विकसित खदान
विकसित भारत

2024

SOUVENIR

42ND ANNUAL METALLIFEROUS

MINES SAFETY WEEK CELEBRATION – 2024

Under The Aegis of Directorate General of Mines Safety
Bhubaneswar Regions 1 & 2

AM/NS INDIA

ArcelorMittal & Nippon Steel India

TATA STEEL
WeAlsoMakeTomorrow

TATA

RECOGNITION FOR OUR GREEN DEDICATION

Tata Steel has been recognised as a Steel Sustainability Champion 2024 by worldsteel, making it one of only two companies to receive this recognition every year since the programme's inception in 2018. This achievement highlights our commitment to environmental stewardship, social responsibility and governance excellence. Sure, we make steel.
But **#WeAlsoMakeTomorrow.**

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42nd ANNUAL METALLIFEROUS MINES SAFETY WEEK CELEBRATION

Bhubaneswar Regions 1 & 2

2024

SOUVENIR

42ND ANNUAL METALLIFEROUS MINES SAFETY WEEK CELEBRATION-2024 (BHUBANESWAR REGIONS)

SAFETY WEEK COMMITTEE

Shri Prafulla Ranjan Thakur
Chairman

Shri T. Hari Prasad
Vice Chairman

Shri Ulimela Siva Sankar
Vice Chairman

Shri Sharanappa Kambalii
Convenor

Shri Pramod Mishra
Secretary

Shri B Jagadeesh Kumar
Joint Secretary

Shri Sambit Mohapatra
Treasurer

42ND ANNUAL METALLIFEROUS MINES SAFETY WEEK CELEBRATION 2024

42ND ANNUAL METALLIFEROUS MINES SAFETY WEEK CELEBRATION-2024 (BHUBANESWAR REGIONS)

SOUVENIR COMMITTEE

G.V Satyanarayana
Chairman

B. Jagadeesh Kumar
Member

Pankaj Kumar
Member

Vijay Kumar
Member

P.C Barua
Member

D Vijayendra
Member

Keshabananda Gharei
Member

Pramod Kumar Patra
Member

Sibaprasad Panigrahi
Member

Rajesh Ranjan
Member

Dr. Hari Babu Kambhampati
Governor, Odisha

RAJ BHAVAN
BHUBANESWAR - 751 008

July 05, 2025

MESSAGE

I am delighted to know that **ArcelorMittal Nippon Steel India Pvt Ltd.** is hoisting the 42nd Annual Mines Safety Week celebration on July 13, 2025 at Barbil, Odisha. A commemorative **Safety Week Souvenir** is also being brought out during the event.

As a cornerstone of the nation's growth and economic progress, the mining sector presents distinct challenges and hazards that necessitate steadfast dedication to safety measures. Through collaborative efforts, we can cultivate a workplace that prioritizes safety, enhances well being and boosts productivity.

I am hopeful that the planned initiatives and activities for this Safety Week will promote a robust culture of safety and proactive risk management. I wish the event and publication all success.

(Hari Babu Kambhampati)

Phone : 91-674-2536111/2536222, Fax : 91-674-2536582, E-mail : govodisha@nic.in, Website : www.rajbhavanodisha.gov.in

MOHAN CHARAN MAJHI
CHIEF MINISTER, ODISHA

सत्यमेव जयते

LOKASEVA BHAVAN
BHUBANESWAR

MESSAGE

I am glad to know that the 42nd Annual Metalliferous Mines Safety Week Celebration under the aegis of DGMS Region-1 & Region-2 of Bhubaneswar is being observed from 11th Nov'24 to 28th Nov'24.

Odisha is one of India's most mineral-rich states, playing a crucial role in the country's industrial economy. In the context of huge mining activities in the state, it is essential to maintain high standards of safety norms for the protection of workers in this sector. There is a need to develop safety standards with new technological support and promote awareness. Implementation of safety norms will certainly help prevent accidents and save human lives.

I extend my best wishes to the organizers, participant, and all mining units, and wish the event all success.

(MOHAN CHARAN MAJHI)

Phone : Office : 0674-2531100, 2531500, 2535100 (Fax)

1089/6-11-2024.

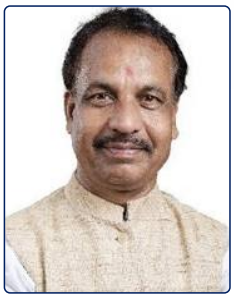
BIBHUTI BHUSHAN JENA
MINISTER
Commerce & Transport,
Steel & Mines.

Telephone :
PBX No. :
Mobile No. :

D.O. No. ...../MCTS&M.

BHUBANESWAR

Date .....



Message

I'm glad to know that the 42nd Annual Metalliferous Mines Safety Week Celebration under the aegis of DGMS Region-1 & Region-2 of Bhubaneswar to be observed from 11th Nov'24 to 28th Nov'24.

Safety is an integral part of Mining operations, and each of us bears responsibility for its adherence. Proper training on safety needs to be imparted to all stakeholders and highest safety standards should be practiced in all mines that are currently operational in our state. I commend the Odisha Metalliferous Mines Safety Week Committee for their efforts in fostering a culture of safety among mine owners and workers of all backgrounds, aiming to minimize accidents and achieve a zero-injury milestone in our mines.

I extend my warmest congratulations and best wishes to all committee members, mine owners, workers, invitees, visitors, and delegates participating in this meaningful event.

(Bibhuti Bhushan Jena)

SHRI SAMPAD CHANDRA SWAIN
MINISTER OF STATE (Ind. Charge)
Industries, Skill Development &
Technical Education, Odisha

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Email: minind2024@gmail.com

D. O. No. ...../MoS(I)ISD&TE.

BHUBANESWAR

Date 11.11.2024

MESSAGE

I am extremely delighted to know that, "42nd Annual Metalliferous Mines Safety Week-2024" is going to be commemorated from 11th to 28th November and a Souvenir is being brought out to commemorate the occasion.

The celebration's primary goal is to encourage all mine owners and workers to improve safe work procedures in order to drastically cut down on and eventually achieve zero damage in the mines.

I would like to thank all of the members of the organizing committee who participated in the celebration once again. I also hope that the Mine Owners, Workers and Mining Employees would enthusiastically attend the closing day function.

I congratulate all the Members and wish the celebration as well as publication of Souvenir all success.

(Sampad Chandra Swain)

42ND ANNUAL METALLIFEROUS MINES SAFETY WEEK CELEBRATION 2024

आज़ादी का अमृत महोत्सव

G20 भारत 2023 INDIA

Ujjwal Tah
Director General of Mines Safety

सत्यमेव जयते

भारत सरकार
Government of India
श्रम एवं रोजगार मंत्रालय
Ministry of Labour & Employment
खान सुरक्षा महानिदेशालय
Directorate General of Mines Safety

खान सुरक्षा महानिदेशालय
DIRECTORATE GENERAL OF MINES SAFETY

Message

I am very much delighted to know that Metalliferous Mines in the state of Odisha have observed 42nd Annual Mines Safety Week under the aegis of DGMS Bhubaneswar Regions 1 & 2 from 11th November 2024 to 28th November 2024 and the final day function is scheduled on 13th July 2025 at Barbil, Keonjhar-Odisha, which is being hosted by ArcelorMittal Nippon Steel India Pvt Limited.

It is learned that total 113 mines have enthusiastically participated in the Safety Week under the Bhubaneswar Regions-1 &2 including 89 mines of major minerals,22 mines of minor minerals and 02 underground mines.

The Pre-final events like 05 days defensive driving training and trade tests were organized for participation of workmen from all mines.

Odisha state is endowed with great abandons of reserves of Coal and other minerals needed by the nation. While bestowed with bounty of minerals reserves, the operation in mines of this region warrant special care and attention to maintain and promote safety of miners.

The awareness in Safety is an important step in the ladder of Safety promotional programs. Celebration of Safety fortnight is not only powerful tool of education but also a means of creating awareness amongst the mine workers, officials and other family members and sure that this safety fortnight creates greater safety consciousness that is sustained through out the year.

I am pleased to announce that this year theme **"VIKASIT KHADAN, VIKASIT BHARAT"** is helpful to mining community to maintain good health and safety as a part of our nation building.
I Convey My best wishes for the success of Annual Mines Safety Week Celebration, Safe & Productive workings of the Mines.

(Ujjwal Tah)

42ND ANNUAL METALLIFEROUS MINES SAFETY WEEK CELEBRATION 2024

आज़ादी का अमृत महोत्सव

सत्यमेव जयते

G20 भारत 2023 INDIA

भारत सरकार
Government of India
श्रम एवं रोजगार मंत्रालय
Ministry of Labour & Employment
खान सुरक्षा महानिदेशालय
Directorate General of Mines Safety
दक्षिणी पूर्वी जोन, रांची
South Eastern Zone, Ranchi

Dr. S. S. Prasad
Dy. Director General of Mines Safety
South Eastern Zone, Ranchi

Message

It is a matter of immense pleasure that 42nd Annual Mines Safety Week 2024 was observed from 11th to 28th November 2024 under the aegis of DGMS Bhubaneswar Regions 1&2, and its final day function will be hosted by M/s Arcelor Mittal Nippon Steel Ltd. on 13th July, 2025 at Barbil, Odisha.

It is learned that total 113 mines have enthusiastically participated in the Safety Week Celebration, including 89 opencast mines of major minerals, 22 mines of minor minerals and 02 underground mines.

Observance of safety weeks in the form of competitions has provided a good platform for creating awareness and inculcating safety consciousness amongst the mining community. It will also boost and stimulate the efforts of mining fraternity for harnessing the upcoming technological development and adoption of modern mining methods with advanced heavy earth moving equipment.

This year's theme "**VIKASIT KHADAN, VIKASIT BHARAT**" is helpful to the mining industry to achieve good standard of safety, health and welfare as a part of our nation building.

The observance of Mines Safety Week Celebration has been generating a lot of safety awareness over the years. I am sure the positive impact created by this celebration will go a long way in improving the overall safety standards in the mining industry.

I congratulate all participating mines on this occasion and wish this event a great success in achieving the goal for promoting safety in mines.

(S. S. Prasad)

42ND ANNUAL METALLIFEROUS MINES SAFETY WEEK CELEBRATION 2024

आज़ादी का अमृत महोत्सव

सत्यमेव जयते

G20 भारत 2023 INDIA

Nasina Balasubrahmanyam
Director of Mines Safety

भारत सरकार
Government of India
श्रम एवं रोजगार मंत्रालय
Ministry of Labour & Employment
खान सुरक्षा महानिदेशालय
Directorate General of Mines Safety
भुवनेश्वर क्षेत्र-2
Bhubaneswar Region-2

Message

It is with great pleasure to learn that the successful observance of the 42nd Annual Mines Safety Week 2024, held from November 11th to 28th, 2024, under the aegis of DGMS Bhubaneswar Regions 1 & 2. The concluding ceremony will be hosted by M/s ArcelorMittal Nippon Steel Ltd. on July 13th, 2025, in Barbil, Odisha.

A total of 113 mines actively participated in the Safety Week celebrations, comprising 89 open-cast mines specializing in major minerals, 22 mines dealing with minor minerals, and 2 underground mines.

Organizing Safety Week activities through competitions has proven to be an effective platform for raising awareness and fostering a safety-first culture within the mining community. Such initiatives encourage miners to adopt and integrate modern mining techniques and advanced heavy earth-moving equipment, paving the way for technological progress in the sector. This year's theme, "VIKASIT KHADAN, VIKASIT BHARAT," emphasizes the importance of safety, health, and welfare in the mining industry, contributing to the broader goal of nation-building.

Over the years, the Mines Safety Week celebration has played a significant role in promoting safety consciousness across the industry. It is my firm belief that the positive impact generated will continue to enhance safety standards in mining operations.

I extend my congratulations to all participating mines and wish this event great success in furthering the cause of safety in the mines.

N Balasubrahmanyam

(Nasina Balasubrahmanyam)

42ND ANNUAL METALLIFEROUS MINES SAFETY WEEK CELEBRATION 2024

आज़ादी का अमृत महोत्सव

सत्यमेव जयते

G20 भारत 2023 INDIA

ए. के. मिश्र
खान सुरक्षा निदेशक

भारत सरकार
Government of India
श्रम एवं रोजगार मंत्रालय
Ministry of Labour & Employment
खान सुरक्षा महानिदेशालय
Directorate General of Mines Safety
भुवनेश्वर क्षेत्र-1
Bhubaneswar Region-1

संदेश

मुझे यह जानकर अत्यधिक खुशी हो रही है खान सुरक्षा महानिदेशालय के तत्वावधान में 42 वाँ वार्षिक खान सुरक्षा पखवाड़ा 2024, दिनाँक 11.11.2024 से 28.11.2024 तक भुवनेश्वर क्षेत्र 1 और 2 के अधिकार क्षेत्र के अंतर्गत आने वाले धात्विक खानों में आयोजित किया गया था। यह भी खुशी की बात है कि पुरस्कार वितरण समारोह दिनांक 13 जुलाई 2025 को बड़बिल में आयोजित किया जाना है, जिसके दौरान एक स्मारिका जारी की जा रही है ।

राष्ट्र निर्माण के लिए खनिजों की बढ़ती माँग के साथ-साथ महत्वपूर्ण प्रौद्योगिकियों के विकास ने देश में खनन कार्यों के बड़े पैमाने पर मशीनीकरण का मार्ग प्रशस्त किया है और इसलिए, खान श्रमिकों की सुरक्षा आज की जरूरत बन गई है।

मुझे यकीन है कि इस तरह के समारोह खान के कामकाज में सुरक्षा की संस्कृति को विकसित करने में बेहद मददगार साबित होंगे और शून्य हानि के लक्ष्य को हासिल करना भी आसान बना देंगे। मुझे उम्मीद है कि सुरक्षा पखवाड़ा के विचार-विमर्श से खनन क्षेत्र में सुरक्षा के बारे में जागरूकता में काफी वृद्धि होगी।

खान सुरक्षा पखवाड़ा का पालन ऐसी उत्पादन रणनीतियों को तैयार करने के लिए खाका तैयार करने में काम आता है। ऐसे समारोहों से न केवल हितधारकों के बीच जागरूकता फैलती है बल्कि व्यावसायिक स्वास्थ्य और सुरक्षा के क्षेत्र में तत्काल और समयबद्ध कार्रवाई की आवश्यकता वाले मुख्य क्षेत्रों को समझने में भी मदद मिलती है।

इस अवसर पर मैं 42 वे वार्षिक खान सुरक्षा पखवाड़ा 2024 के पुरस्कार वितरण समारोह की सफलता की कामना करता हूँ।

(ए. के. मिश्र)

42ND ANNUAL METALLIFEROUS MINES SAFETY WEEK CELEBRATION 2024

आज़ादी का अमृत महोत्सव

सत्यमेव जयते

G20 भारत 2023 INDIA

भारत सरकार
Government of India
श्रम एवं रोजगार मंत्रालय
Ministry of Labour & Employment
खान सुरक्षा महानिदेशालय
Directorate General of Mines Safety
दक्षिण पूर्वमंदल
South Eastern Zone

S. Ratnaker
Director of Mines Safety
(Mechanical)

Message

I am glad to know that M/s. ArcelorMittal Nippon Steel India Limited, Odisha is hosting State Level – 42nd Annual Mines Safety Week Celebration-2024 on 13th July 2025 at Barbil, Odisha under the aegis of the Directorate General of Mines Safety, Bhubaneswar Regions- 1&2.

India stands fourth in the production of Iron Ore and third largest producer of Chromite in the world. While mining has historically affected the health and safety of miners, advances in technology and introduction of mechanization along with automation in the mines has minimized and mitigated the hazardous mining methods. The selection of proper equipment/HEMM and provision of required Safety devices plays a paramount role in achieving safe production. The Iron Ore, Manganese and Chromite mining industry has been adopting new technologies and deploying suitable mining equipment conforming to the national & international standards and regulatory requirements, to ensure safe production.

I am confident that this 'Mines Safety Week Observance' has provided a platform for different Mine managements to explore the better working environment for enhancing the Occupational Safety and Health standards practiced by various mines. It also have provided the exposure to new facilities in Workshops and varied good maintenance practices adopted under the increased man-machine interaction.

I sincerely congratulate the Organizers for their initiative in conducting this Mines Safety Week Observance.

I wish you all complete success in achieving "Zero Harm".

(S. Ratnaker)

42ND ANNUAL METALLIFEROUS MINES SAFETY WEEK CELEBRATION 2024

आज़ादी का अमृत महोत्सव

सत्यमेव जयते

G20 भारत 2023 INDIA

भारत सरकार
Government of India
श्रम एवं रोजगार मंत्रालय
Ministry of Labour & Employment
खान सुरक्षा महानिदेशालय
Directorate General of Mines Safety
दक्षिण पूर्वमंदल
South Eastern Zone

Sankarsana Behera
Director of Mines Safety (Mechanical)
South Eastern Zone, Ranchi

Message

It gives me immense pleasure to know that the Celebration of Final day of 42nd Annual Mines Safety Week 2024, Bhubaneswar Region-1&2 is being observed and a souvenir is also being released to commemorate the occasion.

November 2024 in all the metalliferous mines of Bhubaneswar Region 1&2. Odisha is a mineral rich state and apart from huge coal reserve it has abundant reserves of high-grade Iron ore, Bauxite, Chromite, Manganese ore along with other minerals such as Coal, Limestone, Dolomite, Tin, Nickel, Vanadium, Lead, Graphite, Gemstone, & Decorative Stone etc. Previously some mines were in Chaibasa Region and it was found difficult to make awareness programs to enhance the propaganda of safety from a single platform. Now since all the mines come under the two regional offices of Odisha it is supposed to enhance the propaganda of safety in the mines in organized and organized sectors more conveniently. Since, the minerals contribute a large of GDP of our country and the economy of Odisha also being affected by the mines. As such the safety of workers and protection of environment is a must for the survival of the nature and the creatures in the surroundings. Such programs will definitely add to the country's endeavor for sustainable economic, social and financial growth of all its stakeholders.

I extend my sincere appreciation to the organizers and wishes for the great success of the program.

(Sankarsana Behera)

42ND ANNUAL METALLIFEROUS MINES SAFETY WEEK CELEBRATION 2024

आज़ादी का अमृत महोत्सव

सत्यमेव जयते

G20 भारत 2023 INDIA

Maheswara Reddy Kanala
Director of Mines Safety (Electrical)

भारत सरकार
Government of India
श्रम एवं रोजगार मंत्रालय
Ministry of Labour & Employment
खान सुरक्षा महानिदेशालय
Directorate General of Mines Safety
दक्षिणी पूर्वी अंचल
South Eastern Zone

Message

I am privileged to be associated with the celebration of "42nd Annual Mines Safety week" for the year 2024 from 11.11.2024 to 28.11.2024 under the aegis of Directorate General of Mines Safety, South Eastern Zone, Bhubaneswar Regions. The final day function and prize distribution ceremony will be organised at Barbil on 13.07.2025, hosted by M/s Arcelor Mittal Nippon Steel India Limited. I am also pleased to note that a Souvenir is being brought out in commemoration of the occasion.

Safety assumes greater significance in all operations, especially in mining Industry where operations are being done with in earth crust and in high-risk environment. Celebrations of 'Mines safety week' will bring safe working conditions and inculcate better safe practices among the workmen and officials in mines, aided with technological advancements. The safety week celebration is a tool for gaining knowledge and sharing of different safe working practices among the employees. These celebrations also stimulate the improvement of working environment to attain the goal of "Zero Harm" in mines.

I wish for grand success of the final day celebration of the "42nd Annual Mines Safety week" organised by M/s Arcelor Mittal Nippon Steel India Limited.

(K. Maheswara Reddy)

42ND ANNUAL METALLIFEROUS MINES SAFETY WEEK CELEBRATION 2024

Ulimella Siva Sankar
Dy. Director of Mines Safety

सत्यमेव जयते

भारत सरकार
Government of India
श्रम एवं रोजगार मंत्रालय
Ministry of Labour & Employment
खान सुरक्षा महानिदेशालय
Directorate General of Mines Safety
भुवनेश्वरक्षेत्र-2, भुवनेश्वर
Bhubaneswar Region-2, Bhubaneswar

Message

It gives me immense pleasure to learn that M/s ArcelorMittal Nippon Steel India Ltd., has organized the "Annual Mines Safety Week" for all Odisha State Metalliferous Mines from 11.11.2024 to 28.11.2024 and the Valedictory Function will be held on 13th July 2025 at Barbil, Odisha.

Odisha is endowed with vast resources of a variety of minerals and occupies a prominent place in the country as a mineral rich State and thus playing a major role in the industrial and economic growth of the country. Mining being one of the most hazardous professions challenged with many inherent geo-mining, operational and occupational hazards. Perpetuation of safety is a precondition for any mining operation.

Reduction of exposure of miners to major risks is viably possible through adoption of scientific methods and technological tools with vigilant supervision and Safety management system coupled with promotion of standardized safe work practices.
The Annual Safety Week celebrations provide an opportunity to introspect, take stock of the existing safety environment and inculcate a sense of confidence and better safety awareness among the miners. Such functions also promote synergetic competitiveness for the improvement in safety and production and facilitates exchanging views and understanding best practices amongst all concerned.

I wish the "Annual Mine Safety Week" a grand success and hope the spirit of safety achieved through this function is carried whole the year for achieving better results in all spheres in all the Metalliferous mines of Odisha State.

