MINES SAFETY ASSOCIATION KARNATAKA

NATIONAL MINING CONCLAVE-2024

Technical Update

IN ASSOCIATION WITH

MINING ENGINEERS' ASSOCIATION OF INDIA

NATIONAL MINING CONCLAVE -2024

CONTENT


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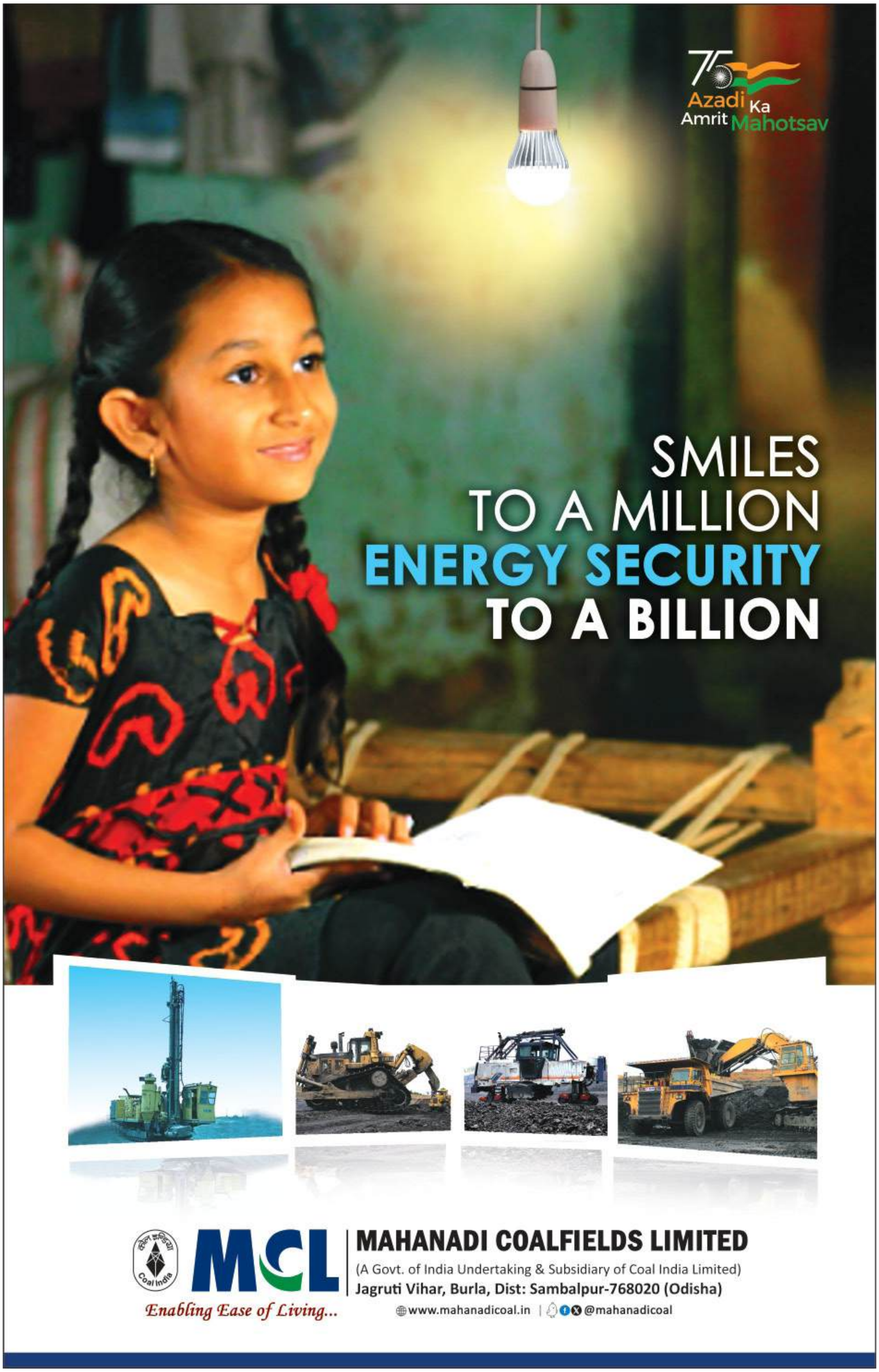
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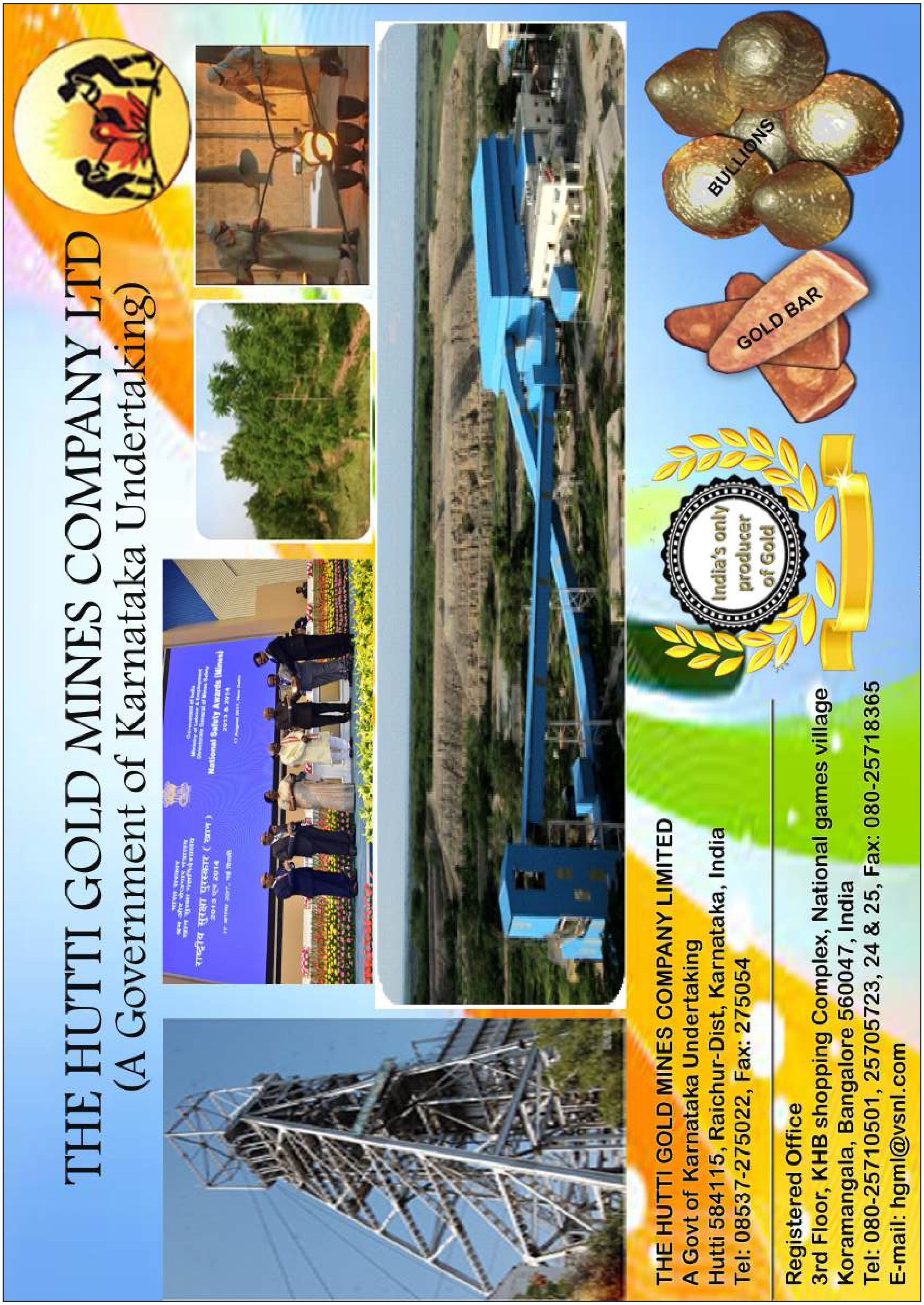
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Manganese Ore Mine


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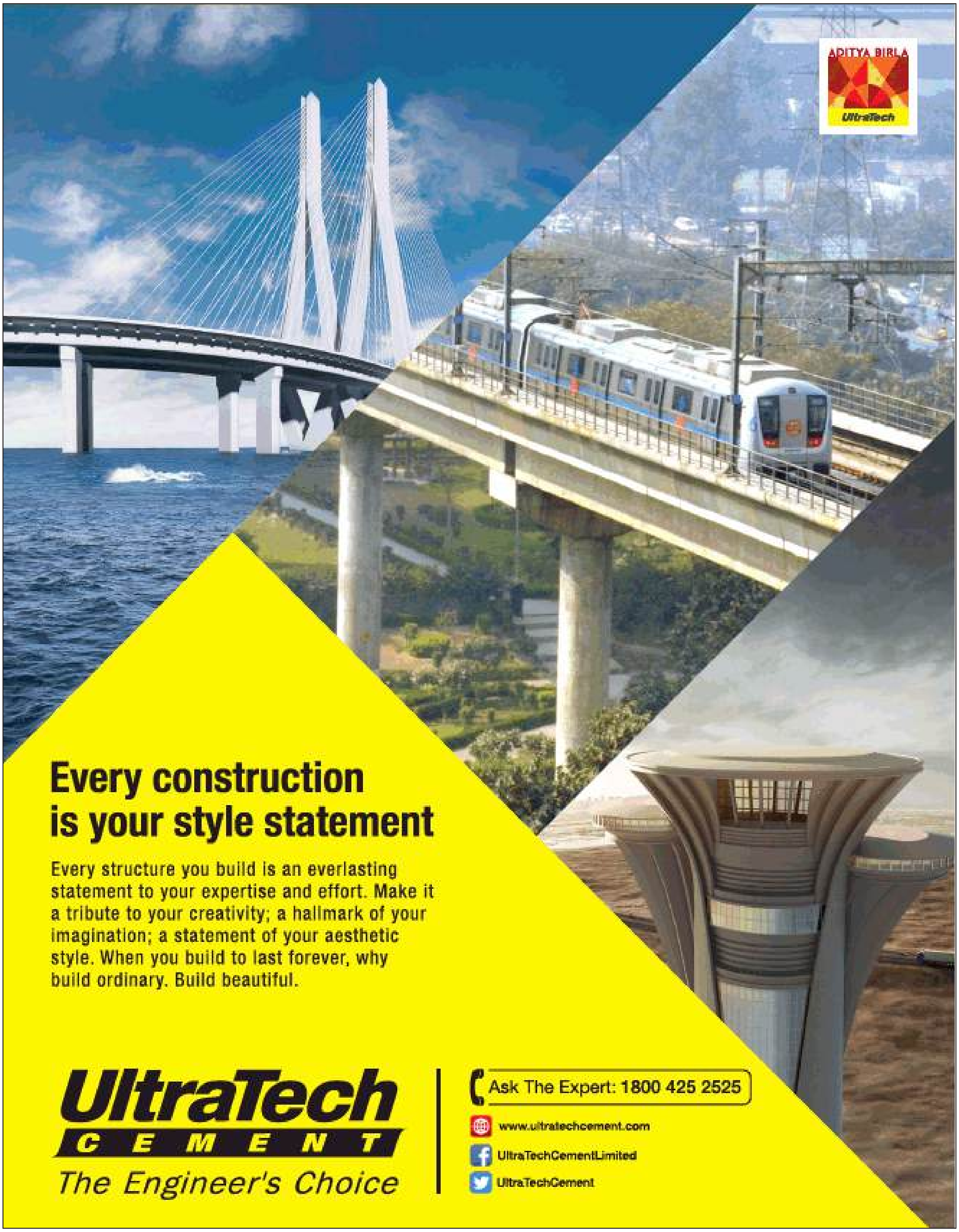
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SHRI. R. PRAVEEN CHANDRA
Chairman, ERM Group

VICE CHAIRMAN

SHRI. RACHAPPA S
Vice President (Mines)
M/s. Doddannavar Brothers

HON. SECRETARY

SHRI. K. MADHUSUDHANA
Chief Executive Officer
M/s. MSPL Limited

JOINT SECRETARY

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Sr. General Manager
M/s. Chettinad Cement Corporation Private Limited

TREASURER

SHRI. K.RAMANI
General Manager
M/s. R. Praveen Chandra

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Dr. MEDA VENKATAIAH
Director
M/s. MSPL LIMITED

SHRI. DHANANJAYA G REDDY
Chief Operating Officer
M/s. R. Praveen Chandra

MINES SAFETY ASSOCIATION KARNATAKA

EXECUTIVE COMMITTEE MEMBERS

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Asst. General Manager
M/s. SMIORE

Shri. Sreenivas Rao P
General Manager (Mines)
M/s. BKG Mining Pvt. Ltd., Sandur

Shri. G. Lakshminarayana
General Manager (Mines)
M/s. R.B. Seth Shreeram
Narsingdas, Sanklapur

Shri. Chandrasheakar Halli
Dy. General Manager
M/s. GVTC, Sandur

Shri. S.N.Hiremath
Mine Owner, M/s. Basava Minerals

Shri. Laxmiputrappa Revadi
Mine Owner
M/s. Tumkur Granite Quarry

Shri. Veeresh P Kiragi
General Manager
M/s. Dolphin International

Shri. Shrishaila Gouda
CEO-IOK
M/s. Vedanta Limited

Shri. Lohithashwa R
Mines Manager, Chikkamagaluru

Shri. KVS Subramanyam
Mines Manager, M/s. KG Granites

Shri. Rajesh N
Mines Manager, M/s. R S Rocksand, Kolar

Shri. Nandan S Bhandary
General Manager
M/s. JSW Steel Limited

Shri. KNS Reddy
VP-Mines, M/s. Ultra Tech Cements Limited,
Tadipatri

Shri. J. Naveen Kumar Reddy
DGM-Mines
M/s. Penna Cement Industries Ltd.,

Shri. Nanda Kumar
Mines Manager, M/s. Vesco

Shri. H.G. Shreepada
Mine Owner, M/s. Ashirwad Minerals

Shri. Suresh
Agent, M/s. Hutti Gold Mines Limited

Shri. Dawood Sab
Mine Owner, M/s Nobel Granites

Shri. G.S. Narasimha Murthy
Sr. Mine Manager, Lokapur

Shri. Y.RamaMohan Reddy
Manager, M/s. GVTC, CN Halli

Shri. Sanjeev Tripathi
General Manager, M/s. ACC Limited

MINES SAFETY ASSOCIATION KARNATAKA

PAST CHAIRMAN & SECRETARIES

Period	Chairman	Hon. Secretary
1968-1981	Shri. S.C.Mohanty	Shri G.D. Deshpande
1981-1989	Shri. G.D. Deshpande	-
1990-1994	Shri. T.Narayan	-
1994-1998	Shri. S.K. Agarwal	Shri. A. Narayana Swamy
1998-2002	Shri. G.S. Purohit	Shri. A. Narayana Swamy
2002-2005	Shri. Narendrakumar A. Baldota	Dr. Meda Venkataiah
2005-2008	Shri. H. Noor Ahamed	Dr. Meda Venkataiah
2008-2012	Shri. Ajay Saraf	Dr. Meda Venkataiah
2012-2017	Shri. Narendra Kumar Nanda	Dr. Meda Venkataiah
2017-2022	Dr. Meda Venkataiah	Shri. Dhananjaya G. Reddy

NATIONAL MINING CONCLAVE-2024

CHIEF PATRON

Shri. PRABHAT KUMAR

Director General of Mines Safety
Ministry of Labour & Employment
Government of India, Dhanbad

PRINCIPAL CONVENER

Shri. R. PRAVEEN CHANDRA

Chairman
Mines Safety Association Karnataka &
Chairman, ERM Group, Bengaluru

ASSOCIATE CONVENER

Shri. S.N. MATHUR

President
Mining Engineers' Association of India
Hyderabad

CONVENER

Shri. K. MADHUSUDHANA

Hon. Secretary, MSAK &
Chief Executive Officer
M/s. MSPL LIMITED

सत्यमेव जयते

ಥಾವರ್‌ಚಂದ್ ಗೆಹ್ಲೋಟ್
थावरचंद गेहलोत
THAAWARCHAND GEHLOT
Governer of Karnataka

THAAWARCHAND GEHLOT
Governer of Karnataka

MESSAGE

I am glad to know that Mines Safety Association of Karnataka is organizing National Mining Conclave-2024 with a theme of Sustainable Mining for A Brighter Future on 28th and 29th June, 2024 in association with Mining Engineers Association of India and have propose to bring out a Souvenir containing technical papers for benefit of delegate / industry members to upgrade their knowledge in the technology and create awareness among the mining community for sustainable mining.

I send my felicitations and best wishes to the Organizers, participants and souvenir team and also for a grand success of the event.

7.6.24

(THAAWARCHAND GEHLOT)

S.S. MALLIKARJUN
Minister of Mines & Geology,
Horticulture and Davanagere
District Incharge Minister

Room No. 305-305A
3rd Floor, Vidhana Soudha
Bengaluru - 560 001
Phone : 080-22255023
22033564
E-mail : mghminister@gmail.com

S.S. MALLIKARJUN
Minister of Mines & Geology,
Horticulture and
Davanagere District
Incharge Minister

MESSAGE

I am glad to know that the Mines Safety Association Karnataka is organizing the National Mining Conclave-2024 in association with the Mining Engineers' Association of India. This notable event, themed "Sustainable Mining for a Brighter Future," is scheduled to take place at the J.N. Tata Auditorium, Indian Institute of Science, Bengaluru, on the 28th and 29th of June, 2024.

In the current scenario, where sustainable practices are not just a necessity but a mandate, this Conclave holds significant importance. I firmly believe that such dedicated efforts towards organizing this event will substantially enhance our collective understanding and implementation of health and safety measures, ultimately fostering increased productivity within the mining sector. These seminars serve as crucial educational platforms, providing invaluable opportunities for shared learning and creating a forum for experts from various fields and organizations to deliberate on critical issues surrounding safety awareness and sustainable mining practices.

Today, it is imperative that the exploration and utilization of our natural resources be conducted systematically and scientifically. This methodology must prioritize safety, environmental conservation, and the welfare of local communities, while also considering the preservation of flora and fauna.

With the surging demand for minerals driven by rapid technological advancements and industrial growth, it is essential to adopt sustainable mining practices. Responsible extraction and processing of minerals not only ensure the longevity of our natural resources but also help mitigate environmental impacts, thereby enhancing socio-economic benefits for the surrounding communities.

I extend my heartfelt congratulations to the organizers for their commendable initiative in hosting this pivotal event. I am confident that the discussions and outcomes of the Conclave will be fruitful and will significantly contribute to the advancement of sustainable mining practices in our country.

I convey my best wishes for the grand success of the Conclave and for the continued safe and productive operation of the mines.

S.S. MALLIKARJUN

सत्यमेव जयते

आज़ादी का अमृत महोत्सव

भारत सरकार / Govt. of India
भारत सरकार / Ministry of Labour& Employment
खान सुरक्षा महा–निदेशालय / Directorate General of Mines Safety

PRABATH KUMAR
Director General, DGMS

MESSAGE

It gives me immense pleasure to note that the Mine Safety Association Karnataka, in association with Mining Engineers Association of India, is organizing “National Mining Conclave-2024” on “Sustainable Mining for A Brighter Future” on 28th & 29th June 2024. I am also happy to note that the eminent personalities from universities, Institutions, R & D centres and expert from mineral industry are expected the join the Conclave and on the eve of the inauguration ceremony, a souvenir with proceedings of the technical papers is scheduled to be published.

Technical papers covering aspects of Safety in mines, Mineral exploration, Advance Technology, Digitization, Coal & Oil Mining, Mine Environment and Community development etc. will be presented during the conference. This will provide an opportunity for the industry, policy makers/regulators and academic world to meet and discuss solutions for achieving safe, sustainable and economically viable mining operations.

For achieving the infrastructural growth trajectory set out by the Government, the mining sector plays an important role. The contribution of the mining sector to the country’s GDP is around 2.5 % and is expected to grow in the coming years. In view of increasing ESG concerns, responsible mining in a cost-effective manner is the challenge ahead. The conventional practices need to be revisited by the mine operators in order to integrate modern technologies with safety, sustainability and economics. DGMS is on the forefront for the introduction of new technologies that increase the productivity in the mines without any compromise in the safety standards.

I congratulate the organisers for taking up this initiative and also extend my best wishes for a grand success of the event.

(Prabhat Kumar)

सत्यमेव जयते

भारत सरकार / Govt. of India
श्रम एवं रोजगार मंत्रालय / Ministry of Labour& Employment
खान सुरक्षा महा–निदेशालय / Directorate General of Mines Safety
दक्षिणी अंचल, बेंगलूरू / Southern Zone, Bengaluru

DEO KUMAR
Deputy Director General of
Mines Safety, Southern Zone,
Bengaluru.

MESSAGE

I am very glad to note that the mines Safety association, Karnataka in Association with the Mining Engineer's Association India is conducting National Mining Conclave-2024 on 28th June 2024 and 29th June-2024, at J.N Tata Auditorium, Indian Institute of Science, Bengaluru . I am also happy to know that a technical update will be released to commemorate the event.

Mining Industry in India is growing at a very fast pace with increase levels of Mechanization and modernization. Mining is hazardous operation and poses significant Environmental, Health and Safety risks to Miners. It is therefore imperative to conduct from time to time technical sessions to aware all the stakeholders about basic status and change in the technologies and developments for reduction in mine accidents and related direct /indirect cost; thereby increasing production and productivity.

It is well known to every stakeholder that the mine Safety Association of Karnataka and Mining Engineer's Association of India are playing a pivotal role in increasing safety awareness in the mining community as well as in the general public connected with the mining industry. I am confident that organizing such events at regular intervals will help the mining industry achieve the goal of Zero accident potential.

I extend my good wishes for the grand success of the event.

DEO KUMAR

वी. जयाकृष्ण बाबू
खान नियंत्रक (द. अ.)
V. JAYAKRISHNA BABU
CONTROLLER OF MINES (SZ)

भारत सरकार
GOVERNMENT OF INDIA
खान मंत्रालय
MINISTRY OF MINES
भारतीय खान ब्यूरो
INDIAN BUREAU OF MINES
खान नियंत्रक (द.अ.) कार्यालय
OFFICE OF THE CONTROLLER OF MINES (SZ)

V. JAYAKRISHNA BABU
Controller of Mines
South Zone
Indian Bureau of Mines
Bengaluru

MESSAGE

It gives me immense pleasure to learn that the Mines Safety Association Karnataka is organizing the National Mining Conclave-2024 in Association with Mining Engineers' Association of India. The event, themed "Sustainable Mining for a Brighter Future" at J.N. Tata Auditorium, Indian Institute of Science, Bengaluru, on the 28th and 29th of June, 2024.

I firmly believe that this Conclave, organized with dedication and the right spirit, will significantly enhance our collective health and safety awareness, ultimately boosting productivity across the sector. These seminars are invaluable educational tools, offering opportunities for mutual learning and providing a forum for experts from diverse fields and organizations to review and discuss critical issues related to safety consciousness and sustainable activities.

In today's context, it is more crucial than ever that the development and utilization of our natural resources are carried out in a systematic and scientific manner. This approach must prioritize safety awareness, environmental conservation, and the well-being of local communities while also considering the impacts on flora and fauna.

Furthermore, with the increasing demand for minerals driven by rapid technological advancements and industrial growth, adopting sustainable mining practices is essential. Responsible extraction and processing of minerals ensure the longevity of our natural resources and help minimize the environmental footprint, enhancing the socio-economic benefits for surrounding communities.

I sincerely congratulate the organization for their initiative in organizing such a seminal event. I am confident that the deliberations will yield positive outcomes.

I extend my best wishes for the success of the Conclave and for the safe and productive operation of the mines.

V. JAYAKRISHNA BABU

R. GIRISH, I.A.S.
Director
DEPARTMENT OF MINES AND GEOLOGY
Govt. of Karnataka

ಆರ್. ಗಿರೀಶ್, ಭಾ.ಆ.ಸೇ
ನಿರ್ದೇಶಕರು
ಗಣಿ ಮತ್ತು ಭೂ ವಿಜ್ಞಾನ ಇಲಾಖೆ
ಕರ್ನಾಟಕ ಸರ್ಕಾರ

R. GIRISH, IAS
Director,
Department of Mines and Geology
Govt. of Karnataka

MESSAGE

It is undeniably a great pleasure to learn that, the Mines Safety of Karnataka has been engaged in organizing Seminars / Workshops to promote development of Mining Industry of our Nation. I am very much delighted to know that the Mines Safety Associaton of Karnataka in association with the Mining Engineer's Association if India Bengaluru Chapter is presently organizing National Mining Conclave-2024.

The said National Mining Conclave will facilitate a podium for the policy makers, Stake holders and the mining fraternity to resolve their challenges currently faced by them. It seems that the event will be technical sessions wherein papers will be presented by renowned experts may throw more light on utilization of advanced technology in mineral exploration and exploitation so as to ensure the development of Mining Industry in the state.

National Mining Conclave-2024 is the need of the hour. I trust the deliberations of Workshop will enlighten the mining fraternity for a safe and sustainable mining in the state.

I wish a grand success for the workshop and also extend my best wishes to the organizers.

R. GIRISH, IAS

ನಂ. 49, ಖನಿಜ ಭವನ, ರೇಸ್ ಕೋರ್ಸ್ ರಸ್ತೆ, ಬೆಂಗಳೂರು – 560 001
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Tel : 080-22269632, General : 080 - 2238 4134 / 35 / 36

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THE HUTTI GOLD MINES COMPANY LIMITED

(A Govt. of Karnataka Undertaking)

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SANJAY B SHETTENNAVAR, IAS
Managing Director

MESSAGE

It gives me an immense pleasure to know that Mine Safety Association of Karnataka in association with Mining Engineer's Association of India is Organizing a "National Mining Conclave-2024" with a theme of "Sustainable Mining for a Brighter Future" which is scheduled to be held on 28th & 29th June 2024 at J.N. Tata Auditorium, IISC Bengaluru.

Now-a-days, the Mineral Industry is facing a number of challenges needing innovative technology to overcome the problems and there should be a mechanism for continuous evaluation and up-gradation of technology to meet the standards of sustainable Mining and economical Mining.

I wish to send my felicitations and best wishes to the Organizers, participants and the Souvenir and also wish for a grand success of the event.

Sd/-
SANJAY B SHETTENNAVAR

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KUDREMUKH

ಜಿ.ವಿ. ಕಿರಣ್
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जी.वी. किरण
अध्यक्ष-सह-प्रबंध निदेशक
G.V. KIRAN
Chairman-cum-Managing Director

ಕೆಐಓಸಿಎಲ್ ಲಿಮಿಟೆಡ್
(ಭಾರತ ಸರ್ಕಾರದ ಉದ್ಯಮ)
೨ನೇ ಬ್ಲಾಕ್, ಕೋರಮಂಗಲ, ಬೆಂಗಳೂರು-೫೬೦ ೦೩೪.
केआईओसीएल लिमिटेड
(भारत सरकार का उद्यम)
II ब्लॉक, कोरमंगला, बेंगलूरु-560 034.
KIOCL LIMITED
(A Government of India Enterprise)
II Block, Koramangala, BENGALURU-560 034.

G.V. KIRAN
Chairman - cum -
Managing Director

MESSAGE

It is of great pleasure to know that the Mines Safety Association of Karnataka, in association with the Mining Engineers' Association of India, is hosting the National Mining Conclave 2024 under the theme & quot, Sustainable Mining for a Brighter Future.

In today's industrial scenario, sustainability is paramount, and we commend MSAK and MEAI for championing this crucial topic through the conclave. India's mining sector, with its numerous small operational mines engaging over 1 million people, plays a pivotal role in our economy However, the industry faces challenges such as the closure of depleted mines and the exploration of new ones. Therefore, finding sustainable technologies and solutions is the need of the hour.

I am confident that this conclave will serve as a vital platform for policymakers, stakeholders, and industry leaders to address the persistent challenges of sustainability in mining. Also, it will play a pivotal role in fostering innovation, paving the way for advanced solutions and technologies to tackle these challenges.

I must emphasize that the proactive efforts of MSAK and MEAI in enhancing professionalism and competence of the mining industry are commendable, making this conclave a significant initiative.

I wish a grand success for the conclave and extend my best wishes to the organizers.

G.V. KIRAN

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वेबसाइट Website : www.kioclltd.in
https://www.facebook.com/kioclltd

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KSMC

JAYAVIBHAVA SWAMY, I.A.S.
Managing Director
M/s. Karnataka State Minerals Corporation Limited

MESSAGE

I am delighted to know that the MSAK is conducting "National Mining Conclave – 2024" with a theme of "Sustainable Mining for a Brighter Future" in association with MEAI on 28th and 29th June 2024 at J. N. TATA Auditorium, Indian Institute of Science, Bengaluru, Karnataka, India under the aegis of the Director General of Mines Safety, Govt. of India, which is most welcome and in the right direction.

National Conclave provides a deeper insight about occupational health and safety in mining operations with social reference to Minor Minerals and also the need of implementing state-of-the-art technologies to achieve enhanced efficiency and environmental sustainability in mining. The conclave shall address the challenges and opportunities for sustainable mining practices in the current socio-economic landscape.

MSAK is bringing safety awareness among the mining community and building relationship between mine management, government authorities and employees and also take part in the health welfare and other social activities in the mining industry. Safety in mines is a subject of vital importance as it dwells upon the safety, health and wellbeing of Workers, Supervisors and Managers engaged in hazardous mining operations. Safety is the backbone of production and productivity for any industry.

I am sure, the organizers of the function would be successful in creating proper motivation towards safety amongst all the participating mines in realizing the ultimate goal of zero harm in mines towards improving knowledge and skills of employees working in the mining and allied industries.

I wish a grand success of the event.

JAYAVIBHAVA SWAMY

Mining Engineers' Association of India

Regd. Under Societies Act 1860

S.N. MATHUR
President, MEAI

MESSAGE

It is learnt that the Mines Safety Association of Karnataka is organising a National Mining Conclave 2024 in association with Mining Engineers' Association of India with theme topic of "Sustainable Mining for a Brighter Future" at Bengaluru on 28th & 29th June 2024. I am informed that the MSAK has been organising such conferences biannually to inculcate the Safety Awareness among the mining community and to build harmonious relationship amongst the members, Mine Management and the regulatory authorities through health, welfare and other social activities.

I wish the Conclave a grand success and hope that it may help the MSAK to fulfil its moto.

S.N. MATHUR

National Head Quarters & Secretariat

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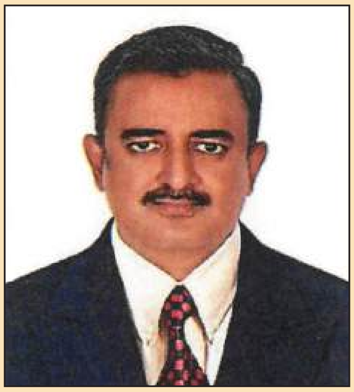
Tel : 040 - 223200510 & 29801069, Mob : 77801 17320

E-mail : meai1957@gmail.com, Website : meai.org



R. PRAVEEN CHANDRA
Chairman, Mines Safety Association Karnataka & Chairman, ERM Group, Bengaluru

MESSAGE

Indeed, it is my pleasure that Mines Safety Association Karnataka (MSAK) in association with Mining Engineers' Association of India is organising "National Mining Conclave 2024" on 28th & 29th June, 2024 on the 56th year of its establishment. MSAK is organising similar events regularly and National Mining Conclave is being organised biannually from the past 20 years.

Mining and Minerals industry plays a pivotal role in the economic development of the nation. Mineral Industry plays an important role to achieve the "Third Largest Economy" target set by our Hon'ble Prime Minister. The Mining Industry not only generates direct employment in the rural areas in a big way, but also generates indirect employment in many folds. The Minerals Industry generates unskilled, Semi-skilled, Skilled and highly skilled employment opportunities, which is the need of the hour to engage our youth. We have the advantage of demographic dividend, and we have to utilize them by skilling and training to suit our requirements. It is also need of the hour for the Mineral Industry to adopt to ESG standards in all our areas of operations. Preserving a pollution – free environment for the future generations and living beings is our responsibility and we should strive hard to protect it.

I hope the technical presentations and deliberations in the Conclave will enhance our knowledge on Health, Safety, Environment, Technology, Digitization, etc., as far as the Mineral Industry is concerned.

My sincere gratitude to the DGMS, IBM, DMG, PESO officials, and other Government officials, Sponsors, MSAK members, Executive Committee and office bearers for their relentless support in organising this event.

I hope and wish the National Mining Conclave 2024 a grand success.

R. PRAVEEN CHANDRA

K. MADHUSUDHANA
Hon.Secretary, MSAK &
Chief Executive Officer
M/s. MSPL LIMITED

MESSAGE

It gives me great pleasure that the Mines Safety Association Karnataka is conducting the National Mining Conclave every alternate year. This year, the National Mining Conclave-2024 is being organized in association with the Mining Engineers' Association of India on the theme "Sustainable Mining for a Brighter Future." The event will take place at the J.N. Tata Auditorium, Indian Institute of Science, Bengaluru, on the 28th and 29th of June, 2024.

I am proud to be part of an initiative that brings together leaders, experts, and professionals from the mining industry. This Conclave represents a significant step forward in our collective efforts to promote sustainable mining practices and address the critical challenges facing the industry today.

Our focus during this Conclave will be on fostering a deeper understanding of how we can balance the need for mineral resources with the imperative to protect our environment and ensure the safety and well-being of those who work in and around mines. We aim to explore innovative technologies, share best practices, and discuss strategies that can lead to more efficient, safe, and environmentally friendly mining operations.

It's really important that we use sustainable methods to protect our resources, limit harm to the environment, and help local communities. We'll talk about the newest mining technology, ways to reduce environmental damage, and how to make sure workers stay safe and healthy.

I extend my sincere thanks and congratulations to all the Organizers, Sponsors, Speakers, Office bearers, Executive members and participants for their dedication and hard work in making this event possible. I express my gratitude to the President of MEAI and all members of MEAI for their support. I am confident that the insights and knowledge shared during the Conclave will lead to positive outcomes for the mining industry, academia, and research institutions.

My special thanks to the All DGMS Officials of Southern Zone and Other Zones for their immense support in organising this event

Let us learn and innovate, ensuring a sustainable and prosperous future for the mining sector.

K. MADHUSUDHANA

Dr. MEDA VENKATAIAH
Director, M/s. MSPL Limited Hosapete

EDITORIAL

It is my immense pleasure to share about the upcoming National Mining Conclave 2024, scheduled for June 28th and 29th, 2024, at the Indian Institute of Science, Bengaluru. This biennial event continues our tradition of gathering industry leaders and experts to explore the theme "Sustainable Mining for a Brighter Future."

The National Mining Conclave 2024 is designed to be a pivotal forum for discussing innovative approaches and technologies that promote sustainable mining practices. Our agenda includes six focused sessions covering critical topics such as Mines Safety - special reference to Minor Minerals, Mineral Exploration, Methods of Mining, Innovation and Advanced Technologies, Sustainable and Digitalization practices in Mining and Sustainable Mining. These sessions aim to stimulate insightful conversations and foster collaboration among stakeholders.

I extend my sincere gratitude to the Directorate General of Mines Safety (DGMS) officials for their indispensable support in organizing this event. Special thanks also go to the Office Bearers, Executive Committee Members, Zonal Secretaries, and Souvenir & Technical Committee members for their dedicated efforts in making this Conclave a reality.

Furthermore, I express appreciation to our presenters and authors, as well as our sponsors and advertisers, whose contributions have made the printing of this souvenir possible. Their support ensures that the insights and knowledge shared during the Conclave reach a broader audience, thereby enriching our collective understanding.

Let us come together to chart a sustainable and prosperous path forward for the mining industry.

Dr. MEDA VENKATAIAH

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A Brief Summary of NATIONAL MINING CONCLAVE -2022

The Mines Safety Association Karnataka (MSAK) in Association with Mining Engineers' Association of India (MEAI) and The Institution of Engineers (India), Karnataka State Centre under the patronage of Directorate General of Mines safety (DGMS) organised two-day's NATIONAL MINING CONCLAVE 2022 as part of 75th years of India's Independence (Azadi Ka Amrit Mahotsav) at JN Tata Auditorium, IISc, Bengaluru during 12th and 13th August 2022. As a part of knowledge dissemination and training this conclave has been organised by MSAK adhering to one of its objectives. Technical sessions, stalls by various mining companies & others were part of this conclave.

1. Registration:

Around 700 delegates were registered for the conclave including VIPs, Government officials, Academicians, Researchers, Authors and Students. The officials from Department of Mines & Geology, Govt of Karnataka, DGMS, Indian Bureau of Mines, NMDC, KIOCL, KSMCL, HGML, (Public Sector Undertakings) also participated in the conclave.

2. Stall Exhibition:

To begin with, the Chief Guest Shri Prabhat Kumar, DG, DGMS inaugurated the exhibition of stalls and held interactions with various stall personnel about their products and services.

3. Inauguration:

Chief Guest:

Shri. Prabhat Kumar, Director General, Directorate General of Mines Safety, Ministry of Labour and Employment, Govt of India.

Guests of Honour:

1. **Shri. Malay Tikader,** Deputy Director General of Mines Safety, Southern Zone, Bengaluru.
2. **Shri Muralidhar Bidari,** Director of Mines Safety, Bengaluru Region.
3. **Shri Umesh M Sawarkar,** Director of Mines Safety of Ballari Region.

President: Dr. Meda Venkataiah, Chairman, MSAK & ED MSPL

Convenor: Shri Dhananjaya G. Reddy, Honorary Secretary, MSAK; Chairman, Mining Engineers' Association of India, Bengaluru Chapter and COO, R Praveen Chandra.

Other Guests:

1. **Shri K Madhusudhana,** President, Mining Engineers' Association of India & VP, MSPL
2. **Shri Rajesh Sambrey,** Vice Chairman, MSAK and Sr. VP, UltraTech Cements.

To begin with:

The safety arrangements of the auditorium were explained.

- The Chief Guest inaugurated the conclave by lighting the lamp along with the dignitaries.
- Shri Dhananjaya Reddy welcomed the august gathering and, in his speech, he highlighted

about MSAK & its activities to achive the goal and objectivies of the MSAK.

- Shri Muralidhar Bidari & Shri Umesh M Sawarkar addressed everyone and urged the delegates from different mining companies to actively participate in this conclave and attend all technical sessions.

- Shri K Madhu sudhana in his address highlighted the efforts in organising and conducting the National conclave. He briefly explained about the activities of MEAI and how MEAI stands with various stake holders all through their journey.

- Shri Malay Tikader in his address to the gathering appreciated the works of MSAK and recognised the efforts of MSAK. He emphasised that how this conclave shall be useful to various stake holders and the role of DGMS in regulating the mines.

- The Chief Guest Shri Prabhat Kumar released the technical souvenir of the conclave and distributed the copies to other guests present on the dais.
- The Chief Guest at the outset in his speech congratulated the organisers of the conclave and the officials of MSAK. He clearly explained the role of DGMS and emphasised that being a regulator DGMS is equally a facilitator. He urged the mining companies to approach DGMS for solutions in compliance to various statutory provisions. He stated that the relationship between DGMS and mines is symbiotic in nature by working together the solutions for various problems can be achieved. He highlighted

the benefits that can be reaped from the conclave by the delegates.

- Dr Meda Venkataiah, President MSAK in his address to the audience explained about the probable outcome of this conclave. He thanked the DGMS officials for their support in organising such a mega event after two years. He also stressed on problems faced by the various mines in strict compliance to various statutory provisions. He thanked DGMS officials from different zones who were present for the conclave.
- The Chief guest later released a book entitled "Mine Waste Utilisation" written by Dr Ram Chandra, Assoc. Professor, Dept of Mining Engineering, NITK Surathkal & Dr. Gayana.
- The guests were felicitated by MSAK for their gracious presence and continuous support.
- Shri Rajesh Sambrey, Vice Chairman, MSAK during his speech thanked Shri Prabhat Kumar DG, DGMS and other the Guests of Honour for gracing the occasion. He thanked the DMS of various regions, DDMS, MEAI President for attending the event. He also thanked the delegates, sponsors, print media, authors, students etc., for their presence.

