actions including quality assurance, quality control activities inherent in drill core sample preparation, analyses and synthesis and data interpretation.

All the above mentioned activities represent areas of paramount importance for successful completion of the indigenous potash resource development endeavour and consequently, it is felt, would merit immediate and urgent and expeditious attention including essentially needed quick decision making process. It has been the impression of the author, that because of the cumulative work load, both in GSI and MECL and also on account of their need to follow the laid down procedures, many a times urgent decision making process becomes a casualty and came in the way of urgent procurement of related equipments, reagents, drill mud ingredients and getting access to external analytical facilities etc.

Under the current policy dispensation both MECL and GSI are the exclusive privy in areas of potash exploration mission which in turn would make them all the more accountable for timely completion of the mission, particularly in appreciation of the national relevance of the above Potash bearing sub basins and for advancing the development course of the project to a stage that would enable permit undertaking scope level study

Conclusion

In the backdrop of the prevailing scenario that pervades the country in potash front, hardly there is any alternate option but to explore and exhaust the possibilities for development of the only latent potash potential of some of the known subbasins in NHG evaporite basin showing apparent promise of their development. It is now or never like situation. In a techno-commercially and time consuming loaded project like the the one of potash development, attention of interested and capable developers can only be attracted as and when the deliverables in the plate are rendered attractive.

Earth Leakage Relay is used fornon-linear loads like ups, transformer, motors, drives & other applications.

Technical Session IV

Infrastructure development around Mining Stakeholder

MINING AT NMDC
AN INTEGRATED APPROACH TOWARDS VALUE ADDITION

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Abstract

It is generally considered that mining has significant impact to the environment through its activities such as blasting, excavation and waste disposal. In order to make mining sustainable and to minimize the tarnish in the era of stringent environmental norms, it is inevitable to strive towards achieving integrated approach for improving the value chain from mine to metal. These efforts for improving the value chain doesn't relate only to mineral & non-mineral matter, but it is essentially all those efforts which minimize the adverse impact on the environment through conservation of minerals, energy, water, reduction in air & noise pollution and better waste management. It is also prudent to direct efforts towards environmental sustainability and safe mining practices apart from considerations related to economic viability, every step towards maintaining sustainability should not be measured with cost alone. Meanwhile, the efforts for achieving sustainability in the entire value chain from excavation to extraction are gaining momentum and started showing positive signs. Collaboration is becoming an integral part of research in mining to overcome multifaceted challenges. This article enumerates the efforts of NMDC towards achieving integrated approach starting from excavation, processing, value addition and management of tailing. It is worth mentioning that NMDC has attained significant success in majority of the concerns through beneficiation and the efforts have shown promising results in the rest.

Key words: *Mining, Beneficiation, Sustainability, Safety, Environment,*

About NMDC

Incorporated in 1958 as a Public enterprise, fully owned by Government of India, National Mineral Development Corporation Limited has progressed and contributed significantly to the domestic mineral sector over the last six decades to transform itself from Schedule - A to a Navaratna Public Sector Enterprise, NMDC Limited under the administrative control of Ministry of Steel.

NMDC Limited is the single largest producer of Iron ore in India with a throughput over 35 million metric tons in the previous financial year from its three fully mechanized mines situated in the states of Chhattisgarh and Karnataka. The company

also has the pride of operating only mechanized diamond mine with an installed capacity of producing diamond over 80000 carats per annum. NMDC has been partnering in nations growth and is contributing towards the National Steel Policy through forward integration of its business and is at the verge of commissioning its 3 million tons per annum steel plant in Chhattisgarh.

The company has the ambitious strategic management plan to enhance its throughput to 67 MTPA by FY22 apart from strengthening its value added business in the form of pelletization, steel making and exploration activities. NMDC is also working aggressively in diversifying into strategic and critical minerals required by the nation.

Mining and future trends

The purpose of mining is to meet the demand for metals and minerals resources to develop infrastructure and to improve the quality of life of the society. The primary products extracted from mining in many cases are the raw materials for the metallurgical and manufacturing industry.

Mining activities comprise drilling - blasting and excavation, by their nature are considered as the potential sources of destruction to the environment. The production of mineral commodities and extraction of metals invariably associated with large quantities of waste at each stage of value addition. The waste generated during the process is a major contributor for environmental degradation. Though, waste management is on the priority of every industry, it is an 'after the event' measure. Thus, there is a need for a different approach of dealing waste with an aim to reduce or eliminate it at the source to the possible extent. It is prudent to think of value addition to these wastes either by exploring the possibility of recovering certain secondary minerals or think of possible alternate usage to improve the value chain. Thus, the aim of mining need not be use of the ore or mineral of business interest but certainly the aim ought to minimize the adverse impact on the environment by improving the value chain in entire domain of mining. For a mining company, sustainable practices are at the core of its license to operate. The time has come to realize that the only way to be economically viable is to operate environmentally and socially responsible.

"If the mining companies fail to change the way of their business, probably, they will be compelled to change their business of mining".

In a larger perspective, thrust on the mining must be the optimum utilization of the resources associated with the industry such as mineral commodity, mining & plant machinery, sources of energy, air, water, land and the human resource with an integrated approach towards value addition at each stage.

Achieving sustainable productivity improvements will garner by fostering a healthy workplace. Productivity, it is a word that has always been hot on the lips of every miner and will continue to do so. Technology can leverage productivity by bringing new advancements which would make workplace safer and easier. Data capturing from the

operational system is one of the simplest form of technology adoption. However, many mining organizations are struggling to improve the legacy reporting systems and not yet completely utilizing the data captured. The electronic data capturing and data interpretation will improve planning, control and decision making. Many of the technologies that mining can apply have been emerging in the industry for at least a decade now, including remote operating centres, autonomous equipment and the use of cloud-based applications. Only companies like Rio Tinto and BHP are at the forefront in adopting technologies.

Efforts of NMDC

Being the largest miner of Iron ore in the country, NMDC operates with a tagline 'eco-friendly miner' and 'miner to the nation'. Thus, the onus on NMDC is to set benchmarks for others to follow, to accomplish its objectives the company continuously strives to improve the standards and leave no stone unturned. NMDC is at the forefront of adoption of technology in creating better living standards for their stakeholders. The recent one being promoting Space Applications in exploration and other mining activities for "Satellite Based Geological Mapping and Multidisciplinary Exploration of Iron, Diamond and other mineral deposits", which is a step forward towards "Digital India" as Space Technology provides real-time data for generation of digital maps. Use of advanced software for mine planning and deploying advanced machinery for excavation and processing.

Every mining industry has to face tough challenges before succeeding in their core business areas. Following are the few of them that are encountered in their value addition process.

- Blasting
- Handling overburden and waste
- Managing low and lean grade resources
- Tailing management
- Energy optimization
- Water conservation
- Afforestation

NMDC adopts an integrated approach towards value addition at each stage of the value chain and deals each of these with utmost care to strike balance with the environment.

Blast management:

Blasting is the most critical activity in mining from the perspective of storing and handling of explosives, charging the blast hole and detonation, which demand for maintaining utmost safety of men and machinery and are governed by statutory regulations. Thus, we practice Blast Management Plan based on the statutory guidelines and adopt management & monitoring methods to minimize blasting impacts. The practices include:

- Restricted timing for blasting
- Maintaining proper direction & detonation design
- Avoiding blasting during adverse weather conditions
- Designing the detonation sequence with optimum delays between the holes
- Blast plan based on the strata

These eliminate the risks to men and machinery; minimize impact of vibration, lesser effect of blast waves to the adjoining neighborhood.

Managing overburden and Waste:

Handling and managing overburden or waste is an integral part of mining industry and is associated with the challenge of managing the permissible space. The challenges are compounded with maintaining slope stability and controlling dust from waste dumps. The risks multiply during extreme weather conditions such as heavy rains which wash of off the dumps polluting land and nearby water sources; turbulent winds blow dust polluting air.

These challenges are encountered by

- Appropriate design of waste dumps by maintaining the slope not exceeding 200.
- Covering the dumps with coir net
- Constructing drainage and diverting the water towards check dams
- Plantation on the waste dumps for their stabilization

In order to explore the possibilities of using these waste dumps the R&D centre has taken up the challenge. The roadmap planned comprises:

- Characterization of the waste dump to assess the constituents
- Exploring the possibilities of extracting or recovering any valuable minerals present
- Exploring the possibility of any alternate usage such as developing building material or supplement for agriculture

Based on the characterization, the R&D would collaborate with appropriate research partner for utilization of these wastes.

Managing low and lean grade resources:

It is envisaged that the utilization of relatively inferior iron resources (low grade, sub-grade and lean grade) would become imperative from the perspective of mineral conservation and to meet the demands in accordance with the National steel policy.

It is worth mentioning that the R&D Centre has done extensive research on utilization of these resources. Apart from DSO (direct shipping ore), during the process of iron ore mining, we tend to come across low grade ore (Fe>55%), sub-grade ore (Fe: 45 – 55%) and lean grade ore (Fe<45%). These resources are to be dealt properly from the prospective of mineral conservation. In order to develop a roadmap for systematic mining, NMDC has worked extensively on such resources from all the operating mines and has developed beneficiation processes to produce marketable end products. The beneficiation processes comprise unit operations from gravity concentration and magnetic separation. The concentrates obtained have required physical and chemical properties qualifying them as a suitable feedstock for sintering and pelletization. Following is the outcome of the studies carried-out on these resources:

Resource	Concentrate		Tailing	
	Grade(%Fe)	%Yield	Grade(%Fe)	%Yield
Low grade (~55%Fe)	>64	~ 55	<43	~45
Sub-grade(45-55%Fe)	>64	~ 50	<35	~ 50
Lean-grade (<45%Fe)	>64	~ 35	<28	~ 65

Tailing management:

In Indian context of iron ore mining, NMDC is on the forefront of better tailing management, whether it is efforts for utilization of mine waste or process rejects. The effort for managing mine waste is mentioned in the earlier section of this article.

Tailing are the beneficiation process rejects comprising significant amount of mineral constituents. Though, these iron ore tailing are chemically similar to the parent ore, general concern is about the possible contamination by any chemicals used in the process such as milling, flotation or thickening.

The most common methods adopted or the options available for managing tailings are:

- Discarding them in the form of thickened slurry or as paste into tailing ponds
- Using them for backfilling
- Dry-stacking (after filtration) of thickened tailings

The tailings generated at NMDC's operations in the last six decades are mostly free of any such chemicals. The tailings accumulated in the tailing dams of NMDC are primarily washed rejects from iron ore processing with d80 of 0.15 mm (80% of the particles less than 0.15 mm) and Fe~58%.

Moving ahead of conventional tailing management practices, NMDC has carried out extensive beneficiation studies and set up slime beneficiation followed by pelletization plant in Donimalai complex. It is proposed to use the utilize the slimes from Bailadila sector as a feedstock for pelletization after beneficiation in the proposed pelletization plant at Nagarnar in the vicinity of upcoming steel plant. The concentrates obtained have suitable physical and chemical properties for pellet making, also the pellets produced from the beneficiated slimes have excellent physical and metallurgical properties qualifying them as an excellent feedstock for iron making through blast furnace and direct reduction route.

Further, from the envisaged utilization of relatively inferior iron resources (low grade, sub-grade and lean grade), it is apparent that these tend to produce relatively higher quantities of tailings. The R&D Centre has carried out extensive studies on these tailings for their amenability for producing dry stackable tailings enhancing water recovery from the process and minimizing the space requirement for their storage, production of bricks and tiles. The R&D Centre has also developed processes which have shown

promise in producing high-tech products such as Silica Sol and Nano iron powder from these lean tailings.

Afforestation and Green energy Initiatives:

Doing mining business with a tagline 'eco-friendly miner', NMDC strives to maintain harmony with the environment through its extensive afforestation programs and green energy initiatives. NMDC carries out extensive plantation along the waste dumps and around the vicinity of operating mines to compensate in many folds for the green cover lost in developing mines.

As mining operations are often in remote locations, it is expensive to connect to the grid; and often separate power facilities need to be build or diesel is used that needs to be brought onsite. These challenges gives an opportunity for mining companies to explore the possibility of utilizing renewable energy sources like solar or wind farms to power the operations.

Apart from regeneration of power through its downhill conveyor systems in the operating plants, NMDC has also taken up initiative for generation of renewable energy through wind mills in Karnataka and proposed solar energy plants in its operating mines.

Concluding remarks:

NMDC Limited is a responsible mining organization striving for a visible and effective solutions by having its behaviour move in recent decades from complying with regulations to corporate social responsibility in addition to moving progressively to 'closing the loop' strategies to dramatically reduce the quantities of wastes. The drivers for change have moved from being almost exclusively profit to include regulations, stakeholders and increasingly to changing social values. In parallel, the materials cycle focus has shifted from a narrow focus on products towards including co-products like slime beneficiated to generate pellet feed concentrate followed by Pelletization and initiatives towards innovative dewatering strategies, development of products like nano-sized iron powder and utilization of waste as input material for construction industry.

Increasingly, the company is shifting its focus to the entire materials cycle and, ultimately, to the entire value chain.

Waste reduction through re-engineering is what NMDC aims to utilize minimize the quantity of waste produced or to produce a by-product in a form that can be used more readily. This involves process modification or even completely redesigning the flow sheet. There can be primarily three broad approaches:

- flow sheet simplification-use of dry screening method in wet screening design to minimize use of water for processing
- use of novel equipment like HGMS, etc for enhanced recovery to minimize generation of waste
- use of novel processing conditions like beneficiation of slimes and fines in tandem and dewatering followed by conveying and stacking or paste thickening of lean tailings instead of conventional thickening followed by tailing dam impounding

NMDC is aware that large financial investments are needed for major changes in technologies. Established technologies have been refined over many years and operations usually give financial returns long after the capital costs have been depreciated. The introduction of new technologies introduces production risks which can, and often do, prove very costly but still as a responsible miner and corporate NMDC does not have any reluctance to introduce new technologies albeit in an incremental way so that it has minimum impact to production.

The environmental challenges posed by non-renewable mineral resource extraction and use need to be addressed within the broader context of sustainability through an integrated strategy for managing the stocks of resources from which materials are obtained, the materials themselves, and the goods, products and infrastructure that contain materials.

Vision 2050 (WBCSD, 2010), produced by the World Business Council for Sustainable Development, is a major development in business thinking. It envisages by 2050 'a planet of around nine billion people, all living well – with enough food, clean water, sanitation, shelter, mobility, education and health to make for wellness – within the limits of what this small, fragile planet can supply and renew, every day'. The pathway to achieve this vision involves fundamental changes in governance structures, economic frameworks, and business and human behaviour. It involves incorporating the cost of externalities (carbon, ecosystem services, water), halving carbon emissions worldwide (based on 2005 levels), and achieving a four- to 10-fold improvement in the use of resources and materials.

The International Council on Mining and Metals has adopted some of the principles of sustainability and corporate social responsibility but the industry is yet to fully incorporate sustainability thinking within its business models at all levels. The inevitable closing of the materials cycle will create new opportunities for mining and minerals companies prepared to adopt new business models.

Acknowledgements: The authors express their gratitude to Sri Baijendra Kumar, Chairman – cum – Managing Director for according necessary permissions. The support of their colleagues at R&D Centre is duly acknowledged.

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STAKEHOLDERS' EXPECTATIONS OF ETHICAL MINING AND ITS RESPONSIBILITY TOWARDS SOCIETY.

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ABSTRACT:

The present day environment demands to hMining is an essential activity for the sustainability of human beings and development of the country. Without exploitation of natural resources such as ores and minerals it is difficult to live in the modern society that is suffering from consumerism and unending demands.

But unfortunately ores and minerals occur under the surface of the Earth either in thick forests or adjacent to them. Unscientific Mining in the past decades resulted Loss of biodiversity and endemic flora and fauna, unmanaged waste dump yards & health hazards etc.,

But, different enforcements by the GoI, such as R & R policy, The Mines and Minerals (Development and Regulation) Amendment Act, 2015 (MMDR Act, 2015), Corporate Social Responsibility - Indian Companies Act 2013 etc., resulted in bringing positive changes of mining in India.

When mining is inevitable, it shall be sustainable and shall consider the local stakeholders perceptions and needs. The stakeholders are the people living in and around mining areas who are directly or indirectly affected positively or negatively by mining activities.

The ores and minerals are the non-renewable natural resources which will exhausted soon if we do not slow down the extraction process. As the population grows fast, their demands also become endless. Hence we need to preserve the minerals and ores for coming generations.

Key words: Ethical mining, Sustainable mining, mining and stakeholders, Social responsibility, Iron Ore Mining,

CSR ACTIVITIES AT A GLANCE

Shri D.P. Mukhopadhyay
Rajashree Cement Works, Ultratech Cement Ltd.

Our Glorious Indian History witnessed famous emperors of Rastrakuta like Nrupatunga, Amogvarsha, etc. They chose Malkhed as their capital. Jainism was officially recognized state religion by Rastrakuta. Islam followers were also permitted as traders, who later settled here. Malkhed was an ancient prosperous town but with passage of time problems of basic infrastructure like roads, illiteracy, financial incapability, unsafe drinking water etc. we're being faced local population. With a view of overall socio-economic upliftment of the society through industrialization, Aditya Birla Group choose Malkhed to setup Rajashree Cement Worksin 1984-85, which is now one of the largest single location cement manufacturing unit in India.

For generations, the Aditya Birla Group has been reaching out to communities with the spirit and culture of sharing and caring. At UltraTech, this legacy is carry forwarded by taking concrete steps to co-create value for business and the society. Vision of UltraTech is - "To actively contribute to the social and economic development of the communities in which we operate. In so doing build a better, sustainable way of life for the weaker sections of society and raise the country's human development index" (Mrs. Rajashree Birla, Chairperson, Aditya Birla Centre for Community Initiatives and Rural Development).

UltraTech believes in the trusteeship concept. This entails transcending business interests and grappling with the "quality of life" challenges that underserved communities face, and working towards making a meaningful difference to them. In that line, "Kagina Jan Seva Trust"was establishedin the year 1988. Initially, development activities were covered at Malkhed and its surrounding 10 villages, with a population of about 70,000. Now, the benefits are being enjoyed in 21 villages in the surrounding area. We pursue a project-based approach with a robust implementation structure, monitoring process and a team of professionals in place across all locations. To erase barriers of accessibility and, go deeper and wider, we collaborate with district rural development authorities, local hospitals, healthcare institutions and district panchayati raj institutions with the objective of empowering the community. In collaboration with FICCI,

we have set up Aditya Birla CSR Centre for Excellence to make CSR an integral part of corporate culture.

UltraTech's social projects are designed with the long-term goal of creating sustainability and self-reliance. Hence, the projects focus on factors that will lead to empowerment and capacity building. Though UltraTech operates in five focus areas viz. Education, Health Care & Family Welfare(Safe Drinking Water & Sanitation), Sustainable Livelihood & Watershed Management, Infrastructure Development and, Social Reform, its major emphasis has been on providing quality education and healthcare facilities. Importance is also given to building infrastructure, as ultimately it is the tool that fuels growth. The results of these projects will not only benefit their respective communities but also the nation at large. The Corporate CSR activities are concentrated in 407 villages, in proximity to its 22 plants, across the country.

At Rajashree Cement Works, the first thing the company did is to provide employment for those dependents whose land had been acquired for establishment of the factory. Villagers are depending upon agriculture and only one crop mainly TUR is grown in a year. Aditya Birla Group provided direct and indirect employment opportunities to the villagers. Because of the Cement factory, villagers have established their own shops, hotels, transport business, etc. Tremendous growth in the agricultural output could be achieved over a period due to irrigation facilities provided by construction of barrage cum bridge on river Kagina by the company. Various welfare driven activities have been initiated including mobilization of resources for the upliftment of the under privileged and weaker section of the society with the coordination of Banks, Govt., NGO's and local institutions. Kagina Jan Seva Trust has continued to extend a helping hand to the needy while encouraging people to be self-reliant.

Kagina Private Industrial Training Centre (KPITI) one of the unique project was established in 1996 in partnership with Dept. of Employment & Training, Govt. of Karnataka and presently five trades are being trained viz. Electrical, Fitter, Welder, safety and Electronic Mechanical with annual intake capacity of 99 students. So far 891 students have been trained and availed employment opportunities in various organizations. One more special project "Kasturba Gandhi Balika Vidyalaya," (KGBV) Udgi, in partnership with the Dept. of Sarva Shikshana Abhiyan, Govt. of Karnataka, was started initially with 50 girl students as per the guidelines of Sarva Shikshana Abhiyana, Govt. of Karnataka during the year 2005. KGBV has been adjudged as one of the best managed schools in Gulbarga District by the Dept. of Education. From June, 2006 Govt. of Karnataka has increased the intake capacity of girls from 50 to 150. Kasturba Gandhi Balika Vidyalaya provides residential education facilities with an objective to bring down the dropout rate of the girl child. The school provides residential school facilities with education to children between the age group of 11 to 16 years from Class VI to X thereby, bringing them back to the main stream of education. Gender disparities still

persist in rural areas, especially among the backward communities. The objective of KGBV is to provide quality education and vocational training to girls belonging to the economically weaker sections of society. The Trust with the coordination of the District Adult Literacy Department has organized short term courses that span over 6 months for 1500 women at 9 surrounding villages in 10 centers. With an endeavor towards women empowerment and self-reliance, Self-Help Groups have been formed and supported to more than 350 SHGs trained and linked to economic institutions. The groups are formed with an objective to organize the women for development action. The self-help groups are envisaged to be the basic institution of all village development proposals. Besides the core activity of savings and credit and maturing to village development institution, they also market their own products. The Animal Husbandry is the one of the supportive income source to the farmers. Farmers and members of self-help groups are being encouraged to rear cattle, namely goats, sheep and poultry. With low capital, Animal Husbandry can be started and the additional funds are provided by the Trust.

Swachh Bharat Mission was launched on 2nd Oct. 2014 by Govt of India to fulfill the vision of cleaner India by 2nd Oct 2019, as a tribute to Mahatma Gandhi on his 150th birth anniversary. The mission drives towards achieving universal sanitation coverage, improving cleanliness and eliminating open defecation. A SwachhtaPakhwada was observed by Ministry of Mines from 16th to 31st Dec 2017. Rajashree Cements participated in large scale duly conducting cleanliness campaign in plant & mines area & surrounding villages. Several awareness programs were conducted in nearby schools and panchayats.

As a result, we find the Improvement in Living standard of the community through enhance inEducational level (67% Literacy level, 10 villages are Zero Drop out from school, Increase in Girl Child Education), etc.Providing Health facilities which ensured reach of 99% to Institutional Deliveries, Reduction in IMR rate,100% Pulse Polio coverage. Other focus areas include Sustainable livelihood activities like Training Women in marketable skills, Empowering Women and Framer groups through Self Help Group(SHGs) development & Training & 100% coverage of Basic Infrastructure facilities like Internal Roads, Drains, CC Roads, Water Supply & Toilets in surrounding villages.

The Company's engagement in CSR activities is disseminated on its website, Annual Reports, in-house journals and through the media. Management and all of our employees subscribe to the philosophy of compassionate care. We believe and act on an ethos of generosity and compassion, characterized by a willingness to build a society that works for everyone. This is the cornerstone of our CSR policy.

DISTRICT MINERAL FOUNDATION[DMF] & NATIONAL MINERAL EXPLORATION TRUST[NMET]

Shri Kamlesh V. Patel
BE [Chem], MMEAI, Joint Secretary, MSAK &
Mining Agent,Bagalkot

DISTRICT MINERAL FOUNDATION [DMF] :

District Mineral Foundations are statutory bodies in India established by the State Governments by notification. They derive their legal status from section 9B of Mines and Minerals (Development and Regulation) Act, 1957 as amended on 26 March 2015 as Mines and Minerals (Development and Regulation) Amendment Act, 2015. This amendment came into force from 12 January 2015.

The Mines and Minerals (Development and Regulation) Amendment Act, 2015, which enforced the auction route for issuance of mining leases, had also mandated the setting up of DMFs in all districts in the country affected by mining activities.

Specifically, the distinction between existing mining lease holders and future mining lease holders has been made using the date January 12, 2015, the date on which the Act came into force.

The scheme has been dubbed the Pradhan Mantri Khanij Kshetra Kalyan Yojana (PMKKKY) and has been launched on the Prime Minister Narendra Modi's birthday.

The objective of the PMKKKY scheme is to implement various developmental and welfare projects in mining affected areas that compliment existing schemes of the Central and State Government, minimize adverse impact of mining on environment, health and socio-economics of the people in the districts and ensure long term sustainable livelihood for affected people. High priority areas like drinking water supply, healthcare, sanitation, education, skill development, women and child care, welfare of aged and disabled people and environment conservation will get 60 per cent of the share of the funds.

Balance funds will be used for making roads, bridges, railways, waterways projects, irrigation and alternative energy sources.

"This way, Government is facilitating main streaming of people from lower strata of society, tribals and forest-dwellers who have no wherewithal and are affected the most from mining activities," .

Centre for Science and Environment (CSE) organized a multi stakeholder meeting in Bhubaneswar Odisha, to review the implementation of status of District Mineral Foundation (DMF) in key mining districts of India, with a specific focus on Odisha, and discuss strategies to maximize the potential of DMFs.

The meeting was attended by the concerned state department officials, district officials, planning experts and civil society members.

The meeting brought out issues that DMFs must consider for effective implementation in various districts of Odisha, and key deliberation and action points were identified by the participants in a consultative manner.

Model District Mineral Foundation (Trust) Rules, 2015

In 2008, the Centre for Science and Environment (CSE) published a detailed report on the mining sector titled: Rich Lands, Poor People: Is sustainable mining possible? We pointed out that minerals are found where there are forests, from where water comes and where adivasis and the poorest of India live. These are also the places where Naxalism is spreading. We intervened to ask for a new social and environmental contract in the mining sector, keeping in mind the need to utilize mineral resources, but also the interests of the people and the environment. Such considerations fructified in the form of the Mines and Minerals (Development and Regulation) Bill (MMDR), 2011. But due to disagreements within the United Progressive Alliance (UPA) government and pressure from the industry, the Bill was allowed to lapse in February 2014. We believe that the MMDR Bill, 2011, made an attempt to balance all concerns.

There were lacunae in it, but it recognised the need to incorporate community interests and environmental protection. In this way, there was a movement forward in the 2011 Bill from the MMDR Act of 1957.

Now we have the MMDR Amendment Act, 2015, which was passed by the Parliament in March 2015. Though the amendments introduced to the 1957 Act leave much to be done with respect to ensuring a sustainable mining future, it does create an opportunity to address the injustice that has been inflicted upon communities in the mining areas. It provides for the establishment of the District Mineral Foundation (DMF), a Trust that would function as a non-profit body to "work for the interest and benefit of persons, and areas affected by mining related operations". The Act further states that the objective and functioning of the DMF should be guided by Constitutional provisions as it relates to Fifth and Sixth Schedules for governing tribal areas. It should also be guided by the provisions of the Panchayats (Extension to Scheduled Areas) Act (PESA), 1996, and the Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 – in short the Forest Rights Act (FRA).

1. Government of India vide notification dtd:27.03.2015 has amended the MMDR Act 1957, as per Section 9(b) of the Act, the State Government shall establish a non -profit trust called District Mineral Foundation (DMF) for the restoration of the areas affected by mining activities.

2. Government of Karnataka has issued notification dtd: 05.11.2015 for establish ment of DMF in each of the 30 districts of the

state which shall be deemed to have come into existence w.e.f 12.01.2015. Thereafter, Rules and amendment to Rules have been brought on 11.01.2016 and 25-07-2016 respectively.

3. As per Hon'ble Supreme Court in Transferred case (civil) No. 43/2016 FIMI v/s Union of India and others dtd:13.10.2017 the DMF rules came into existence with effect from Dtd: 17.09.2015.

4. Every holder of a mining lease or a prospecting licence-cum-mining lease shall, in addition to the royalty, pay to the District Mineral Foundation of the district in which the mining operations are carried on, an amount at the rate of –

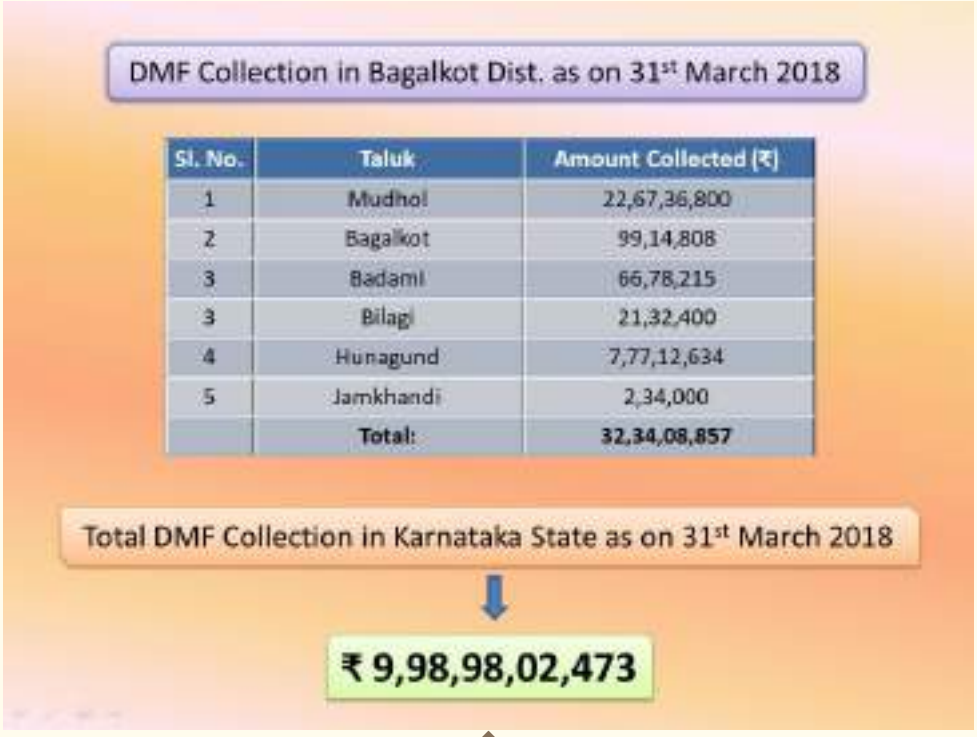
(i) ten per cent of the royalty paid in terms of the Second Schedule to the Mines and Minerals (Development and Regulation) Act, 1957 (67 of 1957) (herein referred to as the said Act) in respect of mining leases or, as the case may be, prospecting licence-cummining lease granted on or after 12.01.2015; and

(ii) Thirty per cent of the royalty paid in terms of the Second Schedule of the said Act in respect of mining leases granted before 12.01.2015.

5. In respect of Minor minerals, DMF was incorporated in KMMCR Amendment Rule 2016 and became effective w.e.f. 12.08.2016.

6. In consultation with Director of Treasury and Accountant General all the respective offices of Department of Mines & Geology have been informed to collect District Mineral Foundation (DMF) as per provisions of Act and Rules and informed to remit to the Head of Account 8449-00- 120-9-45.

Now focusing on Karnataka with respect to the DMF collection as on 31st March 2018 depicted as follows:



Districtwise DMF Approved Action Plan details –March2018

Sl.No.	District	Total			Amount Spent (in Lakhs)
		Total No. of Units	No. of Beneficiaries	Amount	
1	Udupi	87	5	118.40	0.00
2	Hassan	47	11972	122.25	0.00
3	Mysore	0	277	22.38	0.00
4	Shimoga	303	19133	56.94	0.00
5	Tumkur	246	138459	1691.52	5.00
6	Belgaum	21	21	310.35	0.00
7	Bellary	91774	210683	39103.02	1955.66
8	Bidar	9	0	47.77	0.00
9	Davanagere	193	274	275.94	0.00
10	Koppal	82	0	669.21	0.00
11	Raichur	251	219050	1146.00	0.00
12	Uttara Kannada	141	0	448.07	0.00
13	Dakshina Kannada	52	0	165.50	0.00
14	Chamarajanagar	116	0	484.00	0.00
15	Ramanagara	40	0	611.00	0.00
16	Gadag	56	0	114.22	22.57
17	Chitradurga	1979	1380	2100.00	2.51
18	Kalburgi	618	2386	10604.44	0.00
19	Dharwad	16	16	61.90	0.00
20	Bijapur	559	0	144.50	0.00
21	Chickmagaluru	293	4733	83.54	0.00
22	Bangalore Rural	45	6482	104.5	0.00
23	Bangalore Urban	464	900	995	0.00
24	Chikkaballapura	65	290	639.89	0
25	Kodagu	2	869	14.5	0
26	Bagalkot	238	0	1912.75	0
Grand Total		**97697**	**616930**	**62047.592**	**1985.74**

Districtwise DMF Approved Action Plan details – April 2018

Sl.No.	District	Total			Amount Spent (in Lakhs)
		Total No. of Units	No. of Beneficiaries	Amount	
1	Udupi	18	152	5.00	118.40
2	Hassan	47	47	12577.00	122.25
3	Mysore	3	277	6300.00	22.38
4	Shimoga	19	303	19792.00	56.94
5	Tumkur	222	222	134769.00	1184.52
6	Belgaum	21	21	65660.00	310.35
7	Bellary	263	91774	210683.00	39103.02
8	Bidar	9	9	13848.00	47.77
9	Davanagere	8	310	9194.00	275.94
10	Koppal	33	82	11660.00	669.21
11	Raichur	30	251	219050.00	1146.00
12	Uttara Kannada	57	142	12897.00	448.07
13	Dakshina Kannada	52	52	10073.00	165.50
14	Chamarajanagar	34	117	32157.00	484.00
15	Ramanagara	20	40	3550.00	611.00
16	Gadag	56	56	145732.00	114.22
17	Chitradurga	1979	1979	1380.00	2100.00
18	Kalburgi	618	618	2386.00	10604.44
19	Dharwad	16	56	3567.00	61.90
20	Bijapur	11	28008	5540.00	144.50
21	Chickmagaluru	15	293	4733	83.54
22	Bangalore Rural	45	45	6482	104.50
23	Bangalore Urban	19	468	1375	995.00
24	Chikkaballapura	65	65	290	639.89
25	Kodagu	2	2	869	14.5
26	Bagalkot	160	271	243050	1924.02
Grand Total		**3822**	**125660**	**1177619**	**61551.862**

STATE DMF FINANCIAL ACCRUALS FOR THE YEAR - 2015-16, 2016-17 & 2017-18

Sl. No.	District	2015-16	2016-17	2017-18	2018-19	Total
1	Chitradurga	0.00	913.18	4537.83	55.76	5506.76
2	Bagalkot	0.00	1991.91	1242.18	102.01	3336.10
3	Bellary	0.90	15369.73	40627.37	4022.96	60020.97
4	Tumkur	0.00	372.82	554.45	61.12	988.39
5	Davangere	0.00	217.09	228.48	9.68	455.25
6	Belgaum	17.65	191.31	498.37	27.38	734.71
7	Kalaburagi	0.00	9369.72	6487.41	495.67	16352.80
8	Mysore	1.40	13.11	27.50	2.30	44.31
9	Chickamagalur	0.00	51.78	130.53	8.82	191.13
10	Shimoga	0.00	72.30	38.96	1.64	112.90
11	Koppal	0.00	967.97	1220.04	83.23	2271.24
12	Mandya	0.00	8.71	15.47	1.66	25.84
13	Bangalore Rural	0.00	126.91	309.94	39.76	476.61
14	Bangalore Urban	0.00	158.59	381.26	33.89	573.74
15	Bidar	0.00	67.81	9.91	0.90	78.62
16	Bijapur	0.00	47.87	190.22	1.80	239.90
17	Chamarajanagar	0.00	301.92	458.14	29.91	789.97
18	Chikaballapura	0.00	378.72	690.03	40.25	1109.00
19	Dakshina kannada	0.00	94.51	170.78	16.04	281.32
20	Dharwad	0.00	54.43	85.60	9.76	149.79
21	Gadag	0.00	70.19	171.51	11.24	252.94
22	Hassan	0.00	41.67	210.98	7.93	260.58
23	Haveri	0.00	27.61	155.21	4.07	186.89
24	Kodagu	0.00	5.07	18.53	2.56	26.16
25	Kolar	0.00	43.53	112.95	11.00	167.48
26	Raichur	0.00	944.06	268.31	84.63	1297.00
27	Ramanagara	0.00	460.46	680.06	44.91	1185.42
28	Udupi	0.00	84.02	172.85	10.53	267.40
29	Uttara Kannada	0.00	364.03	376.86	29.72	770.61
30	Yadgir	0.00	27.15	16.91	0.12	44.18
	Grand Total	**19.95**	**32838.18**	**60088.62**	**5251.24**	**98198.00**

PMKKKY Schemes/Projects implementation details

Number of Schemes/Projects	No. of Units	Details of Schemes/projects under implementation	No. of individual beneficiaries assisted	Amount Allocated	Amount spent on date
374	520	Drinking water supply	197258	4826.47	20.54
153	89260	Environment prevention and pollution control measures	120078	5965.74	4.00
163	276	Health care	322282	4067.48	0.00
689	2506	Education	241597	10553.14	1810.38
188	1266	Welfare of woman & children including on their nutrition	7287	6998.16	0.00
1579	2964	Welfare of agedand disabled persons	2612	925.23	0.00
54	132	Skill development	27998	1250.36	148.48
174	240	Sanitation	74423	2815.86	17.96
316	331	Physical infrastructure	160840	15813.99	331.38
27	27	Irrigation	20467	3778.56	0.00
82	119	Energy & water shed development	957	1885.61	0.00
23	28019	Any other measures for enhancing environmental quality in mining district	1820	2671.26	0.00
3822	125660		1177619	61551.86	2332.74

Futher focusing on our Bagalkot district where we find Limestone & Dolomite Mines ,the location of which is having hard strata where affected nearby villages which are required for proper sanitation is a major issue due to the problem in constructing septic tanks & soak pits for proper discharge of polluted water & its safe disposal without creating nuisance, health hazard & maintaining clean environment.