(Ulimella Siva Sankar)

42ND ANNUAL METALLIFEROUS MINES SAFETY WEEK CELEBRATION 2024

सत्यमेव जयते

Tangallapally Hariprasad
Dy. Director of Mines Safety

Bhubaneswar Region-1
Directorate General of Mines Safety
Ministry of Labour and Employment
Government of India
E-mail: dgmsbbsr22@gmail.com

Message

It gives me immense pleasure to be associated with the celebration of **42nd Annual Metalliferous Mines Safety Week Celebration 2024 (AMMSWC)"**, that is being observed under the aegis of Directorate General of Mines Safety, Bhubaneswar Regions 1 & 2 from 11th November to 28th November, 2024 discharging all responsibility by M/s. ArcelorMittal Nippon Steel India, the Final day Function shall be held on 13th July, 2025 at Barbil, Odisha by M/s. AM/NS India, Odisha Mines division. I am very pleased to be closely involved in preparation of an e-Souvenir slated for release on the occasion of Final Day Celebration.

Mining Industry producing materials from ore to oil and sand to stone used for soil to sky plays an important role for overall development of the country which in turn raises the general standard of living of countrymen including poverty alleviation. All of us aware that economic growth of any country is primarily based on its mineral deposit.

I feel proud that the State of Odisha is a house of hidden treasure with huge deposits in the form of mineral wealth like coal, chromite, iron ore, limestone, bauxite, quartzite, rare earth mineral, graphite, granite and many more. Mining of these minerals poses many challenges and issues related to safety. The Occupational Health, Safety and Welfare of persons employed in the mining industry and development of the mining areas and standard of living of miners is utmost importance for its growth.

Safety Week Celebration, in addition to spreading of safety awareness amongst all concerned, provides an opportunity to give a fresh look into the safety measures being undertaken in the different mines and to exchange the ideas of new technologies. Observance of Mines Safety Week provides an opportunity to inculcate safety consciousness among mine workers, supervisors and officials.

I express my gratitude for the success of Final Day Celebration of **42nd Annual Metalliferous Mines Safety Week Celebration 2024 (**AMMSWC**)"** a grand Success.

(Tangallapally Hariprasad)

42ND ANNUAL METALLIFEROUS MINES SAFETY WEEK CELEBRATION 2024

AM/NS INDIA

Dilip Oommen
Chief Executive Officer & Nominated Owner
Arcelor Mittal & Nippon Steel Indian Ltd.

Message

It is a great honor for AM/NS India to host the 42nd Safety Week for the Metalliferous Mines of Odisha, held under the esteemed guidance of the Directorate General of Mines Safety (DGMS) Regions 1 and 2. This important event, from November 11 to 28, 2024, is a powerful reminder of our shared commitment to the safety, health, and well-being of our mining communities.

The mining sector is fundamental to India's progress, not only fueling the manufacturing industry but also playing a crucial role in building a self-reliant nation. As we advance towards this goal, it is essential to remember that at the heart of all our grand plans and operations lies the precious lives, propelling forward with a steely resolve. It is our collective duty to place the safety of every miner at the forefront, striving toward a vision of zero injuries. The DGMS has made tireless contributions in this regard, developing vital regulations, conducting seminars, and promoting safety initiatives since 1901 to protect the workforce and surrounding communities.

I am particularly pleased to note that, this year's commemorative souvenir highights forward looking themes such as innovation in mining, Al-driven advancements, sustainable mining practices, and pathways to decarbonization, aligning with India's net-zero ambitions by 2070. These themes not only inspire thought leadership but also provide a valuable platform for young professionals to share insights on making mining safer, more sustainable, and future ready.

May this Safety Week inspire us all to renew our dedication to safe and sustainable mining practices. I wish the event great success and hope it serves as a strong foundation for our industry's ongoing journey toward excellence and safety.

(Dilip Oommen)

42ND ANNUAL METALLIFEROUS MINES SAFETY WEEK CELEBRATION 2024

Alok Kumar Mehta
Director - Mining & Strategic Projects
ArcelorMittal Nippon Steel India

AM/NS INDIA

Message

I am glad to be given the opportunity to share message for 42nd Annual Mines Safety Week-2024 under the aegis of DGMS Bhubaneswar Region.

As we gather to commemorate the 42nd Annual Mines Safety Week in 2024, it is with immense pride and a profound sense of responsibility that we reflect on our collective commitment to safety in the mining industry. This week serves as a vital reminder of the importance of safeguarding the health and well-being of every individual who contributes to this essential sector.

We extend our heartfelt gratitude to the Directorate General of Mines Safety (DGMS) for their unwavering support and guidance in our safety endeavours. Their leadership is instrumental in shaping policies that prioritize the health and safety of all mine workers. Together, we can continue to build a mining industry that not only meets the demands of our economy but also upholds the highest standards of safety and integrity.

As we embark on this week of reflection and action, let us reaffirm our commitment to safety. Let us work together to ensure that every worker returns home safely at the end of each day. Remember, safety is not just a priority; it is a value that must be ingrained in our culture.

Wishing you all a successful and enlightening Mines Safety Week 2024.

(Alok Kumar Mehta)

42ND ANNUAL METALLIFEROUS MINES SAFETY WEEK CELEBRATION 2024

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ONE EARTH - ONE FAMILY - ONE FUTURE

Sarada Bhushan Mohanty
Chairman & Managing Director (I/c)
& Director (Finance)

Message

I am happy to note that the 42nd Annual Mines Safety Week Celebrations - 2024, Bhubaneswar Region 1 & 2 is being organized from 11th to 23rd November 2024 with valedictory function scheduled on 13th July 2025 under the auspices of Director of Mines Safety (DMS), Bhubaneswar, Region - 1 & 2 at Bhubaneswar, Odisha.

The ultimate aim of this safety promotion campaign should be to ensure "ZERO HARM" to all Mine workers in the region. This aim can be achieved by Safety Promotional Activities, Exchange of Accident Investigation Details for better learning, Sharing of best safety practices in different Mines etc.

As we all know, "Safety Needs Promotion" and creating awareness among Mine workers by Class room training, Tool room talks and Prominent display of safety related video and posters help the cause in a big way.

I take this opportunity to urge the delegates to disseminate the latest practices learned during the event to respective organizations and implement it. Let this event be a catalyst for change in moving forward with mindset towards elimination of unsafe condition and unsafe act at the work place.

I wish the event a grand success.

(Sarada Bhushan Mohanty)

42ND ANNUAL METALLIFEROUS MINES SAFETY WEEK CELEBRATION 2024

T V Narendran
CEO & Managing Director
Tata Steel Limited

TATA

Message

Dear Delegates,

On behalf of Tata Steel, I am delighted to extend my heartfelt congratulations for the 42nd Annual Mines Safety Week, Bhubaneswar Region. This significant milestone reflects our unwavering dedication to safety, which remains a fundamental value for our industry.

For decades, we have endeavored to establish a culture of safety within our mining operations, prioritizing the welfare of our employees and our environmental responsibilities. Each year, Mines Safety Week reinforces the vital importance of continuous improvement and innovation in our journey toward a safer, more sustainable future.

This year highlights our commitment to cultivating a safety-oriented culture that goes beyond mere compliance, adopting a proactive and collaborative stance. We are continuously investigating advanced technologies and methodologies to refine safety protocols, lessen environmental impact, and foster sustainable practices throughout our mining activities.

As we commemorate this remarkable occasion, let us reaffirm our pledge to collectively endeavor for a future where safety is not just a statistic but a fundamental way of life.

With warm regards,

(T V Narendran)

42ND ANNUAL METALLIFEROUS MINES SAFETY WEEK CELEBRATION 2024

D B Sundara Ramam
Vice President - Raw Materials
Tata Steel Limited

TATA

Message

Dear Delegates,

I am delighted to learn the commencement of the 42nd Annual Mines Safety Week- Bhubaneshwar region. This year, we are making significant strides towards a safer and more sustainable future, driven by a commitment to gender equity, transformative technology, and innovative thinking.

We believe that safety is a collective responsibility, and that includes creating a truly inclusive environment for all. We are actively promoting gender equity, not just for women, but also for transgender individuals. By recognizing and embracing the unique perspectives and experiences of our transgender colleagues, we are fostering a culture of respect and inclusivity that empowers everyone to contribute to a safer work environment.

Technology is revolutionizing the way we approach safety and sustainability. From advanced monitoring systems to data-driven risk assessments, we are harnessing the power of innovation to create a safer and more sustainable mining landscape. We are also actively exploring ways to utilize technology to provide opportunities for transgender individuals, empowering them to contribute their skills and talents within our organization.

The integration of technology, gender equity, and innovation is leading to a new era of safety. We are seeing a tangible impact on our operations, with a focus on sustainable practices and a commitment to safeguarding the environment. We are also actively working to create sustainable livelihoods for transgender individuals, helping them to build a better future for themselves and their communities.

Together, we can create a mining sector where every voice is heard, every talent is valued, and every individual has the opportunity to thrive in a safer environment.

(D B Sundara Ramam)

42ND ANNUAL METALLIFEROUS MINES SAFETY WEEK CELEBRATION 2024

Sauvick Mazumder
COO, JSW Steel Ltd.

JSW Better Everyday

Message

As India emerges as one of the fastest growing economies in the world, bolstered by innovative government programmes, remarkable advancements from India inc. and the transformative impact of industry4.0, we recognize the pivotal role of the mining industry in sustaining this economic development.

In our journey towards progress, safety and occupational health stands as paramount pillars. It is our collective responsibility to prioritise these aspects ensuring that every worker returns home safely each day. Together , we can foster an environment where innovation thrives alongside safety.

We extend our heartfelt congratulations to the Directorate General Of Mines safety (DGMS), Bhubaneswar Regions for their unwavering commitment in promoting safety standards in the mining sector. Your dedication inspires us all to strive for excellence in safety practices.

Let us continue to work together, championing a culture of safety that supports the growth of our nation and safeguards the wellbeing of our workforce.

(Sauvick Mazumder)

42ND ANNUAL METALLIFEROUS MINES SAFETY WEEK CELEBRATION 2024

Pankaj Malhan
Executive Director I/C
Jindal Steel & Power, Angul

JINDAL STEEL & POWER

Message

On behalf of Jindal Steel & Power Ltd., it is a great pleasure to offer warm felicitations and greetings. I am glad to congratulate all participating mines & associates in the "**42nd Annual Mines Safety Week Celebration**", **2024** under **Bhubaneswar Region (I & II)** of D.G.M.S. and a souvenir is being published on the noble occasion.

Minerals are the wealth of the country and should be used in a professional and responsible manner. We should not only ensure the safety of operations but also protect the environment. Our endeavor should be to eliminate accidents totally and attain **ZERO ACCIDENT** rate. I am sure, a week long celebrations will go a long way in educating the work force employed in the mines and will inculcate the sense of safety in operations and maintenance.

I feel that the proper training of labourers would automatically improves the safety standard and increase the productivity. Mines Safety Week will be an occasion to review the security measures and make sure that the past mistakes are not repeated. I would request the miners to ensure the safety of workers in their units while taking care of ecological and environmental aspects.

I hope everyone will take full advantage of all the sessions that will be covered during the safety week.

I will the celebrations all the success.

(Pankaj Malhan)

42ND ANNUAL METALLIFEROUS MINES SAFETY WEEK CELEBRATION 2024

Siddharth Rungta
Chairman
Rungta Sons Private Limited

SR RUNGTA GROUP

RUNGTA HOUSE
CHAIBASA - 833201 (JHARKHAND)

Message

I am very delighted to know that, the 42nd Annual Mines Safety Week Celebration-2024 for metalliferous mines of Bhubaneswar Region is scheduled to be observed under the aegis of the Directorate General of Mines Safety, Ministry of Labour & Employment, Government of India.

The Mining industry has strengthened our nation in terms of supporting growth of manufacturing, infrastructures and many other sectors including MSME Industries with an ultimate objective of sustainable, inclusive and equitable growth towards economic development of the country.

Every year celebration of the Safety Week shows our commitment towards adherence to safety standards in work places & spreading safety awareness among all concerned. This celebration absolutely strengthens safety awareness among the entire workforce and entire mining fraternity. It is an initiative that aligns management, managers, supervisors and stakeholders in respect of their safety values.

In an era where the demand for minerals continues to surge, we must ensure that our operations are not only efficient but also responsible and environment friendly. The Annual Mines Safety Week is not just a celebration; it is a testament to our collective dedication to create a culture of safety. It provides a platform to raise awareness, share best practices and renew our commitment to create a safer work environment.

On this note, I would like to urge all to continue our good efforts in technological transformation in safety and vigilance in keeping good HSE performances and strive towards zero harm in our work place. Let us ensure that "every worker returns home safely every day".

I extend my sincere greetings & Best Wishes for Grand Success of 42nd Annual Mines Safety Week Celebration- 2024 of Bhubaneswar Region.

(Siddharth Rungta)

42ND ANNUAL METALLIFEROUS MINES SAFETY WEEK CELEBRATION 2024

FINAL DAY FUNCTION OF 41ST ODISHA METALLIFEROUS MINES SAFETY WEEK CELEBRATION 2023

LIFETIME ACHIEVEMENT AWARD 2024

AVIJIT GHOSH

Name	:	Avijit Ghosh
Date of Birth	:	02/12/1958
Qualification	:	B.Tech (Mining) from ISM Dhanbad
Family Details	:	Wife-Mrs. Ranu Ghosh, Son-Avishek Ghosh Daughter-Megha Ghosh pursuing Post Doc in Neuroscience at University of Washington

Experience Details

Joined Malanjkhand Copper Project in 1980. He has worked for number of companies and has blend of 34 years of experience in Metalliferous Mines both Public and Private Sector. He worked in Hindustan Copper Limited as Director (Mining) from 01.06.2010 to 31.12.14.Presently Expert Appraisal Member (NCM) MoEFCC, Govt of India

Achievements

1. He was awarded Dr. J. Coggin Brown Memorial (Gold) Medal: 2010-2011 by the Mining Geological & Metallurgical Institute of India (MGMI) for outstanding contribution in the field of Metal Mining.
2. He was adjudged as Eminent Mining Engineer by the Institution of Engineers (India) on 23rd February, 2012.
3. He was awarded CEO WITH HR ORIENTATION is the most prestigious Award by ascent, ASIA pacific HRM at Bangalore on 11.09.2015.

Some of his notable achievements include

After having a successful stint in both Public Sector and Private Sector industry, Mr. Ghosh was selected to head the prestigious of the country- Heavy Engineering Corporation Ltd. at Ranchi as the Chairman cum Managing Director. He joined HEC on 1st January 2015.He published number of technical papers.

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42ND ANNUAL METALLIFEROUS MINES SAFETY WEEK CELEBRATION 2024

Last Ten Years Annual Mines Safety Week Celebration (Bhubaneswar Region)

HOST DETAILS

Year	Final Day Host Organization	Celebrating Year
2015	M/s ACC	33rd
2016	M/s IREL	34th
2017	M/s FACOR	35th
2018	M/s Tata Steel (on behalf of BC Mohanty and Misrilal)	36th
2019	M/s Utkal Alumina Limited	37th
2020	Virtual mode by M/s UAL	38th
2021	M/s Tata Steel Mining	39th
2022	M/s IMFA	40th
2023	M/s JSW	41st
2024	M/s AM/NS India	42nd

42ND ANNUAL METALLIFEROUS MINES SAFETY WEEK CELEBRATION 2024

PARTICIPATING MINES DETAILS
42ND ANNUAL MINES SAFETY WEEK CELEBRATION-2024
(BHUBANESWAR REGION-1)

Group-A1

Sl. No	Name of Mine	Name of the Owner
1	Jajang Iron Ore Mines	M/s JSW Steel Limited
2	Thakurani Iron Ore Mines	M/s. AM/NS India Pvt Ltd.
3	Gandhamardan Iron Ore Mines, Block-B	M/s. Odisha Mining Corporation Ltd.
4	Katamati Iron Mine	M/s. Tata Steel Limited
5	Joda East Iron Mine	M/s. Tata Steel Limited
6	Khondbond Iron & Mn Mine	M/s. Tata Steel Limited
7	Guali Iron Ore Mines	M/s. Odisha Mining Corporation ltd
8	Bolani Ores Mines	M/s. Steel Authority of India Limited
9	South Kaliapani Chromite Mines	M/s. Odisha Mining Corporation Ltd.
10	Sukinda Chromite Mine	M/s. Tata Steel Limited

Group-A2

Sl. No	Name of Mine	Name of the Owner
1	Jilling Langalota Iron Ore Mines	M/s. Odisha Mining Corporation Limited
2	Kasia Iron & Dolomite Mines	M/s. Jindal Steel & Power Limited
3	Balda Iron Ore Block Mines	M/s. Serajuddin & Co.
4	Nuagaon Iron Ore Mine	M/s. JSW Steel Limited
5	Joda West Iron & Manganese Mine	M/s. Tata Steel Limited
6	Jaribahal Iron Ore Mines	M/s. Kashvi International Pvt Ltd.
7	Roida II Iron Mines	M/s. Narbheram Power And Steel Pvt Ltd
8	Daitari Iron Ore Mines	M/s. Odisha Mining Corporation Ltd
9	Orissa Sands Complex (OSCOM)	M/s. IREL (India) Limited

Group-A3

Sl. No	Name of Mine	Name of the Owner
1	Unchabali (Mahaparbat) Iron Ore Mine	M/s. Odisha Mining Corporation Ltd
2	Gandhamardan Iron Ore Mines, BLOCK-A	M/s. Odisha Mining Corporation Ltd
3	Khandbandh Iron Ore Mines	M/s. Sree Metaliks Limited
4	Siljora-Kalimati Iron & Mn Mines	M/s. Debabrata Behera
5	Khandbandh Iron Ore Mine	M/s. Odisha Mining Corporation Ltd
6	Banspani Iron Ore Mines	M/s. Odisha Mining Corporation Ltd
7	Sirkagutu Iron & Manganese Mines	M/s. Prakash Industries Ltd
8	Badampahar Iron Ore Block	M/s. GM Iron & Steel Co. Ltd.
9	Tiringpahar Iron Ore Mines	M/s. Odisha Mining Corporation Ltd
10	Roida-C Iron & Manganese Mines	M/s. Odisha Mining Corporation Ltd

Group-A4

Sl. No	Name of Mine	Name of the Owner
1	Bamebari Iron and Manganese Mine	M/s. Tata Steel Limited
2	Tiringpahar Iron & Mn Mine	M/s. Tata Steel Limited
3	Naibaga Iron & Manganese Mines	M/s.Tarini Prasad Mohanty
4	Jururi Iron Ore Mines	M/s. Jagat Janani Services Pvt Ltd
5	Nayagarh Iron Ore Mine	M/s. KCP Iron Pvt Ltd
6	Gorumahisani Iron Ore Block	M/s. Ghanashyam Misra and Sons Private Limited
7	Murgabeda Iron Ore Mines	M/s. D. R. Patnaik
8	Deojhar Iron Ore Mines	M/s. Tarini Minerals Pvt.Ltd.
9	Bagiaburu Iron Mines	M/s. The Orissa Minerals Development Company Limited
10	Katasahi Mn Mines	M/s. Agrasen Sponge Pvt. Ltd.

Group-A5

Sl. No	Name of Mine	Name of the Owner
1	Sukinda Mines (CHROMITE)	M/s. Indian Metals & Ferro Alloys Ltd.
2	Kaliapani Chromite Mines	M/s. Jindal Stainless Limited
3	Sukrangi Chromite Mines	M/s. Odisha Mining Corporation Ltd.
4	Ostapal Chromite Mine	M/s. Ferro Alloys Corporation Limited
5	Kalarangiatta Chromite Mine	M/s. Ferro Alloys Corporation Ltd.
6	Kamarda chromite mine	M/s. Tata steel Limited
7	Saruabil Chromite Mine	M/s. Tata Steel Limited

Group-A6 (UG)

Sl. No	Name of Mine	Name of the Owner
1	Mahagiri Mines (Chromite)	M/s. Indian Metals & Ferro Alloys Ltd
2	Bangur Chromite Mines	M/s. Odisha Mining Corporation Ltd

Group-A7

Sl. No	Name of Mine	Name of the Owner
1	Gobindapur Decorative Stone Mine	M/s.Odisha Mining Corporation Limited
2	Kundakundi Kunda Decorative Stone Quarry, Narangarh	M/s. Odisha Mining Corporation Ltd
3	Logu Decorative Stone Mines	M/s. Meenakshi Granites
4	Barlanda Decorative Stone Mine	Smt. Y. Rajani, Paralakhemundi
5	Laxmi Granite	M/s. Neelachal Granite
6	M. Murali Krishna	M. Murali Krishna
7	Mahughara Hill Decorative Stone Mine	M/s. Nirman Vikas Pvt Ltd
8	Mahughara Decorative Stone Mine	Lessee : SUMITA DAS
9	Amarjyoti Granite	Amarjyoti Granite
10	Bhagabanpur granite Mines	M/s. Neelachal Granite
11	Illiyas Ahammed	Illiyas Ahammed
12	Khamarigaon Granite Mine	M/s. Galaxy Enterprises
13	Badadumula Decorative Stone Mines	M/s. Ajaxpetro
14	Bhagabanpur Decorative Stone Mines	Illiyas Khan
15	Bhagbanpur Decorative Stone Mines	M/s. Sobhan Kumar Mahapatra
16	Bhaganpur Decorative Stone Mines	A.N. Baxi
17	Bhagabanpur Decorative Stone Mines	M/s. Royal Granite
18	Pandiapathar Decorative Stone Mines	M/s. MD Irfan Razzak
19	Dindipalli Decoration Stone Mines	Ranjulata Swain

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PARTICIPATING MINES DETAILS
42ND ANNUAL MINES SAFETY WEEK CELEBRATION-2024
(BHUBANESWAR REGION-2)

Group-B1

Sl. No	Name of Mine	Name of the Owner
1	Sanindpur Iron & Bauxite Mines	M/s. Rungta Sons Private Limited
2	Oraghat Iron Mines	M/s. Rungta Sons Private Limited
3	TRB Iron Ore Mines	M/s. Jindal Steel And Power Limited
4	Narayanposhi Iron and Manganese Mines	M/s. JSW Steel Limited
5	Lanjiberna Limestone & Dolomite Mines	M/s. Dalmia Cement Bharat Limited
6	Baphlimali Bauxite Mine	M/s. Utkal Alumina International Limited
7	Panchpatmali (Central & North Block) Bauxite Mine	M/s. National Alumunium Company Ltd

Group-B2

Sl. No	Name of Mine	Name of the Owner
1	Kurmitar Iron ore Mines	M/s.Odisha Mining Corporation Ltd.
2	Raikela Iron Ore Mines	M/s. Geetarani Mohanty
3	Ghoraburhani Sagasahi Iron Ore Mine	M/s. AM/NS India Pvt Ltd.
4	Nadidihi Iron Ore Mine	M/s. ESL Steel Ltd (Vedanta)
5	Barsua Iron Mines	M/s. Steel Authority of India Ltd. (SAIL)
6	Kalta Iron Mine	M/s. Steel Authority of India Ltd. (SAIL)
7	KJST Iron, Manganese & Bauxite Mine	M/s. S. N. Mohanty
8	Kodingmali Bauxite Mine	M/s. Odisha Mining Corporation Limited

Group-B3

Sl. No	Name of Mine	Name of the Owner
1	Taldih Iron Mines	M/s. Steel Authority of India Ltd. (SAIL)
2	Neelachal Iron Ore Mine	M/s. Neelachal Ispat Nigam Limited
3	Patabeda Iron Mines	M/s. MGM Minerals Ltd
4	Nadidihi Iron & Manganese Ore Mine	M/s. ESL Steel Limited
5	Birmitrapur Limestone & Dolomite Mines	M/s. Bisra Stone Lime Company Ltd. Birmitrapur
6	Raikela and Tantra Iron Mines	M/s. Penguin Trading and Agencies Ltd.
7	Panchpatmali (South Block) Bauxite Mine	M/s. National Aluminium Company Ltd.