The Concluding Session was held on 13th August evening, Shri. Malay Tikader, Deputy Director General of Mines Safety, Southern Zone, Shri. T Swaminathan-CMD & Director (commercial) Addl Charges-KIOCL, Shri. Dev Kumar,DMS-Bilaspur, Dr. C V Raman-Jt Director, Directorate of Mines & Geology-Govt of Karnataka, Shri. Muralidhar Bidari-Director of Mines Safety,

Bengaluru Region, Dr. Meda Venkataiah, Chairman-MSAK, Shri. Dhananjaya G. Reddy, Honorary Secretary-MSAK, Shri Narshimamurty ,Jt. secretory, MSAK, were the part of concluding function.

Lucky dip was held and 05 lucky winners were rewarded with cash award of Rs.10,000/- each.

After addressing the audience, the guests were honoured by MSAK for their august presence.

The Persons who were behind the screen and contributed towards the arrangement & conduct of the conclave were also felicitated.

*** Program concluded with National Anthem ***

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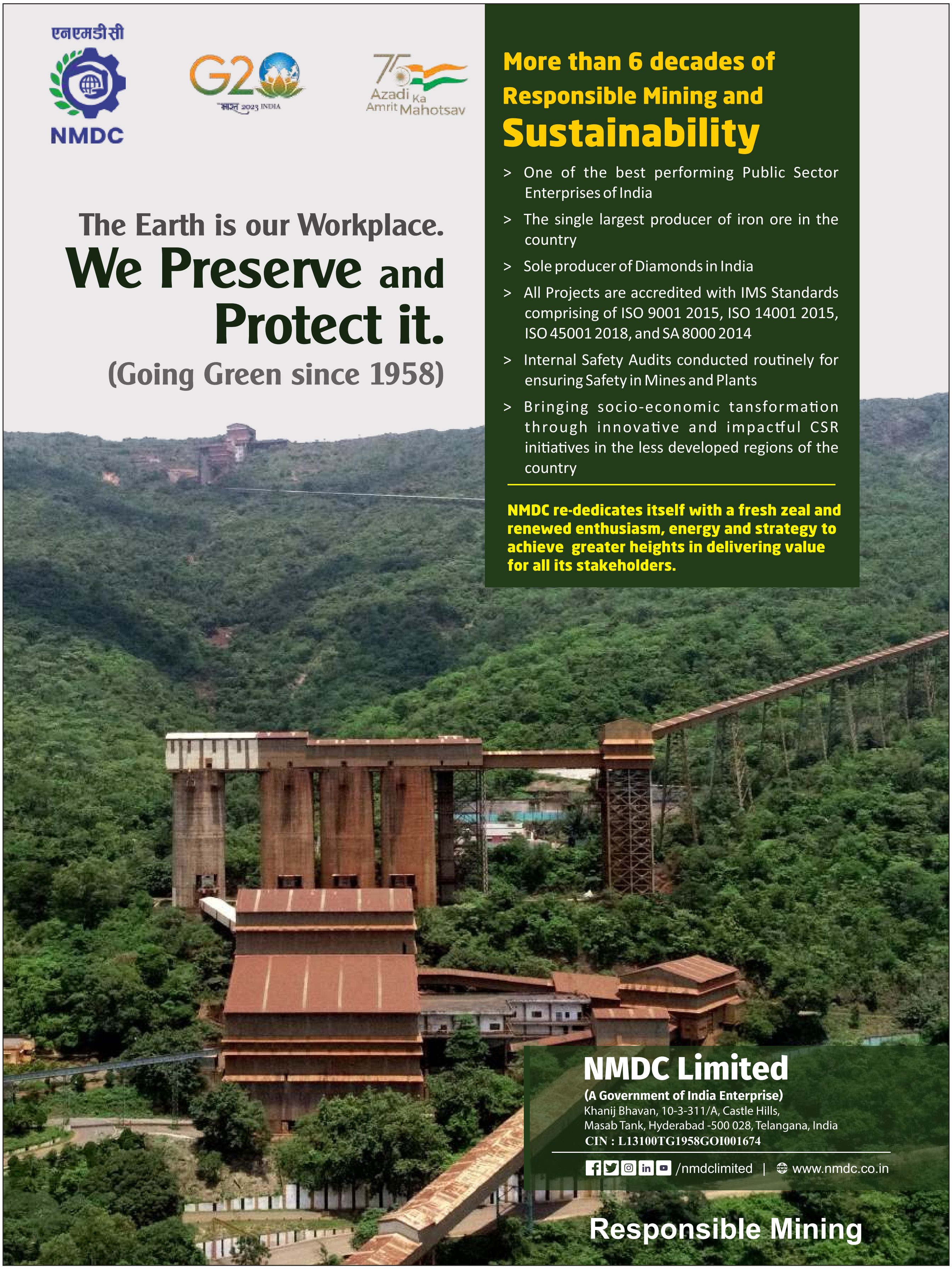
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PROGRAMME

28.06.2024 **First Day**

Registration	08.30 AM to 09.30 AM
Inaugural Session	09.30 AM to 11.00 AM
High Tea	11.00 AM to 11.30 AM
Technical Session	
Technical Session - I	11.30 AM to 01.30 PM
Lunch	01.30 PM to 02.30 PM
Technical Session – II	02.30 PM to 04.00 PM
Tea Break	04.00 PM to 04.15 PM
Technical Session - III	04.15 PM to 05.30 PM

29.06.2024 **Second Day**

Technical Session - IV	10.00 AM to 11.30 AM
Tea Break	11.30 AM to 11.45 AM
Technical Session - V	11.45 AM to 01.30 PM
Lunch	01.30 PM to 02.30 PM
Technical Session - VI	02.30 PM to 03.45 PM
Valedictory Session	03.45 PM to 04.45 PM
High Tea	04.45 PM onwards

Details of Technical Session-I
MINES SAFETY - SPECIAL REFERENCE TO MINOR MINERALS

PANEL DISCUSSION		
1	Blasting operations in stone quarries covered under the purview of the Mines Act 1952	**Shri. Yohan Yejerla** Director of Mines Safety (Mining) DGMS, Ballari Region-II
2	A Unified Framework: Harmonizing National mineral (minor)Taxation for Equitable Development "underlining the subject of financial safety of the minor mineral mines which are small and micro enterprises (SME's)"	**Dr. CH Rao** Secretary General, Federation of Minor Minerals Industry (FEMMI) & Chairman, Visakhapatnam Chapter, MEAI
3	Best Quarrying Practices Considering Slope Stability & Blasting Operations in Small Scale Quarries	**Dr. K. Ram Chandar** Professor, Former-Head of the Department Dept. of Mining Engg. NITK- Surathkal

LUNCH BREAK

Details of Technical Session-II
MINERAL EXPLORATION

1	Recent Advancements in Exploration Techniques	**Shri. Omprakash Somani** Vice President, Exploration M/s. MSPL Limited
2	Advanced Geophysical Technology for Lowering Risk in Mineral Exploration	**Shri. Karunakar Gandarapu** CEO & Director STEIGER Geoscience and Engineering LLC
3	Development and deployment of Shallow angle Drilling (<45°) Technology at HZL: Advancing safe Surface Exploration for steeply dipping orebody with limited site accessibility.	**Shri. Kuldeep Singh Solanki** Director, Exploration – HZL

TEA BREAK

Details of Technical Session-III
METHODS OF MINING

1	Safety aspects in Heavy Earth Moving Machinery (HEMM) to meet technology trends in Open Cast Mining applications	**Shri. K. Vijayakumar** Director of Mines Safety (Mech), Southern Zone, Bengaluru.
2	Implementation of innovative mining method at SKM	**Shri. Pradeep Kumar** Head-Geotechnical Engineering (Mining), Sindesar Khurd Mine
3	Does shallow depth of working connote more stability?	**Dr. Pramod Rajmeny** Director, M/s Rajmeny Min Care Consultants

29.06.2024 **Second Day**

Details of Technical Session-IV
INNOVATION AND ADVANCED TECHNOLOGIES

1	Techniques to Improve Visibility in Dense Fog Condition at Khondbond Iron Mine, Tata Steel – An Approach	**Shri. Mujigela Maniteja** Technologist Mining M/s. Tata Steel Limited
2	Advanced technologies usages to optimize Mining cost	**Shri. Lalit Agarwal** GM, M/s. Deepak Fertilizers and Petrochemicals Pvt. Ltd
3	Potential for Multi-mineral Exploration and sustainable mining in Sandur Schist Belt, Karnataka	**Kum. Ramya Doddamani &** **Kum. Lavanya Hegde** Research Scholar and Assistant Professor, Department of Geology SKSJTI, Bengaluru-560001

TEA BREAK

Details of Technical Session-V

SUSTAINABLE AND DIGITALISATION PRACTICES IN MINING

1	Digital and Sustainable Transformation of Logistics in Chrome ore Mines using Artificial Intelligence	**Shri. Viraj A Verlekar** Sr. Area Manager, Geology M/s. Tata Steel Limited , Sukinda Chromite Mine
2	A Novel Solution for Humate Removal from Bauxite Ore in Bayer's Process	**Dr. S.C. Patnaik** Ex-DGM, Nalco Advisor-Mining additives, Kimberlite Chemicals India Private Limited, Bengaluru
3	Sustainable Mining for a Brighter Future	**Shri. Swapnil Gupta,** CEO, Minception

LUNCH BREAK

Details of Technical Session-VI

SUSTAINABLE MINING

1	Innovative Waterless Dust Collection Technology for Mining and Mineral Industry	**Dr. P. Sharath Kumar** Chairman Dept. of PG Studies and Research in Mineral Processing VSKUPG Centre, Nandihalli
2	Iron ore Beneficiation – A need of the hour	**Dr. Meda Venkataiah** Director, M/s. MSPL Limited
3	Systematic Dimension of stone Mining	**Shri. Ganesh Murthy** Senior Manager, M/s. Bannari Amman Sugars Limited.

VALEDICTORY SESSION 3.45 PM to 4.45 PM

HIGH TEA 04.45 PM onwards

Blasting operations in stone quarries covered under the purview of the Mines Act 1952

YOHAN YEJERLA
Director (Mining), Bellari Region-II, DGMS

Abstract—This paper deals with the Blasting operations in stone quarries covered under the purview of the Mines Act 1952, conducted by the holder of Shot firer's certificate issued by PESO under Explosive Rules 2008. Stone quarrying is a labor-oriented small-scale industry which involves drilling, blasting and crushing activities in Karnataka and some parts of the rest of India.

In most cases, the mine owners are entering into agreements with explosive suppliers and are conducting blasting operations at their mines by the holder of Shotfirer's Certificate issued by PESO. Whereas no such provision exists under the Mines Act, 1952, as such blaster/shot-firer is not reportable to the manager and is employed in more than one mine and is getting his wages/remuneration on the amount/quantity of work he is performing. Unscientific and unplanned blasting activities conducted in the mines by inexperienced persons resulting in fatal accidents and complaints from the neighbouring residents have become a growing concern to the persons employed in and around the mines in general and regulatory authorities in particular.

With the increase in the growing demand for building stone, the scale of quarrying operations has been increased by deploying sophisticated machinery, which necessitates the deep hole drilling and blasting conducted at the mine. These blasting operations can lead to Fly rock, and ground vibrations causing damage to the structures in the vicinity besides causing fatalities and injuries to the persons employed in the mines and the people residing nearby, if the Blasting operations are not conducted as required under the provisions of the Mines Act 1952, Rules, Regulations and orders made thereunder.

This paper highlights various Statutory obligations in conducting the blasting operations in the quarries covered under the purview of the Mines Act 1952.

A Unified Framework: Harmonizing National mineral (minor) Taxation for Equitable Development "underlining the subject of financial safety of the minor mineral mines which are small and micro enterprises (SME's)"

Dr. C H RAO

Secretary General, Federation of Minor Minerals Industry (FEMMI)

Chairman, Visakhapatnam Chapter, MEAI

Executive Summary

Across India, the minor mineral mining industry faces existential threats from disproportionate taxation, which not only hampers its viability but also adversely impacts rural economies and employment. This report, drawing from various sources including state department portals and district survey reports, calls for urgent, harmonized tax reform under the banner "One Nation, One Mineral, One Tax" to safeguard and stabilize this crucial sector.

1. Introduction: Minor Minerals as Developmental Minerals

This introduction aims to seamlessly connect the significance of minor minerals with the central issues of taxation irregularities and the need for a unified policy approach, setting a comprehensive agenda for the detailed discussions that follow in the report.

Minor minerals, often referred to as Developmental Minerals in frameworks such as those provided by the United Nations Development Programme (UNDP), represent minerals of low individual value but collectively contribute 40-50 percent of the Gross Domestic Product from all minerals in India. These minerals—encompassing aggregates, sand, building stone, clay, limestone, quartz, feldspar, mica, quartzite, granite totalling 55 minor minerals are pivotal for infrastructure development and sustain various key industries, including construction, agriculture and manufacturing.

Ninety percent of minor mineral mining is managed by Micro, Small, and Medium Enterprises (MSMEs) which includes Artisanal small mines too(ASM's). These enterprises are crucial to India's broader mining ecosystem, driving rural employment, supporting local economies, and fostering grassroots-level exploration and development activities. Their operations, while vital, face unique challenges and opportunities, particularly in terms of sustainable and profitable management.

Despite their critical role, the regulatory and taxation framework governing these minerals exhibits marked inconsistencies across different states, leading to a lack of uniformity that can hinder efficient management and equitable growth of this sector.

This report aims to explore these irregularities in detail, presenting a comparative analysis of dead rents and royalties, examining the tax policies and their impact on these enterprises, and recommending policy and legislative reforms.

The significant growth in minor mineral leases, from 5,500 twenty-five years ago to over 55,000 mines today (excluding river/stream sand mines), underscores the urgency for a systematic review and overhaul of the existing frameworks.

2. Socio-Economic Profiles of Minor Mineral Investors

Overview:

Minor mineral investors, often involved in the extraction of materials such as sand, gravel, clay, and stone, play a vital role in the construction and local industries. Typically characterized as "entrepreneurs of sustenance," these individuals operate on a small scale, primarily to support their livelihoods rather than to scale up into large enterprises.

Socio-Economic Characteristics

These entrepreneurs of small medium enterprises (SME's) constitute artisanal and small-scale mining (ASM), which is often driven by poverty and located in rural areas. The workforce in this sector generally consists of unskilled labourers earning low incomes. SME and ASM activities are crucial for the survival of these individuals and their families, offering essential, albeit modest, economic opportunities in their communities.

National Policy and Poverty Eradication

Mainstreaming poverty eradication into national policymaking, particularly in the mineral sector, is vital. Promoting small-scale mining can serve as a catalyst for other productive activities, fostering economic growth and sustainability in impoverished regions. By adopting a bottom-up approach through pro-poor strategies and participatory methodologies, policies can be more effectively tailored to the needs of these communities, enhancing their impact.

Role in the Mineral Sector

The role of these small and micro-entrepreneurs is both foundational and transformative within the mineral sector. They are often at the forefront of discovering and developing new sources of minor minerals, which are crucial for various industrial applications. Understanding their socio-economic profiles helps in appreciating their contribution and the challenges they face.

Implications for Uniform Mineral Taxation

Incorporating an understanding of the socio-economic dynamics of minor mineral investors into the framework for uniform mineral taxation is essential. A nuanced approach to taxation, which considers the economic realities of these entrepreneurs, can help in designing policies that do not disproportionately burden them but rather support their growth and sustainability. The policy should aim to create a conducive environment that promotes fair practices and equitable growth opportunities across the sector.

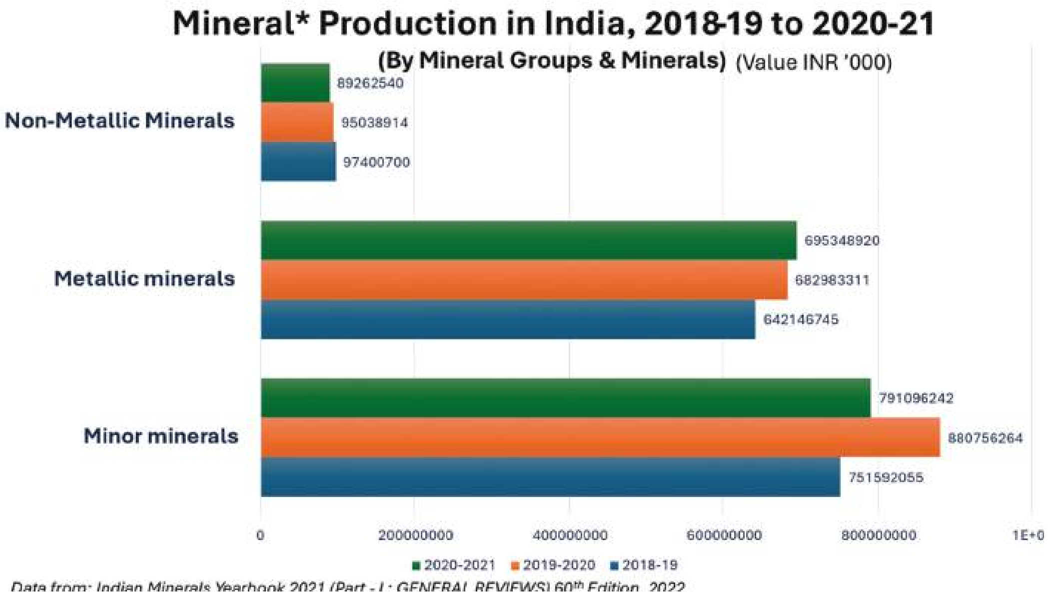
3. Minor minerals vis-à-vis Metallic & Non-Metallic minerals

1. Mineral Production in India (2018-2021)

The bar graph detailing mineral production in India from 2018 to 2021 shows the production values for non-metallic minerals, metallic minerals, and minor minerals. Despite minor minerals being categorized differently from major metallic and non-metallic minerals, they show substantial production values. In 2020-2021, for instance, minor minerals had a production value close to those of metallic minerals, underscoring their significant contribution to India's Gross Domestic Value. This robust output highlights their crucial role, especially in construction and manufacturing sectors that are pivotal for infrastructure development.

2. Export Figures for Iron Ore and Granite Products

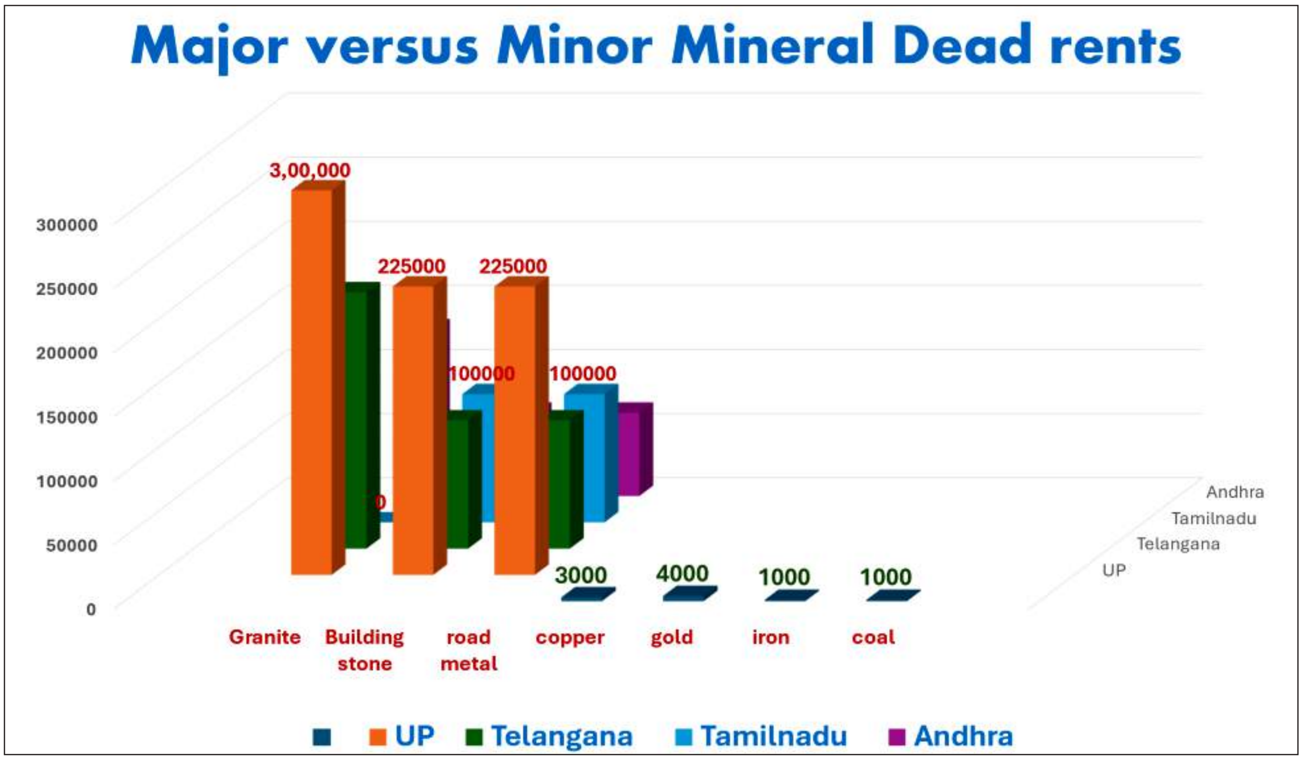
The infographic on export figures provides insights into the economic value derived from specific minerals such as iron ore and granite products. It shows that despite the comparatively lower market prices or global recognition, the export value of these products is substantial. The data



for 2020 indicates significant revenue generation, emphasizing that minor minerals like granite have a strong presence in international markets, contributing to India's foreign exchange earnings.

3. Major versus Minor Mineral Dead Rents

This bar graph comparing dead rents for major and minor minerals across different states (Andhra Pradesh, Telangana, Tamil Nadu, and Uttar Pradesh) illustrates a disparity in financial burden. Minor minerals often have lower dead rents compared to major minerals such as granite and metal ores, but given their volume and usage, the overall financial impact is considerable. This visualization serves to point out the relative underemphasis of minor minerals in policy considerations despite their high utility and contribution to the domestic economy.



The comparison of major and minor minerals shows a significant financial burden placed on the minor minerals sector, which, despite its lower individual commodity value, contributes nearly 40 percent to the Gross Domestic Value of the overall mineral sector. This highlights a discrepancy in government focus, which often prioritizes more lucrative or globally recognized minerals like metals, potentially overlooking the foundational role minor minerals play in the economy.

4.National Mineral Policy 2019 and the Drive for Uniform Mineral Taxation

In response to the Supreme Court of India's judgment in "Common Cause vs. Union of India", which called for comprehensive reform and a more coherent framework in the mining sector, the National Mineral Policy 2019 (NMP-19) was formulated. This policy sets out to address various systemic issues within the mineral sector, with a significant focus on creating a uniform taxation system that aligns India with global mining practices.

Fiscal Aspects of NMP-19:

Fiscal measures play a crucial role in the promotion and sustainability of mineral exploration and development. Point 8 of the NMP-19 specifically states the government's commitment to designing fiscal measures conducive to this end. The policy highlights the necessity of periodic examinations of fiscal changes, ensuring they are consistent with global standards and the general tax structure through the normal budgetary process. This approach aims to make India an attractive destination for mineral exploration and mining by benchmarking and harmonizing royalty and all other levies and taxes with those prevalent in other significant mining jurisdictions.

Inter-Ministerial Mechanism for Sustainable Development:

The Inter-Ministerial Mechanism established under the Ministry of Mines as per NMP-19 involves members from various ministries, including Coal, Earth Sciences, and MoEFCC, along with state governments. This body aims to promote sustainable mining by addressing environmental and socio-economic issues in mining areas and advising on royalty and dead rent rates.

The NMP-19 seeks to comply with Supreme Court directives and promote equitable growth in the mining sector by advocating for uniform mineral taxation. This policy aims to remove discrepancies and create a level playing field across states, fostering a stable and predictable regulatory environment for investors and operators.

5. Misinterpretation and Exploitation of Section 15 by States in Taxing Minor Minerals

The Section 13 and the Section 15 of MMDR Act provide the Central and State Governments, respectively, the authority to regulate major and minor minerals. These sections are crucial for maintaining a balanced and legal framework for mineral extraction and taxation. While Section 13 (for major minerals) specifies the terms for fees and charges clearly, Section 15 (for minor minerals) has been interpreted more loosely by various state governments, leading to inconsistent and often excessive taxation practices.

Comparison of Section 13 and Section 15

Both sections contain similar stipulations regarding the governance of mineral resources; however, there are critical differences in the clarity and definition of terms. In Section 13, fees associated with reconnaissance permits, prospecting licenses, or mining leases are well-defined. Conversely, Section 15 lacks such specificity, particularly under clause (g), which discusses the "fixing and collection of rent, royalty, fees, dead rent, fines, and other charges." The absence of detailed definitions and boundaries has led some states to interpret this as a carte blanche for imposing additional taxes, such as the 'consideration tax' in Andhra Pradesh and the 'permit tax' in Telangana. These taxes are viewed

Similarity of Section 13 for Major Minerals & Section 15 for Minor Minerals	
13.Power of Central Government to make rules in respect of minerals.	**15. Power of State Governments to make rules in respect of minor minerals.**
The Central Government may, by notification in the Official Gazette, make rules for regulating the grant of 1[reconnaissance permits, prospecting licenses and mining leases] in respect of minerals and for purposes connected therewith. (2) In particular, andwithout prejudice to the generality of the foregoing power, such rules may provide for all or any of the following matters, namely:- **....(a), (b), (c), (d) (e),(f), (g), (h),** **(i)** the fixing and collection of fees for [reconnaissance permits, prospecting licenses or mining leases], surface rent, security deposit, fines, other fees or charges and the time within which and the manner in which the dead rent or royalty shall be payable;	The State Government may, by notification in the Official Gazette, make rules for regulating the grant of quarry leases, mining leases or other mineral concessions in respect of minor minerals and for purposes connected therewith. (2) (1A) In particular and without prejudice to the generality of the foregoing power, such rules may provide for all or any of the following matters, namely: - **...(a), (b), (c), (d), (e), (f).** **(g)** the fixing and collection of rent, royalty, fees, dead rent, fines or other charges and the time within which and the manner in which these shall be payable;

by many in the industry as arbitrary and beyond the legal scope of the statute.

Legislative Context and Need for Amendment

The introduction of the District Mineral Fund (DMF) through amendments to both sections in 2015 illustrates the necessity of parliamentary approval for any new taxes on minerals. This precedent underscores that any imposition of additional taxes beyond royalties should require similar legislative endorsement. Whereas, the misuse of Section 15 by states underlines the urgent need for revising and strengthening this section to make its provisions clear and unambiguous, ensuring that state-level taxation aligns with national legal standards and does not unfairly burden the minor minerals sector.

> *To prevent further misinterpretation and ensure fair taxation practices, Section 15 (g) should be explicitly revised to define the scope of permissible charges and the methodology for their application. This clarification will protect minor mineral enterprises from undue financial burdens and contribute to a more consistent regulatory environment across states.*

6.Analysis of Variability in Royalty Rates

To understand the variability of the royalty rates of various minor minerals across the Indian state, we have compiled the data from various State Government published Gazette notifications. The data provides a variable royalty rate across the mineral spectrum. Almost all the minor minerals are presented in the main report, however in this report we choose only few industrial minor minerals as examples to indicate the variability of the royalty rates.

Barytes: The royalty rates for Barytes show an extreme range from Rs. 45 per ton in Gujarat to Rs. 2,000 per ton in Karnataka. Other states like Andhra Pradesh, Madhya Pradesh, Rajasthan, Tamil Nadu, and Telangana also display varied rates, spanning from Rs. 66 to Rs. 780 per ton. Such disparities create a non-uniform cost base for businesses involved in the extraction of Barytes.

Quartz: For Quartz, the royalty fluctuates from Rs. 20 per ton in Chhattisgarh to Rs. 500 per ton in Karnataka, with intermediate values in other states like Andhra Pradesh, Gujarat, Madhya Pradesh, Orissa, Rajasthan, Tamil Nadu, Telangana, and

Uttar Pradesh. This variance could potentially redirect investments and operations towards more financially favourable jurisdictions, undermining resource management strategies.

Dolomite: The Dolomite royalty rates range dramatically from Rs. 20 per ton in Chhattisgarh to Rs. 500 per ton in Karnataka. Other states have their rates set within this range, creating a diverse and inconsistent taxation landscape that impacts both local businesses and broader economic planning.

7. Implications of Royalty Rate Discrepancies : Lack of uniformity in royalty rates across states can lead to several challenges:

Economic Inefficiency: Varying costs can lead to inefficiencies where resources may not be utilized optimally. Companies might prioritize mining in states where the cost (royalty rate) is lower, potentially leading to overexploitation or underutilization based purely on financial rather than environmental or supply considerations.

Competitive Imbalances: Enterprises operating in states with higher royalty rates are at a competitive disadvantage, which can skew development opportunities and hinder fair market competition.

Regulatory Arbitrage: The variability invites regulatory arbitrage, where businesses may choose to operate in jurisdictions with lower royalty demands, affecting local economies and state revenues.

Royalty Rates of Minor Minerals – State Wise

Mineral	ANDHRA	CHATTISGARH	GUJARAT	KARNATAKA	MADHYAPRADESH	ORISSA*	RAJASTHAN	TAMILNADU	TELANGANA	UTTARPRADESH
Granite	1533	500	210	2,750	666	1,300	290	1,680	1,600	1,666
Marble	120	250	230	5,000	333	582	500		130	206
Agate	145	20	100	1,500	66	120	145	135	156	50
Ball Clay	75	20	60		66	120	150	100	78	50
Barytes	1,100	-	45	2,000	66		90	540	780	0
Calcarious Sand	90	60	45		66	12 percent advol	44	110	97	50
Calcite	90	60	60	400	66	15 percent adv	160	110	91	50
Chalk	95	60	95		66	15 percent adv	80	100	104	50
China Clay	60	20	200	400	66	12 percent advol	500	100	78	50
Clay (Others)	60	20	45		66	70 cbm	65		52	50
Corundum	120	20	45		66	12 percent advol	435	3,510	78	500
Diaspore	415	20	45		66	12 percent advol	160	540	351	
Dolomite	100	20	75	500	66	75 ton	265	110	130	
Dunite or Pyroxenite	60	20	45	300	66	30 ton	55	150	52	
Felsite	130	20	45	600	66	12 percent advol	105	150	143	
Feldspar	100	20	40	500	66	15 percent adv	235	135	97	
Fire Clay	60	20	45	400	66	12 percent advol	80	45	65	
Fuschite Quartzite	90	20	40		66	12 percent advol	90	135	91	
Gypsum	150	20	45	750	66	20 percent	160	175	91	
Jasper	145	20	45	750	66	20 percent	125	230	156	
Kaolin	60	20	45		66	8 precent		45	78	
Laterite	200	20	70	800	66	25 percent	80	285	130	
Limekankar	90	20	50	400	66	130 ton		110	123	
Mica	2,000	20	45	7,500	66	1,000	625	2,700	2,600	
Ochre	60	20	45	300	66	20	45	36	45	
Pyrophyllite	200	20	45	1,000	66	50	100	270	234	500
Quartz	90	20	60	500	66	300	320	230	78	100
Quartzite	90	20	40	500	66	120	4,350	100	78	
Sand (Others)	100	20	40	400	66	15	50	80	78	
Shale	180	20	45	750	66	80 ton	145	160	169	100
Silica Sand	100	20	45	500	66	10 percent of sale price	90		78	
Steatite or Talc or Soapstone	550	20	45	1,000	66	18 percent advalorium		100	390	
Limestone (Minor)	90	41	50	250	66	90		180 cbm	130	
Mosaic Chips	90		45		66	105	110		58	
Ballast	60	41	50		66	65	50	60		106
Boulders	60	41	50		20	65	50	60		106
Building Stone	60	41	50	350	20	65	155	60	65	106
Gravel	30	13	40		66	15	50	28	20	106
Murram	30	13	25	200	33	15	32	28	20	100
Ordinary Earth	30	20	25		33	15	50	28	20	44
Road Metal	60	41	50	200	40	65	50	500	65	106
Rough Stone	60	41	50	200	40	65	44	500	65	73
Manufactured Sand	60	20	50		40			500	65	
Limestone Slabs - Black	120	41	50		200	200	155	60	130	
Limestone Slabs - Colour	120	41	50		200	200	155	60	130	
Chalcedony Pebbles	60		60		66			60		

7(A). A case study of Andhra Pradesh

Overzealous Taxation and Its Impact on Andhra Pradesh's Minor Mineral Sector

The narrative of mineral taxation in Andhra Pradesh serves as a cautionary tale of regulatory excess, where the pursuit of immediate revenue enhancement through ad-hoc government orders has led to dire consequences for the minor mineral sector. This case study not only reflects the unsustainable fiscal practices but also highlights the urgent need for central intervention to prevent similar future scenarios in other states.

Escalating Government Measures:

In a series of rapid and aggressive regulatory changes beginning December 17, 2000, with G.O 90, the Andhra Pradesh government implemented a policy to appropriate security deposits based on production performances that did not meet projected quantities in the mining plan. This approach failed to consider market conditions, buyer demand, and operational challenges, setting a precarious financial precedent for mine owners.

Subsequent orders intensified the financial burden on the sector:

February 26, 2021: Introduction of G.O 13 by the Andhra Pradesh Pollution Control Board, which escalated the CFO and CFE rates by exorbitant amounts.

June 7, 2021: Amidst the economic disruptions caused by COVID-19, the state introduced a consideration fee, essentially doubling the existing royalty rates for each mineral.

August 4, 2021: G.O 65 was issued, introducing a premium tax of 10 times the dead rent for Letters of Intent on pending applications, alongside a levy of five times the security deposit of dead rent on the overall lease extent.

Consequences of Regulatory Overreach:

This barrage of taxation and regulatory measures has significantly increased operational costs, directly impacting pricing and competitiveness. The attractiveness of Andhra Pradesh as an investment destination for mining has starkly diminished, leading to:

Widespread Mine Closures: Within just two years, approximately 42 percent of minor mineral mines in Andhra Pradesh were forced to shut down.

Economic and Social Fallout: The closure of mines triggered widespread unemployment, pushing thousands of workers out of jobs and leading many mining enterprises towards insolvency and bankruptcy.

Long-Term Sector Damage: The heavy-handed approach to taxation during a global pandemic exemplifies a short-sighted fiscal strategy focused more on immediate revenue generation than sustainable economic growth.

7(B). Telangana's Taxation Tactics: A Mirror to Andhra Pradesh's Fiscal Folly

The case of Telangana adopting similar tax measures to those of its neighbour, Andhra Pradesh, exemplifies a troubling trend among state governments of exploiting minor mineral taxation as a quick fix to revenue challenges. This pattern of "policy replication" reveals a broader regional issue in the mining sector, where short-term financial gains are prioritized at the expense of long-term industry health and sustainability.

Policy Replication and Its Impact:

Taking a page from Andhra Pradesh's playbook, Telangana implemented similar aggressive taxation measures through government orders, with only minor variations. This mimicry has led to comparable economic downturns within its mining sector, mirroring the adverse effects witnessed in Andhra Pradesh. Such replication of fiscal policies underscores a shared regional challenge, where states view minor mineral taxes as low-hanging fruits—easily accessible sources of revenue.

The Draw of "Low-Hanging Fruits":

Describing minor mineral taxes as "low-hanging fruits" aptly captures their appeal to state governments desperate for funds. These taxes are often seen as an expedient means to bolster state coffers, ostensibly to support welfare schemes and other government programs. While this may address immediate fiscal shortages, the approach is inherently flawed, short-sighted, and unsustainable. It risks the long-term viability of the mining sector, which is pivotal for economic stability and growth.

The Dangers of Short-Sighted Fiscal Policies:

The allure of quick revenue from minor mineral taxes leads to a cycle where states compete in a downward spiral of tax increases and regulatory burdens, often copying one another's policies without regard to the broader economic or environmental repercussions. This can stifle investment, deter business development, and ultimately lead to industry decline—as evidenced by the downturn in both Andhra Pradesh and Telangana.

Political Motivations and Economic Consequences:

The tendency of states like Telangana to adopt such fiscal measures can often be traced back to political motivations—securing quick funds to fulfil short-term promises at the expense of long-term economic health. This strategy, while perhaps providing temporary political gains, does substantial damage to the sector's competitiveness and sustainability, affecting countless livelihoods and economic opportunities in the process.

Inferences from these two States:

The experiences of Telangana and Andhra Pradesh serve as clear indicators that without a strategic rethink on minor mineral taxation, states risk the long-term vitality of their mining industries for short-lived financial relief. It is imperative for central and state governments to collaborate on crafting policies that balance immediate fiscal needs with sustainable economic growth strategies.

The excessive taxation on minor minerals in India, with rates surging to as high as 360% on commodities like gravel, ordinary earth, and road metal, and similarly exorbitant rates on other essential construction materials, is having profoundly detrimental effects on the mining industry. These taxation policies not only burden mine owners and mining enterprises but also have broader socio-economic and environmental ramifications. Here's a comprehensive narrative that highlights the cumulative and effective taxation and its adverse impacts:

7(C). Detrimental Effects of High Cumulative Taxation on Minor Minerals

Exorbitant Tax Rates:

Staggering Taxation Levels: Minerals essential for construction and infrastructure, such as limestone slabs, manufactured sand, and rough stone, are subjected to taxation that cumulatively results in an effective tax rate ranging from 127% to an overwhelming 540%. Such high rates drastically increase the cost of raw materials, making them less accessible for various sectors, especially housing and construction.

Specific Impacts: For instance, gravel and ordinary earth, fundamental in everyday construction, face a cumulative tax effect of 360%, while limestone slab mines endure a 267% tax. Manufactured sand and rough stone are even more heavily taxed at 387%.

Economic Consequences:

Inflationary Pressures: These excessive taxes contribute significantly to inflation in the construction sector, escalating the costs of housing and infrastructure development. This inflation disproportionately affects low and middle-class families, who rely on affordable building materials for housing.

Competitiveness and Viability: For mining enterprises, such high tax rates undermine economic viability and competitive positioning. Many mines, unable to sustain operations under such fiscal pressure, are forced to reduce their workforce or shut down entirely, leading to job losses and decreased economic activity in mining-dependent regions.

Impact on Sustainable Development Goals (SDGs):

Undermining SDG Achievements: The adverse effects of mineral taxation not only impact economic activities but also hinder progress towards achieving the Sustainable Development Goals (SDGs). By escalating costs and reducing the availability of essential minerals, these tax policies adversely affect efforts to reduce poverty, improve health and education, and promote gender equality by limiting job opportunities and economic inclusivity.

Community and Environmental Sustainability: Over-taxation threatens the sustainability of mining practices, as it encourages rapid extraction to compensate for financial pressures, potentially leading to environmentally destructive practices and community disengagement.

8. Conclusion: The Necessity for Tax Reform & A Unified Call for "One Nation, One Mineral, One Tax

A Vision for Uniformity in Mineral Taxation:

The diverse and disparate taxation rates on minor minerals across different states not only create economic inefficiencies but also perpetuate market distortions and investment hesitancy. It is imperative, therefore, that India moves toward a unified taxation framework—encompassing the principle of "One Nation, One Mineral, One Tax." This approach mirrors the successful implementation of the Goods and Services Tax (GST) and seeks to establish similar uniformity and predictability across the nation's mining industry.

Urgent Need for Legislative Amendment:

The current state of affairs, characterized by volatile mineral prices and inconsistent tax policies, underscores the urgent need for amending the Mines and Minerals (Development and Regulation) Act. Specifically, Section 15 of the MMDR Act requires revision to allow for a centralized taxation system that ensures fairness and streamlines regulatory processes. This change would not only mitigate regional disparities but also bolster national economic stability.

Benefits of a Centralized Taxation System:

A uniform taxation policy would provide numerous benefits:

Economic Stability: It would cushion the mining industry from the abrupt shocks of price fluctuations and policy shifts, fostering a more stable business environment conducive to long-term planning and investment.

Encouragement of Investments: Predictable tax rates are essential for attracting both domestic and international investors, who are often deterred by the current unpredictability and complexity of state-specific tax regimes.

Support for SMEs: By harmonizing tax rates, the financial burden on small and medium-sized enterprises (SMEs) within the mining sector would be significantly reduced. This would enhance their operational viability, promote local development, and facilitate equitable wealth distribution.

Strategic Imperatives for Policy Change:

The compelling need for policy change is driven by the necessity to sustain the mining sector's viability and its critical contribution to the broader economy. The impact of taxation and fiscal policies must be carefully considered to ensure the health and growth of this sector. Therefore, it is not just advisable but essential for the central government to take decisive action to reform mineral taxation.