Construction of Biological toilets & Lavatories will have to be emphasized in a proper way.

National Mineral Exploration Trust (NMET)

The National Mineral Exploration Trust (NMET) was established by the Government of India vide Gazette Notification G.S.R.633(E) of 14th August 2015, in pursuance of subsection(1) of Section 9C of the Mines and Minerals (Development and Regulation) Act, 1957, with the objective to expedite mineral exploration in the country.

The Rules governing NMET were made vide Gazette Notification G.S.R.632 (E) dated 14th August 2015. These Rules are effective from 12th of January 2015, the date MMDR Amendment Act, 2015 came into force.

The office of the Trust is situated in the Ministry of Mines, Shastri Bhawan, New Delhi.

NMET has a two tier structure. The apex body is the Governing Body, chaired by the Hon'ble Minister of Mines. It holds the overall control of the Trust. The Executive Committee, chaired by Secretary, Ministry of Mines, administer and manage its activities. To implement mandated activities an NMET Fund has been established. The NMET Fund receives money from holders of mining lease or a prospecting licence-cum-mining lease,

an amount equivalent to two percent of royalty paid in terms of the Second Schedule of the MMDR Act.

The Trust supports regional and detailed mineral exploration in the country and other activities approved by the Governing Body, to achieve its objects. They include- special studies and projects to identify, explore, extract, beneficiate and refine deep seated and concealed mineral deposits, studies on mineral development, sustainable mining, mineral extraction and metallurgy adopting advanced scientific and technological practices, detailed and regional exploration for strategic and critical minerals, upgradation of mineral exploration status in an area from G3 to G2/G1 level, exploration leading to grant of mineral concessions, aerial and ground geophysical surveys, geochemical surveys, capacity building of personnel engaged in mineral exploration, etc.

National Mineral Exploration Trust (MET) is a Trust set up as a non-profit body by the Central Government for the purposes of regional and detailed exploration of minerals using the funds accrued to it and in such manner as prescribed by the Central Government.

The Mines and Minerals (Development & Regulation) Amendment Act, 2015, (MMRDA) mandated the setting up of Mineral Exploration Trust. The Rules in this regard were notified by the Central Government on 14 August 2015.

The holder of a mining lease or a prospecting licence-cum-mining lease has to pay to the MET, two per cent of the royalty paid by it. Such contributions are made to the relevant state government along with royalty payments, and the state government, in turn, transfers the amount to MET.

State Governments are instructed to report the details of the royalty payments as well as the data on contribution to MET to the Indian Bureau of Mines.

NMET contribution is applicable with effect from 12.01.2015. As on 30.04.2016, a total Rs.168.38 crore has been received by NMET from States.

An inter-ministerial executive committee chaired by the Secretary of Ministry of Mines manages the day to day affairs of the Trust on the basis of the policies set by the Governing Board chaired by the Union Minister of Mines. Composition of Executive Committee and Governing board were notified on 14 August 2015.

MET is similar to the District Mineral Foundation set up under the same Act, but with different rate of contribution (2% instead of 10-30%), level of operation (boosting exploration effort instead of enhancing welfare of the mining affected) and comes under different jurisdictional authorities (central Government instead of state governments)

Functions of MET

MET carries out regional (inter-state) and detailed exploration for minerals including those activities deemed necessary by the Governing Body of MET. Some such sanctioned activities include:

- funding special studies and projects designed to identify, explore, extract,

beneficiate and refine deep-seated or concealed mineral deposits; Priority is given to strategic and critical minerals.

- undertaking studies for mineral development, sustainable mining, adoption of advanced scientific and technological practices and mineral extraction metallurgy;
- facilitating completion of brown-field regional exploration projects in obvious geological potential areas (G3) including conducting high-risk exploration for deep-seated mineral deposits through modern technologies;
- promoting completion of detailed exploration (G2 or GI) across India in the areas where G3 stage exploration has been completed;
- deciding the priorities for exploration after consulting Central Geological Programming Board
- facilitating geophysical, ground and aerial survey and geochemical survey of obvious geological potential areas and rest of India;
- facilitating a national core repository for encouraging research in earth sciences and for evaluation of the mineral prospects;
- organizing capacity building programmes to raise technical capability of personnel engaged in or to be engaged in exploration;

In pursuance of the Mines and Minerals (Development & Regulation) [MMDR] Amendment Act 2015, the National Mineral Exploration Trust (NMET) was set up vide gazette notification No. G.S.R. 633 (E) dated 14.8.2015. The NMET has started receiving payments of a sum equivalent to 2% of the royalty paid in terms of the minerals listed in the Second Schedule as per the provisions of the MMDR Amendment Act 2015. NMET contribution is applicable with effect from 12.01.2015. As on 30.04.2016, a total Rs.168.38 crore has been received by NMET from States.

The National Mineral Exploration Trust has a Governing Body and an Executive Committee. The composition of the Governing Body and Executive Committee of NMET, as contained in the said gazette notification dated 14.08.2015, is available on the website of Ministry of Mines i.e. www.mines.nic.in. The overall control, periodical reviews and policy directions of NMET are vested with its Governing Body chaired by Minister of Mines. The Executive Committee chaired by Secretary, Ministry of Mines is responsible to manage, administer and supervise the day to day activities of NMET.

The Rules governing the NMET have been notified vide gazette notification No.G.S.R. 632 (E) dated 14.08.2015 and are available on the website of Ministry of Mines. As per the Rules the funds accrued to NMET will be utilized primarily for the purpose of regional and detailed mineral exploration, inter-alia, by:

(a) Special studies / projects to identify, explore, extract, beneficiate and refine deep seated or concealed mineral deposits.

(b) Regional and detailed exploration for strategic and critical minerals.

(c) Detailed exploration in areas where regional exploration has been completed.

(d) Facilitating ground and aerial geophysical survey and

geochemical survey in obvious geological potential areas.

(e) Organising capacity building of personnel engaged in exploration in

Centre and States.

The main beneficiaries of NMET fund are the State Governments as the amount is to be utilized exclusively for the purpose of exploration, which aims at identification of mineral blocks for grant of mineral concessions by States.

According to NMET Rule 24, maintenance and audit of NMET accounts is the responsibility of the central government and it shall be audited in such manner as decided by the government.

The government has decided to include more entities in the exploration work such as NMDC, SAIL and MOIL, a move that will help India tap potential in this area more efficiently.

The objective of NMET is to use the funds accrued to the Trust for the purposes of regional and detailed exploration in such manner prescribed by the Central Government.

As per the NMET norms, the trust will have a governing council as its apex body that will have the Mines Minister as the Chairman.

There will also be an executive committee, headed by the union mines secretary, to look after the day-to-day functioning of the trust.

As per the government notification: "Governing body will lay down the broad policy framework for the functioning of the trust and review its working. Executive Committee shall manage, supervise and administer the trust and shall also monitor and review expenditure of the trust..."

Besides the mines minister, the governing body will have petroleum minister, coal minister, minister of state for mines, five state mines minister by rotation, union mines secretary and special invitees.

Executive Committee will comprise of a Joint Secretary level officers from the Department of Atomic Energy, Coal, Petroleum, Mines, Director General of Geological Survey of India, Controller General of Indian Bureau of Mines among others.

For funds, the Mines and Minerals (Development and Regulation) Amendment Act, 2015 says: "The holder of a mining lease or a prospecting licence-cum-mining lease shall pay to the Trust, a sum equivalent to two per cent of the royalty paid in terms of the Second Schedule, in such manner as may be prescribed by the Central Government."

NMET Fund Report as on May-2018

Sl. No	State	Royalty Amount (Rs)	Total NMET Amount Due (Rs)	NMET Amount Paid (Rs)	Balance NMET Amount (Rs)
1	Andaman & Nicobar Islands	0	0	0	0
2	Andhra Pradesh	3073740979	61474819.58	88368193	26893373.42
3	Arunachal Pradesh	0	0	0	0
4	Assam	0	0	0	0
5	Bihar	0	0	0	0
6	Chandigarh	0	0	0	0
7	Chhattisgarh	63125759597	1262515192	1370390717	107875525.5
8	Dadra and Nagar Haveli	0	0	0	0
9	Daman & Diu	0	0	0	0
10	Delhi	0	0	0	0
11	Goa	4455542477	89110849.54	89119174.82	8325.28
12	Gujarat	2014432560	40288651.2	40306582.17	17930.97
13	Haryana	0	0	0	0
14	Himachal Pradesh	0	0	0	0
15	Jammu and Kashmir	0	0	0	0
16	Jharkhand	377998097	7559961.94	7529617.64	-30344.3
17	Karnataka	23803267978	476065359.6	476069415.8	4056.26
18	Kerala	173226079	3464521.58	3464564.14	42.56
19	Lakshadweep	0	0	0	0
20	Madhya Pradesh	594437380	11888747.6	12790338	901590.4
21	Maharashtra	722795172	14455903.44	14457218	1314.56
22	Manipur	0	0	0	0
23	Meghalaya	0	0	0	0
24	Mizoram	0	0	0	0
25	Nagaland	0	0	0	0
26	Odisha	83343619759	1666872395	1690468884	23596488.44
27	Puducherry	0	0	0	0
28	Punjab	0	0	0	0
29	Rajasthan	12033142798	240662856	238822179.7	-1840676.28
30	Sikkim	0	0	0	0
31	Tamil Nadu	5670000	113400	113420	20
32	Telangana	14838767342	296775346.8	296808193.8	32846.96
33	Tripura	0	0	0	0
34	Uttar Pradesh	0	0	0	0
35	Uttarakhand	0	0	0	0
36	West Bengal	0	0	0	0
	Total	**208562400218.35**	**4171248004**	**4328708498**	**157460493.8**

References:1)DMF website information and Karnataka DMG ILMS Portal 2) NMET official website portal

Technical Session V

Processing of Strategic Rare Earth Minerals & Beneficiation of low grade bulk minerals

PROCESSING OF STRATEGIC RARE EARTH MINERALS AND BENEFICIATION OF LOW GRADE BULK MINERALS

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ABSTRACT

In the context of todays seminar, a paper on mining, separaton and processing of high grade radio active mineral like Monazite available in Indian beach sand as well as low grade non radioactive mineral like Carbonatite of Rajasthan assumes importance from the point of view of resource utilisation, safety and environmental protection.

Monazite – a phosphatic [(Ce,La,Nd,Th,U) PO4] heavy mineral present in Indian beach sand is unique in the sense that it hosts oxides of two strategic nuclear metals like thorium and uranium as well as four light rare earths in high concentrations and eight more medium and heavy rare earths in exploitable concentrations. As per the estimate of Atomic Mineral Division of Department of Atomic energy (DAE), monazite reserve as present in beach sand is of the order of 10 million tons Its only drawback is its high radioactivity making it beyond the scope of private enterprenaurs to recover and process as per the laws of the country. As a result, a PSU like Indian Rare earths Ltd under Department of Atomic Energy has been entrusted with the job of mining , separation and chemical processing of monazite for the last 5 decades in limited quantities

Search for a non radioactive mineral resource of rare earths has resulted in a recent discovery of REE mineralisation at a place called Kamthai on the eastern edge of Rajasthan by Ramgad Minerals and Mining Ltd (RMML). The dominant (12%) REE bearing mineral in this Kamthai deposit is Carbocernaite[(Ca,Na) Sr, REE,Ba) CO3)2] with very low level of monazite association. As per RMML estimate this resource with 0.5% cut off gives an average 1.5% REE grade ore representing total geological resource of about 12 million tons. This low grade ore is required to be beneficiated to about 20% grade concentrate before subjecting it to suitable hydrometallurgical processing for recovery of 4 dominant light rare earths namely oxides of Cerium, Lanthanum , Neodymium and Praseodymium. Such a resource can easily support a 5000 TPA rare earth oxide Plant in our country.

In the present paper an effort has been made to high and these two resources wrt their mining, separation, beneficiation and chemical processing to recover all the associated strategic and critical rare earths.

GOLD EXPLORATION AND MINING SCENARIO IN INDIA

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Abstract

The demand for Gold in India is not only the highest in the world but also one of the fastest growing market. It is projected, that the gold consumption in India may reach about 1000 tonnes. The domestic mine supply is around 2.5 tonnes/year. The gold resources (about 659.84 tonnes of metal) established by Govt and Private agencies should be upgraded by substantial drilling, exploratory mining & feasibility studies to reach a mine able reserves.

After the closure of Bharat Gold Mines Ltd (BGML) in 2001, impetus was given to the Hutti Gold Mines Co. Ltd (HGML) which is the only unit, processing gold right from the stage of ore. Private sector process gold as a by-product, while processing copper.

The Hutti Gold Mine Company (HGML), a Government of Karnataka Enterprise, has a unique distinction of being the only producer of primary gold in the Country. M/s HGML has been active in the Exploration, Mining and Metallurgy of Gold and Copper deposits occurring in Karnataka. The Company's Corporate Office is situated in Bangalore and it operates two units - the Hutti Gold Unit (HGU) in Raichur district and Chitradurga Gold Unit (CGU) in Chitradurga district.

The M/s HGML has gold reserves of around 15.28 million tones @ 4.41 g/t as on 01-04-2018 in its mining lease hold areas. The company has employee strength of 4160.It is operating three eco-friendly mines i.e. Hutti Gold Mine, Uti Gold Mine and Hira- Buddinni Gold Mine. The M/s HGML has produced so far 94.36tonnes of gold from its lease hold areas. Currently, the company is in the midst of implementing an ambitious Exploration, Mine and Metallurgical expansion plan to enhance its gold production capacity. The Corporate Social Responsibility (CSR) initiatives are not limited to the company's operational areas alone but extended to corners of the state.

The lengthy process of prospecting, exploration, developing and establishing new gold mines in the country should receive serious consideration at all level of decision making.

The paper deals about the geology, mineralization, exploration and mining status of the Indian Gold Deposits.

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UPGRADATION OF LOW GRADE ORE- STRATEGIES WITH EXISTING AND NEW TECHNOLOGIES

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Depletion of high grade ores and modern mining mechanization lead to the generation of fine sized run-of-mine. Also high interlocking relationship between valuable mineral and gangue in low grade ores restricts its subsequent beneficiation. Direct or indirect deportment of such fine particles to tailings results into more tailings accumulation than concentrate production. Recycling and disposal of such huge amount of tailings are now the prime concern for many industries from both economic and environmental aspect. In addition to this, a large part of existing plants have outlived their lifespan. They either need modernization or incorporation of newer technologies to compete with present scenario. Keeping in mind the decreasing grade and size of the ore, possibilities for redesigning the existing process circuits with minimum investment or replacement of certain units with modern equipment or entirely new and development of process flowsheet is the possible solution to this problem.

The paper outlines the potential of new equipment and methods for application to the low grade, finer feeds and tailings.

THE METALLURGICAL PLANT – EVOLVING SCENE HUTTI GOLD MINES

Shri Prabhakar Sangurmath, Shri C.R Ravi
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Abstract

The pursuit of gold has been there since time immemorial.The Hutti Gold Mines of M/s The Hutti Gold Mines Co Ltd (M/sHGML) is the world oldest metal mine.The Hutti Gold Mines Company Limited (HGML), a Karnataka Govt. Undertaking is the premier and major producer of gold from gold ore in India. The gold extraction process from gold ore involves multiple activities like exploration, mining & metallurgical processing of ore.The Metallurgical Plant of Hutti Gold Mine is probably one of the ancient processing plant, dating to the Pre-Ashokan period. Between 1887 and 1920, nearly 7.40 tonnes of Gold was recovered from a very rich ore, at an average yield of 19 gms/tonne.

In 1937, the Nizam's Government decided to prospect the area with a view to reopen the mines. In 1940, based on favourable exploratory result, it was decided to install a processing plant to treat 100 TPD, but before the plant could be commissioned, mining operations were suspended from 1942 to 1946 due to World War-II. The mine was shut down and only dewatering was carried out. After the war, the Hyderabad Gold Mines Co. Ltd., was formed in 1947, and regular mine production started in Sept-1948 at the rate of 130 TPD. By 1972, this was progressively increased to 600 TPD.

In the year 1979, this was increased to 910 TPD and in the year 2010 capacity was increased to 2000TPD.From the inception of the process plant it has undergone many changes for the improvement. In the beginning only gravity recovery of gold was carried out by using Pebble Mills and Strake Tables. Later amalgamation, Cyanidation and Zinc precipitation and finally Carbon-in-pulp gold recovery system was implemented. Grinding plant was modernized by implementing SAG and Ball Mill and Knelson concentrator for free gold recovery as a result the rate of production and recovery enhanced, Modernization and expansion of process plant has also yielded in safe and eco-friendly extraction process plant.

Recent explorations have revealed the presence of large quantities of sulphidic refractory gold ores in which gold is associated with pyrite and arsenopyrite. In order to establish the techno economic feasibility of these deposits through bio-oxidation a pre-treatment route, the project was initiated jointly with Indian Institute of Science (IISc), Bangalore funded by Department of Biotechnology, Govt of India

and Hutti Gold Mines Co Ltd. The Engineers India Limited, New Delhi, given the design for the Demonstration bio-reactor plant.

The G.R.Halli & Ajjanahalli ore was mined & treated at Ingaldhal (C.G.U). As the mining progressed the gold recoveries slided lower side, which is not economically viable. The ore from the G.R.Halli & Ajjanahalli ore were tested. It was found that, both G.R.Halli & Ajjanahalli ore deposits are typical "Refractory ores". Conventional fine grinding and direct cyanidation given unacceptably low gold recoveries and it's uneconomical. Therefore, pretreatment of these ores prior to cyanidation becomes necessary step to improve extraction efficiency. An integrated biotechnological approach to these deposits holds great promise and has the potential to replace traditional technologies (i.e. very fine grinding, roasting, pressure leaching etc).

Until recently, only free milling ore were treated, the refractory fraction in the deposits was simply discarded with the tailings. With the depletion of free milling ore reserves, interest in refractory ore has considerably increased. The standard process followed the treating refractory ore is to roast the sulphide. The residual calcine is treated by cyanidation. However roasting of sulphides is becoming less and less environmentally acceptable because of pollution of atmosphere by sulphur dioxide. Alternative hydro metallurgical process has been developed to replace roasting and very fine grinding is expensive. Bioleaching is one of these processes and is now recognized as technically and economically viable.

In this paper, an attempt has been made to present the growth of Metallurgical Plant and state-of-art metallurgical process followed.

Technical Session VI

Sustainable Mining & Development

USE OF MINERAL RESOURCES AND SUSTAIN ABILITY

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Abstract

This paper deals with the uses of mineral resources and their sustainability over their estimated lifespan.

It considers mineral resources that may be metallic or non-metallic in nature, inferred, indicated or measured and classified as per UNFC. It reviews the mineral resources available in India, their present rate of extraction, and ranking in world production.

It confabulates the self-sufficiency of various minerals in the country, and suggests their extraction in line with the legislative frame work like Mineral Auction Rules (2015), draft NMP (2018).It examines the industrial and domestic uses of mineral resources and considers their continuity.

Finally, it brings out the Sustainability of the resources with their usage over a period of time.

Key words: *sustainability, lifespan, metallic, non-metallic, inferred, indicated, measured, UNFC, ranking, confabulates, self-sufficiency, extraction, legislative frame work, mineral auction, NMP, Sustainability.*

Introduction

Indiais endowed with mineral wealth and produces89 minerals (4 fuel, 11 metallic, 52 non-metallic and 22 minor minerals).

India's major mineral resources include Coal, Iron ore, Manganese ore, Mica, Bauxite, Chromite, Natural gas, Diamonds, Limestone and Thorium (world's largest along coast of Kerala shores). India's oil reserves, found in Bombay High off the coast of Maharashtra, Gujarat, Rajasthan and in eastern Assam meet 25% of the country's demand.

Mineral Resource

A mineral resource is a concentration or occurrence of material of intrinsic economic interest in the earth's crust in such form and quantity that there are reasonable prospects for eventual economic extraction. The location, quantity, grade, geological characteristics and continuity of a mineral resource are known, estimated or interpreted from specific geological evidence and knowledge. Mineral resources are sub-divided, in order of increasing geological confidence, into Inferred, Indicated and Measured categories.

Different categories of resources include Metallic resources like Gold, Silver, Tin, Copper, Lead, Zinc, Iron, Nickel, Chromium, and Aluminum and Non-metallic resources

like sand, gravel, gypsum, halite, Uranium, dimension stone etc. A mineral resource is a volume of rock enriched in one or more useful materials.

Significance of Mineral Resources

They impact our way of life and the health of all the living beings. Minerals are critical to the Nation's economy and knowing where future mineral resources will come from is important for sustaining the Nation's economy and national security.

Uses of Minerals

From time immemorial minerals have found their utility in every walk of life, including construction, infrastructure, medicine, all the items of day to day use. Buildings use a wide range of minerals e.g. Iron (as steel) in the framework of large buildings, clay in bricks and roofing tiles, slate for roofing tiles, limestone, clay, shale and gypsum in cement, gypsum in plaster, silica sand in window glass, sand and gravel, crushed rock as aggregates for fill and in concrete, copper for plumbing and wiring, clays for bathroom fixtures and fittings and tiles, paint may include pigments, extenders and fillers from mineral sources.

With such a vast use and application in domestic as well as industrial establishments, a million-dollar question before us is how much of mineral wealth is available in earth's crust and how long can we sustainit, as minerals are non-renewable and finite resources.

UNFC Classification and Sustainable Resource Management

The United Nations Framework Classification for Resources (UNFC) provides countries, companies, financial institutions and other stakeholders a futuristic tool for sustainable development of energy and mineral resources.

UNFC applies to energy resources including oil and gas; renewable energy; nuclear fuel resources; mineral resources. The UN Framework Classification for Solid Fuels and Mineral Commodities was initiated in 1992.

National Mineral Exploration Policy

The Indian Mining Industry is undergoing significant transformation brought out by the legislations on mining like MMDR Act (2015) and Coal Mines Act (2015). The missing piece was a policy directive on exploration and the government has taken the first steps by releasing the National Mineral Exploration Policy.

Draft National Mineral Policy, 2018

The central government issued the draft National Mineral Policy (NMP), 2018, wherein it stated that a "long term export policy for the mineral sector" is the need of the hour as it will provide "stability" and "incentive" for bringing investments in "large scale commercial mining" activities. A long-term export policy for the mineral sector would provide stability and prove to be an incentive for investing in large scale commercial mining activity.

To develop mining as a stand-alone industry, substantial investment is required. Assurances on export of minerals will be a key factor for investment decisions particularly on foreign direct investment (FDI) in the

sector. The export policy should be based on a clear long-term strategy, the draft NMP stated.

Principal minerals and metals of the world

Table – 1, below indicates the Contribution and of Rank of India in world production of principal minerals.

While India holds Third position in the production of Coal & Lignite, it is ranked Fourth in the production of Chromite, Bauxite, Iron Ore and Steel.

India is self-sufficient in the production of the following metals and minerals:

Bauxite, Barite, Chromite, Dolomite, Ilmenite, Feldspar, Iron ore, Limestone, Manganese ore, Sillimanite, Rutile, Talc.

TABLE – 1

Contribution and Rank of India in World Production of Principal Minerals & Metals (2014-2015)

Commodity	Unit	Production		%	India's Rank
		World	India		
Mineral Fuels					
Coal & Lignite	MillionTonnes	8085	659	8.1	3
Petroleum Crude	MillionTonnes	4197	38	0.9	24
Metallic Minerals					
Bauxite	'000 tonnes	260,000	22,226	8.5	4
Chromite	'000 tonnes	30,000	2164	7.2	4
Iron Ore	MillionTonnes	3378	129	3.8	4
Manganese Ore	'000 tonnes	54,700	2,345	4.3	7
Industrial Minerals					
Barytes	'000 tonnes	9,300	910	9.8	3
Kyanite &Silimanite	'000 tonnes	403	72	18.8	3
Magnesite	'000 tonnes	47,700	276	0.5	12
Apatite,RkPhosphate	'000 tonnes	2,45,000	1580	0.6	17
Talc,Stealite,Porphyllite	'000 tonnes	8,300	774	9.3	3
Mica (Crude)	tonne	3,43.000	636	0.2	17
Metals					
Aluminium	'000 tonnes	53,000	2027	3.8	5
Copper (Refined)	'000 tonnes	22,600	766	3.4	6
Steel (Crude/Liquid)	MillionTonnes	1667	81.7	5.3	3
Lead refined	'000 tonnes	10,600	127	1.2	15
Zinc (slab)	'000 tonnes	13,600	733	5.4	3

(Source: MoM Annual Report 2016-17)

NATIONAL STEEL POLICY 2017

A vibrant Steel industry has historically been the foundation of a nation's rapid Industrial Development. On account of rapid industrial development, from a small capacity of 22 MT in FY 1991-92 prior to deregulation, India has become the 3rd largest steel producer in the world with a production of 90 MT and a capacity of 122 MT in FY 2015-16.

The National Steel Policy 2017 (NSP 2017) is an effort to steer the industry to achieve its full potential, enhance steel production with focus on high end value added steel while being globally competitive.

India's competitive advantage in steel production is driven, to a large extent, fromthe indigenous availability of high grade iron ore and non-coking coal – the twocritical inputs of steel production.

Value addition in Stainless Steel

Though India is 3rd largest producer of steel globally, it is still a net importer ofstainless steel used in high-end applications.

TABLE –2

Production, consumption, imports and exports of finished steel (*Million Tonnes*)

Period	Production for sale	Import	Export	Consumption
Apr 2016 – Jan 2017	82.9	6.1	5.9	68.9
2015-16	91	11.7	4.1	81.5
2014-15	91.5	9.3	5.6	77
2013-14	87.7	5.5	6	74

Source: Ministry of Steel, JPC

TABLE –3

Forecast of iron and steel demand and production by 2030-31

(All values in MT)

S.No.	Parameters	Projections(2030 – 31)
1	Total crude steel capacity	300
2	Total crude steel demand/production	255
3	Total finished steel demand/production	230
6	Sponge iron demand/production	80
7	Pig iron demand/ production	17
8	Per Capita Finished Steel Consumption in Kgs	158

Source: Ministry of Steel, INSDAG, MECON

Iron Ore Resources in India

Hematite and Magnetite are the most prominent Iron Ores found in India. As per United Nations Framework Classification (UNFC) of Mineral Resources,total resources of Iron Ore in the country are around 28.52 billion tonnes (as on 01.04.2010).

Out of 17.88 billion tonnes of Hematite, 8.09 billion tonnes are in "Reserve" category and 9.79 billion tonnes in "Resource" category.

While total resource of Magnetite is estimated at 10.64 billion tonnes of which Reserves are 0.02 billion tonnes and 10.62 billion tonnes are Resources.

Almost the entire present-day production comes from Hematite reserves. Magnetite reserves are not being exploited as they are mostly in eco fragile areas.

Iron Ore Occurrences in India

Distribution of Iron Ore Deposits:

The entire country has been divided into five zones of iron ore occurrences (Fig.1). Zone A coversthe deposits of Jharkhand and Orissa,

Zone-B Chhattisgarh and Maharastra,

Zone-C Karnataka,

Zone-D Goa and Redi and

Zone-EKudremukh, Bababudan and KudaChadari of Karnataka.

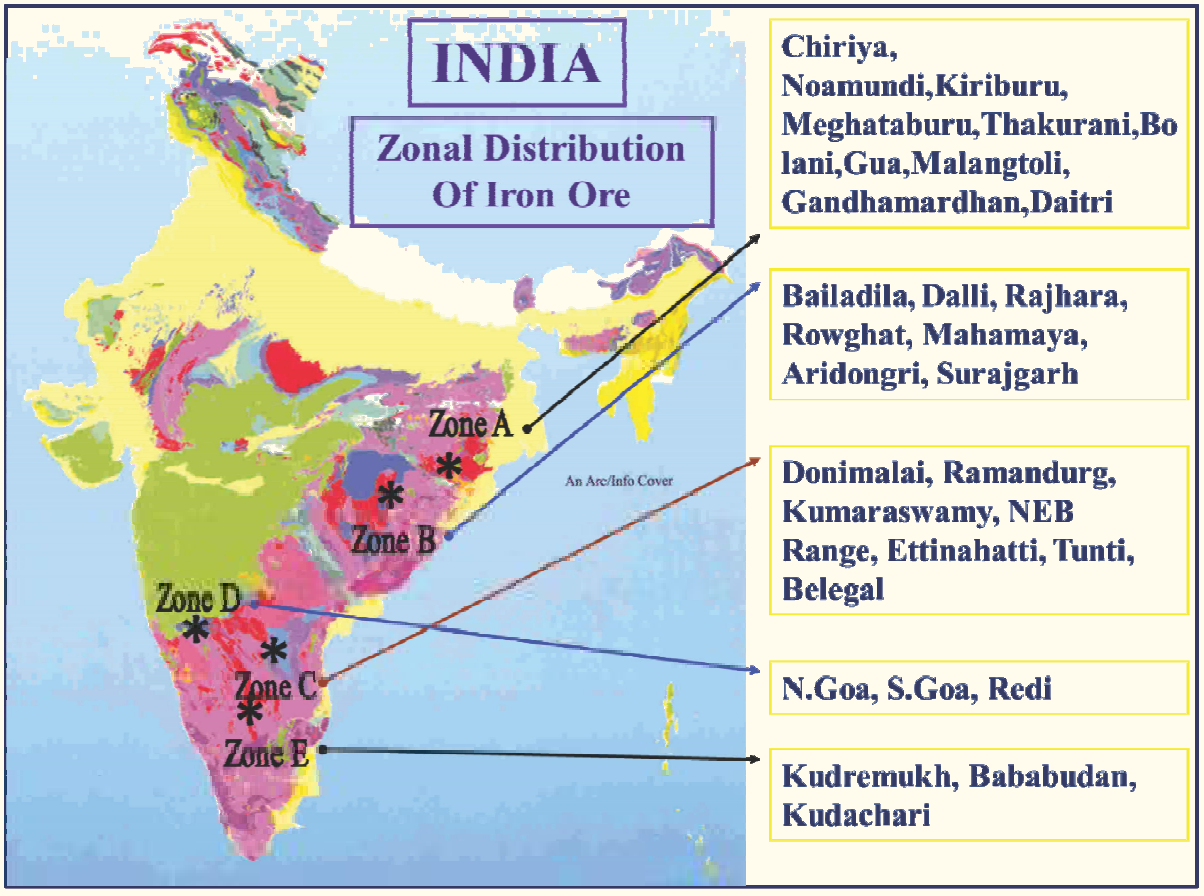


Fig.1 – Occurrences of Iron Ore in India

Production and Consumption of Iron Ore in India

There is no clear trend seen in Iron Ore production in India from 2000-01 to 2015-16. (Fig.2). However, a compound annual growth rate of 4.5% is observed in Iron Ore production during the above period.

Production of Iron Ore was 80587 thousand tonnes in India during 2000-01. Annual growth of 7% was seen in production of Iron Ore to 86226 thousand tonnes during 2001-02 over the preceding year.

Annual growth of 13.61% was observed in production of Iron Ore from 187696 thousand tonnes during 2006-07 to 213246 thousand tonnes during 2007-08.

Annual de-growth of -0.13% was seen in production of Iron Ore to 212960 thousand tonnes during 2008-09 over 2007-08. We have observed an annual de-growthof -15.16% in production of Iron Ore from 152433 thousand tonnes during 2013-14 to 129321 thousand tonnes during 2014-15.

We have seen an annual growth of 20.56% in production of Iron Ore to 155910 thousand tonnes during 2015-16 over the preceding year.

A maximum annual growth of 23.99% was observed in production of Iron Ore in the year 2003-04.

A maximum annual production of 218553 thousand tonne was recorded in production of Iron Ore in 2009-10.