Group-B4

Sl. No	Name of Mine	Name of the Owner
1	Sanindpur Iron & Mn Mines	M/s. Grewal Minerals & Metals LLP
2	Raikela Iron Ore Mines	M/s. Grewal Minerals & Metals LLP
3	Gonua Iron Ore Mine	M/s. JSW Steel Limited
4	Adaghat Iron Ore Mines	M/s. Grewal Minerals & Metals LLP
5	Kolmong Iron & Manganese Ore Mine	M/s. Yazdani Steel & Power Ltd.
6	Bhanjapali Iron Ore Mines	M/s. J N Patnaik
7	Tantra Iron Ore Mine	M/s. Korp Resources Pvt Ltd
8	Khatkurbahal Limestone & Dolomite Mines	M/s. Shiva Cement Ltd
9	Khatkurbahal North Block Limestone & Dolomite Mines	M/s. Shiva Cement Ltd.
10	Maliparbat Bauxite Mine	M/s. Hindalco Industries Limited
11	Bandhamandi Graphite Mine	M/s. Pradhan Industries

Group-B5

Sl. No	Name of Mine	Name of the Owner
1	Kanther - Koira Manganese Mines	M/s. P.M. Granite Export Private Limited
2	Mahulsukha Iron & Manganese Mines	M/s. Rungta Sons Pvt. Ltd.
3	Nuagaon Iron & Manganese Mine	M/s. S. N. Mohanty
4	Bandhal Manganese Mine	M/s. Kanakdhara Mining & Minerals Pvt Ltd.
5	Patabeda Iron & Mn mine (19.425 Ha)	M/s. M G Mohanty
6	Patabeda Iron Mine (14.00Ha)	M/s. M G Mohanty
7	Chhuinpali Quartzite Mines	M/s. TRL Krosaki Refractories Limited
8	Bhikampali Quartzite Mine	M/s. Dalmia Bharat Refractories Limited
9	Gandabahali Graphite Mine	M/s. Agarwal Graphite Industry
10	Khemabeda Decorative Stone Mine	M/s. Hotha Venkatesh
11	Ampavalli Limestone Mines	M/s. Odisha Mining Corporation Ltd.
12	Peta Decorative Stone Mine	M/s. Chava Venugopal
13	Peta Decorative stone Mine	M/s. K.Srinivasa Rao

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ARTICLES

ARTICLE-1

CELEBRATING INNOVATION: MECHANICALLY STABILIZED REINFORCED EARTH WALL CONSTRUCTION IN OPEN CAST MINING

D. K Pradhan (Eng. HSE)
Prasant Kumar (Blasting in Charge)
Sagasahi Iron Mine, AM/NS India

Introduction:

In the evolving landscape of civil engineering, the need for robust soil stabilization techniques is more critical than ever, especially in the demanding environments of mines and industrial sites. Reinforced Earth (RE) wall construction has emerged as a pioneering solution, providing the necessary stability for filled soil and supporting various structures. This article explores the significance of RE walls in ensuring safety, efficiency, and sustainability in these crucial sectors.

Understanding Reinforced Earth:

Reinforced Earth is a construction method that combines traditional soil with high-strength reinforcement materials, such as geogrids or Geostrips. This innovative approach enhances the soil's load-bearing capacity, offering a stable foundation for diverse structures, from industrial facilities to mining operations.

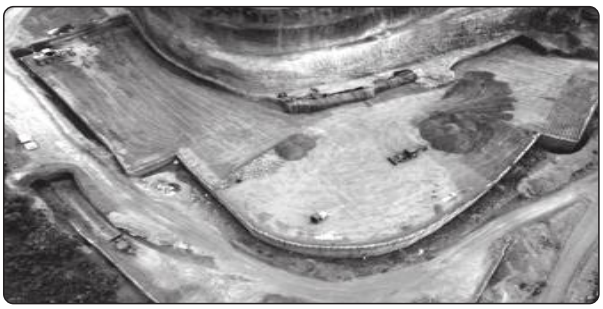

Fig-1

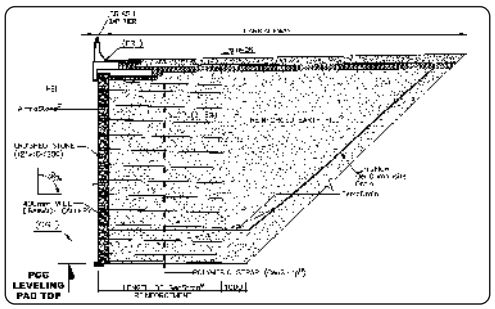

Fig-2

Structure and Design:

Structure and Design of Reinforced Earth (RE)walls is based on combining compacted soil with reinforcement layers, creating as table, load-bearing structure suitable for sloped are as and open-cast mines:

- **Layered Composite Structure**:
  RE walls are constructed with alternating layers of compacted soil and reinforcement materials, such as or Geo textile strips, embedded horizontally. This creates a composite structure that disperses loads evenly, resists lateral forces, and prevents soil deformation. These properties allow the wall to handle heavy loads and adapt to the pressures typically exerted on slopes.

- **Slope Stability**:
  In sloped terrains, RE walls help counteract lateral earth pressure by providing additional tensile strength within the soil mass. This prevents slope failure and mitigates land slide risks, creating as table environment, especially in high-risk, erosion-prone areas.

- **Application in Open-Cast Mines**:
  RE walls are used in open-cast mining to create stable, terraced surfaces, supporting safe excavation and access. By reinforcing the mining slopes, RE walls help prevent wall failures and land slides, enhancing both safety and accessibility for workers and machinery on the sesteep, multi-tieredsurfaces.

Materials:

1. Use of Pads

- **Function**:
  Pads provide as table base for the RE wall, distributing loads evenly and preventing settlement.
- **Application**:
  Base Support: Pads, of ten made of concrete or compacted aggregate, are placed at the foundation of the wall to create a solid and level surface.

❖ **Load Distribution:**
They help in spreading the weight of the wall and any applied load sovera larger area, reducing pressure on the underlying soil.


Fig-3

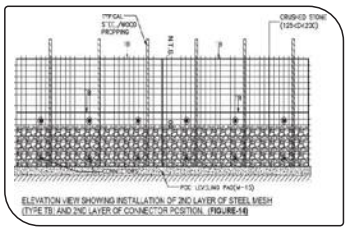
Fig-4

2. Use of Steel Mesh

❖ **Function:**
Steel mesh offers additional tensile strength to the wall structure.

❖ **Application:**
Steel mesh is embedded within the fill material or attached to the wall facing to improve the wall's ability to resist deformation and tensile stresses, especially in steep or unstable slopes.

❖ **Connection to Fill:**
The mesh is used to tie together the fill material and the wall facing, enhancing the overall structural integrity of the RE wall.

3. Use of Coir Non-Woven Geo textiles

❖ **Function:**
Coir non-woven geo textiles are bio degradable fabrics that provide separation and filtration.

❖ **Application:**
Placed between the soil and the stone fill, coir geo textiles prevents oil mixing, maintaining the integrity of both materials.

❖ **Erosion Control:**
They help in reducing soil erosion on slopes by allowing water drainage while retaining soil particles.

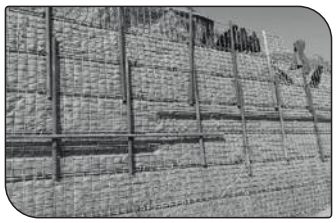
Fig-4

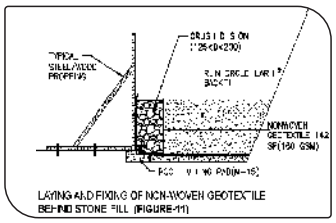

Fig-6

4. Filling of Stone

❖ **Function:**
Stone fill serves as the primary back fill material in RE wall construction.

❖ **Application:**
Back fill Material: Durable stone aggregates are used as fill material behind the wall to provide mass, stability, and drainage. The angular shape of stone fill enhances interlocking, improving load distribution.

❖ **Drainage:**
The voids between stone fill allow for effective drainage, helping to relieve hydrostatic pressure.


Fig-7

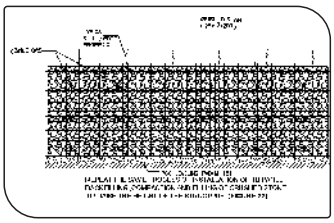
Fig-8

5. Laying of Geo Strap

❖ **Function:**
Geo Strap (a type of geo synthetic reinforcement) add stensile strength to the wall.

❖ **Application:**
Reinforcement Layers: Geo Strap is laid horizontally within the fill layers, extending back into the slope. This reinforces the soil mass, helping to resist lateral forces and enhance stability.

❖ **Connection to Facing:**
The Geo Strap can be connected to facing elements, ensuring that the load is effectively transmitted to the wall.


Fig-9

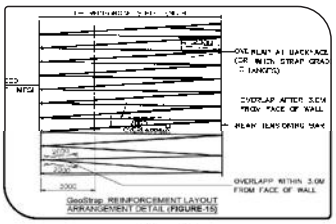
Fig-10

6. Use of Geo composite Drain Rolls

❖ **Function:**
Geo composite drain rolls combine drainage and filtration properties.

❖ **Application:**
Drainage System: The serolls are installed behind the wall to facilitate water drainage. They consist of a geo textile layer bonded to a drainage core, allowing for effective water flow while preventing soil intrusion.


Fig-11

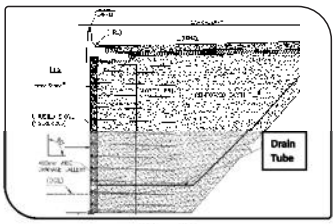

Fig-12

Implementation Plan for using these materials:

❖ **Site Preparation:**

Excavate and prepare the site for the RE wall, ensuring a stable base. Place concrete or compacted aggregate pads as the foundation fort he wall.

❖ **Installation of Steel Mesh:**

Position steel mesh in are as where additional tensile strength is needed, securing it to both the fill and facing elements.

❖ **Use of Coir Non-Woven Geo textiles:**

Lay coir geo textiles over the prepared ground and around the stone fill to provide separation and prevent soil erosion.

❖ **Filling with Stone:**

Add stone fill in layers, compacting each layer to enhance stability. Ensure proper drainage within the fill material.

❖ **Laying of Geo Strap:**

Install Geo Strap horizontally within the compacted fill layers, ensuring proper overlap and connection to the facing.

❖ **Installation of Geo composite Drain Rolls:**

Place geo composite drain rolls in strategic locations behind the wall to facilitate drainage. Cover them with additional stone fill to ensure effective water management.

Importance of RE Walls in Mine slopes:

In mining, where the ground can be unpredictable, the stability of filled soil is vital for safe and efficient extraction processes. The application of RE walls offers several advantages:

1. Enhanced Stability:

By reinforcing filled soil, RE walls prevent settlement and slip page, crucial for the safety of personnel and equipment.

2. Support for Heavy Structures:

RE walls provide the necessary support for heavy machinery and structures, ensuring that they remain securely anchored in challenging conditions.

3. Preventing Land slides and Collapses:

RE walls stabilize steeps lopes, reducing the risk of landslides or sudden soil collapses that can endanger lives and equipment in both mines and sloped terrains.

4. Enhanced Erosion Control:

They minimize soil erosion, preventing loose rocks or debris from dislodging, which could otherwise cause dangerous rock falls, especially in high-rainfall areas or areas with loose soil.

5. Stable Access for Operations:

By supporting access roads and paths, RE walls create safe, reliable routes for heavy machinery and worker movement, especially on steep slopes in mines or hilly areas.

6. Load-Bearing Capacity:

They are designed to bear heavy loads, helping secure heavy mining equipment or infrastructure on uneven ground without compromising stability.

7. Environmental Compatibility:

RE walls allow for vegetation and naturald rainage, reducing environmental degradation while maintaining slope stability for long-term safety.

Applications in Industrial Settings

In industries, the stability of foundation sand surrounding soil is essential for various operations, including manufacturing and storage. RE walls offer multiple benefits:

1. Load Distribution:

The design of RE walls allows for even distribution of loads, reducing stress on the under lying soil and preventing structural failure.

2. Adaptability:

RE walls can be customized to meet specific project requirements, accommodating various structural designs and weights.

3. Cost-Effectiveness:

By minimizing the need for extensive excavation and back filling, RE walls can significantly reduce construction costs while maintaining high safety standards.

The Construction Process:

The construction of RE walls involves several critical steps:

1. Site Evaluation:

Geo technical studies assess soil strength, slope angles, load requirements, and environmental conditions to guide material choice and wall design.

2. Design Planning:

Engineers develop a custom design based on findings, choosing reinforcement materials (e.g., Geotextile, Geostrips etc) that suit the site's geo technical needs and loading conditions.

3. Excavation and Preparation:

The site is excavated to the required depth, and controlled filling is done to create a solid foundation. The base layer is compacted to stabilize the ground for wall assembly.

4. Placement of Reinforcement:

Reinforcement layers are positioned horizontally within each layer of compacted soil, providing tensile strength that counteracts lateral earth pressure and slope- induced forces.

5. Wall Assembly:

Modular wall panels or facing soil. These components are often a esthetically designed, especially in industrial or public areas.

6. Finalization and Drainage:

Proper drainage systems (such as Geo composite Drain Rolls drain tube and gravel layers) are added to control water flow and minimize hydrostatic pressure, which enhances the wall's long-term stability. This method results in a durable, stable, and safe wall structure, ideal for preventing land slides and ensuring safe access in slopy and mining environments.

Environmental Benefits:

The implementation of RE walls aligns with sustainable construction practices. By utilizing local materials and reducing waste, this technique minimizes the environmental impact associated with traditional construction methods. Moreover, the design can incorporate greenery and landscaping, promoting ecological balance at industrial and mining sites.

Conclusion:

Reinforced Earth wall construction stands as a testament to innovation in soil stabilization, addressing the unique challenges (space constraints) faced in mines and industrial applications. Its ability to enhance stability, support various structures, and offer cost- effective solutions makes it a vital component of modern civil engineering. As industries strive for safer and more sustainable practices, RE walls will continue to play an essential role in shaping the future of infrastructure development without using steel and concrete.

ARTICLE-2

GROUNDWATER CONTROL AND DEWATERING TECHNIQUES IN OPEN PIT MINING FOR SAFETY

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Abstract

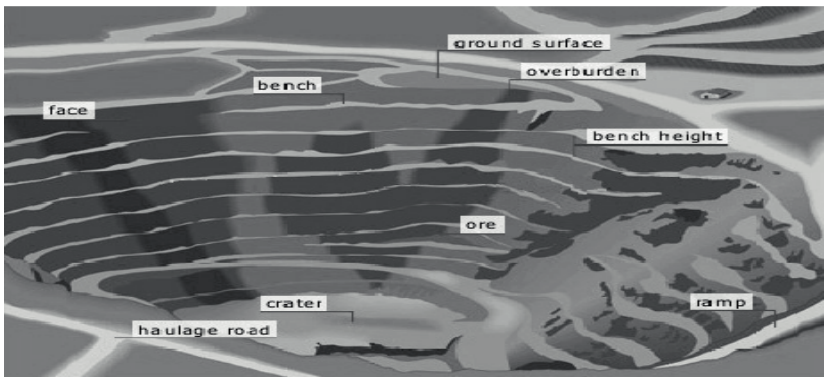
Open pit mining operations often encounter significant challenges related to ground water. Excess water in an open pit can lead to safety hazards, hinder mining progress, and impact the stability of pitwalls. Open pit mining is a widely used method for extracting minerals from the Earth's surface. This approach, while efficient, brings with it the challenge of managing groundwater, which has a significant impact on both the safety of mining operations and their overall efficiency. This article explores the crucial role and the importance of groundwater control and dewatering technique in ensuring the safety and efficiency of open pit mining operations and emphasizing their crucial role in ensuring the safety of workers and the protection of the environment.

Introduction:

- The importance of open pit mining in mineral extraction.
- The impact of groundwater on safety and mining operations.
- Open pit mining is a fundamental method for extracting valuable minerals from the Earth's crust.
- The Significance of open pit mining in mineral extraction and focuses on the safety features and practices that are crucial for protecting the well- being of workers and the environment.

Open Pit Design and Safety:

- Factors influencing open pit design, including slope stability and groundwater.
- The role of safety features, such as haul roads, berms, and warning system.



The Impact of Groundwater on Safety and Mining Operations:

- Groundwater is a critical factor in the mining Industry, impacting both the safety of mining operations and the overall efficiency of mineral extractions.
- Mining is a fundamental industry that provides essential raw materials for a wide range of applications, from construction to technology. The extraction of minerals from the Earth's crust is a complex process that is not without its challenges.
- One of the most significant challenges in mining is the presence of groundwater, which has a profound impact on both safety and the efficiency of mining operations.

Geological Factors:

- Exploring the geological conditions that influence groundwater presence in mining area.
- The geological composition of an area plays a critical role in the presence and behaviour of groundwater in mining operations. The permeability and porosity of rocks and soils affect how water moves underground.
- Geological surveys are conducted to assess the groundwater potential of a mining site. In areas with specific geological formations, such as limestone, shale, or fractured bedrock, groundwater is more likely to be encountered.
- There must be the relationships between geological features and water table levels.

Safety Hazards Associated with Groundwater:

- Groundwater poses a range of safety hazards to mining operations. One of the most significant dangers is the potential for slope instability.
- Excess groundwater can saturate soil and rock, leading to landslides and pit wall collapses. These events not only endanger the lives of miners but also disrupt mining activities and result in substantial economic losses.

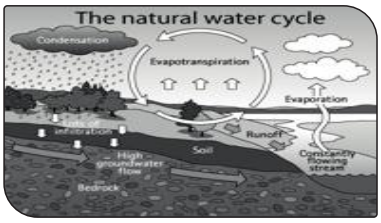
- Inadequate groundwater management can also lead to flooding within the mine, which poses a direct threat to workers' safety.
- Real-life examples of accidents and incidents caused by inadequate groundwatermanagements.

Operational Efficiency and Productivity:

- Efficient mining operations are dependent on maintaining control over groundwater. Excess water can lead to delays and disruptions, causing reduced productivity.
- Wet and unstable conditions can also damage mining equipment, resulting in increased maintenance costs. Effective groundwater control techniques are essential for ensuring the smooth and efficient progress of mining activities.

Groundwater Hydrogeology:

- Understanding the geological and hydrogeological conditions that influence groundwater inflow.
- The connection between geological features and groundwater levels.
- Ground-water hydrology is the subdivision of the science of hydrology that deals with the occurrence, movement, and quality of water beneath the Earth's surface.



Groundwater Control and Dewatering Techniques:

- To mitigate the safety hazards associated with groundwater, mining operations employ various dewatering techniques. Dewatering involves removing or controlling groundwater to maintain safe working conditions.
- Overview of common dewatering methods, including wellpoint systems and deep wells. Explaining dewatering techniques used to manage groundwater levels in mining pits.
- The geological factors that influence the choice of dewatering technique.
- The role of geological surveys in selecting the suitable dewatering locations.

Worker Safety and Emergency Preparedness:

- Ensuring worker safety in the presence of groundwater is of paramount importance. Miners working in or near groundwater-prone areas must receive proper training, wear protective equipment, and be well-versed in emergency response protocols.
- Geological expertise is crucial in predicting and identifying potential hazards associated with groundwater, enabling miners to take pre-emptive measures to stay safe.

Environmental Impact and Regulatory Compliance:

- Environmental considerations are another significant aspect of groundwater management. Discharging excess ground water without proper treatment can lead to water pollution, affecting local ecosystems and water quality.
- Regulations and industry standards are in place to ensure responsible groundwater management in mining operations, and geological assessments are a critical component of regulatory compliance and reporting.
- Addressing the environmental consequences of ground water management related to dewatering, such as water quality and ecosystem impact.
- Geological solutions for responsible water management.

Monitoring, Prediction, and Future Trends:

- Continuous monitoring of groundwater levels and conditions is essential for the safe and efficient functioning of mining operations.