Call to Action:

We urge policymakers to recognize the critical situation and initiate immediate steps to amend the relevant sections of the MMDR Act. Implementing "One Nation, One Mineral, One Tax" is not merely a fiscal reform but a transformative shift that will secure the future of India's mineral wealth and ensure its benefits are maximized for all stakeholders involved.

In conclusion, the pathway to a thriving, equitable, and sustainable mining sector in India lies through the corridors of uniform policy and taxation. Let this be the moment for bold reforms that will lay the groundwork for a prosperous future.

Best Quarrying Practices Considering Slope Stability & Blasting Operations in Small Scale Quarries

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Abstract

Quarrying is essential to supply coarse aggregates for construction and infrastructure projects. At present, slope stability and blasting studies have become essential to get the required permissions to start quarrying from regulating bodies. Natural topography, nature of the rock mass, geological conditions, nature of surrounding structures etc., influences the quarrying operations. A sound scientific knowledge is essential in order to design blasting operations which gives optimum fragmentation, with reduced side effects and without causing any damage to the surrounding structures. It is difficult to predict the intensity of ground vibrations generated due to blasting operations accurately without conducting trial blasts. This paper gives some details about the various investigations to assess the effects of rock blasting and different methods of controlling them. A few case studies are presented under different geo-mining conditions. Some of the best practices are suggested based on large number of studies carried out in different quarries located in Karnataka, Kerala, Tamil Nadu, Andhra Pradesh and Telangana. Along with technical issues, trained and competent man power also essential to run the quarries safely and efficiently by following the best practices.

INTRODUCTION

Quarries have been worked for thousands of years. Ancient Egyptians built the Great Pyramids with massive limestone and granite blocks cut by hand from nearby quarries. There are many evidences of usage of rock for different tools in the history long ago. However, still quarry sector is being considered as conventional and small scale and facing multiple problems.

Some of the problems faced by Quarry sector are:

- Lack of availability of good deposits
- Stringent regulations
- Multiple reregulating bodies with multiple permissions
- Close to human habitats and sensitive areas
- Non-cooperation of local people
- Linking landslides (slope stability) to quarrying activity in the recent past.
- Negative image of rock blasting, where as blasting is essential in quarries.

The discussion is limited effect of rock blasting in this paper.

In fact, the use of explosives for rock blasting began way back in 1627 in a Hungarian gold mine. At that time, blastholes were hand drilled, black powder was placed into the holes and wooden plugs were tamped tightly into the holes to confine the explosives. The use of black powder to break the rock mass, proved to be much faster and efficient than traditional methods like fire setting and chiselling. Since then, blasting has been more popularly accepted for rock fragmentation than other methods like mechanical cutting, hydraulic fracturing etc. This may be due to the distinct advantages of explosive energy like economy, efficiency, convenience and ability to break the hardest rocks (Konya, 1990).

Blasting is only the first step in the production process for mines, quarries and other excavation projects. The costs of this first step is normally only 8% to 12% of the total costs. (Konya, 2004). The main objective of rock blasting is to break the rockmass for achieving required fragmentation with minimum side effects. The term fragmentation refers to post blast size distribution of the rockmass. In addition the rock mass should not only be adequately fragmented but it should also be displaced into a muckpile, providing better conditions for digging and hauling equipment (Harries, 1987). In general, in a properly designed blast around a meagre15 to 20per cent of the energy is doing useful work and the remaining is wasted in generating side detrimental effects (Hagan, 1973). Berta (1990) approximately estimated the distribution of utilization of total explosive energy into following categories:

Fracture in-situ:	<1 %
Breakage:	15%
Displacement:	4%
Crushing in the vicinity of the hole	1.5 to 2%
Fly-rock	<1%
Deformation of solid rock behind the shot	<1%
Ground vibrations	40%
Air blast/noise	38 to 39%

A number of factors influence the blast results, which can be grouped under controllable and uncontrollable factors. Parameters like explosive type, burden, spacing, sub drilling, stemming, delay timing, charge weight per delay, initiation system, initiation pattern etc, may be grouped under controllable parameters. The geological parameters like mineralogy, lithology, structural discontinuities and the physico-mechanical properties of rock mass come under uncontrollable factors, as they are given by nature.

Rock Blasting in Quarries

The major problem with rock blasting is quarries is ground vibration, noise and fly rock. In fact, it is very difficult to sense the ground vibrations by humans but higher noise levels can be sensed easily which leads to more complaints. However, ground vibrations are the major concern for structural damage.

Ground Vibrations

There are particle movements as the seismic waves travel through the rock. This is commonly known as vibration. The movement of any particle in the ground can be described in three ways; displacement, velocity and acceleration. Velocity transducers (geophones) produce a voltage proportional to the velocity of movement and can be easily measured and recorded (Spain et al., 1991). Ground particle motion (vibration) occurs in three dimensions: vertical, radial, and transverse. Each particle has a velocity when there is vibration; the maximum velocity is referred to as the peak particle velocity. This motion is typically recorded using a seismograph, and the maximum velocities in all three directions are given. Most researchers use the peak particle velocity reading as the standard for measuring the intensity of the ground vibrations. The maximum measurement of any of the three components is used in reporting rather than the combined resultant vector of all three components. In most cases, the PPV is closely related to the potential for structural damage rather than the rock's acceleration or displacement.

Many researchers have intensively researched ground vibrations by developing numerous equations considering the different parameters. The research determined the mathematical relationship between vibration level, charge weight and distance. The relationship is known as the Propagation Law, developed in the U.S Bureau of Mines Bulletin is shown in Equation-1

$V = K\,[D/W\alpha]\,\beta$ --- eq-1

Where,

V = Peak particle velocity (m/s)

W = Maximum explosive charge weight per delay (kg.)

D = Distance between the blast location and monitoring point (m)

K = Particle velocity intercept

α = Charge weight exponent

β = Slope factor exponent

The values of α, β, and k are determined by condition in the area, rock type, local geology, overburden thickness, and other factors.

Many organizations proposed the damage criteria, including USBM, DGMS, Indian Standards, etc., based on the Permissible PPV in mm/s and Frequency of the ground vibrations for various types of structures. The criteria based on the Permissible PPV in mm/s and Frequency of the ground vibrations for various types of structures as per DGMS (1997) is presented below in Table-1.

Table-1 Permissible Peak Particle Velocity (PPV (mm/s)) near Surface Structure (DGMS (Tech) (S&T) Circular No.7 of 1997)

Types of Structure	Dominant excitation Frequency (Hz)		
	<8 Hz	8-25 Hz	>25 HZ
A. Buildings/Structures not belonging to the owner.			
Domestic houses/Structures (Cement)	5	10	15
Industrial buildings (RCC and framed Structures)	10	20	25
Objects of historical importance and sensitive Structures	2	5	10
B. Building belonging to owner with limited span of life.			
Domestic houses/Structures (Cement)	10	15	25
Industrial buildings (RCC and framed Structures)	15	25	50

Some case studies are presented below describing the specific problems at the quarry site and the solutions suggested.

Case Study: 1

This is a case study of a quarry in Thiruvananthapuram District of Kerala. This is a new quarry and there were concerns as there is a water tank at a distance of around 30m from the lease boundary. A broad view of the quarry is shown in Fig. 1 and the water tank is shown in Fig. 2. The tank is built over hard rock mass with proper foundation. There are some visible cracks on the compound wall of the water tank and these appears to be within the plastering zone. Four sample cracks are marked and signed by the officials present at the site during the study (Fig. 3). Keeping the close proximity of the water tank from the lease boundary of the quarry, 1m wide and 1.5m deep trench is created which acts as a discontinuity in propagation of ground vibrations (Fig. 4) i.e., which reduces ground vibrations and also acts as a drainage channel.

Blast Design

Blast design is important aspect in order to achieve the required blast performance and also in reducing the side effects of blasting like ground vibrations, noise, fly rock etc. Based on the preliminary inspection of the site, required fragmentation, etc., the following blast deign is adopted (Table- 2). In addition to the above, every blast is prepared with clear free face and the top of the area cleared off any small pieces of rock in order to avoid fly rock problem, before starting drilling operation itself. Effective stemming is also essential for proper confinement of explosive charge inside the blasthole.


1. BROAD VIEW OF THE QUARRY


2. VIEW OF WATER TANK


3. MARKING OF SAMPLE CRACKS


4. A VIEW OF TRENCH CREATED

AS PART OF PRE-BLAST SURVEY

TABLE- 2 BLAST DESIGN ADOPTED IN BUILDING STONE QUARRY

Sl. No.	Parameters	Suggested Value
1	Diameter of Blasthole (mm)	32
2	Burden (m)	0.76
3	Spacing (m)	0.91
4	Depth of Blasthole (m)	1.51
5	No. of Blastholes	Maximum of 30
6	Explosive Charge / Hole (gm)	250 to 375
7	Maximum Charge / Delay (gm)	250 to 750
8	Initiation System	NONEL based shocktube detonators
9	No. of Rows	Maximum of 3

Blasting Operations

Blasts are conducted as per the above design. Required number of cartridges are placed in the blasthole along with shocktube and the remaining depth is filled with inert material and effective stemming is done. Muffling arrangement with blasting mat and sand bags is made, which reduces the fly rock drastically. Ground vibration monitoring at the water tank is shown in Fig. 5. Ground vibration readings of different blasts are given in Table- 3.


5. GROUND VIBRATION MONITORING NEAR THE WATER TANK

Distance (m)	Peak Particle Velocity (mm/s)	Noise (dB)
100	0.56	92.07
35	4.40	97.36
60	<0.51	-
55	3.25	86.71
75	<0.51	
65	2.38	99.35
80	1.679	118.5
50	3.71	98.51
75	2.301	113.6

From Table- 3, it can be observed that beyond the trench, no vibration was recorded. Without trend the instrument triggered at 100m also, but with trench at a distance of 60m also, no vibration is recorded. Hence, it can be stated that the trench is effectively controlling the ground vibrations.

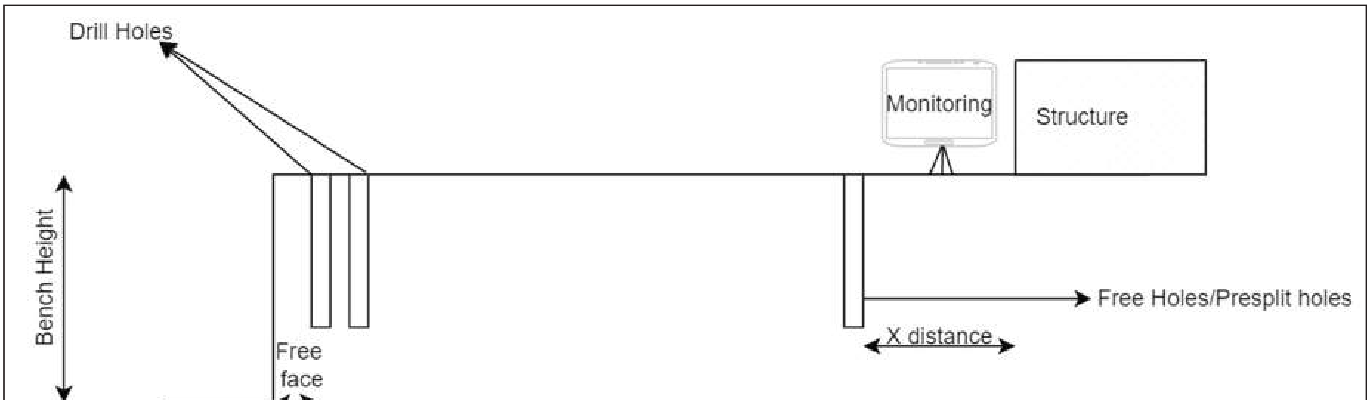
Case Study- 2

This case study is taken in Guntur District of Andhra Pradesh. Broad view of the quarry is shown in Fig. 6. There are some houses and a temple beyond 200m.

Field investigations are carried out to assess the intensity of ground vibrations generated due to blasting operations. Blasts are planned in different locations of the mine and a suitable blast design is adopted. As the temple is very old and historical, in order to keep the ground vibration level very low at the temple, a pre-split is created. It is difficult to create a trend here as there is a hard rock mass. A series of holes are drilled and blasted to create a pre-split plane (Fig. 7 & 8)

6. A VIEW OF THE QUARRY

7. CREATING A PRE-SPLIT PLANE



8. SCHEMATIC REPRESENTATION OF PRE-SPLIT

Ground Vibration & Noise Monitoring

Ground vibrations & Noise generated from different blasts were monitored at different distances including temple. Fig. 9 shows the ground vibration monitoring at the temple, and no vibration was recorded indicating that the trench is very effective.

9. GROUND VIBRATION MONITORING AT THE TEMPLE

Case Study: 3

This case study is taken in Anantapur District of Andhra Pradesh. A broad view of the quarry is shown in Fig. 10. There are some houses beyond 300m.

Pre- Blast Survey

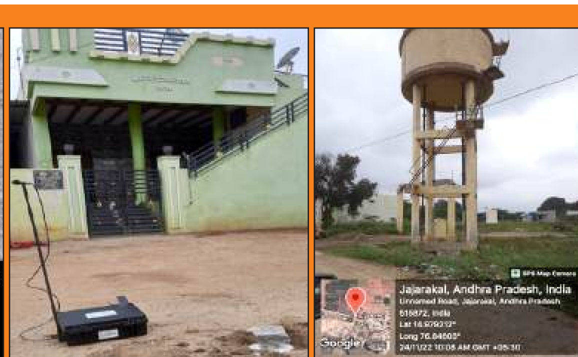
As there are some concerns about the blasting operations from the villagers about the effect of blasting on their houses, some of the houses were inspected. Some sample cracks were marked on the external west side wall of the houses (Fig. 11). Water tank and some other houses also were inspected. Some cacks were observed in different structures, so some of these were marked to verify is there any elongation of these cracks due to blasting activity. In general, many houses will have structures due to various other reasons also like poor quality of cement, improper plastering of walls etc.

Blasting Operations

Field investigations are carried out to assess the intensity of ground vibrations generated due to blasting operations and their impact on the nearby structures. Blasts are planned in different locations of the quarry. Ground vibrations are monitored at the structures of concern and no vibration was recorded (Fig. 12)


10. A VIEW OF QUARRY

11. PRE-BLAST SURVEY



12. GROUND VIBRATION MONITORING AT THE STRUCTURES

From the above studies, it can be concluded that in case study- 1 trench is created to arrest vibration, in case study -2 a pre-split plane is created and in case study- 3 only with blast design ground vibrations were within the permissible levels. So, each study is a site specific. All the design are expected to give the required results when the explosives and imitating devices also work as per their design criteria. However, there are many evidences the delay timing is not accurate. A study carried out by the author about inaccuracy in delay timing of Nonel based shocktube initiation system is presented in Table- 4

TABLE- 4 INACCURACY IN DELAY TIMING

Range of % Error	Blast No.1		Blast No.2		wBlast No.3	
	Surface Error	In-hole Initiation Error	Surface Error	In-hole Initiation Error	Surface Error	In-hole Initiation Error
<20	1	0	0	0	9	1
>20 - <40	6	0	5	0	5	3
>40 - <60	9	5	3	3	7	4
>60 - <80	4	6	3	8	1	3
>80 - <100	0	1	0	2	0	0

As an example, a simple layout which is as per design may go wrong with an inaccuracy of 10% delay in timing and may result finally the maximum charge per delay double or more based on the no of holes getting initiated within 8ms. In order to overcome such problems electronic detonator is a better option, however, its application in quarry sectors depends upon the economic viability.

Conclusions

- Rock blasting is essential to extract the hard rock in quarries. Many problems can be avoided with proper planning. Wherever str tires exists near to the quarry better to take the advise of an expert and establish an optimum blast design and methodology.
- Quarrying sector needs skilled man power. Man power requires training in handling of explosives to conduct blasting efficiently without compromising on safety
- Training centres (Need not be MVTCs) may be established in specific places where more no of quarries are in operation.
- Need based training and periodic training to be provided.
- 'Every quarry should have a manager' may be changed to 'One manager for maximum of 'N' number of quarries within a radius of 'x' km.
- Some of the regulations may be translated into regional leagues- Quarry owners Associations should take such responsibility and can involve some experts.
- Instead of enforcing the man power to follow regulations, educate them to realise the importance of following the rules and regulations (interms of safety)
- Quarry owners, regulating bodies, trainers/ academicians, some retired technocrats, etc., should come together to improve the performance in quarry sector.

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Recent Advancements in Exploration Techniques

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The hunt for mineral resources has always been at the forefront of technological innovation, driven by the ever-increasing demand for metals and minerals essential to modern industries. Recent advancements in mineral exploration techniques have significantly enhanced the efficiency, accuracy, and environmental sustainability of locating and mining these resources.

This paper provides a comprehensive review of the latest developments in geophysical, geochemical, and remote sensing methods that are revolutionizing the field of mineral exploration.

Advanced geophysical techniques, such as three-dimensional seismic imaging, magnetotellurics, and induced polarization, have improved subsurface imaging, allowing for more precise identification of mineral deposits. Innovations in geochemical analysis, including portable X-ray fluorescence (XRF) and laser-induced breakdown spectroscopy (LIBS), have enabled rapid, on-site element detection, facilitating real-time decision-making during exploration activities.

The integration of satellite-based remote sensing and drone-based surveys has provided high-resolution, large-scale data, enhancing the ability to identify surface mineralization patterns and alterations. Furthermore, the application of artificial intelligence (AI) and machine learning (ML) in data processing and interpretation has streamlined the exploration process, enabling the analysis of vast datasets to identify potential mineral targets with greater accuracy.

Exploration companies have massive amounts of data from various sources. Advanced algorithms can analyze this data to identify patterns and predict promising areas for exploration. This helps focus drilling efforts and reduces exploration risks. The use of big data analytics and predictive modeling has also contributed to reducing exploration risks and costs.

In parallel, developments in drilling technologies, such as automated drilling rigs and core scanning systems, have improved the efficiency and safety of sample collection and analysis. These advancements are complemented by environmental monitoring technologies that ensure compliance with regulatory standards and minimize the ecological impact of exploration activities.

This review highlights the synergy between these innovative technologies and their collective impact on enhancing the mineral exploration landscape. By leveraging these advancements, the industry is better equipped to meet the growing demand for mineral resources while adhering to sustainable and responsible exploration practices.

Introduction

Mineral exploration is a comprehensive and complex process aimed at discovering new deposits of valuable minerals, metals, and resources concealed beneath the Earth's surface. This crucial activity serves as the initial step in the mining lifecycle and is essential for ensuring a continuous supply of raw materials necessary for various industries, from manufacturing to energy production. Mineral exploration is vital for:

Sustainable Development: Ensuring a steady supply of essential minerals for sustainable industrial growth and technological advancements.

Economic Growth: Generating significant economic benefits through the discovery and development of new mining operations.

Technological Innovation: Driving the development and adoption of new exploration technologies, contributing to more efficient and less environmentally invasive mining practices.

Traditional Exploration Techniques

Traditional exploration techniques include:

Geological Mapping: Detailed on-site surveys to understand the underlying rock formations and structures.

Geochemical Sampling: Collecting and analyzing soil, rock, and water samples for mineral signatures. This helps navigate regional mapping for mineral targeting.

Drilling and Coring: After locating some anomalies through geological mapping and geochemical sampling, the next stage is drilling for extracting core samples to directly assess the composition and quality of the mineral deposit.

Advances in Geophysical Techniques

The geophysical surveys, both ground and aerial, including magnetic, gravity, IP, EM, and radiometric, have a long history of usage. However, over the years, innovation is likely to transform their application in pinpointing targets for mineral exploration.

(a) Airborne Surveys

There have been major changes in this field, providing a better understanding of geology and structure in any terrain. Using planes or drones to map the Earth's magnetic, gravitational, and electromagnetic fields from above, drone-based magnetic surveys have been used in India. The benefits of drone geophysical surveys are immense, particularly in accessible areas, without damaging the environment. These very low-altitude surveys have the advantage of more detailed data, helping in better interpretation compared to conventional aerial surveys.

(b) Seismic Imaging

3D reflection seismic imaging has been useful in oil and gas for understanding subsurface structures and lithology. 3D seismic imaging helps in identifying and mapping faults and fractures with high precision, which is critical for understanding the structural controls on mineral deposits. It allows geologists to delineate different geological layers, helping to understand the stratigraphic setting of mineral deposits. Advanced seismic techniques can sometimes directly detect minerals or at least the anomalies associated with mineral deposits (e.g., changes in density or velocity). It is particularly useful in regions where the mineral deposits are hidden beneath thick layers of rock or sediments. By providing a detailed subsurface image, 3D seismic imaging helps in pinpointing the most promising drilling targets, thereby reducing the risk and cost associated with exploration drilling. Better subsurface understanding can also minimize the environmental impact by reducing unnecessary drilling. 3D seismic imaging is a powerful tool that enhances the efficiency and success rate of mineral exploration projects. By providing detailed and accurate subsurface images, it enables geologists and exploration companies to make more informed decisions, ultimately leading to more successful and cost-effective exploration campaigns.

Drilling

(a) Diamond Drilling

Extracting a cylindrical core of rock from the ground to analyze subsurface geology and structure. Advances in automation technologies have significantly reduced the need for manual intervention, leading to safer and more efficient operations. Fully autonomous drilling systems use AI and machine learning to optimize drilling parameters in real time, improving drilling accuracy and reducing operational costs. Integration of advanced sensors in drilling equipment allows for real-time monitoring of drilling parameters such as temperature, pressure, and vibration, enabling immediate adjustments to optimize performance.

(b) Reverse Circulation Drilling

RC drilling uses a dual-walled drill pipe to collect rock samples and drilling fluids for analysis. Recent advancements in reverse circulation (RC) drilling have focused on enhancing efficiency, accuracy, and environmental sustainability. Here are some notable developments: Development of more efficient air compressors that provide consistent and higher pressure, improving the speed and quality of drilling operations. Implementation of noise reduction technologies to make air compressors quieter and more environmentally friendly.

(c) Directional Drilling

Directional drilling allows multiple target intersections by drilling branch holes off the mother hole and also controls deviation. Directional drilling has seen significant advancements in recent years, driven by the need for increased precision, efficiency, and reduced environmental impact.

Innovative Geochemical Approaches

(a) Portable XRF and LIBS

Hand-held X-ray fluorescence analyzers for on-site, real-time identification of mineral compositions. Portable XRF is good for preliminary grade analysis on the spot at a very minimal cost. Portable X-ray fluorescence (pXRF) technology has seen several advancements in recent years, improving its accuracy, versatility, and usability across various applications in mineral exploration. Its use helps in minimizing the cost reduction for costly chemical analysis. Portable LIBS: Portable Laser-Induced Breakdown Spectroscopy (LIBS) has seen significant advancements, making it a powerful tool for rapid, on-site elemental analysis across various industries. Portable XRF cannot perform analysis of lighter elements (lighter than Na), but the LIBS can perform analysis of lighter elements; thus, elements like Br and Li can be analyzed by LIBS.

(b) Apatite Trace Element Compositions by LA-ICP-MS

It's a robust new tool for mineral exploration. Apatite can accommodate at least 58 elements in its structure, including gold. The apatite grains collected from geochemical sampling can be analyzed in LA-ICP-MS (Laser Ablation-Mass Spectrometer). The higher concentration of REE, U, Th, gold, etc., can lead to the identification of favorable mineral provinces and exploration targets (Mao Mao et al., 2016).

Ref: Mao Mao, Alexei S. Rukhlov, Stephen M. Rowins, Jody Spence, and Laurence A. Coogan, Economic Geology, v. 111, pp. 1187–1222, 2016.

Advancements in Remote Sensing

Recent advances in remote sensing have significantly enhanced its applications in geology, offering more precise, efficient, and comprehensive tools for geological studies. These advancements encompass improvements in sensor technology, data processing techniques, and integration with other geospatial technologies. Here are some notable recent advances:

(a) High-Resolution Satellite Imagery

Very High-Resolution (VHR) Satellites: New satellites, such as WorldView-3 and Pléiades, provide imagery with spatial resolutions of less than one meter. This enables detailed geological mapping and the identification of small-scale geological features. Enhanced spectral resolution allows for better discrimination of minerals and rock types.

(b) LiDAR (Light Detection and Ranging)

High-Density LiDAR: LiDAR technology has advanced to provide higher point densities, which improves the accuracy of topographic models and enables detailed mapping of geological structures, fault lines, and landslide-prone areas. Integration with other data types, such as multispectral and hyperspectral imagery, enhances the interpretation of surface and subsurface geological features.

(c) Improved Hyperspectral Sensors

Sensors like the Airborne Visible/Infrared Imaging Spectrometer (AVIRIS) and the Hyperspectral Imager Suite (HISUI) offer hundreds of contiguous spectral bands, allowing for precise identification of mineral compositions and subtle variations in rock types, including alteration features characteristic of many hydrothermal deposits. The recent notable example of hyperspectral imagery interpretation is Alteration Mapping for Porphyry Cu Targeting in the Western Chagai Belt, Pakistan, Using ZY1-02D Spaceborne Hyperspectral Data(Lei Leu et al, 2024)

(d) Unmanned Aerial Vehicles (UAVs)

UAVs equipped with high-resolution cameras, multispectral, hyperspectral, and LiDAR sensors offer flexible, cost-effective, and high-resolution data acquisition. This is particularly useful for detailed mapping of small or remote areas. UAVs facilitate rapid deployment and data collection in challenging terrains.

Automation and Robotics in Exploration

(a) Aerial Drones

Aerial drones have revolutionized exploration in various fields, providing significant advancements in efficiency, safety, and data accuracy. Drones are equipped with advances in battery technology and energy efficiency, which have extended the flight times of drones, allowing for longer missions and greater coverage. Modern drones are equipped with high-resolution cameras, LiDAR, multispectral, and hyperspectral sensors, providing detailed and accurate data to map the area for geological features.

(b) Robotic Rovers

Robotic rovers incorporate Multispectral and Hyperspectral Imaging technologies. These imaging technologies aid in identifying mineral compositions and alterations by capturing data across various wavelengths. Rovers can carry magnetometers, ground-penetrating radar (GPR), and other geophysical sensors to detect subsurface mineral deposits and geological structures. Some rovers are equipped with robotic arms capable of performing drilling and on-site sample collection for further analysis. They are primarily used in space exploration for the analysis of soil and rocks on the moon and Mars.

Data Analytics and Machine Learning

Data analytics and machine learning (ML) are transforming mineral exploration by enhancing the ability to analyze vast amounts of geological data, identify patterns, and make accurate predictions. Below are some key advancements and applications of data analytics and machine learning in mineral exploration:

Big Data Integration: Big Data integration combines data from various sources such as geophysical surveys, remote sensing, drilling logs, and geochemical assays to create a comprehensive dataset for analysis. Cloud platforms are utilized for storing, processing, and analyzing large datasets, facilitating real-time collaboration and data sharing.

Advanced Machine Learning Algorithms: Advanced Machine Learning Algorithms employ deep neural networks for pattern recognition and anomaly detection in complex geological datasets. They use supervised learning for predictive modeling and unsupervised learning for clustering and identifying hidden patterns in geological data.

Geospatial Analysis: Geospatial analysis incorporates Geographic Information Systems (GIS) for spatial data analysis, mapping, and visualization. Spatial ML techniques are applied to analyze and interpret spatially distributed geological data.

Applications of AI and ML in mineral exploration

Exploration Targeting: Machine Learning algorithms help create mineral prospectivity maps that highlight areas with high potential for mineral deposits and models to predict the likelihood of discovering new mineral deposits based on historical exploration data and geological factors.

Geophysical and Geochemical Analysis: Machine Learning aids in identifying geophysical and geochemical anomalies that may indicate the presence of mineral deposits by analyzing geochemical assays to detect patterns and correlations that can guide exploration efforts.

Drill Hole Data Analysis: With the help of Image recognition and ML automation, the analysis of drill core samples can be done, reducing the time and cost of manual logging. Historical drilling data is also analyzed to optimize the design and implementation of new drilling programs.

Remote Sensing and Satellite Imagery: ML techniques are applied to analyze hyperspectral and multispectral satellite imagery for mineral exploration. AI and ML-based predictive modeling platforms have been used in some gold exploration projects in Nevada for identifying new drilling targets and for prospectivity mapping in the copper mining regions of Chile.

The integration of data analytics and machine learning in mineral exploration is driving significant advancements in the field. These technologies enable more accurate targeting, efficient resource estimation, and real-time decision-making, ultimately leading to higher success rates and reduced exploration costs. As algorithms and computing power continue to improve, the impact of these technologies on mineral exploration is expected to grow, making them indispensable tools for modern exploration efforts.

Conclusion:

Recent advancements in mineral exploration techniques and associated technologies represent a paradigm shift in how we locate and extract valuable mineral resources. Through the integration of cutting-edge geophysical, geochemical, and remote sensing methods, coupled with the application of automation, robotics, data analytics, and machine learning, the industry has witnessed remarkable improvements in efficiency, accuracy, and sustainability.

Furthermore, the synergy between traditional exploration techniques and innovative technologies has paved the way for a more comprehensive understanding of geological formations and mineralization patterns. By leveraging these advancements, exploration companies are better equipped to meet the growing demand for mineral resources while adhering to sustainable and responsible practices.

As we continue to push the boundaries of technological innovation, the future of mineral exploration holds great promise. With ongoing improvements in sensor technology, data analytics, and automation, the industry is poised to further enhance resource discovery, optimize resource utilization, and contribute to the continued development of global economies.

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Advanced Geophysical Technology for Lowering Risk in Mineral Exploration

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Key Objective of **Mineral Exploration** is to **Discover, Delineate and Develop** Large Long-Life Resources in a Safe, Sustainable & Profitable Manner in the **Greenfields** or find extensions in **Brownfields.**

Key components of exploration:

- ✓ **Right Areas** > best ground
- ✓ **Right Ideas** > best interpretation
- ✓ **Right Technologies** > innovation and distinctive capabilities
- ✓ **Talented people** > Strong positive culture team
  - ❖ Maximise number of quality opportunities
  - ❖ Minimise risk
  - ❖ Minimise cost
  - ❖ Minimise time / project life cycles

Size of discoveries are declining with terrain maturity and costs are rising. Most of the shallow, easily accessible deposits close to existing infrastructure have already been found. Inability to detect mineral deposits beneath cover is considered as a major impediment to success. Exploration is a **high risk - high reward** business. Extensive, complex transported cover is a major hurdle. New deposits are likely to be found much deeper below the surface and in extreme or challenging environments which includes the capabilities of existing conventional exploration tools and methods are stretched to their limits. The value of mineral exploration opportunities needs to reflect their high risks and challenges.

Use innovative targeting with advanced geophysical technologies to lower the risk and tackle these challenges. Over the last decade, many new improved geophysical technologies emerged for deep earth imaging.

We are now able to process huge data sets (TBs) in minutes and days. High resolution (50 to 200 m line spacing) low flying airborne / drone surveys for electro-magnetic, magnetics and gravity mapping guide exploration targeting. Multi-array and multi-channel geophysical setups detect electrical conductors at 1000m depth and map fault structures and rock alteration to 2 kilometers depth.

Capacity of Electro-magnetic and Induced Polarisation Transmitters are increased from 3 KW to 80 KW which provides excellent Signal to Noise ratio and increased depth penetration. Sensors for electromagnetics increased the sensitivity and developed SQUID magnetometers for recording femto Tesla (Ten to the power of minus fifteen) working at room temperature. This measurement increases the depth of investigation by a factor of three. Induced polarization technology has drastically changed from conventional two potential electrodes to multi-electrode systems like seismic surveys and with the help of high-power transmitters, earth imaging became easy task. Magneto Telluric surveys are now popularizing with its deep penetration power and integrating with IP-Resistivity is providing clear subsurface mapping even in the presence of conductive overburden. Multi sensors (Magnetic gradiometry and Gravity gradiometry) is becoming very popular which provides excellent mapping tool for geology litho-structural information. Software revolution in geophysics with 2D / 3D inversion algorithms are providing new dimension to our thinking. 3D GIS packages are providing data integration and analytical power to generate high quality targets. Borehole tools for orientation and expanding search beyond drill hole up to 200 - 300 m radius is another development using borehole EM probes.

Advancements in Geophysical Prospecting:

Improved Instrumentation:	Improved Data Processing Techniques:
• Resolution Enhancement with higher sensitivity, design etc • Development of sensors for Increased Power for deeper penetration	• Huge data handling, data management & processing • 3D Modeling • Constrained & Joint Inversions
Improved Data Acquisition Techniques: • Quicker Data Acquisition using multi-channels, multi-sensors • Use of drones and other aerial survey. • Use of Borehole tools	**Improved Data Integration:** • Data Integration of multidisciplinary data, Visualisation • Interpretation using AI and data analytics • High quality targets Generation

New Geophysical Technologies which are cost effective solutions for lowering the risk at early-stage exploration and advance stage exploration for focused drilling.:

- GPS integrated Magnetic and Gravity Surveys (Ground, Air, Drone Based)
- Induced Polarisation - Resistivity Surveys (High Power TX, Multi-electrode)
- Electromagnetic Survey (SMARTem, InfiniTEM, SQUID and DHEM)
- Deep Earth Imaging Surveys - Integrated IP - MT (Titan - 24, DIAS-32 etc)
- Low flying Heliborne Surveys (FTG, Magnetic gradients and TEM)
- 3D Modeling - Inversion / co-inversions (Grav / Mag / EM / IP / MT)
- Multi-disciplinary Interpretation – Data Integration

The modern geophysical technologies with increased resolution and effective depth of probing will provide great support for new discoveries.

Selection of right technology at right place not only aid better predictability and but also reduces costs.

Multi-disciplinary prospecting, data integration and data interpretation with concepts is very important for future discoveries.

Development and deployment of Shallow angle Drilling (<45°) Technology at HZL: Advancing safe Surface Exploration for steeply dipping orebody with limited site accessibility

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Abstract

Exploration drilling in challenging geological features like narrow & steeply dipping lensoidal mineralization of base metal deposits, often requires innovative solutions. One such innovation is the shallow angle core drilling machine.

Traditional surface exploratory drill rigs are limited to drilling angles greater than 45 degrees; this advanced machine can drill at any angle between 0 and 90 degrees from the surface. This flexibility addresses several significant challenges in mineral exploration, especially in areas of drilling angle constraints, restricted surface site availability, making underground development for UG exploration etc.

This machine effectively addresses the limitations posed by conventional rigs to drill at any angle, even in restricted sites with fast-tracked resource upgradation by providing mining-ready ore bodies, accelerating the overall exploration process with safety & cost effectiveness.

This innovative approach can overcome the challenges and drive the efficient discovery and development of Mineral Resources.

Introduction

Exploration drilling of base metal Pb-Zn deposits, particularly those with challenging geological features, often requires innovative solutions. One such innovation is the shallow angle drilling machine, a customized core drilling machine designed specifically for the Zawar deposit, which is characterized by steeply dipping and narrow mineralization. Unlike traditional surface drill rigs that are limited to drilling angles greater than 45 degrees, this advanced machine can drill at any angle between 0 and 90 degrees from the surface. This flexibility addresses several significant challenges in mineral exploration, especially in areas with restricted surface site availability.

Design and Features

The shallow angle drilling machine is compact and equipped with sophisticated safety instruments to ensure a safe working environment. Its ability to drill at any angle offers a substantial advantage over conventional rigs, making it particularly effective for deposits with complex geometries.

The drilling hole plan to target shallow depth orebody/veins of 3-5 meters wide, have significant following challenges:

1. **Location Limitations:** Traditional drilling rigs often face difficulties in setting targets at precise locations, especially in confined or difficult-to-access areas.

2. **Drilling Angle Constraints:** Conventional rigs are unable to drill at angles less than 45 degrees, limiting their effectiveness in certain geological settings.

3. **Shape and Dip of Mineralization:** Steeply dipping and narrow veins pose a challenge for conventional drilling methods.

4. Depth of Mineralization: Accessing shallow mineral deposits without disturbing the surface excessively requires precise and adaptable drilling capabilities.

Overcoming Challenges

The customized shallow angle drilling rig was developed based on extensive experience and practical knowledge. By enabling drilling at any desired angle, this machine effectively addresses the limitations posed by conventional rigs. Its compact size allows it to be deployed in areas with limited space, and its advanced safety features ensure that operations can be conducted safely and efficiently.

Benefits of Implementation

The introduction of the shallow angle drilling machine has led to several key benefits for the exploration of Orebody at Zawar Mine:

1. Targeting Shallow Deposits: The ability to drill at any angle, even in restricted sites, allows for precise targeting of shallow mineral deposits.

2. Resource Upgradation: The machine facilitates fast-tracked resource upgradation by providing mining-ready ore bodies, accelerating the overall exploration process.

3. Discovery of New Lenses: The ability to drill at shallow angles without requiring extensive mine development enables the discovery of new mineral lenses, guiding future mine development strategies.

4. Cost Savings: The machine reduces overall drilling costs to drill from surface, instead of making mine development & exploratory drive to explore the shallow level potential area and making exploration more cost-effective.

Conclusion

The implementation of shallow angle drilling technology has significantly enhanced the productivity of exploration activities at Zawar Mines. It has enabled the discovery of shallow-depth lenses close to mine development areas, increased the rate of drilling, opened new areas for exploration, and optimized costs. Moreover, the advanced safety features of the machine have improved the safety of drilling operations. This innovative approach to mineral exploration demonstrates how customized solutions can overcome specific geological challenges and drive the efficient discovery and development of Mineral Resources.

Potential for Multi-mineral Exploration and sustainable mining in Sandur Schist Belt, Karnakataka

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Abstract :

Sandur schist belt is bestowed with rich mineral deposits of Iron and Manganese and mining activities have been going since many decades. However due to environmental constraints mining activities became challenging, affecting the economic activities and sustainable development. Sandur region receives high rainfall of 750 mm per year; hilly topography, covered with thick forest and environmentally sensitive area. Mine dumps are getting drained into the reservoirs causing siltation in the reservoir; water percolating through mines contaminating the ground water; floods carrying dumps into low lying areas and damaging the agricultural fields etc are the common experiences.

Overcoming all these, mining became a challenging issue. Sandur schist belt is rich with vast Fe and Mn ores; mafic and ultramafic rocks. Ultramific rocks are rich in Cr, Co, Ni, Au and Cu and promise for exploration for these deposits. Reported gold occurrences from the schist belt corroborates the scope for multimineral exploration which adds to the value of mined product, compensate the coast of mining and make it sustainable. Keeping these in mind we propose "Petro-Mineralogical study of South-eastern extension of North Eastern Block and Geo-chemical characteristics of ore with respect to the trace metals".

Implementation of innovative mining method at SKM

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Hindustan Zinc limited, India

Abstract

Underhand mining methods with Cemented paste Fill (CPF) are used to safely mine in difficult ground conditions and as a primary mining method where access below the ore is limited. This method is preferred ahead of overhand mining in the areas where structural complexity increases and multiple folding phases and faulting affects the orebody and stress increases with depth. In overhand mining risk increases due to accumulation of stresses, Crown & Hanging wall damage is severe in overhand mining method. The extent of damage confirms the need to transition to underhand mining, as at this level of HW strain, the conditions in the work areas of an overhand mining front would be unmanageable. At Sindesar khurd mine of Hindustan zinc limited, at 900m depth successfully implemented Underhand mining method below CPF. Modelling results suggested that underhand mining would be significantly advantageous in terms of recovery and reliability, in deeper levels, underhand mining is suitable method to increase stability and enhance the recovery. The most important aspect of underhand stopping method is the maintenance of a consistent fill quality; this includes percentage of solids, cement content, and placement. The proper combination of these factors is required so that the cemented tailings will develop enough strength to protect the miners working under it. Modelling results indicate that the extraction of the orebody directly below paste-filled stopes does not cause any significant yielding in the overlying paste-fill material. In fact, the paste artificial roof shows better stability as compared to the rock mass, hence scientifically suggesting the stability of underhand mining in these conditions.