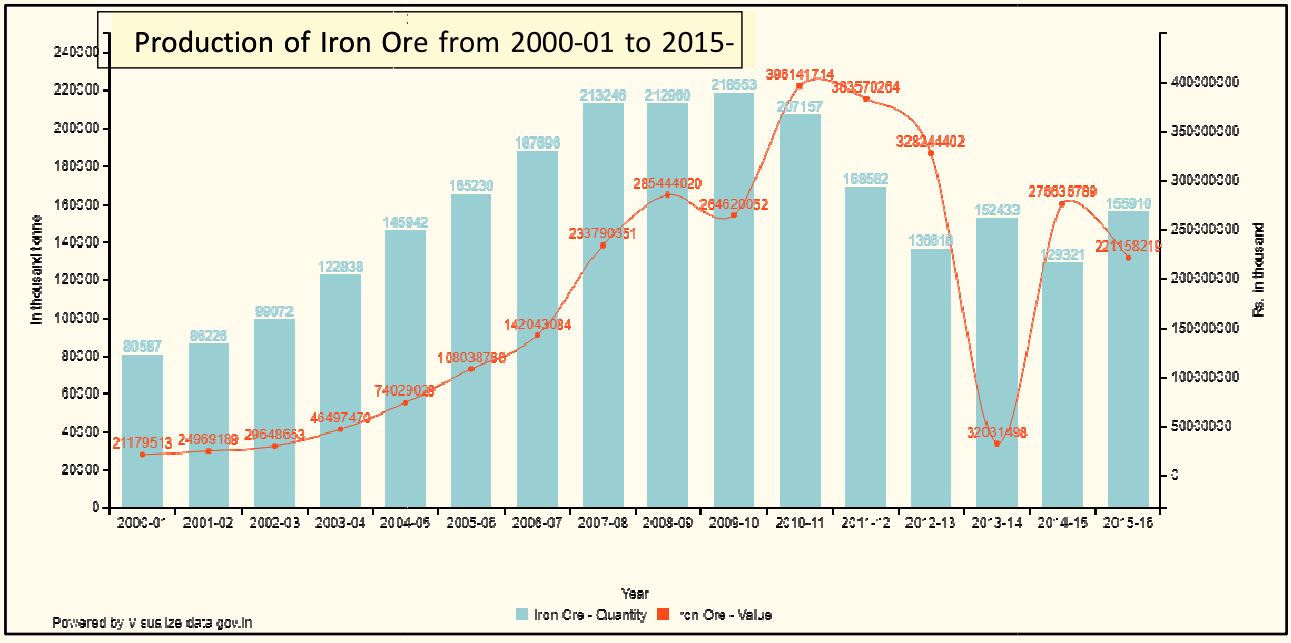


Fig. 2 – Production of Iron Ore in India from 2000-01 to 2015-16

Iron Ore Consumption in India

Total domestic consumption of Iron Ore during 2009-10 was around 90 million tonnes. Of this, 98% accounted for the steel industry and 2% was consumed by cement, coal washers, ferro alloys and other industries. (Fig.3)

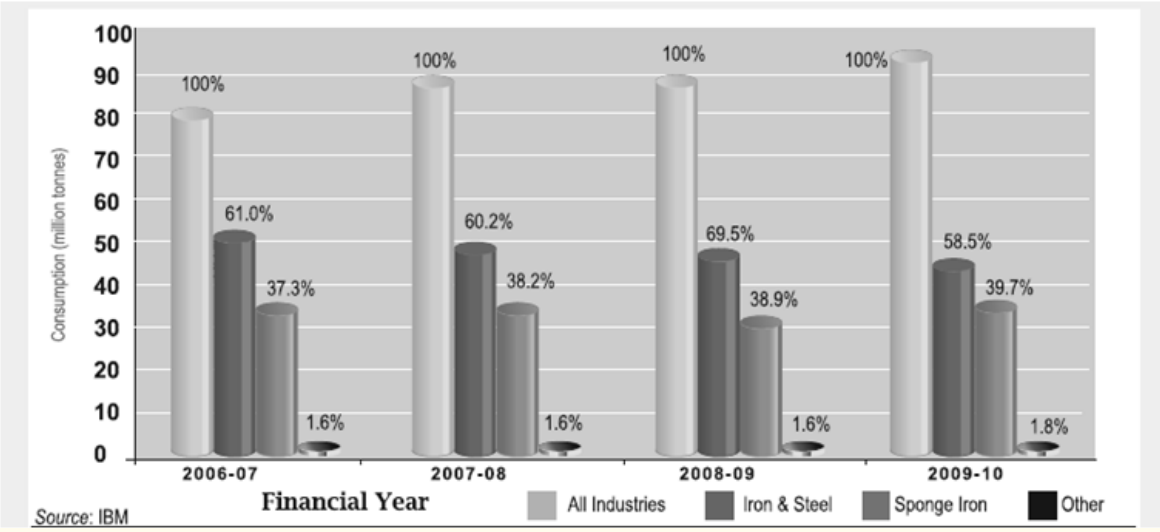


Fig.3 – Iron Ore Consumption in India (2006-2010)

Coal Production and Consumption

India's coal dependence is borne from the fact that 54 % of the total installed electricity generation Capacity is coal based. Furthermore, over 70 % of the electricity generated is from coal based power plants.

In order to achieve economic growth of 8-9% in terms of GDP, country's total coal demand has been projected to increase from ~ 730 million tons in 2010-11 to ~ 2,000 million tons in 2031-32. Of this, about 75 % of coal would go to power plants. Given the projected increase in coal requirement, the domestic coal industry alone cannot fully meet the demand.

Table – 2 below depicts the reserve position of Coal in the top 10 countries in the world. India occupies fifth position with 60.60 billion tonnes of Coal Reserves.

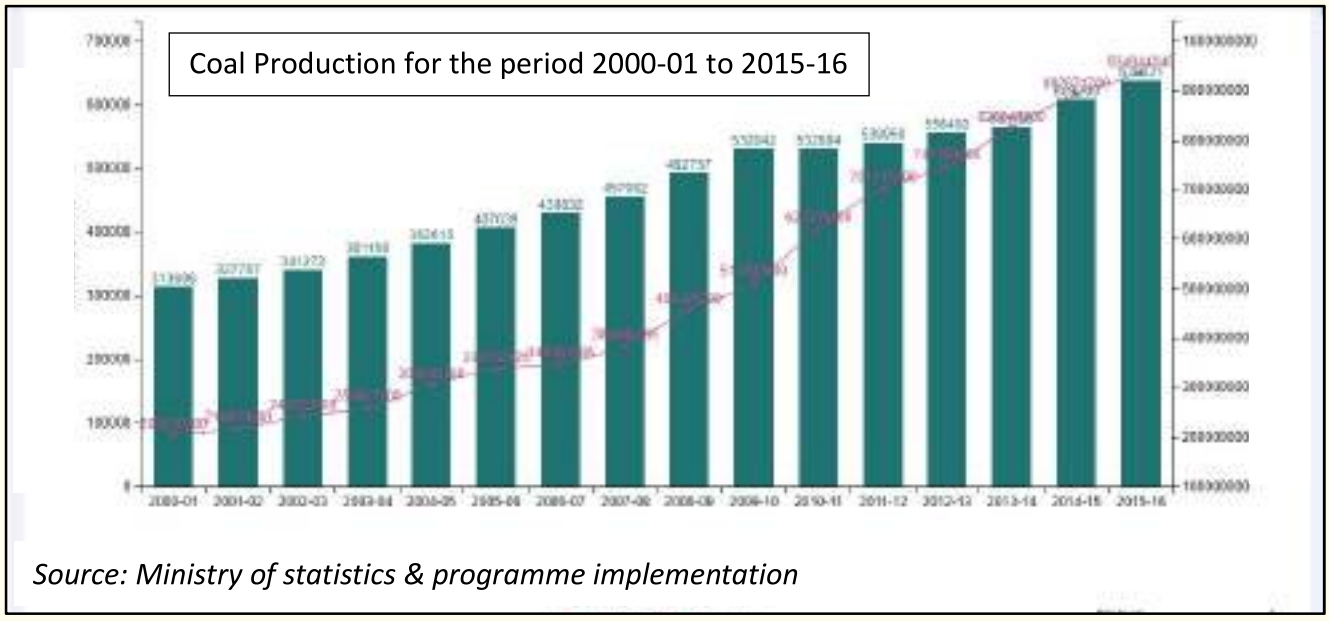
The total reserves of coal in the world are estimated at 1.1 trillion tonnes, expected to last for about 150 years.

Fig.4 indicates the production of Coal for the period –2000-01 to 2015-16

TABLE – 4

Countries with the biggest Coal Reserves in the World

Country	Reserve (Billion Tonnes)	Position
USA	237.295	1
Russia	157.01	2
China	114.50	3
Australia	76.40	4
India	**60.60**	**5**
Germany	40.70	6
Ukraine	33.873	7
Kazakhistan	33.60	8
Colombia	06.746	9
Canada	06.582	10



Source: Ministry of statistics & programme implementation

Fig.4 - Production of Coal for the period – 2000-01 to 2015-16

TABLE – 5

Consumption of Coal by different Industries in India

Consumption of Raw Coal by Different Industries

(Million Metric Tonnes)

Year	Electricity	Steel & Washery	Cement	Railways	Paper	Cotton @	Others *	Total
1970-71	13.21	13.53	3.52	15.58	0.27	1.45	23.67	71.23
1973-74	16.64	13.78	3.65	13.92	1	1.78	26.89	77.66
1978-79	24.8	20.26	4.88	12.13	1.72	2.34	34.02	100.15
1979-80	30.03	19.85	3.87	11.36	1.54	1.99	36.89	105.53
1984-85	57.66	25	7.29	9.46	2.83	2.57	36.64	141.45
1989-90	108.32	30.61	9.53	5.8	2.9	2.7	43.564	203.424
1990-91	113.71	30.91	10.43	542	2.81	2.58	47.68	213.36
1991-92	126.84	34.03	10.8	5.06	2.67	1.96	50.97	232.33
1996-97	199.62	39.76	10.08	0.14	3.51	1.311	44.199	298.62
2001-02	265.191	30.036	14.847	-	2.775	0.936	35.955	349.74
2002-03	267.9	30.603	16.359	-	2.788	0.721	43.374	361.745
2003-04	279.956	29.671	16.634	-	2.513	0.522	50.109	379.405
2004-05	305.348	34.43	18.097	-	2.612	0.464	46.457	407.408
2005-06	316.486	32.416	18.08	-	2.773	0.288	63.214	433.257
2006-07	331.58	34.9	19.67	-	2.62	0.303	73.251	462.324
2007-08	360.735	39.017	21.351	-	2.642	0.366	78.549	502.66
2008-09	407.49	40.986	21.787	-	2.947	0	64.58	537.79
2009-10	411.06	41.11	21.34	-	3.5	0.270	110.200	587.48

* Includes jute, bricks, coal for soft coke, colliery, fertilisers & other industries consumption.

Source: IEB 2012

TABLE - 6

Projected Coal Demand (2021-2032)

Table-1 : Projected Coal Demand (Million Tons)							
Sector	2005-06	2006-07	2011-12	2016-17	2021-22	2026-27	2031-32
Electricity (A)	310	341	539	836	1,040	1,340	1,659
Iron & Steel	43	43	69	104	112	120	150
Cement	20	25	32	50	95	125	140
Others	53	51	91	135	143	158	272
Non-elect. (B)	116	119	192	289	350	403	562
Total (A) + (B)	426	460	731	1,125	1,390	1,743	2,221

Source:IEB 2012

TABLE – 7

Forecast of major raw material requirement for Steel production by 2030-31

(*All Values in MT*)

SN.	Raw materials	Projections (2030-31)
1	Iron ore requirement	437
2	Coking coal requirement	161
3	Non-coking coal requirement for PCI	31
4	Non-coking coal requirement for DRI	105
5	Natural Gas (in MMSCMD5)	20
6	Manganese ore requirement	11
7	Chromite ore requirement	5
8	Limestone & Dolomite requirement	86
9	Ferro-alloys	4
10	Refractories	3
11	Scrap	16

Source: Ministry of Steel, MECON

Conclusion

As the earth is finite, it is intuitively appealing to consider mineral resources as static.

As discussed in the paper, the minerals of Coal and Iron ore, the prime ingredients for Steel, have limited resources and as per the National Steel Policy, the proposed level of Steel production by 2030 would be 300 MT. That means a faster depletion of the resources which are finite and would last for a limited period depending upon their usage / depletion! Therefore, it is imperative to explore the possibilities of alternative energy against thermal energy - Solar energy / Wind energyas an alternative!

It would be advisable to adoptThree'R's – Reduce / Reuse /Recycle which would ensure in economizing on the use of resources.

At the Historic Agreement on Climate Change at the Paris Convention (UNCCC-2015), France has made the following commitments:

1. End sales of all Petrol and Diesel Vehicles by 2040 as part of the Paris Agreement – to ensure saving on oil / petroleum products.

2. France would no longer use Coal to produce electricity after 2022- to preserve the natural resource.

3. €4 billion will be invested in boosting energy efficiency.

Mineral resources have been used for millennia and are a key to society's development. With the growing importance of new technologies and the energy revolution, and uncertainty regarding the future availability of resources of metals and industrial minerals, it is essential to ascertain the actual lifespan of each mineral deposit and find alternative technologies / substitutes for them. For example, the use of Fibre Optic for copper wire, Rare earth metal Samarium Cobaltor Scandiumas substitute forCobalt in magnet, Production of synthetic nitrate fertiliser etc.

Acknowledgements

The author is deeply indebted and highly thankful to Dr.MedaVenkataiah, ED, MSPL and Principal Convenor, Mr Dhananjay G. Reddy, the Convenor and the organisers of the National Conference on "Future Trends in Mining" for providing me the opportunity to present this paper.

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SUSTAINABLE MINING

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The mineral industry in India is an important contributor to the Country's GDP and foreign trade and also a significant source of employment generation. The industry is distributed almost all across the country and has operations in some of the remotest areas, where it has also serves as a sole source of infrastructure development.

Geological evidence suggests that India is richly endowed with mineral resources. Explanations have established over 20,000 known mineral deposits. India produces 89 mineral, out of which four are fuels, 11 metallic, 52 non-metallic, 3 atomic and 23 minor minerals. The mining leases occupy about 0.7 % million hectares, which is 0.21% of the total land mass of the Country. The Indian economy depends to a great extent on the value of the minerals produced, as these represent a major portion of raw materials for the nation's industrial activities. India is the third largest producer of coal in the world and one of the World's leading producers of bauxite, iron ore and zinc ore.

India's major mineral reserves lie under its richest forests and in the watersheds of its key rivers- these lands are also the homes of India's poorest people, its tribals. The three tribal dominated States of Jharkhand, Odisha and Chattisgarh are the most productive mineral bearing States and account for about 70% of India's coal reserves, 80% of its high grade iron ore, 60% of its bauxite and almost all its chromite reservoir. Forest cover in these States is far higher than the natural average of the top 50 mineral-producing districts in the country, almost half are tribal where average forest cover is 28% much more than the natural average of about 21% An estimated 1.66 lakh ha of forest land has been diverted for mining in the country. A large part of the country's mineral bearing areas are in the grip of nexalism. 40% of the mineral– rich districts in the top six mineral producing States are affected by the naxal movement which is opposing the lopsided development that mining brings in.

Indiscriminate and unplanned mining causes irreversible damage and deterioration of natural resources. Mining activities affect surrounding i.e. air, water, soil, land, biological diversity etc. apart from the society. The environmental, social and economic impacts of mining activities may have short-term as well as long-term implications. Guidelines for taking necessary precautions before, during and after mining operations are laid down to ensure

sustainable development. The role of mining in sustainable development is one issue that decision makers and resource managers have wrestled with for decades. Mining is one of those activities that really connect issues relating to people, development, and the environment. The negative impact of mining on health, land, water, air, plants and animals, and other aspects of society can be reduced by careful planning and implementation of mining activities. It is essential to strike a balance between mineral developments on the one hand and the restoration of the environment on the other.

Increasing globalization of the mining industry has led to changing public attitudes regarding the costs and benefits of mineral extraction and an increase in public pressure to minimize the environmental and social costs associated with mineral development. When the environmental impacts of mining operations are not properly managed and mitigated, it is often too costly to restore mined lands to beneficial use once mineral deposits have been exhausted, leading to a net reduction in available land. It is therefore essential that the Indian minerals industry follows the principles of sustainable development by using methods and practices that minimize the release of contaminants to water, air and soil, preserve and restore lands for future use, and manage displaced populations.

Mining is a vital segment of the Indian economy. Appropriate systems have been put in place to ensure sustainable growth of the sector, which include formulation of procedures for scientific prospecting and mining and development of a mechanism of prior environmental and forest clearances for mining projects. Our endeavor is to protect the health and safety of mine workers and the surroundings, as well as to safeguard the interests of indigenous people through rehabilitation and resettlement packages. Efforts are also under way to mainstream the artisanal and small-scale mining sector in order to promote equity in the mining industry. The issues of scientific closure and reclamation of the abandoned mine sites and the exhausting ones are being taken on top priority by various policy instruments. Sustainable Development Framework (SDF) as formulated under the Natural Mineral Policy 2008 is in place to promote sustainable mining.

WASTE MANAGEMENT AT MINES

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Zero Waste is a new vision for a new millennium.

It is a goal, a process, a way of thinking that, profoundly changes our approach to use resources and production. With population growth the needs of mankind is increasing. It is necessary to conserve the natural resources. Hence, it is necessary to discuss seriously and adopt the possible methodology.

The mining industry produces several billion tonnes of solid inorganic wastes or by-products through its mineral processing operations. As a result, stockpiles of waste are growing exponentially as dwindling reserves push miners into increasingly diluted ore bodies. At the same time the environmental impact of mining operations is coming under intense scrutiny

Benefits and Opportunities of Zero Waste

It is directed at:

- Finding cost savings and new revenues in existing operations
- Creating new markets
- Developing new technologies, processes and products
- Addressing cumulative effects of production and consumption
- The Environmental costs of extracting Virgin resources
- Problems of land fill
- Conserves natural resources.

Steps in Zero Waste Management

The principles of waste management and fundamental steps are as follows:

- Prevention
- Recovery
- Disposal

Possible steps.

- Long term planning with exploration data.
- Drilling and blasting to avoid loss of mineral.
- To avoid losses in the operation of transport, processing, handling.
- Identifying economical beneficiation methods of low grade ores.
- Identifying future raw material

Research & Development:

New developments in Metallurgy to use low grade ores

Improvements of Process/Equipments in mineral beneficiation.

Technical Session VII

Legislation, Amendments

AMENDMENT OF MINERAL LEGISLATION IMPACT ON MINING/MINERAL INDUSTRY AND WAY FORWARD

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Abstract

Government of India has introduced major amendment to Mines & Mineral (Development and Regulation) Act, 1957 during 2015 and also enacted a relevant rules to enable implementation of the Act. This has brought in a sea change in allocation and administration of mineral resources in the country. In view of the amendment, the existing leases are extended up to 31st March 2020/2030 depending upon whether they are stand alone or captive. After this period, these mineral blocks shall be put up for auction. This is going to greatly affect sustainable mining in the country. Both mining and mineral based industry are feeling the possibility of a greater vacuum after 2020.Through amendment, Government of India has given powers to State Governments for granting mineral concessions to all minerals except energy and atomic minerals. Though this move is towards decentralisation, the State Governments and their Departments are not really prepared to take this responsibility.

At present, the only route for grant of new mineral concessions is through auction except non-exclusive reconnaissance permit. Even after two years of amendment, auction of new mineral concessions are far and few. Mineral concessions auctioned about 2 years back are nowhere near production. Though, there are apprehensions on the success and utility of NERP to the industry, even to this day States are not prepared for acceptance of applications for NERP.

Amounts collected under District Mineral Foundation and National Mineral Exploration Trust have accumulated and are considerably huge. This amount needs to be properly utilized and a road map is required for this purpose.

Above situation calls for serious look in to the whole system and remedial measures have to be initiated. In this paper, issues which have cropped up after amendment and suggestions to overcome these issues have been discussed.

IMPLEMENTATION OF SUSTAINABLE DEVELOPMENT FRAMEWORK (SDF) IN THE MINING SECTOR AND ITS REVIEW

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ABSTRACT

Minerals form the basic raw materials for most of the core sectors of our economy. Therefore, harnessing of mineral wealth is an important economic activity for developing economies. India is also blessed with hosts of mineral deposits and mineral industry is contributing significantly in the economy of our country.

At the same time, it is a fact that most of the mineral rich areas in the country are situated in forest and tribal areas, which needs development and integration in the mainstreams. Besides exploration, development, production and disposal of minerals affect the environment & ecology of the area. This has necessitated policy approaches and systems that ensure that mining activities are carried out in a way that causes least damage to the natural resources. Keeping in view, the National Mineral Policy 2008 advocated for designing a framework of sustainable development (SDF) which takes care of bio-diversity issues and to ensure that mining activity takes place along with suitable measures for restoration of the ecological balance.

As part of roll out of SDF, the Union Ministry of Mines through Indian Bureau of Mines has brought out a concept of star rating evaluation of mines. Under the star rating scheme, a credible system of evaluation of mining footprints and to take up mining activity, encompassing inclusive growth, without adversely affecting the social, economic and environmental well-being has been developed. Suitable legislative provisions have also been made in the Mineral Conservation and Development Rules 2017. In this direction the star rating templates have been designed to capture leaseholder's information on managing impacts at the mine level, progressive and final mine closure and landscape restoration, addressing social impacts of rehabilitation and resettlement requirements, community engagement & welfare programmes and assurance and reporting. Indian Bureau of Mines has developed online system for filing and validation of these templates. The present paper deals with details of the SDF and the concept of star rating of mines.

PROS AND CONS OF THRESHOLD VALUES FOR THE ATOMIC MINERALS

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Atomic Minerals Concessions Rules , 2016 has been enforced with threshold values of elements like U, Th, Nb, Ta, Be, Li etc. The threshold values for U_3O_8 is 60 ppm, ThO_2 , 250ppm and Nb_2O_5, 100ppm, Ta_2O_5 100 ppm, BeO 0.1% , Li_2O 5000 ppm in rock and Li 200 ppm in brines. In case of beach sands 0.75 % monazite is the threshold value. Whereas, Mineral Concession Rules, 1960 held the idea of atomic minerals that in any mineral concession if atomic minerals exist, that will be handed over to Department of Atomic Energy. With this rules Department of Atomic Energy has been benefitted greatly because most of the beryl and columbite-tantalite or lithium mineral stockpile in the country has been made as a byproduct of mica mining in Bihar Mica Belt and tin mining from Bastar Pegamatite Belt.

Natural ores cannot be governed by the threshold values, and the Atomic Minerals cannot be properly conserved with this rule. The threshold values for Singhbhum area in Jharkhand is 150 ppm, whereas in other parts of the country it is 60 ppm, this is a proof of the fact that natural ores cannot be governed by any threshold or any mathematical value.

Under such circumstances instead of natural ores certain cut off grade should be introduced indicating that mineable or non-minable grades could be considered. For example in case of uranium deposits of the world and India cut off grade varies from 100 ppm to 300 ppm, therefore at least lowest cut off grade of 100 ppm should have been considered. Likewise, for other atomic minerals also cut off grade criteria would have been more logical rather than present threshold values.

With the given logic threshold values either could be upgraded to cut off grades which however should vary depending upon the market price of the commodities or the old rules of separating the atomic minerals from the lease areas while mining for some other commodities. This will ensure proper monitoring of the safe disposal of atomic minerals.

The concept of threshold values in ore is brought for the first time with the facts mentioned needs reconsiderations.

A NEW APPROACH TO MINING – POST AUCTION SCENARIO

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Introduction & Background:

India has abundant reserves of iron ore for meeting the growing demands of Steel & Sponge Iron Industries. Whenever the extraction of mineral or overexploitation of mineral is carried out in an un-scientific and unsustainable manner, it becomes highly detrimental to the environment, maintenance of eco-system and also disturbs the Socio-economic equilibrium of the local people.

Mining activities in Karnataka and various states has caught the attention of General public, print and Electronic media, Government and Judiciary for all the wrong reasons in field of mining. Considering the severe and significant damages caused due to unscientific and unregulated mining mainly in Karnataka, Goa and Odisha, the governments appointed the Enquiry Committees like Lokayuktha, Shah Commission, etc. to look into the extent of illegalities carried out.

In case of Karnataka, based on the report of the Lokayuktha & subsequently on the findings of the CEC, the Hon'ble supreme court of India vide its order Dated: 29.07.2011 & 26.08.2011 imposed complete ban on mining in three districts Bellary, Chitradurga & Tumkur because mining has been done in an environmentally unsustainable manner and without taking into consideration the essence of inter generational equity, large scale illegalities and irregularities.

Particularly in Karnataka, The Hon'ble Supreme Court of India directed Indian Council of Forestry Research and Education (ICFRE) to undertake Micro level EIA study and based on the Macro Environmental Impact Assessment (EIA) report submitted by ICFRE, directed the Government of Karnataka to submit a Reclamation and Rehabilitation (R&R) plan for the mine affected districts, which is a pre-requisite for re-opening of mines.

The ban imposed on the Iron Ore Mining significantly started affecting the value added plants like integrated steel plants, sponge & allied industries. Considering the said factor the Hon'ble Supreme Court of India allowed auction of material lying at various mine head, stockyard & also sub grade dumps through E-Auction to be conducted by Monitoring Committee &Vide

its order Dated: 03.09.2012 & 18.04.2013 accepted the recommendations made by **CEC regarding:**

Reopening of Category "A" & Category "B" Mines.

Cancellation of Category "C" Mines and auctioning amongst the existing end users.

There were some impacts of illegal Iron ore mining especially in three districts of Karnataka namely Bellary, Chitradurga & Tumkur which are mentioned below:

Categorization of Leases into A, B & C Categories based upon the Illegality (Encroachment & Dumping Issue).

- Penalty for Leases found Partial or Marginal Illegal (B Category Leases).
- Cancellation of '51' C Category Leases.
- Formation of Monitoring Committee to look out E-Auction & other financial aspects and R&R Work.
- Auction of Iron Ore through E-Auction Platform.
- Reclamation and Rehabilitation (R&R) plan for the mine affected districts, which is a pre-requisite for re-opening of mines.
- Constitution of "Special Purpose Vehicle (SPV)" for the development of Mining affected areas.
- Introduction of Integrated Lease Management System (ILMS) by DMG & Forest Produce Tracking System (FPTS) by Forest Department for Transportation of Iron ore (Dispatch through Online Platform).
- Auction of Cancelled 51 'C"Category Leases through E-Auction (Transparent Bidding Process).
- Capping of Production Quantity to 30 MMTPA (recently enhanced from 30 to 35) combining Bellary, Chitradurga & Tumkur districts.
- Stock Yard Permission granted earlier were Cancelled & further no such permissions for Stock yard will be given.
- Material Value, Royalty, FDT, Service Tax, GST and other Payments to be made by Buyer to Monitoring Committee as per the orders of Hon'ble Supreme Court.

Reforms in Mining Legislations:

The process of bringing out new MMDR Act pursuant to the announcement of National Mineral Policy 2008, was initiated by the GOI in the year 2008 itself by way of constituting the HUDA committee. Reforms in the mining sector were brought about by amending the Mines and Minerals (Development and Regulation) (MMDR) Act, 1957 through the MMDR Amendment Ordinance, 2015 which was promulgated on 12th January, 2015.

The Act was further amended in 2016 to allow transfer of mining leases granted otherwise than through auction for captive purpose. In view of the judgment of Apex court with regard to allocation of natural resources for improving transparency in allocation of mineral resources, the concept of auctioning of mineral concessions is introduced for the first time, after the act was framed in the year 1957.

The Mines and Minerals (Development and Regulation) Act, 1957 regulates the mining sector in India and specifies the requirement for obtaining and granting mining leases for mining operations.

The promulgation of Ordinance became necessary to address the emergent problems in the mining industry. In the last few years, the number of new Mining Leases granted in the country have fallen substantially. In addition, second and subsequent renewals have also been affected by Court judgments. As a result, the output in the mining sector has come down drastically, leading to import of minerals by users of those minerals.

The Act and Rules provide regulatory framework for administration, regulation and development of mineral sector in the country.

The salient provisions of the Ordinance are listed below:

- Removal of discretion, auction to be sole method of allotment.
- Impetus to the mining sector.
- Safeguarding interest of affected persons.
- Simplification of procedure and removal of delay.
- Direct auction for mining leases for bulk minerals, auction of prospecting licenses-cum-mining leases for deep-seated minerals.
- Uniform lease period of 50 years, no renewalsas in the earlier system & auction at the end of lease period and will solve issues arising out of all SC judgments on second and subsequent renewals.
- Transition period of minimum 15 years for captive mines and 5 years for other mines. No sudden stoppage as a result of amendment. Central Government to frame separate rules for atomic minerals.
- The previous approval of the Central Government will not be required for grant of mineral concession except for Atomic Minerals, Coal and Lignite.
- Enabling powers for reservation for the public sector to continue.
- Higher penalties and jail terms for offences &special courts may be constituted, if necessary
- Powers to Central Government to intervene even where State Governments do not pass orders within prescribed time lines, this will eliminate delay.
- Assured tenure and easy transferability of concessions granted through auctions, in order to attract private investment and Foreign Direct Investment.

The most important provision of the MMDR Amendment Act, 2015 is:

- The grant of mineral concessions, for major minerals, through auction by competitive bidding which is a transparent and non-discriminatory method(earlier it was the 'first-cum first serve' mechanism of mineral blocks allotment) and which will also obtain for the State Government its fair share of value of the mineral resources.
- Constitution of District Mineral Foundation (DMF) to take care of people and areas affected by mining related activities.

- Stricter punitive provisions to deter illegal mining, wherein penalties have been increased from Rs. 25 thousand per hectare to Rs. 5 Lakh per hectare and the term of imprisonment has been increased from 2 years to 5 years.
- National Mineral Exploration Trust (NMET) to be set up for impetus to exploration Easy transferability of concessions obtained through auctions so as to attract private investment and FD and also for regional and detailed exploration.
- Transition provisions for extension of existing leases to obviate disruptions in supply of ore and to ensure regular supply of raw material to the industry.

National Mineral Exploration Policy, 2016 has been notified in July, 2016.

The policy inter-alia, provide for:

- Sharing of baseline geo-scientific data free of cost in public domain as a public good.
- Aero-geophysical survey of the country in a mission mode, initially in the obvious geological potential [OGP] area of about 8.0 lac sq. kms and subsequently in the rest of the areas.
- A pilot project over OGP area of about 2.06 lakh sq. km. has been initiated.

The following rules have been framed under the MMDR Amendment Act, 2015:

- Minerals (Evidence of Mineral Contents) Rules, 2015
- Mineral (Auction) Rules, 2015
- Mines and Minerals (Contribution to District Mineral Foundation) Rules, 2015
- Mineral (Mining by Government Company) Rules, 2015
- Mineral (Non-exclusive Reconnaissance Permits) Rules, 2015
- National Mineral Exploration Trust Rules, 2015
- Minerals (Transfer of Mining Lease Granted Otherwise than through Auction for
- Captive Purpose) Rules, 2016
- Atomic Minerals Concession Rules, 2016
- Mineral (Other than Atomic and Hydro Carbons Energy Minerals) Concession Rules2016
- Mineral Conservation and Development Rules, 2017

Some State Governments have already conducted auction for grant of mineral concessions for major minerals and throughout India 35 blocks have been successfully auctioned& in case of Karnataka 07 mineral blocks have been auctioned and & third phase of auction of 09 Leases will be conducted with in short Span. Advisory to State Governments have also been issued to incorporate a transparent and non-discriminatory regime for grant of mineral concessions for minor minerals.

Further there was an amendment in the mineral auction process which will lead to enhanced participation in the auction process. Further, it is expected that this will also give a fillip to the auction process and will result in more mineral blocks being auctioned successfully. It is expected that by

March 2018, 34 blocks will be put through the process of auction.

Amendment to the Mineral Conservation and Development Rules, 2017 to Expedite the Auction Process:

The lease period of merchant miners extended under the section 8A(6) of the MMDR Act, would expire on 31 March, 2020.

There are about 288 mining leases which would expire in 2020, of which 59 are working leases, which givesubstantial production of key minerals viz. iron ore, manganese and chromite ore etc.

The auction process needs to beinitiated well in advance to ensure a seamless transition from the existing to the new lessees as the new auctioned leases and that the mineral production is not affected due to expiry of these leases. Exploration of the blocks was required to done for the auction process of these mineral blocks. The Central Government had earlier issued a directive in 2010 which mentioned that all the existing leases have to be brought to an exploration level of G2 or G1 in 5 years' time.

It has been further strengthened by inserting rule 12 (4A) in the Mineral Conservation and Development Rules, 2017 (MCDR) by way of an amendment notification, published in Gazette of India vide G.S.R. No. 289 dated 27.03.2018. The rule mandates exploration in G2 level as stipulated under clause (a) of rule 5 of the Mineral (Evidence of Mineral Contents) Rules 2015, to be carried out in the mining leases expiring in 2020 by 1 April, 2019.

The rule also lays down the timelines for implementation of the exploration plan prepared with the approval of IBM for satisfying the requirements.

Major Initiatives from Various Departments for monitoring scientific mining, curb illegal mining Activities& also related to Transparency of Auction of Leases :

'Star Rating' system:

A 'Star Rating' system has been instituted by the Ministry of Mines through Indian Bureauof Mines (IBM) vide notification no. 31/4/2016- M.III dated 23rd May, 2016,in which star rating is awarded to the mines for their efforts and initiatives taken for implementation of the Sustainable Development Framework (SDF). Rating of one to five stars is given to the mines by IBM.

The best performing leases is given 5 Stars. The amended MCDR, 2017 mandates that all working mines of major minerals would be required to have at least 4 star ratings within 2 years of the notification of these rules or the start of mining operations as the case may be. The Star Rating has been included as statutory provision in the MCDR for time- bound (2 years) achieving of minimum 4 stars.

A web enabled online system for evaluation of measures has been developed and launched on 18th August, 2016 as a vital step for ensuring compliance of environmental protection and social responsibility by the mining sector. A template for star rating of miner minerals is also being prepared.

Mining Surveillance System (MSS):

The Ministry of Mines, through Indian Bureau of Mines (IBM), has developed the Mining Surveillance System (MSS), in collaboration with Ministry of Electronics and Information Technology (MEITY) and Bhaskaracharya Institute for Space Applications and Geoinformatics (BISAG), Gandhinagar, to use space technology for facilitating State Governments in curbing illegal mining activities in the country. MSS uses the Satellite Remote Sensing Technology together with Information Technology.

MSS is a transparent & bias-free system, having a quick response time and capability of effective follow-up. The Mining Surveillance System has been launched on 15.10.2016.

Transparency, Auction Monitoring and Resource Augmentation (TAMRA):

In view to facilitate and expedite various clearances / approvals required after the mineral block is allocated, it had been decided at the apex level to constitute an Inter-Ministerial Group (IMG) and call it Post-Auction Mining Clearances and Approvals Facilitator (PAMCAF). Under PAMCAF, "TAMRA" which stands for Transparency, Auction Monitoring and Resource Augmentation" web based portal and Mobile APP has been conceptualized to provide the status of mining block auctioned/ to be auctioned in India to the public in a 'transparent' manner.

The objective to enhance transparency and accountability, as a part of the Ease of Doing Business in the Mining sector, TAMRA is a step to speed up mining activity in India and facilitate all the stakeholders to track the status of the statutory clearances associated with mining blocks for getting mines to reach till operationalization for the same. It will be an interactive platform for all the stakeholders to compress the timelines for statutory andother clearancesas it would help minimize the gestation period for commencing production.