- Advances in predictive modelling and geological assessments enable mining companies to anticipate changes in groundwater behaviour and take proactive measures.
- Emerging technologies, including drones, sensors, and automation, are contributing to more effective groundwater control and safety.
- The evolving role of geologists in sustainable dewatering practices.

The Future of Groundwater Control:

- As the mining industry evolves, so do the strategies for groundwater control and dewatering techniques in open pit mining.
- Technological advancements, including the use of drones, sensors, and automation, are contributing to more effective groundwater control.
- These innovations are enhancing safety and efficiency and reducing the environmental footprint of mining operations.

Conclusion:

The importance of groundwater control and dewatering techniques in open pit mining cannot be overstated. These techniques are pivotal for ensuring the safety of workers, protecting the environment, and maintaining operational efficiency. As the industry continues to advance, so too does the understanding and implementation of effective groundwater management practices, highlighting the integral role of geological expertise in the open pit mining sector. It is a complex challenge that requires a multi-faceted approach, encompassing geological expertise, advanced technologies, and strict safety protocols. As the mining industry evolves, so does the understanding of groundwater's impact, leading to more effective strategies for managing this critical aspect of mining. Safety and efficiency are two sides of the same coin in the mining industry, and addressing groundwater challenges is central to both.

ARTICLE-3

ARTIFICIAL INTELLIGENCE IN THE MINING INDUSTRY: AN OVERVIEW

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Abstract:
Keeping the Digitalization and Upgraded Technology in mind, the effort to rapidly transform the way we use energy, it is required to advance new technologies and accelerate the lowering of carbon emissions. However, their extraction often comes with high societal and environmental costs. Therefore, developing ways to extract various minerals in a way that benefits global as well as an individual country's sustainability goals and mitigates direct and indirect negative impacts of extraction, is a worthwhile endeavor. Artificial intelligence (AI) enabled applications provide one avenue by which to potentially speed up this process. The question remains, how do we ensure AI is used in an ethical way that benefits communities, societal development, and environmental sustainability in the mining industry? In this article we give an overview of current and potential uses of AI in the mining sector and present some ethical considerations for the use of AI in the industry. We then outline a way forward to a more ethical and sustainable approach to using AI in the mining sector.
Keywords : Artificial intelligence; Mining industry; AI Ethics; Sustainability.

1. Introduction:

To realize the plans for electrification of transport, power, and heat sectors, and for deployment of fossil-fuel-based alternatives, the expansion of mining operations is needed. However, the metal and mineral resources should help to address the climate change and environmental problems brought by the utilization of fossil fuels, their extraction is often associated with water, land, and air pollution, health problems, and other issues (Adler et al., 2007; Ayuk et al., 2020; Bolger et al., 2021). Although the total land footprint estimates vary depending on the methodology applied, the most recent global mining assessments suggest that close to 100,000 km2, or an area larger than Portugal or South Korea, has been used for mining or mining associated activities, such as waste dumps, across 135 countries (Tang and Werner, 2023). Moreover, over 50 % of current mining sites and deposits are located in politically unstable and economically poor countries of South America, Africa, and Asia, or the 'Global South' group.

In many locations, counterintuitively, the growth in production correlates with acute social and economic challenges, threatening the ability of poor and underdeveloped countries to follow the sustainable development path (L`ebre et al., 2020; Sengupta, 2021; UNEP, 2019). Besides the climate-related considerations, there is an important economic development and value argument that urges mining growth. Resource extraction is a strong contributor to the economic sustainability of 81 countries (United Nations, 2021), of which 63 % are lowand middle-income countries, whose national budgets increasingly depend on resource production revenues (Roe, 2016). For example, mining provides almost 50 % of the government's revenues and generates over 99 % of the exports revenues in the Democratic Republic of Congo (DRC).But how much we rely on the technology and AI for sustainability is the main concern.

Such a large-scope and multifaceted question calls for an approach powerful enough to perform a complex system analysis and to run simulations of future developments, capturing nonlinear time-varying behavior of the involved parties. Recent advances in methods for optimization and simulations highlight artificial intelligence (AI) capabilities and AI-enabled applications as a promising tool for identifying a development venue leading to the desired outcome (Barmer et al., 2021; Mirjalili and Dong, 2020; Xu et al., 2021). Improvements in computational abilities and data availability empower AI algorithms and lead to a new era of AI-based research. The fast-growing body of research shows that machine-learning (ML) and AI-driven approaches may enhance mining economics. Superior in data mining and analytics, AI algorithms used for projections and simulations help people choose the best patterns of behavior and management practices, boosting productivity, optimizing operations, and increasing profitability (Jung and Choi, 2021; Kumar and Dimitrakopoulos, 2021; Noriega and Pourrahimian, 2022; Sircar et al., 2021).

The benefits of using the same models and approaches for achieving environmental sustainability and/or social justice, however, are obscure and questionable (Dauvergne, 2021, 2022; Francisco, 2023; Halpern, 2021). Along with the worries regarding the narrow focus and, thereby, impact of AI solutions, scientists and the general public, it has been raised concerns about the ethics of AI solutions (Boddington, 2017; Hickok, 2021; Jobin et al., 2019; Srikumar et al., 2022). Debates on the

subject, namely on the guidelines and principles for conducting research and using AI applications, signal that consensus has not yet been reached and that the developed recommendations have not spread far (Chatila and Havens 2019; Hagendorff, 2020). It is important to also note that while much of the increase in mining activities, and therefore related AI use, occurs in "developing" countries of the Global South, a prevailing body of the frameworks mentioned above have been established by the "developed" members of the Global North region, appealing to its ethics, community values, and political and institutional capabilities (Amugongo et al., 2023; Corrigan et al., 2023; Eke et al., 2023). The differences in cultural perspectives, immediate needs, technical capabilities, and institutional capacities of the two regions have given rise to the debate over the use and design of AI-enabled tools and associated data. Along with the necessity to recognize those distinctions comes the need for review of where, with which tools, and how AI can be employed. In this context, driven by the question of how AI approaches can help communities in societal development, environmental sustainability, and economic growth when it comes to the mining industry, we discuss the use and applicability of AI in the mining sector, what ethical considerations need to be discussed alongside the use, and how multi-objective optimization, as an approach, has the potential to use AI to provide a more sustainable, in terms of the UN's definition, pathway forward in this important industry.

2. Overview of Ai in Mining:

Formulated at the United Nations summit in Rio de Janeiro in 2012, the seventeen UN Sustainable Development Goals (SDGs) set the objectives for the balanced economic, societal, and environmental development needed for achieving equity and prosperity on a global or planetary level. The comprehensive system of SDG indicators helps track an individual country's, but not industries, progress. The industry sustainability taxonomy substituted by the environmental, social, and governance (ESG) reporting lacks clarity, transparency, and international consistency. Therefore, in this section, we outline the need for innovative solutions for making mining sustainable in the 'global' UN SDGs sense.

We review the current state of the mining industry, that are falling far behind on their SDGs, and we point out the scope of changes needed and the associated complexity that calls for the use of powerful AI algorithms. Next, we take a general view on mining processes and discuss how AI-based approaches may help with particular operations and decisions. We purposely focus on the opportunities for AI applications, leaving the discussion of the associated ethical challenges for usage of AI.

2.1 Background:

To mitigate climate change, which is threatening human populations around the world, countries should cooperate in reducing greenhouse gas (GHG) emissions and switching to clean energy technologies (IPCC, 2023). The solutions, such as adopting battery-based electric vehicles or increasing large-scale offshore and onshore wind power generation, however, requires a manifold increase in metals and minerals supply. This raises a critical question of whether such developments will bring low-income and resource-rents-dependent economies more prosperity and improvements along multiple axes of sustainability or instead will deepen the often-cited "resource curse". To understand why AI algorithms, applications, and their design are of great value and importance in the mining industry, consider the SDGs' multidimensionality and complex interdependencies. Although we are heading towards the AI era, but many of the Mining industries with low profit margins are not showing interest towards AI because of high cost.

2 Current and upcoming uses of Ai applications in Mining :

Several areas have been identified, where AI applications have already proven to be useful in the mining industry. Loosely speaking, resource extraction may be divided into the exploration, exploitation, and reclamation phases. Mining activities and upstream operations may differ dramatically depending on resource, production method, location, equipment used, and more. Taking a general look at the data types and decisions made, we distinguish a few more stages and position the review of AI use around them . We start the discussion with the models focused on exploration. Next, we review AI methods supporting mining and production approach and design decisions. We discuss the use of AI in mine operation and management practices separately, highlighting the aspects overlapping with SDGs. Additionally, with the goal of analyzing the effect of mining on sustainability, we consider activities associated with mining, namely extracted ore processing. Finally, we highlight the critical but often neglected stage of mineclosure and abandonment. Note, our objective is to provide an overview of AI's capabilities assisting decision-making related to resource extraction and enhancing mining industry operations. Therefore, technical details on AI models and algorithms are beyond the scope of this paper. The provided list of references and discussions, however, should inspire interested readers to critically review and revisit the setups and frameworks of AI applications, following the suggestions provided in the next two sections.

2.2.1 Exploration :

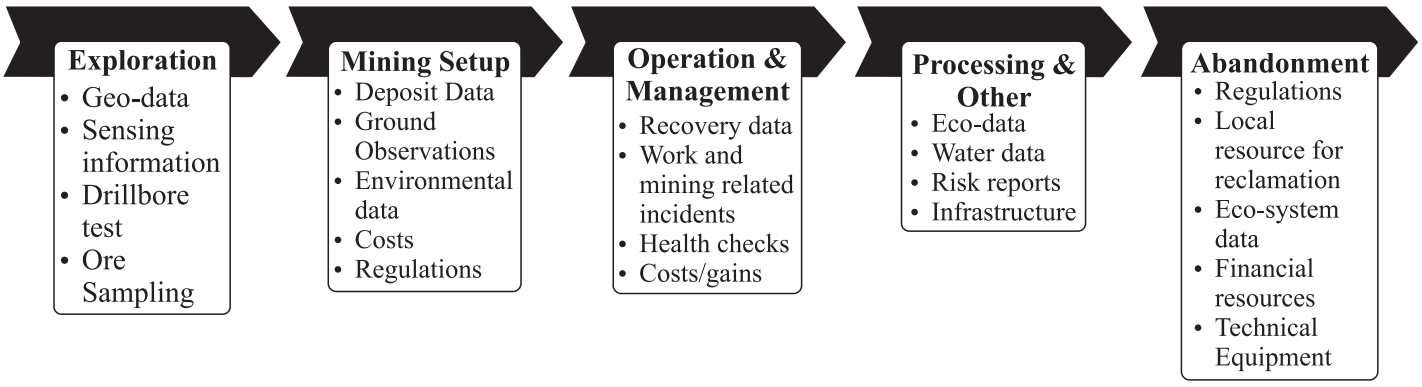
The AI applications focuses on prospecting and exploration, representing the initial stage of resource development. It includes the potential mining site or deposit location and an analysis of its grade or characteristics critical for productivity and profitability. Existing AI-enabled approaches use data obtained from geologic and geophysical resource properties mapping, remote and other sensing surveys, and chemical and mineralogical analyses, among others. Such data are compiled during exploration sampling and borehole logging, during laboratory work, and upon further investigation of prospects' operations .ML methods such as support vector machines (SVMs) and deep learning models are commonly used to clean and process data, perform imputations, and conducting data mining, addressing missing and erroneous data issues. Those functions are especially useful when it comes to information collected from drilling, sensors, or measurements made in real time (Jung and Choi, 2021). Results generated with the help of AI aid in understanding and predicting future resource production characteristics and supply potential, examples of use having come already from Goldspot Discoveries Incorporated and IBM Watson (Murphy, 2019). Thereby, AI-based analyses underpin and facilitate economic evaluations, enable measuring the financial potential of mining operations under various market conditions, and support investment and fiscal decisions (Lane, 1988).

2.2.2 Mining Setup :

After the location of the deposits is known from the exploration and survey, Mining owners and industrialistshave to make a decision about mining method. The two commonly distinguished mining approaches are open-case/ surface mining and underground mining. The primary characteristics influencing the decision on mining approach are geologic and mineralogy properties of the deposit, i.e. its depth and size, which affect productivity and extracted resource quality. The next most influential factors are economic. Open pit and underground production methods are compared on the basis of expected profitability, accounting for the equipment needed, its costs and operational expenses, costs to comply with corresponding regulations, mining site abandonment costs, and more. Advances in experimental geomechanics, combined with the growing collections of geologic rock data and insights from rock engineering, led to applications of AI in mining site design, e.g. tunneling and underground excavations, for improved productivity and profitability (Morgenroth et al., 2019). Along with that, the understanding of rock physical properties allows providing recommendations on safer and resilient mining. Thanks to continuous operational data collection, AI models can also now be applied to the analysis of surface vibrations (and micro earthquakes) and slides predicting blasts and various failures (Montiel et al., 2016; Ali and Frimpong 2020; Bui et al., 2020; Ali, 2022). Thus, AI not only helps improve mining efficiency and economics, but also can reduce life-risks, suggesting the optimal mining approach.

2.2.3 Operations :

Mining setup and operations management studies intertwine with AI-enabled tools by incorporating workplace safety considerations along with productivity and environmental impact analyses. Mining activities may be associated with a variety of risks, for instance, when resource extraction environment is represented by small workspace with inadequate lighting and contact with toxic materials, waste, and gasses. Inhalation of harmful particles not only damages the health of involved workers, but also leads to respiratory infections, which have become the top cause of death in Africa (Madhi and Klugman, 2006; Reiner et al., 2019). Drilling and blasting, heavy machinery, and specialized equipment operations may result in critical injuries, thus raising questions of mine safety and calling for monitoring and mine hazard assessments. For this reason, AI tools have been created to limit workers' exposure to these conditions through machines that 'autonomously monitor the atmosphere, send signals and warnings, locate problematic areas, and work continuously even in dangerous situations' (Hyder et al., 2019). Furthermore, AI-enabled tools have a potential role for government use in monitoring mining site and worker safety violations. For instance, some of the same technologies being already used to monitor biodiversity (Arteta et al., 2016; Kesari, 2019; Microsoft, n.d.) or detect air or water pollution violations (Carbon Tracker Initiative, n.d; Han et al., 2022), could help governments in mining communities also monitor violations. Earth observation techniques that employ machine learning can also potentially aid in identifying illegal mining, speeding up verifications or administration for land management, or identifying and planning for effective reclamation of land. On the company side, facial recognition and image detection systems are already being used in public spaces (Tucker, 2020) and could aid in monitoring.



3 Conclusions :

The use of AI-enabled tools in the mining industry is already underway. Given the key role of this sector in the energy transition and the speed with which that transition needs to occur, AI has the potential, if used correctly, to increase the efficiency of this process. If AI is employed while factoring in sustainability and community development needs, the potentially negative ethical implication of AI use could be significantly reduced. However, if considerations for the ethical use of these tools, and the tradeoffs that accompany their use, are not taken into account.We thus losing the opportunity to transition away from fossil fuels in a sustainable and planet/human-centric way. Thus, it is a pressing and worthwhile endeavor for both industry players and policymakers to take an ethical and holistic perspective on the use of AI in the mining sector. Moving beyond economic and efficiency gains, AI-enabled tools have the potential to help improve the comprehensiveness or sustainability of decision-making in mining operations.

By incorporating not only large amounts of economic data, but also significant amounts of data on environmental, land use, communities, and governance factors, multiobjective optimization of operations through machine learning processes is potentially useful. Generally, AI applications aimed at decision-making for economic outcomes are prone to accept utilitarianism, originated from consequentialism moral theory, focusing on the maximization of the overall consequences. Although this concept allows for redistribution of benefits to compensate for suboptimal individual outcomes, the inclusion of transparency and moral principles often remains neglected. Without scrutiny and transparency in the trade-offs, the use of such tools may accelerate already unjust or suboptimal results. Acknowledging that this is just a starting point, we conclude our review of the path forward, noting that whereas data and AI algorithms may empower the scientists and decision-makers, without transparency and continuous verification of ethical principles, the society may not be able to use its powerful tools for a greater good, stepping out of the way toward SDGs.

Acknowledgment :

This research is completely based on the Secondary data and there is no relevance and connection with any mining Industry.

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ARTICLE-4

ENHANCING SAFETY THROUGH DRIVER FATIGUE MONITORING SYSTEM (DFMS) AT KHONDBOND IRON & MN. MINE, TATA STEEL LIMITED

Garav Vikram Singh (Head)
Vishnu Kant Tiwari (Area Manager)
HB Jena (Area Manager)
Karthicksamy K (Manager-Equipment Maintenance)
Khondbond Iron & Mn Mine, Tata Steel Ltd

1. Abstract:
This technical paper explores the comprehensive deployment of the Driver Fatigue Monitoring System (DFMS) at Tata Steel's Khondbond Iron & Mn. Mine.It presents an analysis of the mining sector's complexities, the challenges associated with driver fatigue, and the careful execution of DFMS as a pivotal solution. The paper examines the critical issues, the innovative technology behind DFMS, the intricacies of implementation, and the remarkable benefits realized. This paper demonstrates how cutting-edge technology can significantly enhance safety protocols and operational efficiency in high-risk industrial settings.

2. Introduction:
Mining operations involving Heavy Earth Moving Machinery (HEMMs) are inherently complex and demanding. With the expansion of operations and increased fleet size, ensuring the safety of operators has become a paramount concern. This section introduces the pressing need for advanced monitoring systems and outlines the objectives of implementing DFMS.
Several historical accidents have occurred related to driver fatigue in mining operations. Statistics, case studies, and incidents are required to be analysed to understand the gravity of the issue. Regulatory frameworks and safety standards set by DGMS (Tech) are explored, emphasizing the need for compliance and the importance of proactive safety measures.

3. Current Issue Or Problem:
The paper explores the specific challenges faced by Khondbond Iron Mine of Tata Steel Limited, such as the vast operational area, diverse fleet, and the constant risk of accidents due to driver fatigue. Real-life incidents and their impact on both personnel and equipment. The financial implications of downtime and accidents are analysed, underlining the urgency for a robust solution.
In the fast-paced and highly productive environment of any opencast Iron ore mine, ensuring the safety of our Heavy Earth Moving Machinery (HEMMs) & Light Vehicle drivers is our prime motive. With increase in fleet size & utilization of HEMMs and extensive driving routes have made it challenging to mitigate the potential risks associated with driver fatigue.
Although Various DGMS Circulars have been issued by the Director from time to time for safe HEMMs & other vehicle operations with reference to provisioning and satisfactory working of various safety features, but driver fatigue continues to be a major cause of safety concern. So DGMS (Tech) circular No. 06 of 2020 in respect of the minimum required design/functionality of DFMS and other safety features was issued as stated below.

DGMS (Tech) circular No. 06 of 2020:
Enclosure to DGMS (Tech) Circular No. of 2020 guidelines in respect of provisioning of safety features of HEMMs& Heavy/Light Vehicles for safe deployment in opencast mines.

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

Fig: Snap of Driver sleeping while driving

The Warning System for Operator Fatigue shall meet the following minimum requirements and standards:
1. The system shall boot automatically along with starting of Engine.

2. The system shall detect state of drowsiness of Operator from regular driving behaviour and shall provide loud verbal warnings.
3. The system shall have following four stages:
   a) Initialization
   b) Tracking
   c) Drowsiness Detection
   d) Warning
4. Components of the system shall in no way obstruct Operator's line of sight hindering.
5. The System may be provided with provisions for 96 hours recording the warning generated with time stamp.
6. For determining type, duration and sound level of audio warning and intensity of external Visual warning.

4. Analysis:

The human factors contributing to driver fatigue were analysed. The psychological, physical, and environmental aspects affecting operator alertness were explored. The paper delves into existing safety measures, highlighting their limitations and emphasizing the need for a more sophisticated and proactive approach in real time basis.

5. Solution Adopted :

DFMSis introduced as a ground-breaking solution to tackle driver fatigue effectively. The technology, including cameras, processors, and advanced algorithms, is explained in detail. The system's ability to monitor operator behaviour, detect signs of fatigue, and trigger timely alerts is elaborated upon. The integration of DFMS with existing safety protocols is discussed, showcasing the synergy between cutting-edge technology and established safety practices.

DFMS system has been installed to mitigate driver fatigue within our Departmental & contractual fleet. This system will utilize cutting-edge technology to track driver behavior, phycological indicators and external conditions to provide timely alerts and interventions, ultimately improving safety, reducing accidents, and enhancing operational efficiency.

6. Technical Details :

6.1. Main Unit:

Item	Description
Main Processor	ARM Cortex A7 Quad
Sub Processor	ARM Cortex M0(for illusion & Camera Control)
Camera	Effective Pixels (720 X 480)
View Angle (Camera)	42^0 (D) 30^0 (H) 42^0 (V)
Video (Video Out)	CVBS 1Vp-p 75Ω

6.2 Hardware :

Main unit	Power cable 3P	PCI Box
		
Micro SD card (Consumable)	Contactless CAN Reader (Optional)	FMS Cable (RS-232) (Optional)
		

6.3 LED Warning System :

Features	Features	Level (Seconds) 3	2	1	LED 2 (Blinking)
Drowsiness	When the driver closes eyes for certain period	1.5	2	2.5	✹
	If the driver closes eyes again within 30 seconds	-			✹ & ✹
Distraction	When the driver looks outside at warning range below	3	4	5	✹
	If the driver remains distracted for certain period	5	6	7	✹ & ✹
Yawning	When the driver yawns for 3 seconds twice within 1 minute	3			✹
Phone use	When the driver talks over the phone for certain period (Every 30 seconds)	2	3	4	
Smoking	When the driver smokes for certain period				✹

6.4 Parameters of Warning :

Type of warning	Level 3		Level 2 (Default)		Level 1	
	Time	Angle	Time	Angle	Time	Angle
Drowsiness	1.5S	Left : 25° Right : 25° Top : None Down : 15°	2S	Left : 30° Right : 30° Top : None Down : 20°	2.5S	Left : 35° Right : 35° Top : None Down : 25°
Distraction	3S Extra warning: 5S		4S Extra warning: 6S		5S Extra warning: 7S	
Phone	2S		3S		4S	
Smoking						
Yawning	3S		3S		3S	

6.5 Checkpoints to identify whether DFMS Camera is working or not on-site?

Checkpoints 1

From the Fig, we can observe 3 lights representing 3different Indications.