INTRODUCTION

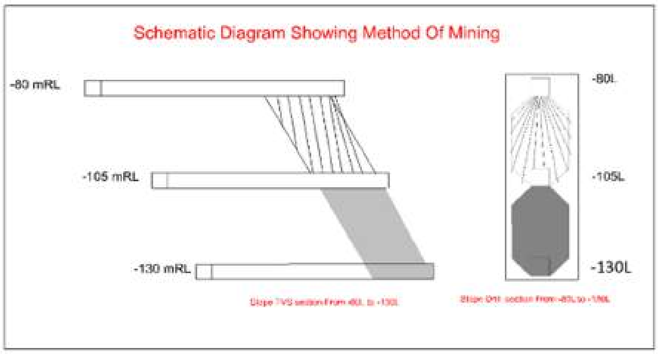
Underhand mining methods with Cemented paste Fill (CPF) used in areas where ground condition is hazardous and where there is limited access to reach below the orebody to safely mine in these areas this method is used. Due to the evolvement of underhand mining method below CPF in hard-rock mining, it made hazardous ground conditions safer. Underhand mining uses cemented mill tailings for backfilling the mined-out stope, making the mining process in the following cuts safer because the miners are always working beneath a cemented-backfill that will not fall during a rock burst.

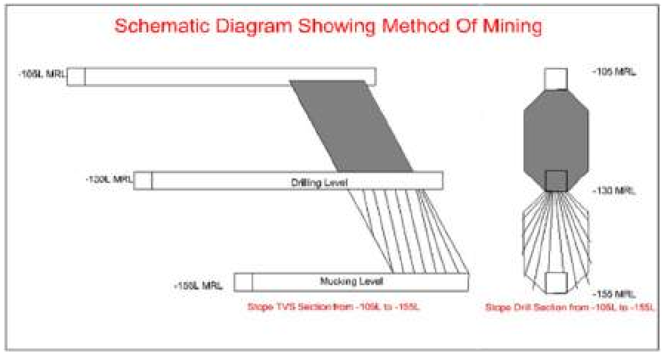
In this method at SKM first a designed cement tailing combination recipe of CPF poured at certain height to achieve the plug strength than bulk filling is done upon plug fill. Once the CPF achieved his desired strength development has been done in CPF with a systematic Support rule of 1st layer of fibre reinforced Shotcrete (FRS), wire mesh with split set followed by 2nd layer FRS. Once development done in CPF, mining has been done with designed hydraulic radius, and the CPF roof were having great stability thought the process.

Keywords – Underhand mining, CPF(Cemented paste Fill). SKM (Sindesar khurd mine).

SUMMARY

The most important aspect of this method is the maintenance of a consistent fill quality; this includes percentage of solids, cement content, and placement. The proper combination of these factors is required so that the cemented tailings will develop enough strength to protect the miners working under it. The underhand method effectively mitigates ground-fall injuries because

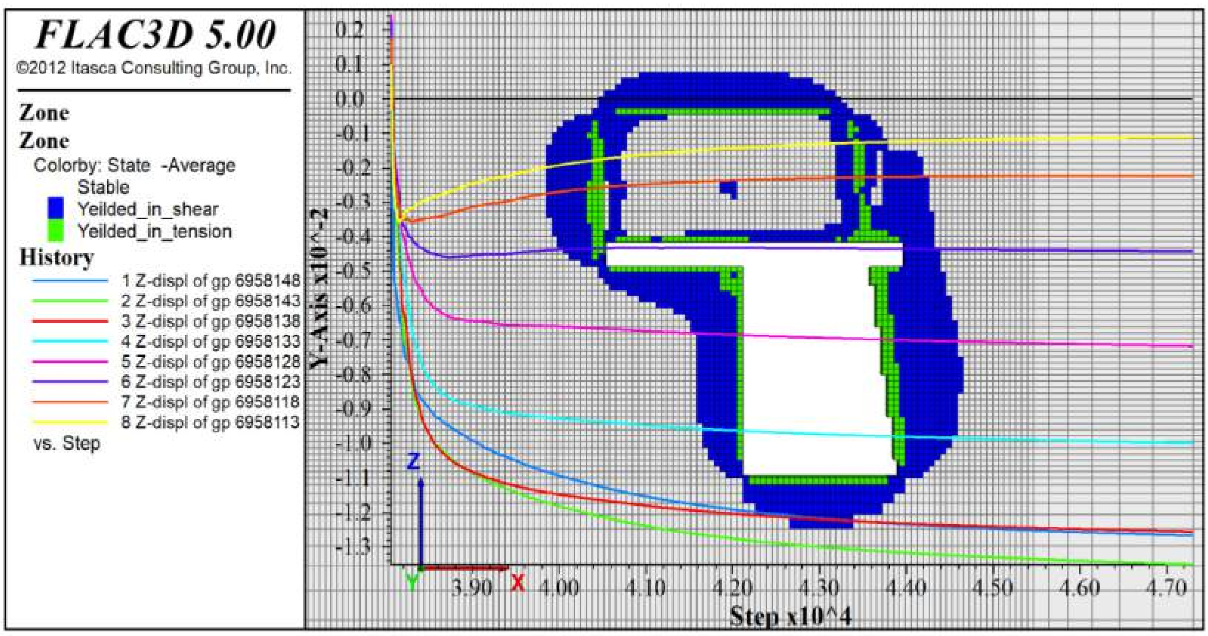




the backfill created is capable of withstanding the shock of a rock burst as well the paste behave like homogenous, elastic, discontinuity free mass . The safety implications related to backfill stability make it the most important aspect of underhand mining. Backfill pressure was monitored with earth pressure cell.

The SKM orebody is in the central part of the eastern limb of a major syn-formal fold. The area is structurally complex, and this complexity increases to the south with multiple folding phases and faulting affecting the orebody. The orebody widths are typically 30m but with significant variation occurring along strike and dip. In the southern section, the orebody plunges to the south and has a steep easterly dip. The orebody remains open at depth as we go deeper in Lower D block & E block at SKM We are likely to face more structural complexity with increasing folding and faulting, higher stress with increasing depth & high-anticipated changes in stress in overhand mining cause damage in the back & hanging wall.

The extent of damage confirms the need to transition to underhand mining, as at this level of HW and crown strain, the conditions in the work areas of an overhand mining front would be unmanageable. Modelling suggested that underhand mining would be significantly advantageous in terms of recovery and reliability. The mine could continue overhand mining, but the risk increases due to accumulation of stresses. There is presence of Shear in the orebody itself and hanging wall at SKM .The presence of shear govern the decision for underhand mining. In deeper levels, underhand mining is suitable method to increase stability and enhance the recovery. To continue safe operation in Lower D block & E block,

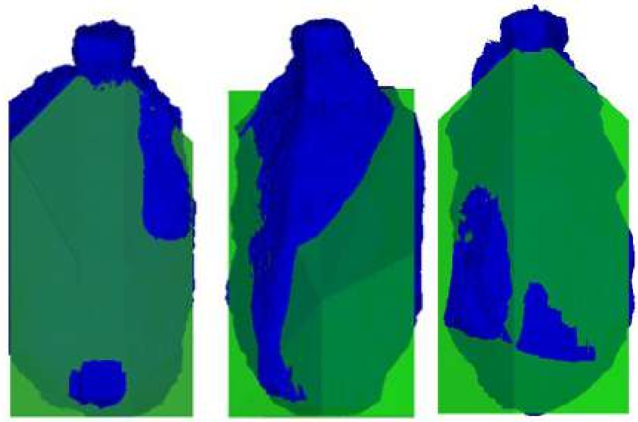


it is required to go for Underhand Mining as per the scientific studies.

The modelling results indicate that the extraction of the orebody directly below paste-filled stopes doesn't cause any significant yielding in the overlying paste-fill material. In fact, the paste artificial roof shows better stability as compared to the rock mass. Due to the lower elastic properties of the paste-fill, material the stress builds up within the paste-fill is much lower as compared to the rock mass. The stability of the paste-filled stope back is anticipated to be quite good, in fact better than the rock mass stope back for a paste plug fill having a UCS of 1.0 MPa. Hence, considering a safety factor of 1.5, the required UCS of plug fill for enabling underhand mining shall be 1.5 MPa

The following Observation seen during underhand mining

No deformations observed at the back and the sidewalls after blasting completion. Cavity Monitoring System (CMS) scans were done to understand the exact void created after blasting and to calculate the volume of the generated void. CMS scan was analysed to ensure no broken muck left in the void before starting of paste filling. No major over breaks were found between actual shape and planned Mine boundary. The CMS scans along with the planned mine boundary are shown in the figure below



CMS scans of the stopes along with the planned mine boundary

CONCLUSION

Several mines around the world have adopted LHOS underhand mining with CPF as their preferred stopping method to cope with poor ground conditions, allowing them to develop and work in an engineered material, removing sill and crown pillars and managing high stress and seismic conditions. Mines have opted for this method because of structural complexity affecting the ability to develop and rehabilitate the upper levels, improved recovery with the removal of pillars, Reduction in relaxation zone over the immediate working area, and improved sequencing where adverse seismic activity and adverse stress conditions occur

The use of cemented paste fills providing the flexibility to work under and beside the fill which is an engineered material that, Can be easily placed, Can provide tight fill, Can have its strength increased or decreased depending in its intended function.

Does shallow depth of working connote more stability?

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Abstract

There is common perception prevailing in the mining industry is that a shallow mine is more stable and therefore, does not require its slope management. However, on contrary, the history is replete with gross instabilities resulted in crippling the shallow pits. The major accidents in shallow granite Panna Mishri granite mine (Pali, Rajasthan) and Iron ore (Kirandul, NMDC, Chhatisgarh) in the recent past, bear testimony to the reality.

At shallow depth, adversely affecting factors like weathering, rain water, have profound effects. The degree of degradation in the physico-mechanical properties with weathering or depth are quantified during investigation of the geotechnical holes drilled at Rampura Agucha mine.. Likewise, the mine working at the shallow depth often faced more geotechnical challenges. As an extreme case, the general rockmass up to a depth of 250m has highly weathered and reduced to soil stage Sukinda chromite belt, Iron ore belt in Goa, etc. Under such extreme conditions, rockmass response to mining also grossly changes- weathered rockmass deform highly before physical failure. Even the mode of failure also gets altered from planar to circular failure method. The over all slope angle in such conditions drastically falls to 33-35° against 50° in virgin un-weathered rock stuff.

Nevertheless, prediction of slope behavior at shallow depth also becomes difficult. The only game changer for safe and sustainable mining is the smart slope management.

Introduction:

There are two very commonly prevailing paradoxical notions in the mining industry that (a) a shallow mine is a safe mine and slope stability cannot be a problem and (b) slope management is an expenditure, it hinders mine production. Under such circumstances, a majority of miners do not heed to slope behaviour. Even when the mine is experiencing tension cracks at the pit crest, these are highly ignored and taken as granted that their occurrence is very common and nothing happens. The author has seen some shallow depth mines totally collapsing in no time- without noticing the warning symptoms.

The surface and near surface topography in general are weathered- though the degree of weathering depends on the climatic conditions, rock fabric, etc. The depth of weathering varies region wise. In dry and arid zones, the effect of weathering may be around 30-50m (e.g. Rajasthan) while in rainy zones- it may extend as deep as 200m or even 500m (Orisa, Sukinda chromite belt). The weathering may be simply oxidation of geological joints – coatings, filled with clay or in-fillings. The intact rock strength also gets degrading- the strength may be reduced. The reduction in strength may be around 20% to some times reduction in to soil stage.

It is worth to share some of the worst experiences of slope failures at shallow depth. Experience elsewhere suggests that pits at shallow depth succumb very severely. One such open pit in Africa was operating at a depth of about 70-80m, one of its pit wall completely collapsed unexpectedly killing two and injuring more than a dozen. It took about 5-6 months to recover two dead bodies incurring about Rs 250 crores.

In this paper, the degree of weathering in semi-arid region to rainy regions are presented so as to provide an idea of the effect of weathering as case studies.

A well managed slope is not only conducive for production ramp but also could lead to higher depth of working. To quote a one of the best beneficiaries of smart slope management is the Rampura Agucha mine which was struggling at a depth of 100-150m, managing its slopes smartly not only enabled it to triple its mine production (making it the largest lead zinc producing mine) but also matured safely at a depth of 420m (making it the deepest open pit in India). Nevertheless, the paper would be restricting to the former- i.e. dealing with shallow depth working

2 Effects of shallow depth:

Shallow depth entails its innate drawbacks – turning a slope more vulnerable to instability than that situated at a depth. Shallow depth subjects rock mass to enhanced effect of weathering, dynamic action of rain water, etc. The main effects include:

The shallow depth from surface adversely affects the rock mass:

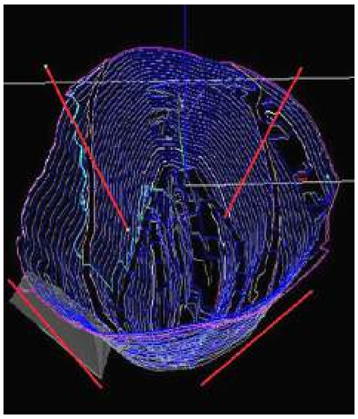
- Rock strength
- Rock characteristics
- Weathering of rocks
- Enhanced role of water
- Mode of failure- from stress induced to structurally controlled,
- Mode of failure- Planar / wedge to circular, etc.

2.1 Degradation of rock properties

In every mine, some of the upper most benches are situated in weathered rock mass and have different behaviour as compared to their lower benches. The extent of weathering to the rock mass is governed by intensity of rain, composition of rock, geological features, etc.

Generally strata near surface- may be 50-60m is more weathered. The weathering reduces their strength and turns them very weak, friable, powdery – very different from its mother rock. Chemically too, the weathering causes oxidation- specially iron rich minerals, Zinc rich mineral, clayey substances rich in Aluminum, etc. The oxidized material is just a fine mass. Weathering erodes properties of joint filling and make the material more prone for failure.

Just for example, amphibolite rock is very hard and strong, Uniaxial Compressive Strength is more than 120MPa. But when weathered, it can break by hand- soft and spongy. Hence original properties of Amphibolite are totally changed. Likewise, Pegmatite- which is also strong mineral, but when oxidizes, it gets kaolinzed into brittle and powdery substance which is very weak too. It is often termed as limonitic rock.

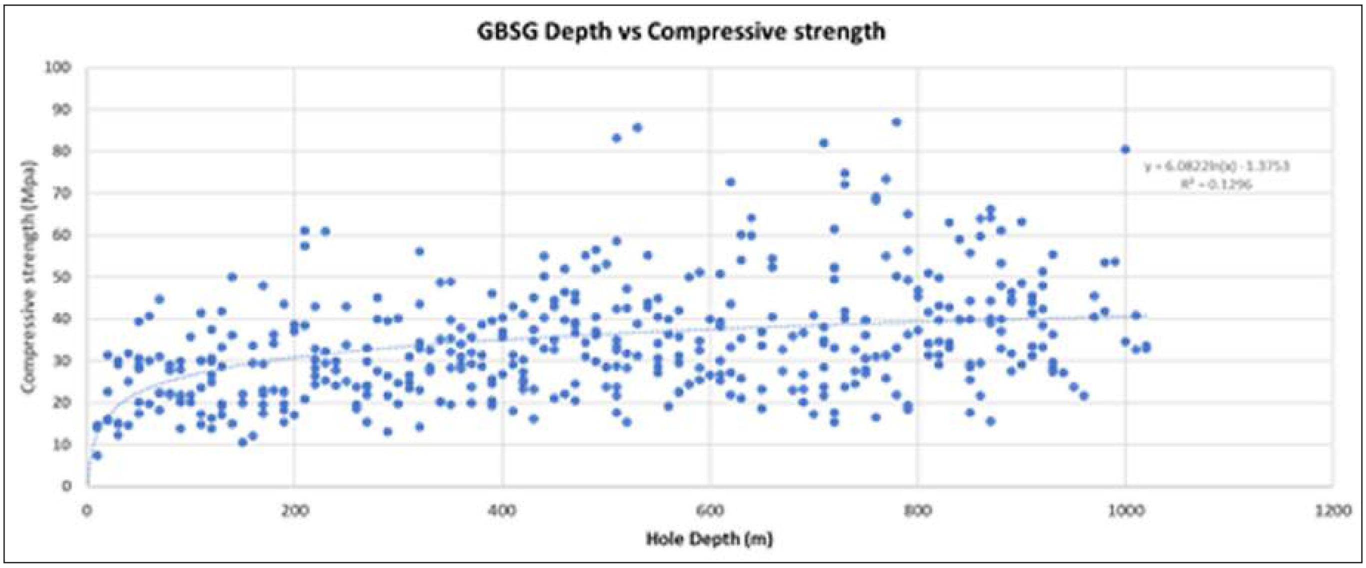


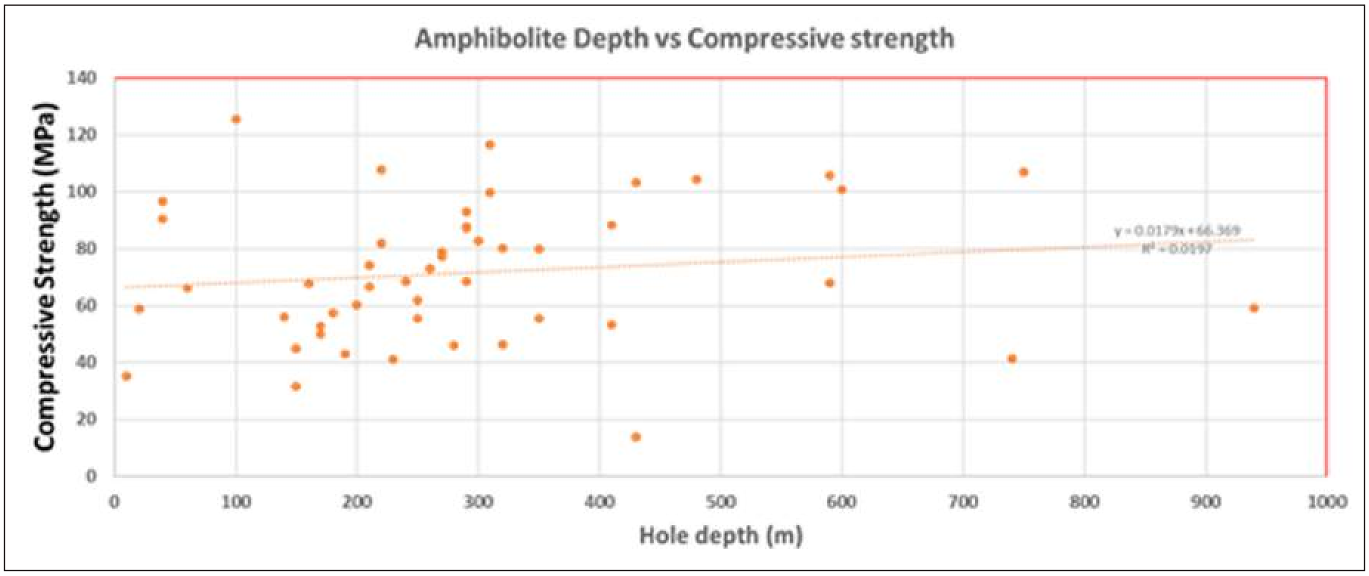
To substantiate the degrading effects of weathering on rock characteristic, results of Rampura Agucha mine where 4 geotechnical holes were drilled stitching whole mining area and as the name suggested, from the cores of diamond drilling holes, cores were tested for strength parameters (Fig.1) as a part of detailed mine planning (Rajmeny & Joshi, 2024).

From these data, it can be understood that shallower the depth, lower is the uniaxial compressive strength of the rocks. The region receives an average rainfall of about 700-800mm per annum.

2.2 Enhanced role of geological planes of weaknesses:

Failure of a slope takes place in two conditions, either it is stress induced or structurally induced. When the pit depth increases substantially, say beyond 300-500m, the stresses play their role and may induce failure of the slope. The role of the geological planes is secondary. While in the mines operated at shallow depth, the geological planes of weaknesses play dominant role and often failure is dictated by them. Under such conditions, depending upon the spatial distribution of the geological plane



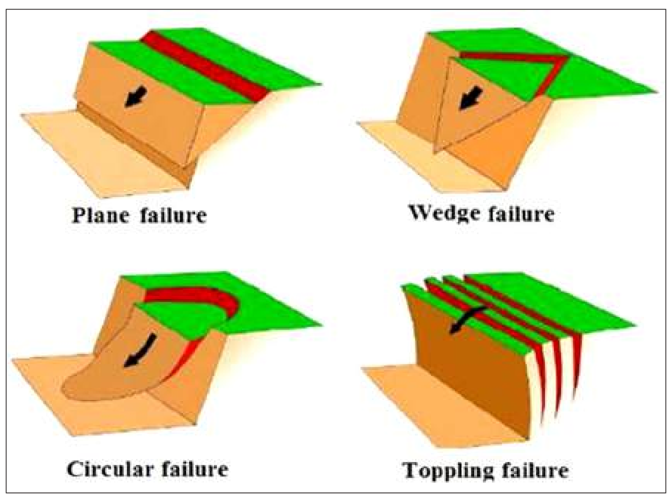


with respect to the slope geometry, the failure may be (Fig.2) :

- Planar
- Wedge
- Circular
- Toppling.

Very near to the surface, where is high degree of weathering, resulting into degeneration of the geological features or substantial reduction in the rock strength or the joint spacing is too fine as compared to the size of the opening, often circular failure do take place.

When the geological plane is dipping away from the slope, is within $\pm 20°$ of the slope strike and dips



2. DIFFERENT MODES OF ROCKMASS FAILURE at a angle more than angle of friction, it enables the planar failure.

Similarly, when the line of inter-section of two joint sets forming wedge dips into the slope, and have similar geometrical conditions as in planar failure, the slope qualifies for wedge failure.

When strength of the rockmass is very poor (like highly weathered rock or heavily jointed) rock mass or soil fail by circular failure mode.

In moderate to strong rocks, with upper mass highly weathered, more failures are anticipated like phyllite, Limestone, etc. In this case, it is mostly structurally controlled failure. It permits time to respond may be in days. While in poor rocks, the rocks turn into fines like Serpentinite, Limonite, Laterite, etc. The mass becomes very weak and fail by circular failure specially in rainy seasons. The failure develops very fast therefore, the warning time is too short may be hours- 30-36 hours.

At shallow depth, the failure behavior changes from Planar to circular.

2.3 Enhanced role of water:

Near surface, the rain water affects very adversely. Main components of rain fall include

- Surface run-off,
- Water flow through geological features, and
- Percolation through rock fabric

Unfortunately, all these components inter act with pit walls in full swing. The second component- water flow through geological features like joints, faults, shears result in wash out of the in-filling material. Water acts as lubricant for sliding.

2.4 A sneak in to weathered rock gamut:

Experience suggests that overall slope angle in un-weathered medium strength rocks like limestone can be as high as 50-55° for most of the mines operating at a depth of 100-150m. Let's take case of Sukinda valley, where the rainfall is 1700-1800mm per annum. Or, take case of Goan mining belt where the rainfall is 3000-4000mm per annum. The heavy rain causes intense weathering, if the rocks are conducive for it- highly porous.

One of the most stark case of degradation of physico-mechanical properties and gross change in rockmass behaviour is Sukinda Chromite valley. In general, the rocks are highly weathered to a depth of 250-300m. Limonite, Serpentinite, etc. have been weathered to soil stage. Even the basic rock structures like beddings, joints etc. have been preserved just for name sake, else the density has grossly reduced to 1.2 from its normal value of 2.7. Strength-wise, the host rocks of the mines in the area cannot be termed as rocks but soil bricks put together- unbaked. With a result that the overall pit slope has been reduced to 33-35° while it could have been as steep as 55° as in their un-weathered counter-parts.

Likewise, the with presence of foliation, joints, etc. in serpentinite, the mode of failure should have been planar or wedge, but with weathered rock stuff, these unbaked soil stacked fail by circular failure and with the degraded strength, often the rock stuff flows with rainwater.

Normal rock stuff- like limestone, gneiss, phyllite, etc. when undergoes failure, emit failure symptoms or failure marker like spalling of the benches, development of extension cracks, dislocation of already existing discontinuities, development of tension cracks at the pit crest and emitting of micro-seismic signals. But contrary to it, the weathered rocks deform to a large extent before the physical failure do appear on the slope face. Generally, all the failure markers listed above are almost absent except development of tension cracks at the crest of the slope. Failure process get completed in shorter time with very emergence of failure symptoms – thus difficult to observe by the geotechnical engineer.

Another remarkable feature of behaviour of rockmass is that these rocks deform to a large extent before physical failure do appear on the slope face.

3 The way forward: The Smart Slope Management:

For carrying out safe and sustainable mining, the mine slopes should be managed smartly. On one hand, safety requires a slope to be as flat as possible while its economical extraction calls for steepening of the slopes. Under such conditions, slope management plays a vital role so that miners work under confidence.

Fundamentally, slope management consists of :

A. Proper slope design using scientific studies

B. Monitoring health of the mine slopes

C. Enhancing stability of the slope by minimizing the effects of adversely affecting factors

D. Prediction of failure and formulating Trigger Action Response Plan (TARP).

In most of cases, the scientific institutes carry out part A and B but shrieks off their shoulders from remaining two components.

It is pertinent to mention here that slope management is the key to successfully and safely achieving the business targets. One of the best beneficiaries of smart slope management is Rampura Agucha mine (Rajmeny & Joshi, 2024) where the systematically managing the slope has not only enabled to ramp up the mine production three times but increasing the working depth to 420m from a mere 100m depth when the pit was struggling for its survival.

One thing, which is very critical in the slope management is visual observations of the slope which is very crucial. It is used to authenticate the degree of reliability of radar monitoring, etc.

3.1 Slope Monitoring:

However, with advancement of technologies, increasing number of slopes are monitored by real time monitoring system like Radars, etc. (Fig.3). The real time wide area monitoring provides every details of the failure or slope performance trajectory and are very useful if analyzed properly.



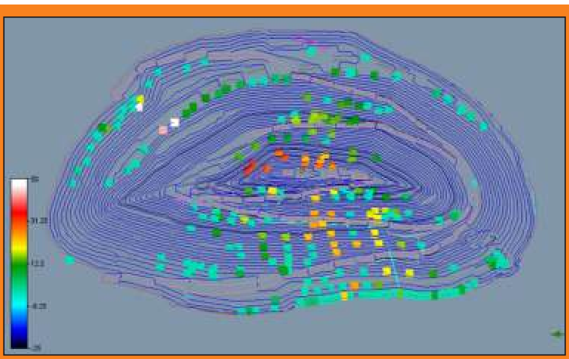


FIG 1. 2. 3. INSTRUMENTATION SCHEME AT A MECHANIZED OPEN PIT (RAJMENY & JOSHI, 2024)

3.2 Managing or Enhancing stability: Respect the geometry of the slope

Maintain proper height, do not merge the benches making the slope steeper. It is very common practice in open pit mining that the bench heights are increased more than its design value i.e against design value of 7m, the bench height would be 8 to 10m. As if it is not sufficient, the most damaging feature is trimming of bench width from its respective design value. It is very common occurrence where the benches are cut in mineralized zone like limestone, Iron ore, etc.

The narrow width with higher height of benches results in steepness of the slope from its over all slope value and constitutes thus one of the major factor resulting in instability.

For maintaining proper geometry, it is very effective to carry out a post blast joint visit of planning engineer, blasting engineer and geotechnical engineer and post blast damage-measurement the back break and plotting on the pit plan.

3.3 Minimize the blast induced damage

One of the main factor adversely affecting stability of a slope is ill planned blasts. The blast should be planned respecting geology of the area- rock type, geological features, etc. Likewise, blast design should incorporate proper inter hole, inter row delays. In general increasing the number of rows in blasting results in considerable back break (Fig.4) which ultimately reduces the bench width.

4. Trend of blast induced back-break

Similarly, when blasting near major geological faults, shears, proper care must be taken.

To minimize the effect of blasting, controlled technologies like pre-split, etc can be tried or even non-blasting methods like use of rock breakers, surface miner or silent explosive can be used.

3.4 Support the geological planes

Stability of slope at shallow depth is governed by the geological planes of weaknesses. Unfortunately, their role is mostly under-rated.

In supporting, depending upon the site specific conditions, rock bolting, cable bolting, grouting, shot-creting, etc., can stabilize a slope.

The recent instabilities occurred at Panna Mishri granite mine (Pali), Kirandul Iron ore mines is a potent testimony of role of geological planes.

At Kirandul, the slope is very shallow, but two orthogonal steeply dipping joints formed a wedge and its basal plane is also dipping towards the pit. All these joints are very smooth, persisting, planar. On top of it,

3.5 Depressurize the pit walls:

At shallow depth, effect of rain water is also much pronounced. Water washes away the joint filling, facilitates sliding. Under such condition, the slope should be depressurized by vertical borewells, horizontal drain holes, or any suitable arrangement such that water should not build up pressure behind the pit walls.

As is known, water affects a slope very adversely. Presence of water raises the pore water pressure which in turn depletes the effective force to bind joints. Secondly, water mechanically lubricates a plane of weakness, washes out the in-filling thereby facilitates the failure.

Just to understand the role of water, the latest Panna Mishri Granite accident bears a clear cut case. Water was chronically trickling in the failure zone. It has weathered the phyllitic rocks and joints, resulting in failure.

4 Some recent case studies of shallow pits:

Panna Mishri Granite mine Pali (Rajasthan)

On 21st Feb 2024, a pit wall collapsed at Panna Mishri Granite mine, Pali Rajasthan (Fig.5) involved 3 persons. Naturally, granite is very strong rock-strength more than 120-150MPa. But in this mine, it had astonishingly following remarkable features:

- The mine has a very shallow depth of 40-50m only (6-8 benches each of 7-8m)
- However, there is blatant violation of stable bench parameters- some benches are almost merged, some are even undercut
- Devoid of bench widths, there is no places to hold the roll down from upper part of the slope
- The place where the collapse took place, it was undercut and enabled collapse of the blocks formed by joints dipping in the slope.
- The profusely seeping water for long time reduced the strength of rock mass,

5. Fatal accident in Granite mine of Pali

Kirandul Iron ore mine, NMDC, Chhatishgarh:

The iron ore mine, at its screening plant, just at surface, while excavating by backhoe excavator, a big chunk of rockmass- traversed with prominent joints gave way killing four persons on the spot on 27th Feb 2024 (Fig.6).

A close look at the media, the area was traversed with two orthogonal joints set making a wedge and the third joint set- its basal plane. All these joints are prominent, very smooth, planar and persistent. It resulted in formation of a wedge with unstable basal plane.

5 CONCLUSIONS

The mines situated at shallow depth, are inherently more susceptible to instability because of degradation of their basic material strength, geological joint properties, etc. The enhanced effects of rain water plays a vital role in washing out the joint filling material, weathering of their surfaces. These changes often alter the mode of failure from planar to circular.

With shallow depth working, more emphasis should be paid to the doctrine of prevention is better than cure. Failure along geological features at shallow depth needs special care. Management is under illusion that shallow mines are stable.

All such slopes should be religiously monitored. Merely compliance of statute can not solve this problem, each mine has to follow the self regulation. It is time to look beyond statute. The observations could be summarised as:

6. Recent instability at Kirandul Iron ore mine
The undercutting of the wedge might have led to the sudden and catastrophic failure

- Higher degree of weathering- reduces the strength significantly
- Role of geological features become dominant
- Water worsens the stability equation.
- Therefore, at shallow depth:
- More attention should be given in maintaining the designed geometry
- Enhanced depressurization
- Assiduously monitor the slopes –
- However, results may not be encouraging with deformation monitoring unless the geological structure is instrumented.
- Generally at shallow depth, dilation of joints/ geological features is instantaneous and difficult to capture well before the failure.
- Visual observations are of much use but by an experienced geotechnical engineer.

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The author is very grateful for getting invitation from Mr. Madhusudan, Ex-President- MEAI for encouraging to share our experiences, specially of shallow mines.

Techniques to Improve Visibility in Dense Fog Condition at Khondbond Iron Mine, Tata Steel – An Approach

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Abstract

In automotive and aviation industry, inclement weather conditions - such as fog, rain, snow, and haze - pose significant safety challenges for drivers and pilots. Fog decreases contrast and fades colors, which limits human vision. In surface mining operations where capital intensive heavy equipment (dumpers, shovels, drills, and loaders) operates round the clock, reduced visibility poses potential safety risks, particularly for dumpers that actively ply on mine haulroad. Khondbond Iron Mine experiences dense fog conditions during rainy and winter seasons, which reduces visibility to less than 10 m. Considering safety concerns and statutory norms, dumper operations are halted, leading to operational detentions impacting production. While aviation and automotive sectors have developed customized innovative solutions to deal with dense fog, focussing on either visibility enhancement or accident prevention or both, the mining industry remains in search of a comparable breakthrough. Enhancing visibility in dense fog requires a holistic approach, combining intelligent systems and sensors, including fog removal algorithms and advanced sensor-based technologies such as digital cameras, infrared cameras, and radars etc., customized to mining. In a typical study, traditional and machine learning- based dehazing algorithms were evaluated on a foggy image. Furthermore, an intelligent Longwave Infrared based camera technology was tested in the field to understand the system's effectiveness. The study provided significant insights for designing the Fog Vision System (FVS), which aims to improve mine haulroad visibility for dumper operators in dense fog conditions.

Keywords:

Dense fog, visibility, dehazing algorithms, image enhancement, dark channel prior (DCP), contrast limited adaptive histogram equalization (CLAHE), camera, longwave infrared (LWIR).

1. Introduction

Inclement weather conditions such as fog are one of the major reasons of vehicle accidents around the world. Presence of fog in the atmosphere limits the visibility range and affects the performance of the driver thereby leading to accidents [1]. Fog is a dense cloud of tiny water droplets suspended in the atmosphere near or at the earth's surface that obscures or limits visibility.

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When the temperature drops and water vapor in the air condenses, fog is created. Fog is produced when molecules of water vapor combine to form microscopic liquid water droplets suspended in the atmosphere. As per world meteorological organization, a lower visibility range < 1 km is the primary criteria when defining fog (WMO). The fundamental difference in the fog with haze, rain and cloud lies in the size of the water droplets and its concentration in the air. Fog has water droplets suspended in air with radius of the particle 1-10 μm and concentration of about 100 – 10 cm-3 whereas for cloud the concentration increases to about 300 -10 cm-3. In contrast haze contains aerosol type particles unlike fog with radius of about 10-2 – 1 μm and concentration of about 103 – 10 cm-3.

In presence of fog, the light emitted from the source interacts with the water droplets of fog in a way that it attenuates as per Bouguer–Lambert law which affects visibility and lighting conditions. Light undergoes scattering, absorption, and diffusion resulting in a significant reduction in the overall illumination level in the presence of fog making it difficult for human vision as well as sensors, to an extent, to function effectively [2].

Opencast mining operations are vulnerable to adverse weather conditions like fog and rain, which can disrupt regular activities and increase accident risks involving heavy earth-moving machinery (HEMM), particularly dump trucks. Mine haul roads are usually prone to damages in rainy season and with reduced visibility due to fog, operating HEMM becomes most challenging [3]. Mining companies must prioritize safety measures and implement protocols to mitigate these risks, as mandated by regulatory bodies such as Directorate General of Mines Safety (DGMS). Mine safety regulatory body, DGMS, in its circulars mandated safety systems for preventing/ mitigating accident risks in mining including front & rear vision camera, proximity warning devices, blind spot visibility, driver fatigue monitoring, safety device to protect driver in the

2. Literature Review

2.1 Improving the lighting systems.

Fog lights are one of the most common lighting arrangements used in a vehicle to enable the driver to navigate through dark, rain and fog conditions. Fog lights operate at higher wavelength than headlights thereby giving yellow colour [6]. Bolin Xu et. el. conducted an experiment in a simulated fog chamber to compare the effectiveness of low-position road lighting and automotive lighting. The key findings showed that low-position road lighting outperformed automotive lighting in enabling target identification, particularly in fog, increasing the visual distance from 1.5 m to 3.0 m. However, the system's lacked detection of farther targets [7].

2.2 Image dehazing methods to enhance visibility.

Image enhancement is a technique for improving an image from its original state. Image enhancement methods include as smoothing, noise reduction, edge detection, and others [8]. The images taken in fog will have reduced information due to degradation by fog/ haze which lose the contrast and colors. In context of fog, image enhancement techniques include fog/haze removal from the degraded image. Techniques like Single image dehazing using Dark channel prior (DCP), Multi-image dehazing, Contrast limited adaptive histogram equalization (CLAHE), Retinex based models, Deep learning CNN based models are used for enhancement of images taken under foggy weather (Fig. 1) [9 - 11]. Nanjun Ma et. el. developed a fast haze removal algorithm for video processing based on dark channel prior model. Further optimization of the algorithm produced realtime output with less lag [12].

Fig. 1: Original image and defogged image obtained using image dehazing methods

2.3 Thermal imaging solutions to see through fog.

Infrared (IR) is a part of electromagnetic spectrum having wavelength ranging from 0.74 μm to 14 μm (Fig. 2). All objects above absolute zero (T > 0 K) radiate heat and the amount of heat radiated is determined by the temperature and surface condition of the object. Since heat transfer by radiation occurs at the speed of light images of the objects can be formed. One can record thermal images captured by the IR camera on video, view the camera display. The difference is that, unlike digital camera, IR camera senses and displays a spatial distribution of thermal (heat) energy which allows IR camera to see in dark, haze, foggy, and unfavourable weather conditions.

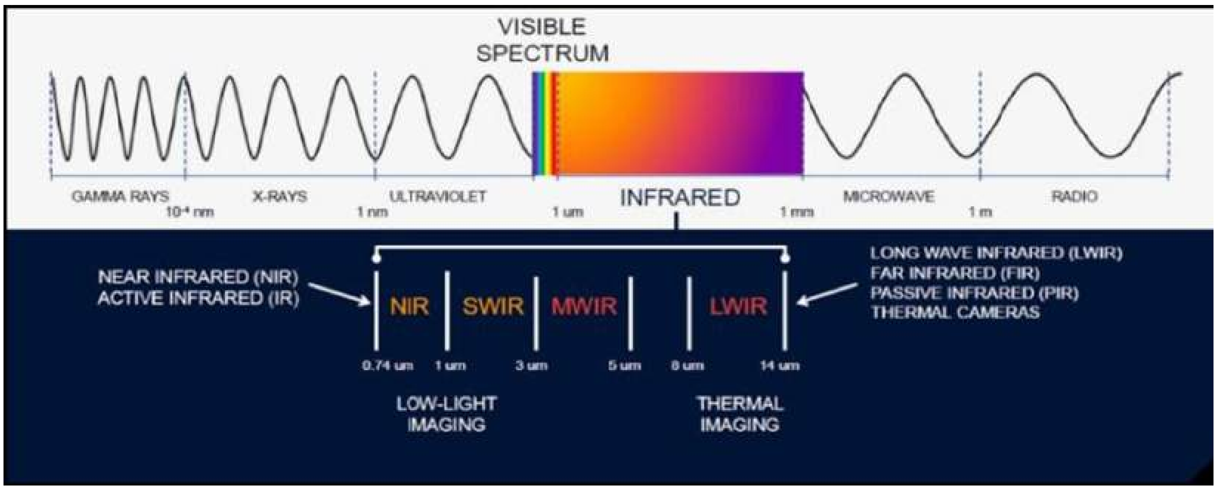


Fig. 2: IR imaging spectrum in EM wave and divisions (NIR, SWIR, MWIR, LWIR). (Source: Teledyne FLIR [13])

Nicolas et. al. [14] as a part of AWARE (All Weather All Roads Enhanced) vision project tested a different camera including RGB, Near infrared (NIR), Short-wave infrared (SWIR), and Long waver infrared (LWIR) to identify the technologies providing the best all-weather vision (Fig. 3). The study measured pedestrian detection at various fog densities and the results showed that LWIR camera performed better in terms of fog penetration, dark/low light penetration with protection against glare from the opposite vehicle.

Fig. 3: Comparison of Visible, NIR, SWIR, LWIR in tunnel with artificial fog chamber: test setup (right) and cameras view in fog (left)

2.4 Solutions adopted by Aviation, Defence and Automotive industries.

Weather is crucial in aviation. Landing operations are categorized based on visibility. Poor weather reduces visibility, making landing challenging. Runway beacons guide aircraft but are less recognizable in dense fog. Aviation uses RVR (Runway Visual Range), Instrument landing systems (ILA), Precise landing systems (PLS) to aid operations in low visibility [15]. Military applications rely on Infrared (IR) and Radar technologies for target object detection/security etc. While defence aviation uses high end IR and Radar technology for visibility, accident prevention, and target object detection.