TAMRA will send triggersto the concerned authority so that the remedial steps can be taken immediately by those responsible.The Ministry of Mines will also receive triggers generated by TAMRA, which willfacilitate in expeditingclearancesin case the timelines set against each of the statutory clearances are not met. Further, the status of each of the clearances will be reflected on the portal.

This portal also enables the successful bidder to give suggestions and other inputs for improving the current process of issuing Statutory clearances in the Mining Sector which would help to establish a participative and informative network among all stakeholders.

TAMRA covers block-wise, state-wise and mineral-wise information of the mines to be auctioned, monitors various statutory clearances, and also highlights the additional resources generated through e-auction

Conclusion:

There should be an environment of "Ease of Business" in the states to enhance the

production of Minerals in order to contribute towards growth of the Industrial production and growth of GDP in the country. Reforms in Mining legislations have bought greater transparency in the process and also higher revenue for the states.

In the context of Prime Minister's 'Make in India' initiative, it is imperative that auctioned blocks should commence production within the shortest possible gestation period. The objective of ease of doing business will get defeated if there is an undue delay in granting the requisite clearances. The MINES AND MINERALS (DEVELOPMENT AND REGULATION), (MMDR) Ordinance is a revolutionary step in revival of mining sector in the country.

The Government has been proactively using technology to deter illegal mining. An MoU was signed between Indian Bureau of Mines (IBM) and National Remote Sensing Centre (NRSC), ISRO in January 2016 to undertake a pilot project on "monitoring of mining activities using satellite imagery". Initiatives taken from various departments like star rating, MSS & also TAMRA will have complete& updated information and regular monitoring on mining activities so that there will be no deviations from rules and by which scientific and systematic mining can be done.

Technical Session VIII

Alternative System of Transportation
Downhill Conveyors and
Railway siding etc;

"SINGLE FLIGHT CONVEYOR"- ASTATE-OF-THE-ARTTECHNOLOGY

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Abstract

NMDC Limited is having two mines viz. Donimalai Iron Ore Mine and Kumaraswamy Iron Ore Mine at DonimalaiTownship area of Sandur Taluk, Ballari District in Karnataka. Both the mines are well accessed by road and about 22 KMs from nearest Airport (Vidyanagar / Ballari). The Donimalai Iron Ore Mine was established long ago and presently producing around 7 Million Tonnes of Iron Ore. Considering the consistent demand of the Iron Ore in Ballari-Hospet area for catering to the need of the domestic Steel Plants, NMDC has set up a new mine called Kumaraswamy Iron Ore Mine, which is around 10 KMs away from the Donimalai Township. The Mine has been developed with high level mechanization by providing large size Crusher of 1800 Ton per hour capacity along with "Single Flight Downhill ConveyorSystem" having similar capacity to convey 1800 Ton per hourof Iron Ore from Kumaraswamy Iron Ore Mine to the existing Screening Plantof atDonimalai which is about 5.2 KMs away.

The Single Flight Downhill Conveyor System is a unique system and it is considered as the first of its kind in India, havingthe technology of Triangular Gantry with self PropelledTrolleys for maintenance purpose. The unique features of the said belt conveyor are that it is having 4 nos. of Horizontal curves and 7 nos. vertical curves and having elevational difference of around (-) 220 mtrs. Further, this conveyor has been provided with unique features like automatic Fire Detection and Suppression System (FDSS), Belt turn-over arrangements located at Head-end and Tail-end to increase the life of the rollers and belts, noiseless and long life rollers from FMC, China, Belt Rip Protection System, etc. The details have been covered in the Technical Paper followed with this abstract. This Conveyor has been installed at Kumaraswamy Iron Ore Mine (KIOM) of NMDC Limited, situated at Sandur Taluk of Ballari District in Karnataka.

KIOM Plant is designed for a capacity of 7MTPA. The ROM is fed to the crushing plant to crush the ore to (-)100mm and it is conveyed to Existing Screening Plant / Proposed new Screening Plant at Donimalai, which is approximately 5.20 Km away from the Crushing Plant through a Downhill Conveying System.

Downhill Conveyor is a High Speed, trough Conveyor, supported inside a Triangular Gantries. Two Nos. of Self

Propelled Trolleys provide maintenance access to the whole elevated Conveyor sections. This Conveyor includes four Horizontal Curves and seven Vertical Curves. (4 nos. of Concave Curves & 3 nos. of Convex Curves).

Downhill Conveyor - 723 Details

Material Conveyed:	Iron Ore , (-) 100mm Max.Size
Conveyor Length:	5.02 kms.
Overall Elevation :	(-) 218.9 mtrs.
Belt Speed:	6.0 m/s
Power:	1600 kw,(2 x 800 kw) Regenerative type
Tonnage:	2,000 tph
Belt Strength:	ST-3150 STEEL CORD, 3150 N/mm

DESIGN FEATURES OF DOWNHILL CONVEYOR 723

The following are the main Design features for this Conveyor.

1) High Speed Conveying

The long downhill belt Conveyors operated at a speed of 6.0 m/sec, produces cost effectiveness as per following;-

- Narrow Belt Width,1050 mm
- 4 nos. of Horizontal Curves thus eliminating Transfer Towers
- Increased Idler Spacing
- Compact Triangular Gantry Design.

Due to selection of High speed for the conveyor, a small belt will allow the design of a lightweight Technological Structure, small curve radius and low material load on belt. With reducing material load, the idler spacing can increase therefore minimizing the idler quantities and also Idler roll raw material cost.

2) Conveyor with Horizontal Curves

In this conveyor, there are four horizontal curves included to reduce the need for an additional three transfer towers with structure, chutes, drives & electrical, dust extraction and maintenance / operating personnel thereby increasing the reliability ofthe total belt system.

3) Triangular Pipe Gantries

The gantry is fabricated from standard tube sections on to which conveyor technological structures are mounted. A significant feature of this gantry design is the absence of access walkways throughout length of Conveyor. So, it reduces structural cost. The tubular structure allows greater spans when compared to conventional profile steel design.

4) 3 Roll Return Side Idlers

To help control belt displacement, a three roll idler set is used on the return side of the conveyor. The use of a 3-roll return set increases the longitudinal stiffness of the belt. Therefore the belt flap and resonance is typically much better than a conventional two-roll VEE return system.

Furthermore, the idlers can be pitched farther apart, which offsets the cost of additional rolls. For example on a conveyor with a 4.0 m VEE returns spacing, a three-roll set could use 8.0 m. Therefore a smaller number of rolls and idler frames are required.

5) Belt Turn Over on Return side

Belt turnovers were also installed on the system. The turnovers served three distinct purposes:

- To keep the return side idlers clean. This increases the idler life and reduces maintenance and belt vibration.
- To prevent excessive fatiguing of the belt at the idler junction joint due the three roll return idlers.
- Reduce the belt tensions. The belting incorporated a low rolling resistance rubber compound on the bottom belt cover, which would be in contact with both the carry and return side idlers.

6) A Self Propelled Maintenance Trolley

This trolley automatically provides full access to the conveyor belt for inspection & maintenance purpose. The trolley is used by the personnel to travel the full extent of the conveyor belt on a daily basis. So, for long belt Conveyors, this is the best way with eliminating walkway access throughout the conveyor.

7) Low Speed Proportional Control & Digital Brake System

The tail end drive pulley is also equipped with a combined proportionally controlled and digital braking system to control the stopping of the conveyor in the event of loss of power of the conveyor drives or in an emergency stop condition.

It should be emphasized that the normal mode of stopping the conveyor is a controlled stop using the Drive's VFD control system.

8) Variable Frequency Drive Arrangement (VFDs)

All the high Speed Conveyors are designed with Variable Frequency Drives (VFDs).Because, there are some advantages as per below,

- VFD system allows the operator to run the Conveyor in creep mode, which is more important for inspection of high speed Conveyor belt.
- VFDs do not decouple the motor from the belt during stops. So, Flywheels are not required.
- If, Fluid Coupling with Conventional motor used, then it consumes more power than equivalent to VFD system.
- Starting, Stopping & Load sharing of the Conveyor is more predictable with VFDs.
- Maintenance time of VFD System is very less then equipment motor with Fluid Coupling.

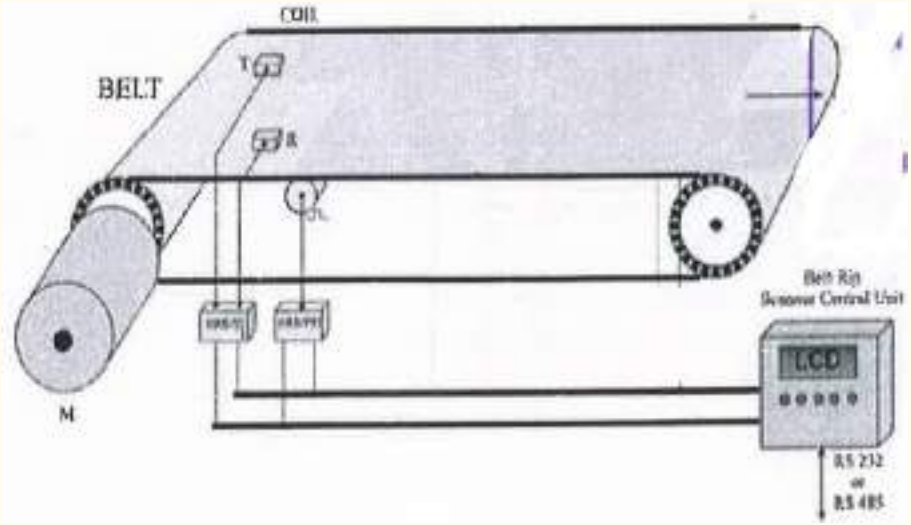
9) BELT RIP DETECTION SYSTEM

Rip detection system is designed to protect the conveyor from damage resulting from progressive damage of belt when it is ripped. This system continuously monitors the belt for any rip and stops the belt in case any damage is detected on the belt.

WORKING PRINCIPLE :

The transmitter and receiver shall be mounted on bracket, just after the most critical point in the system (discharge and receiving end). The belts shall have sensor loop embedded below top cover at every 100m interval. If the belt is damaged, the sensor loop gets broken and the signal is not transmittedto receiver. This gives the signal to PLC system to stop the drive immediately.

LAYOUT OF RIP DETECTION SYSTEM :



10)FIRE DETECTION AND SUPRESSION SYSTEM.

This is a system installed in the conveyor for protection of conveyor in case of Fire.

The system automatically detects the fire and simultaneously suppresses it by means of high pressure water present in the charged line all along the conveyor.

Working principle:

There is a two parallel system present for detection of fire

a) LINEAR HEAT SENSING CABLE

b) UV-IR Detector

In event of fire on conveyor, a linear heat sensing cable(LHS)(laid all along the conveyor on both sides) will melt by virtue of temperature and send a signal to fire alarm control panel in the circuit.The fire alarm panel in turns sends the signal to the deluge valve of affected zone detected by LHS Cable and simultaneously activates fire alarm viz hooter for alertness.

The deluge valve further activates the solenoid valve of the zone and activates succeeding two and one precedingsprinkler zone (40Mtr each) for spraying of water in the affected zone. Similarly the UV-IR detector also detects the fire flames and sends a command to fire alarm panel and all the above procedures will be repeated making it a fail-safe system.The detection of fire by fire alarm panel in-turn sends signal for main PLC for stopping the conveyor.

TRANSPORTATION OF IRON ORE SLURRY THROUGH PIPELINE AT KUDREMUKH MINE

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KIOCL a flagship Company under the Ministry of Steel, Government of India, with Mini Ratna Status, had operated the highly mechanized magnetite iron ore mine to produce 22.5 million tons of Run of Mine (ROM) per annum with state-of-the-art beneficiation technology to produce 7.5 million tons of iron ore concentrate TILL END OF December 2005. To provide diversification to its products, KIOCL has established Pellet Plant in the year 1987 and Blast Furnace Unit in the year 2001, both at Mangalore. Iron ore concentrate produced at Kudremukh was being transported to Mangalore in slurry form through a pipeline of 67 KM length.

The slurry transportation system consisted of two agitator slurry storage tanks, two banks of slurry pumps, pipeline and two agitator storage tanks at the receiving end. The pipe line runs through rugged terrain passing through 1.7 KM tunnel. The tunnel is 2.25 M wide x 2.25 M high with a semi circular ceiling. Gradient of the tunnel is rising @ 1% up to half the way and then falling @ 1.57% up to the end of tunnel. The slurry is pumped from the pump house to the high point and from this high point to the port facility, the slurry flows by gravity.

From zero meter i.e from pumping station up to 9.2km chainage of pipeline, pipe is 450mm Dia with a wall thickness of 13.5mm. From 9.2km chainage of pipeline up to the receiving station at Mangalore, pipe is 400mm Dia with a wall thickness of 18.3mm.

Initially water will be pumped through one of the slurry pump banks for about 2.5 hours. This is to ensure that the pipeline is completely filled and water received at Mangalore end. Then slurry will be pumped immediately after water received at Mangalore. Pumping will be continuous till slurry batch ends. Afterwards water pumping will be done for 8 hours for flushing the pipeline. The slurry flow rate is 1500T/Hr. Percentage of solids was 60-70 and the balance was water. Iron ore concentrate size was mix of (-) 325 mesh (45 microns) and (+) 100 mesh (150 microns).

Cleaning of the pipeline is done through pigging. The Dia of the pig will be the same as the Dia of the pipe at pumping station. Pigging helps in clearing of any deposits inside pipeline.

COMMON RAILWAY SIDING: IMPROVED ENVIRONMENT VIS-À-VIS ECONOMICS

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Introduction

Iron ore is a metal of universal use & is considered as the backbone of modern civilization. The intensity of steel use in Indian economy is expected to increase and the requirements for steel will continue to grow every year which has currently achieved to 192MT of iron ore production in the financial year(2017-2018) in India. With the continuous growth of Indian steel industry, the demand for iron ore will be on the rising side which will give way to more mining activities which calls for effective environmental management system &cheaper transportation.

Importance of Mine rail freight transportation:

Rail freight service is generally the most effective & economical mode of transportation available for carrying larger volumes of mainly iron ore, coal, cement etc over longer distances from a mine railway siding to any interior customer market destination of a country. It is paved as the safest & reliable way of transportation which has very less impact on environment and traffic slowdowns than conventional road transport.

Economy growth of Indian railways by iron ore freight transport:

The Indian railway freight service has transported 137MT of iron ore in financial year (2016-17) which generated revenue of 8175 crores in rupees which is 14% growth compared to financial year(2015-16) which handled 114MTof iron ore by generating revenue of 6896 crores in rupees. This revenue growth will have positive impact on nation's basic infrastructure facilities to meet public aspirations,introducing advanced safety technology, modernization, and technological innovation & automations.

Effective environment management system in a private mine railway siding Includes air pollution control system, efficient maintenance & design of haul roads at siding, Provision of wind screen system, Green belt development etc.

Innovative technology in a mine railway siding Embraces of Rapid Loading System, Installation of pipe conveyor system, High mast LED Lightning system etc

Conclusion:

As the iron ore production in our country is expected to reach 300 MT by 2021. Improvement in safety, environment technology & infrastructure facilities will play an important role in effective private railway siding operation in the forthcoming years to come with RLS & pipe conveyor systems.

Thanks to the initiative from government of India for focusing on installation of pipe conveyor system from mine to rail siding.

Technical Session IX

Mining Education :
Global Challenges and Prospects

CURRENT SCENARIO OF SKILLING IN MINING SECTOR IN INDIA

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1. Mining in India is gradually transforming with greater emphasis on mechanization of current mining operation, zero waste mining and stress on health and safety at workplace. The thrust on increasing domestic output and growing focus on "Make in India" for meeting the demand of India's expanding economy, calls for a skilled and digitally literate manpower.

2. Key factors that are driving the skills development in mining sector are:

I. Mining operations across sub – sector arewitnessing a trend for using advance and high end machinery

II. Innovation in mining sector are specifically focused on cost effective extraction, technology optimization, and safety at workplace,

III. Government's aim to increase the volume of mined minerals by 30% to 35% annually and increase the share of mining in GDP by1% and

IV. The emphasis on increased Productivity, Health & Safety at workplace.

3. To integrate general and vocational system of education and training, the Government of India notified the National Skills Qualification Framework(NSQF) on 27th December 2013. NSQF is a competency based framework that organizes all qualifications across 10 levels, defined in terms of learning outcomes which the learner must possess regardless of whether they are obtained through formal, non-formal or informal learning. It is a quality assurance framework. Recognition of Prior Learning (RPL)is an important associated function of the NSQF, especially in the Indian context where majority of the workforce has received minimal or no formal training. All workforce – regular and contractual – has to be certified as per National Skills Qualification Framework by December 2018.

4. Skill Council for Mining Sector promoted be Federation of Indian Mineral Industries (FIMI)and supported by ministry of mines was setup by NSDC (MSDE). SCMS was registered under section 8 of the companies' act 2013. SCMS has carried out Occupational Mapping and Skills Gap studies for sector. It has developed skills competency standards and qualification packs, benchmarking it with national & international standards for operator level job roles both for opencast and underground mines. Created competency standards and curriculum aligned to NSQF

levels. An initial skills assessment exercise of semi – skilled and skill category workers reveal that 50-55% of such manpower is with minimal formal training.

5. SCMS is also working on creating Centre of Excellence in collaboration with the industry. Ministry of Skill Development and Entrepreneurship (MSDE) in its notification dated 17th March 2015 has notified SCMS as a non – statutory certifying agency. SCMS is a registered company under section 8 of companies' act 2013 and have been issued 80G & 12A certificate under income tax act 1961 in October, 2015. This allows SCMS to undertake training under cooperate Social Responsibility (CSR) projects for various companies.

6. Training initiative of SCMS is to ensure availability of certified workers to improve standards of productivity and safety through its Training Partners with adequate training infrastructure of lab facilities. It has carried out series of Training of Trainers (TOT) and Training of Assessors (TOA) programs and has created a pool of trainers, Master Trainers and Assessors.

The types of trainingsincludeShort Term Training (STT) on job role which are in demand from mining industry with a training duration ranging from 200-500 hour, Long Term Training on critical job roles which are in demand specific to a mining company with 6-18months duration and upskilling and Certification of the in service workforce under recognition of Prior Learning (RPL).

7. As regards technological advances and migration to industry 4.0 mining in India remains at an early stage in the adaptation curve. Barring few mining company, the level of mechanization remains low. This will require a need for skilled human resource and upskilling of the existing manpower.

HR PRACTICES

Shri Praveen George
Head HR, Vedanta Limited

Mining Industry has been synonymous of being faced with fluctuating demand and commodity pricing coupled with ever increasing Stakeholder expectation while having to continuously maximize Productivity and Profitability. Given the dynamic nature of the Business and Technological advancements, successfully managing the Human Capital will be differentiating factor between an Ordinary Mining Company and a Market Leader with Competitive advantage over peers.The recipe for success clearly revolves around the seamless alignment of Business Strategy and HR Strategy resulting in value generation. Quality of Leadership, quality of people and their ability to align themselves to the Business strategy and deliver results and execution of policies and processes to meet the Organization goals will define the scale of presence of any Organization in the prevailing competitive industry.

The best Human Resource Strategy/ practice in Organization would operate in a bi-pronged approach to address the following needs of the Organization:

a) Strategic needs b) Operational needs

The HR Strategy of an Organization must meet the needs of the current and future landscape of the Industry considering the important factor of Automation, while laying continuous emphasis on Up-skilling the Workforce and developing people to manage technological changes and withstand the boom and bust cycle prevalent in the industry. The design of HR programs must becrafted in a manner that will instill a sense of pride in all employees associated with the Organization. Key HR focus areas to make this possible will be:

i) Talent Management Initiatives

ii) Learning and Development

iii) Employee Engagement

iv) Reward and Recognition

v) Labour Relations

An inclusive approach with participative management from the entire workforce including Contractors will define the progressive nature and future readiness of an Organization.

Other Session

FATIGUE INHUMAN –CAUSES AND CONTROLS

Shri Arunachalam. B

1.0 INTRODUCTION

11th National conference on safety in mines recommended addressing of fatigue as an issue for concern that could have an impact on safety. Operator fatigue is a major factor especially in truck transport accidents. Studies have shown fatigue influences reaction times, attention spans and causes more accidents than alcohol. In General manpower is planned and and arranged regular working of mines. Sudden absence of important persons due to various reasons forces other people to work overtime and in some tims for nearly sixteen hours. Situation gets worse if after working eight hours one has towork anothee shift or night shift and report back again within eight hours. Fatigue also may be due to noisy, dusty, over /less illuminated environment, doing the same activity throughout the shift .

We also have a situation that people after work do not get adequate sleep in the house due to noise, day light or need to attend to domestic needs. Last but not the least is continuous change of work instructions... Fatigue can lead to incidents because employees/workers are not alert and are less able to respond to changing circumstances. Fatigue can lead to long-term health problems.

This paper deals about areas which will help in identifying hazards where fatigue plays a key role. Control measures suggested are of general in nature.

2.0 What is fatigue?

Fatigue can be defined as a state of impairment that can include physical and/or mental elements, associated with lower alertness and reduced performance.

2.1 Causes fatigue?

2.1.1 General

Fatigue builds when there is not enough rest or sleep between activities

Fatigue results from insufficient rest and sleep between activities (e.g. from poor quality sleep). The inter-related causes of fatigue include:

- Time of day that work takes place
- Length of time spent at work place and in work-related duties.
- Quantity and quality of rest obtained prior to and after a work period
- Activities outside of work, such as family commitments or a second job,

- Individual factors, such as sleeping disorders.

2.1.2 Work-related causes of fatigue

Acute fatigue is caused by immediate episodes of sleep deprivation; for example, because of long periods of wakefulness from excessively long shifts or night shifts without adequate daytime rest. Ongoing sleep disruption can lead to sleep debt and chronic sleep deprivation, placing individuals in a state of increased risk to themselves and to others.

2.1.3 Non work-related causes of fatigue

The contribution of non work-related factors varies considerably between individuals. Non work- related fatigue is best managed at an individual level.

- Sleep disruption due to ill health of family members
- Strenuous activities outside work, such as a second job
- Sleep disorders
- Inappropriate use of alcohol, prescription and illegal drugs, and
- Stress associated with financial difficulties or domestic responsibilities.

2.1.4 Signs of fatigue

Signs of fatigue include tiredness even after sleep, irritability, psychological disturbances, and loss of energy, frequent yawning and inability to concentrate.

.2.1.5 Effects of fatigue (Physical)

- Unpleasant muscular weariness
- Tiredness in everyday activities,
- Reduced coordination and alertness.
- Digestive problems
- Heart disease
- Stress
- Harmful drug and alcohol use
- Mental illness.

2.1.6 Effectsof fatigue (in performing task)

Levels of work- related fatigue are different for individuals performing the same tasks. Fatigue causes an increased risk of incidents because of tiredness and lack of alertness. When employees/workers are fatigued they are more likely to exercise poor judgment and have a slower reflexes. This can increase all risks on site because fatigued employees/workers are less able to respond effectively to changing circumstances, leading to an increased likelihood of incidents due to human error.

3.0 MANAGING FATIGUE

Fatigue management should cover managers, professional staff, contractors and those who work on planned rosters and unplanned work, such as overtime. Commuting times should also be considered.

Risk factors for fatigue can be identified in a variety of ways. Typically this would start with consulting the workforce and contractors. In addition, examining records to look at incidents and health concerns that have occurred previously sometimes provides useful information

- Identify the hazards of fatigue
- Assess the risks of fatigue
- Implement effective risk control measures,
- Monitor and review regularly the effectiveness of the controls.

When taking a risk management approach to fatigue, it is very important to look at how fatigue, and long working hours in general, can interact with other workplace hazards. Exposure to some hazards can be increased when working extended hours – e.g. manual tasks and exposure to hazardous chemicals, dust and noise.

3.0 Hazards

3.1.1 Mental and physical demands of work

The mental and physical demands of work can contribute to an employee/worker becoming impaired by fatigue in a number of ways. These can increase the risk of fatigue by producing mental and/or physical tiredness

- Concentrating for extended periods of time,
- Performing repetitious or monotonous work
- Performing work that requires continued physical effort
- Pressure due to a heavy workload
- Fast paced work
- Is work intensive?
- Need for high vigilance and/or concentration

3.1.2 Work scheduling and planning

The way work is planned and scheduled, the time work is performed and the amount of time worked can increase the risk of fatigue. Scheduling work in a way that fails to allow employees/workers enough time for travel to and from work and/or physically recover and socialise can produce fatigue. Working at times when employees/workers are biologically programmed to sleep (which can disrupt an employee/worker's body clock) and working for long periods of time can also produce fatigue. Particular issues to look for include:

- Night shifts, including the number of consecutive night shifts.
- Long hours of work in a single shift, or across a shift cycle. (including travel time, especially for remote sites)
- Short breaks between or within work shifts
- Shift start/finish times (e.g. a start time between 10 pm and 6am)
- Changes to rosters
- Unplanned work, overtime,emergencies, break downs
- Complex physical or mental tasks undertaken on night shift
- Time between work shifts to allow for adequate sleep
- Is fatigue management taken into account in roster changes

3.1.3 Work environment conditions

Working in harsh and/or uncomfortable environmental conditions can contribute to the risk of fatigue in a number of ways. Heat, cold, noise and vibration are some of the environmental conditions that can make employees/workers tire quicker and impair their performance.

3.1.3.1 Stress

- Poor social relations at work, e.g. bullying
- Low social support from peers and supervisors at work
- Low recognition for the effort involved in the work

3.1.3.2 Adverse working conditions

- Noise
- Heat
- Cold
- Dust
- Hazardous substances

3.1.4 Excessive commuting

Having to travel long distances before or after work is an important potential cause of fatigue. Is significant travel to and from work necessary each day so that time for adequate sleep is reduced?

Are long-distance commutes necessary at the beginning of a work cycle?

3.1.5 Individual and non-work factors

- Lifestyle: e.g. having caring or child-care responsibilities,
- Family commitments
- Alcohol and drug use
- Voluntary work, having more than one job,
- Level of fitness, social life or diet
- Home environment: e.g. noisy neighbours or a bedroom that is too hot or not dark enough for day-time sleep, health conditions: e.g. insomnia, sleep apnoea, or alcohol or drug dependence.

4.0 Examples of hierarchy of control for fatigue risks

Elimination (100%) Eliminatingor controlling night shifts in some areas or for limiting high risk expostasks.

Substitution (75%) increasing the length of breaks in a shift.

Separation/Engineering(50%)Provisions of medians on haul roads,different shift workers in different location.improving ventilation and heating to improve alertness and ensure exposure to hazardous substances is reduced during extended shifts.Proximity sensors. Auto dipping systems

Administration (30%)using a checklist to help supervisors identify and assess fatigue impairment. Regular vision check, assigning rosters

Training (20%) with simulatorsto assess reflexes by conducting at the shift end,

PPE (5-10%) ensuring appropriate equipment is used. For example, standard hearing protection devices may not provide sufficient attenuation over a 12-hour shift as opposed to an 8 hour shift.

5.0Fatigue management – Control measures

5.1 Improving the work environment

- Scheduling less complex or less safetycritical tasks at times of highest fatigue risk
- Training employees about personal limitations and strategies to increase alertness
- Close supervision
- Working in pairs or teams depending on the task
- Task rotation
- Checklists
- Self-assessment checklists for signs and symptoms of fatigue
- Support for new personnel by experienced personnel

5.2 Work Environment

- Operator's Seat in the Vehicle/HEMMs should be ergonomically designed
- Self-selected break times
- Provision of appropriate welfare facilities for break time: lunch room, power napping facility in a quiet environment
- Appropriate lighting
- Control over temperature
- Vibration management
- Provision of fast transport for personnel to commute
- Ensure high-risk activities are conducted during the day, rather than at night, where possible
- Avoid boring and mundane tasks at times of higher risk for fatigue

5.3 Shift arrangements and circadian rhythms

- Night shift causes significantly worse effects on work performance and fatigue levels than either afternoon or day shift due to working against nature.
- Afternoon shift is significantly worse than dayshift. The night and afternoon shift have such effects on key parameters such as work performance, alertness and ability to concentrate.
- Consecutive shifts sleep debt is likely to be accrued.

5.4 Other control measures

Provide training to allow multi- skilling and effective job rotation, this reduces monotony

Use alarms and monitors, particularly for solo work (egg driving vehicles)

Use plant, machinery and equipment to eliminate or reduce the excessive physical demands of the job

Reduce the amount of time employees/ workers need to spend performing sustained physically and mentally demanding work.

Ensure there are adequate employees/ workers and other manpower resources to continue the job without placing excessive demands on working staff.

Ensure adequate breaks during shifts to allow recovery

Schedule complex tasks for daytime

Make sure that there is enough time in a break for six hours uninterrupted sleep

Provide rest days (opportunity for two consecutive night sleeps)

Don't start or finish between 10pm and 6am

Avoid working during periods of extreme temperature

Control exposure to hazardous substances and environments

Provide effective protective clothing and equipment, allowing for different shifts

Use heating and cooling to control ambient temperatures to support alertness

Provide adequate facilities for rest, sleep, meal breaks, onsite accommodation (if appropriate) and other essential requirements, such as bathroom facilities

Install adjustable, vibration free seats in appropriate machinery and vehicles

Ensure the workplace and surroundings are well lit, safe and secure

5.5.0 PPE as control measure

Quite a few gadgets are available that keeps track on eye lid, eye ball, movement of head to one side and remaining there itself etc. These ultimately are post facto in the sense when an operator gets drowsy and runs over a bund and system cautions it may be too late

5.5.1 Buzzing seats it tracks where the user's mouth is in order to work out when the workers are not looking at the road. To help identify these features truck cabs are also fitted with an infrared lamp. An accelerometer and GPS chip are also installed to confirm the truck is being driven at the time, and the data is processed by a computer mounted behind the driver's seat which is designed to cope with strong vibrations and dust.

The aim is to detect the onset of micro-sleep - periods when a person passes out for anywhere from a fraction of a second to up to half a minute, and then wakes up again without realising they lost consciousness.

5.5.2 Head nod sensors Head-nod sensors - either built into workers' helmets or hooked around their ears - but the nature of the drivers' job means false alarms can be a problem.

5.5.3 Haul check Australia's Acumen offers a product called Haul Check which uses laser scanners and guide posts along truck routes to sound an alarm if trucks head off-path.

5.5.4 Astir British firm Fatigue Management International offers a system called Astir which monitors steering movements to detect exaggerated corrections and other indicators of sleepiness.

5.5.5 Anti sleep alarms

Anti-sleep alarms do more than simply startle and annoy drivers -- they can save them from by alerting them if they start to nod off behind the wheel... This lightweight plastic device has an arm that slips over one ear, like some telephone earpieces or portable headphones do. Once it's on, a sensor inside the case measures the angle from a perpendicular perspective. If the driver is looking straight ahead -- as he should -- the alarm measures the angle at zero degrees. While the safest course of action is to get a good night's sleep or to take a nap before driving, an anti-sleep alarm could come in handy on a late-night drive.

6.0 Conclusion

Fatigue is a complex issue, the causative factors are many. Controls vary from individual to individual. Age has its role to play. Reduction in activities during high fatigue prone time, increased number breaks, one way traffic, minimum change of instructions, maximum supervision and monitoring dumper movements etc., increase safety standards.

PPE should be last line of defense. Any accident investigation should also cover

- Whether fatigue was a contributing factor.
- the work schedule provided sufficient sleep opportunity for the employee
- the employee actually obtained sufficient sleep

- any fatigue-related symptoms observed prior to the event
- Whether they have recently used medications known to have an effect on alertness.
- Hours worked on the day of the incident and during the previous week.

The results of this review should allow determining whether fatigue may have been involved and to identify weaknesses in the fatigue-risk control measures in place in the organization. Intention should not be push the cause as human failure and in case of fatalities on the victim itself

Plans should address each of the main areas identified. The fatigue management plan should also be incorporated in the overall health and safety management plan including contractor workers.

MINERAL LEVIES ON MINING OF MAJOR MINERALS UNDER THE MM (D&R) ACT, 1957 AND ITS RULES IN INDIA ISSUES & CONCERNS.

Shri Vijay Singh A R

ABSTRACT

January 12, 2015 is a historical day for the mining industry qua mining lease holders &/or mine owners, since the Union Government carried out major amendments in the MM(D&R) Act, 1957 and thereafter repealed the much simpler "The Mineral Concession Rules, 1960 & The Mineral Conservation and Development Rules, 1988" amongst others and promulgated new rules to be in line with the massive amendments carried out in the MM(D&R) Act, 1957. In the course of amendments the current dispensation has altered the way the Mining Leases are sanctioned, governed & administered and has also brought in new levies on major minerals viz., contributions to DMF & NMET, transfer charges, etc. Provisions such as provisional assessments on payment of royalty on removal of minerals; interests @ 24% p.a. on delay in payments of royalties among others have been brought in. If one were to get into the details of the amended provisions of the mineral laws, one can make out that the polity have sprinkled provisions of direct tax (income tax) and indirect taxes (other than income tax) in the amended MM(D&R) Act, 1957 and its rules. If you read on, you would notice that amendments have made administration and levy & collection of royalty, contributions to DMF & NMET, transfer charges, payment of GST, Tax Collection of Source, etc. by the DMG have become cumbersome to the statutory authorities and to lessees as well. In addendum the new laws have paved the way for needless, unwarranted and unending litigations at the Hon'ble High Courts and the Hon'ble Supreme Court of India.

INTRODUCTION

In India (including Jammu & Kashmir), all major mineral Mining Leases (MLs) viz., Iron-ore, Manganese, Limestone, Bauxite, Magnesite, etc. are sanctioned, governed, administered etc. by the Central Government and the State Governments under the provisions of:

a) The Mines and Minerals (Development and Regulation) Act, 1957 (MM (D&R) Act, 1957);

b) The Minerals (Other than Atomic and Hydro Carbons Energy Minerals) Concession Rules, 2016;

c) The Mineral (Auction) Rules, 2015;

d) The Mineral Conservation and Development Rules, 2017;

e) The Minerals (Transfer of Mining Lease Granted Otherwise than through Auction for Captive Purpose) Rules, 2016; &

f) Other allied rules.

The Constitution of India, under Entry 54, List I of the Seventh Schedule, empowers the Union Government to regulate mines and mineral development, as declared by the Parliament by law to be expedient in the public interest, and the Union Government has under section 2 of the MM(D&R) Act, 1957 has made an express declaration as to the expediency of Union Control of Mines and Mineral development as provided under the said MM(D&R) Act, 1957.

The Hon'ble Supreme Court of India in M/s. The Sandur Manganese & Iron-ores Ltd. vs. State of Karnataka (CIVIL APPEAL NO. 7944 OF 2010) has held as under:

"By virtue of Section 2, the State Legislature is denuded of its legislative powers to make any law w.r.t. regulation of mines and mineral development to the extent provided in the MM(D&R) Act, 1957. Thus there is no question of the State having any power to frame a policy de hors the MM(D&R) Act and Rules."

Hence in the light of above, it is only the Union Government that can formulate, amend, provide for any levies on major minerals through the provisions of the MM(D&R) Act, 1957 and its rules.