Red - Power Supply, turns ON immediately after Engine ONand then turns OFF.

Green - GPS Tracking, turns ON immediately after Engine ONand then turns OFF.

Blue - GSM Signal, keeps blinking until the Engine turns OFF.

Checkpoint 2

When the Engine turned ON, we need to hear "Trip Started"

6.6. Error Description:

Error Description	LED Color		Possible Cause
Camera Error		LED 1: Yellow LED 2: Red	Camera component error
GPS Error		LED 1: Yellow LED 2: Blue	GPS component error
Other problems		LED 1: Yellow LED 2: Green	SD Card or Video recording error CAN communication error

6.7. Main Functions of DFMS:

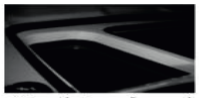
i) Operator Alert


Eye Closure


Yawning


Head down


Look Around


No driver found


Phoning


Face Occlusion


No seatbelt


Over speeding

ii) Tracking System

Communication with Authorized Person: Simultaneously, the system can send messages to authorized individuals or parties. This can be done through various communication methods, such as SMS, email, or app notifications. The message sent to the authorized person includes details about the driver's condition, such as the driver's location, vehicle information, the behavior patterns that triggered the alert, and the time of the incident.

iii) Alert Details & Monitoring

The Alerts is also sent to Online DFMS fleet dashboard where all alerts can be reviewed & analyzed.

We have set up a command center to monitor live events & to communicate instantly to fatigued operators thru two-way communication system installed in vehicles & command center.

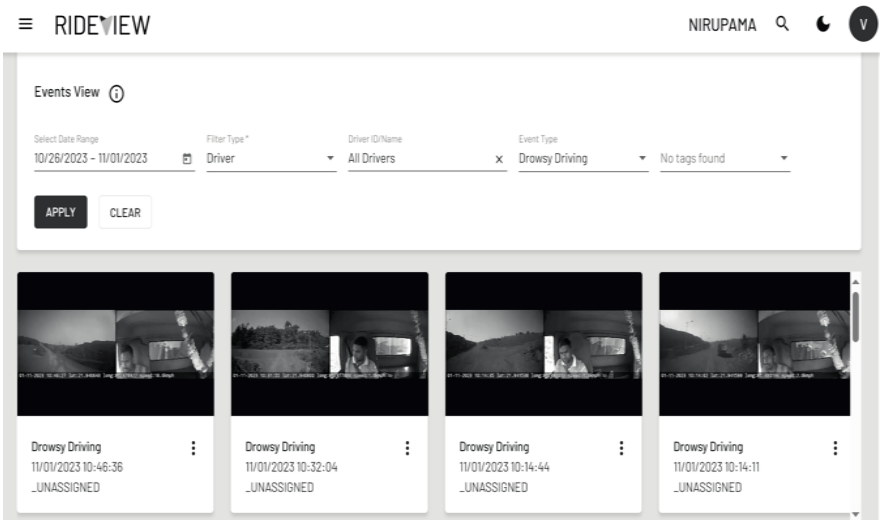


Fig: Online DFMS control Room at Khondbond Iron & Mn. Mine

iv) Workflow of DFMS:

1. Data Collection
(The camera captures face, eyelid, neck, hand movements Drowsiness-Eyes Closed for 1.5 Sec or accumulated time of closed eyes exceed 6 seconds within 60-second interval.)

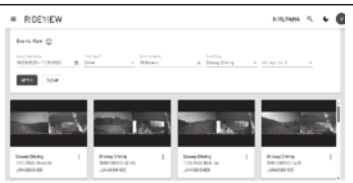
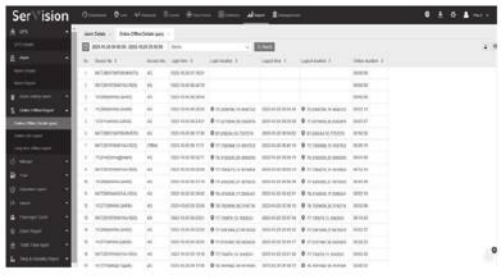
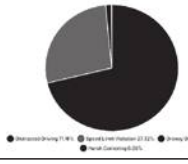
→

2. Data Analysis
(Image collected like closed eyelids is used to analyze drivers' behavior thru different algorithms)

→

3. Alerts and Interventions
(When the system detects signs of driver fatigue. It triggers alerts.)

v) Features of Online DFMS fleet dashboard:

Features	Description	Features	Description
Live information of Safety Alarm.		Remote video surveillance and GPS-based positioning and tracking	
Auto Upload of alert video & image recording with remote obtainment (Viewing and playback of history footages) thru App/Weblink.		Device malfunction, tampered, online & offline report.	
Dangerous driving behavior alert analysis (Operator, Machine, Location, Type of alert wise).			

7. Implementation Process:

The implementation process covers vendor selection, system customization, training modules designed for operators and staff, and the integration of DFMS with the mine's existing infrastructure. Challenges faced during the implementation phase, such as logistical issues and operator resistance, are addressed, showcasing the adaptability and resilience of the implementation team.

8. Conclusion:

The successful implementation of Online driver fatigue monitoring system at Khondbond Iron & Mn. Mine illustrate the commitment towards safety enhancement. This system successfully generating all the enabled driver abnormalities in real time. The continuous monitoring and action on these alerts significantly reduced the risks of HEMM and Supporting equipment/LMV operation at mines. The operators with true alerts are counselled to create awareness on drowsy driving.

9. Reference:

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ARTICLE-5

OPTIMIZING BLASTING EFFICIENCY THROUGH ADVANCED AUTOMATION TECHNOLOGIES AT KHONDBOND IRON& MN MINE, TATA STEEL LTD.

Saurabh Singh (Sr. Manager)
Anup Kumar Roy (Safety Officer)
Khondbond Iron & Mn. Mine, M/s Tata Steel Ltd.

1. Introduction:

Khondbond Iron & Mn Mine is a part of the Ore Mines & QuarriesDivision of Tata Steel with a lease area of 978.0 ha. The mine is situated near Joda in the Kenojhar District of Orissa. Mine is worked by the open-cast method on a series of benches in two. Deep hole blasting is being carried out at Khondbond Iron & Mn mine using Site Mix Emulsion (SME) Explosives along with the latest technologies, such as Advanced Vibration Monitoring (AVM) based blasting and electrotonic detonators being used with the NONEL system.

2. Process Flow Of Khondbond Iron Mine :

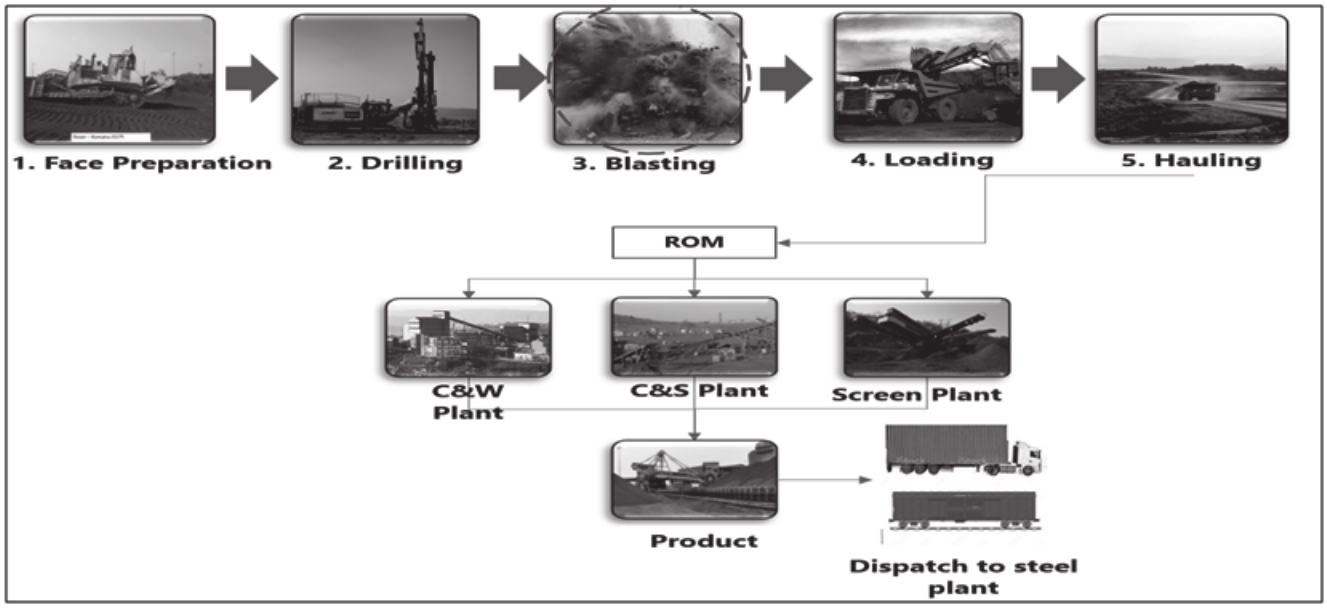


Fig 1: Process flow of Khondbond iron & Mn. Mine

3. Problem Statement :

One of the active mining pits of Khondbond Iron Mine, Pit-2, is situated at a very close proximity to critical infrastructure, such asHigh-Rate Thickener (approx. 100m away from blast patch), Sub Grade Dump and other structures along with the challenging geology of massive widely jointed hard ore strata, complicating the optimization between blast vibrations and rock fragmentation. Peak Particle Velocity (PPV) must be restricted to below 5 mm/s near these structures. Further, the adverse geology impairs fragmentation, leading to detention of Crushing & Wash Plant due to jamming of the boulder. With the existing blasting practices, the P80 value was in range of 800mm to 950mm, whereas the PPV was in the range of 4.2 mm/s to 6 mm/s with dominant frequency range varying between 3.125 Hz to 19.7 Hz.

4. Approach To The Problem:

A.Use of Advanced Technologies to Improve Blast Efficiency

a. Use of Advanced Vibration Modelling (AVM) tools to predict PPV values prior to the blast at critical structures.
b. Regular Fragmentation Analysis to determine the P80 value for regular monitoring and improving the blast fragmentation.
c. Regular measurement of confined Velocity of Detonation (VOD) to test the strength of explosive.
d. Maintaining the digital blast reports to monitor and rectify any deviations from the plan.
e. Digital drill plans to facilitate accurate drilling operations.
f. Digital blast plan and simulating the blast hole delay timings to eliminate the chances of fly rock.

B. Use of Electronic Detonators - to provide flexibility and accuracy in delay timings.

5. Parameters Selected For Field Experiment:

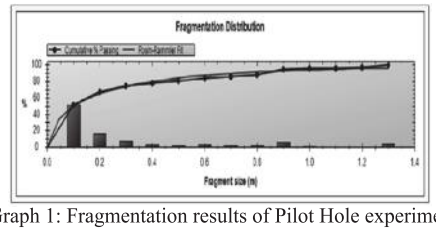
Field experiments are planned at Khondbond Iron Mine by varying the controllable parameters to optimize the blast induced vibration & fragmentation.

1. Maximum Charge Per Delay (MCPD) in Kg.
2. Delay Timings in Millisecond.
3. Burden in Metre.
4. Spacing in Metre.
5. Stemming Length in Metre.

6. Field Experiments:

6.1 Trial of Drilling Pilot Hole

Trial of drilling Pilot Hole (5m depth)in between the holes in bench of 10m height to eliminate the boulders generated from the drill hole collars (in stemming length the explosive is absent thus boulders are generated from the top column of the blasthole), resulting in improved fragmentation with P_{80} value of 407 mm.



Graph 1: Fragmentation results of Pilot Hole experiment

6.2. Varying the MCPD and delay timings:

Five experiments were performed by varying Maximum Charge per Delay (MCPD) and inter hole & inter row delay timings to observe the effects of MCPD and delay timings on Blast induced ground vibrations (PPV values) and blast fragmentation (P_{80} value).

PPV - Peak Particle Velocity; MCPD – Maximum Charge per Delay

6.2. Varying the MCPD and delay timings:

Design of Experiment-1(DOE-1)

- The inter-deck delay is 4ms and inter-hole delay is 20ms and MCPD is 120 kg.
- The POI distance to blast face is about 235 m and vibration got 5.2 mm/s.
- 80% of passing fragments size is 557 mm.

Design of Experiment-2 (DOE-2)

- The inter-deck delay is 2ms and inter-hole delay is 8ms and MCPD is 90 kg.
- The POI distance to blast face is about 240 m and vibration got 4.8 mm/s.
- 80% of passing fragments size is 460 mm.

Design of Experiment-3 (DOE-3)

- The inter-deck delay is 3ms and inter-hole delay is 12ms and MCPD is 75 kg.
- The POI distance to blast face is about 227 m and vibration got 3.3 mm/s.
- 80% of passing fragments size is 466 mm.

Design of Experiment-4 (DOE-4)

- The inter-deck delay is 4ms and inter-hole delay is 20ms and MCPD is 100 kg.
- The POI distance to blast face is about 210 m and vibration got 4.9 mm/s.
- 80% of passing fragments size is 491 mm.

Design of Experiment-5 (DOE-5)

- The inter-deck delay is 4ms and inter-hole delay is 16ms and MCPD is 80 kg.
- The POI distance to blast face is about 227 m and vibration got 3.2 mm/s.
- 80% of passing fragments size is 483 mm.

Parameters	DOE-1	DOE-2	DOE-3	DOE-4	DOE-5
Location - Pit-2	680mRL				
No. of holes	37	51	37	49	46
Burden (Metre)	3.2	2.8	2.8	2.8	3
Spacing (Metre)	3.2	3.2	3.2	3.2	3.2
Hole depth (Metre)	11	11.5	11	11.5	11
Stemming (Metre)	3.2	3.2	3.2	3.2	3.2
Decking (Metre)	1.5	1.5	1.5	1.5	1.6
POI distance (Metre)	235	240	227	210	227
PPV (mm/s)	5.2	4.8	3.3	4.9	3.2
Passing size (mm)	557	460	466	491	483
Inter hole delay (MS)	20	8	12	20	16
Inter deck delay (MS)	4	2	3	4	3
MCPD (KG)	120	90	75	100	80

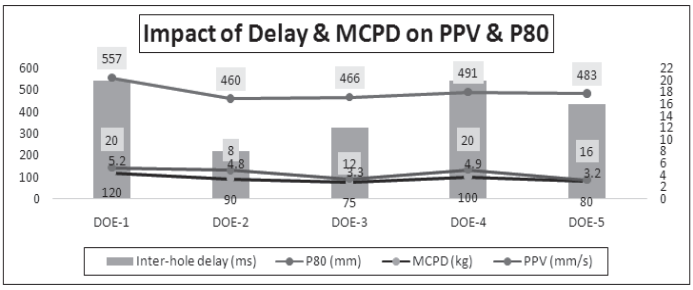
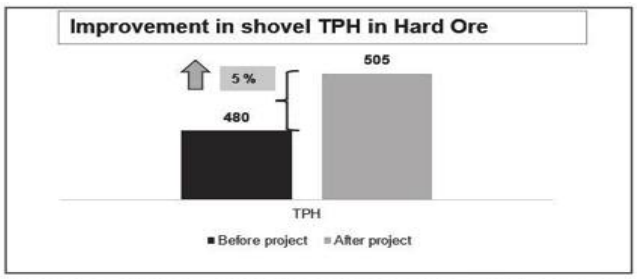


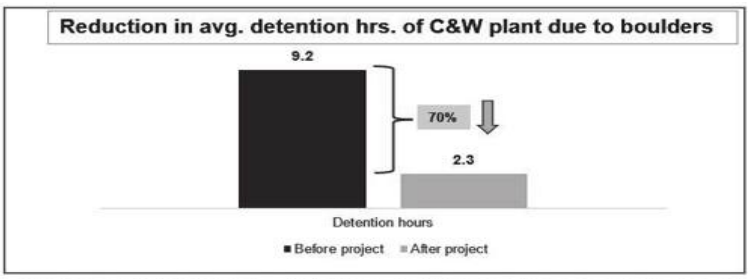
Chart 1: Blast Parameters of various design of experiments performed by varying the MCPD and delay timings.

7. Conclusion :

1. **Vibration Control -** Achieved by decreasing the MCPD, increasing the inter charge/hole delays.
2. **Fragmentation Improvement -** Achieved by squeezing the pattern (Burden and Spacing), increasing the MCPD and decreasing the inter charge/hole delays.
3. **Vibration Control and Fragmentation Optimization -** By squeezing the patterns, optimizing the MCPD and inter charge/hole delays vibration was kept in control while also improving the fragmentation of the blasted rock.
4. **Trial of Pilot hole drilling -** Yielded good results in elimination of collar boulders & improving fragmentation.

8. Result:

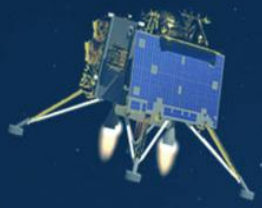




1. Improvement in shovel TPH by 5%
2. Reduction in avg. detention hrs. of C&W plant due to big boulders by 70 %
3. Improvement in Fragmentation avg. P_{80} by 42% from the range of 0.85m to 0.49m
4. Improvement in blast induced ground vibration control to PPV values of less than 5mm/s
5. Elimination of the fly rocks.

CO_2 REDUCTION

JSL
JINDAL STAINLESS



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ARTICLE-6

TRIAL OF COLLISION AVOIDANCE SYSTEM (LEVEL-8) AT KHONDBOND IRON AND MN. MINE, TATA STEEL LTD.

Rajesh Kumar (Mine Manager)
Santosha Kumar Raut (Area Manager)
Gorre Srinadh (Assistant Manager)
Khondbond Iron & Mn. Mine

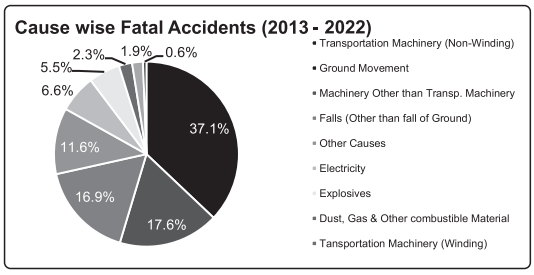
1. Abstract :

The mining industry plays a significant role in India's economic growth, contributing about 2% of Indian GDP directly, and remains one of the key suppliers of raw materials to the core industries such as steel, cement, and power. On the other hand, the mining industry remains one of the most incident-prone industries, with frequent incidents and inherent risks of mining operations. As per DGMS publication, 37% of the fatal accidents are due to transportation machinery (other than winding) in the period 2013-2022. The rapid mechanization of mines, coupled with the sheer size of machinery deployed in mining operations make the machine operators experience blind spots, increasing the likelihood of collisions. Despite the implementation of various levels of collision avoidance systems in the mines, vehicular collision risks remain a persistent challenge. To reduce the risk of vehicular collisions, Khondbond Iron & Mn. Mine has experimented with Level-8 Collisions Avoidance System. This study provided significant insights for the implementation of the Level-8 Collision Avoidance System at Khondbond Iron & Mn. Mine and horizontally at all mines of Tata Steel to reduce the risk of vehicular collisions.

Key words: DGMS Publication, Rapid Mechanization, Vehicular Collisions, Collision Avoidance System.

2. Introduction :

The index of mineral production stood at 126.4 in FY'24 (base 2011-2012), with significant Y-o-Y growth rates and 5.4% growth against FY'23. This growth of the mining industry in India is due to extensive mineral auctions and mechanization of existing mines. With the increased mechanization in the mining industry, the share of accidents related to Man- Machinery interaction has also increased. Transportation machinery, excluding winding equipment, is a leading cause of fatal accidents in mines. Due to the sheer size of machinery deployed in mines such as haul trucks, shovels, loaders, and Dozers, the operators of these machines experience significant blind spots, making it challenging to navigate safely in the mines without any collisions. Collision Avoidance System (CAS) is one of the emerging technologies in the mining industry to ensure safety. The evolution of collision avoidance systems (CAS) in mines has been driven by the need to improve safety and operational efficiency. Initially, mining equipment operators relied on basic safety installations such as rearview mirrors, blind spot mirrors and radio communication from ground personnel etc for safe navigation of mining equipment. As technology advanced, mines adopted radar and proximity detection systems to warn operators of equipment or nearby personnel. Modern collision avoidance systems are integrated with advanced technologies like sensors, Artificial intelligence and 5G for real-time data processing and provide real time alerts to the operators to improve safety by preventing collisions.



2.1 Evolution Of Collision Avoidance :

The collision avoidance system has evolved at various levels in the mining industry, as shown in the Table-1. With the intervention of artificial intelligence and the 5G network, Level 9 of the collision avoidance system is evolving with industry customizations.

Table-1: Levels of Collison Avoidance System

1. Site Requirements	Equipment Specifications, Standards, mine design/plans
2. Segregation Controls	Berms, access control, traffic segregation, time schedule
3. Operating Procedures	SOP's, maintenance, road rules, quality control, lockout
4. Authority to operate	Training licences, induction, access control
5. Fitness to Operate	Fatigue state, drug & alcohol
6. Operating Compliance	Pre-start, safety tests, Vehicle health
7. Operating Awareness	Cameras, live maps, mirrors, solar delineators
8. Advisory Controls	Alerts: Proximity, Fatigue, Overspeed, operator behaviour
9. Intervention Controls	Inter locks: PreventStart, Slow-stop, Rollback, Retarder

3. Working Principle Of Collision Avoidance Systems:

Collision Avoidance Systems function by using a network of various sensors and systems, all working together to monitor the vehicle's surroundings and detect potential road hazards. The primary components of these systems include radar sensors, LiDAR sensors, and cameras, which are fundamental for Collision Avoidance Systems to work effectively.