In automotive systems, technologies such ADAS (Advanced Driver Assistant Systems), CAS (Collison Avoidance Systems) which relies on sensors and systems including RGB (Red Green Blue) Cameras, LIDAR (Light Detection and Ranging), Radar, Acoustic, GPS, object detection models, lane assistance, automatic emergency breaking, communication systems etc. are used focussing primarily on accident prevention [16,17]. While they can assist drivers through improved situational awareness. In most cases, automated systems take over the control of vehicle. However, in case of Indian mining, where vehicle autonomy is limited, technological interventions are required to enhance visibility in dense fog thereby improve safety of the operator.

Chaulya S. K. et al. [18] envisaged an intelligent driving assistance system to improve drivers' visibility in opencast mines during adverse weather conditions such as fog. The system integrates various devices such as proximity radar, infrared cameras, global navigation satellite systems (GNSS), wireless devices, anti-collision laser lights, and image processing algorithms for dehazing to help drivers navigate in dense foggy conditions.

2.5 Technology Selection based on Technology Readiness Level (TRL) Mapping

While some technologies are in final stages of pilot studies, there are solutions such as IR camera technology based which have been commercially deployed in automotive, defence and aviation industries. To identify best technology solution for field trial, a comparison of various solutions of the technologies have been made and analyzed. The technologies that are either commercially deployed or mapped as per the Technology Readiness Level are being considered (Fig. 4).

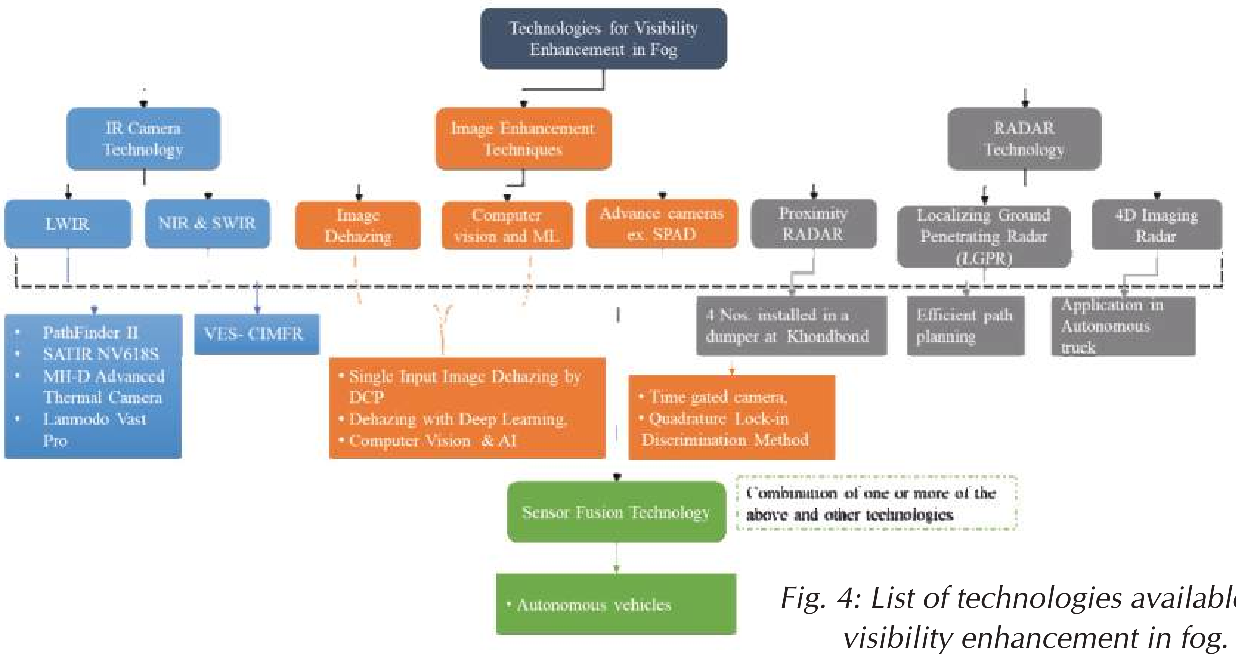


Fig. 4: List of technologies available for visibility enhancement in fog.

Scanning based on TRL highlighted technologies such as LWIR camera technology, Image dehazing and computer vision-based solutions, Proximity and 4D imaging Radar based solutions have a high TRL with commercially deployment in automotive and defence industry. Therefore, these technologies were selected for field trials to improve haulroad visibility in dense fog.

3. Challenges of Dense Fog at Khondbond Iron Mine and Initial attempts to Deal with it.

3.1 Overview of the mining operations at Khondbond Iron Mine

Khondbond Iron and Manganese (KIM) mine has a mine lease hold area of 978 ha. The project is located in Khondbond village of Bichakundi PO, Keonjhar district, Odisha, India. EC capacity of the mine is 8 MTPA ROM. The mine is worked by open cast mining method with benching by combination of shovel-dumper system. 5.9 m3 Shovels and 9m3 loaders are used as loading units. 10 Nos. of 100T Dumpers of make Komatsu HD785-7 are used for hauling of the loaded material. Bench height and width maintained as per 106-2B permission of KIM, 10 m and 20 m respectively while the haulroad width is maintained at 25 m. Operations are carried out on 3 shift basis. Cyclic unit operations are practiced in the mining and the ROM (Run off Mine) from face is processed in processing plant and the final product is dispatched to steel plants of Tata Steel (Fig. 5). The overburden and sub-grade material is stacked separately as per the plan. The current highest operating level is 710 m RL and the highest elevation level is 755.43 m RL

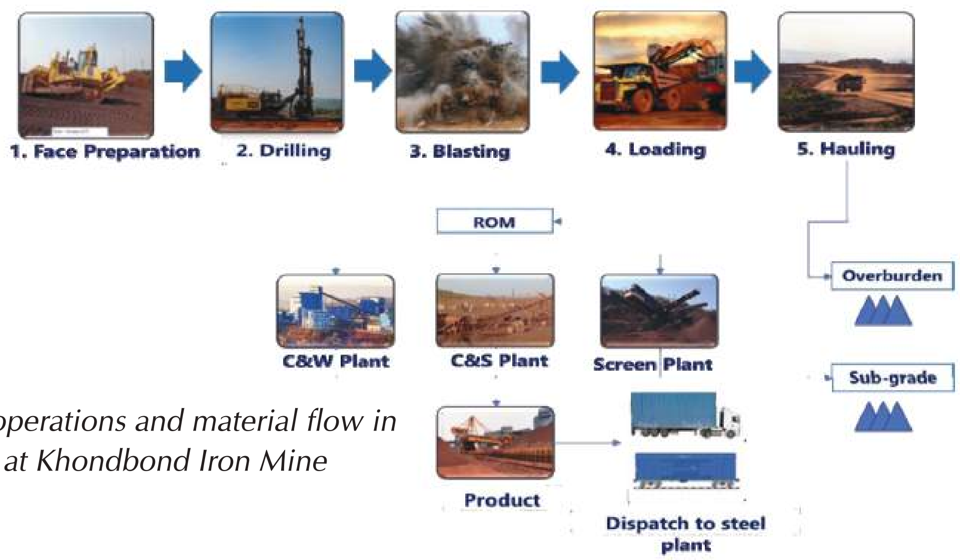


Fig. 5: Unit operations and material flow in mining at Khondbond Iron Mine

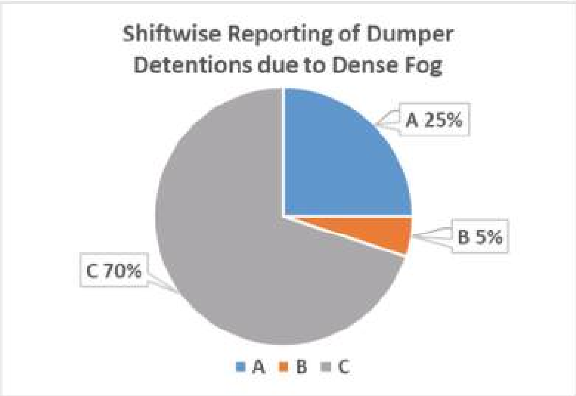
3.2 Visibility challenges due to dense fog and its impact on operations

Dumpers actively ply on mine haulroad carrying ore and waste material from mine face to the desired locations. Safe operation of these dump trucks is of paramount importance. During monsoon and winter seasons the mine faces operational challenges due to dense fog. Presence of dense fog reduces the mine haulroad visibility below 10 m in extreme conditions (Fig. 6). Due to reduced naked eye visibility range, the operators face challenge in navigating the truck. Compliance with statutory guidelines of DGMS, allowing truck operation only when visibility exceeds breaking distance (~ 30 m) further underscored the severity of the issue. Considering safety and statutory concerns, the dump truck operations are forced to stop causing operational detentions thereby impacting throughput.

Fig. 6: Reduced visibility due to dense fog at Khondbond Iron Mine

Field studies revealed that dense fog is observed mostly during monsoon and winter with the average dump truck detentions due to dense fog at ~60 hr/yr., mostly observed in night shift (~70%) (Fig. 7).

Although attempts including use of solar delineators, translucent poles and upgraded lighting arrangements aided the operators in normal and dark conditions, these were not highly effective incase dense fog.



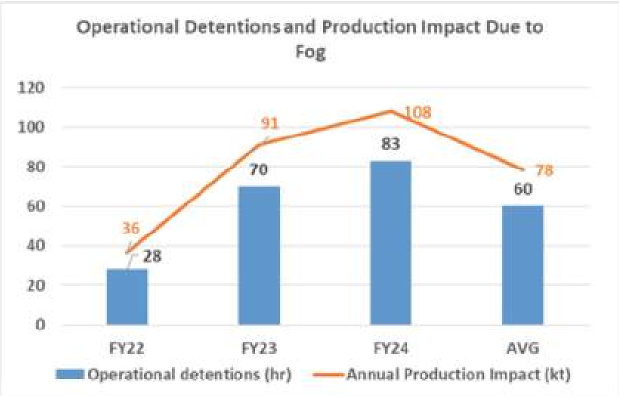


Fig. 7: Shift wise dense fog reporting (left); Operational detentions and production impact due to dense fog (right) at KIM.

4. Field Experiments for Enhancing Visibility in Dense Fog.

Field experiments were conducted to understand the effectiveness of Image dehazing models and Longwave Infrared (LWIR) imaging technology in dense fog condition.

4.1 Experiments using image dehazing methods.

In computer vision and computer graphics, the hazy image can be described by the following equation:

$$I(x) = J(x)t(x) + A(1 - t(x))$$

Where, I(x) – observed intensity of image, J(x) – Original clear image,

t(x) – Transmittance component A – Air light component

With dehazing, one is trying to recover the J(x) to maximum extent possible. Various methods of image dehazing were explained in literature review section. Single image dehazing using dark channel prior (DCP) and Contrast Limited Adaptive Histogram Equalization are some of the most popular methods and were used in present study.

In the first stage, foggy images were collected from site; image dehazing algorithms were developed using Dark Channel Prior (DCP) and Contrast Limited Adaptive Histogram Equalization (CLAHE) methods. Detailed explanation on the working of these algorithms is beyond the scope of this paper but can be referred at Kaiming He et. el [10] and Zuiderveld [19]. In present study, DCP and CLAHE were applied independently for a single image input and the effectiveness of the output results were observed.

DCP is a statistical method based on non-foggy images taken in clear view and uses single foggy image as input for dehazing. It is based on a key observation – "most local patches in haze-free outdoor images contain some pixel (dark pixels) which have very low intensities in at least one colour (rgb) channel". The algorithm follows a series of operations in image dehazing as described below.

- Estimate the Dark Channel: Calculate the minimum intensity value for each pixel in a local patch from the RGB channels. This produces the dark channel image.
- Estimate the Atmospheric Light: Identify the brightest pixels in the dark channel to estimate the atmospheric light.
- Estimate the Transmission Map: Use the dark channel and atmospheric light to estimate the transmission map, which indicates the portion of light that is not scattered.
- Refine the Transmission Map: Apply a soft matting algorithm or a guided filter to refine the transmission map, reducing noise and preserving edges.
- Recover the Scene Radiance: Use the refined transmission map to recover the de-hazed image by subtracting the atmospheric light and dividing by the transmission.

Foggy images collected from the mine and DCP algorithm was applied as shown in Fig. 8. The result of dehazed image shows better details than the original foggy image with haze tint removed from it. The DCP is applied to other images collected from the site. The algorithm is executed in about 0.28 seconds.

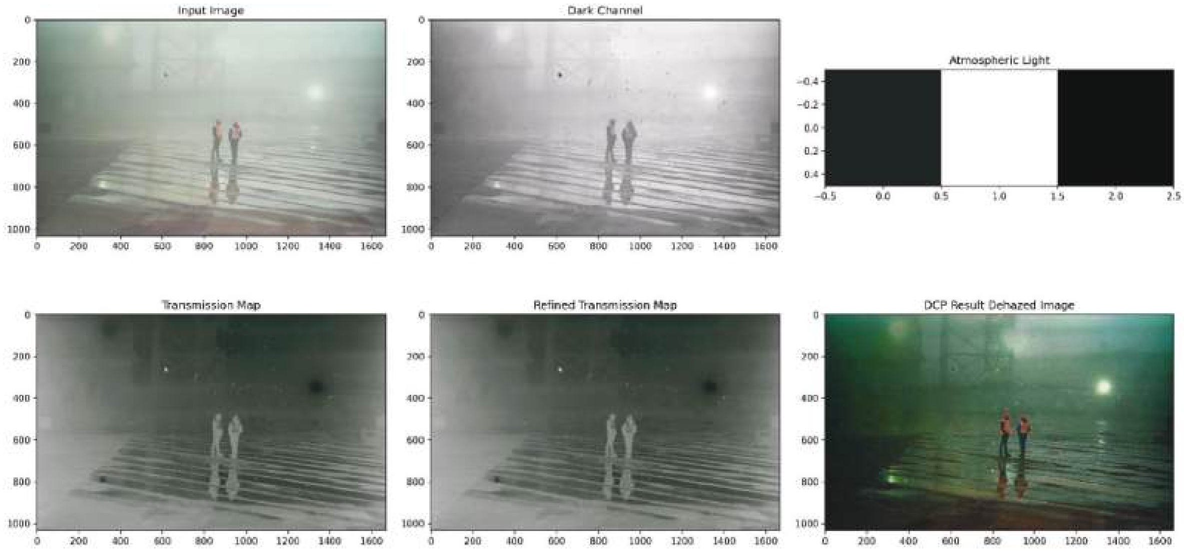


Fig. 8: Intermediary steps and final outputs in single image dehazing using dark channel prior model.

Contrast Limited Adaptive Histogram Equalization (CLAHE) is an improved version of Adaptive Histogram Equalization (AHE) image enhancement method, designed to address its noise amplification problem. It is effective for enhancing local contrast and visibility in images with poor lighting conditions, including foggy images. The algorithm strikes the balance between noise, contrast, and enhancement of image resulting in an enhanced image without introducing significant artifacts. The steps involved in CLAHE are as follows:

- **Dividing Image into Tiles:** The image is divided into non-overlapping rectangular tiles. Each tile is processed independently giving control of contrast locally.
- **Apply Histogram Equalization:** Histogram of pixels is computed for each tile. Histogram equalization is applied redistribute pixel intensities uniformly thereby enhancing contrast within each tile.
- **Contrast Limiting:** After this, contrast limiting is

performed to prevent over amplification of image noise. Contrast is adjusted to a threshold value.

- **Interpolation to avoid Artifacts:** After processing each tile, bilinear interpolation is performed to ensure smooth transition between tiles avoiding boundary artifacts.
- **Result:** The final resulting image with an improved local contrast visibility and retaining overall features with an enhanced clarity is given as output.

CLAHE algorithm performed on the same images where DCP dehazing is done. Fig. 9 outlines the performance of CLAHE algorithm with intermediary step image outputs. The final resulting enhanced image contains more details and clarity compared to original input image. Furthermore, the execution time for this image enhancement was observed to be about 0.024 seconds much lower than that of DCP.

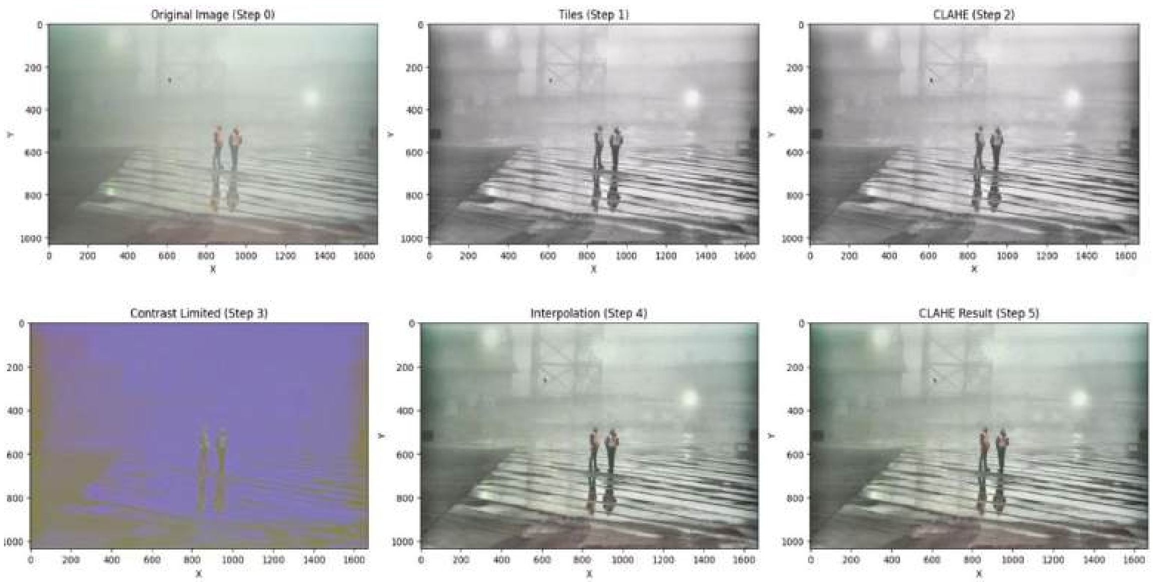


Fig. 9: Intermediary steps and final outputs in image enhancement using CLAHE model.

4.2 Experiments using LWIR infrared imaging technology.

In the second stage, a Longwave Infrared (LWIR) camera-based technology, Fog Vision System (FVS), was tested on site in dense fog. FVS is based on passive LWIR principle and utilizes the heat/thermal signatures radiated from the objects to create a visual representation of the surroundings. Automatic image optimization and human detection algorithms were integrated within FVS. The main components of FVS are LWIR camera, ECU, dashboard (Fig. 10). Table 1 details the technical specifications of the FVS.

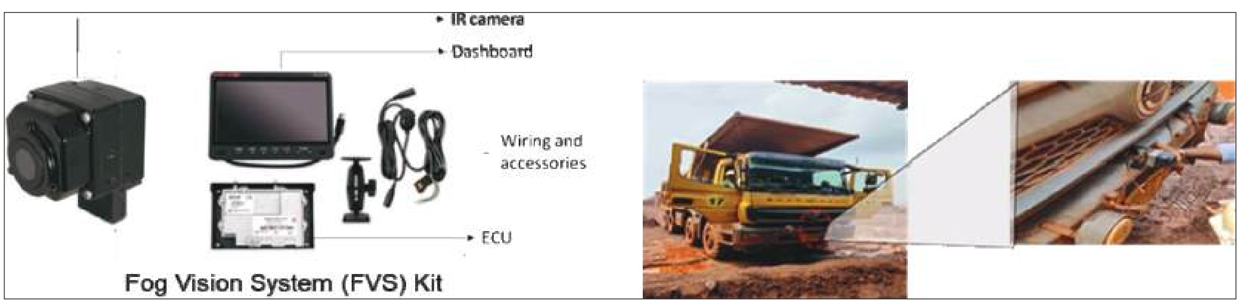


Fig. 10: Components of Fog Vision System (left) and its installation on Bharat Benz dump truck

Sl.No.	FVS Key Components	Characteristics
1	IR Sensor Resolution and Type	320 x 240, VOx Uncooled Microbolometer
2	Field-of-View	26° (h) x 18° (v)
3	Spectral Band	8-14 microns (LWIR)
4	Frequency/ Frame Rate	8 Hz
5	NETD (Noise Equivalent Temperature Difference)	40 mK
6	Outputs	NTSC (60 Hz)
7	Dust and Water Resistance (Camera)	IP69K, Automotive Qualified
8	Camera Dimensions & weight	60 × 86 × 82 mm , 300 g
9	Dashboard Make & Model	Brigade BE870 FM
10	Dashboard Dimensions	197 mm (W) x 30 mm (D) x 135mm (H)
11	Dashboard Resolution	800 x 3(RGB) x 480

Though intended for 100t dumpers, for test cases, the system was installed on a 30t Bharat Benz 3128 dump truck (Fig. 10). A detailed SOP was prepared for the operation of the FVS in foggy weather. The field trials in foggy weather were conducted in a controlled process taking all safety precautions. As the naked eye visibility is reduced in foggy weather, the speed of the testing truck and the target vehicle was kept under control.

The field trials were conducted in C shift (10:00 PM – 6:00 AM) at varying fog levels in both dark and daytime (Fig. 11). The main objectives of trial are to increase the visibility range beyond 40 m with human and vehicle detection, haul road & berm visibility. The trials focused on three aspects which includes finding:

- Detection range of human in varying fog levels
- Detection range of vehicle
- Visibility range of haul road & berm

Fig. 11: Trial of Fog Vision System in varying weather conditions: (a), (b) – Dark & Clear; (c), (d) – Dark & Dense fog; (e), (f) – Day & Dense fog; (g) – Measuring Camera's FOV on field.

5. Results and Discussions

5.1 Results of DCP and CLAHE

The image dehazing algorithms DCP and CLAHE evaluated for three different input images presented in Fig. 12 are compared. The output results from both algorithms shows that final enhanced image has better clarity and features that were not visible in the original scene.

Fig. 12: Comparison of the results of image dehazing through DCP and CLAHE algorithms.

Image outputs from DCP shows more details with contrast and saturation compared to CLAHE which is also evident from the higher entropy values for DCP in the Table 2 evaluation metrics. However, DCP is not computation effective with base level system i.e., the execution times of DCP is higher than that of CLAHE except for image 3 in which there are less features. While DCP excels in recovering scene radiance, it may suffer from computational complexity and artifacts. This can be observed in the image 1 where slightly tint of colours are formed as compared to original and CLAHE output. Similar observation can be made in image 2 which shows dark spots in light source.

Table 2: Execution time of the image dehazing through DCP and CLAHE.

Image ID	Execution time (s)		Entropy			PSNR		RMSE	
	DCP	CLAHE	Input	DCP	CLAHE	DCP	CLAHE	DCP	CLAHE
Image 1	0.28	0.024	6.48	6.77	6.69	11.7	23.89	66.34	16.29
Image 2	0.71	0.02	6.01	6.28	6.32	11.23	25.65	69.95	13.31
Image 3	0.03	0.004	6.30	6.82	6.30	12.07	32.5	63.56	6.05

CLAHE is trying to strike balance between enhancement of image and retaining of the features without introduction many artifacts. It can be observed that CLAHE outputs are smooth and does not show much noise. CLAHE algorithms is computational efficient producing results in less than 50 ms. Furthermore, the results are consistent with consistently better RMSE value than DCP.

Overall, the results are encouraging and could be studied further with focus on evaluation and integration of multiple dehazing models, increasing computational efficiency and application to real time videos.

5.2 Results of FVS, an LWIR camera technology

The results of FVS presented in Table 3 shows that the FVS outperformed normal visibility in human detection. In dense fog with visibility below 15 m, the FVS had a maximum detection range of 40 m. In daytime dense fog with visibility up to 20 m, the FVS range reached 60 m. Tests at varying fog levels consistently demonstrated the FVS had a greater detection range than normal visibility (Fig. 13).

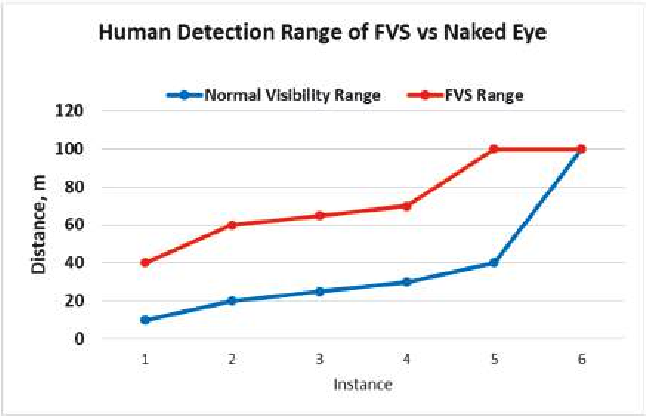


Fig. 13: Human detection range of Fog Vision System compared to Naked eye range

Sl. No.	Weather	Subject	Required visibility	Normal Visibility	Fog Vision System (FVS) Range	FVS Status	Remarks
1	Dark & Clear	Vehicle	40 m	>100 m	>100 m		
2	Dark & Clear	Human	40 m	>100 m	>100 m		Detection and highlight
3	Dark & Clear	Haulroad & berm	40 m	>100 m	>100 m		
4	Day & Dense Fog	Human	40 m	10 - 20 m	60 m		Detection and highlight
5	Day & Dense Fog	Vehicle	40 m	10 - 20 m	40 m		Partially detected
6	Day& Dense Fog	Haulroad & berm	40 m	10 - 20 m	-		Not visible
7	Dark & Dense Fog	Human	40 m	10 - 15 m	40 m		Detection and highlight
8	Dark & Dense Fog	Vehicle	40 m	10 - 15 m	40 m		Partially detected
9	Dark & Dense Fog	Haulroad & berm	40 m	15 m	-		complete blackout

For vehicle detection, the FVS had a range of up to 40 m when normal visibility was 10-20 m, but only captured the heated parts of the vehicle, not the full outline. However, the trials were ineffective in improving haulroad and berm visibility, which remained indistinguishable from the surroundings.

The main reason for the failure to enhance haulroad and berm visibility was the system's limitations in dense fog conditions. Specifically:

- Inadequate LWIR sensor: IR sensitivity plays an important role in overall effectiveness. The lower resolution (320x240), low frame rate (8Hz), and high noise-equivalent temperature difference (NETD, 40mK), used in FVS could have limiting its performance in dense fog.

- Temperature contrast: The LWIR camera relies on temperature differences, but dense fog reduced the contrast between the haulroad and surroundings, making it difficult to distinguish them, directly related to the high NETD.
- Unprecedented fog: The dense fog conditions exceeded the system's capabilities.

6. Conclusions

The study evaluated various technologies for enhancing visibility for drivers in dense fog with an objective to understand its applicability for dumpers in mining industry. Two prominent technologies were evaluated on site which includes (a) Image dehazing methods and (b) LWIR camera technology.

Image dehazing were performed using dark channel prior (DCP) and contrast limited adaptive histogram equalization (CLAHE) models. Both models performed equally well and goes with some challenges. While image enhancement was better in former the computational efficiency and noise reduction observed positive in the latter. Further research is required to evaluate multiple models and their combined effect of image dehazing.

The introduction of LWIR camera-based technology, Fog Vision System, in mining industry is relatively new and is a novel integration. The goal was to leverage knowledge and technologies to develop a robust mining specific solution to address the visibility enhancement in dense fog. Field trials showed FVS performed exceptionally well compared with respect to human and vehicle detection with visibility $\geq$ 40 m even in dense fog. However, it could not meet all the objectives. Despite limitations, Fog Vision System shows huge promise in improving the mine haulroad visibility under dense fog.

Future trials with customization are critical to ensure robustness in dense fog and address specific limitations, enhancing visibility. This can be achieved through improved IR camera sensitivity, particularly detector resolution and field of view. Furthermore, sensor fusion integration of RGB camera and Radar can enhance the overall system performance. Image dehazing methods could be used on the output video of LWIR and RGB camera to further enhance visibility and overall clarity.

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Advanced technologies usages to optimize Mining cost

LALITH AGARWAL
General Manager, M/s. Deepak Fertilizers and Petrochemicals Pvt. Ltd.

1. Site Profile

Pali Limestone Mine deposit is highly complex with steeply dipping ore which is intruded with Pegmatite & Amphibolite (High Silica and Alumina). Total Minable reserves are 194 million Ton with approx. 1:1 Stripping Ratio. Ore body is limited in multiple ridges. Its width is 200-250 meters and strike length of approx. 1-2.5 Km.

2. Objective

The main objective was to study the efficacy of ANFO explosive in production blasting of the Mine and resolve the issues in mining operation through KPIs: improvement in Powder factor, reduction in Drill and Blast cost, control in Ore dilution, and Improvement in on bench QA/QC.

The blasting in Limestone deposit, with Amphibolite and Pegmatite, resulted in ore dilution and reduction in load & haul productivity.

Downstream cost of the mine operation was impacted significantly because of boulders generated due to explosive energy escape at some places.

The mentioned KPIs were measured and analysed for the study.

Fig 1. Load and Haul Operation

3. Methodology

Powder Factor is defined by Blast tonnage generated by blasting per kg of explosive and measured in MT/Kg. The average volume calculated through design and surveyed by drone were used to calculate the Powder Factor.

Fragmentation plays a crucial role in affecting the downstream activities. The fragmentation analysis at the site was carried out using handheld instrument WipFrag and Drone enabled AI software.

WipFrag is an automated image-based software which operates on granulometry system. It uses digital image analysis of rock to determine the size with reference to measured scale. The analysed images and histogram curves of the blasted rock are depicted in Figure [2] provided below. D80(mm) was accepted as measurable item for comparison.

Drone enabled AI Software is 3-D modelling software which was used for Prediction and designing of the blast benches and analysis of the blast outcomes without any manual intervention. The software was used in Pre & Post blast stages to capture the real 3-D bench and simulations were performed to check the best design prior to bench blasting.

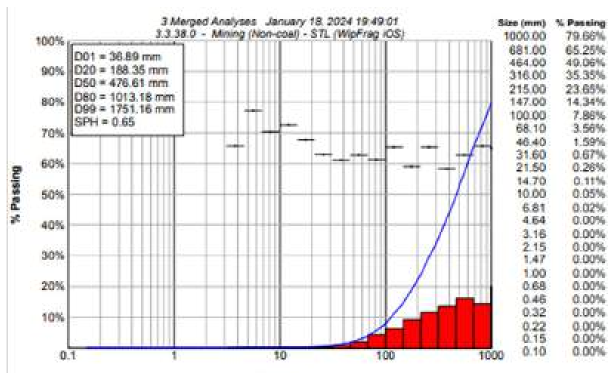

Fig 2. Fragmentation Analysis

Rock Breaker Hours were recorded for each blast and jointly signed off with UTCL team.

Excavator Productivity was calculated for each blast by recording excavator data. Productivity was calculated in T/Hr.

4. Observations

Productivity was impacted due to mixing of Amphibolite and Pegmatite in the muck pile. Amphibolite constitutes Alumina and Silica and is reactive in nature hence it is blended with limestone having LSF of 21.26, Pegmatite is nonreactive in nature and cannot be blended in ROM and Its LSF is 6.55.

The Deposit had fractures and preformed boulders at the top bench which was the key reason for explosive energy escape. Figure 3 shows an indicative image of blast bench.

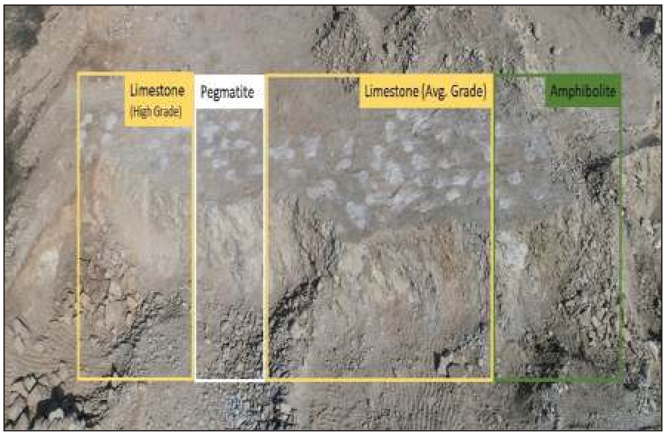

Fig 3. Indicative image of the bench

Deepak Mining Solution Limited (DMSL) identified the areas of improvement with own latest technical tools. With Prediction and analysis module, DMSL were able to predict the blast results including blast nuisance, muckpile characteristics and Fragmentation after understanding the rock strata.

The explosive energy in each hole needed to be monitored to overcome the issue of energy escape and ore dilution.

5. Conclusion

- Drill yield improvement was observed as 23%.
- Powder factor increased from 6.32 ton/kg to 7.82 ton/kg due to proper blast design while maintaining the muck-pile fragmentation.
- Reduction in boulder generation from 744mm to 655mm due to on bench Drill hole supervision & accurate drilling techniques.
- The Drill & Blast cost improved by 28%.
- Excavator Productivity improved from 344MT/hr to 401Mt/Hr. The Productivity Improvement comparison is shown in Figure 4.

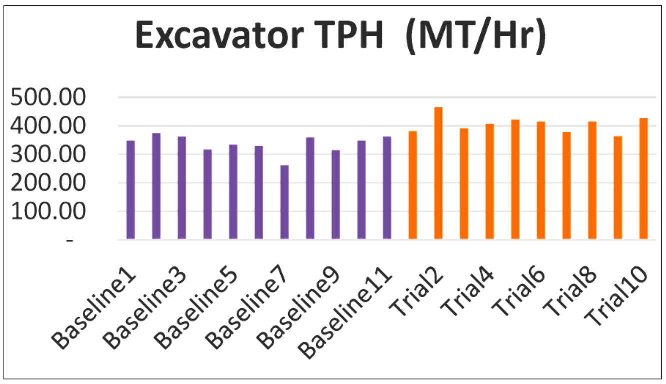

Fig 4. Excavator Productivity Comparison

6. Acknowledgement

Deepak Mining Solution Limited (DMSL) sincerely acknowledges and appreciates the support rendered by UTCL Pali Cement Works for this study. We thank Mr. Deepak Sharma (HoD – Mines), Mr. Muralidhar Pandey (Blasting Head), Mr. Vinod Mantri (Head – Operations) and the entire blasting team for all the valuable support provided during the study.

Highlights:

- Excavator Productivity Improvement by 17%.
- D&B Cost Improvement by 28%.
- Drill Yield Improvement by 23%

Safety aspects in Heavy Earth Moving Machinery (HEMM) to meet technology trends in Open Cast Mining applications

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Abstract :

With increasing dependence on opencast mines for all the production demands in the Coal and Metalliferous sector, there has been a steep rise in the population of HEMMs and heavy/light vehicles in mines, distributed between both departmental and contractual components. The recent statistics on alarming rise in cases of incidences/ accidents in opencast mines singularly point to the basic cause as intricately connected to such deployment in mines. Though, several statutory provisions have already been made under the Coal Mines Regulation 2017 and the Metalliferous Mines Regulations, 1961 and various statutory permissions issued thereunder apart from DGMS Circulars having been issued from time to time, the issue of their safe operations with particular reference to provisioning and satisfactory operation of various safety features, continues to be a major cause of concern to all.

Introduction

Safety features and devices to be provided in Heavy Earth Moving Machinery (HEMM) used in coal mines including trucks and tippers has already been notified by the Chief Inspector of Mines(CIM) vide gazette notification No.987(E) dated 1st October 2018. Design requirements of Ore Handling plant was also specified through number of technical circular time to time.

Inspections by the officers of the Directorate in the recent past have revealed highly unacceptable level of compliance in mines, with mere provisioning of such safety features gaining the upper hand rather than effective and sustained functionality. Even on provisioning, it has been observed that there are wide variations on design aspects, with availability of multiple but unverified types/models, mostly without adherence to any acceptable Indian/ International standards wherever available already. In nut shell, the very purpose of provisioning and effective functioning of such safety feature with HEMMs deployed in opencast mines appears to be largely defeated as could be appreciated by the alarming rising trends of connected incidences and accidents. Hence the Directorate recommended minimum design requirements of following safety features of the HEMM as guidelines in Technical Circular 06 of 2020.

1.0. Rear Vision Camera: A system that consists of a Monitor (component that provides visual image of Blind Area), Camera (component that transmits the images detected by it to the monitor) and other components capable of detecting objects including people within the Blind area unambiguously with an uninterrupted sequence or signal or information appropriate to detection Zone/Field of View (Blind Area).

Applicability: All Heavy Earth Moving Machinery

1.1. The Rear vision camera shall meet the following minimum requirements and standards:

1.1.1. The system shall boot automatically along with starting of Engine / Power source of Machine, shall perform an initial system check and shall give readiness indication. The system shall shutdown along with shutting down of Engine / Power source. The system shall have system readiness, standby and system malfunction indication to indicate its status.

1.1.2. The system shall remain in stand-by mode (operation mode whereby the system is active, but no information is transmitted by the camera Or monitor) and shall wake up automatically upon selection/engagement of appropriate control(s) (such as reverse gear, etc) by Machine Operator for negotiating blind Area (Killing Zone) to provide uninterrupted vision of Blind Area(s) to the operator. The-system shall return to Stand-by mode upon release the appropriate controls by the operator. The monitor shall be so positioned that it can easily be seen by the Operator sitting in his/her seat in either Day light or Darkness without strain. Appropriate shielding shall be used to reduce the effect of direct sunlight onto the Monitor.

1.1.3. The system shall be provided with auto mode tail light with adequate illumination for better visibility during darkness, The system shall be capable of operating in dark and shall automatically switch to infrared / any other suitable technique / mode when the brightness of field of view is too low or in case of failure of the tail light.

1.1.4. Components of the system shall in no way restrict any function or operation of the machine. The components shall be so designed and mounted to the machine in such a way to limit exposure to, or amplification of, dynamic loads, temperature, shock or vibration and dust that could prematurely damage the device and to deter unauthorized disablement or their removal. Components of system shall be adequately protected from external damage.

1.1.5. The system shall have field of vision in accordance with ISO 16001 (Earth-moving machinery-Object detection systems and visibility aids-Performance requirements and tests) (or equivalent Indian standard when formed), shall satisfy test requirements of ISO 16001 and shall have Ingress protection of IP 69K in accordance with IEC 60529 (Degrees of Protection Provided by Enclosures (IP Code)) and test Certificates to these effects shall be obtained from any Government / NABL Accredited institutions/Test Houses having adequate test facilities.

1.1.6. The System may be provided with provisions for recording the images captured with time stamp to enable easy retrieval and analysis of the immediate past 24 deployment operating hours.

2.0. Warning System for Operator Fatigue: A system capable of analyzing various symptoms associated with Operator fatigue to detect drowsiness of Operator from regular driving/ operating behavior and sound loud audio and visual warnings immediately upon detection of drowsiness to alert the Operator and others in the vicinity by incorporating one or more technique(s)' .

Applicability: All Heavy Earth Moving Machinery.

2.1. The Warning System for Operator Fatigue shall meet the following minimum requirements and standards:

2.2.1. The system shall boot automatically along with starting of Engine / Power source of Machine, shall perform an initial system check and shall give readiness indication. The system shall shutdown along with shutting down of Engine / Power source. The system shall be provided with system "ON", initialization, tracking and system malfunction indication to indicate its status.

2.2.2 The system shall detect state of drowsiness of Operator from regular driving behaviour and shall provide loud verbal warnings to him / her and simultaneously flash externally mounted warning light easily visible to others for alerting the Operator and others in the vicinity to pay attention. It shall also be capable of detecting the drowsiness even when spectacle is worn by the Operator.

2.2.3. The system shall have following four stages

a) **Initialization -** Every time the system is started, it needs to be set up and optimized for current user (Operator) and conditions. The initialization process shall be a quick one,

b) **Tracking -** continuous monitoring of the Operator within a dynamically specified tracking area in real-time,

c) **Drowsiness** Detection and

d) **Warning -** Once it has been determined that the driver/operator appears to be in an abnormal driving state, the system shall alert the driver of potential dangers that can arise. Combination of audio and visual alerts is used to attract the operator's attention and raise their alertness level. Alerting has to be implemented in such a way as not to cause the opposite effect of intended and startle the driver / operator into causing an accident.