Never-the-less, as per the federal structure of Republic of India, land is always a state subject and unless otherwise specified, the levies on major minerals are levied and collected by the State Governments in its territorial jurisdictions as per the law framed by the Central Government.

TYPES OF MINERAL LEVIES

The following are the various types of mineral levies on mining of major minerals under various statutes:

Sl. No.	Charge/levy on extraction of major minerals	Reference in the applicable statute
(1)	Royalty	Section 9 read with Second Schedule of the MM(D&R) Act, 1957.
(2)	Contribution to District Mineral Foundation (DMF)	Section 9B of the MM(D&R) Act, 1957 read with Rules 2 & 3 of 'The Mines and Minerals (Contribution to District Mineral Foundation) Rules, 2015'.
(3)	Contribution to National Mineral ExplorationTrust (NMET)	Section 9C of the MM(D&R) Act, 1957.
(4)	Transfer Charges	Rule 6 read with Schedule IV of 'The Minerals (Transfer of Mining Lease Granted Otherwise than through Auction for Captive Purpose) Rules, 2016'.
(5)	Other local levies imposed by the State Governments	As per the applicable statutes

I. ROYALTY

The term royalty has not been defined in the MM(D&R) Act, 1957 and neither in any of the allied rules, hence one has to rely on the general dictionary meaning of royalty.

As per Webster's dictionary the meaning of the word "royalty" is as hereunder:

"A compensation or portion of proceeds paid to the owner of a right, as an oil right or a patent, for use of it".

Royalty ought to be paid in respect of any mineral removed or consumed by the lessee&/or owner, or by his agent, manager, employee, contractor or sub-lessee from the lease area or otherwise, except in case of coal consumed by workman engaged in a colliery, provided that such consumption by the workman does not exceed one-third of a tonne per month (Section 9 of MMDR Act, 1957).

Royalty on extraction of all major minerals are paid at the rates specified in the Second Schedule to the MM(D&R) Act, 1957 either on ad-valorem basis or otherwise. The royalty is computed on ad-valorem basis at a fixed percentage of "Average Sale Price" as decided and published by the Indian Bureau of Mines (IBM), Govt. of India on a monthly basis for a particular mineral and for a particular state. For example:

(a) On magnesite mineral – royalty is computed and paid @ 3% of average sale price on ad-valorem basis.

(b) On Lime stone (LD grade – less than 1.50% silica content) – royalty is paid at a fixed rate of Rs. 90 per tonne. On Lime stone (others) – royalty is paid at a fixed rate of Rs. 80 per tonne.

Royalty shall not be enhanced in respect of any mineral more than once during any period of three years (proviso to section 9(3) of the MM(D&R) Act, 1957).

ISSUES & CONCERNS

A. IS ROYALTY A TAX?

The answer to the above is YES & NO.

- The Hon'ble Supreme Court of India(7 Judge Bench) has held that ROYALTY IS TAX in M/s. India Cements Ltd. vs. State of Tamilnadu reported in (1990) 1 SCC 12.

- In another case the Hon'ble Supreme Court of India(5 Judge Bench) has decided that ROYALTY IS NOT A TAXin State of West Bengal vs. M/s. Kesoram Industries Ltd. reported in(2004) 10 SCC 201.

- Final decision whether royalty is tax or not? Referred to a 9 Judge Bench of Hon'ble Supreme Court in Mineral Area Development Authority vs. SAIL & Others. Reported in (2011) 4 SCC 450.

Hence the matter is seized before the Hon'ble Supreme Court of India and final decision is awaited.

In case the Hon'ble Supreme Court of India decides that royalty is a tax then the service tax imposed by the Central Government on the payment of royalty @ 15% (including cess) w.e.f. 01-04-2016 to 30-06-2017 and GST (Goods and Services Tax) @ 18% w.e.f. 01-07-2017 may not survive, since there cannot be payment of tax on tax.

Lately the Hon'ble High Court of judicature for Rajasthan at Jodhpur in D.B. Civil Writ

Petition No. 14578/2016 in its judgement dated 24-10-2017 has upheld the levy of Service tax on payment of royalty.

It would be in the best interest of lessees/owners, if payment of GST on royalty is paid under protest, so as to claim refund of the same if the decision of the Hon'ble Supreme Court on royalty (supra) is rendered in favour of lessees/owners.

B. SHOULD ROYALTY BE PAID ON MINERALS EXTRACTED FROM PRIVATE LANDS i.e. NON-GOVERNMENT LANDS?

The Hon'ble Supreme Court of India in a judgement in CIVIL APPEAL NOS.4540-4548 OF 2000 dated 13.07.2013 in the case of Threesiamma Jacob & Ors Vs. DMG Kerala & Ors. has held that in case of private lands, not only the surface rights even the sub-surface rights, including minerals beneath, belong to the land owner. In this scenario, then a question came before the Hon'ble Court as to why royalty has to be paid on the minerals extracted from the private land, since the land and neither the minerals lying underneath belong to the Government. The Hon'ble Court has referred this issue along with a batch of other similar petitions to a different bench, and the matter is yet to be heard and decided by the Hon'ble Supreme Court on payment of royalty from minerals extracted from private lands not owned by State Government.

C. VALUE ON WHICH ROYALTY IS TO BE COMPUTED AND PAID IN CASE OF PAYMENTS MADE ON AD-VALOREM BASIS AND OTHER CONNECTED MATTERS?

Where-ever royalty has to be paid on ad-valorem basis, then the base value to be considered for the purpose of computation of royalty as per Second Schedule to the MM(D&R) Act, 1957 is the "AVERAGE SALE PRICE (ASP)" as published by the Indian Bureau of Mines (IBM) for a month and for that mineral and for a particular state. It is very clear that royalty has to be discharged to the State Government or Dept. of Mines and Geology (DMG) of the respective states where the mineral is excavated on the basis of ASP, irrespective of the actual selling price of the lessees/owners in the market.

Illustration:

Mineral considered - Magnesite.
Location - ML in Karntaka
Date of supply / sale - 01.04.2018

Particulars	Scenario I	Scenario II
Actual selling price of Magnesite mineral per tonne	Rs. 7,000	Rs. 6,500
ASP as published by IBM for Magnesite per tonne*	Rs. 6,737	Rs. 6,737
Royalty @ 3% ad-valorem on ASP	Rs. 202	Rs. 202
GST (CGST + SGST) @ 5% on supply / sale of Magnesite	Rs. 350	Rs. 325

*ASP published by IBM and put up on the website for January, 2018.

As seen above royalty has to be paid on ASP declared by IBM irrespective of the actual sale value. However GST has to be paid on the actual selling price of goods i.e. Magnesite sold/removed from the lease area, when royalty is not shown on the face of tax invoice.

As per Rule 39 (Payment of royalty) of the Minerals (Other than Atomic and Hydro Carbons Energy Minerals) Concession Rules, 2016 (here-in-after referred to as MCR, 2016):

i. Royalty to be paid when the minerals are removed out of the ML area, whether for sale or otherwise.
ii. Royalty to be paid on minerals whether processed or un-processed?
iii. Royalty has to be paid whether the mineral is sold or not.

Also as per Rule 43 of MCR, 2016 i.e. Publication of Average Sale Price (ASP) – IBM ought to publish average sale price (ASP) within 45 days from the due date of filing of monthly returns as specified under MCDR, 2017.

Due date of filing monthly Returns (10th day of the following month for the previous month)
+
45 days
(10 + 45 days = 55 days)

For minerals excavated in April2018, IBM to publish the ASP by June 24, 2018

This essentially means that at the time of removal of minerals from the mining lease area for sale or otherwise, the correct ASP for that mineral for that state is not available for the lessee/owner to defray the royalty, contributions to DMF& NMET, payment of GST on royalty, etc.

The lessee to consider the latest available IBM declared ASP for the mineral in the state, pay the royalty, contributions to DMF& NMET, etc. collect the Mineral Despatch Permits (MDPs) from the DMG and remove the mineral from the mining area.

Therefore, the Central Government i.e. Ministry of Mines, New Delhi has introduced, for the first time, a concept of Provisional Assessment and Adjustment in Rule 40 of the Minerals (Other than Atomic and Hydro Carbons Energy Minerals) Concession Rules, 2016, contributing to the already existing chaos.

In addendum, Rule 49 talks about payment of simple interest @ 24% p.a. on expiry of the 60th day from the date fixed by the Government.

As per Rule 40 (Provisional Assessment and Adjustment) of MCR, 2016 the royalty, contributions to DMF & NMET, paid at the time of removal of the minerals from the mining area is always provisional and the lessee has to re-compute the royalty, contributions to DMF & NMET, once the IBM publishes the ASP for the specified mineral for the specified month and state and pay the difference or adjust the difference for the subsequent period removals.

In continuation of illustration on removal of Magnesite on 01-04-2018 from an ML area in Karnataka, the IBM publishes the Average Sale Price of Magnesitefor Karnataka, under Rule 43 (Publication of ASP) of MCR, 2016 on or before 24-06-2018, let'ssay:

i. at Rs. 7,000 per tonne; or
ii. at Rs. 6,000 per tonne

then the royalty, contributions to DMF & NMET, GST on royalty shall have to be revised and made good as follows:

1) ASP as published by IBM at Rs. 7,000 per tonne of Magnesite in Karnataka.

Particulars	Scenario I	Scenario II
Actual selling price of Magnesite per tonne at the time of removal on 01-04-2018	Rs. 7,000	Rs. 6,500
ASP as published by IBM for Magnesite per tonne on or before 24-06-2018 under rule 43 of MCR, 2017 for the month of April, 2018	Rs. 7,000	Rs. 7,000
Actual Royalty to be defrayed on ASP published by IBM on or before 24-06-2018for the month of April, 2018 @ 3% ad-valorem	Rs. 210	Rs. 210
Less: Royalty already paid at the time of removal of Magnesite on 01-04-2018 from the ML area	(Rs. 202)	(Rs. 202)
Difference in royalty to be paid to the DMG within 60 days from the date of removal to escape payment of interest under rule 49 of MCR, 2016	Rs. 8	Rs. 8
GSTon royalty @ 18% to be paid on the difference amount	Rs. 1.44	Rs. 1.44

(2) ASP as published by IBM at Rs. 6,000 per tonne of Magnesite in Karnataka

Particulars	Scenario I	Scenario II
Actual selling price of Magnesite per tonne at the time of removal on 01-04-2018	Rs. 7,000	Rs. 6,500
ASP as published by IBM for Magnesiteper tonne on or before 24-06-2018 under rule 43 of MCR, 2017 for the month of April, 2018	Rs. 6,000	Rs. 6,000
Actual Royalty to be defrayed on ASP published by IBM on or before 24-06-2018for the month of April, 2018 @ 3% ad-valorem	Rs. 180	Rs. 180
Less: Royalty already paid at the time of removal of Magneiste on 01-04-2018 from the ML area	(Rs. 202)	(Rs. 202)
Difference in royalty to be paid to / (received from) the DMG within 60 days from the date of removal	(Rs. 22)	(Rs. 22)
GSTon royalty @ 18% to be paid / (refunded) on the difference amount	(Rs.4)	(Rs.4)

The above exercise shall have to be done for contributions to DMF & NMET as well, since contributions to DMF & NMET are directly linked to payment of royalty.

Simple matters have got complicated in the light of provisions under Rule 49 (Payment of interest) of MCR, 2016 concerning payment of interest after expiry of 60 days from the date of removal.

In the opinion of the author, and as per the interpretation of Rule 49 (Payment of interest) of MCR, 2016, if there is a delay beyond 60 days from the date of removal of minerals from the mining area then the lessee &/or the owner ought to pay interest @ 24% p.a. till the difference amount of royalty, contributions to DMF & NMET is made good or adjusted.

The above provisions of MCR, 2016 has inherently inbuilt a mechanism wherein if the actual ASP published for a month within a period of 55 days is more than the ASP considered by the lessee &/or the owner at the time of removal of minerals for sale or otherwise, then the lessee has to mandatorily

a) Pay interest on delayed remittance of GST on royalty, since the due date for remittance of GST is 20th of the following month, for the previous month;

b) Lessee to rectifyhis/its monthly or quarterly GST returns in FormsGSTR-3B, GSTR-1, GSTR-2 & GSTR-3, depending on the month when the IBM actually publishes the ASP for the minerals removed from a lease area. In GST Laws there is no concept of filing revised returns, the registered person ought to rectify his / its returns subsequently along with payment of interest;

c) Lessees could face this issue on a recurrent and regular basis wherever the royalty has to be defrayed on ad-valorem basis when the prices are linked to the ASP published by IBM; &

d) Lessees are put to much greater hardship for no fault of theirs.

Probably it appears that Ministry of Mines, New Delhi has lost sight of erstwhile service tax and now GST aspects while framing the rules i.e. MCR, 2016, and neither have they actually taken practical aspects into consideration while framing the aforesaid rules.

The State Govt. or DMG collects tax at source (Tax Collection at Source – TCS) at the time of receipt of royalty @ 2% on the value of royalty under section 206C(1C) of the Income tax Act, 1961, from the lessees/owners.

In the light of above discussed provisions of Rule 40(Provisional Assessment and Adjustment) of MCR, 2016, it would lead to collection of taxes (Tax Collection at Source – TCS) on a provisional basis and the lessee has to revise &/or adjust the same subsequent to publication of ASP by the IBM within a period of 55 days.

Provisional collection of taxes in a very novel concept in the annals of direct taxes i.e. income taxes, and the same is enforced through a mineral law by the Ministry of Mines, Govt. of India, New Delhi.

Imagine the plight of the officers of DMG who enforce this and collect TCS every time the ASP declared by IBM is higher than that considered by the lessee at the time of removal of mineral from the mining area after obtaining Mineral Despatch Permits (MDPs).

This also would bring us to a question of payment of interest on the delay in collection and remittances of TCS amounts from the lessee??

Who is to pay the interest on delay in collection of TCS amounts and deposit into the credit of Income tax dept.? Will the Collector of tax i.e. DMG pay the interest, since the obligation is cast on the DMG of each state to collect TCS? There are no clear answers.

In addendum, as per the provisions of the Income tax Act, 1961 every deductor or collector of tax i.e. TDS deductor or TCS collector is mandatorily required to file quarterly returns and handover tax deduction or collection certificates to the deductee or collectee i.e. the lessee/owner. In case of provisional assessments how would the Directorates of Mines and Geology comply with filing of quarterly TDS or TCS returns and issue relevant tax deducted or tax collected certificates?

The issue of provisional assessment of royalty, contributions to DMF & NMET etc. and final assessment of the same is very cumbersome and the lessee would be put to great difficulty in keeping track and making good the shortfall and adjust the excess amount paid, if any.

Innocuously the Ministry of Mines, New Delhi has brought in in-congruency in provisions of MCR, 2016 vis-à-vis the Income tax Act, 1961, GST laws, etc. This anomaly has to be set right at the earliest.

II. DISTRICT MINERAL FOUNDATION:

Section 9B of the MM(D&R) Act, 1957 gives power to the State Governments to establish a trust as a non-profit body to be called as District Mineral Foundation and to make rules towards functioning of the same.

Section 9B was inserted in the MM(D&R) Act, 1957 w.e.f. 12-01-2015 through MM(D&R) Amendment Ordinance, 2015, dated 12-01-2015. However the Central Government notified "The Mines and Minerals (Contribution to District Mineral Foundation) Rules, 2015" vide Gazette notification no. G.S.R. 715(E), dated 17-09-2015, w.r.e.f. 12-01-2015.

The levy of contribution to DMF as prescribed in the aforesaid rules is as hereunder:

Particulars	ML or PL cum ML granted on or after 12-01-2015	ML or PL cum ML granted on or before 12-01-2015
Amount of contribution to be made to DMF by the lessee/owner	10% of Royalty	30% of Royaltya

Despite making a provision in the MM(D&R) Act, 1957 towards levy of contribution to DMF w.e.f. 12-01-2015, the Central Govt. prescribed the rules for collection of contribution to DMF @ 10% or 30% of royalty only on 17-09-2015, after a delay of 8 months & 5 days.

Like rubbing salt on the wound, Rule 2 of

The Mines and Minerals (Contribution to District Mineral Foundation) Rules, 2015 deems the same to be applicable with retrospective effect from 12-01-2015, putting the lessees/owners across the country in a very piquant situation and exposing themselves to pay contributions for all removals of minerals for past period of over 8 months in one go (from 12-01-2015 to 16-09-2015).

The Hon'ble Delhi High Court, New Delhi,came to the rescue of lessees in W.P.(C) 12027/2015 & CM Nos.31892/2015-31894/2015 (M/s. Federation of Indian Mineral Industries & Others vs. Union of India & Another), wherein in its judgement dated 22-12-2015 directed the Governments not to use coercive measures towards collections of contribution to DMF for the retrospective period.

In all, the Mines and Minerals (Contribution to District Mineral Foundation) Rules, 2015 has 3 rules, even after an amendment carried out in the same vide G.S.R. 837(E), dated 31-08-2016, and which would fit in one A4 size page and the Central Govt. could have notified the same much earlier rather than waiting for a period of over 8 months, putting the lessees in a very difficult situation and opening a pandora's box for litigations.

WHEN WILL THE CONTRIBUTION TO DMF KICK IN?

a) On the date when the MM(D&R) Act, 1957 inserted section 9B in the statute w.e.f. 12-01-2015?

b) On the date the Mines and Minerals (Contribution to District Mineral Foundation) Rules, 2015 was notified vide Gazette notification no. G.S.R. 715(E), dated 17-09-2015?

c) On the date the District Mineral Foundations are set up by the State Governments? The state of Chattisgarh established DMF on 22-12-2015; the state of Madhya Pradesh established DMF on 28-07-2016; the state of Maharashtra established DMF on 01-09-2016; etc.

The issue reached the Hon'ble Supreme Court of India, New Delhi and the Hon'ble Court has in the Transferred Case (Civil) no. 43 of 2016 ruled that for the holder of a mining lease or a prospecting licence-cum-mining lease in case of minerals other than coal, lignite and sand for stowing, shall pay contributions to DMF w.e.f. 17-09-2015, when the rates were prescribed by the Central Government and in case of coal, lignite and sand for stowing, contributions to DMF are to be made w.e.f. 20-10-2015 in its order dated 13-10-2017.

Capping of contribution to DMF: As per sub-section (5) to section 9B of the MM(D&R) Act, 1957 the amount of contribution to DMF cannot exceed more than one-third of royalty to be paid.

III. NATIONAL MINERAL EXPLORATION TRUST (NMET)

Unlike DMF, NMET shall be established and controlled by the Central Government and the funds accrued to NMET shall be used for the purposes of regional and detailed exploration as may be prescribed.

The holder of mining lease or a prospecting licence-cum-mining lease shall pay contributions to NMET a sum equivalent to 2% of royalty.

The state Govt. is denuded of the powers to levy and collect contributions to NMET even on minor minerals, where the rule making powers are given to the concerned State Governments.

IV. TRANSFER CHARGES

Transfer charges are levied under sub-rule (1) of Rule 6 of 'The Minerals (Transfer of Mining Lease Granted Otherwise than through Auction for Captive Purpose) Rules, 2016 w.e.f. 30-05-2016.

Transfer charges shall be paid by transferee who has got the mining lease transferred in his name under the provisions of the said rules.

Transfer charges shall be paid to the State Government @ 80% of royalty in addition to royalty, contributions to DMF& NMET, etc.

It can be seen that transfer charges are linked to payment of royalty and as discussed above all issues in relation to provisional assessments, payment of interest, etc. shall have to be endured even for payment of transfer charges.

In the opinion of the author, the transfer charges par-take the character of royalty and GST has to be paid @ 18% on transfer charges in addition to GST being paid on royalty under the reverse charge mechanism.

SUMMARY OF TOTAL MINERAL LEVIES

As per the extant provisions of mineral laws, the total levies on extraction of major minerals in the revenue land (i.e. not forming part of any forest) owned by the State Govt. by taking iron-oremining lease as an example, is as here-under:

Particulars (as a percentage of Average Sales Price published by IBM)	Mining Lease Holder		Transferee in case of transfer of Captive mines
	Before 12-01-2015	On or after 12-01-2015**	
Royalty on ASP	15%	15%	15%
Contribution to DMF	30% of 15% = 4.50%	10% of 15% = 1.50%	30% of 15% = 4.50%
Contribution to NMET	2% of 15% = 0.30%	2% of 15% = 0.30%	2% of 15% = 0.30%
Transfer charges	--	--	80% of 15% = 12%
GST on royalty & transfer charges under reverse charge mechanism u/s 9(3) of the CGST Act, 2017	18% of 15% = 2.70%	18% of 15% = 2.70%	18% of (15%+12%) = 4.86%
Total*	22.50%	19.50%	36.66%

***GST on supply (i.e. sale) of mineral shall be extra.**

****w.e.f. 12-01-2015 all new major mineral Mining Leases shall be granted only by way of auction and the additional premium to be paid by the successful bidder is not considered here-in-above. Also additional levies viz., Forest Development Fees, etc. have not been considered in the table above, since these are levied and collected by the State Government &/or local authorities.**

CONCLUSION

In the light of above facts & issues brought to the fore, and the insurmountable litigations at various fora, the current dispensation should immediately step in and correct the anomalies as spelt out in this write-up and take measures to suitably amend the statutes to be in line with the provisions of the Income tax Act, 1961, Goods and Services Tax (GST) laws, etc. Rectifying the GST monthly returns in line with the provisional and final figures of taxes paid on royalty& transfer charges, contributions to DMF & NMET would be nothing less than a nightmare for lessees involved in mining operations in the country.

Place: Bangalore Sd/-
Date: March31, 2018 **VIJAY SINGH A R**

P. S.:

1. **The above write-up has been made out on the basis of position of various mineral laws and other statutes that are relevant as on 31-03-2018.**
2. **The opinions expressed here-in-above is that of the author alone.**
3. **The readers are to refer to actual provisions of various laws and take suitable decisions.**

DEPOSIT CHARECTERISATION AND THE RIGHT TECHNIQUES OF QUARRYING TO ENHANCE THE RECOVERY PERCENTAGE IN COMMERCIAL GRANITE QUARRIES- A CASE STUDY FROM THE BLACK GALAXY GRANITE DEPOSITOF ONGOLE, AP.

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ABSTRACT

Deposit Characterization in evaluation of Commercial Granite Quarries is the foremost and fundamental aspects that determine the success and failure of quarry operations besides on adopting the right techniques of quarrying to enhance its output to maxmise the operation and conservation of natural resource at large. This is the most emerging scientific technique and sought after to establish the geometry of the prospect and broadly includes an in depth study on regional geology, micro analysis on geomorphology, petrography, structure and its impact on recovery in the quarry. All these factors ultimately decide on the investment plan and production prognostication to work out the marketing strategy and supply schedule to meet the demand. Considering the importance, the paper highlights based on case study of working premium granite quarries in black galaxy belt of Ongole , Andhra Pradesh to explain the overall impact on recovery of saleable blocks besides on methods of quarrying that are more suitable to maxmise the output.

PART- I: PREAMBLE.

1. Background Information:

All over the World, shield areas are the best geological entities where vast resources of granites and other rock types occur. Indian sub-continent is a potential area for locating and exploiting such rock resources. By now, it is well realized that India has vast and significant resources of multi coloured granites in States like Andhra Pradesh, Tamil Nadu, Karnataka, Orissa, Gujarat, Rajasthan, Kerala, Madhya Pradesh, Uttar Pradesh, Assam and Bihar. Similarly basic/mafic and ultrabasic/ultramafic dykes, anorthosite, alkaline rocks etc., are also found in association with granites and gneiss in these states.Though resource wise, the potential appears to be quite encouraging, it is always a buyers' preference, which controls or even sometimes restricts the demand to certain types having special colour, texture, dimension, and amenability to take polish, mineability etc. It is quite obvious that the buyers' terminology, which sometimes is exotic and fanciful, somewhat over imprints and even discusses the geological terminology, with the result that commercial nomenclatures like "black granite" is widely used for basic and ultramafic rocks in general and "Multi coloured Granite is used for a variety of rocks of granite family, anorthosite, syenite, leptynite etc., Atleast more than 200

attractive commercial names have been assigned to various rock types in the world marked to-day, out of which atleast 80 types can be identified to occur in India also.

2. Deposit Characterization:

The fundamentals of deposit character ization broadly include the following:

- Compilation of regional Geological data.

An in depth study of the Prospect on:

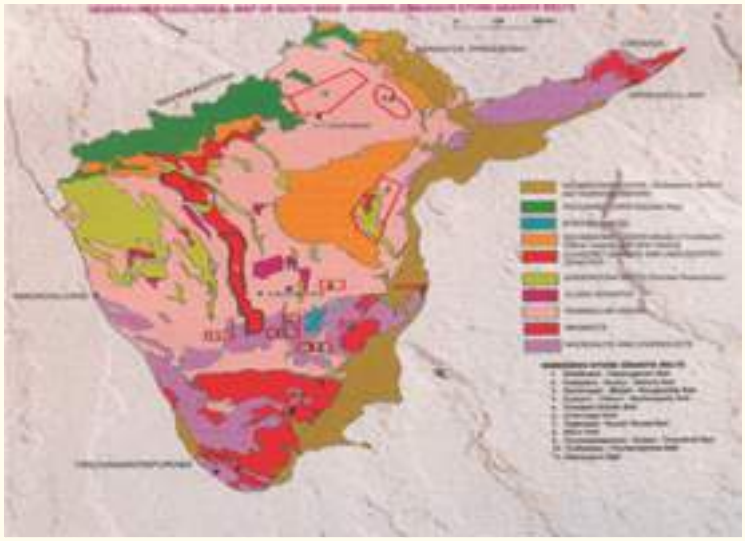
- Geomorphology & sheet chara cteristics.
- Petrography. design, fabric and colour characteristics of the rock formation.
- Micro analysis of the structure / geometry of the formation and its impact on recovery of saleable blocks-

Most important factor that decides on success of a quarry operation and its life.

a) Compilation of Regional Geological Data.

Regional geological data of a particular terrain where the prospect lies is vital to understand the various rock types occurring and the regional structures like lineaments, major joint pattern and more important on regional shear pattern which are more related to tectonic features of the area. All these factors can be mainly sourced from the published geological maps and literatures of Geological Survey Of India(GSI). Regional variations in particular the major shear and intrusive pattern will have an impact on the prospect under study and that is why the importance being stressed in this paper.

Regional Geology



b) In depth study of the Prospect:

i) Geomorphology and Sheet characteristics:

The geomorphology of the prospect under study like above (Hill) and below ground (Plain) and the nature of occurrence of boulders, sheet formation, slope of the area and orientation of small streams soil and weathering pattern will help to infer on the depth of occurrence of sheet rock especially in below ground deposits.

ii) Petrography. design, fabric and colour characteristics of the rock formation:

Petrographic study includes both megascopic and microscopic to understand the nature of variations of the formation both along and across the deposit like colour design and pattern variations which are vital in determining its price and demand in the global market. Inclusions like black patches intrusive patterns that affect the recovery in multi-coloured granite deposits and inclusions like white moles, lines colour variations like light and dark with its background shades like brown, blue and green in black granite decide on the price and success of exploitation.

iii) Micro analysis of the structure / geometry of the formation and its impact on recovery of saleable blocks:

Geological structures like joint/ fracture pattern, folds, faults, shears play a vital role in determining the success and failure of any quarry operation vis- vis the recovery percentage. Most of these geological structures are corroborated with the regional structural pattern of the terrain and directly related to the tectonic aspects of its origin. Therefore, we need to study them carefully and to analyze in the field and plot them systematically on the geological map/plan and interpret its impact like intrusion of foreign material viz. pegmatite/quartz vein etc. More interference of such geological structures in the study area/prospect and interception while quarrying will decide on the recovery both at the surface and at depth of quarrying. One should not ignore such structures when interfering in operation. Following geological structures which favour and disturbs in operation are highlighted:

Rocks in general have undergone more than one phase of deformations and accordingly exhibit a variety of geological structures which have a definite bearing on the degree of commercial exploitation.

Favorable geological structures normally facilitate easy recovery of blocks of desired export sizes with minimum usage of men, material and machinery forces. The presence of such favorable structures viz. sheet joints; vertical joints; steep dipping foliation planes; magmatic structures etc. in a granite deposit can enhance the recovery percentage in quarry operations besides on value addition by way of producing of big gang saw size blocks.

Favourable Geological Structures

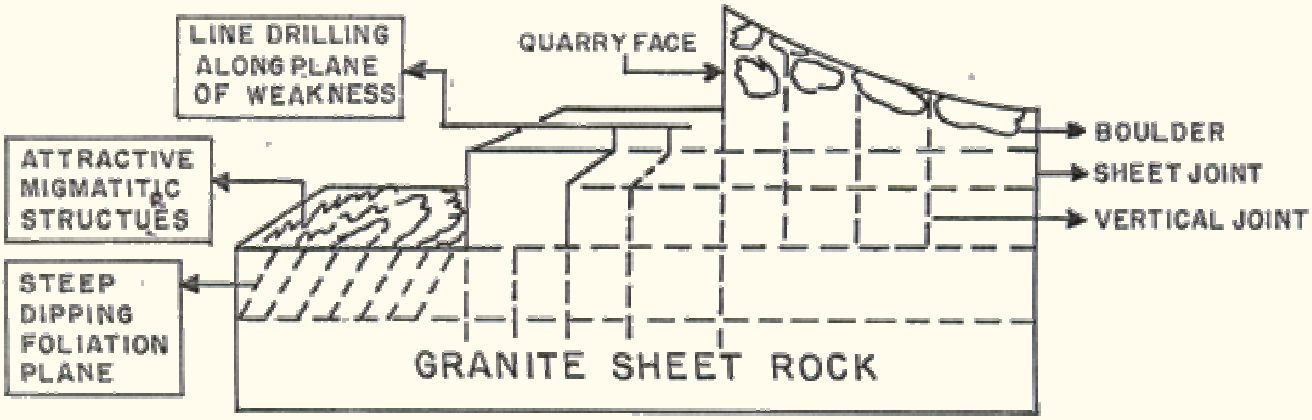


Fig.1. FAVOURABLE GEOLOGICAL STRUCTURES

Favourable Geological Structures

 FAULTSare common structural features in black granite dykes that exhibit dextral and sinistral movements along its 'Run' which decide on the recovery percentage in that quarry.

Unfavorable Geological Structures

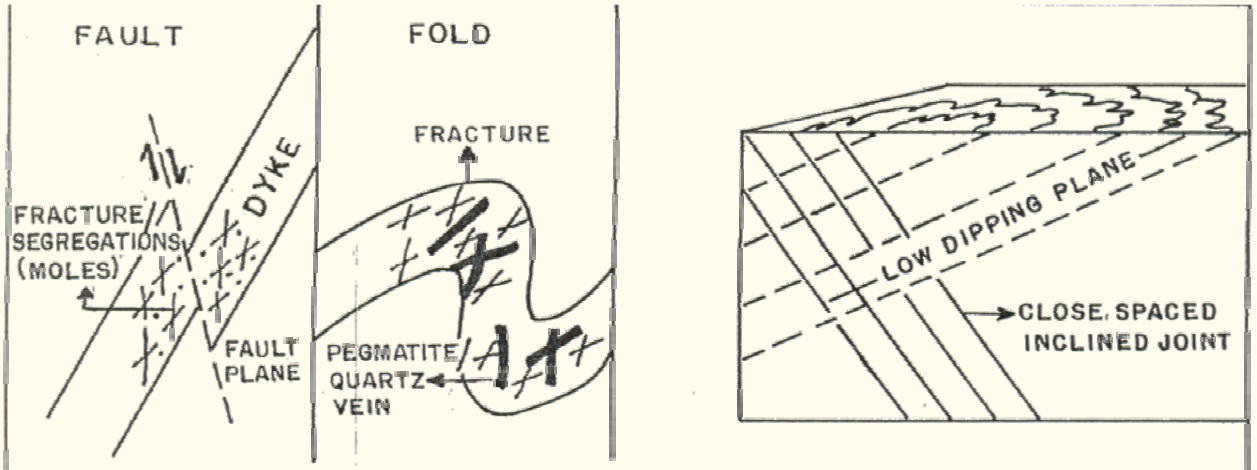
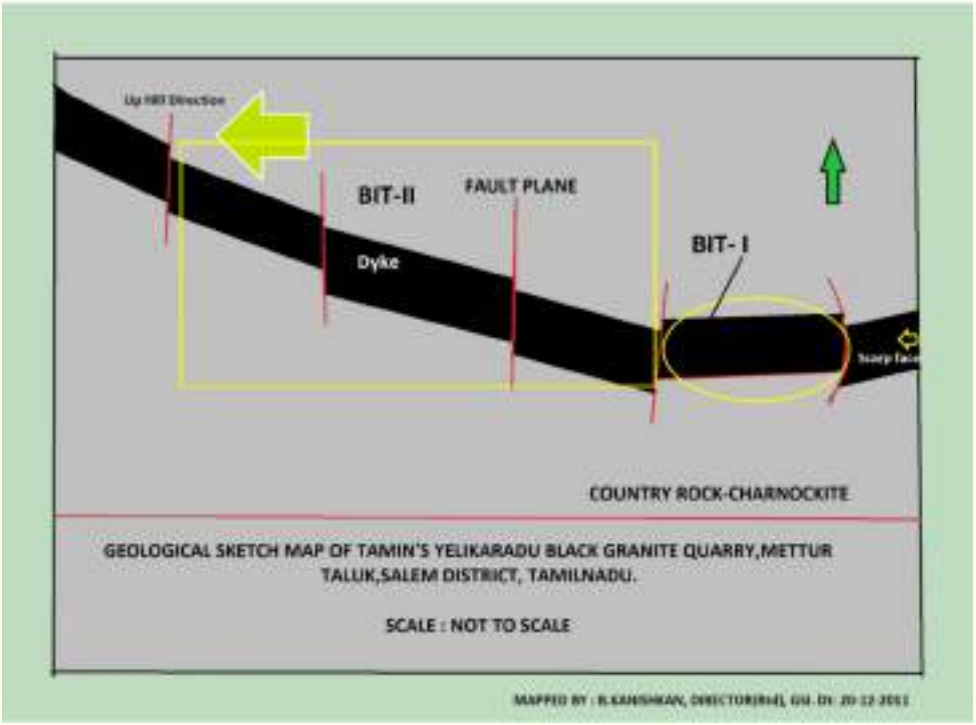


Fig. 2. UNFAVOURABLE GEOLOGICAL STRUCTURES

Unfavorable Geological Structures



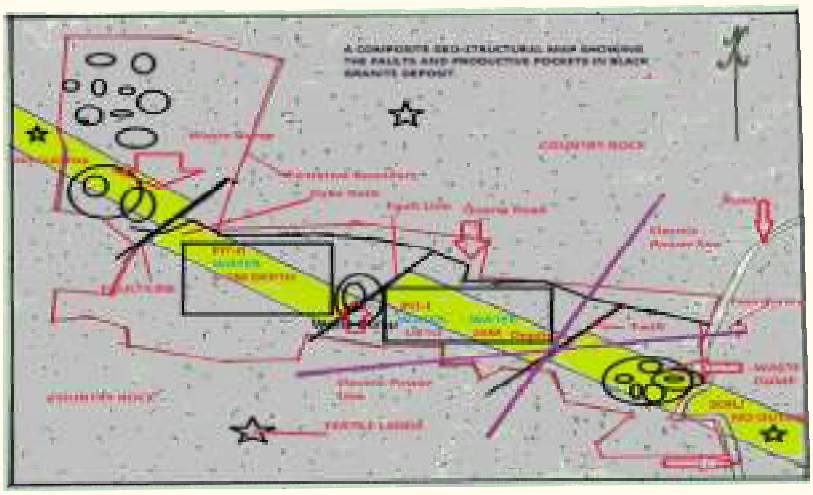
SHEAR FRACTURES are normally associated within the structurally disturbed zones. The effects of minor shear in a granite deposit is manifested in the form of thin and linear nerve like fractures cross-cutting the formation which are harmful to quarry operations.