Radar sensors, typically mounted on the front and rear of the vehicle, utilize radio waves to detect the distance, velocity, and direction of objects around the car. These sensors are crucial for the real-time data they provide, which is integral to the operation of Collision Avoidance Systems. LIDAR sensors emit light waves to create more detailed 3D maps of the environment around the vehicle, offering another layer of data critical for effective collision avoidance.

Camera sensors, working together with the radar and LiDAR sensors, provide essential visual data that can identify objects such as vehicles, pedestrians, and traffic signs. Sometimes, ultrasonic sensors are also used in modern vehicles, especially for low-speed functions like parking. All these sensors work in unison to give the central control unit a comprehensive picture of the car's surroundings, enhancing the functionality of the Collision Avoidance System. Collision avoidance systems are actually acombination of different Passive and Active ADAS systems designed to detect, warn, and prevent collisions.

3.1 Passive Systems in Collision Avoidance systems:

a. **Driver Monitoring Systems(DMS):** DMS monitors the driver's behaviour and alerts them if they are showing signs of drowsiness or distraction. This can help prevent accidents caused by driver error.

b. **Forward Collision Warning(FCW):** This system uses sensors to detect the speed and distance of objects infront of the vehicle. It then alerts the driver if they are getting too close to a potential hazard, allowing them time to react and avoid a collision.

c. **Lane Departure Warning (LDW):** LDW uses cameras to detect lane markings and alerts the driver if they are unintentionally drifting out of their lane. Preventing collisions caused by unintentional lane changes.

d. **Blind Spot Monitoring (BSM):** This system uses sensors to detect objects in the vehicle's blind spots, warning the driver if it is unsafe to change lanes. Helping avoid crashes caused by blind spot visibility issues.

e. **Pedestrian Alert Systems (PAE):** PAE uses cameras and sensors to detect pedestrians or other vulnerable road users in the vehicle's path. This system aims to deter drivers from unintentionally colliding with a pedestrian.

3.2 Active Systems in Collision Avoidance systems:

a. **Automatic Emergency Braking (AEB)**: AEB uses sensors to detect potential collisions and automatically applies the brakes if the driver does not respond in time. Helping to reduce the severity of crashes or potentially avoid them altogether. As an example, if the FCW systems alert the driver of a potential collision and the driver does not respond, AEB will kick in to prevent or reduce the impact.

b. **Lane Keep Assist (LKAS)**: LKAS uses cameras and sensors to monitor the vehicle's position within the lane. If the vehicle begins to drift out of its lane, LKAS will gently steer it back into its proper position. This system is especially helpful for preventing accidents caused by driver drowsiness or distraction if the driver does not respond to alerts given by the DMS.

4. Overview of Khondbond Iron & Mn. Mine :

Khondbond Iron and Manganese mine has a mine lease hold area of 978 ha with the production capacity of 8 MTPA ROM (Run Off Mine). The mine is located at Guruda & Baitarani R.F. village, Champua Taluk, Keonjhar district, Odisha, India. The mine is worked by open cast mining method with benching by combination of shovel-dumper system. Khondbond Iron mine is equipped with 10 dumpers (Komatsu HD-785-7), 4 shovels, 2 loaders, 4 drills ,5 dozers, 2 water sprinklers, and a grader and other ancillary equipment. Tippers are being used for internal product shifting from various processing plants to despatch stocks. Therefore, Khondbond Iron mine experiences heavy vehicular movement inside mines. Although, many levels (up to Level-7) of collision avoidance systems in place, 99% LMV-HMV road separation and dedicated road for internal shifting have been provided, Vehicular collision still exists as one of principle hazards of the mine. Therefore, to reduce this risk, Khondbond Iron Mine has experimented Level-8 of Collision Avoidance System.

5. Trial of Level-8 Collision Avoidance System :

The Level-8 Collision Avoidance System uses the latest advances in three-dimensional technologies combined with artificial intelligence to provide an intelligent pedestrian and object detection system. Artificial intelligence technology integrated in each camera with in the system provides human-like intelligence to each camera. This allows the camera system to detect and re-act to dangerous conditions. The main components of the Level-8 Collision Avoidance system are 3D cameras, Smart displays, GPS system, M12 data cables for data transfer from cameras to display, External LED & Siren system to provide alarms.

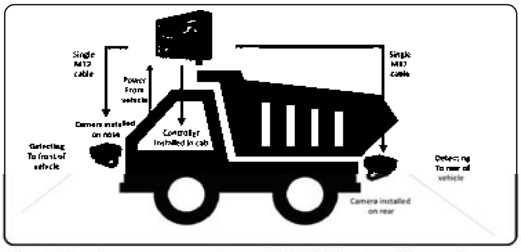
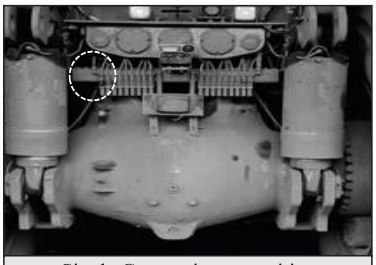


Fig-1:KeyComponentsofLevel-8CollisionAvoidanceSystem

Table-2: Characteristics of the key components of Level-8 Collision Avoidance System

S.No.	CAS (Level-8)KeyComponents	Characteristics
1	Camera IP Rating	IP69K
2	Camera Field of View	90 Degrees horizontal, 62 degrees vertical
3	Camera Detection Range	Upto 25m for pedestrians, upto 50m for vehicles
4	Camera Dimensions & Weight	160 mm x 160 mm x 135 mm & 2.7Kg
5	Display IP Rating	IP65
6	Display Dimensions	264 mm (W) x 172mm (D) x 53 mm (H)
7	Display Parameters	Brightness 450mC/m2|Size=10”
8	Data Ports	M12 sealed Connector



Single Camera inrear position

Two Camera in front position

Fig-2: Position of cameras installed on dumpers

All the necessary components of the CAS are installed and Configurations for display, sensors, relay, and alerts are done. Two cameras are installed at front an done at rear side of the dumper. The camera detection zone has been configured as shown below fig.3.

The 3D camara willdetect objects and determine the range ofthe objects. Once anobject has been detected in the detection zone, the stereoscopic camera will range to the object.

Three zones are available:

- Warning zone: The farthest zone that will generate allow priority warning.
- Slow down zone: The middle zone that will generate a higher pitch warning to the operator.
- Stop zone: The closest zone to the camera, this zone will generate the highest priority warning with a high pitch beep.

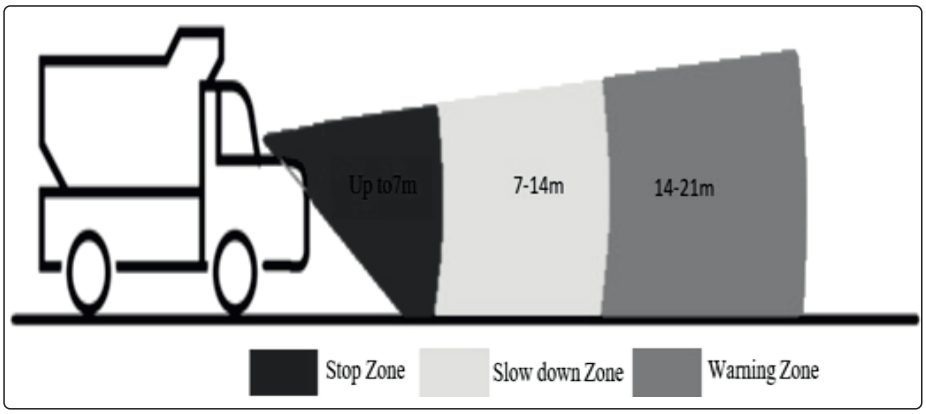


Fig-3: Detections zones configured at Khondbond Iron Mine

6. Results & Discussions :

The system has given satisfactory results in terms of object/person detection. The zoning of the object/ person has also been successful, and alerts are generated based on the distance on which the detected object/person falls. The intensity and frequency of alerts vary based on the detection zones, as follows:

- Warn zone frequency: 3 seconds.
- Slow down zone frequency: 2 seconds.
- Stop zone frequency: 1 second.

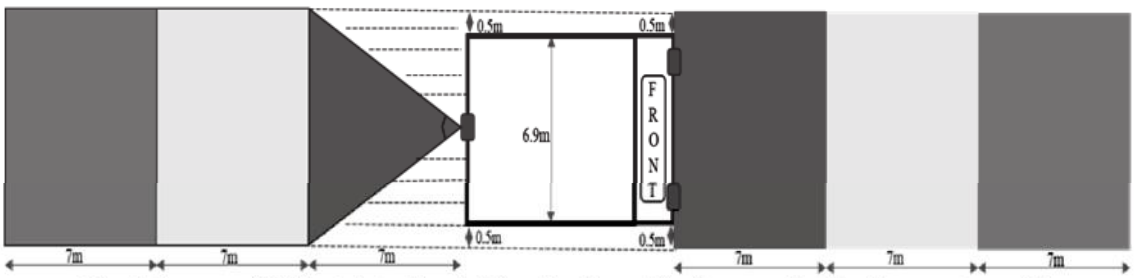


Fig-4: Images of Object detection & Visualization at display provided in the operator cabin

Formation of the blind zone at rear side of the dumper is a major concern and the installation of two cameras at the rear side is not practical given the space constraint at rear side of the dumper.

7. Way Forward :

- ❖ Further trials are required to over come the blind spots and to providethe360°viewof the vehicle in the operator's cabin with object detect ability at all sides of the vehicle.
- ❖ Currently the trials were conducted only in static mode with constant detection zones, which has given good results in terms of object detect ability. Furthermore, trials are required on dynamic mode as the alert zones vary along with the vehicle speed and determine the speed of the oncoming vehicle without any false alarms.

With successful trials and certain customization to the Level-8 collision avoidance system, it can be able to replace the following safety devices: -

- Rear view camera
- AVA system (through sound level-dBA need improvement)
- Proximity sensor

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ARTICLE-7

ESTABLISHING A PERMANENT DIESEL FILLING POINT AT NUAGAON IRON ORE MINES, JSW STEEL.

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Ashutosh Patel, Arundeep Bhattacharya
JSW Steel Limited

Introduction

The Nuagaon Iron Ore Mines, operated by JSW Steel with a vast lease area of 776.969 hectares, began its mining operations in 2020 under a Mining Development Operator (MDO). As operations expanded and the need for increased mechanization grew, JSW Steel made a strategic decision to shift towards departmental mining to enhance productivity and establish a benchmark in the mining industry. This transition began with the procurement of advanced heavy equipment, including 4 excavators in the 125-ton class, 12 dumpers with a 100-ton capacity, 1 wheel loader, and other ancillary Heavy Earth Moving Machinery (HEMMs). This significant move towards departmental mining aligns with JSW Steel's commitment to improving operational efficiency and safety within the mine. As part of this commitment, the establishment of a permanent diesel filling stand at the Nuagaon iron ore mines represents a pivotal shift in how wheel-mounted equipment such as dumpers and other HEMMs are refueled within the mine. The new setup serves as a centralized point for diesel refueling, eliminating the need for fuel bowsers to navigate the hazardous terrain of mine pits, thereby enhancing safety and operational effectiveness.

Centralized Refueling for Enhanced Safety

One of the primary advantages of this permanent diesel filling stand is the elimination of fuel bowser movements within the mine pits. Previously, mobile diesel bowsers were used to refuel equipment across various locations, a practice that posed significant risks. The movement of these large fuel trucks within the uneven and often unpredictable mine terrain increases the likelihood of accidents, including spillage, vehicle rollovers, and collisions with other equipment. By centralizing the refueling process at a single, fixed location, the new diesel filling stand substantially reduces these risks. All wheel-mounted equipment now converges at this designated point for refueling, ensuring that diesel filling occurs in a controlled environment. This not only minimizes the potential for accidents but also ensures compliance with stringent safety protocols.

Fig 1:- Centralized Diesel Filling Point

Challenges Of Previous Refueling Practices

Before the establishment of the permanent diesel filling stand, refueling wheel equipment'swithin the Mines pits presented significant safety challenges. The mobile diesel bowsers had to travel into the mine pits, navigating through hazardous and uneven terrain. This movement not only created congestion within the pits but also heightened the risk of accidents, including potential vehicle rollovers and collisions with other equipment.

Additionally, the refueling process itself involved helpers climbing up ladders to reach the filling points on the dumpers, exposing them to the dangers of slips, trips, and falls. These unsafe practices made the refueling procedure not only hazardous but also inefficient, further complicating operations within the mine.

Fixed Stand: A Sustainable and Efficient Solution

The fixed diesel filling stand is designed with sustainability and efficiency in mind. It is strategically located within the mine to ensure easy access for all equipment without causing significant downtime. The stand ensures quick and efficient diesel transfer to the machinery.

The permanent nature of the stand also allows for better management of diesel resources. Unlike mobile bowsers that are prone to spillage, the fixed bowser stand has a robust system, reducing the risk of environmental contamination. Additionally, it is easier to monitor and maintain, ensuring that the equipment is always in optimal condition for safe and efficient operation.

Fig 2: Diesel Filling in Dumper at fixed fueling point

Streamlined Diesel Filling Procedure

The introduction of the permanent diesel filling stand has led to a more streamlined and standardized diesel filling procedure. Operators are now required to adhere to a specific protocol when refueling their equipment to ensure safety and efficiency:

1. **Parking**: Upon arriving at the diesel filling stand, the operator must first park the machine in the designated area.
2. **Battery Cut-Off**: Before refueling can commence, the machine's battery must be cut off. This crucial step prevents any accidental start-up or movement of the equipment, which could otherwise lead to dangerous run-off incidents.
3. **Refueling**: Once the machine is securely parked and powered down, the refueling process begins.
4. **Post-Refueling Check**: After refueling, the operator ensures the completion of the process by signing the diesel logbook and performing a walk-around inspection of the equipment.
5. **Return to Operation**: The operator then switches on the battery cut-off and proceeds with the operation.

Fig 3: Battery Cut-off by operator

Fig 4: Diesel Refuelling in Dumper

This standardized procedure ensures that each step is followed meticulously, reducing the chance of human error and significantly increasing the overall safety of the operation.

Cost-benefit Analysis

- **Average Diesel Consumption per Hour:** 5 liters/hour
- **Average Running Hours per Day (Before Setup):** 8 hours
- **Average Running Hours per Day (After Setup):** 3 hours
- **Reduction in Running Hours per Day:** 5 hours

Diesel Consumption And Cost Savings

Diesel Savings per Day:

1. **Before Setup**: 8 hours/day * 5 liters/hour = 40 liters/day
2. **After Setup**: 3 hours/day * 5 liters/hour = 15 liters/day
3. **Daily Diesel Savings**: 40 liters - 15 liters = 25 liters/day

Cost Savings:

1. If the cost savings are approximately Rs 4000 per day, this likely includes savings on both diesel and maintenance.
2. **Daily Savings Estimate**: Rs 4000

- **Cost Savings per Day**: Rs 4000
- **Annual Savings**: Assuming 365 operational days, the annual savings would be approximately Rs.4000 * 365 = Rs 14,60,000.

This analysis shows significant cost savings primarily due to reduced diesel consumption and maintenance, making the setup of the permanent diesel filling stand a financially beneficial decision.

Conclusion

The establishment of a permanent diesel filling stand at Nuagaon iron ore mines is a significant advancement in JSW Steel's commitment to safety and operational efficiency. By centralizing the refueling process and eliminating the need for mobile bowsers within mine pits, the new setup not only enhances safety but also optimizes the overall efficiency of mine operations. The fixed bowser stands, with its advanced technology and streamlined procedures, ensures that diesel refueling is conducted in the safest and most effective manner possible, aligning with JSW Steel's goals of sustainable and responsible mining practices.

Acknowledgment

We thank our Mines Agent / Operation Head of JSW Odisha Mines, Shri Ram Shanker Sharma for his guidance, constant support and giving free hand in preparing this article in the most elaborate manner.

Disclaimer

The article is an amalgamation of data collected from own views and thoughts and actions. JSW Steel Limited does not necessarily subscribe to the views and thoughts expressed in the article and should not be held responsible for the same.

ARTICLE-8

SAFE IRON ORE DESPATCH PROCESS UNDER i3MS, INCLUDING STACK PREPARATION

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Ajay Yadav (Area Manager)
Neelachal Iron Ore Mine

Introduction

The despatch of iron ore from Odisha is tightly controlled to ensure transparency, prevent illegal activities, and maintain accountability. The **Integrated Mines and Minerals Management System (i3MS)** plays a central role in this process, especially following the recent updates in the **Odisha Minerals (Prevention of Theft, Smuggling, Illegal Mining, and Regulation of Possession, Storage, Trading, and Transportation) Rules (OMPTS)**. This article provides a step-by-step overview of the iron ore despatch process, from **stack preparation** to **final delivery**, following the i3MS framework. Visual aids have been provided to clarify each stage.

1. Stack Preparation

The process starts with **stack preparation**, where iron ore is segregated by grade and quantity. Proper stack management ensures accurate record-keeping in the i3MS system.

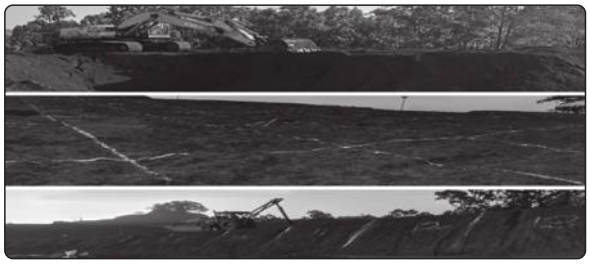

Fig. 1

Key Steps:

- Segregation of ore by grade and volume as per standards.
- Marking of stacks with unique identifiers.
- Applying **Form S** for Stack verification.
- Joint survey by mining officials and leaseholders.
- Entry of stack data into the I3MS portal for transparency.

2. Application for Despatch Permit (Form J)

Once the stack is prepared and registered, the mining leaseholder must apply for a **despatch permit** via **Form J** in the I3MS system. The system verifies whether the requested quantity for despatch aligns with the available inventory and regulatory requirements.

Key Steps:

- Submission of Form J in the i3MS.
- Verification of stack records and mining quotas.
- Payment note creation.
- Approval of despatch permit based on compliance in **Form L**.

3. Vehicle Scheduling and e-Pass Generation (Form M)

After the permit is issued, the vehicles assigned for transportation must be registered in the I3MS, and an **e-pass (Form M)** is generated for each consignment. This e-pass contains details such as the source, destination, vehicle registration, and transport route.

Key Steps:

- Vehicle registration and linkage with the e-pass.
- Issuance of **Form M** for each transport vehicle.
- GPS tracking enabled for real-time oversight.

4. Safety check of Transporter vehicles

Linked vehicles shall undergo thorough safety checks such as Vehicle fitness, RTO documents verification, safety devices and after being certified by security team the vehicle shall be given clearance to enter the mine premises.

Key Steps:

- RTO documents, insurance copy verification
- Safety devices such as DFMS, Camera, AVA etc shall be checked and verified.
- Driver and vehicle cabin shall be checked for carrying any hazardous substances.
- Appropriate PPE to be ensured and mobile phone of the driver to be collected by security personnel before giving entry.

5. Weighment at the Source

Before loading the iron ore, vehicles undergo tare weighment at a government-approved weighbridge. After the loading is

complete, a gross weighment is conducted to ensure that the authorized quantity of ore is being transported. This data is automatically uploaded to the i3MS.

Key Steps:

- Tare and gross weighment before and after loading, load adjustment to be done according to permissible limits.
- Digital logging of weighment data in the I3MS system.
- Verification of the transported quantity with the despatch permit.

6. GPS Tracking During Transit

The vehicles transporting iron ore are equipped with GPS devices, ensuring that they follow the approved routes. Any deviations or unauthorized stops generate alerts in the i3MS system, helping authorities monitor and prevent illegal off-loading.Fig. 2

Fig. 2

Key Steps:

- Real-time monitoring of the vehicle's route.
- Immediate alerts for any deviations.
- Detailed reports generated for tracking compliance.

7. Final Weighment and Delivery

Upon arrival at the destination (e.g., steel plants or export facilities), the vehicle undergoes a final weighment to verify that the transported quantity matches the originally loaded amount. The consignee acknowledges receipt in the I3MS system, completing the transaction.

Key Steps:

- Final weighment at the delivery point.
- Receipt acknowledgment by the consignee.
- Reconciliation of transported and received quantities in i3MS.