2.2.4. Components of the system shall in no way obstruct Operator's line of sight hindering his / her visibility and restrict any function or operation of the machine. The components shall be so designed and mounted to the machine in such a way to limit exposure to, or amplification of, dynamic loads, temperature, shock or vibration and dust that could prematurely damage the device and to deter unauthorized disablement or their removal.

2.2.5 The System may be provided with provisions for recording the warning generated with time stamp to enable easy retrieval and analysis of the immediate past 96 deployment operating hours

2.2.6. For determining type, duration and sound level of audio warning and intensity of external Visual warning, DGMS Circulars, Indian and International standards issued in this regard may be referred to

3.0. Auto Dipping System:

Applicability: Dumpers /Tippers / Light and Heavy Vehicles plying in the Mine.

A System comprising sensor(s) and a Control Unit capable of automatically switching high beam lamp to low beam as soon as it senses a vehicle approaching from the opposite direction at a distance of about 150 meters and switches it back to high beam when the vehicles pass each other to avoid glare and blinding of Operator so as to relieve the operator from frequent switching between high and low beam of head light.

3.1. The Auto Dipping System shall meet the following minimum requirements and standards:

3.1.1. The system shall boot automatically along with switching "ON" of head light of the vehicle/ machine, shall perform an initial system check and shall give readiness indication. The system shall shutdown along with switching "OFF" of the head light. The system shall be provided with system "ON" and system malfunction indication to indicate its status.

3.1.2. System sensor shall be capable of detecting high beam light of incoming vehicle approaching from opposite direction at a distance of about 150 meters or at much closer proximity in case of vehicles approaching from branch roads and send signal to Control unit. Suitable filters shall be incorporated in the system to avoid nuisance/false reaction to Pole lights, spot lights and haul road general lightings. The sensor shall send appropriate signal immediately to control unit upon cessation of high beam light falling on it.

3.1.3. System control unit shall automatically activate Low beam or high beam upon receipt of appropriate signal from the sensor without the intervention of the Operator. 3.1.4. Components of the system shall in no way obstruct Operator's line of sight hindering his / her visibility. The system shall be equipped with Operator Override to comply with authorized override to meet eventualities.

3.1.4. Test Certificates to these effects shall be obtained from any Government / NABL Accredited institutions/ test Houses having adequate test facilities.

4.0. Mechanical Device to avoid Head to Tail Collision of Dumpers: A mechanical system / device(s) adequately designed to protect operator of Dumper in the event of Head to Tail collision even in mixed capacity dumpers operating environment. The device(s) / system shall be of standalone mechanical structure or combination of mechanical structures wherein maximum impact energy generated by collision is absorbed by the device / system or diverted away from the operator to protect the operator when the operator is adequately constrained in his / her seat by seat belt.

Applicability: Dumpers

4.1 The Mechanical Device to avoid Head to Tail Collision of Dumpers shall meet the following minimum requirements and standards:

The system / device(s) shall be of standalone Mechanical structure or combination of Mechanical structures, viz, combination of Operator cabin protective structure and protection arrangement at Tail end of the Dumper or bumper extension or any other suitable arrangements. Hydraulic system or any other suitable system may be included as add-on. As far as possible, in new Dumpers, the Device(s) / System shall be part of original design of the Dumpers to avoid retro fitting difficulties.

4.1.1 The system / device(s) shall protect the Dumper Operator during head to tail collision when the operator is constrained by operator seat belt even in mixed capacity dumper operating environment.

4.1.2 Components of the system / device(s) shall not affect visibility of Operator, stability of the Dumper and intended use for which the Dumper is designed.

4.1.3. The system / device(s) shall absorb most of impact energy generated by collision or divert most of the impact energy away from the Operator so as to ensure protection from direct hit or crushing of Operator.

4.1.4. Components of the system / device(s) shall not hinder with loading operation or foul with components of Loader / Shovel / Excavators.

5.0. Automatic Fire Detection and Suppression System (AFDSS) for HEMM: An automatic system to detect and suppress fire in hot zones of machine and is capable of sensing, activating and delivering the fire suppression agent(s) without human intervention in the event of fire with additional provision for manual actuation and appropriate indication and warning to Operator by incorporating one or more kinds of heat sensing system and suitable fire suppressant agents.

Applicability: All Heavy Earth Moving Machinery

5.1. The Automatic Fire Detection and Suppression System (AFDSS) shall meet the following minimum requirements and standards:

5.1.1. The system shall meet requirements of DGMS (Approval) Circular No. 2 dated 08.07.2013. In addition, it shall meet following additional requirements:

5.1.2. The system shall have system healthy and system malfunction indication to indicate its status. The system shall be provided with Manual actuation control(s) inside Operator cabin and the outside of operator cabin preferably away from hot zones. Components of the system shall in no way obstruct Operator's line of sight hindering his / her visibility.

5.1.3 The system shall cover all fire susceptible areas including engine, diesel tank, battery box, transmission, exhaust pipe and other hot zones having potential to cause fire.

5.1.4 The system shall be fully automatic, robust and shall not be damaged / made inoperative during routine maintenance activities. Components of system, in particular, sensing elements, shall be adequately protected from external damage. Nuisance heat sensing shall be avoided by the system.

5.1.5. The system, as far as practical, shall be designed in such a way to supply adequate quantity of fire suppressing agent to the zone where the fire is detected and to be suppressed on need basis for effective fire fighting and to avoid re-ignition of fire instead of blind discharge through all discharge nozzles.

6.0 Dump Body raised position indicator with warning:

A system or a device capable of sensing non-return of dump body to completely retracted & transportation mode, restricting transmission of

Dumpers / Tipper trucks, when engaged, up to first gear while the dump body is not completely lowered and simultaneously triggering an audible and/or visual warning till such time the dump body is completely lowered.

Applicability: Dumpers / Tipper trucks

6.1. The Dump Body raised position indicator with warning shall meet the following minimum requirements and standards:

6.1.1 The system shall trigger visual warning sooner Dump body is raised from its retracted cum transport mode. The warning shall remain "ON" till such the time the Dump body is not completely retracted/lowered. The system may have additional mechanical indicator to show that the dump body is not in fully retracted position. The visual warning shall be so located as to be readily visible and recognizable in the daylight and distinguishable from other alerts at night time by the operator when seated in operator seat. As far as possible, the warning indicator shall be integral part of Operator console / Display Panel.

6. l.2 The system shall sound Audio warning in addition to Visual Warning when Dumper / Truck is attempted to move from its stationary position with dump body not in completely retracted position. The system shall not allow engagement of transmission system beyond first gear when the dump body is in raised position.

6.1.3. Sensors of the system shall have Ingress Protection of IP 68 in accordance with IEC 60529 and test Certificates to this effect shall be obtained from any Government / NABL Accredited institutions/ test Houses having adequate test facilities.

7. 0. Exhaust Brake:

Applicability: Dumpers / Tipper trucks / Heavy Vehicles

7.1.1 The Exhaust Brake shall meet the following minimum requirements and standards:

7.1.2. The brake shall be an Auxiliary Braking System and shall be compliment but not a replacement to service Brake.

7.1.3. Control forces of the braking system controls and other brake testing requirement shall be in accordance with IS 16479 (performance requirements and test procedures of braking systems for wheeled high-speed rubber-tracked Earth Moving Machines and construction equipment vehicles) stipulated for Retarder. For Heavy vehicles, it shall be in accordance with relevant Automotive Industry Standard (AIS).

7.1.4. The Brake control shall be provided in the Operator's cabin within the Zone of Reach and distinctly marked.

8. 0. Load Indicators

An automatic Load sensing, measuring and data logging system to monitor load, to sound warning when loaded beyond its designed safe carrying load and to record the payload during machine operation. The system shall have signaling provision on both sides of the Dumpers / Tipper trucks to indicate the loading status along with indication to the Operator.

Applicability: Dumpers / Tipper trucks

8.1. The Load Indicators for Dumpers and Tippers shall meet the following minimum requirements and standards:

8.1.1. The system shall comprise of onboard automatically load sensing/measuring device, indicating arrangement and warning system.

8.1.2. The system shall have exterior load indicating device(s) (in the form of different light indicators) so that the loader Operator is aware of under load, safe load and Over Loading of the Dumpers / Tippers. The indication shall also be extended to Dumper / Tipper Operator and the indication shall be suitably placed in Operator cabin as easily seen by the Operator without strain and without affecting his outside visibility, The Exterior load indicator shall be provided on both sides of Dumper / Tipper.

8.1.3. The system shall sound Audio warning when safe carrying capacity of Dumper / Tipper is reached. The Warning shall be continuous when the Dumper/truck is overloaded. The system shall not have manual override.

8.1.4. The system shall have Ingress Protection of IP 68 in accordance with IEC 60529 and test Certificates to this effect shall be obtained any Government / NABL Accredited institutions/Test Houses having adequate test facilities.

8.1.5, Light intensity of the Indicator shall be as per the requirements of AVA stipulated by DGMS, Intensity of Audio Warning shall be as per the requirements of AVA stipulated by DGMS.

8.1.6. The System may be provided with provisions for recording the warning generated with time stamp to enable easy retrieval and analysis of the immediate past 96 deployment operating hours.

9.0. Dump Body Stabilizers for Tippers:

The Dump Body Stabilizers for Tippers shall meet the following minimum requirements and standards:

Adequate and suitable mechanical arrangement(s) in the form of stabiliser to prevent toppling of Tipper / separation of dump body of the Tipper from lift cylinder(s) during dumping operation of the Tipper shall be provided in all Tippers. As far as possible, the dump body shall be designed during design phase of Tippers.

10.0. Seat belt and Seat Belt Reminder:

Applicability: Dumpers / Tipper trucks / Light and Heavy Vehicles.

10.1 The Seat belt and Seat Belt Reminder shall meet the following minimum requirements and standards:

10.1.1. Seat Belt

a) Seat Belt shall be an arrangement of strap(s), 3 point contact type with a securing buckle with quick release, adjusting devices and attachments which are capable of being anchored in Operator's cabin of HEMM.

b) Seat Belt shall be designed to minimize the risk of injury to its wearer (Operator), in the event of-collision or of abrupt deceleration of the vehicle, by limiting the mobility of the wearer's body. It shall be capable of returning to normal operating position sooner the condition(s) causing the risk is/are diminished and shall not hinder normal operations of the Operator.

c) A cutting arrangement shall be provided in Operator cabin at a place which is easily approachable by the operator/person for cutting the strap in case of jamming of securing buckle during escape / rescue operations in case of any eventualities.

10.1.2. Seat Belt Reminder System

a) The system shall detect an unfastened safetybelt and initiate two stages of both Visual and Audible alerts, namely, First Level Warning and Second Level Warning.

b) The visual warning shall be so located as to be readily visible and recognizable in the daylight and distinguishable from other alerts at night time by the Operator when seated in Operator Seat. As far as possible, the warning indicator shall be integral part of Operator console / Display Panel. The Visual Warning shall be flashing tell-tale.

Note 1: "First Level Warning" means a visual warning activated when the ignition switch is engaged (engine running or not) and the Operator's safety-belt is not fastened. An audible warning can be added as an option.

Note 2: "Second Level Warning" means a visual and audible warning activated when a Operator operates a vehicle without fastening of Operator safety-belt.

Note 3: Reference for Test requirements: AIS 145 (for appropriate N type vehicle) or any other acceptable international automotive standard.

11.0. Proximity Warning Device

A system designed for early detection of static and moving objects, vehicles, human beings encountered within virtual target area during movement of Dumper / Tipper and for triggering warning the operator to prevent collision or run over. The system shall comprise sensors which may employ one or more or combination of technology / methodology (for detection of objects, vehicles, and human beings), control unit(s) (for receiving input from sensor(s), processing it and forwarding necessary input to Warning Unit) and warning unit to trigger Audio visual warning to the operator. The system shall have variable target area during forward movement depending upon speed of the Dumper / Tipper and predetermined target area during rearward movement.

Applicability: Dumpers / Tipper trucks

11.1. The Proximity Warning Device shall meet the following minimum requirements and standards:

11.1.1. Proximity warning device / system shall be provided for detecting static and moving objects including human beings on its own during the vehicle movement for a specified range, and warn the operator in the operator's station.

11.1.2 At least one object detection sensor, accessible and not interfering with the Dumper's / Trucks operation shall be provided both in the front and at rear of the Dumper / Truck at suitable locations, The system shall be ergonomically designed and mounted for operator and maintenance personnel.

11.1.3. The system shall be reliable and be able to provide an adjustable audio visual warning when it detects static and moving objects including human beings, least height light motor vehicle used in the mine, etc., within the virtual target area of respective Dumper/Truck.

11.1.4. The sensor shall detect static and moving objects in a virtual target area as defined below. The manufacturer shall ensure maximum possible detection coverage in the virtual target area depending on the available fitment area and proximity detection technology defined as below:

11.1.5. Virtual Target Area in Front of Dumper/ Truck:

a) Width of the virtual target area shall be equal to the width of the Dumper/Truck plus 0.5m on both sides,

b) The inner edges (base line) that represent the width of the virtual target area shall pass through the inner edge of bumper of Dumper/Truck. The centerline of the virtual target area and the Dumper/Truck centerline shall coincide.

c) Length of the virtual target area shall conform to maximum stopping distance as mentioned in the IS: L6479 (Performance requirements and test procedures of braking systems for wheeled highspeed rubber-tracked Earth Moving Machines and construction equipment vehicles) and the length of virtual target area shall be calculated by the Control Unit of the system dynamically and automatically with relation to vehicle's speed at any given point of time while covering the blind spot distance observed within the width of virtual target area when the Dumper / Tipper was in static pre-start (ignition - on) condition. While calculating stopping distance in accordance with IS 16479, the test slope percentage may be taken as 6.25 % (i.e. 1 in 16, which is maximum permissible slope of haul road under normal operating conditions). Further, Brake response time and operator response time shall also be considered while calculating the stopping distance.

11.1.6. Virtual Target Area in Rear of Dumper/ Truck:

a) Width of the virtual target area shall be equal to the width of the Dumper/Truck plus 0.5 m on both sides.

b) Length of the virtual target area shall be more than or equal to the length of the Dumper/Truck.

c) The inner edges (base line) that represent the width of the virtual target area shall pass through the centreline of the rear axle of the Dumper/ Truck.

d) The centreline of the virtual target area and the Dumper's/Truck's centreline shall coincide.

11.1.7. The system shall not detect any obstacles beyond the width of the virtual target area and its detection area shall be restricted along the vehicle's pathway for minimizing false alarm. The system shall have intelligent alert generating mechanisms like indication of obstacle in the vehicle's pathway, whether left, right or center and triggering audio alerts after detection of obstacles of autocut off type, to avoid operator inconvenience/distraction. The System shall be provided with provisions for recording of details of warning generated with time stamp with location details (if feasible) to enable easy retrieval and analysis of the immediate past 96 deployment operating hours.

11.1.8. The system shall be tested at any Government approved laboratories or Test houses accredited by NABL subject to confirmation of its ability to conduct such tests conforming to following Standards (or ifs revised versions) and the test house shall not be part of Manufacturer's testing facility.

a) IEC 61000-4-5:2014 - Electromagnetic compatibility (EMC): Testing and measurement techniques - Surge immunity test.

b) IEC 61000-4-6:2013 - Electromagnetic compatibility (EMC): Testing and measurement techniques-Immunity to conducted disturbances, induced by radio frequency fields.

c) JSS 55555:2000(Rev-2) - Sinusoidal Vibration Test, Frequency: 8 to 500 Hz, Acceleration: 40 m/sec2 , Duration 2 hrs in each axis.

d) IS-9000: part-V/Sec 1-1981 Reaffirmed 2007-Damp Heat Test (at 400 C & 95% RH for 16 Hrs).

e) IS-9000: Part-II/Sec 3-L977 reaffirmed 2004 - cold Test (-100 C).

f) IS-9000: Part-III/Sec 3-7977 reaffirmed 2004 - Dry Heat Test (+700 C).

g) IS-9000: Part-XIV/Sec 2-1998-Rapid Temperature cycle Test.

h) Ingress Protection Test, IP-66 required;

11.1.9. Rules/guide lines framed by Ministry of Communications and Information Technology (Wireless planning and Co-ordination Wing), wherever applicable, shall be complied. The technology / technologies of the system shall also comply with other_ applicable statutory guidelines framed under various Rules /Regulations / Acts by Government of India.

Conclusion:

It may please be noted that these guidelines are only the minimum recommended levels and may be altered from time to time as per evolving needs and that there is no bar on adherence to any higher/ superior levels of design and functionality in the interest of safety, It also further be appreciated that adherence to these requirements will go a long way in drastically minimizing hazards due to operation of both HEMM and light/heavy vehicles in opencast mines as well as in ore handling plants thus commensurately enhancing safety in mines.

Digital and Sustainable Transformation of Logistics in Chrome ore Mines using Artificial Intelligence

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Chrome Ore is being dispatched from our mines at Sukinda Chrome Valley. Around 400+ trucks are operated every day, making the entire operations quite complex and time taking. The entry of the trucks at mines start in early morning from 5 am onwards. The process of entering of trucks, loading and dispatch continues whole day and by the time the last truck is dispatched from plant, it becomes quite late in evening. The entire operation is manual as described below:

The truck sequencing is done manually and so the entry of the trucks at the parking yard. Then the trucks are given entry slip and gate pass manually and the same is entered in the log-book by an operator. Once this activity is done, the driver drives the truck for tare weight. At the weighbridge, the driver gets down of the truck to hand over the document to weigh bridge operator for tare weight capture and the same is entered manually in i3MS and SAP. Even the loading stack is selected manually, and the pre-loading receipt is handed over to the driver and the truck is then guided towards the concerned stack for loading. The entire loading operation takes almost 1 hr. Then the loaded trucks are weighed after physical checking. Each truck is checked manually for weight limit violations. The gross weight is entered manually in SAP & i3MS, then the TP and delivery challan are printed manually, followed by bulk generation of e-way bill. Then the entire documents are consolidated by the operator and handed over to the driver. At the exit gate, truck details are recorded manually in log-book. The transporter supervisor manually generates LR.

Problem Statement:

1. Issue in truck sequencing
2. Limited visibility and control
3. Manual and multiple paper-based documentation causing delays and errors
4. High turnaround time of trucks inside mines
5. Productivity and efficiency loss
6. Potential unsafe situations inside mines

Solution implemented: A digitally enabled e-log system has been implemented in Sukinda Mines to overcome above problems.

The revised process is: The truck sequencing and issue of token is done through system. The gate-pass is auto-generated and GPS is issued along with RFID. When the truck reaches the entry gate, the RFID reader switch traffic light and the boom-gate opens. The same can be cross-verified by entry-gate operator. The RFID reader triggers Weigh Bridge Software, auto fetch tare weight and update tare weight in SAP. The RFID reader only allows authorized trucks inside and the trucks await intelligent loading through display board. The loading is done manually / mechanically. Then the RFID reader triggers Weigh Bridge Software, auto fetch gross weight, TP gets generated in i3MS, auto invoice in SAP, auto E-Way Bill generation, auto digital LR generation - all printings are done through SAP. At the exit gate, printed documents are handed over to the driver and the GPS is collected back. This helps the shift In-charge with Real-time dashboard, Update DO in app, i3MS permit info in app, Behavioral based truck blocking and generate hourly reports in app. Apart from enabling complete visibility and bringing unmatched safety features, this project has resulted in reduced TAT of trucks, saving papers and ease of doing transportation to the ecosystem.

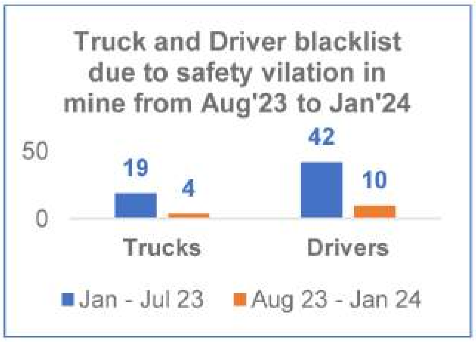
This project gives saving of almost 50,000 papers a month resulting into saving of full grown 65 TEAK trees per year (225 KG CO2 equivalent reduction in carbon footprint per month). This project is not only sustainable for environment perspective, but also benefitting key stakeholders like drivers, transporter, government, and local ecosystem through following ways:

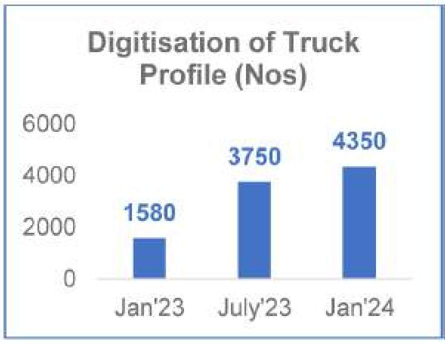
1. Smooth and seamless journey inside mines
2. Real-time dash-board access
3. Behavioural based truck / driver blocking
4. Digital profiles for visibility of truck's location
5. Digital entry at parking for entry on First Come First Serve basis
6. Auto validation of documents in VAHAN and PARIVAHAN sites
7. Entry of authorised trucks through boom-barrier
8. Auto alert too shift in-charge for any malfunction
9. RPA powered auto-generation of documents
10. Limit trucks in each location digitally to minimise congestion and man-machine interface

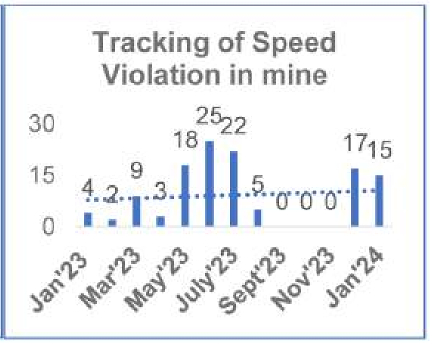
In summary, following are the KPIs monitored

Sr. No.	Subject	Before	After	Result
1	Manual Intervention (excluding loading area)	9 instances per truck	2 instances per truck	Improvement in Safety - Reduction in Man-Machine interface
2	Usage of Paper (A4 sheet per truck)	8	3	Saving of almost 50,000 papers a month -> reduction in Carbon Footprint
3	Turn-Around-Time inside mines	4-5 Hours	2 Hours	Faster completion of daily job
4	Mental Stress	High waiting time	Less waiting time	Improved Work-Life balance
5	Process and Systems	Complex, no visibility	Simple & complete visualisation	Digitization

During the execution of the project, when the profile of trucks and truck drivers got digitised and tracked, we could monitor the instances of safety and speed violations inside our mines.







This project can be horizontally deployed across all mines by customising the solution as per their business rules for seamless transportation and thereby reducing TAT and man-machine interface.

A Novel Solution for Humate Removal from Bauxite Ore in Bayer's Process

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Abstract:

In the Bayer's process of alumina production, alumina present in the bauxite dissolves under a hot caustic soda solution. Undissolved impurities like iron, titanium, silica, and other residues form red mud. After clarification, alumina hydrate is precipitated from the clear sodium aluminate liquor. However, bauxite ore naturally contains organic materials that emerge as humates during digestion, contaminating the solution alongside alumina. With plant operation time, humate content increases due to spent liquor recirculation. Humate presence adversely affects the brightness and fineness of precipitated alumina hydrate, posing a significant challenge for alumina refineries.

This paper introduces a novel additive developed by M/s Kimberlite Chemicals India Private Limited. This solution effectively removes soluble humate material from the sodium aluminate liquor without impacting liquor productivity. This advanced technology in alumina refinery provides a sustainable solution and bright future for the mining industries. We will discuss detailed laboratory experiments demonstrating this innovative approach to address humate challenges in Bayer's process.

Keywords: Bauxite ore, Bayer process, Humate removal, Alumina hydrate, Kimberlite additive

Sustainable Mining for a Brighter Future

Dr. SWAPNIL GUPTA
CEO, Minception

Mining and Metals: Driving the Global Economy

India, a treasure trove of mineral resources, unearths a staggering 95 different minerals, fuelling its industries and propelling economic growth. India's abundant reserves of metallic minerals like bauxite, chromite, and iron ore, as well as mineral fuels such as coal and lignite, position the country for significant economic growth.

The mining and metals sector are a cornerstone of global economic development. It's the backbone of countless industries, providing the essential raw materials that drive progress and innovation across the globe. Mining and metals significantly impact a nation's GDP (Gross Domestic Product). It directly contributes through the value of extracted minerals and metals. For instance, India, a major mining player, sees roughly 2.4% of its GVA (Gross Value Added) coming from mining and quarrying.

The mining and metals sector is a major employer, offering jobs in various roles, from extraction and processing to logistics and administration. This provides a vital source of income for millions globally. The sector attracts substantial investments, stimulating economic activity and job creation in related industries such as manufacturing, transportation, and infrastructure development. Many countries are key exporters of mined resources, earning foreign currency and contributing to a positive trade balance.

Mining operations often occur in remote areas, bringing economic opportunities and development to these regions. This can lead to improved infrastructure, better healthcare facilities, and educational opportunities for local communities. The mining and metals sector often operates behind the scenes, but its impact on our world is undeniable. Here's a closer look at how mining plays a critical role in driving progress.

The sector provides the raw materials that fuel innovation across various industries. From the metals used in cutting-edge electronics and construction to the minerals essential for renewable energy technologies, mining plays a vital role in driving progress. Mining forms the bedrock of a complex supply chain. It feeds raw materials to numerous downstream industries, ensuring a steady flow of resources for manufacturing and construction activities. Secure and reliable access to mined resources is crucial for national security and economic independence. Many countries strive for self-sufficiency in critical minerals to avoid dependence on external sources.

The Detrimental Effects of Traditional Mining Practices

Traditional mining practices, while apparently straightforward, leave a trail of destruction on the environment, society, and even economic structures. Let's explore deeper into the specific problems caused by these methods:

Environmental Degradation:

- **Pollution:** Mining activities generate a significant amount of dust, leading to air pollution. Processing of extracted materials can release harmful chemicals into the air and water bodies, contaminating them and harming wildlife.
- **Deforestation:** Establishing mines often requires clearing vast paths of land, destroying forests

and the delicate ecosystems they support. This loss of vegetation can lead to soil erosion and disrupt natural water cycles.

- Land Degradation: Mining operations often leave behind scars on the landscape. Open-pit mines create large craters, and waste disposal creates tailings ponds that contaminate soil and water. Reclamation efforts are often inadequate, leaving behind barren and unusable land.

Social Disruptions:

- **Displacement:** Communities residing near mining sites can be forced to relocate due to land acquisition or environmental damage. This uproots traditional ways of life and can lead to social unrest.
- **Health Issues:** Exposure to dust, chemicals, and contaminated water can cause respiratory problems, skin diseases, and other health issues for people living near mining areas.
- **Livelihood Loss:** Traditional livelihoods, such as agriculture and fishing, may become impossible due to environmental degradation caused by mining activities. This can lead to poverty and social instability.

Economic Inequalities:

- **Unequal Benefits:** While mining companies may generate significant profits, these benefits are often not shared equally with the local communities. This can lead to resentment and a feeling of exploitation.
- **Resource Depletion:** Traditional mining methods often extract resources inefficiently, leading to faster depletion of valuable minerals. This can create economic insecurity in the long run.
- **Unskilled Labour:** Traditional mining practices may rely heavily on unskilled labour, offering limited opportunities for upward mobility within the communities impacted.

India's mining sector shows the challenges of balancing growth with environmental and social responsibility. While it's a significant contributor to the economy, its focus has been on subsidizing downstream industries like steel and power, neglecting advancements in mining practices themselves. This approach has led to:

- **Outdated Techniques:** Traditional, less efficient methods are often employed, hindering productivity and resource extraction.
- **Missed Opportunities:** India hasn't fully embraced advancements like automation, precision mining, and data analytics that could revolutionize the industry and minimize its environmental footprint.

As the world strives for sustainable development, the mining sector faces increasing pressure to adopt environmentally and socially responsible practices. This requires a multi-pronged approach:

- **Technological Revolution:** Embracing new technologies is crucial. Automation can improve safety and efficiency, while precision mining can minimize waste and environmental impact. Data analytics can further optimize operations and resource extraction.
- **Regulatory Framework:** Stricter environmental regulations by governments can hold mining companies accountable for their practices. India, for instance, has introduced reforms to streamline the sector and promote sustainable mining practices.
- **Focus on Efficiency:** Shifting the focus from subsidizing end products to optimizing mining operations themselves is essential. This can lead to a more efficient and globally competitive mining sector in India.

The mining industry is responsible for 2 to 3 percent of global CO_2 emissions and plays a significant role in reducing these emissions. While much of the industry's efforts have been on portfolio shifts, such as divesting from coal assets, there is growing pressure from regulators, investors, and customers to decarbonize operations. The sustainability of miners is increasingly a focus for the capital markets, with access to capital now more frequently dependent on sustainability.

The United Nations ratified the Paris Agreement, the aim is by keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and pursue efforts to limit the temperature increase to 1.5OC above the pre-industrial level. To achieve a 1.5°C climate-change target by 2050, the mining industry will need to reduce direct CO_2 emissions to zero.

Breakdown of current mining emissions

Emissions within mining can be broken down into three broad types

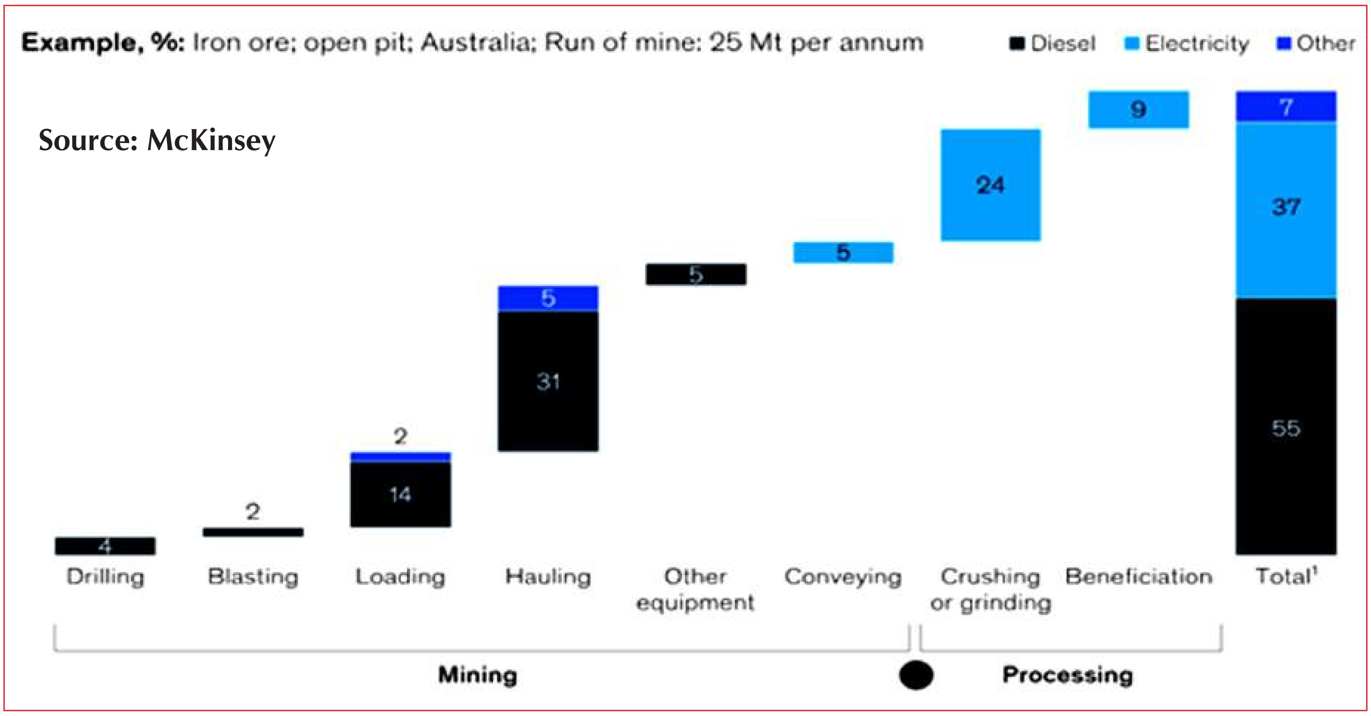
Scope 1. Emissions from diesel

Scope 2. Emission from Electricity generation

Scope 3. Emissions from the supply chain and transport

Today 40 to 50 percent of CO_2 emissions come from diesel used in mobile equipment, with another 30 to 35 percent from non-renewable electricity.

Case Study: Iron ore open pit Mine, Australia: Addressing emission from the multiple sources



In this particular example, haulage trucks are the single biggest source of emissions from the mine (accounting for 20 to 25 percent of the total), followed by comminution or crushing equipment (approximately 20 percent of emissions), bulldozers (7 percent), and excavators (5 percent). Addressing carbon emissions from these four types of equipment offers a substantial opportunity to make a step change in reducing overall mining emissions.

Sustainable Mining Practise

Sustainable mining practices are a set of techniques that aim to minimize the environmental and social impact of mining activities. These practices are becoming increasingly important as the world becomes more aware of the need to protect our planet and its resources.

In 2012, at the UN Conference on Sustainable Development, the outcome document, The Future We Want, recognized in paragraph 228 the "importance of strong and effective legal and regulatory frameworks, policies and practices for the mining sector that deliver economic and social benefits and include effective safeguards that reduce social and environmental impacts, as well as conserve biodiversity and ecosystems, including during postmining closure."

Our world relies on minerals for countless technologies, from smartphones to clean energy infrastructure. But traditional mining practices can have a significant negative impact on the environment and surrounding communities.

Sustainable mining offers a solution. It's a way to extract these vital resources while minimizing environmental damage and fostering positive social and economic outcomes. Here's how sustainable mining can create a brighter future:

1. Minimizing Environmental Footprint:

- **Reduced Water and Energy Consumption:**
  - Implement water recycling and reuse systems to minimize freshwater usage.
  - Utilize energy-efficient equipment and explore renewable energy sources like solar or wind power.
- **Waste Management:**
  - Develop strategies for minimizing waste generation during mining and processing.
  - Implement safe and responsible disposal or re-use of waste materials.
  - Explore opportunities for using waste rock in mine rehabilitation projects.
- **Air and Noise Pollution Control:**
  - Utilize dust suppression techniques like water sprays and covered haul roads to reduce air pollution.
  - Employ noise reduction technologies on machinery and equipment.

2. Land Rehabilitation and Reclamation:

- **Planning for Post-Mining Land Use:**
  - Conduct pre-mining assessments to understand the existing ecosystem and plan for its restoration.
  - Design mining operations to minimize permanent land disturbance.
- **Rehabilitation Techniques:**
  - Implement strategies for re-grading and re-vegetation of mined land.
  - Utilize native plant species to promote biodiversity and restore ecological functions.
  - Explore innovative solutions like bioremediation for the treatment of contaminated soil and water.

3. Social Responsibility:

- **Community Engagement:**
  - Maintain open communication & collaboration with local communities throughout mining life cycle.
  - Address community concerns regarding environmental and social impacts.
  - Partner with communities for sustainable development initiatives.
- **Social Impact Assessment:**
  - Identify potential social impacts of mining projects, such as population influx or cultural disruption.
  - Develop mitigation plans to address these impacts.
  - Respect cultural heritage and traditional practices of local communities.
- **Workforce Development:**
  - Provide training and employment opportunities for local communities.
  - Ensure fair labor practices and uphold worker safety standards.

Case: The Mineral Foundation of Goa (MFG), a non-profit organization founded by nine Goan mining corporations to address social and environmental externalities in the State's mining belt, has completed several development projects and worked with the State for the benefit of the mining communities in Goa.

4. Technological Innovation:

- **Precision Mining:**
  - Utilize advanced technologies like GPS and laser guidance for more targeted extraction, reducing waste and minimizing disturbance.
  - Explore drone technology for surveying and monitoring mining activities.
- **Clean Technologies:**
  - Research and adopt innovative technologies that minimize environmental impact, such as bio-leaching (using microbes to extract metals) or phytomining (using plants to extract metals).
- **Automation and Digitalization:**
  - Implement automation in mining processes to improve efficiency and safety.
  - Utilize digital tools for data collection, analysis, and decision-making to optimize mining operations.

5. Transparency and Accountability:

- **Environmental and Social Impact Reporting:**
  - Regularly monitor and report on environmental and social impacts of mining operations.
  - Ensure transparency in data collection and reporting practices.
- **Independent Verification:**
  - Seek independent verification of environmental and social performance by third-party organizations.
  - Adhere to international best practices and sustainability standards in the mining industry.

Conclusion

Sustainable mining practices are not just an option but a necessity for ensuring a harmonious balance between resource extraction and environmental conservation. By adopting eco-friendly technologies, minimizing waste, and enhancing resource efficiency, the mining industry can significantly reduce its ecological footprint. Additionally, fostering strong relationships with local communities, respecting indigenous rights, and ensuring fair labor practices contribute to the social sustainability of mining operations.

The transition to sustainable mining is bolstered by stringent regulations, innovative research, and a commitment to corporate social responsibility. This paradigm shift promises not only to protect and preserve our planet for future generations but also to drive economic growth through the creation of green jobs and the development of sustainable technologies.

In conclusion, embracing sustainable mining practices paves the way for a brighter future where economic development and environmental stewardship coexist. By prioritizing sustainability, the mining industry can ensure that its contributions to society are both valuable and enduring, securing a healthier planet and a prosperous future for all.

Innovative Waterless Dust Collection Technology for Mining and Mineral Industry

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ABSTRACT:

Dust generation is a significant concern in mining and mineral processing plants due to its potential environmental and health impacts. The suspended fine particles have become a serious concern in mining sector. Major of open cast mines, material handling sections and beneficiation units are suffering from severe air pollution from fine particulate matter which affects the health condition of human beings and working environment. To address these challenges, there are many systems available to suppress the dust using air and water sprayes. The current dust suppression systems use enormous water quantity, and also temporary solution for dust suppression. The electrostatic principle is an effective mechanism for charging particulate pollutant to enhance the dust size thereby increasing the collection efficiency for those with a particle diameter of 2.5μm or less (PM2.5). In this research, A electrostatic based models have been proposed to the sections like tripping points, loading area and other area where the dust evolution is concern. The technology focuses the fine particle charging with opposite polarity and mixing, which leads to agglomeration of particle and which will effectively enhance the collection of fine particles, especially of PM2.5. Experimental testing was carried with prototype models with common cyclone separator & IRRA Electrostatic Cyclone, a series of trials were conducted at air volume flowrate capacity 500 m3/h. For evaluating performance parameters, the pressure drop and collection efficiency was measured. A Thorough iso-kinetic sampling, the outlet emission was measured with IRRA Electrostatic Cyclone was 16 mg/Nm3, while that of common cyclone separator was 140 mg/Nm3.The novel IRRA Electrostatic Cyclone collector is an effective way to PM2.5 source control in the process of industrial application and environment protection. This development is of great significance for the improvement of dust suppression technology without water.