DISASTROUS GEOLOGICAL STRUCTURES are harmful in totality in granite operations. These structures are of regional phenomena like the lineament zone, major shear zone, suture zone, active fault zone etc.

Sheared Dyke

PREPARATION OF A COMPREHENSIVE GEOLOGICAL MAP:

The critical analysis of all these factors facilitate in preparation of a comprehensive Geological Map of the prospect delineating the zones of productive, defective and promising which ultimately decide on recovery percentage and reserve estimation of the prospect. The geological map will indicate the nature of the deposit, its orientation, quality variation besides on the structural discrepancies of the deposit. Based on the accuracy and precision of the geological plan one can make out the investment and Mining Plan for exploitation of the deposit. The accuracy of the interpreted geological plan depends on the field and quarry knowledge of the Geologist who prepares it. This is the basic tool for preliminary assessment of recovery percentage of the virgin quarry and the authenticity of this data can be corroborated with the actual mining data.

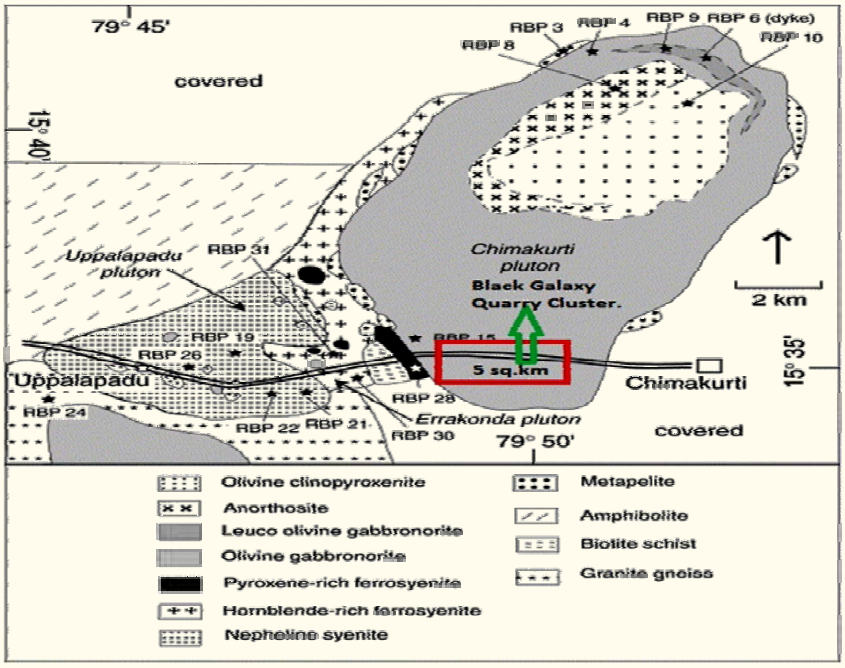


PART-II -CASE STUDY:

In the preamble chapter, the nitty gritty of various geological parameters that affect the recovery of granite blocks within the spread of granite belts have been discussed. In this Chapter, the premium variety of a granite hub viz. black galaxy in AP has been taken up as a case study to demonstrate how the structures affect overall production in the quarries.

BLACK GALAXY BELT, CHIMAKURTHY, ANDHRA PRADESH:

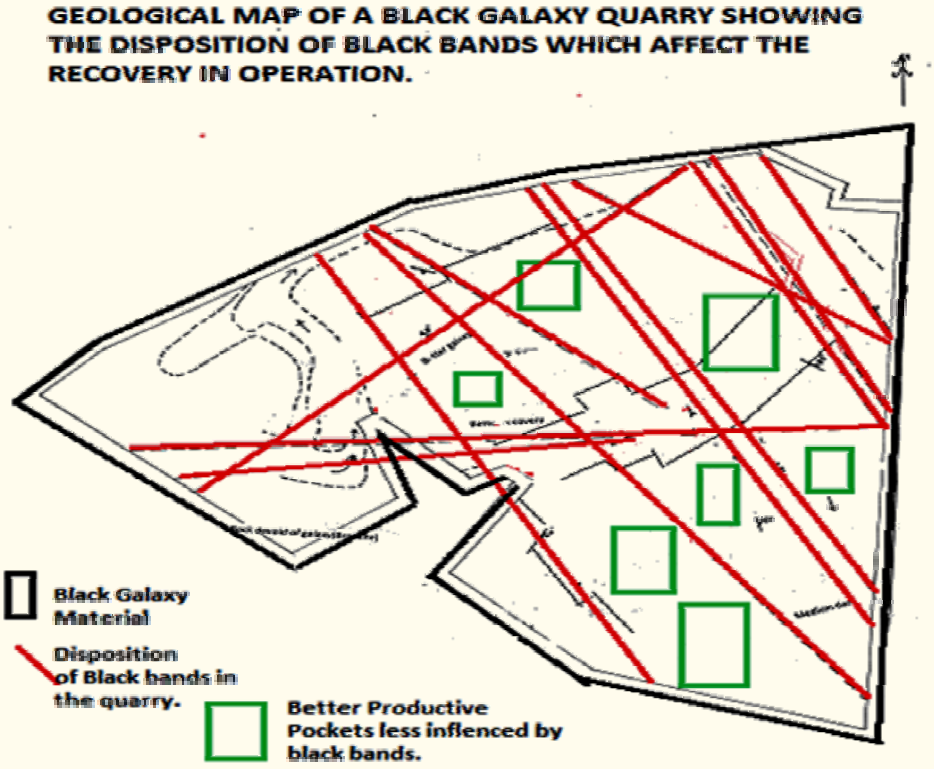
The occurrence of black galaxy deposit (bronzite gabbro) within the Chimakurthy layered complex is unique in the world considering its expanse (5 sq.km) of its occurrence and massiveness of quarry operation within the belt.



GEOLOGICAL MAP OF CHIMAKURTHY BELT

The Black galaxy deposit in Chimakurthy belt, Prakasam belt, Andhra Pradesh is being quarried since nineties and more than 50 quarries are in operation within this belt. The material is in great demand in the world market and the export price is around 1050 USD/Cbm (net). The quarries are operatedin the area which is composed of a thin soil cover followed by 2-3 m thickness of weathered zone and below which occurs the black galaxy sheet rock. The bronzite minerals are embedded along the foliation plane and exhibit the golden yellow galaxies and therefore the cutting plane to expose the galaxy is perpendicular to the foliation direction and any wrong cutting of blocks while quarrying will not expose the galaxy spread. Further, the deposit is intruded by a series of fine grained lineardykes (black bands) mainly oriented along E-W NE-SW and NW-SE directions. The thicknesses of these bands vary from a few cm to 2-3m wide and the inclination of these black band may be either vertical or inclined at depth. All these factors affect badly in recovery of blocks both in size and volume. On an average the recovery percentage within this belt ranges between 5 to 8 % only. The effect of such geological disturbances in production is narrated below with the observations made in the quarry operated within this belt.

GOOGLE IMAGE SHOWING THE SPREAD OF BLACK GALAXY QUARRIES



• i) Impact of shear/ black band intrusions within the deposit in over all production in the quarry:

• Adjacent to the zone of intrusion within the deposit will have black lines/white lines or shear fractures and moles- Nil Recovery.

• In some places the foliation planes exhibit tilting nature and as a result regular method of cutting of blocks will miss the galaxy plane.

• Better productive pockets within the quarry can be demarcated based on the displacement of black bands(Green boxes as shown in the above map)

• Inclination of the black bands at depth may give wrong prediction of production in the next level occurring just below the bench having better recovery.

• Based on the disturbances in the quarry, the quality of the blocks do show background colour variation from dark to light besides the dissemination pattern of galaxy. All these factors decide on the price and marketing potential.

• Based on the behavior of these black bands within the quarry spread one can prognosticate the production every month while the quarry is advancing systematically duly considering the better and defective zones.

• Therefore, it is a thumb rule within this Galaxy belt the Mass excavation(ROM) in a month is the deciding factor on the production achievement.

ii) Following pictures elucidate the impact of these structures in production.

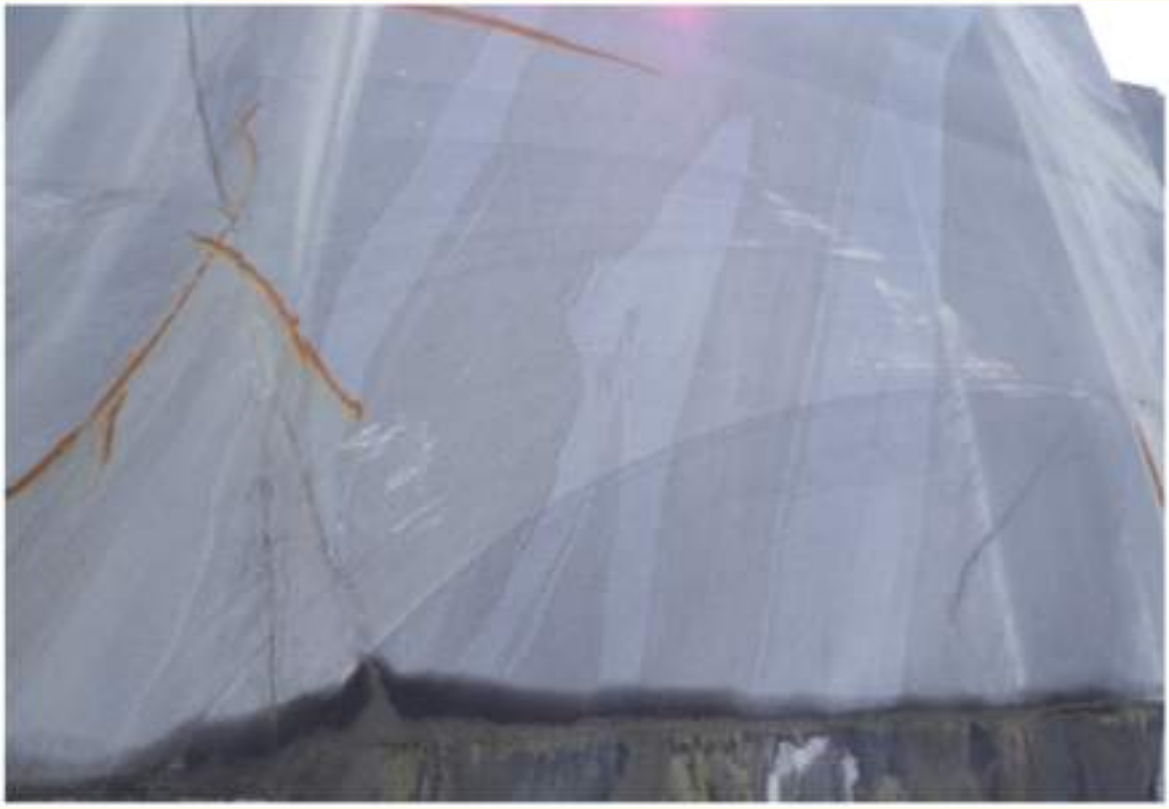
SECTIONAL VIEW OF A BLACK GALAXY QUARRY

DYKE/BLACK BAND INTRUSION SHEAR PLANE(Defective Zone)

DEFECTIVE SHEAR PLANES WITH NIL PRODUCTION

WIDTH OF A DYKE/BLACK BAND IN THE QUARRY

BLACK BAND/SHEAR EFFECT ALONG VERTICAL SECTION



WHITE PATCHES/LINES AS SEEN ALONG SUCH DISTURBED ZONES

DYKE EMPLACEMENT AS SEEN ON THE SURFACE OF THE QUARRY

DYKE EMPLACEMENT AND CORRESPONDING WHITE/BLACK PATCHES

iii) INFERENCE:

Characterization of a quarry based on geological parameters as discussed in foregoing paragraphs will predetermine the potential of a quarry and its future.

III. ADOPTING THE RIGHT TECHNIQUES OF QUARRYING TO ENHANCE THE RECOVERY PERCENTAGE IN QUARRY OPERATIONS:

The deposit characterization and preparation of acomposite thematic geological map/plan depicting all the structural features will facilitate to prepare a master quarrying plan and deployment of State of the Art Machineries like Excavators, Dumpers, Drifters, Line drilling machines, Diamond wire cutting machines, LD bore machine, Compressors etc. that are more suitable to target the mass removal(ROM) to achieve the monthly target considering the low recovery potential of the quarry which ranges between 5-10%. In this context, it is vital to understand the nature and behavior (geometry) of the deposit at every level of operation and to deploy the cutting orientation meaningfully to retrieve the best blocks that are possible. Orientation and deployment is the basic tenets of quarrying in such complicated terrain. Blind cutting of the formation without understanding its behavior is a suicidal step to destroy the whole operation. Shear zones/weak planes will help to cut trenches to reach the next level of operation. Jumping of galaxy planes as mentioned above to be carefully handled by tilting the slices and to orient the sub-cutting parallel to the foliation/galaxy plan. Regular cutting method will result in wrong cutting of blocks devoid of galaxy exposures. These are some of the critical observations which will enrich our knowledge to orient the production meaningfully.

CONCLUSION:

Deposit characterization of an area/ quarry requires an in-depth knowledge on geological/structural mapping with application to quarrying. The Black Galaxy belt is a structurally complicated deposit which needs to be operated carefully like a glass duly understanding its nature of occurrence and will help to scientifically enhance its recovery percentage besides conserving the unique occurrence within this belt of 5 sq. km area. Further, the study will also help to avoid major disaster of high wall collapse as it happened during 2010 in a quarry causing huge loss of human lives and property and in this context we need to stabilize the walls with proper treatment from time to time depending upon the intersection of these bands on the walls and the wedges formed to prevent any sliding.

FACTORS AFFECTING THE PERFORMANCE OF SOLAR PHOTOVOLTAIC PANEL IN SURFACE MINES

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ABSTRACT

Due to increase in power consumption and greenhouse problem all over the world, an alternative source is necessary for generating clean and environmental friendly electric power. In this regard, solar energy could be a good choice of power generation, since the cost of solar panels decreasing rapidly in the past few years. Moreover, solar energyhas also become more efficient as compared to other source of energy systems. The performance of solar photovoltaic (PV) panel is primarily dictated by its surrounding environmental parameters, such as dust, temperature, wind speed and humidity. This paper highlights findings of some of the major studies carried out on the effect of environmental parameters on the performance of solar PV panel. In addition to this, an analysis of the advantages of different systems of cleaning of dust from panel surface, such as natural, manual, mechanical and electrical systems is also presented.

Keywords: Fossil fuels, PV panel, Electric power and Dust

1. INTRODCUTION

The production of electrical energy is based on fossil fuels, nuclear and renewable energy sources. Among these, the renewable energy sources are considered as clean and environmental friendly energy source. There are different types of renewable energy sources, such as hydro, geothermal, biomass, wind and solar. Solar energy experienced a rapid growth and popularity in the last one decade because of its huge advantages, like availability of raw material, no emission of pollutants, can be used in remote areas, not generate noise problem and easy to install. Therefore, Solar energy is the most promising and vital energy source to produce electricity in a current scenario [1]–[4]. The Photovoltaic (PV) panel is a part of solar energy that converts solar radiation energy (solar energy) into electrical energy [5]. Whenever sunlight strikes on PV cell surface, which is made up of silicon type semiconductors, it separates electron-hole pairs inside the semiconductor material. This separation of electron-hole pairs inside the semiconductor material is the main cause for electrical power generation in solar photovoltaic system.The PV panels are operated in an open atmosphere, where it experiences a significant variation due to environmental parameters, such as wind speed, ambient temperature, solar radiation, humidity and dust pollutants [6]. These

environmental parameters affect the performance of PV panel in an open atmosphere. Among these parameters dust plays a significant role in reducing the performance of PV panel [7]

In remote areas it is very difficult to provide electric power and also it is very expensive. In such cases, solar energy could be a good choice for providing electrical power. In general, the mining industries are situated in remote areas, where the electrical power is provided either from transmission line (Grid) or from diesel generator (DG) set. Since, the price and utilization charges of both of these energy sources are continuously increasing, solar energy technology could be the best alternative energy source for the mining industry. The PV panel installation requires vast land which is easily assessable in the mining areas in the form of waste dump yard, abandoned mine area, pit bottom area, tailing ponds etc. In these areas PV panels can be effectively installed and utilized. The electricity, thus generated by solar energy can be utilized for spot lighting, haul road lighting, lighting crushers, beneficiary plant, pumping area etc. But due to dusty and bad environment prevailing in the mines PV panel may not perform well as ensured by the manufactures. In fact, the performance of PV panel degrades with time due to such dusty and bad environment[8].Thus,the knowledge of the environmental parameters effect on the performance of PV panel is very essential. Therefore, the major emphasis of this review is to study the effect of environmental parameters, such as solar radiation, dust, wind speed, temperature and humidity on the performance of PV panel. The possible method of dust cleaning method is also examined in this review.

2. EFFECT OF ENVIRONMENTAL PARAMETERS ON THE PERFORMANCE OF SOLAR PVPANEL

In general, the PV panel is operated in an open atmosphere, where it experiences a significant variation in its performance due to its surrounding environmental parameters [6]. The generation of electrical energy from the PV panel mainly depends upon its performance. The performance degradation of PV panel depends on internal and external parameters. The internal parameters that affect the PV panel performance are surface temperature, panel configuration, tilt angle, corrosion and breaking of cells, delamination of the cells etc.; and the external parameters are dust, humidity, ambient temperature, wind speed, solar radiation and the rate of shading across panel surface. Among all the external parameters, dust plays a significance role in reducing the PV panel performance. Atmospheric temperature, wind speed and humidity of the surrounding environment play a critical role in deposition and spreading of dust on the module surface.

2.1 Effect of Solar Radiation on PV Panel Performance

The overall technical and economical performance of solar PV panel strongly depends on the solar radiation falling on it. Therefore, the measurement and estimation of solar radiation is an important aspect to determine the PV panel performance. The output power of the panel decreases almost linearly with the decrease in the intensity of falling solar radiation on its surface. Unfortunately, the solar radiation falling on

the panel surface is not constant. In a normal sunny day, it increases from morning to noon and then decreases till sunset, when radiation intensity falls to zero. Due to this variation in the solar radiation, the output power of the PV panel also changes throughout the day. The output current produced by PV panel is the linear function of the solar radiation falling on its surface [9], [10]. But the output voltage of the panel is a logarithmic function of the solar radiation falling on its surface [11], [12].

2.2 Effect of Dust on PV Panel Performance

Due to the fast industrialization and urbanization the effect of air pollution is becoming a very serious problem in the area of solar energy utilization[13]. Because of the air pollution effect, the air borne dust particles get deposited on the surface of PV panel. The deposition of dust on PV panel surface is the main cause for its performance degradation[8], [14], [15]. Dust creates a barrier between PV panel surface and sunlight falling on its surface, which attenuates the part of the incoming sunlight[16]. The attenuation of sunlight depends on the size of dust, density of dust and type of dust[17]. This attenuation of sunlight considerably reduces the performance of PV panel[18], [19].

It was found that due to dust deposition on panel surface the power generation capacity and conversion efficiency of PV panel reduces to 92.11% and 89%, respectively[20]. A study shows that the reduction in glass transmittance ranges from 12.38% to 52.4% for 4.48 to 15.84 g/m2 of dust deposition[21]. One more study reported that the reduction in conversion efficiency of PV panel due to dust deposition was 10%, 16% and 20%, respectively, for 12.5 g/m2, 25 g/m2 and 37.5 g/m2 dust density [22].

As per the literature review, studies have been carried out on the following 12 types of dust pollutants to explain its effect on the performance of the PV panel:

1. Red soil 2. Sand 3. Lime stone 4. Ash

5. Silica 6. Cement 7. Carbon 8. Mud

9. Talcum 10. Natural dust 11. Calcium carbonates 12. Clay

A study carried out by Kaldellis and Kapsali (2011) demonstrated that the energy loss of PV module due to red soil, lime stone and ash is, respectively, 19%, 10% and 6%[23]. Similarly one more study reported that dust shows a minimum reduction of 0.9V output and a maximum of 4.7V for ash, among five kinds of air pollutants, such as red soil, ash, sand, calcium carbonate and silica gel[24].The performance degradation of PV panel due to the deposition of dust on its surface also depends on PV cell technologies, like monocrystalline silicon (mc-Si), polycrystalline silicon (pc-Si) and amorphous silicon (a-Si)[25]. The variation in electrical parameters of PV module due to dust accumulation is also influenced by the type of PV technology. A study reported that the reduction in PV module power output due to dust effect is 77.75% for mc-Si module and 18.02% for pc-Si module[26]. One more study shows that due to the deposition of dust on the panel surface, its short circuit current reduces up to 41%, 4.79% and 7.34%,

respectively for the monocrystalline, poly crystalline and amorphous PV panel[27].

2.3 Effect of Temperature on PV Panel Performance

The panel surface temperature is a key environmental parameter that influences the performance of PV panel by changing its electrical parameters, such as open circuit voltage (VOC), short circuit current (ISC), maximum power output (PM) and fill factor (FF) [28], [29]. In general, PV panels are made of silicon semiconductor material and like all semiconductor materials, PV panels are also temperature sensitive. Hence, temperature of PV panel is an important environmental parameter, which affects its performance. The panel surface temperature depends on the encapsulating material, solar radiation, atmospheric temperature, humidity and wind speed[30].

As the temperature of PV panel increases its VOC, PM and FF decreases. Moreover, the ISC of PV panel experiences a very small increment with the rise in its surface temperature. As a result of this, the overall performance of PV panel reduces due to increase in its surface temperature [31]. The rise in panel temperature for c-Si PV panel decreases its VOC at the rate of-0.45%/K [32]. Similarly, the decrease in power output and fill factor of the PV panel to increase in panel surface temperature are at the rate of -0.65%/K and -0.2%/K, respectively [33].

2.4 Effect of Humidity on PV Panel Performance

Humidity is an ambient parameter which is defined as the amount of water vapour present in the atmospheric air. To analyse the effects of humidity, two scenarios need to be considered. The first scenario is the effect of humidity on the solar radiation and the second scenario is humidity ingression to the solar cell enclosure. Whenever, the sunlight rays hit the water droplets they undergo the phenomena of refraction, reflection and diffraction. These effects alter and reduce the solar radiation reaching panel surface in non-linear manner due to non-uniform distribution and random sizes of water droplets in the atmosphere [34]. Thus the overall performance of PV panel (output current, voltage and power) reduces with the increase in the humidity level in the environment [35], [36].

In the second scenario, when the PV panels are exposed to humidity for a long time, there may be a possibility of moisture ingression into the glass of the PV panel. In this case, when moisture enters the solar panel, it provides an additional shunt path for the output current of the cell. Thus, the effective shunt resistance of the cells in the panel reduces which further reduces the output current of the panel. This reduction of output current will be more significant if the series resistance of the cells increases due to the corrosion of the contact pads under the exposure of moisture. Sometimes, the moisture ingression into the cell of the panel reduces the life span of the crystalline cell by delamination, embrittlement and corrosion of encapsulant material of the PV cell [37], [38].

2.5 Effect of Wind Velocity on PV Panel Performance

Wind speed plays an important role in the performance of PV panel. It is having dual

effect on the performance of PV panel – sedimentology effect and aerodynamic effect[39].

Sedimentology effect

In this phenomena wind speed supports the panel performance by removing dust from its surface. Wind speed affects the ripple height and ripple spacing of accumulated dust on panel surface. Ripple height is nothing but the physical height of dust particle and ripple spacing is the spacing between two adjacent dust particles. High wind speed decreases the ripple height and increases the ripple spacing of dust particles. The increment in ripple spacing allows more sunlight on panel surface which enhance its performance. The sedimentology effect of dust on panel surface is depicted in the Figure 1.

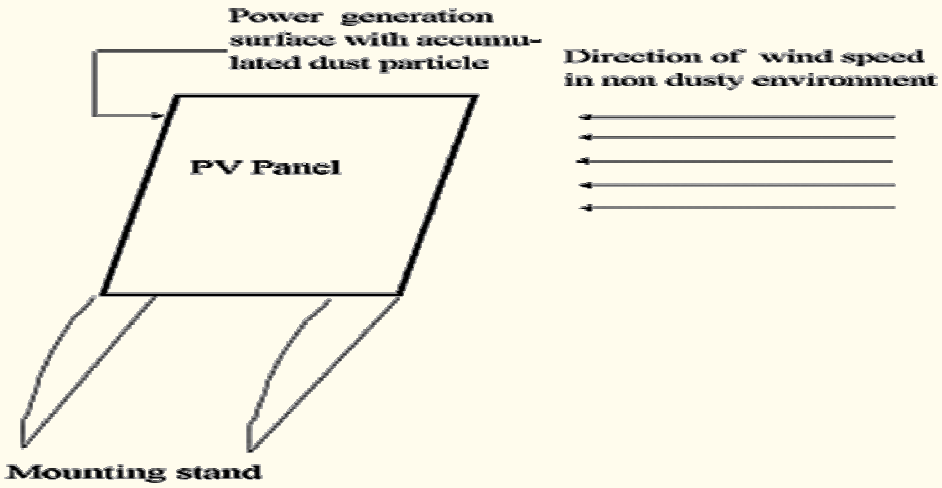

Fig. 1 Sedimentology effect of wind speed on PV panel performance in non-dusty environment

The lager number of fine particles occupies a largest fraction of total volume, which reduces the ripple spacing. Due to this, the reduction in light transmittance is more when compared to coarse particles. Therefore, coarse dust particles having less impact on PV panel performance compared to fine particles.

Aerodynamic effect

This effect states that wind speed supports the dust deposition on panel surface and thus the panel performance reduces significantly. The aerodynamic effect of wind speed on PV panel performance can be defined by equation (1). Figure 2 shows the aerodynamic effect of wind speed on PV panel.

$$F_s = V_d \times C \qquad (1)$$

where, F_s = Sedimentation flux or dust deposition density ($g/m^2/s$)

Vd = Wind velocity (m/s), and

C = Airborne dust concentration (g/m3)

As stated in equation (1), the increase in wind speed enhances the dust deposition on the panel surfaces, which degrades the performance of PV panel.

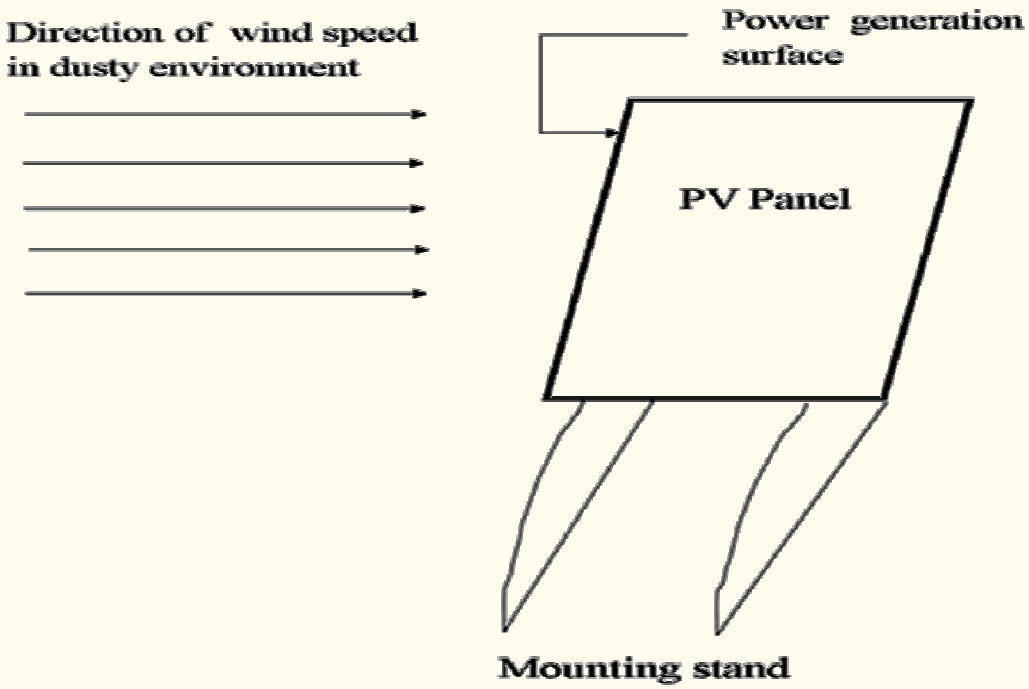

Fig.2 Aerodynamic effect of wind speed on PV panel performance in dusty environment

3. DUST CLEANING TECHNIQUES FROM PV PANEL SURFACE

The literature study shows that the accumulation of dust on PV panel surface is the main cause for its performance degradation. Therefore, an effective dust cleaning system is required in order to get the satisfactory performance form the PV panel. There are various dust cleaning systems, such as natural cleaning, manual cleaning with water, automatic cleaning, electrostatic cleaning system [40]. The detailed explanation of these cleaning systems is discussed in the subsequent sections.

3.1 Natural Cleaning System

Rainfall is considered to be the most efficient natural cleaning system. Rainfall removes the accumulated dust particles from the panel surface and improves the panel performance. This cleaning system can be achieved by installing the panel other than the horizontal orientation. The study conducted in the higher latitude zone shows the significant improvements in the panel performance due to natural rainfall [41]. But this cleaning system will be very ineffective where the rain fall events are infrequent i.e., semi-arid and desert areas where the rainfall occasionally happens. Moreover, low rainfall in the dusty environment followed by dusty wind increases the accumulation and reduces the panel performance. Thus, this cleaning system of dust from the panel surface is not reliable and efficient in low rainfall area.

3.2 Manual Cleaning with Water

Water often mixed with detergent followed by wiper of soft cloth is the most common practice for cleaning the PV panel

surface in small scale installation [42], [43]. However, for large scale installation of PV plants, high-pressure water jet, followed by brushing has been reported in many investigations [44]. It is considered as one of the most efficient cleaning systems among existing practices, because it is less harmful to the panel surface. One study reported that the manual cleaning with water brush arrangements increased 6.9% the output power of the PV plant [45]. But, this cleaning system has increased the cost of cleaning as it includes the cost of labour, water and requires trained personnel. Moreover, this cleaning system is not applicable where the scarcity of water is the prime concern.

3.3 Mechanical Cleaning System

An automatic cleaning system, particularly that which does not require water is most desirable for maintaining the performance of PV panel in dusty environments. The automatic cleaning system uses the computer controlled mechanical devices to clean the panel surface. This cleaning system is more efficient and reliable as it reduces the labour and water cost. A study conducted by Tejwani and Solanki (2010) reported the design and testing of an integrated automatic mechanical cleaning system in order to maximize the output power by 15% compared to that without the cleaning system [46].

3.4 Electrical Cleaning System

The electrostatic dust cleaning is another method of dust removal from the PV panel surface. It consists of series of alternating electrode embedded in a transparent dielectric film and applied to the panel surface. Whenever, the panel surface is charged, the array will attract particles of opposite charge and repel particles of the same charge. This cleaning system requires high electric field for the short duration to generate a standing wave by an alternating electric field. The dust removal process requires no water and moving parts. This method of cleaning is in the developmental stage [47], [48] .

4. CONCLUSIONS

Solar energy is opted as a better choice of power generation world-wide, especially in remote areas, where mining and mineral industries are rarely accessed, because in these areas, continuation deposition of dust particle might damage the solar panel. This paper emphasizes on how environmental parameters in surface mines bring undesirable results over the performance of PV panel. The environmental parameters, such as dust, humidity,temperature and wind velocity have a negative impact on the performance of solar PV panel. As these factors degrade the PV panelperformance, therefore, itis essential to keep the panel free from the dusty environment by ensuringit's cleaning and cooling at regular intervals.

IMPACT OF CHEMICAL COMPOSITION OF BRICKS PREPARED USING IRON ORE WASTE ON ITS COMPRESSIVE STRENGTH

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ABSTRACT

Manufacturing of building materials like brick, cement, steel and aggregates etc. which are consumed in bulk quantities, puts great pressure on natural resources (raw materials) and are highly energy demanding. Therefore, the use of alternative materials for brick construction should be encouraged. Mine wastes and tailings can be converted into bricks, which can meet the demand of bricks in construction works for the next 30 years or even more. Further, building blocks from mine waste are eco-friendly as it utilizes waste and reduces air, land and water pollution. It is energy efficient and also cost effective as reported by various agencies in the past. Through this ,study an attempt was made to investigate the impact of chemical composition of prepared IOW bricks on its compressive strength. The chemical compositions like total percentage of Al_2O_3, SiO_2 and Fe_2O_3 present in a brick were observed through the output of Java program which was executed in NetBeans 8.1 IDE for all the mix ratios. Based on the available data, investigation has revealed that there is no proper relationship between the total percentages of SiO_2 and Al_2O_3 present in a brick with its compressive strength. However, with increase in total percentage of Fe_2O_3 present in a brick, its compressive strength was found to decrease gradually.

Keywords

Iron Ore Waste (IOW), Fly-ash, Compressive Strength, Al_2O_3, SiO_2, Fe_2O_3.

1.0 Introduction

The general perception about mining is that, it is hazardous industry causing significant damage to the environment in different ways. To make mining activities more environment-friendly, economically feasible, and socially acceptable, it is important to use practices that are more sustainable in handling the wastes generated. The voluminous amount of waste generated from the mining and processing activities is one of the major concerns for the mining industries and the community at large. The availability of iron ores in Karnataka particularly Hospet sector has attracted significant investment in the mining sector and it has resulted in several operating of iron ore mines. The high extent of mining activities in this sector has brought about significant volumes of mine wastes which needs to be handled by the mining firms. Some of these wastes generated are iron ore waste, iron ore tailings, waste rocks, overburden etc. The disposal of these wastes

needs to meet local legislations and expectations of the community around.

There is a significant demand of building materials in India and elsewhere. It is therefore imperative to use the mining and mineral wastes in the production of bricks, concrete blocks and other value added products [1] [2]. Since the need for building materials is growing at an alarming rate, in order to meet the demand for new buildings, new ways and techniques must be evolved. Manufacturing of building materials like brick, cement, steel, aggregates etc. which are consumed in bulk quantities, puts great pressure on natural resources (raw materials) and are highly energy demanding. Therefore, the use of alternative materials for brick construction should be encouraged. Mine wastes and tailings can be converted into bricks ,which can meet the demand of bricks in construction works for the next 30 years or even more. Further, building blocks from mine waste are eco-friendly as it utilizes waste and reduces air, land and water pollution. It is energy efficient and also cost effective as reported by various investigators in the past.