Flow chart of Dispatch cycle

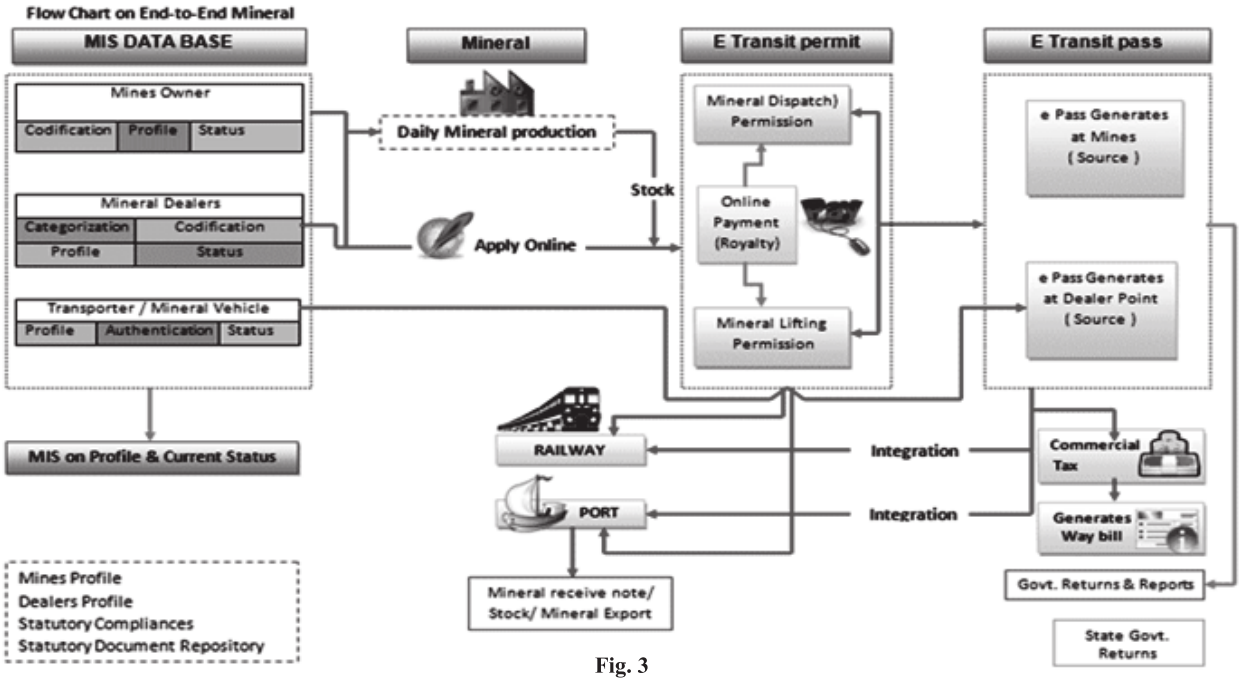

Fig. 3

Conclusion

The integration of stack preparation, real-time tracking, and digital monitoring within the I3MS framework, aligned with the updated OMPTS guidelines, ensures a secure and transparent iron ore despatch process in Odisha. By streamlining operations from extraction to delivery, this system greatly reduces opportunities for illegal mining and smuggling, setting a benchmark for mineral transportation across India.

References

- OMPTS Guidelines
- i3ms website
- Neelachal Iron Ore Mine Dispatch process

ARTICLE-9

INDUSTRIAL WASTEWATER TREATMENT METHODS

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1. Introduction

In recent years, the availability of clean water has become a pressing issue globally, affecting both developed and developing nations. Over 1.1 billion people lack access to improved water sources, while 2.6 billion people face inadequate sanitation [1]. Water consumption has significantly increased, from 1,382 km³ per year in 1950 to an estimated 5,235 km³ per year by 2025. By then, water availability is projected to fall to about 872 m³ per capita annually, well below the 1,000 m³ per capita thresholds that defines water-scarce regions [2]. This growing water scarcity is a critical environmental challenge, expected to impact 3.5 billion people i.e.48% of the global population by 2025[3]. As populations grow, the diminishing availability of fresh water will hinder socio-economic development in many countries. To combat this, reusing wastewater is emerging as a vital strategy to augment water resources, provided it can be managed safely [4].

Industrial wastewater treatment typically involves multiple stages aimed at removing contaminants. The municipal wastewater treatment process consists of three main steps: primary (physico-chemical processes like precipitation and sedimentation), secondary (biological treatment such as activated sludge or trickling filters), and tertiary (sand filtration and polishing)[5]. Sewage wastewater contains a variety of contaminants, including suspended solids, organic matter, microorganisms, nutrients, heavy metals, and increasingly, pharmaceutical residues [6]. The activated sludge process, commonly used in wastewater treatment plants (WWTPs), leads to increased sludge production around 9 million tons in Europe by 2005 posing environmental and economic challenges. Disposing of and treating sludge can account for up to 50% of WWTP costs [7]. Moreover, conventional treatment processes struggle with efficiency, time, and cost, and excess nutrients like phosphate and ammonium nitrogen in the effluent can cause eutrophication in water bodies, depleting oxygen levels and increasing toxicity [8].With these challenges, there is an urgent need to develop new wastewater treatment technologies that are cost-effective, simple, robust, and efficient.

One promising solution is the use of nanomaterial offer significant advantages in wastewater treatment compared to conventional methods. Due to their small size and large surface area, nanomaterial exhibit enhanced adsorption and reactivity, making them highly effective at removing a wide range of contaminants, including heavy metals, organic pollutants, and emerging contaminants like antibiotics. Unlike traditional techniques, which can be time-consuming, costly, and less efficient at removing residuals, nanomaterial can rapidly degrade pollutants and reduce sludge volume. Their magnetic properties also allow for easy separation and recovery, contributing to more sustainable and efficient water treatment processes.Functionalized nanoparticles also exhibit unique physico-chemical properties, such as size, surface charge, and specific interactions with contaminants in wastewater. Their use can optimize several treatment parameters, and response surface methodology can be employed to evaluate experimental data against computational predictions. However, understanding the toxicity of nanoparticles is essential before applying them on a large scale in wastewater treatment.

Considering the importance of sewage wastewater treatment globally, and to meet the rising water demands, there is pressing need to develop new technologies for cost effective, simple, user-friendly, robust and efficient systems. Heavy metals like mercury, lead, cadmium, arsenic, and chromium (Cr) pose serious risks to human health. Among these, chromium is a particularly hazardous contaminant found in wastewater from industries such as textiles, leather tanning, paints, plastics, metallurgy, and electroplating. Chromium's persistence in the environment, its accumulation in living organisms, and its inability to degrade biologically make it a significant source of pollution. Chromium typically exists in two forms: trivalent chromium [Cr(III)] and hexavalent chromium [Cr(VI)]. Of these, Cr(VI) is far more toxic and carcinogenic than Cr(III) because it can easily penetrate cell membranes, leading to harmful effects such as lung cancer, skin irritation, and damage to vital organs. The hexavalent state of chromium can occur in various forms, including hydrogen dichromate ($HCr_2O_7^-$), chromic acid (H_2CrO_4), chromate (CrO_4^{2-}), dichromate ($Cr_2O_7^{2-}$), hydrogen chromate ($HCrO_4^-$), tetrachromate ($Cr_4O_{12}^{3-}$), and trichromate (Cr_3O102-).

According to World Health Organization (WHO) guidelines, the permissible limits for hexavalent and trivalent chromium in drinking water are set at 0.05 mg/L and 5 mg/L, respectively.Trivalent chromium, at lower concentrations, plays an essential role in the metabolism of animals and plants, whereas hexavalent chromium is harmful to various organisms, including animals, plants, and microorganisms. Due to the known toxicity of Cr(VI) to humans, it is crucial to remove it from wastewater. Several methods, such as ion exchange, adsorption, bacterial reduction, and chemical reduction, are frequently used to eliminate Cr(VI)[9-11]. However, many of these approaches are expensive and have low efficiency in removing

Cr(VI). To address these limitations, the use of heterogeneous photo catalytic reduction has emerged as an effective alternative for converting Cr(VI) to the less harmful Cr(III). Photo catalysis offers significant advantages, such as utilizing renewable solar energy, being cost-effective, and producing minimal by-products, making it a superior method for chromium removal.

Titanium dioxide (TiO_2) nanoparticles have garnered significant attention as an effective photocatalyst for various environmental applications, such as dye degradation and photo reduction. This popularity is due to the low cost, non-toxicity, enhanced stability, and excellent electrical and optical properties of TiO_2 nanoparticles. They have been successfully employed in various forms, including both pure and heterostructure morphologies, for applications like photocatalytic dye degradation and water splitting. When TiO_2 is irradiated with ultraviolet (UV) light, electrons are generated, which facilitate the photo reduction of toxic Cr(VI) to the less harmful Cr(III). However, this process is often hindered by slow reaction kinetics. To improve efficiency, the addition of hole scavengers, such as acids, along with the photo catalyst can accelerate the reduction process. Studies have shown that the inclusion of acids like formic acid enhances the reduction of Cr(VI) by lowering the pH and increasing proton concentration, which boosts photocatalytic activity. Despite these improvements, the prolonged conversion time required when using acids limits the effectiveness of conventional batch processes for reducing hexavalent chromium.The photocatalytic reduction was carried out without the addition of any electron or hole scavengers.

2. Literature Review

Water with dissolved and suspended substances discharged from various industrial processes, such as the water released during manufacturing, cleaning, and other commercial activities, is termed industrial wastewater. The nature of the contaminants present in industrial wastewater depends on the type of factory and the industry. Examples of industries that produce wastewater are the mining industry, steel/iron production plants, industrial laundries, power plants, oil and gas fracking plants, metal finishers, and the food/beverage industry. The various contaminants commonly found in industrial water outlets are chemicals, heavy metals, oils, pesticides, silt, pharmaceuticals, and other industrial by-products. In general, it is difficult to treat industrial wastewater, as an individual examination of the set-ups and specific treatment plants are required on an industry-based level. Therefore, to deal with this, on-site filter presses are installed to treat the effluent wastewater [12].

Among a variety of heavy metals, chromium and lead have garnered significant attention due to their detrimental effect on the environment. The possible potential threats to ecosystem by these two metals are as follows: Both trivalent and hexavalent forms of chromium are normally found in wastewater. The hexavalent forms are chromate (CrO42-) & dichromate (Cr2O72-) ions. Because of its mutagenic and carcinogenic qualities, the hexavalent chromium ion is believed to be more dangerous to human health, but the trivalent form is very less in toxicity, solubility and mobility and found in soils as oxides, hydroxides, or sulphates [13]. Chromium in the form of chemicals are used in a variety of industrial processes, including leather tanning, chrome ore mining, steel and alloy production, dyes production, glass production, wood preservation, textile production, film & photography. It causes liver damage, lung congestion, oedema, and skin irritationetc.

Out of two oxidation states (+2 and +4), more frequent and reactive type of lead is Pb(II). Apart from its presence in natural sources, anthropogenic sources include electroplating units, explosive production, battery manufacture, printing, finishing, photographic materials, glass & ceramic industries [14].Lead has major health impacts in living creatures even at very low concentrations. Lead poisoning can harm the nervous system, reproductive system and kidneys and long-term exposure can cause sterility, abortion, and other problems [15]. Given the importance of heavy metal removal and variety of treatment techniques developed, still research continues to develop a viable, cost effective and green approach methodology for all types of wastewater.

Numerous techniques such as reduction, reverse osmosis, precipitation, flocculation & ion exchange are used to remove these metals from effluents, however their limitation lies on the fact that they are costly, rigorous and generates secondary pollutants that are environmentally unfriendly [16]. Owing to this, a newer and better alternative which is environmentally friendly, of less cost, efficient and renewable has been of choice in recent past for capturing of heavy metals from aqueous solutions [17]. Further few are inappropriate, unavailable, inefficient, ineffective or too costly. Adsorption has currently been demonstrated to be a low-cost and effective way of removing heavy metals from wastewater. Although a variety of materials have been used for adsorption, use of metal oxide nano-particles has gained importance due to inexpensive and readily available in huge amount.

The application of nanoparticles in water treatment offers significant advantages due to their high surface-to-volume ratio, which enhances properties such as reactivity, adsorption capacity, and dissolution activity. Unique features like super Para magnetism, semiconducting capabilities, and quantum confinement further contribute to their effectiveness in treating wastewater. Recent advances include various nanomaterials, such as nanostructured catalytic membranes, nano sorbents, and

nano catalysts, used for removing toxic metal ions and organic pollutants from water. Carbon nanotubes (CNTs) have revolutionized water treatment technologies due to their high adsorption capabilities for a range of organic pollutants, including dioxins and pesticides, and their ability to be cross-linked with functionalized polymers for enhanced performance. Additionally, metal and metal oxide nanoparticles, including silver, ferric oxides, and titanium oxides, are widely used for heavy metal removal due to their high surface area and minimal environmental impact.

Studies have demonstrated the efficacy of these nanoparticles in removing metals like arsenate, mercury, and lead from wastewater. Specifically, hexavalent chromium and lead, both highly toxic, pose significant environmental and health risks, necessitating effective removal methods. Traditional techniques such as reduction, reverse osmosis, and ion exchange, while effective, are often costly and environmentally unfriendly. Recent research emphasizes the use of metal oxide nanoparticles for adsorption due to their cost-effectiveness, high efficiency, and minimal environmental impact, addressing the need for sustainable and efficient heavy metal removal from wastewater. Although a variety of materials have been used for adsorption, use of metal oxide nano-particles has gained importance due to inexpensive and readily available in huge amount.

2.1 Review on application of TiO2 nanoparticles in wastewater treatment

Titanium dioxide nanoparticles have gained significant attention in wastewater treatment because of their photocatalytic properties. Researchers have conducted numerous experiments to explore the effectiveness of TiO2 nanoparticles in wastewater treatment [18]. The results have been promising, showing that TiO2 nanoparticles can efficiently degrade various organic pollutants and eliminate bacterial contaminants under UV or visible light irradiation. Further studies have focused on optimizing the synthesis of TiO2 nanoparticles to enhance their photocatalytic activity and stability. Different methods such as sol-gel, hydrothermal, and son chemical methods have been explored to enhance, efficiency of TiO2 nanoparticles in the wastewater treatment applications [19]. In addition to their photocatalytic properties, TiO2 nanoparticles also exhibit antibacterial properties, making them effective in disinfecting wastewater. This dual functionality makes TiO2 nanoparticles a versatile and attractive option for addressing water pollution challenges. The application of TiO2 nanoparticles of wastewater treatment has shown degradation of organic pollutants, removal of unwanted metals and design. As the demand for sustainable and efficient wastewater treatment technologies continues to grow, it is expected that TiO2 nanoparticles will play an increasingly important role in meeting these demands [20]. Further research and development in the field will likely lead innovative applications and advancements in the utilization of TiO2 nanoparticles for wastewater treatment [21]. In addition to their photo catalytic properties, TiO2 nanoparticles also exhibit high surface area and stability, making habitable for wastewater treatment applications. They are easily immobilized onto different supports, such as membranes or beads, allowing for convenient separation after treatment [22]. Moreover, the low cost and abundance of titanium dioxide make it an attractive option for large-scale wastewater treatment projects. However, challenges such as reusability, recovery of nanoparticles, and potential environmental impacts need to be further addressed and researched.

2.2 Importance of TiO_2 nanoparticles for other hazardous pollutants

Recently, there's been a growing fascination with developing eco-friendly ways to make titanium dioxide nanoparticles (TiO_2).This "green synthesis" approach is a double win, as it's good for the environment and opens doors to exciting applications in many fields. Scientists are investigating several green synthesis techniques, including using extracts from plants, harnessing the power of microorganisms, and even mimicking natural processes. One popular technique involves extracts from everyday plants like tea, neem, or aloe vera. These plant extracts act like double agents with two cool powers: reducing the starting materials and stabilizing the resulting nanoparticles. This natural approach allows for the creation of TiO_2 nanoparticles with custom-designed shapes and properties that are ideal for various applications. The Table-1 illustrates the efficacy of TiO_2 nanoparticles as a nano photo catalyst for the removal of various pollutants in millimoles per litter (mmol/L)).

Table1 Efficacy of TiO2 nanoparticles as a nano photocatalyst

Nano Photocatalyst	Target Analyte	Initial Concentrations of Pollutant	Efficiency	Abs. Nano photocatalyst	References
TiO_2	Nitrobenzene	50mmol/L	100%	0.1 g/L	[23]
TiO_2	Methylorange	30mmol/L	100%	3g/L	[24]
TiO_2	Rhodamine	125mmol/L	90%	00.1g/100g	[25]
TiO_2	Parathion	50mmol/L	70%	1g/L	[26]
TiO_2	Benzene	45mmol/L	72%	5g	[27]
TiO_2	Rhodamine b	$1.0 \times 10{-}5M$	100%	1.8g/L	[28]
TiO_2	Toluene	45mmol/L	97%	50 g/L	[29]

Another promising approach is the microorganism-mediated synthesis of TiO_2 nanoparticles. The use of microorganisms presents a sustainable and cost-effective method for synthesizing TiO_2 nanoparticles, with the added advantage of potentially tuning the properties of nanoparticles through, microorganism choice and conditions ofgrowth.Bio-inspired synthesis techniques, mimicking natural processes, have also been investigated for the green synthesis of TiO_2 nanoparticles. These techniques aim to harness the principles observed in biological systems to fabricate TiO_2 nanoparticles with enhanced properties, such as improved stability and reactivity. The review of relevant literature as given at Table 2, provides valuable insights into the various green synthesis techniques for TiO_2 nanoparticles and their potential for sustainable and eco-friendly nanoparticle production. Further research in this area holds great promise for advancing green synthesis methodologies and expanding the applications of TiO_2 nanoparticles in diverse fields.

Table2 : Applications of various nanoparticle-based systems for the treatment of pollutants in wastewater

Sl. No.	Nano particles	Techniques to characterize the nano particles	Contaminants	Parameters studied	Reference
1	Aluminum oxide	SEM	Dunaliellasalinacells	Morphology, chlorophylla, and carotenoid content	[30]
2	Ceriumoxide	SEM	Proteobacteria, unclassified bacteria, Firmicutes, and Actinobacteria Phosphate and nitrate	NaR and NiR, ADKandPPK	[31]
3	Copperoxide	XRD, TEM	Industrial waste water	Catalytic oxidation,COD	[32]
4	Graphene	TEM	Rhodamine B	Adsorption kinetics, Langmuir isotherm	[33]
5	TIO_2	Powder XRD, FTIR,DLS, TEM, BET surface area, zetapotential and UV-vis-spectroscopy	Waste water	Photo degradation	[34]
6	TiO_2	Powder XRD, FTIR,DLS, TEM, BET surface area, zetapotential, and UV-vis-spectroscopy	Dyes	Photocatalysis	[35]
7	TiO_2	Powder XRD, FTIR, DLS, TEM, BET surface area, zeta potential, and UV-vis spectroscopy	Chromium	Photocatalysis	[36]
8	ZnO	X-ray diffraction and TEM	Bacteria	MIC, MBC	[37]
9	ZnO	UV-visible spectrophoto-meter, variations in color, pH, and particle size	Bacteria, nitrogen, analysis phosphorus	EPS	[38]
10	Magnetic iron oxide and silicon oxide	FTIR, SEM, and TGA	Cu(II), PB(II)	Sorption efficiency	[39]
11	Iron oxide, silicon oxide, and visible titanium oxide	DLS, zeta potential, UV-spectroscopy, EDX, SEM	Organic content of OMWW	COD	[40]
12	Titanium oxide, magnesium oxide, and aluminum oxide	DLS, zeta potential, UV-visible spectroscopy, EDX, SEM	Cd2þ, Cu2þ, Ni2þ and Pb2þ	Freundlich and Langmuir isotherms, SEM- EDX, SI	[41]
13	Titanium Oxide and gold	DLS, zeta potential, UV-visible spectroscopy, EDX, SEM	Thiocyanate ions, azodyes, 4-chlorophenol		[42]

3. Motivation, Objective And Scope Of Work

3.1 Motivation

Nanotechnology-based pathways, which are being employed for wastewater remediation, are adsorption and bio-sorption, nano-filtration, photocatalysis, disinfection and pathological control, sensing and monitoring and so on. Nanometal oxides are considered more effective adsorbent as compared to activated carbon when removal of heavy metals and radioactive metals are concerned. Additionally, their small size and large surface area offers a small intraparticle diffusion distance which can be compressed without altering their surface area. The sorption process is mainly governed by the complexation between dissolved metals and the oxygenin metal oxides. So it will be an interesting study to find the application of metal oxide nano-particles which was prepared using ultrasonic assisted green synthesis technique, in treating waste water particularly the selected heavy metals.

3.2 Objective & Scope of the Work

The objective of the present work is to assess the performance of green synthesized metal oxidenano-particles as adsorbent for removal of heavy metals from synthetic and industrial waste water. With the above objective, the following study plans are made:

a) To prepare green synthesized metal oxidenano-particles using plant extract and metal salt solution assisted by ultrasonic technology.
b) To characterize the metal oxidenano-particles (MONP) by using various techniques such as X-ray diffraction, Scanning Electron Microscopy (SEM), Energy Dispersive Spectroscopy (EDS), UV-Visible spectroscopy study and particle size analysis.
c) To study the optimum solution pH and effective adsorbent dosage for maximum metal ion removal using MONP.
d) To determine the equilibrium time and use it to other sorption experiments.
e) To study effect of various adsorption parameters such as metal conc& temperature on removal of heavy metals.
f) To determine the adsorption capacity of MONP for the removal of metal ions using different adsorption isotherms.
g) To study the adsorption kinetics mechanism that governs the adsorption process.
h) To evaluate the thermodynamic parameters, and to find out the nature of the adsorption process
i) To study the mass transfer parameters and rate-limiting steps.
j) To examine the desorption of metal ions from MONP by using distinct suitable reagent to regenerate the adsorbent for several cycles.