Keywords: Pollution, Cyclone, Electrostatic, DC Electric field, Agglomeration

1.0 INTRODUCTION

The pollution of ambient air by suspended fine particles has become a serious global concern in recent years [1,2]. Particle pollution can be termed as a heterogeneous mixture of aerosols sourced from many naturally occurring events like volcanoes, dust storms, forest fires etc., and human generated sources including waste gases from power plants, incinerator of agricultural waste, by products of automobile combustion etc., which generates fine particles of PM 2.5 that affects the health condition of human beings and are known to be one of the root causes for various allergies and diseases like asthma, lung emphysema[3]. Many industrial processes, such as mineral processing, petroleum refining, chemical engineering, food processing and environmental cleaning, require the removal of particle matter from an air stream. There is a general desire to control the emission of particulates in industrial gas streams in light of government regulations designed to curtail pollution. Cyclone separator is considered a proven particulate control device under the category of gas-solid separation. These have been considered as integral part of particulate or dust removal processes in various industrial applications mainly because of their simple design, easy maintenance, absence of moving parts and low cost. However, their low collection efficiency for particulates smaller than 5 microns [4] Cyclone separator is widely used device for separating particles from gas streams in view of its main advantages of simple structure and low cost. A common type of cyclones is the so-called "reverse flow" cyclones where particle-rich gas can be withdrawn from the tangential inlet of the cyclone bodywhile clean gas essentially reverses flow from its initial path toward the end of the cyclone body, back toward the vortex finder (the gas outlet) [5-7]. In this type of cyclone, particles are separated based on the balance between inertial and fluid forces acting on the particles in a flow field. Therefore, this type of cyclone generally has low separation efficiency for fine particle or particles whose density differs very little from the density of the fluid [8-9] Further, when there are a high percentage of fine particles in the gas stream, the collection efficiency of conventional cyclone separator is relatively low because the resulting centrifugal forces are smaller and often insufficient to segregate the particles. Even heavier particles encounter flow turbulence and secondary flows which tend to bounce them off the cyclone walls, thereby causing re-entrainment. There are several theories proposed on particle separation in the cyclones by researchers using different approach models and assumptions. Significant amount of researches have been carried out to investigate the effect of cyclone geometry and operating conditions on the cyclone performance. Many cyclone designs have been suggested to enhance the collection efficiency of cyclones [6-10]. Many variations in cyclone designs have been suggested to improve cyclone efficiency. Typical reverse-flow cyclones are associated with low efficiency for small particles (2.5 μm) [11–12] has shown that this effect may be minimized using numerically optimized cyclones. In spite of this optimization, for fine and low-density particles, the non-ideal effect of re-entrainment may occur, being justifiable both by the smaller aerodynamic diameter of the particles and also for too high inlet velocities for a given geometry. This non ideal effect may decrease collection efficiency below theoretically predicted values. And also include the use of electrostatics to increase the driving force of particles to the walls, and once-through cyclone designs to eliminate secondary re-entrainment through re-circulation system [13-15] And acoustic agglomeration to increase particle size, water injection to reduce particle bounce off the walls,. None of these previous refinements has achieved the performance needed to make cyclone collection efficient.Theoretical calculations for cyclone collection efficiency and pressure drop are made using the established theories available in the literature [6-13]. Further these theoretical predictions are validated against the experimental results. In order to gain greater insight of complex flow phenomenon inside a cyclone separator and predict cyclone performance, for the proposed design CFD has been carried out [16-18,22-23]. Other various current market available industrial particle separationsinclude electrostatic separation [19],settling separation [20], Bag-filter [21].However, electrostatic separation requires higher footprint area with higher capital cost, high operational costs; the devices used in settling separation are always very large footprint area with lower efficiency and need a longer settling time; Bag filter is a high efficient operation equipment but difficult to maintain in stable operation for long time and requires higher operational cost like regular bag replacement, compressor air for regular interval cleaning in order to maintain the pressure drop. Therefore, with these current technologies it will be difficult to obtain outstanding socialand economic benefits in fine particle separation, especially in the PM2.5 separation.

In this development, we designed a multi-inlet electrostatic reverse rotation cyclone separator with integrating centrifugal charge accelerators proximately arranged tangentially to the cyclone body and each accelerator consisting of cylindrical section containing a discharge electrode having discharge spike for generating positive and negative DC electric filed intensity separately in different accelerator, and for charging particle-contaminated gas stream entering tangentially and equally through the inlet. Once the fine particle are charged with opposite polarity mixes in cyclone body which leads to agglomeration of particle and which will effectively enhance the separation of fine particles, especially of PM2.5. This development is of great significance for the improvement of cyclone separation technology, as well as for the separation and capture of PM2.5. And also the present prototype model is intended to computationally investigate using the k-epsilon model, RNG, swirl dominated flow for the geometrical optimization for achieving high collection efficiency of fine particles and obtaining more details about the flow field pattern and velocity profiles.Multi-inlet electrostatic reverse rotation cyclone separator the provides for an efficient separator apparatus and improved method for separating fine particles from a particle-contaminated gas stream, which is capable of maximizing the overall collection efficiency to meet the stringent emission norms imposed by the pollution regulatory authority and thereby effectively contributing to green technology that materially enhances the quality of the environment.

2.0 NUMERICAL SIMULATION AND DIMENSIONAL OPTIMIZATION:

Selection of the turbulence model

For the turbulent flow in cyclonesseparator, the key to the success of CFD lies with the accurate description of the turbulent behaviorof the stream line flow pattern. To model the swirling dominated turbulent flow in a cyclone separator, there are a number of turbulence models available in ANSYS FLUENT. These range from the standard k-epsilon model to the more complicated Reynolds stress turbulence model (RSM). Selection of a suitable turbulence model for the highly swirling flows has been investigated by many researchers [22-23].

The k-epsilon model, RNG, swirl dominated flow was selected to studies the geometrical parameter variation for enhancing the collection efficiency of fine particulate matter. It yields an accurate prediction on the swirl flow pattern, axial velocity; tangential velocity, streamline flow, cut-off diameter and pressure drop in cyclone separator simulations. It will be used in this study to reveal the effect of reverse rotation in the turbulent flow in the multi-inlet cyclone separator. Figure:1, schematic diagram of Multi-Inlet Cyclone with meshing model

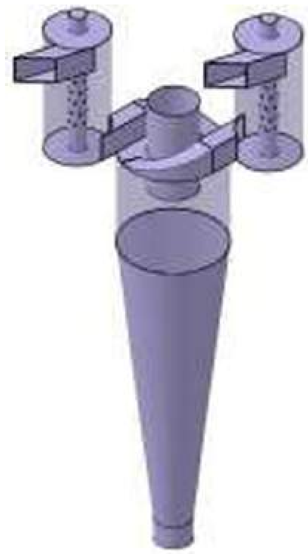


Fig 1 Schematic Diagram Of Multi-Inlet Cyclone

EXPERIMENTAL STUDIES:

Particle Size Distribution of Dust Particles

In the design of cyclone, the size of the particles in the input gas stream is of high relevance. It is therefore necessary to assess the particle size distribution (PSD) with reasonably high accuracy. In the present study the particle size at the cyclone

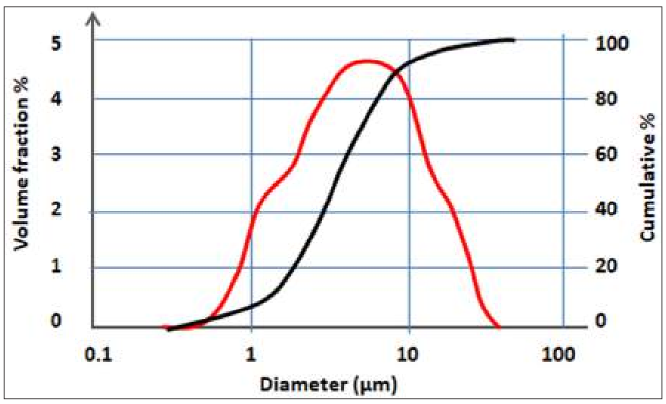


Fig 2 Particle size distribution of test sample

inlet were measured using the well-established procedure for Particulate matter. The PSD analysis was conducted using a Laser Diffraction instrument known as Mastersizer 2000. Fig. 2 shows the PSD of the dust particles of test sample.

Design of Multi-Inlet Reverse Rotation Cyclone

There are three major types of cyclone designs which are wildly used in the various industries. These can be classified as the high efficiency cyclone, conventional efficiency and high through put cyclone. This classification is essentially based geometric proportion of cyclone dimensions. Using the above classification, the conventional cyclone design was modified into 1D3D categorized to be high efficiency. The multi-inlet reverse rotation cyclone is designed based on high efficiency 1D3D design with the integration of centrifugal charge accelerator. In centrifugal charge accelerator the fine particle area charged with the oppositely charged in DC electric filed intensity that occurs in the gas space between the electrodes where the gas ions generated by the corona bombard and become attached to the particles. The level of charge attained by a particle depends on the gas ion concentration, the electric field strength, the conductive properties of the particle, and the particle size.

The expression "reverse rotation effect" means, effect achieved by reversing the motion of the particle in the cyclone body as compared to motion of rotation of the particle in the centrifugal charge accelerator, or vice versa. The multi-inlet electrostatic reverse rotation cyclone separator will enhances the performance of a conventional cyclone separator by combining the properties of electrostatic agglomeration of particle with reverse rotation effect resulting in higher particle collection efficiency.

Experimental test setup

The overall schematic of the experimental test setup along with multi-inlet reverse rottation cyclone is shown in Fig. 3. And charging phenomenon is shwon in figure 4 In separate experimental set-ups, using the conventional cyclones& multi-inlet reverse rotation cyclone,a series of trials were conducted at air volume flow rate capacity 300 m3/h. These trials were conducted using fly ash of wood incinerator application. For evaluating performance parameters, thepressure drop and collection efficiency was measured.

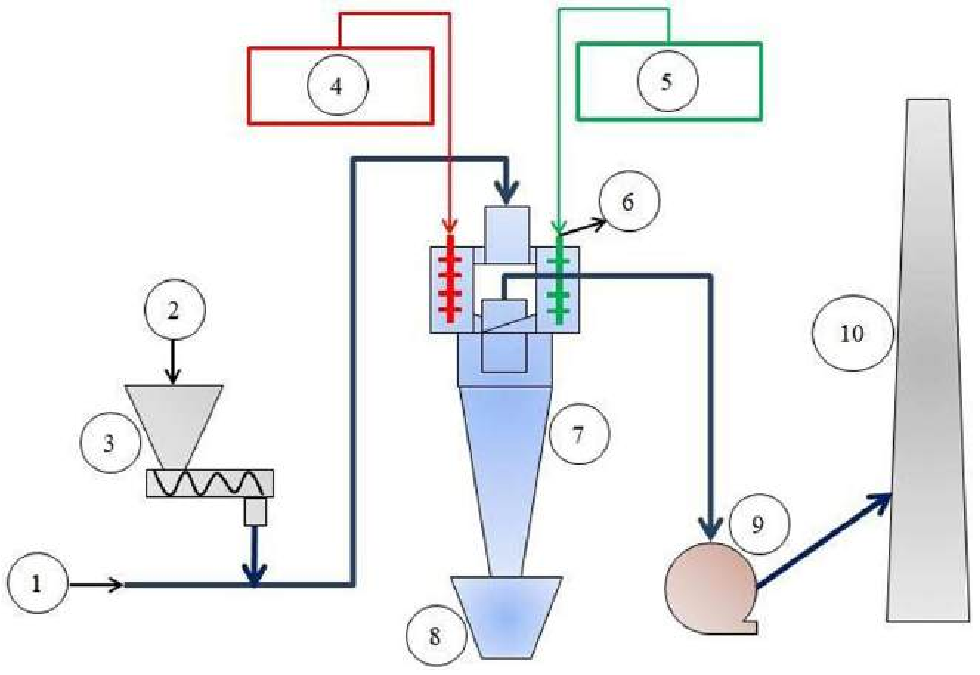
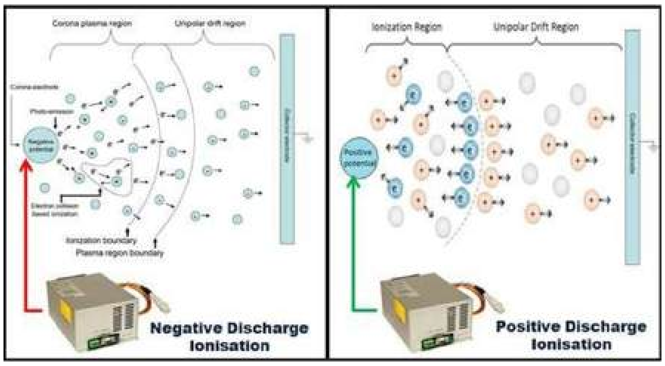


Figure. 3 Experimental line diagram; 1-Air inlet, 2-Fly ash, 3-Screw feeder, 4- Positive HV Power supply, 5- Negative HV power supply, 6- Discharge electrode, 7- Multi inlet Cyclone, 8- Ash hopper, 9- ID fan, 10- Outlet stack.

Particle Charging Phenomenon

Figure 4: Particle charging phenomenon



RESULTS & DISCUSSION:

The results are shown in the figure 5 shows the collection efficiency of the cyclone design , the new design concept has shown the 99.6 % collection of PM 2.5 and clean air will be the exhaust.

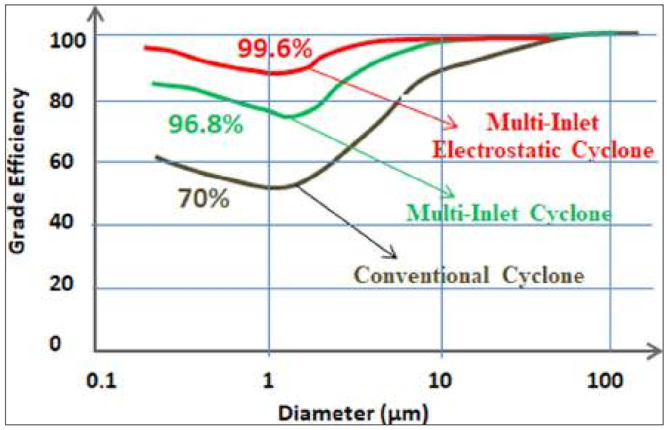
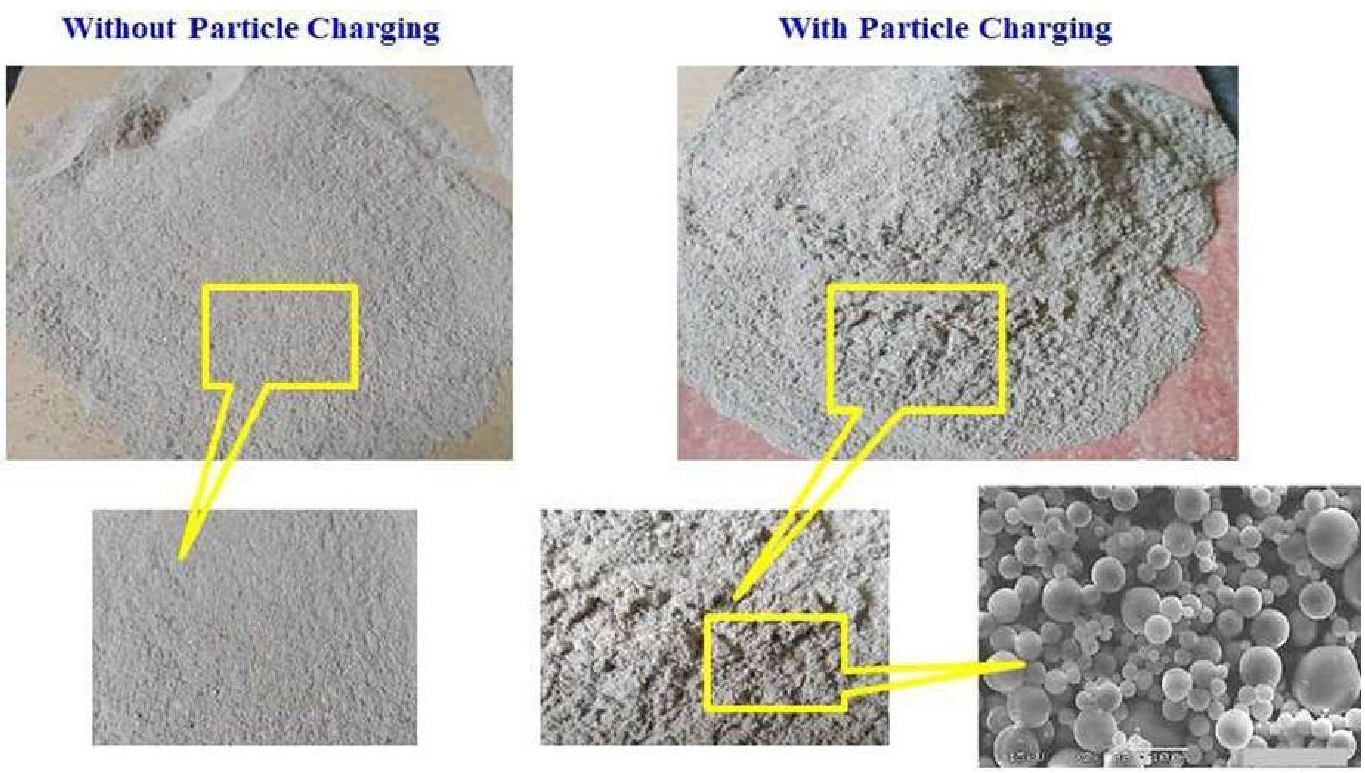


Fig 5 Collection efficiency of cyclone configuration



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Iron ore Beneficiation
A need of the hour

Dr. MEDA VENKATAIAH, Director, M/s. MSPL Limited

ABSTRACT

India has plans to increase the production of Iron & Steel to meet the requirement of infrastructure development of the Country. The iron ore mining at Karnataka, Odisha, Chhattisgarh completed more than 7 decades after independence.

Bellary -Hospet Iron Ore deposits of Karnataka forms a part of 'Sandur Schist Belt". The formation belongs to Iron Ore stage of Dharwad group of Schistose rock. The Banded Hematite Quartzite/Jaspers, the important source rocks for the Iron Ores in the area are prominent.

Over a period of 70 years extraction of Iron ore for export through MMTC till 1990, later for direct export during 2000 -2015, the best quality of iron ore available on the top layers of the deposits vanished and now low-grade ores and High Siliceous ores as defined by IBM classification are being extracted.

Except to New Mine areas being auctioned in Eastern Sector, the present working Mine areas are also started the low grade ore extractions and up gradation is being considered.

As per threshold of IBM, it is necessary to extract and use +35% Fe ores. Hence, the beneficiation of these grades of Iron ore became Need of the hour. Except to very few Mines in NEB range, the present operating mines are extracting low grade ores only. The detailed exploration reveals average grade of resources/reserves left over around 50 to 53% Fe.

Many progressive Mining Companies already conducted tests and planning of beneficiation and value addition. The test conducted show the feasibility of upgradation to acceptable grades of Iron ore to Pellet Plants with Mass recovery ranging from 40 to 50%.

There are two scenarios:

1. Mine head beneficiation and supply to the end user
2. Supply to the Vendor who has facility to beneficiate low grade ores.

In this paper, the details of Mineralogy and processes involved are broadly discussed.

Systematic Dimension of stone Mining

GANESH MURTHY
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Introduction

Dimension stone is a collective term for various Natural stones used for Structural or Decorative purpose in construction and Monuments, defining features of dimension stone is that unlike other Mineral commodities which have mainly as result of their Physical properties

The ultimate success in marketing a Natural Stone as a dimension stone lies firstly in its appearance and secondly in Quality and Quantity of rectangular blocks of suitable dimensions

The extraction of dimension stones has been an integral part of human civilizations since ancient times

Dimension Stone Extraction Methods

Advanced Technology

The extraction of dimension stones using Advanced techniques entails the process of obtaining large blocks or slabs of natural stone from quarries through methods predating modern machinery and technology. These methods have been historically employed by ancient civilizations and traditional stone workers across different regions.

Driven by the rapid technological advancements in recent decades.

The natural stone extraction, including both traditional and mechanized approaches. The industry's shift towards state-of-the-art

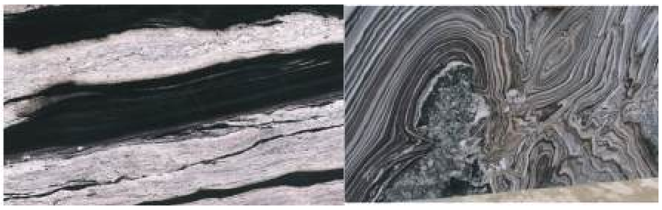
Granite is composed mainly of Quartz and Feldspar with minor amounts of Mica, Amphiboles, and other mineral Granite is an intrusive Igneous rock, characterized as Dark /light colored & Fine/ coarse grained Granite requirement is increasing with demands from rapidly growing infrastructural projects & housing sectors

Granite has a broad range of Physical and Chemical properties. The suitability of a granite for any purpose is decided by its properties which meet the specification established for the purpose.

Granite is mostly used because of their pleasing appearances and physical strength and the chemical properties are less important than the physical properties

Granite is composed mainly of quartz and feldspar with minor amounts of mica, amphiboles, and another mineral. Granite is an intrusive igneous rock, characterized as Dark /light colored & Fine /coarse grained Granite requirement is increasing with demands from rapidly growing infrastructural projects &housing sector The most important Stone quarrying and Processing activities have recently been involved in an impressive technological by advanced methods.

Modern quarrying techniques and scientific methods of Operations have led to very good recovery and less wastage of the valuable material.



Method of Successful quarry

- PROSPECTING
- Development
- Production of Raw Blocks and Processing in to Slabs Tiles and Monuments
- Granite Waste Utilization
- Operational Technique in Boulders and Sheet Rock
- Granite Waste Utilization

Granite Quarrying operation are opencast Semi Mechanized / Highly Mechanized by formation of benches, compact high wall are maintained without loose boulders /weathered Rock, Rock stability study are Frequently done.

Granite blocks are removed from disinterred deposits, on the basis of density, Fractures / bedding planes as the depth increases the operation technique to be changed. Quarry faces opening at the right location with sufficient provision for development of working faces, haul road, expansion of benches is important. Splitting becomes easy when prominent loose joints are present in vertical and horizontal planes, inspect the jointing patterns and confirm its nature.

Double Blade Cutting Machine can be deployed in a sheet rock with even with more joints, advisable in Black Granite and Colour hard Rocks formations.

No Drilling and Blasting required in the Exposed Sheet Rock

(Double Blade Cutting Machine- Diamond Wire saw – Air bags - Front End Loader- Chain Saw Machine)

The mining methods utilized in the extraction if dimension stone range from relatively simple and low technology methods to some quite technologically advanced methods, extracted using relatively advanced non-explosive cutting technologies and is even quarried in underground situations.

Mining dimension stones, it is necessary to split or cut the stone in to successively smaller required sizes until the final desired blocks size is achieved and saleable blocks are produced. From a particular quarry is made by the buyer (Marketing) Quality Quantity & defects free blocks Value addition with systematic and scientific method of operation.

Cycle of Quarrying Operations

The Granite mining process involves three important stages of operation

1. Prospecting
2. Granite Blocks production by quarrying Removal of Over Burden & Operation Technique in Boulders & sheet Rock
3. Blocks processing in to Slabs, Tiles & Monuments

Conventional Technique and Non-Conventional Mining Techniques

Conventional Technique

Conventional techniques involve the use of Explosives for Splitting the blocks from the granite mass, drilling with improper angles and Manual Shaping of blocks lets to less recovery and low productivity

Driling the holes manually by compressed Air with improper angle and charged with D-cord result inner cracks

Splitting of blocks without proper free faces causes uneven shape, cost of drilling increases unable to produce bigger size blocks (Gang saw)

Handling of blocks by Excavators results breakage lets to re-dressing of blocks in to small sizes further increases in processing cost and No value in international market. More Manpower required.

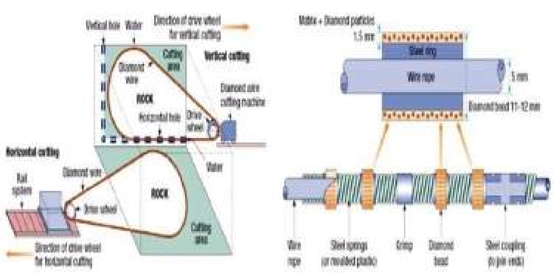
Non-Conventional Mining Techniques

No Drilling and Blasting

HEAVY EARTH MOVING MACHINERY ARE DEPLOYED UPDATED & SCIENTIFIC TECHNOLOGY MACHINERIES

Drilling Machine with Dust Collector and wet Drilling

FRONT END LOADER



Diamond Wire saw Machines

DGMS CIRCULAR

DGMS(Tech) Circular /02/2019 Dhanbad, Dated 29.11.2019

Operation and Maintenance & Safety Provisions, Design of Diamond Wire saw Machines and Diamond rope.

Double disc Blade Cutting Machine

Excavator & Tipper

DGMS CIRCULAR: No, DGMS (Tech) Circular No 6/ of 2020 Dhanbad, dated:27/02/2020 Guidelines in Respect of Provisioning of Safety Features to be incorporated for use in HEMM & Light Vehicles in Opencast Mines

CHAIN SAW GRANITE ROCK CUTTER

Latest advanced Technology in Dimensional Stones (Granite and Marbles) Non-Conventional Method of Mining Operations with very Less Manpower and No Dust, Noise and Vibration Water cutting and Dust Collector Systems.

The Mining Industry plays a crucial role in the extraction of natural resources including Granite

Chain Saw Machines are essential tools used in the mining process to cut and shape granite blocks into usable forms. understanding the products knowledge of these machines is vital for operators to ensure efficient and safe operations, this article aims to provide an overview of the essential product knowledge required for operating granite chain saw machine.

Recovery in Granite Quarrying

Granite waste utilization from the Dump yard

Granite Waste Low recovery poses a serious threat of uneconomic mining operation

The scientific way of operations and exploitation improves the recovery

Recovery Percentage in Black Granite is 5-8% and Colour Granite the Recovery may vary from Shade To Shade @ Max 30-40%

The natural defects present in the rock mass play vital role in deciding the rrecovery of quality blocks and profitability of operations.

Low recovery poses a serious threat of uneconomic mining operation

The scientific way of operations and exploitation improves the recover

The percentage of recovery of granite is quite low and it varies from Shade to Shade, there are more than 150 to 200 shades

The Conventional drilling operations were carried out without scientific and professional as result. the rock mass suffered damages by unwanted cracks. Result low recovery.

Majority of the quarries adopt unscientific method exploitation leading to very low recovery and productivity in terms of saleable blocks/slabs.

Exploitation by Scientific and Systematic, the recovery and Productivity can be improved within a short period.

The most important aspects in determining the recovery percentage depends on buyer in Non-Captive Mines the recovery is about 5% to 30% depend on the shades and deposits and marketing. In Captive Mines with cutting and polishing units by exporting the quality finished products and other sizes are sold in the local market conservation of materials are around 60 to 75%.

Quarry Granite Waste Dump

ENVIRONMENTAL & POLLUTION

Monitoring of Air Water Noise, Soil Erosion and Vibration as per the Norms recommended by the -Central Pollution Control Board - Compliance Report and Environmental Monitoring Reports Once in every six months.

CONCLUSION

Present Quarry technique has changed a lot in the manner of scientific and systematic way of operations and also in Safety and Environmental point of view. Granite waste can been converted in to Tiles, Cubes, Aggregates, M Sand & P. Sand. Minimum Royalty be fixed by the Government All the Granite Dumps can be utilized and save the

Hotels in Abandoned Mining Area

Land and use for Agriculture and other purpose.

Uniform Government Policy to be implemented throughout India for Minor Mineral (Dimensional stone quarries)

GCDR-1999 are applicable for all Granite quarries and each states have their own Rules (Karnataka Minor Mineral Concession Rules)

Our suggestion to the Directorate General of Mines Safety a separate Regulation, Rules Act etc Should be Implemented for Granite, Marble and (Aggregates Rough Stone Quarries.

Mining leases should be more than 5hec for adopting Modern Quarrying Techniques with Scientific way of operation – Improves Safety, Productivity and Safe Environmental Atmosphere.

Granite Quarry are all unorganized Sectors compare to last 20-30 yrs lot changes been happened in safety point of view, employment of statutory personals all most all quarry have come under a shadow of DGMS &workshop been contacted by Mines Safety Associations of Karnataka and mining Engineer's Association

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Separate Mining Zone to be formed like other industries

A Technology for Extraction of Locked-up Coal from Underground Mines using Artificial Pillars

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Abstract

In most of the coalfields of India, there are many mines where the seams are only developed but the pillars could not be extracted due to different constraints like presence of delicate surface/ sub-surface structures, chances of subsidence, forest area, scarcity of suitable filling material, environmental issues, etc. This may lead to spontaneous heating and fire, accumulation of poisonous gases, severe stability issues leading to unsafe workings and environmental problems. There is a need to extract these coal reserves under different constraints to meet the growing demand of coal in the country. It may not be possible to recover this coal in future if an early action is not initiated for development of a suitable technology and may be lost forever. Use of a artificial pillar may be an option to recover this coal locked up in pillars under the various constraints.

Introduction:

COAL is the most important and abundant fossil fuel in India. It accounts for 55% of the country's energy need. The country's industrial heritage was built upon indigenous coal.

Commercial primary energy consumption in India has grown by about 700% in the last four decades. The current per capita commercial primary energy consumption in India is about 350 kgoe/year which is well below that of developed countries. Driven by the rising population, expanding economy and a quest for improved quality of life, energy usage in India is expected to rise.

Considering the limited reserve potentiality of petroleum & natural gas, eco-conservation restriction on hydel project and geo-political perception of nuclear power, coal will continue to occupy centre-stage of India 's energy scenario.

Indian coal offers a unique ecofriendly fuel source to domestic energy market for the next century and beyond. Hard coal deposit spread over 27 major coalfields, are mainly confined to eastern and south central parts of the the country.The lignite reserves stand at a level around 36 billion tonnes, of which 90 % occur in the southern State of Tamil Nadu.

In most of the coal fields in india, there are many mines where the seams are developed by extracting only 15-20% of coal but the pillars could not be extracted due to different constaints like presence of surface/ sub surface features, danger of subsidence, lack of proper methodology, scarcity of suitable filling material, environmental issues, etc.,

As a result, the quantity of good coal is locked up in pillars for many years. Besides probability of loss of valuable coal resources; spontaneous heating , generation/ accumulation of toxic gases, development of unsafe environment, endangering of inhabitants and surroundings are some of the problem associated with locked up coal standing in the developed pillars.

These pillars are slowly becoming unapproachable due to a number of geo technical and environmental reasons. It is anticipated that it may not be possible to extract this coal in future if an early action is not taken for development of a suitable technology for their extraction. The technology would provide economic benfit to the country in general and conservation of coal for better energy resource management in a particular besides reduction of spontaneous heating of coal responsible for mine fire, noxious gases, sudden collapse of overlying roof causing accidents, surface subsidence and damage of land and important built up structure. This paper is undertaking for development of a technology to extract the locked-up coal by using ARTIFICIAL PILLAR.

Present technology to support depillared area:

The void created due to the extraction of coal during depillaring gives adverse effects on the surface/ sub surface structures due to large scale disturbance of overlying stata and caving. There are a number of places, where depillaring by caving is not possible or permitted due to presence of delicate surface/ sub surface constraints. Somewhere stowing or filling of the void is done to handle the detrimental effects of caving. Materials which are being used for stowing/ filling of the void are given below:

1. Sand Stowing
2. High Concentration fill technology using flyash
3. Granulated slag as a stowing material.

Global scenario of use of Artificial Pillars:

Pillars in underground mines plays an important role to support overlying strata and to maintain the stability of surrounding structures. If these pillars are reduced during depillaring the whole structure becomes unstable due to increase of stress as the exposure of roof is much more during depillaring. This may be handled by forming artificial pillars which also increase extraction ratio. Pastarus et al (2012) used the concept of artificial pillar in Estonian oil shale mines to increase the extraction ratio and to reduce the dilution of ore. Waste rock and oil shale combustion ash with some binding material are used as construction material of artificial pillars. Analysis showed if percentage by volume of backfill is from 50 – 80 % and excavation depth is 60 – 80 m, the load on a pillar was less than 4MPa. Consequently, the uniaxial compressive strength of the backfill(pillar) after placement did not exceed 4MPa. Load on a pillar depends on applicable technology, in particularly on roof

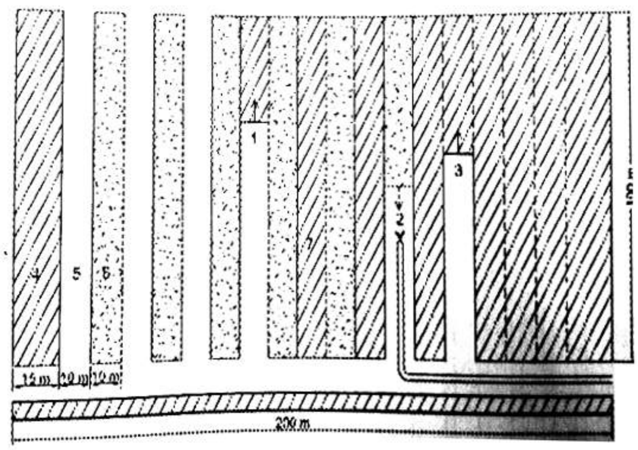

Fig 1

stability conditions and on quantity of available backfill materials(ash and limestone). The method of extraction is shown in figure 1.

Hahn et al. (1983) suggested horizontally reinforced artificial pillars to support tabular excavation.It was postulated that reinforced ash pillars(rib pillars or walls) of adequate strength can be designed with a cross sectional area to ensure that about 25% of the roof and floor is in contact with the new pillars, it tres to expand laterally depending upon its poisson's ratio.

So this expansion can be resistence by making the pillar stiff by reinforcement. It also helps to create confinement to the pillar, thus increase the strength of the pillar. He also suggested that pillar strength and yield strength of the reinforcement material should exceed the pillar load and tensile stress respectively for stability of the pillars. This is economical only if the extraction ratio achieved by conventional bord and pillar method is less than 60%.

Hahn et al.(1983) also modelled continuous artificial rib pillars of 1.2 m wide and 1.8 m high which are separated by 6.3 m in longwall mining panel. The compressive modulus of the pillar material was 1 GPa.

Figure 2 shows the distribution of vertical stresses acting on the abuntments and artificial support pillars. He proposed to compress the lower portion of the support rib to the design load so that advantage of higher reloading modulus can be taken i.e., if the pillars have higher reloading modulus vertical stress is high in artificial pillars and less in abuntment zone. For this, a space of at least 300 mm is required for the insertion of the jacking system.

Xinming et al.(2001) studied stabilization of backfilled material by using Portland cement, Fly ash and tailing with the ratio of 1:2:8. The compressive strength of the material can reach 2MPa after 90 days which meets the requirement of artificial pillar and reduces the coat of filling by 20 – 30 %.

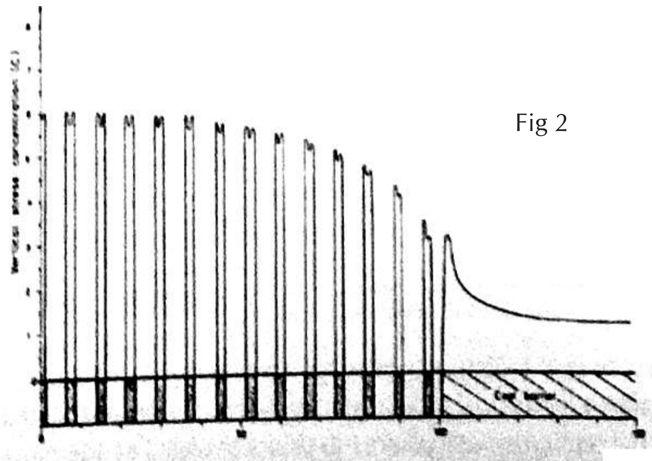

Fig 2

Figure 2: Stress distribution around a 100 m-wide total extraction panel situated at a depth of 100 m

Haul et al. (2008) studied an experiment to evaluate effect of the grounting method on artificial pillar. Here crushed stone of 10 – 20 mm diameter and water cement ratio of 0.5 as grounting material were used to form Artificial Pillar. Three types of grountng method had been suggested:

1. Upward Grounting
2. Lower Grounting
3. Twice cycle upward or downward Grounting

The downward grounting method was much more effective than upward grounting method in respect to the strength of the artificial pillar as porosity decrease due to increase of injection volume which depends on the injection height of grounting material. The large expenditure for stowing the void pushes to think over alternative technology for optimal extract the mineral. In this context artificial pillar comes into play. By using artificial pillar, total area need not to stow which somehow reduces the expenditure of stowing.

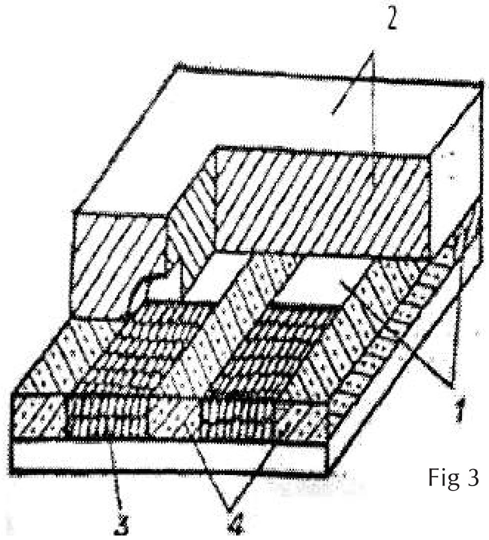

Fig 3

Proper design of Artificial pillar is essential to sustain the load of overlying strata where the area is not stowed. To know the deformation of artificial pillar in mining a deposit with stowing and caving. Here extraction method was proposed to extract the ore by using artificial pillar. Figure 3 shows the method of extraction where the sections were worked between the artificial pillars. Temporary ore pillar were formed between them. The roof span formed between artificial pillars in the stage of extraction of temporary ore pillar was very large and lead to development of uncontrollable roof self caving. The limiting width of temporary ore pillar was established in relation with roof cavability. The load on the artificial pillar starts to increase only behind the working front for temporary ore pillar.

Proposed methodology for extraction of locked up coal:

Extraction of locked up coal becomes very risky operation as it may leads to movement of overlying strata which may causes damage of surface structure if the strain rate goes beyond the stipulated value. Stowing alone cannot prevent overlying strata movement due to compaction of stowing materials. To avoid the strata movement, it is proposed that artificial pillars of suitable dimensions may be erected and or some rib pillars must be during depillaring which must have long term stability. If the rib pillars of sufficient factor of safety are left then the percentage of extraction drastically fall down. Depillaring with leaving sufficient stable rib pillars may avoid the stowing but decrease the percentage of extraction which is generally not satisfactory. It is experimented in the laboratory that the strength of pillar can be increased more than three times by some artificial means. So by increasing the strength of small size rib pillars, it is possible to increase the percentage of extraction.

Figure 4 shows the conventional methodology for extraction of locked up coal pillar(22.6 m * 22.6 m) with stowing by leaving the rib pillars which is a factor of safety almost two. In this case, coal seam situated at a depth of 100 m. Pillar is spitted with 4.2 m split gallery and three dip and rise slices have been driven with gallery width of 4.2 m by leaving eight rib pillars of 9.2 m * 2.5 m. Then the void is filled up with stowing material. By this method only 64% coal is extracted.

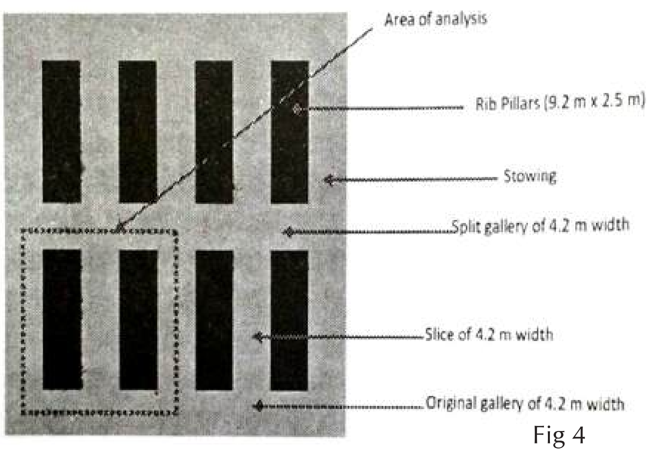

Fig 4

Figure 5 shows the methodology of extraction of locked up coal pillar(22.5 m * 22.5 m) with stowing by leaving the rib pillars(3.5 m * 3.5 m). In this case, double splitting has been adopted. The width of split gallery has been kept to 6 m. After that two slices have been taken with a width of 6 m gallery by leaving nine rib pillars of 3.5 m * 3.5 m and void are filled up with stowing materials. Before filling the voids, strength of rib pillars are increases up to three times by artificial means. The factor of safety of rib pillar achieved in this case is almost three which

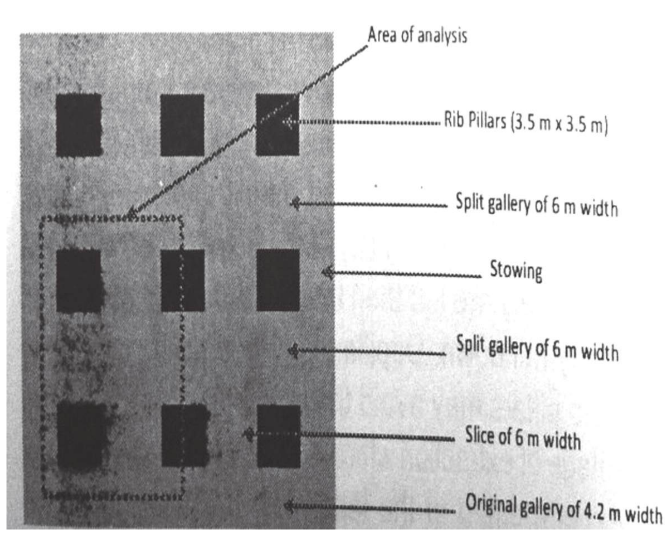

Fig 5

inferred long term stability of these rib pillars. The percentage of extraction may be achieved for this method is up to 78%.