This study focus on the impact of major chemical composition of cement, fly ash and IOW and its impact on compressive strength of the prepared IOW bricks. To carry out this process, the average mass of the bricks with 28 days of curing period were measured. The major chemical compositions liketotal percentage of Al_2O_3, SiO_2 and Fe_2O_3present in a brick were observed through the output of Java program which was executed in NetBeans 8.1 IDEfor all the mix ratios. This was done to avoid tedious and time consuming calculations..

2.0 Chemical Composition

2.1 Iron ore samples (IOW)

The various constituents (in percentage) indifferent IOW samples i.e. S1 to S9 were studied and are given in Table 1. The main aim was to know SiO_2, Al_2O_3 and Fe_2O_3 percentage which influences better bonding in the product and gives better compressive strength to the bricks. However, the impact of various constituents of IOW bricks like SiO_2, Al_2O_3 and Fe_2O_3 will be discussed further. From Table 1 it was observed that the percentage of Fe_2O_3 present in IOW is more than 30 % in case of sample No. 6, 7 and 8. These three samples were not used further for preparation of IOW bricks in this study.

Table 1 Chemical composition of IOW (% by mass)

Sample No.	Na_2O	MgO	Al_2O_3	SiO_2	K_2O	CaO	TiO_2	Fe_2O_3
S1	0.03	0.19	22.27	40.70	0.05	4.79	1.20	22.93
S2	0.89	0.10	27.53	33.02	0.08	3.65	0.94	27.24
S3	0.07	0.06	34.00	40.24	0.06	5.54	1.56	15.20
S4	0.06	0.80	21.42	50.80	0.05	6.85	0.55	20.18
S5	0.04	0.36	25.32	50.13	0.03	3.32	0.85	15.38
S6	0.15	0.02	22.98	21.20	0.07	5.40	0.70	58.88
S7	0.12	0.10	30.45	38.80	0.14	6.52	0.65	32.08
S8	0.37	0.30	13.90	29.45	0.05	2.08	0.36	48.10
S9	0.13	0.27	16.40	41.70	0.14	7.11	1.50	29.45

2.2 Portland cement

Ordinary Portland cement of 43 grade, confirming to IS:8112-1989 [3] was used as binding material for the preparation of bricks. As the cement was finer than the iron ore waste sample, it could be used as a binding material/additive. Fineness or particle size of Portland cement affects the rate of hydration, which is responsible for the strength gain. Table 2 gives the chemical composition of cement.

Table 2 Chemical composition of cement (% by mass)

Chemical Composition (%)	SiO_2	Al_2O_3	Fe_2O_3	Na_2O	K_2O	MgO	M_nO_2	C_aO	ZnO	P_b	C_r
Cement	18.71	10.44	6.47	0.34	0.43	0.00	0.12	51.46	1.05	1.68	0.01

2.3 Fly-ash

Table 3 gives the chemical composition of fly ash, which was collected from thermal power plant (UPCL, Udupi Dist. Karnataka). Fly ash are suspended particles that are toxic in nature and found in the exhaust gases. Fly ash is widely used for commercial purposes by mixing with other cementing materials. The fine fly ash particles (less than 45µm) displaces water between the cement particles and act as hydration sites for the cement, thereby improving the concrete pore structure and stimulating early strength development

Table 3 Chemical composition of fly ash (% by mass)

LOI (%)	Chemical Composition (%)									
	SiO_2	Al_2O_3	CaO	MgO	K_2O	Na_2O	TiO_2	SO_3	MnO_2	Fe_2O_3
0.14	34.80	14.10	16.16	2.70	1.30	5.30	0.86	0.50	0.20	24.14

3.0 Preparation of IOW Bricks

As the collected Iron Ore Waste (IOW) sample was in the form of powder, it did not require further processing like crushing and grinding. Hence, the collected samples were directly suitable for mixing with additives for brick making. For preparing the bricks, iron ore waste was taken as a major aggregate in combination with fly ash and cement. The bricks were prepared with five different combinations of above said aggregates (i.e. cement, fly ash and iron ore waste) by mass percentage as given in Table 4 and were cured for different curing period like 7, 14, 21 and 28 days. In a similar fashion, bricks were prepared with IOW percentage of 65, 70, 75, 80, 85 and 90.

Table 4 Composition for different types of mixes with IOW 65% [4]

Mixture	Ratio (in %)		
	Cement (C)	Fly-ash (FA)	Iron Ore Wast (IOW)
A	30	05	65
B	25	10	65
C	20	15	65
D	15	20	65
E	10	25	65
F	05	30	65

Bricks were prepared using 30 cast iron metallic moulds which were specifically fabricated for this purpose. During brick making, oil was applied to the inner part of the mould and the prepared mixture was poured slowly into it so that it spreads evenly inside the mould. After filling the mould with mixture, load of 20 MPa was applied using compression testing machine {based on the earlier studies carried out by various investigators [5, 6]}to each brick for proper compaction of bricks. The size of bricks prepared was 190mm×90mm×90mm (inner dimension) [7].

The bricks were prepared with different ratio of cement (C), fly ash (FA) and iron ore waste (IOW) which are designated as A, B, C, D, E and F as given in Table 4. The prepared bricks were kept for 24 hours in the mould and then removed and kept under sunlight for drying. Proper curing was done by spraying water for 7days, 14 days, 21 days and 28 days, as shown in Fig. 3. For each number of curing days, five bricks were tested for its compressive strength and five for its water absorption, as per Bureau of Indian Standards [6, 7].

4.0 Chemical Composition of Materials Present in a Prepared Bricks

From Table 5 and Figure 1, it was found that, the major chemical composition in IOW, fly ash and cement are SiO2, Al2O3 and Fe2O3. Table 5 gives the percentage of SiO2, Al2O3 and Fe2O3infly ash, cement and IOW of different locations which is also shown in Figure 1. From Table 5 and Figure 1 it is also seen that the mass percentage of SiO2is highest in case of cement, fly ash and IOW. The mass percentage of Al2O3 varies from 10.44 to 34, the mass percentage of Fe2O3 varies from 6.47 to 27.24 whereas that of SiO2 varies from 18.71 to 50.80 for fly ash, cement and IOW of all the six locations.

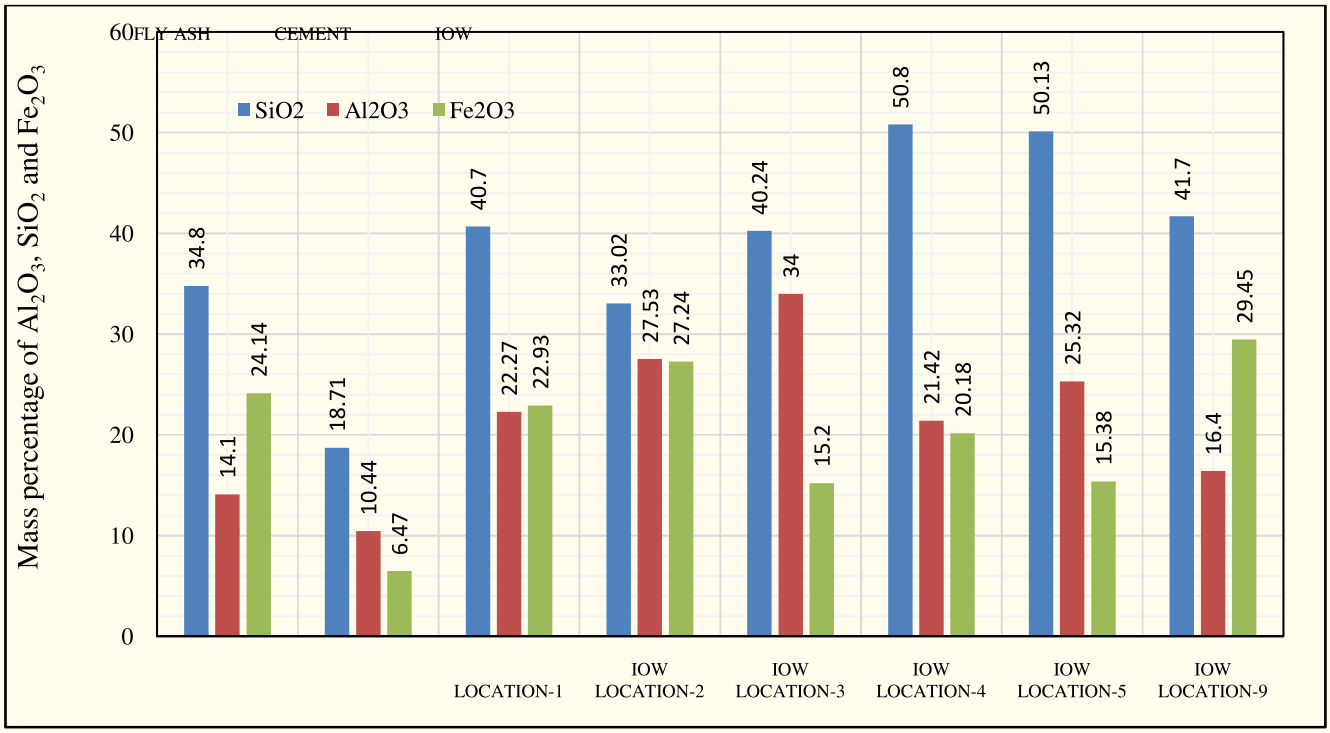

Fig. 1 Mass percentage of S_iO_2, Al_2O_3 and Fe_2O_3 of fly ash, cement and IOW

Items	Major chemical composition (%)		
	SiO_2	Al_2O_3	Fe_2O_3
Fly ash	34.80	14.10	24.14
Cement	18.71	10.44	06.47
IOW, Sample Location-1	40.70	22.27	22.93
IOW, Sample Location-2	33.02	27.53	27.24
IOW, Sample Location-3	40.24	34.00	15.20
IOW, Sample Location-4	50.80	21.42	20.18
IOW, Sample Location-5	50.13	25.32	15.38
IOW, Sample Location-9	41.70	16.40	29.45

Table 5 Major chemical composition of fly ash, cement and IOW

4.1 Total percentage of Al2O3, SiO2 and Fe2O3 in a brick

To investigate the impact of major chemical composition of cement, fly ash and IOW for Sample location-1 to 5 and Sample location-9, the average mass of the bricks with 28 days of curing period were measured. The chemical compositions like total percentage of Al_2O_3, S_iO_2 and Fe_2O_3 in a brick were observed through the output of Java program which was executed in NetBeans 8.1 IDEfor all the mix ratios. This was done to avoid tedious and time consuming calculations over a calculator. The computational program output in the form of screen shot is shown in Figure2.

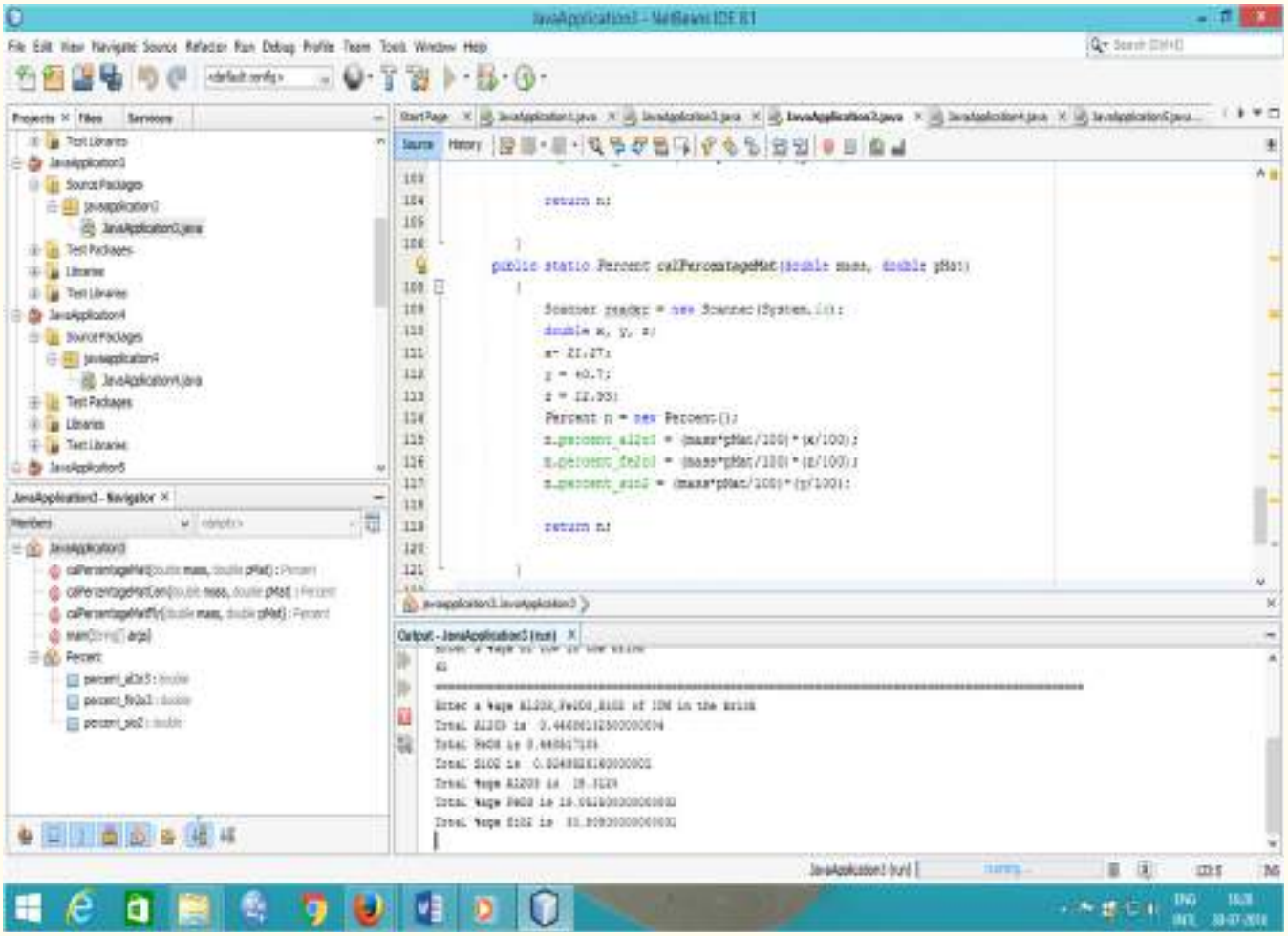

Fig. 2 Program output screen shot to find the total percentage of Al_2O_3, S_iO_2 and Fe_2O_3 presentin a brick

4.2 Methodology used for computation of total percentage of Al_2O_3, SiO_2 and Fe_2O_3 present in prepared IOW bricks

The methodology used for computation of percentage of Al_2O_3, SiO_2 and Fe_2O_3 in the computer program is given below:

Let the mass of the brick = m (kg.)

Let us assume that the brick has 10 % cement, 20 % fly ash and 70 % IOW

Then,

Mass of cement in a brick, C = $\frac{10}{100}$ kg.

Mass of fly ash in a brick, F = $\frac{20}{100}$ kg.

Mass of IOW in a brick, IOW = $\frac{70}{100}$ kg.

Let the percentage of Al_2O_3 in cement be, x %

Let the percentage of SiO_2 in cement be, y %

Let the percentage of Fe_2O_3 in cement be, z %

Then, in $\frac{10\ m}{100}$ kg cement

The percentage of Al_2O_3= $\frac{10\ m}{100}$ x $\frac{x}{100}$ kg

The percentage of SiO_2= $\frac{10\ m}{100}$ x $\frac{y}{100}$ kg

The percentage of Fe_2O_3= $\frac{10\ m}{100}$ x $\frac{z}{100}$ kg

Let the percentage of Al_2O_3 in fly ash be, a %

Let the percentage of SiO_2 in fly ash be b, %

Let the percentage of Fe_2O_3 in fly ash be, c %

Then, in $\frac{20\ m}{100}$ kg fly ash

The percentage of Al_2O_3= $\frac{20\ m}{100} \times \frac{a}{100}$ kg

The percentage of SiO_2= $\frac{20\ m}{100} \times \frac{b}{100}$ kg

The percentage of Fe_2O_3= $\frac{20\ m}{100} \times \frac{c}{100}$ kg

Let the percentage of Al_2O_3 in IOW be, d %
Let the percentage of SiO_2 in IOW be e, %
Let the percentage of Fe_2O_3 in IOW be, f %

Then, in $\frac{70\ m}{100}$ kg IOW

The percentage of Al_2O_3= $\frac{70\ m}{100} \times \frac{d}{100}$ kg

The percentage of SiO_2= $\frac{70\ m}{100} \times \frac{e}{100}$ kg

The percentage of Fe_2O_3= $\frac{70\ m}{100} \times \frac{f}{100}$ kg

$$\text{Total } Al_2O_3 \text{ in a brick} = \left(\frac{10\ m}{100} \times \frac{x}{100} \mid \frac{20\ m}{100} \times \frac{a}{100} \mid \frac{70\ m}{100} \times \frac{d}{100}\right) \text{ kg}$$

$$\text{Total } SiO_2 \text{ in a brick} = \left(\frac{10\ m}{100} \times \frac{y}{100} \mid \frac{20\ m}{100} \times \frac{b}{100} \mid \frac{70\ m}{100} \times \frac{e}{100}\right) \text{ kg}$$

$$\text{Total } Fe_2O_3 \text{ in a brick} = \left(\frac{10\ m}{100} \times \frac{z}{100} \mid \frac{20\ m}{100} \times \frac{c}{100} \mid \frac{70\ m}{100} \times \frac{f}{100}\right) \text{ kg}$$

$$\text{Total \% } Al_2O_3 \text{ in a brick} = \frac{\text{Total of } Al_2O_3 \text{ in a brick (kg)}}{\text{Mass of brick (kg)}} \times 100\ \%$$

$$\text{Total \% } SiO_2 \text{ in a brick} = \frac{\text{Total of } SiO_2 \text{ in a brick (kg)}}{\text{Mass of brick (kg)}} \times 100\ \%$$

$$\text{Total \% } Fe_2O_3 \text{ in a brick} = \frac{\text{Total of } Fe_2O_3 \text{ in a brick (kg)}}{\text{Mass of brick (kg)}} \times 100\ \%$$

The input to the developed program were mass of a brick; percentage of cement, fly ash and IOW; percentage of Al_2O_3, SiO_2 and Fe_2O_3 in cement, fly ash and IOW. The output of the developed program was total percentage of Al_2O_3, SiO_2 and Fe_2O_3 in a particular brick.

5.0 Results and Analysis

The results of the percentage of Al_2O_3, SiO_2 and Fe_2O_3 in bricks prepared from all the six locations are given in Table 6 to Table 11.

Table 6 Percentage of Al_2O_3, SiO_2 and of Fe_2O_3 in bricks (Sample location-1)

Sample location No.	Mix ratio (C:FA:IOW)	Avg. Mass of brick (kg)	Total % of Al_2O_3 in a brick	Total % of SiO_2 in a brick	Total % of Fe_2O_3 in a brick	Compressive strength of a brick for 28 days of curing(MPa)
1	**30:05:65**	2.4402	18.31	33.81	18.05	11.69
	25:10:65	2.4368	18.50	34.61	18.94	11.20
	20:15:65	2.4360	18.68	35.42	19.82	10.81
	15:20:65	2.4355	18.86	36.22	20.70	10.55
	10:25:65	2.4340	19.04	37.03	21.59	4.46
	30:00:70	2.4450	18.72	34.1	17.99	11.59
	25:05:70	2.4410	18.90	34.91	18.88	8.69
	20:10:70	2.4385	19.09	35.71	19.76	6.94
	15:15:70	2.4365	19.27	36.52	20.64	4.47
	10:20:70	2.4355	19.45	37.32	21.53	3.84
	25:00:75	2.4475	19.31	35.20	18.82	11.94
	20:05:75	2.4445	19.50	36.01	19.70	9.47
	15:10:75	2.4425	19.68	36.81	20.58	8.38
	10:15:75	2.4395	19.86	37.62	21.47	4.45
	20:00:80	2.4480	19.90	36.30	19.64	5.79
	15:05:80	2.4472	20.09	37.11	20.52	5.49
	10:10:80	2.4455	20.27	37.91	21.41	3.65
	15:00:85	2.4475	20.50	37.40	20.46	5.32
	10:05:85	2.4458	19.57	36.17	20.20	3.53
	10:00:90	2.4482	21.09	38.50	21.28	3.63

Table 7 Percentage of Al_2O_3, SiO_2 and of Fe_2O_3 in bricks (Sample location-2)

Sample location No.	Mix ratio (C:FA:IOW)	Avg. Mass of brick (kg)	Total % of Al_2O_3 in a brick	Total % of SiO_2 in a brick	Total % of Fe_2O_3 in a brick	Compressive strength of a brick for 28 days of curing(MPa)
	30:05:65	2.4490	21.73	28.82	20.85	11.05
	25:10:65	2.4455	21.91	29.62	21.74	9.35
	20:15:65	2.4435	22.10	30.43	22.62	8.84
	15:20:65	2.4398	22.28	31.23	23.50	8.22
	10:25:65	2.4366	22.46	32.03	24.39	5.40
	30:00:70	2.4462	22.40	28.73	21.01	12.31
	25:05:70	2.4424	22.59	29.53	21.89	11.02
	20:10:70	2.4401	22.77	30.34	22.78	10.45
	15:15:70	2.4387	22.95	31.14	23.66	7.94
2	10:20:70	2.4365	23.14	31.95	24.54	6.70
	25:00:75	2.4470	23.26	29.44	22.05	10.06
	20:05:75	2.4459	23.44	30.25	22.93	9.36
	15:10:75	2.4445	23.62	31.05	23.81	7.92
	10:15:75	2.4405	23.81	31.86	24.70	6.70
	20:00:80	2.4490	24.11	30.16	23.09	8.96
	15:05:80	2.4481	24.30	30.96	23.97	8.08
	10:10:80	2.4469	24.48	31.77	24.85	5.37
	15:00:85	2.4495	24.97	30.87	24.97	6.55
	10:05:85	2.4478	23.77	30.03	23.77	5.46
	10:00:90	2.4502	25.82	31.59	25.16	4.15

Table 8 Percentage of Al_2O_3, SiO_2 and of Fe_2O_3 in bricks (Sample location-3)

Sample location No.	Mix ratio (C:FA:IOW)	Avg. Mass of brick (kg)	Total % of Al_2O_3 in a brick	Total % of SiO_2 in a brick	Total % of Fe_2O_3 in a brick	Compressive strength of a brick for 28 days of curing(MPa)
	30:05:65	2.4462	25.94	33.51	13.03	16.49
	25:10:65	2.4449	26.12	34.31	13.91	15.52
	20:15:65	2.4428	26.30	35.12	14.80	11.12
	15:20:65	2.4311	26.49	35.92	15.68	7.59
	10:25:65	2.4302	26.67	36.73	16.56	4.92
	30:00:70	2.4475	26.93	33.78	12.58	14.41
	25:05:70	2.4457	27.12	34.59	13.46	12.59
	20:10:70	2.4436	27.30	35.39	14.35	11.40
	15:15:70	2.4321	27.48	36.19	15.23	10.75
	10:20:70	2.4300	27.66	37.00	16.12	4.94
3	**25:00:75**	2.4482	28.11	34.86	13.02	9.29
	20:05:75	2.4468	28.29	35.66	13.90	8.40
	15:10:75	2.4449	28.48	36.47	14.78	6.43
	10:15:75	2.4429	28.66	37.27	15.67	6.13
	20:00:80	2.4497	29.29	35.93	13.45	7.75
	15:05:80	2.4491	29.47	36.74	14.34	6.88
	10:10:80	2.4477	29.65	37.54	15.22	5.18
	15:00:85	2.4506	30.47	37.01	13.89	5.87
	10:05:85	2.4497	28.95	35.80	14.01	5.06
	10:00:90	2.4517	31.64	38.09	14.33	4.16

Table 9 Percentage of Al_2O_3, SiO_2 and of Fe_2O_3 in bricks (Sample location-4)

Sample location No.	Mix ratio (C:FA:IOW)	Avg. Mass of brick (kg)	Total % of Al_2O_3 in a brick	Total % of SiO_2 in a brick	Total % of Fe_2O_3 in a brick	Compressive strength of a brick for 28 days of curing(MPa)
	30:05:65	2.4435	17.76	40.37	16.27	17.09
	25:10:65	2.4420	17.94	41.18	17.15	10.55
	20:15:65	2.4408	18.13	41.98	18.03	10.02
	15:20:65	2.4378	18.31	42.79	18.92	8.81
	10:25:65	2.4345	18.49	43.59	19.80	5.18
	30:00:70	2.4469	18.13	41.17	16.07	18.69
	25:05:70	2.4455	18.31	41.98	16.95	16.59
	20:10:70	2.4429	18.49	42.78	17.83	15.75
	15:15:70	2.4400	18.68	43.59	18.72	12.38
	10:20:70	2.4360	18.86	44.39	19.60	8.86
	25:00:75	2.4479	18.68	42.78	16.75	12.34
4	20:05:75	2.4463	18.86	43.58	17.64	9.86
	15:10:75	2.4435	19.04	44.39	18.52	8.07
	10:15:75	2.4405	19.22	45.19	19.40	11.93
	20:00:80	2.4490	19.22	44.38	17.44	11.92
	15:05:80	2.4482	19.41	45.19	18.33	8.65
	10:10:80	2.4445	19.59	45.99	19.23	6.14
	15:00:85	2.4500	19.77	45.99	18.12	7.70
	10:05:85	2.4491	18.89	44.25	18.00	5.17
	10:00:90	2.4510	20.32	47.59	18.81	5.79

Table 10 Percentage of Al_2O_3, SiO_2 and of Fe_2O_3 in bricks (Sample location-5)

Sample location No.	Mix ratio (C:FA:IOW)	Avg. Mass of brick (kg)	Total % of Al_2O_3 in a brick	Total % of SiO_2 in a brick	Total % of Fe_2O_3 in a brick	Compressive strength of a brick for 28 days of curing(MPa)
	30:05:65	2.4469	20.30	39.94	13.15	9.28
	25:10:65	2.4449	20.48	40.74	14.03	8.25
	20:15:65	2.4406	20.66	41.55	14.91	6.56
	15:20:65	2.4370	20.84	42.35	15.80	5.45
	10:25:65	2.4330	21.03	43.16	16.68	4.37
	30:00:70	2.4477	20.86	40.70	12.71	10.14
	25:05:70	2.4469	21.04	41.51	13.59	8.16
	20:10:70	2.4448	21.22	42.31	14.47	7.47
5	15:15:70	2.4395	21.41	43.12	15.36	6.35
	10:20:70	2.4355	21.59	43.92	16.24	6.06
	25:00:75	2.4474	21.60	42.28	13.15	8.91
	20:05:75	2.4454	21.78	43.08	14.04	6.96
	15:10:75	2.4439	21.97	43.88	14.92	6.03
	10:15:75	2.4411	22.15	44.69	15.80	5.34
	20:00:80	2.4497	22.34	43.85	13.60	8.75
	15:05:80	2.4475	22.53	44.65	14.48	7.16
	10:10:80	2.4410	22.71	45.46	15.37	4.64
	15:00:85	2.4511	23.09	45.42	14.04	6.33
	10:05:85	2.4487	22.01	43.72	14.16	5.72
	10:00:90	2.4519	23.83	46.99	14.49	4.30

Table 11 Percentage of Al_2O_3, SiO_2 and of Fe_2O_3 in bricks (Sample location-9)

Sample location No.	Mix ratio (C:FA:IOW)	Avg. Mass of brick (kg)	Total % of Al_2O_3 in a brick	Total % of SiO_2 in a brick	Total % of Fe_2O_3 in a brick	Compressive strength of a brick for 28 days of curing(MPa)
	30:05:65	2.4448	14.50	34.46	22.29	17.61
	25:10:65	2.4432	14.68	35.26	23.17	15.98
	20:15:65	2.4395	14.86	36.07	24.06	14.47
	15:20:65	2.4350	15.05	36.87	24.94	11.87
	10:25:65	2.4317	15.23	37.68	25.82	5.56
	30:00:70	2.4470	14.61	34.80	22.56	15.40
	25:05:70	2.4445	14.80	35.61	23.44	12.40
	20:10:70	2.4412	14.98	36.41	24.32	11.81
	15:15:70	2.4380	15.16	37.22	25.21	10.01
	10:20:70	2.4345	15.34	38.02	26.09	5.66
	25:00:75	2.4479	14.91	35.95	23.71	14.34
6	20:05:75	2.4445	15.09	36.76	24.59	13.50
	15:10:75	2.4424	15.28	37.56	25.47	13.04
	10:15:75	2.4384	15.46	38.37	26.36	7.42
	20:00:80	2.4482	15.21	37.10	24.85	11.34
	15:05:80	2.4466	15.39	37.91	25.74	10.39
	10:10:80	2.4439	15.57	38.71	26.62	4.97
	15:00:85	2.4490	15.51	38.25	26.00	7.88
	10:05:85	2.4455	14.87	36.97	25.41	5.72
	10:00:90	2.4525	15.80	39.40	27.15	5.71

As the aim of this investigation was to find out the impact of major chemical constituents in a brick on its compressive strength, hence using Table 6 to Table 11, careful study was carried out to see the variation of a particular chemical constituent with compressive strength keeping the other two chemical constituents constant. For instance, Table 12 was arrived at by careful study of Table 6 and Table 9. It was found that for constant value of $Al_2O_3 \approx 19$ % and $Fe_2O_3 \approx 19$ %, there is variation in SiO_2 with compressive strength. A plot of total percentage of SiO_2 vs. compressive strength i.e., data of Table 12 is shown in Figure3. From Figure3 it is observed that there is no correlation between the total percentages of SiO_2 present in a brick with its compressive strength.

Table 12 Variation of SiO_2 with compressive strength ($Al_2O_3 \approx 19$ % $Fe_2O_3 \approx 19$ %)

Total percentage of SiO_2	Compressive strength (MPa)
34.61	11.20
34.91	8.69
35.20	11.94
43.59	5.18
43.59	12.38
44.39	8.86
44.39	8.07
45.19	11.93
45.19	6.14

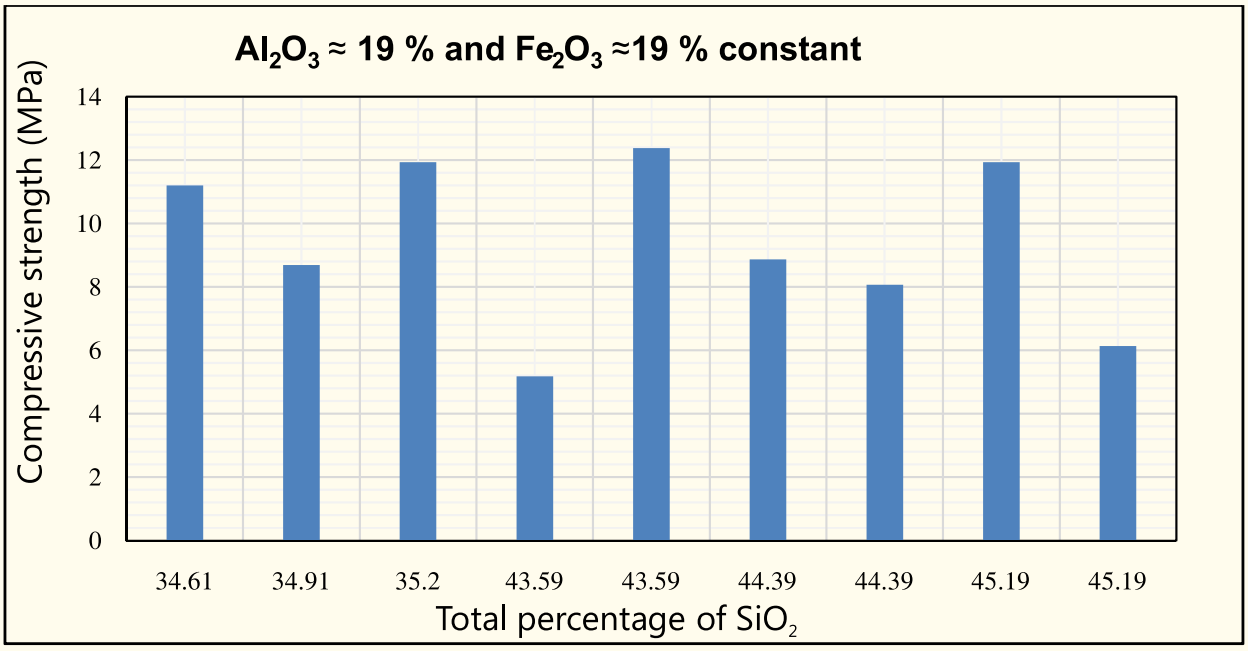

Fig. 3 Total percentage of SiO_2 vs. compressive strength

Similarly, Table 13 was arrived at by careful study of Table 11. It was found that for constant value of $SiO_2 \approx$ 38 % and $Fe_2O_3 \approx$ 26 %, there is variation in Al_2O_3 with compressive strength. A plot of total percentage of Al_2O_3 vs. compressive strength i.e., data of Table 13 is shown in Figure4. From Figure4 it is observed that there is no correlation between the total percentages of Al_2O_3 present in a brick with its compressive strength.

Table 13 Variation of Al_2O_3 with compressive strength ($SiO_2 \approx$ 38 % and $Fe_2O_3 \approx$ 26 %)

Total percentage of Al_2O_3	Compressive strength (MPa)
15.23	5.56
15.28	13.04
15.34	5.66
15.39	10.39
15.46	7.42
15.51	7.88

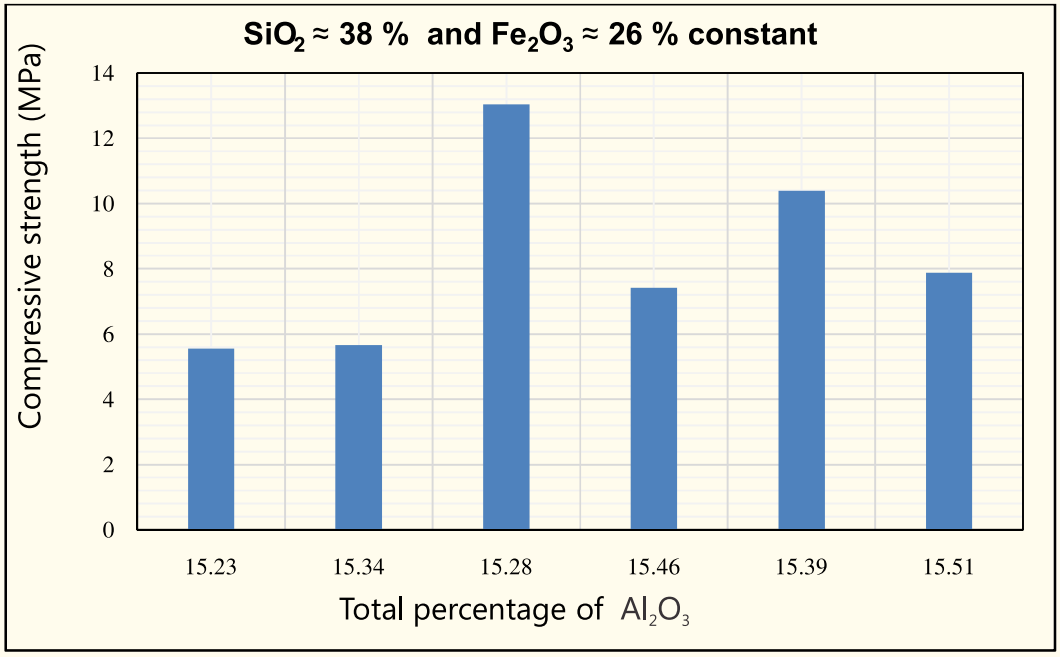

Fig. 4 Total percentage of Al_2O_3 vs. compressive strength

In a similar fashion, Table 14was arrived at by careful study of Table 7($Al_2O_3 \approx$ 24 % and $SiO_2 \approx$ 30 %; Fe_2O_3 varying with compressive strength); Table 15 through Table 9($Al_2O_3 \approx$ 19 % and $SiO_2 \approx$ 44 %; Fe_2O_3 varying with compressive strength); Table 16 through Table 10($Al_2O_3 \approx$ 22 % and $SiO_2 \approx$ 44 %; Fe_2O_3 varying with compressive strength); and Table 17 through Table 11($Al_2O_3 \approx$ 15 % and $SiO_2 \approx$ 37 %; Fe_2O_3 varying with compressive strength).