Conclusion:

There is a pressing need of a technology for the mining industry to extract the huge amount of coal locked up under different constraints. An initiative has been taken to develop such a technology using artificial pillars. Effective use of fly ash or other waste material may be possible to use for construction of artificial pillars and also to increase its strength through artificial means. By replacing coal pillars with artificial pillars, land and important surface/ sub surface structures can be protected. If the technology is developed for coal mining, it would be possible to extract the locked up coal from certain geo-mining conditions in India.

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Importance of Lockout / Tagout (Lotto)

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Abstract:

As industrial processes evolved, advancement in machineries started to require more specialized maintenance procedures. More serious incidents occurred that involved highly technological equipment at the time causing problems for LOTO Safety. Servicing powerful energized systems were identified as one of the key contributors to injuries and fatalities in the evolving times.

Introduction: In 1982, the American National Standards Institute (ANSI) published its first guidance on the practice of lockout/ tagout to provide safety precautions in the maintenance of hazardous energy sources.

LOTO guidelines would then develop into an Occupational Safety and Health Administration also known as (OSHA) regulation in 1989.

The OSHA standard for The Control of Hazardous Energy (Lockout/Tagout) (29 CFR 1910.147) for general industry outlines measures for controlling different types of hazardous energy. This standard applies to the control of energy during servicing and/or maintenance of machines and equipment.

Importance: LOTO is crucial for several reasons: a. Preventing Accidents, b. Protecting Workers

Responsibility: The LOTO standard establishes the employer's responsibility to protect workers from hazardous energy.

The Need: When performing maintenance, Lockout-Tagout can successfully prevent mishaps brought on by moving parts and machine energy. Additionally, the visible presence in the workplace contributes to the development of a strong safety culture so that every employee can make it home safely each day.

By temporarily disconnecting machines from their power sources, Lockout-Tagout prevents industrial mishaps. The technique and related instruments make sure that while work is being done, machines do not abruptly stop or turn on.

Loto procedures can be customized to address the unique energy sources and risks associated with different industries.

Causes of Injuries related to Lockout / Tagout are

- Lack of awareness of LOTO at management and worker level.
- Failure to Lockout Hazardous Energies.



- Failure to disconnect equipment/machines from power source.
- Failure to dissipate STORED ENERGY.
- Failure to verify isolation & zero energy state of machines.
- Failure to follow Machine/Equipment specific procedures.
- Accidental restarting of Equipment.
- Lack of LOTO SYSTEM, periodic training and audit in a plant.

Types of LOTO: There are different types of LOTO procedures, each tailored to specific situations and industries: a. Electrical LOTO b. Mechanical LOTO c. Hydraulic LOTO d. Pneumatic LOTO e. Thermal LOTO f. Chemical LOTO.

The difference between lock out and tag out is the device used. The lockout device stops employees from operating the equipment while the tagout device informs them that the equipment should not be operated. Essentially, a tagout device is the second layer of protection against unsafe equipment operation while a lockout device is the first layer.

The tag can use for a variety of applications relevant to energy release like:

- Blocks
- Disconnect switches
- Line valves
- Electrical circuit
- Gas line
- Water lines
- HEMM Operational Equipments
- Other devices block and isolate an energy source

Types of Lockout & Tagout types: The types are 1. gate valves, 2. ball valves, 3. plug valves 4. butterfly

valves 5. Lockout Cables with Hasps & Locks 6. Lockout Group Boxes.7. Lockout Padlocks 8. Lockout Kits & Stations.

Tagout types: 1. Caution tag. 2. Do not operate tags. 3. Equipment lockout tag. 4. Fire inspection tag. 5. Lockout photo tag. 6. Out of service tag. 7. Scaffolding tag

8 Steps of Lockout-Tagout (LOTO) Procedure

Step 1: Preparation – During this stage, the authorized employee should investigate to identify the equipment, machine, or process to be shut down. As a safety measure, this step should also recognize which energy resources must be controlled and highlight all the potential hazards that come with it.

Step 2: Notification – In the second stage, all affected personnel should be notified of the shutdown. Essential items to communicate can include information such as the equipment to be locked out, the reason behind it, the estimated time frame of the shutdown, the authorized personnel for the shutdown, as well as who to contact for clarifications and questions.

Step 3: Shutdown – After the planning stage, the actual equipment shutdown begins. For this process, follow the shutdown procedures established by the manufacturer or the workplace itself. Turn off the controls and make sure that all the running parts of the equipment come to a total stop.

Step 4: Isolation – This stage, also called de-energization—is the part where the authorized person will be needing to remove the equipment from any energy sources it is connected to. Some equipment may need to be shut down by turning off power from the breaker or by simply shutting a valve.

Step 5: Dissipation – In simpler terms, this is the process of removing possible residual energy still in the equipment. Depending on the type of equipment or power source, residual energy can either be disconnected, restrained, relieved, or made non-hazardous.

Step 6: Lockout/Tagout – During this actual lockout/tagout stage, the equipment is locked using energy-isolating devices. The tag to be attached, meanwhile, should contain the name of the person who performed the lockout and other additional information needed.

Step 7: Isolation verification – In this last stage, all the steps conducted have to be re-checked to ensure that everything is as it should be. Treat this as an opportunity to test the equipment by activating the process controls and observing the result. Non-activation of the equipment is a confirmation that energy isolation is completed.

Step 8: Putting the Equipment Back into Service – When the machine or equipment has been serviced or repaired, it's time to get the work area and personnel ready for startup. Procedures must be followed in the correct order.

- Make sure that the machine or equipment is fully reassembled (guards and safety devices are reinstalled; access panels are closed). Then, check that tools have been cleared from the work area.
- Survey the work area, checking to see that all personnel are in a safe spot or removed from the area.
- Verify all controls are in neutral.
- Remove tags and lockout devices (by the same person who applied them).
- Inform affected personnel that the servicing or maintenance is finished and the equipment is ready for use.

If an Employee is Not Available to Remove the Lock: The safety supervisor can remove the lock, provided that:

- they have verified that the employee is not in the facility
- they have received specific training on how to remove the device
- the specific removal procedure for the device is documented and included in the facility's lockout tagout program

After removing the lock, the safety supervisor must also contact the employee to inform them the lock has been removed and must confirm that the employee is aware of this before they resume work at the facility.

Colors of Lockout Locks and Tags

To sum up, there are no standard rules regarding the colour of Lockout-Tagout locks. Any Lockout-Tagout safety programme can specify its own Lockout-Tagout padlock colour coding. Therefore, depending on the business, a colour may have a different connotation.

Typical color codes are:

- **Red tag = "DANGER"** for machine maintenance, Personal Danger Tag (PDT)
- **Orange tag =** "WARNING for external employees, group isolation or lockbox tag
- **Yellow tag =** "CAUTION for electrical, Out of Service Tag (OOS)
- **Blue tag =** for contractors, used during commissioning and test tag
- **Red lock =** "DANGER" an authorized worker, for machine maintenance, used by an authorized employee to lockout equipment during servicing

- **Orange lock** = "WARNING for external employees, used by a group isolator to indicate that servicing is safe to perform
- **Yellow lock** = "CAUTION for electrical, used by an affected employee to lockout equipment before servicing
- **Blue lock** = for contractors, used instead of an orange lock for lockboxes with more than 6 isolation points
- **Purple** = used when a lock crosses over a shift, it would be put on by the authorized worker, and they will remove their red lock
- **Fluorescent Orange:** for BIOLOGICAL HAZARD

Lock Out Tag Out Training

Since lockout tagouts have different levels of access, there are also different levels of training required for each type of access:

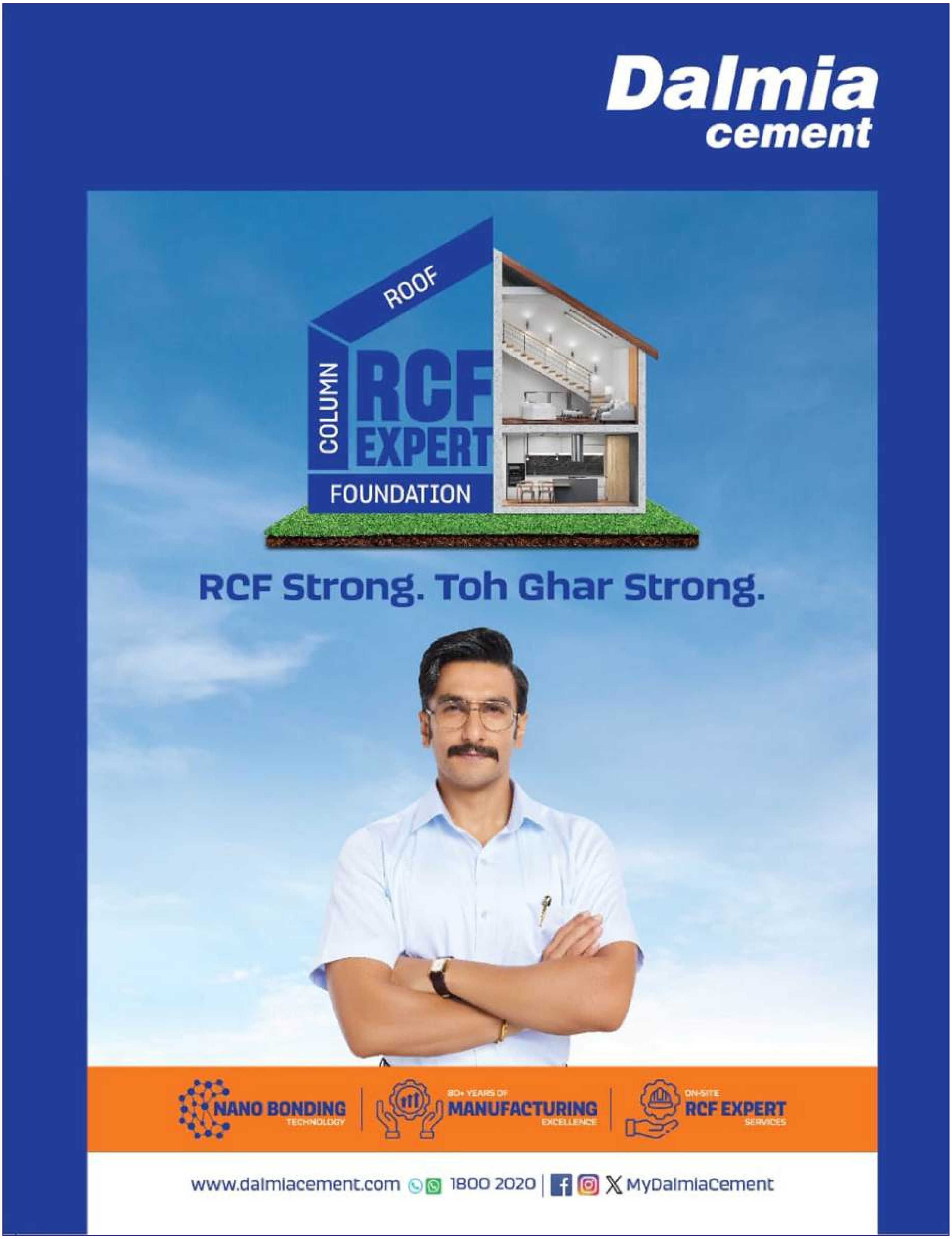
- For authorized employees, training must include hazardous energy sources, the type and magnitude of hazardous energy, and methods for energy isolation and control
- For affected employees, training must include the purpose and use of LOTO procedures
- For other employees who are or could be in the area that LOTO procedures are being applied, training must include prohibition rules on restarting equipment that is locked out

Enforce lockout Tagout documentation

For future mitigation support, ensure that everything related to lockout tagout is documented. This includes the lockout tagout policy, pocedures, inspections, training, reports, and audits. For a centralized.

Conclusion

Performing lockout/tagout procedures is a way to ensure the safety of workers, particularly from hazardous energy sources. Failure to comply with LOTO standards not only causes fines, but also potentially causes injuries and even fatalities. Tools such as lockout and tagout devices, as well as available software, should be maximized to make the workplace safer.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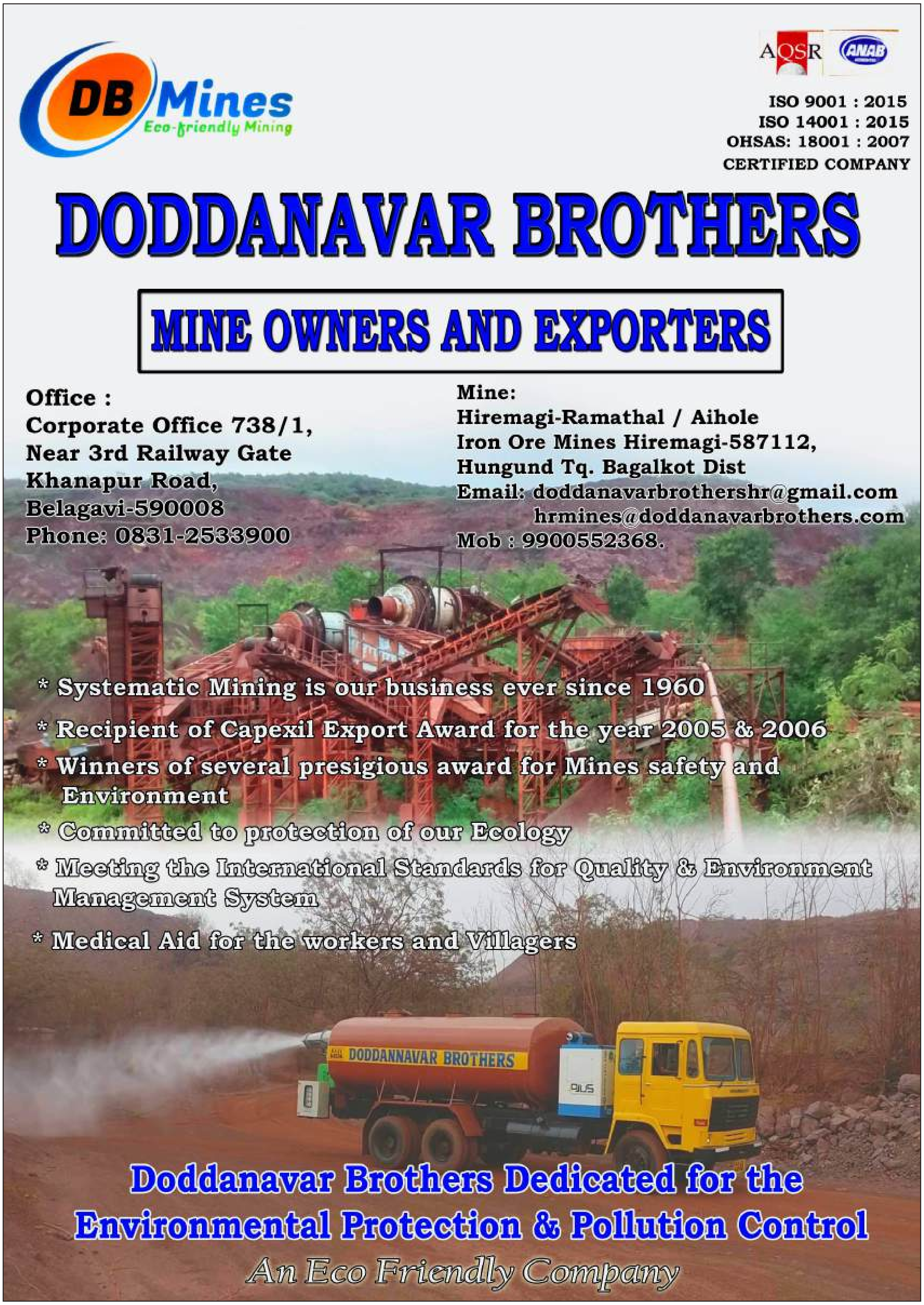
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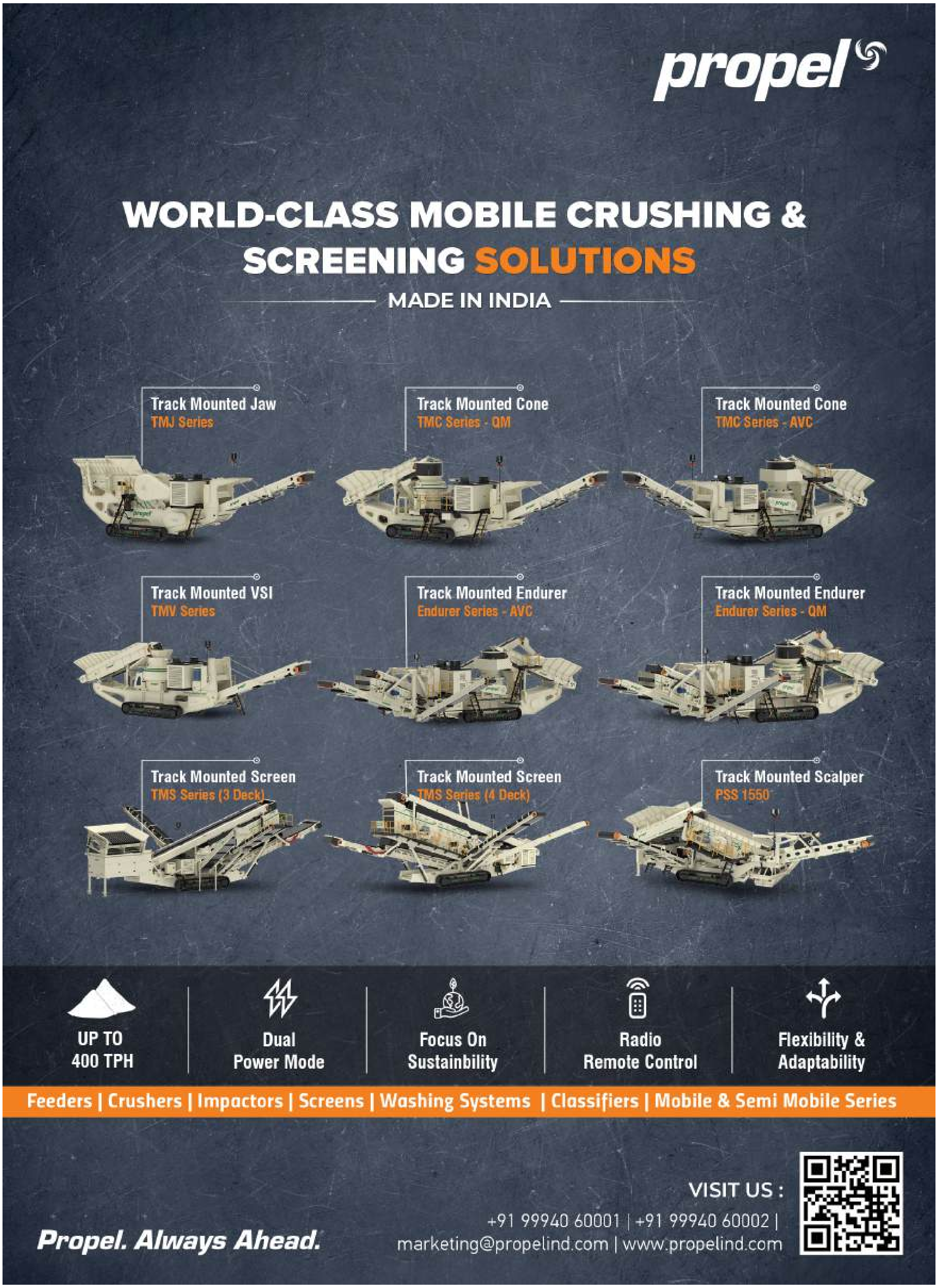
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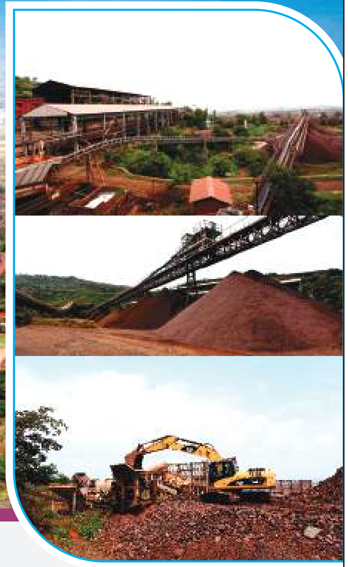

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Rai Bahadur Seth Shreeram Narasingdas Pvt. Ltd. established in 1951 is environmentally conscious, iron ore mining and processing company that approaches its operations in a sustainable and eco-friendly manner.

Our SANKALAPURAM IRON ORE MINE has rarely occurring, rich mineralogy enabling us to supply high-density metallic Hematite, which has applications in the construction of nuclear power plants, thus directly contributing to the nation-building process.

Our IRON ORE BENEFICIATION PLANT of 5.00 MMTPA (Installed capacity) upgrades the unusable low-grade iron ore, available abundantly in this region, and, makes it usable in sponge iron and steel plants.

Our array of Iron Ore products from the Mine and Beneficiation Plant are:

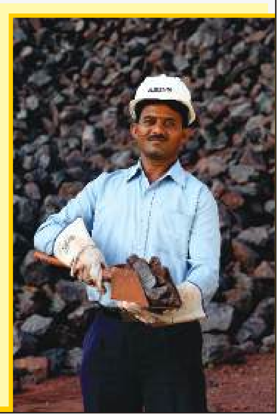
IRON ORE PRODUCTS	Application Industry
Hematite Lumps (10mm to 40mm)	Blast Furnace Plants
Hematite Lumps (5mm to 20mm)	Sponge Iron Plants
High Density Hematite Aggregate	Nuclear Power Plants Construction
High Density Hematite Sand	Nuclear Power Plants Construction
Hematite Fines (-10 mm)	Steel Plants
Sinter Fines	Sinter Plants
Iron Ore Concentrate	Pellet Plant

SAND MANUFACTURING DIVISION

Rai Bahadur Seth Shreeram Narasingdas Pvt. Ltd. Sand Manufacturing Division, located at Somandepalli village in Andhra Pradesh is going to produce M-Sand & P-Sand. The Sand produced here can be used for construction, Interiors & has numerous other uses. The stone waste from the plant can be used for road making and will be sold accordingly.

RENEWABLE ENERGY

Rai Bahadur Seth Shreeram Narasingdas Pvt. Ltd. along with its sister concern M/s Rajlakshmi Minerals, has invested in wind power projects that are located in four Indian states: Karnataka, Tamil Nadu, Gujarat, and Maharashtra, totaling to 34.75 MW of installed capacity. Using this wind power we are 100% self-sufficient in our energy requirements in both the Beneficiation Plant and mines.



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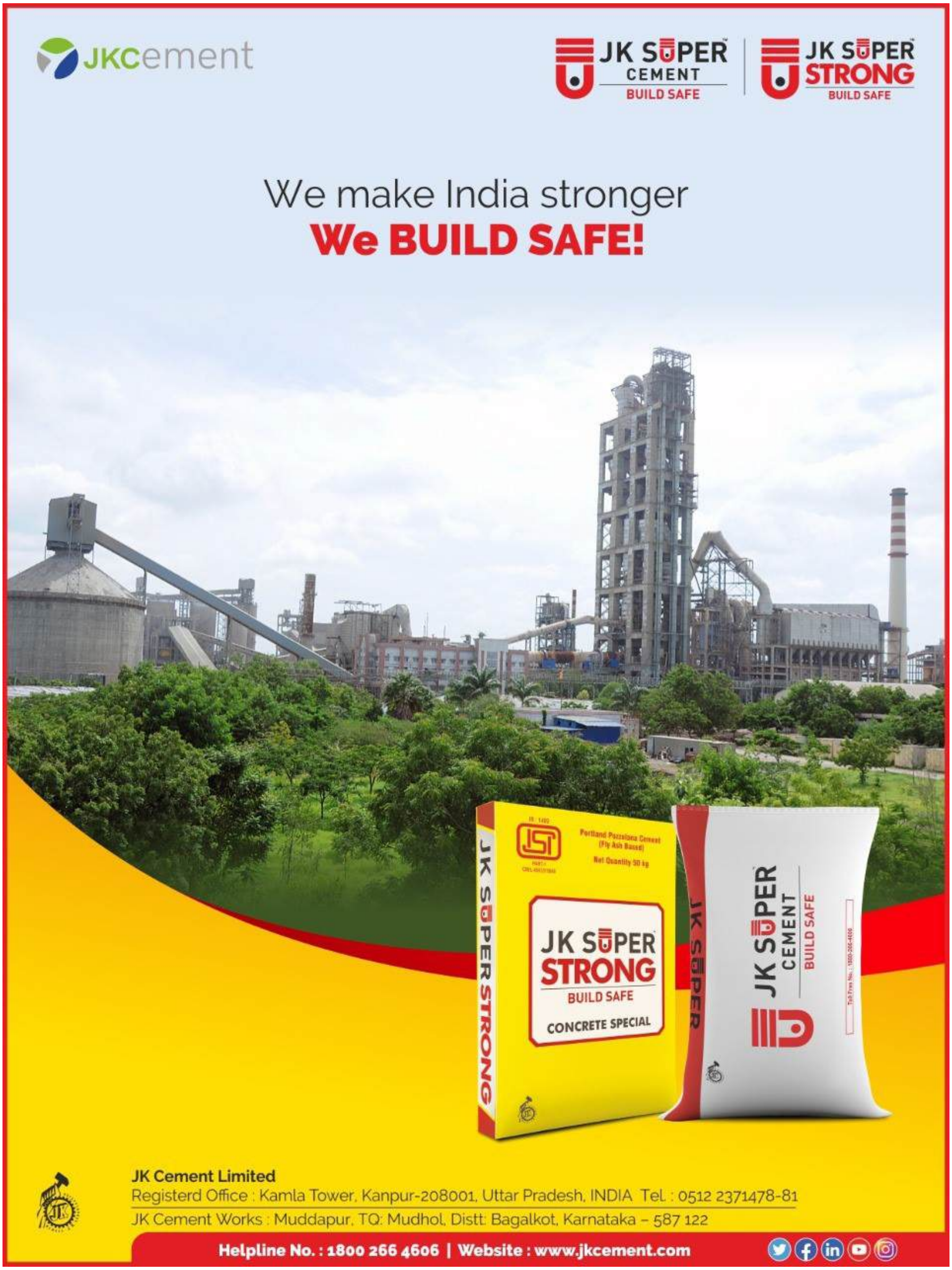
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- Systematic and eco-friendly mining activities
- Extraction and Marketing of Minerals and Granite in the state
- Evolved as a major player in the production of Iron ore, Granite & many other minerals, adopting modern technology.

Minerals produced by KSMCL


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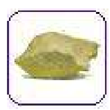
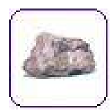

Dolomite

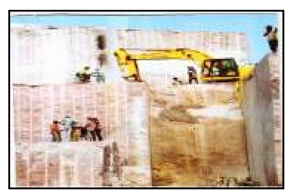

Soap stone


Bauxite

Working of Mines and Quarry


Subbaryahalli Iron ore Mine


Bageshpura Clay Mine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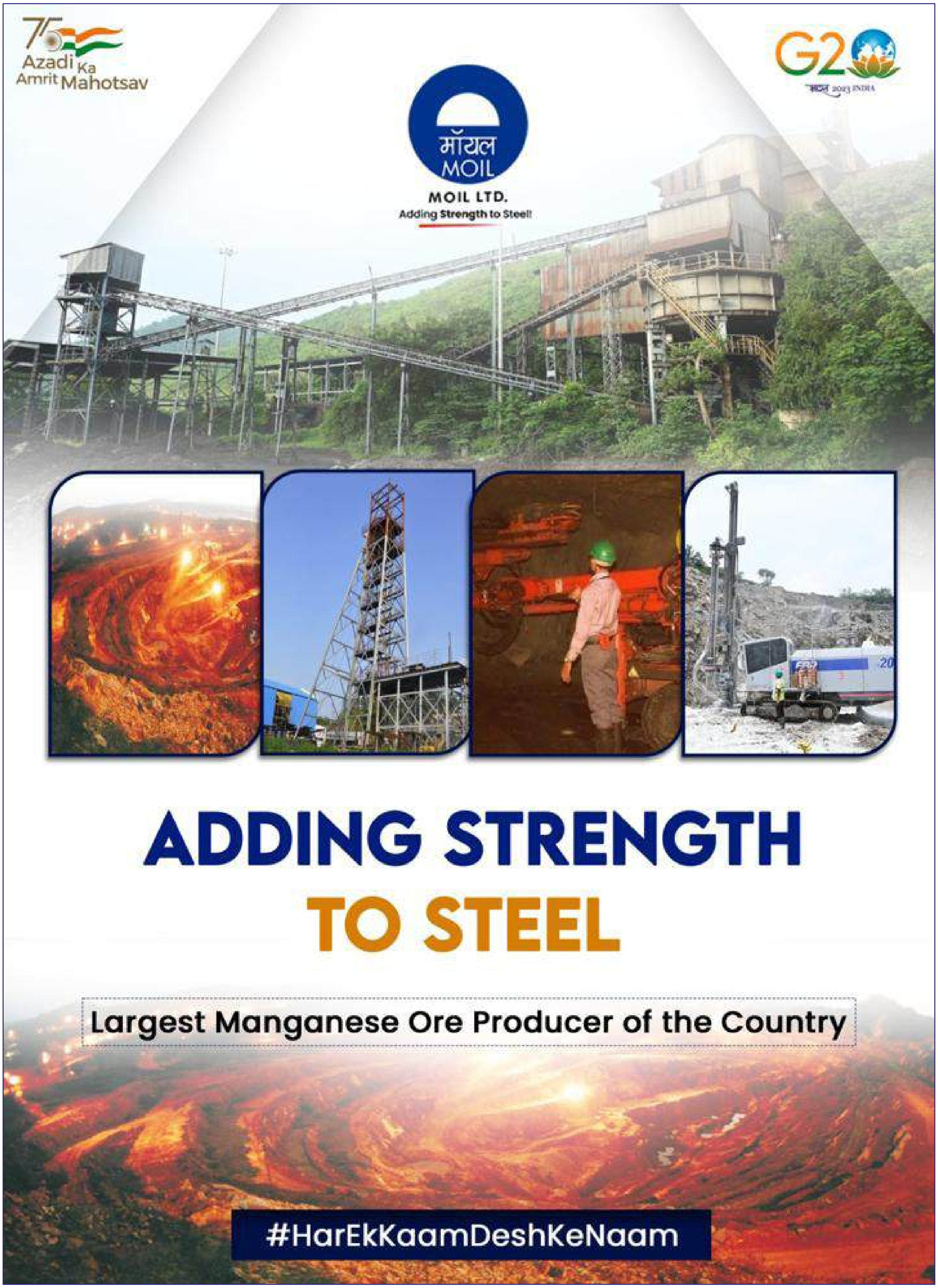
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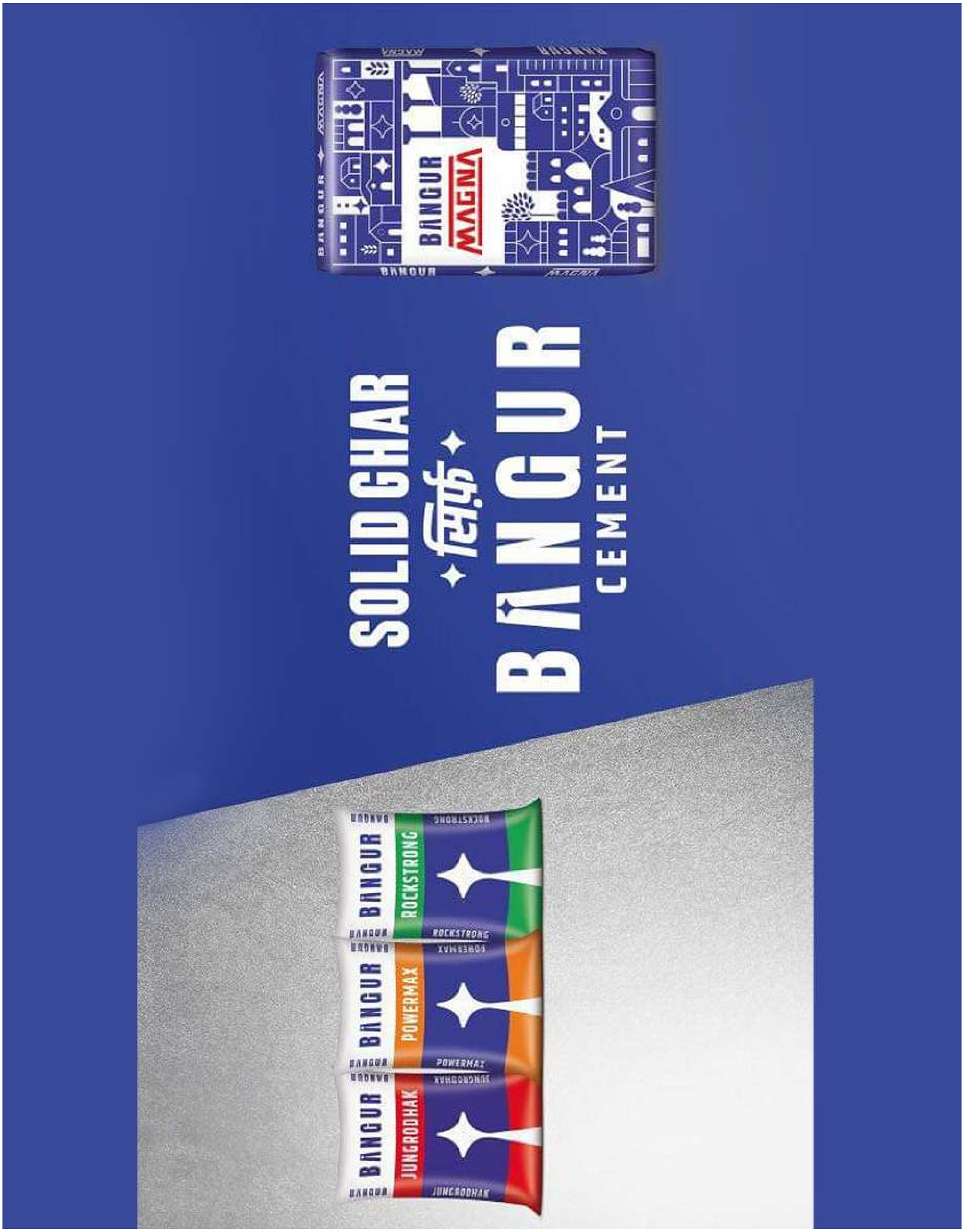
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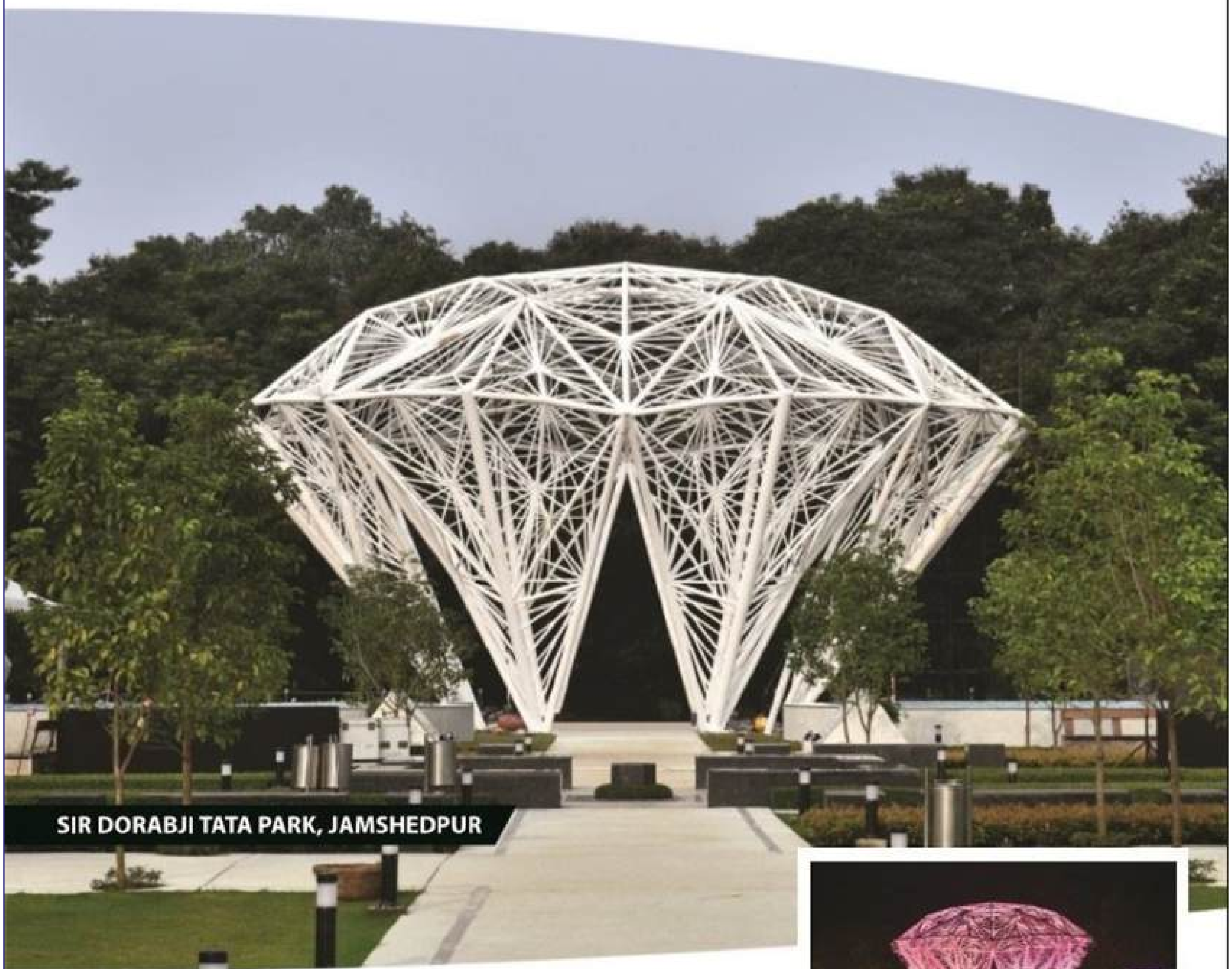

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GVTC - CN Halli, Journey so far…

2008
•GVTC Committee Formed

• Temporary GVTC at MML Byrapura started.

2009 .GTVC Byrapura in operation

2010
•GVTC Trust Registration under Presidentship of Late Shri S.A.Nabi
•Mine owners meeting at Bengaluru under leadership of former DDG, Shri. Sen Gupta seeking contribution towards construction of GVTC & Improvements.

• JC Pura land Registration on 03.03.2011

2011 • Training Started on 25/6/2011 at Rented Building

2012
•Foundation Stone laid for new building
•on 14/3/2012

2013
•Completion and occupancy at present GVTC premises in Feb 2013

2014
.Inauguration of GVTC
On 21.12.2014

2022
.First-aid Training Center inauguration
On 02.06.2022

2023
.Skill Development Training inauguration | PMKVY 4.0 And
Simulator inauguration
on 28.12.2023

Current Activities

Since its commencement in the year 2011,Facilites and key achievements of **GVTC** Chikkanayakana Halli are as follows

MSAK Zone-3, 90 Mines Utilizing the Training Facility

- Till date Initial & Periodical training imparted to 3300 personnel in MSAK Zone 3
- Well equipped Mining , Mechanical Model Rooms and First aid Training Hall with Mankind CPR
- Theoretical classes with Practical Training are followed
- Audio Video mode of training
- Quiz and Interactive Sessions to evaluate training effectiveness
- Well equipped Gas Testing Room to conduct Gas Testing examination
- Dormitory, Library facility For Trainees
- Interactive sessions for competency examinations like Blaster, Mate, Foremen, Second Class and First Class Mines Manager
- Imparting first aid training and issuing First aid Competency Certificate
- Conducting Mock Drill on First Aid
- Till date First aid training imparted to 300 personnel in South India
- Since from 2012 to 2022 Continues conducted Statutory Examinations center like Blaster, Mine Mate and Gas testing
- Simulator Training For Dumper, Front end Loader & Excavator operators
- Skill development Training under PMKVY 4.0 training imparted to 60 drivers