A plot of Table 14 where in $Al_2O_3 \approx 24$ % and $SiO_2 \approx 30$ % and Fe_2O_3 varying with compressive strength is shown in Figure 5. Similarly Figure 6 shows a plot of Fe_2O_3 with compressive strength wherein $Al_2O_3 \approx 19$ % and $SiO_2 \approx 44$ %; Fig. 7 shows a plot of Fe_2O_3 with compressive strength wherein $Al_2O_3 \approx 22$ % and $SiO_2 \approx 44$ % and Figure 8 shows a plot of Fe_2O_3 with compressive strength wherein $Al_2O_3 \approx 15$ % and $SiO_2 \approx 37$ %.

From Figure 5 to Figure 8, it is clearly observed that with increase in total percentage of Fe_2O_3 in a brick, its compressive strength decreases gradually. Hence, it is concluded that percentage of Fe_2O_3 present in a brick certainly has a negative impact on its compressive strength.

Table 14 Variation of Fe_2O_3 with compressive strength ($Al_2O_3 \approx 24$ % and $SiO_2 \approx 30$ %)

Total percentage of Fe_2O_3	Compressive strength (MPa)
21.89	11.02
22.78	10.45
22.05	10.06
22.93	9.36
23.97	8.08
24.70	6.70

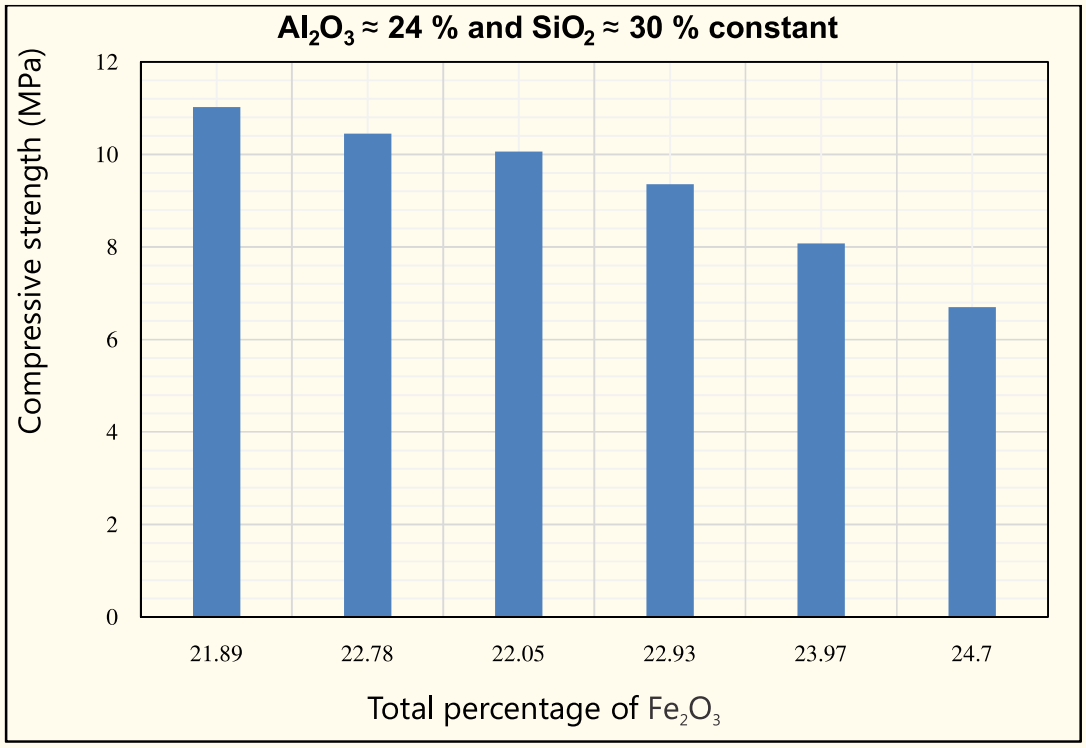

Fig. 5 Total percentage of Fe_2O_3 vs. compressive strength

Table 15 Variation of Fe_2O_3 with compressive strength ($Al_2O_3 \approx$ 19 % and $SiO_2 \approx$ 44 %)

Total percentage of Fe_2O_3	Compressive strength (MPa)
17.44	11.92
17.64	9.86
18.52	8.07
19.60	6.86
19.80	5.18

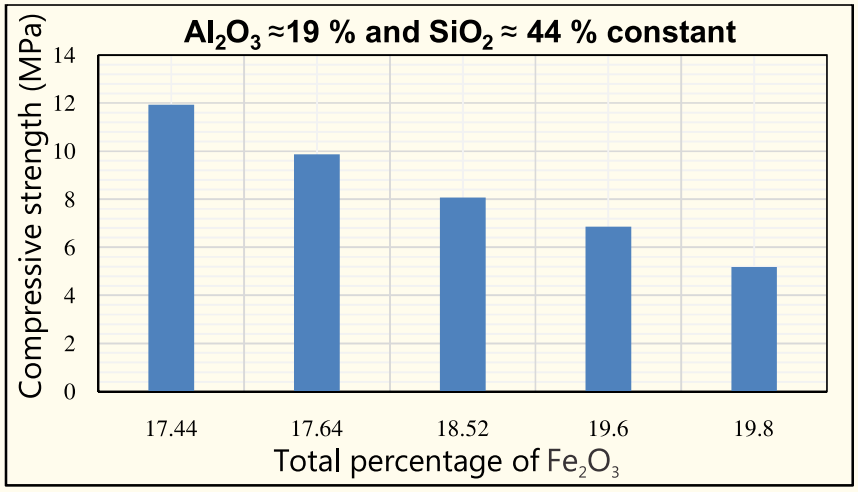

Fig. 6 Total percentage of Fe_2O_3 vs. compressive strength

Table 16 Variation of Fe_2O_3 with compressive strength ($Al_2O_3 \approx$ 22 % and $SiO_2 \approx$ 44 %)

Total percentage of Al_2O_3	Compressive strength (MPa)
15.23	5.56
15.28	13.04
15.34	5.66
15.39	10.39
15.46	7.42
15.51	7.88

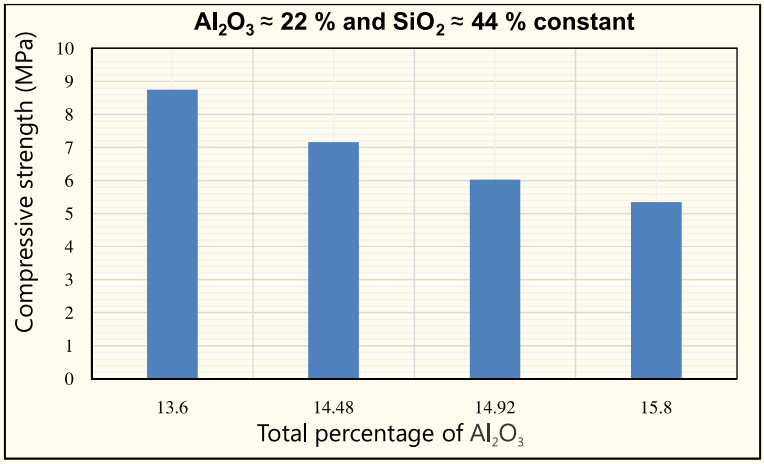

Fig. 7 Total percentage of Fe_2O_3 vs. compressive strength

Table 17 Variation of Fe_2O_3 with compressive strength ($Al_2O_3 \approx 15$ % and $SiO_2 \approx 37$ %)

Total percentage of Fe_2O_3	Compressive strength (MPa)
24.59	13.50
24.94	11.87
25.21	10.01
25.41	5.72
25.82	5.56

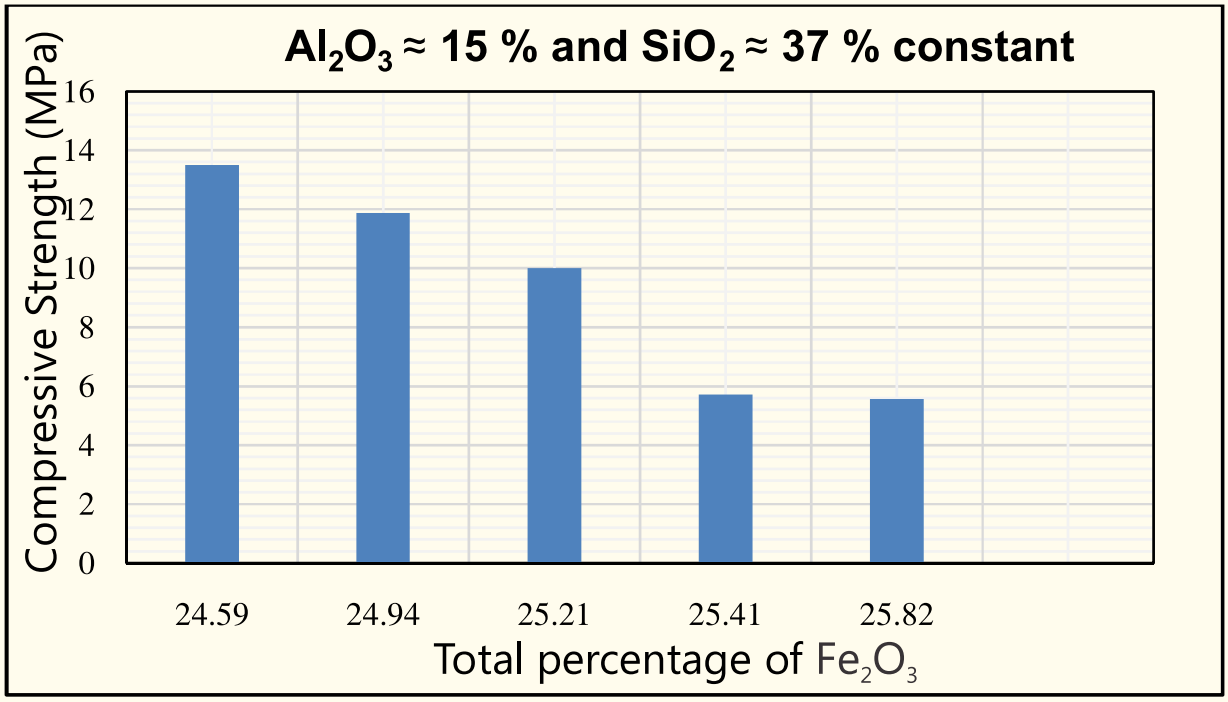

Fig. 8 Total percentage of Fe_2O_3 vs. compressive strength

6.0 Conclusions

Through this investigation, an attempt was made to investigate the impact of chemical composition of prepared IOW bricks on its compressive strength. The chemical compositions like total percentage of Al_2O_3, SiO_2 and Fe_2O_3present in a brick were observed through the output of Java program which was executed in NetBeans 8.1 IDEfor all the mix ratios. The input to the developed program were mass of a brick; percentage of cement, fly ash and IOW; percentage of Al_2O_3, SiO_2 and Fe_2O_3 in cement, fly ash and IOW. The output of the developed program was total percentage of Al_2O_3, SiO_2 and Fe_2O_3present in a particular brick.

Based on the available data, investigation has revealed that there is no proper relationship

between the total percentages of SiO_2 and Al_2O_3present in a brick with its compressive strength. However, with increase in total percentage of Fe_2O_3 present in a brick, its compressive strength was found to decrease gradually.

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MODERN MINES MANAGER ROLE OF MINING ENGINEERS IN CHANGED SCENARIO

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Introduction:

Mining industry is making rapid strides interms of Technology & Innovation. A successful mining operation has strong elements which address to the fundamentals viz Safety-Zero Harm, Sustainability-Zero Waste & Economics-Reaping profits to address stakeholders.

In the modern day parlance, technology has intruded into the mining system and becomes inherent. A progressive organization needs to adopt the technology to sustain their business in a volatile and competitive market.

In other parts of the world, implementation of Robotics, AI, Internet of Things (IoT), 3D Printing, Unmanned Dumpers and Excavators, Drones, Mineral beneficiation, Real time dust monitoring in mining operation, tapping green & renewable energy sources for mining operation etc is underway & yielded positive results. New technologies are enabling workers to make quicker, more informed decisions at the front lines of operations. Increased automation is removing workers from the riskiest parts of the mine, making our mines safer as we strive for zero harm.

In addition to this, socio-political issues in the mining areas from the stake holders need to be addressed properly considering long-term solutions. Apart from above, Legislation with respect to Mineral Concession System, Mines safety, Environmental System, has undergone tremendous changes and sure it will never becomes constant.

A Mining Engineer plays a crucial role and he is the backbone for successful conduct of mining operations. Against above background, this article addresses the skill set required by a Mining Engineer in today's scenario for a successful carrier.

VIBRATION RISKS IN SURFACE MINES - A REVIEW

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ABSTRACT

Surface mining activities involve the use of different types of machinery/equipment like loaders, excavators, dumpers, drills, hand-held power tools etc. This machinery/equipment when used for performing different tasks produces machine induced vibration. The operator, when exposed to this vibration, exceeds the exposure limit value as indicated by the ISO-2631-1 will start developing health risk. The risk could be characterized either by whole-body vibration or hand-arm vibration or foot transmitted vibration. The main aim of this paper is to carry out a systematic literature review over the development and the current status of research into nature of vibration exposures, particularly in the surface mining industry, in India and abroad. The review comprehends an insight into the various issues with a basic search for a period of 1985-2018. This study gives a detailed account of the latest scientific information on the source of vibration, its effects on miners, the various standards used for the measurement of vibration and various mitigation strategies for the occupational vibration highlighting the shortcomings of the hitherto existing studies. The result of the review shows that considering whole-body vibration the maximum mean acceleration was found for dumper and it stands as most hazardous equipment in surface mines. Similarly, among equipments causing hand-arm vibration the maximum mean acceleration was found for jackhammer.

Keywords: Surface mine, Whole-body vibration, Hand-arm vibration, Root Mean Square, Occupational hazard

1. INTRODUCTION

Vibration is a to and fro oscillatory motion about a fixed reference point. Oscillatory moment includes varying velocity in one direction and then a velocity in the opposite direction. The change in velocity is taken as constant acceleration in one direction and then it reverses its direction (Griffin, 1998). The oscillations produced as a result of mechanical disturbance are featured as a simple harmonic sine wave or a multiple wave complex varying in frequency and acceleration, or a random nonrepeating series of complex waves (Palmear, 1998). Vibration necessitates a medium to disseminate the energy through the source (Mansfield, 2005). For a vibration exposed person, the vibration energy is propagated

into the body through compression and refraction of tissues and fluids in the body. Frequency and acceleration are considered to be the two main factors of the vibration signal. The magnitude of the oscillatory signal is measured in acceleration and this is expressed in m/s2. Frequency is defined as a metric of the number of to and fro motions completed in one second and is measured in cycles/second or hertz (Hz). Vibration propagation in three orthogonal axes is designated as; z-axis relates to vertical vibration, X-axis refers to fore-aft and Y-axis relates to side-side vibration.

The mining industry exposes workers to a wide variety of occupational risks. As indicated by the International Labour Organization (ILO), around 30 million individuals are working directly or indirectly in mining industries, globally (ILO, 2016). In the last couple of decades, the mining sector has undergone a shift from manual to a mechanized method of working. As a part of mechanization, with the introduction of the Heavy Earth Moving Machinery (HEMM), miners are forced to spend more time operating machinery and driving vehicles (McPhee, 2004). In 1977 the International Labour Organization (ILO) categorized vibration as an occupational hazard and made recommendations as follows - "safety measures to be initiated to safeguard employees from vibration hazard, the accountable authorities should frame the guidelines to evaluate the risk; when necessary, the exposure limits need to be defined by this framed guidelines. All employees must undergo timely medical checkups upon supervision of employees exposed to vibration well before the start of the specific job".

Directorate General of Mines Safety (DGMS) in 1975 issued a circular under Metalliferous Mines Regulations, 1961 directing the industry to take appropriate steps which would ensure a desirable degree of comfort and protection required from vibration exposure. No specific vibration limits were indicated then because available scientific data were found to be inadequate. Further, DGMS circulated the recommen dations of 10th Conference on Safety in Mines held in November 2007 which include the requirement of vibration studies of various mining machinery to be done before their introduction in mining operations as per the guidelines stipulated by the International Standard Organization. Again no specific vibration limits were indicated and also no definite guidelines for evaluation of health risk were issued in this recommendation (Kaku, 2004). The risk emanating from the equipments used in mines are accountable for many health risks.

2. HEALTH EFFECTS OF VIBRATION

When a tool, machine or supporting surface emanates vibration then vibration exposure occurs and starts transmitting vibration energy into operator's body. For this to occur, a part of the person's body must either be in direct contact with the vibrating object, or another object that is itself making contact with the vibrating object. Vibration transmits in two forms either through whole-body vibration or hand-arm vibration. Segmental vibration exposure refers to the exposure that is mainly transmitted to, and concentrated

on, a specific part of the body – such as the hand, arm or leg. Whole-body vibration and segmental vibration need to be studied separately because they are measured and evaluated using different standards. They also require different control measures and have differing effects on the human body.

2.1 Whole Body Vibration

Whole-body vibration occurs when the mining equipment emitting vibration enters into human body either through lower pelvic bones during sitting posture or through the legs or feet when the operator is working in standing posture. More often than not, the body absorbs vibration causing no harmful effect. However, frequencies between 1 and 20 Hz cause the pelvis and spine to resonate and can lead to many health effects. Vehicles and industrial machinery often vibrate with frequencies in the range where human resonance occurs at 4-8 Hz (Griffin, 1990). The acute and chronic health effects of vibration are summarized in Table1.

Table 1: Summary of short term and long term health effects of whole-body vibration

Acute health effects from short-term exposure to whole body vibration	Chronic health effects from long-term exposure to whole body vibration	References
A headache	lower back pain	Griffin *et al.*,1998; Seidel, 1993
chest pain	damage to the spine	
abdominal pain	major curves in a middle-lower portion of the spine (lumbar scoliosis)	
Nausea	deterioration of the discs in between the vertebrae of the spine (disc disease)	
Fatigue	tears or damage to the discs in between the vertebrae of the spine (herniated discs)	
vertigo (loss of balance)	neck problems	

2.1.1 Whole-body vibration studies in surface mines

Whole-body vibration is prevalent in most of the off-road mining vehicles and it is considered as the most crucial occupational hazard for mobile mine vehicle operators (Bovenzi, 2006; Langer et al., 2015). As part of the daily activities, on a regular basis wide varieties of mobile equipment are used particularly in surface mining operations, exposing them to suffer from whole-body vibration (Eger et al., 2006; Eger et al., 2008; Smets et al., 2010; Chaudhary et al., 2015). Fleet in the mine incorporates huge capacity scrappers, haul trucks, front loaders, graders, bulldozers, water trucks, wheel loaders, hydraulic and electric shovels. Due to the large production demands, most of the mines

are running for three shifts, which sometime demands workers to work continuously for more than eight hours. Mine mobile operators constantly work 12-hr with very few halts and work almost 90% of their shift time only in driving (Wolfgang and Burgess, 2014).

It is because of the exposure to vibration as an occupational hazard, that the vehicle operator's experiences high incidence of musculoskeletal disorders (MSDs) (Bovenzi, 2006). The prevalence rate of MSDs in the mining industries of United States in the year 2015 was 12.9 per 10000 full-time workers, were found to be good enough over the average rates calibrated considering all occupations (Bureau of Labor Statistics, 2016). The epidemiological survey reported a relationship among long-duration whole-body vibration exposure and its ill health effects like MSDs, mainly related to neck and low back pain (Burdorf and Sorock, 1997; Bovenzi, 2006; Okunribido et al., 2007). There are multiple factors on which whole-body vibration depends, which are summarized in Table 2.

Table 2: Factors influencing the whole-body vibration (WBV)

Sl. No	Factors affecting WBV	References
1	Vehicle type and its characteristics: Includes type, suspension, size, seat design, maintenance and tire conditions	(Blood *et al.*, 2012; Milosavljevic *et* al., 2012; Thamusuwan *et al.*, 2013; Wolfang and Burgress-Limerick, 2014)
2	The manner of execution of the task	
3	Task accomplishing by the type of vehicle	
4	Working conditions like tasks and roads	
5	Organization of the work like work cycle and shifts	
6	Individual features include posture and anthropometry of operators	

Studies carried out in the mining industry reveal that when the driver droves over the rough surfaces for the long duration while sitting in a weekly suspended seat is bound to suffer from mechanical vibration and impulsive shock. As a repercussion to this the driver is susceptible to suffer health risk through direct exposure to whole-body vibration (Eger et al., 2008; Smets et al., 2010; Skandfer et al., 2014; Wolfang and Burgess-Limerick, 2014; Chaudhary et al., 2015). The multiple performances carried out by the various mining machinery which leads to whole body vibration is summarized in Table3 .

Table 3: Different machinery and their tasks performed in surface mines

S. No	Vehicle type	Tasks performed	References
1	Hydraulic and electric shovel	• Digging ore or overburden • Loading the material into dumpers/trucks	(Marin *et al.*, 2017)
2	Bulldozer and wheel dozer	Dozing, Extracting and aggregating ore or OB	
3	Front loader	Loading ore or OB into trucks	
4	Grader	Preparing and maintaining haul roads	
5	Scraper	Removing the topsoil and transporting it to storage areas.	
6	Dumpers and trucks	• Transporting ore to crushing plants or stockpiling areas • Transporting the overburden to dump sites for final disposal	
7	Water truck	Watering haul roads to keep road dust down	
8	Drills	Exploration and blast hole drilling	(Kunimatsu and Pathak, 2012)

Various vibration studies have been carried out so far with respect to surface mine machinery and the extent of vibration exposure was evaluated as R.M.S (frequency rooted mean squared acceleration) value. Based on the vibration exposure values obtained in three different orthogonal axes, the most dominant vibration exposure in a particular direction is ascertained. This information gives the direction of vibration energy transmission from vehicle/machinery to a human body and creates a scope for vibration mitigation through ergonomic design of the seat. Table 4 encapsulates the R.M.S values and its dominant axis for various surface mines vehicles.

Table 4: Summary of studies done on evaluation of whole-body vibration in surface mines

Author & year	Equipment type	Frequency rooted mean squared acceleration (R.M.S)	Dominant axis of vibration
(Van Niekerk, Heyns *et al.*, 2000)	Dumper	0.75	z
(Kumar, 2004)		0.37-11.73	z
(Eger, Stevenson *et al.*, 2008a)		0.77	z
(Howard, Sesek *et al.*, 2009)		0.58	--
(Smets, Eger *et al.*, 2010)		0.80	--
(Mandal & Srivastava, 2010)		1.10	z
(Howard, Sesek *et al.*, 2009)	Shovel	0.45	--
(Aye & Heyns, 2011)		0.21-.0.51	z
(Kunimatsu & Pathak, 2012)		0.5-2.5	--
(Dentoni & Massacci, 2013)		0.52-0.97	x
(Van Niekerk, Heyns *et al.*, 2000)	Rock drills	0.16	z
(Howard, Sesek *et al.*, 2009)		0.30	--
(Marin *et al.*, 2017)	Hydraulic shovel	0.56	x
	Electric shovel	0.47	x
	Bulldozer	0.91	x
	Front end loader	0.87	x & y
	Wheel Dozer	1.08	y
	Grader	0.89	y
	Scraper	1.10	y
	240 Ton truck	0.64	z
	Water truck	0.72	z
	320 Ton truck	0.71	z
	190 Ton truck	0.70	z

2.2 Hand Arm Vibration

In the work settings, hand-held power tool operator experiences a very basic type of segmental vibration known as hand-arm vibration. When an operator works on hand-held power tools like drills, the vibration transmits through the fingers, palm and arm of the operator's hand. This transmission of vibration depends on various factors, which are briefed in Table 5.

Table 5: Factors influencing the hand-arm vibration

Sl. No	Factors influencing hand-arm vibration
1	The temperature of the area the person is working in
2	How the tool is gripped
3	How long and how often exposure occurs
4	Whether or not the person is wearing gloves
5	The frequency and amplitude of the vibration

The earliest literature available on the health impact of vibration chiefly refers to the miners. Because of the high prevalence of jackhammers use in the mining industry, it stands out as a major factor of vibration risk affecting human limb. Drilling operators working in the surface mine often use jackhammer and they are the one with the high incidence of the vibration induced disorder known as hand-arm vibration syndrome. Vibrating hand tools like hand drills, chipping machine, riveting guns, control systems of modern large drill machines, locomotive handles, hand-held grinders, scrapers etc., are other sources of HAV exposure in mines (Mandal et al., 2006). The historical moorings about the various developmental phases of occupational hazard with regard to hand-arm vibration are summarized in Table 6.

Table 6: History of the development of the hand-arm vibration

Year	Stages of development	References
1839	Pneumatic tools were first used in French mines	(Griffin, 1998; Raynaud, 1888; Hamilton, 1984; Palmer, 1998; HSE, 2005)
1862	Primary Reynaud's Phenomenon (Reynaud's Disease) identified	
1911	Professor Loriga first described vascular spasm in the hands of Italian miners using pneumatic tools.	
1918	Spastic anemia pertaining to hands was first studied by Alice Hamilton by considering mine drillers as a subject in limestone quarries	
1930-40s	Cases of the white finger were identified studies in fettlers, riveters, boot, and shoe industry workers and users of electrical powered rotating tools	
1968-69	After 12-14 years of continuous chainsaw use widespread complaints of VWF in operators.	
1975	Scale for assessing the extent of vascular injury associated with vibration white finger published by Taylor-Pelmear	
1985	VWF becomes a prescribed disease for Industrial Injuries Disablement Benefit purposes	
1987	First VWF assessment scale by Stockholm was published. BS 6842 as a vibration measuring standard was published.	
1988	UK HSE research on exposure to HAV in a number of industries in Great Britain published.	
1989	EC Machinery Directive adopted; includes requirements on HAV.	
1992	The guidelines dealing vibration-induced white finger was stipulated by UK HSE in foundries.	
1994	UK HSE publishes generic guidance on HAV.	
1997	UK HSE published a book of vibration-reduction case studies.	
30 Sept 1997	UK High Court awards £127,000 compensation for VWFto 7 miners, 12,500 more cases in the pipeline	
2002	With respect to the risk emanating from vibration, Directive 2002/44/EC was published to ensure minimum health and safety for a worker in the Official Journal of the European Communities.	
2006	Introduction of New Irish Regulations to implement the Physical Agents (Vibration) Directive 2002/44/EC.	

3. VIBRATION SCENARIO IN INDIAN SURFACE MINES

India has a unique blend of big and small, manual and mechanized surface and underground mines. 89 minerals are produced out of which 4 are fuels, 11 metallics, 52 non-metallic and 22 minor minerals (Ministry of Mines, 2011). The extent of problem due to vibration hazard can only be assessed with the appropriate available database. The database should encompass information about the percentage of people exposed to vibration, the extent of machines getting regular checkups, its maintainability records etc.

Based on the mines regulator authority report, nearly 5.61 lakhs of workers were employed in the mining sector in India. Citing the information shortcomings, the Director General of Mines Safety (DGMS) estimated the figure to be 10 million (DGMS, 2004). In one study two mines were examined to determine the percentage of mining population regularly exposed to occupational vibration and found that an average of 18% employees were found to be exposed to vibration at work place (Mandal *et al.*, 2006). The surveys conducted in Indian mines have shown that most Heavy Earth Moving Machinery (HEMM) have vibration levels higher than ISO recommended standards and persons employed on HEMM are at risk of developing adverse effects (Mandal *et al.*,2010). In a recent survey conducted by National Institute of Miner Health (NIMH), in various mines, have shown that out of 117 HEMMs, 100% Dozers, 95% Loaders, 90% Dumpers & Tippers, 15% Excavators, and 8% shovels depicted medium to large health hazard to drivers owing to whole-body vibration. 85% of 48 surface mine equipment operators reported musculoskeletal disorders.

4. STANDARDS FOR MEASURING WBV AND HAV

According to ISO 2631-1:1997 standard there are two methods for investigating whole-body vibration: a) frequency weighted root mean square (R.M.S) acceleration (designated as 'A_w' and measured in m/s^2) and (ii) the vibration dose value (designated as 'VDV' and measured in $m/s^{1.75}$). As per ISO 2631-1, the lower limits for health caution guidance zone exposure levels is 0.5 m/s^2 for $A_w(8)$ and 9.1 $m/s^{1.75}$ for VDV(8), for 8-hour daily exposure to whole-body vibration. These lower limit health caution guidance zone exposure levels can vary slightly depending on the country's standards and formulas used. In addition, the ISO 2631–5:2004 standard was also introduced for evaluation of exposure to multiple mechanical shocks/peaks. ISO 2631-5 standard states the guideline for the calculation of cumulative acceleration dose (D_k) and the daily equivalent static compression dose (designated as Sed(8) and measured in MPa). In order to maintain lower health risks over prolonged exposure to shocks, then Sed(8) values need to be maintained less than 0.5MPa (Milosavljevic *et al.*, 2010; Lewis and Johnson, 2012). For measuring hand-arm vibration ISO-5349-1:1986 was developed and adopted.

In 2002, the European Union adopted the European Vibration Directive - 2002/44/EC standards. According to this standard, the legislated maximum permissible vibration exposure limits are as given below.

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Table 7: Standards used in different countries

Country	Standards	References
U.S.A	HAV: ANSI S3.34, ACGIH-HAV	(Donald, 2005)
Canada	ACGIH, ANSI and ISO	(OHS, 2005)
U. K.	European Union Directive 2002/44/EC for HAV and WBV	(Vibration, 2005)
Australia	AS 2670 for WBV and AS 2763 - 1988 for HAV.	(ISO, 1997)

4.1Measurement of Vibration

The vibration intensity is measured depending on the magnitude, frequency, direction, and duration. For simultaneous measurement of multiple exposure parameters a digital vibration monitoring instrument is used in the field to get time domain data which can be later downloaded to computers for further data analysis. Since the magnitude of acceleration is continually changing a single overall value is often considered indicative. The acceleration magnitude is commonly expressed as root-mean square (R.M.S.) value of continually changing acceleration. Root-mean-square acceleration is denoted as 'A_{rms}' and is calculated using Equation (1).

$$A_{rms} = \left[1/T \int_0^T a_w^2\ (t)\, dt\right]^{1/2} \qquad (1).$$

where,

a_w = frequency-weighted instantaneous acceleration in m/s^2

t = corresponding time in seconds

dt = integration being performed with respect to time, and

T = total time period of measurement in seconds.

A typical instrument uses accelerometers as sensors (transducers) which convert the mechanical energy of vibration into equivalent electrical energy and integrates the varying quantities over the period of measurement. The various factors of vibration, such as peak values, R.M.S. acceleration in defined directions (i.e. x, y, and z-axes), vibration dose value etc. thus measured can be downloaded later to a computer terminal for detailed analysis.

The instrument can be programmed to perform the following functions:

- Multiple frequency components of a vibration spectrum can be either accepted, attenuated or rejected using suitable electronic networks.
- Acceleration values in three mutually perpendicular axes are simultaneously obtained (i.e., up-down, side-to-side and front-to-rear) for HAV and WBV.
- The weighting of the vibration signal is done to assess any exposure action value or exposure limit value exceeded with regard to HAV or WBV
- The result is expressed in terms of acceleration in individual axis, the summation of all three axes or vibration dose value, etc., as per their definition and applicability described in reference standards.
- The runtime history is recorded so that the varying magnitudes and their characteristics such as the presence of shocks etc. can be attributed to a particular operation.

5. REDUCTION STRATEGIES FOR WBV AND HAV EXPOSURE

On the field, vibration exposure can be mitigated by adopting different techniques. Some of the suggested measures for mitigation of whole-body vibration and hand arm vibration as proposed by the various researchers are given in Table 8 and Table 9, respectively.

Table 8: Mitigation strategies for WBV

Sl. No	Suggested mitigation measures	References
1	Reducing direction and duration of vibration exposure through the ergonomic intervention	(Mansfield, 2004)
2	• Proper maintenance of vehicle engine • Use of multi-cylinder engines • Better use of axle suspension • Adoption of active suspension seats as engineering control.	
3	Proper road maintenance	
4	Control of speeds and driving through lesser speeds	(Eger et al, 2011)

Table 9: Mitigation strategies for HAV

Sl. No	Suggested mitigation measures	References
1	As an engineering control manufacture hand tools with less scope for vibration emission.	(Mansfield, 2005)
2	Appropriate warnings, such as trigger times, should be tagged to tools known to emit harmful vibrations Tools should also avoid the emission of cold gases on worker's hands.	(Griffin, 1990)
3	The severity of HAVS has been reported to be higher in smokers and it is highly recommended that workers avoid smoking if their work involves vibrating tools.	
4	Use of anti-vibration gloves	(Jetzer et al, 2003)

6. CONCLUSIONS

Miners exposed to vibration risks have potential impact on their health. The incidence of MSDs, like backache is high when exposed to whole-body vibration, whereas segmental vibration produces vibration induced white finger for the workers handling hand-held power tools. Studies shows that despite of the mechanized mode of mining vibration induced health risk still remain as the most potential occupational hazard.

Following are the conclusions drawn from the literature survey in the area of human body vibration risks in surface mines:

1) Studies show that whole-body vibration was found to be highest for dumper operator and lowest for rock drill operator.

2) For hand-arm vibration exposure, highest vibration exposure was found to be with jackhammer operator whereas it is the minimum for chainsaw operator.

3) Since the vibration study in Indian surface mines is limited, there is no quantifiable data available to ascertain the number of miners exposed to whole-body vibration and hand-arm vibration. The number of miners exposed to vibration may be quite higher than the existing one, as identified by regulatory bodies.

4) As no specific standard for vibration measurement is available for the Indian mines, at present all the measurements are made w.r.t ISO and EU Directive standards.

5) As very limited research data is pertaining to vibration hazard in the Indian mines a detailed study needs to be carried out to explore the vibration risks.