4. Materials Under Study

The material undertaken for this research work are metal oxide nonmaterial such

a) Titanium dioxide and
b) Aluminium Oxide

4.1 Methodology

The procedure adapted for green synthesis of nanoparticles is given at Fig. 1

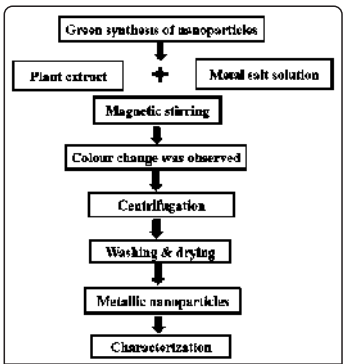

Fig.1 Flow chart for green synthesis of nano-particles

5. Work so far Done

5.1 Synthesis of TiO_2 nanoparticles with leaf extract

To prepare an aqueous lemon grass extract, fresh lemon grass leaves were collected and thoroughly cleaned with distilled water to remove dust particles. Approximately 20 grams of the washed leaves were boiled in 100 mL of distilled water for 30 minutes at 80°C. After boiling, the mixture was filtered using Whatman filter paper to obtain a clear extract. Sonication played a critical role in synthesizing TiO_2 nanoparticles using the leaf extract. The application of ultrasonic waves during this process enhanced reaction kinetics by improving the mixing and increasing the interaction between reactants. This led to a more uniform particle size distribution while preventing nanoparticle agglomeration, ensuring well-dispersed TiO_2 nanoparticles. Additionally, sonication helped break down the plant cell walls, promoting the release of phytochemicals from the extract, which functioned as natural reducing and stabilizing agents. As a result, the reduction of TiO_2 precursors was accelerated, contributing to nanoparticles with enhanced crystallinity and controlled morphology. Overall, the sonication step improved the synthesis process's efficiency, quality, and consistency. For the green synthesis of TiO_2 nanoparticles, 50 mL of the prepared lemon grass extract was mixed with 100 mL of a 1M TiO_2 precursor solution. The mixture was stirred continuously at 50°C for 2 hours, during which a colour change indicated the formation of TiO_2 nanoparticles. The solution was then centrifuged at 3500 rpm to isolate the nanoparticles. The resulting precipitate was repeatedly washed with distilled water to remove impurities. Finally, the purified TiO_2 nanoparticles were dried at 80°C for 12 hours to remove residual moisture and obtain stable, dry nanoparticles as shown in Fig.2.

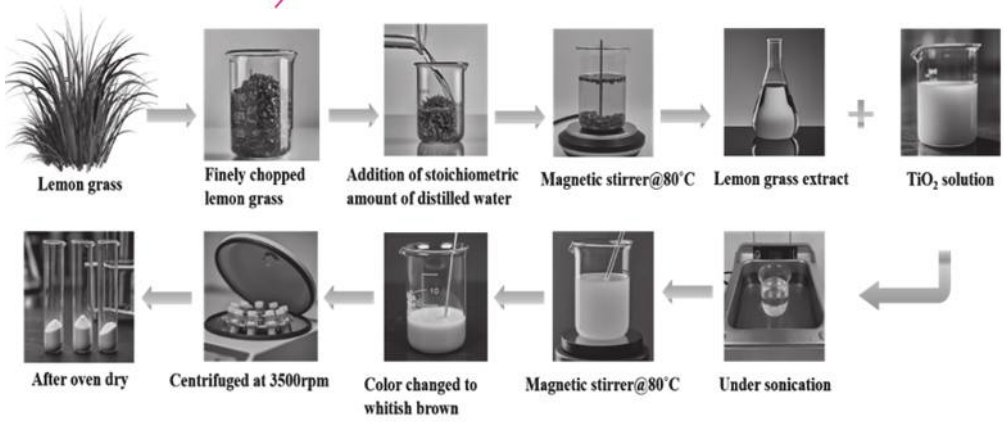

Fig.2 Preparation of plant extract for synthesis of nanoparticles

5.2 Characterization techniques for TiO_2 nanoparticles

Characterization techniques play a vital role in understanding the physicochemical properties of TiO_2 nanoparticles and optimizing their performance in various applications. Evaluating parameters such as size, shape, surface area, crystallinity, and surface chemistry is essential for a comprehensive understanding of these nanoparticles.The XRD pattern of the green produced TiO_2 nanoparticle was shown in figure 3. With diffraction angles of 27.83°, 36.57°, 39.76°, 41.81°, 44.69°, 55.12°, 57.49°, 63.66°, 65.05°, 70.09°, and 70.85°, respectively, and Miller indices of (1 1 0), (1 0 1), (2 0 0), (1 1 1), (2 2 0), (0 0 2), (3 1 0), (3 0 1), and (1 1 2), the sample verified a high degree of crystallinity. This validates the creation of crystalline TiO2 with a Tetragonal crystal structure, as seen in the standard JCPDS file no. 01-088-1174, and a lattice parameter of a=b=4.5300A°,c=2.9210A°. The average particle size of biosynthesized TiO_2 nanoparticles was calculated using Scherer's equation.

$$D_{hkl} = \frac{k\lambda}{\beta_{hkl}.\cos\theta_{hkl}} \qquad (1)$$

Where Dhkl represents the average crystallographic size of the reflected phase, k Scherer constant having value of 0.94, λ is the X-ray wavelength represents the full-width half maximum intensity and qhkl is the Bragg's angle. It has been demonstrated that the average particle size of TiO_2 nanoparticles generated via biosynthesis is 35.79 nm.

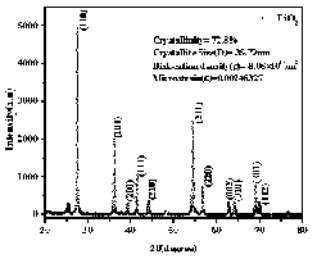

Fig. 3 XRD of TiO_2 nanoparticles

5.3 Understanding of Chromium in wastewater

The treatment strategy for wastewater is crucial in addressing the presence of hexavalent chromium and ensuring its safe disposal. Hexavalent chromium is a highly toxic compound that can be found in various industries and even in drinking water. Therefore, an effective wastewater treatment process must be implemented to remove hexavalent chromium and prevent its release into the environment. There are two main methods for detecting hexavalent chromium:

a) Colorimetric Method: This is the most common method and is based on the reaction of hexavalent chromium with 1,5-diphenylcarbazide (DPC) to form a violet-colored complex. The intensity of the colour is proportional to the concentration of hexavalent chromium, which can be measured using a spectrophotometer.

b) Ion Chromatography (IC) Method: This method separates different ionic species in a sample based on their affinity for a charged stationary phase. Hexavalent chromium is then detected and quantified using ultraviolet (UV) or inductively coupled plasma (ICP) mass spectrometry (MS).

Both methods have their own advantages and disadvantages. Out of the two methods, colorimetric method is used for the current study.

5.3.1 Colorimetric method:

The colorimetric method is a popular technique for detecting hexavalent chromium (Cr(VI)) due to its simplicity and affordability. Below the detailed explanation of the process:

5.3.2 Sampling and storage:

- **Cleaning of Sampling Bottles**: Thoroughly clean sampling bottles dilute with nitric acid with 6N concentration followed by a final rinse with wastewater. This step ensures that the bottles are free from contaminants that could affect the integrity of the samples.
- **Choice of Containers**: Using chemically resistant glass containers for collect and store water samples. These materials are chosen to prevent any unwanted reactions with the sample.

- **Filtration**: Filter the samples through a 0.45 mm membrane filter as same time of sampling. This step is necessary because of determination of dissolved chromium content, likely to remove any particulate matter that could interfere with the analysis.
- **Analysis Timing**: Analyse the filtered samples within 24 hours of sampling. This timeframe helps ensure the accuracy of the results by minimizing any potential changes in the sample composition over time.
- **Preservation**: Acidify the samples with concentrated nitric acid (2 ml of conc. nitric acid per liter of sample) to bring the pH below 2. Instead of acidifying the samples with concentrated nitric acid, adjust the pH of the samples to 8 or above using 1N sodium hydroxide (NaOH). Then, refrigerate the samples.

By adjusting the pH to 8 or above with in sodium hydroxide and refrigerating the samples, we will be better preserving them for the estimation of dissolved hexavalent chromium. This pH adjustment helps to stabilize the hexavalent chromium species in the sample.

5.3.3 Principle

This method is designed for the specific detection of hexavalent chromium [Cr(VI)] concentration. Hexavalent chromium is quantified through a spectrophotometric process by reacting it with Diphenyl carbazide in an acidic solution. This reaction results in the formation of a red violetcoloured complex with an unknown composition. The intensity of this coloured complex conforms to Beer's law and is suitable for spectrophotometric measurements at 540 nm. This technique is effective within the range of 30 to 20,000 µg/L of chromium.

5.3.4 Interference

The reaction involving Diphenyl carbazide exhibits high selectivity for chromium. While hexavalent molybdenum and mercury salts can also produce a colour with the reagent, their colour intensities are notably lower compared to chromium under the specified pH conditions. Concentrations of molybdenum or mercury up to 200 mg/L can be tolerated without causing significant interference. Pentavalent vanadium can cause interference, but concentrations up to 10 times higher than that of chromium are manageable. To prevent potential interference from permanganate, it is essential to first reduce it with sodium azide. Iron present in concentrations exceeding 1 mg/L may generate a yellow color, although this coloration is typically faint and does not present significant issues, particularly when absorbance is measured spectrophotometrically at 540 nm.

5.3.5 Steps for preparation of Chromium based waste water

1. Spectrophotometer (Spectrophotometer capable of measuring absorbance at 540nanometrewavelengths with light path of 1cm. This instrument is essential for quantifying the intensity of the colored complex formed during the reaction with Diphenyl carbazide.)
2. pH Meter (A pH meter for accurately measuring the acidity of the solution. Maintaining the specified pH conditions is crucial for the reaction to occur effectively and for minimizing interference from other substances as shown in Fig. 4
3. Standard Volumetric Glassware (Standard volumetric glassware, such as pipettes, burettes, and volumetric flasks, for precise measurement and preparation of solution as shown in Fig. 5. These ensure accuracy and reproducibility in the experiment.)
4. Stock Chromium Solution: Dissolve 141.4 mg of K2Cr2O7 in water and dilute to 100 ml. Each millilitre of this solution contains 500µg of Cr (500 mg/L).
5. Standard Chromium Solution: Dilute 1 ml of the stock Chromium Solution to 100 ml. Each millilitre of this solution contains 5mg of Cr.
6. Nitric Acid (16N).
7. Sulphuric Acid (36 N).
8. Diphenyl carbazide Solution: Dissolve 250 mg of 1, 5-diphenylcarbazide in 50 ml acetone.

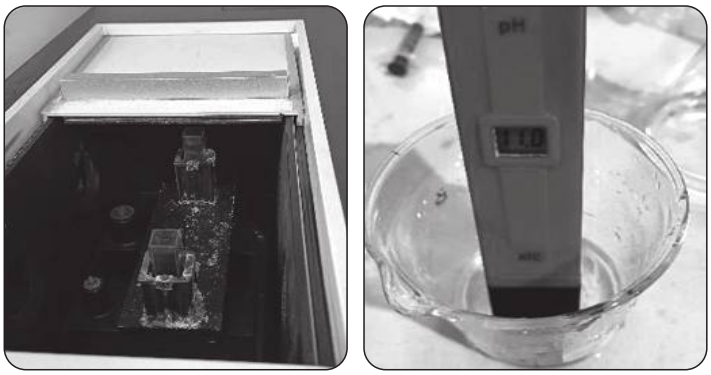

Fig.4 Spectro photometer and pH Meter

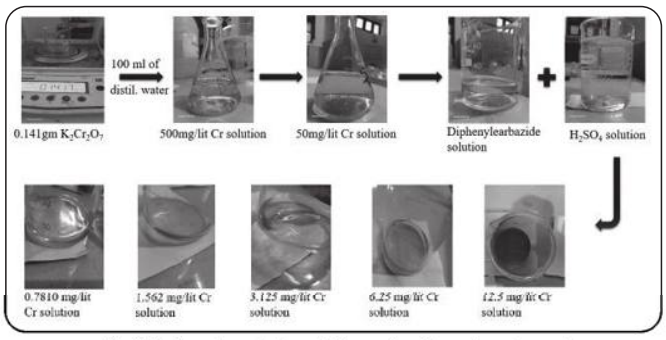

Fig.5 Laboratory designed chromium based waste water

5.4 Procedure for Determination of Chromium

5.4.1 Preparation of calibration curve:

To ensure the precise determination of hexavalent chromium [Cr (VI)] concentrations, standard chromium solutions undergo the same treatment as the samples. This accounts for any potential loss of chromium during the digestion analysis procedures. Standard chromium solutions, ranging from 2 to 20 ml to produce standards for 10 to 100 micrograms of Cr, are transferred into 250 ml beakers or conical flasks. The subsequent treatment mimics that of the samples, including any pretreatment methods employed. Moreover, if cup Ferron treatment is required for the samples, it is also applied to the standards. Following colour development, a portion of each coloured solution is transferred to a 1-cm absorption cell, and absorbance is measured at 540nm, with distilled water serving as a reference. The absorbance readings of the standards are adjusted by subtracting the absorbance for the reagent blank, which is maintained throughout the process.To construct a calibration curve, corrected absorbance values are plotted against the concentration of chromium. This curve facilitates the determination of chromium concentrations in samples based on their absorbance readings. This rigorous approach ensures accurate and dependable results, compensating for any potential losses or variations in chromium content during analysis.

5.4.2 Determination of Hexavalent Chromium before treatment of TiO_2

From Fig. 6, it can be observed that with increase in absorbance, pollutant concentration (Conc) increases. This indicates that more pollutants are present in the wastewater, leading to higher absorbance at the chosen wavelength as shown in Table 3. From the figure, it is clear that, the Calibration Curve value of 0.9958 refers to the coefficient of determination, commonly denoted as R-squared (R2). This represents the proportion of the variance in the dependent variable (instrument response) that is predictable from the independent variable (concentration) in a regression model. An R2 value close to 1 (or 99.5% in this case) indicates that the calibration curve provides an excellent fit to the data, suggesting that most of variability in instrument response can be explained by concentration. Hence, it can be trust for accurately determining substance concentration based on measured instrument responses. It is crucial to note that while a high R-squared value indicates a strong relationship between the concentration and instrument response, it is also important to consider other metrics and factors to ensure the reliability and accuracy of the calibration curve. Additionally, periodic validation and verification of the calibration curve should be conducted to maintain its effectiveness over time. Regular maintenance and quality control procedures will contribute to the ongoing reliability of the quantification process. The high R2 value implies accurate prediction and suggests reliability and robustness for quantifying analyse concentration based on measured as shown in Fig. 6.

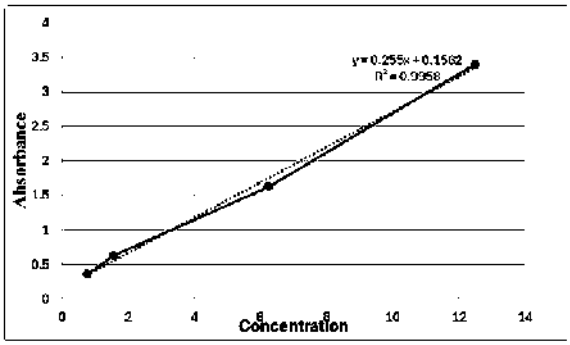

Table 3 : ABS and Conc. value in wastewater before treatment

Concentration (mg/L)	Absorbance
0.781	0.3549
1.56	0.6261
6.25	1.6252
12.5	3.3979

5.4.3 Determination of Hexavalent Chromium after treatment of TiO_2

Here's a basic procedure for treating TiO2 in wastewater treatment:

1. Preparation of TiO2 Suspension: Start by preparing a TiO2 suspension by dispersing TiO2 nanoparticles or TiO2-containing material into water. This can be achieved by stirring the TiO2 powder into water until a homogeneous suspension is formed as shown in Fig.7.
2. Mixing with Wastewater: Introduce the TiO2 suspension into the wastewater to be treated. Ensure thorough mixing to allow the TiO2 particles to come into contact with the contaminants present in the wastewater.
3. Stirring and Agitation: Maintain stirring or agitation of the TiO2/wastewater mixture to ensure uniform distribution of TiO2 particles and enhance contact between the catalyst and contaminants.
4. Reaction Time: Allow sufficient time for the photocatalytic reaction to occur. The duration of the treatment process may

Fig. 7 : Addition of TiO_2 with wastewater

vary depending on factors such as the concentration and nature of contaminants in the wastewater, as well as the intensity of the light source.

5. Separation of TiO2: Once the treatment is complete, separate the TiO2 particles from the treated wastewater. This can be achieved through filtration, sedimentation, or centrifugation methods.
6. Disposal or Reuse: Dispose of the separated TiO2 particles in accordance with local regulations for hazardous waste disposal. The treated wastewater can be discharged into the environment or reused for non-potable purposes, depending on its quality and local regulations.
7. Monitoring and Optimization: intensity, and reaction time may need to be fine-tuned to achieve desired treatment outcomes.

5.5 Batch adsorption experiments

Adsorption of Cr (VI) over TiO2 as an adsorbent were studied through a preliminary batch process to obtain equilibrium data. The Cr (VI) removal studies were conducted by varying initial conc. of Cr (VI) i.e. C0 (0.781 to 12.5 mg/L). The experiments were carried out in a temperature controlled rotary mechanical shaker using 250 ml flasks containing 100 ml of different Cr (VI) concentrations. Solution of HCl and NaOH were used for adjusting pH to 1±0.3. The study was made keeping other parameters fixed such as adsorbent dose of 100 mg, agitation speed of 150 rpm, temperature as 25±2°C and 120 min contact time. Before taking the reading the samples were filtered through filter paper. The residual conc. of Cr (VI) for all samples after adsorption was determined by spectrophotometer. The amount of Cr (VI) adsorbed per unit mass of the adsorbent was evaluated by using the following equation,

$$\text{Adsorption capacity (mg /g) } (Q_t) = \frac{(Co\text{-}Ce)V}{M} \quad (2)$$

$$\text{The percentage adsorption (\%)} = \frac{(Co\text{-}Ce)V}{Ce} \times 100 \quad (3)$$

Where, Co is the initial conc. of Cr (VI) in mg L-1, Ce is the equilibrium conc. of Cr (VI) in mg L-1, V is the vol. of Cr (VI) solution in lit, M is the weight of adsorbent dose in gm

The final concentration after batch adsorption studies is given below in Table 4. The absorbance for each Cr (VI) concentration, before and after adsorption is plotted in Fig. 8.

Table 4 Cr (VI) concentration before and after treatment

Initial Conc. (mg/L)	Absorbance of treated sample	Final Conc. (mg/L)
0.781	0.055	0.121
1.56	0.13	0.324
6.25	0.421	1.62
12.5	1.11	4.1

Initial concentration is one of the effective factors on adsorption efficiency. The kinetics of adsorption with the adsorbents at different initial concentrations were studied while keeping other parameters constant and the results were found and plotted in Fig. 9. From the figure, it can be observed that chromium removal efficiency decreased with the increase in initial chromium concentration. In case of lower conc. of Cr (VI), the ratio of the initial number of moles of Cr (VI) ions to the existing surface area of adsorbent is high and consequently adsorption becomes independent of initial concentration. However, at higher conc., the available areas of adsorption become less, and hence the % removal of metal ions which depends upon the initial conc., decreases [43]. The maximum percentage removal of Cr (VI) is 84.55%. at initial concentration of 0.781 mg/L.

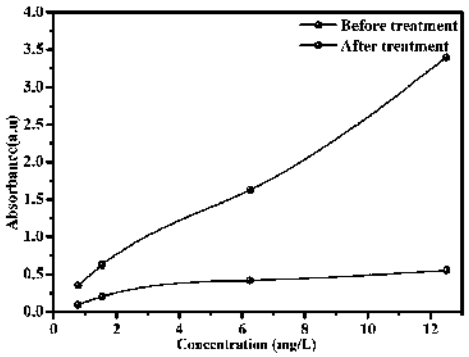

Fig.8 Comparison of absorption of efficiency of TiO2 nano particle

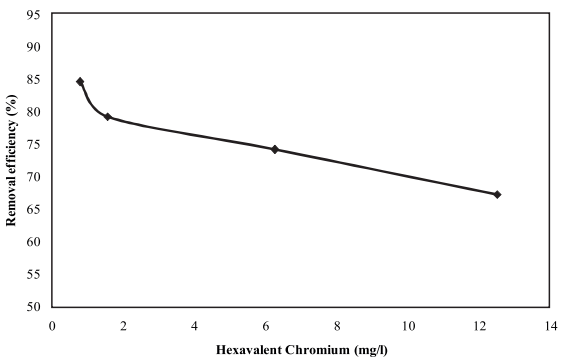

Fig. 9 Effect of adsorbate concentration on removal efficiency chromium (VI)

5.6 Modeling of adsorption isotherms and its studies

For showing the adsorption capacity to simplify possible valuation procedure for a provided application, and to choice of the supreme suitable adsorbent and for the initial calculation of adsorbent dosage necessities the investigational isotherms are most valuable. For the design of the adsorption operations and investigation, the isotherm leads an essential part in the methodical modelling techniques. Langmuir and Freundlich isotherms are often utilized to denote the data of adsorption from the solution [44].

5.6.1 Freundlich Isotherm

The model is generally used to define adsorption over non-homogenous surface. The empirical equation predicts multilayer adsorption due to difference in affinity over adsorption sites. Because of such dissimilarity the isotherm model likewise assumes variation in surface energy of adsorption also [45]. The linearized form of Freundlich isotherm is represented by following mathematical equation:

$$Q_e = K_f(C_e)^{1/n} \Rightarrow \quad \ln(Q_e) = \ln K_f + 1/n\,(C_e) \qquad (4)$$

Where, Ce is the equilibrium conc. of adsorbate in bulk solution in mg/L, Qe defines amount of solute adsorbed per unit weight of adsorbent in mg/g, Kfand n are Freundlich constants representing capacity and intensity of adsorption respectively. Values of Kf and 1/n are acquired from intercept and slope of logeQe vs loge Ce linear plot respectively. High value of Kf signifies higher adsorption capacity and value of n between 1 and 10 depict favourable adsorption.

The experimental records were set with Freundlich model, which is presented in Fig. 10. The isotherm diagram showed a linear pattern. Freundlich model constants and R2 values are calculated and defined in Table 5. The computed value for R2 is 0.997 which illustrates an excellence fit and reveal the presence of multilayer adsorption. The values of 'n' was calculated to be 1.36 and showed the favourable heavy metals adsorption [44]. The situation n > 1 is most common and may be due to a distribution of surface sites or any factor that cause a decrease in adsorbent-adsorbate interaction with increasing surface density [46]. The values of Kfwas found as 30.45.

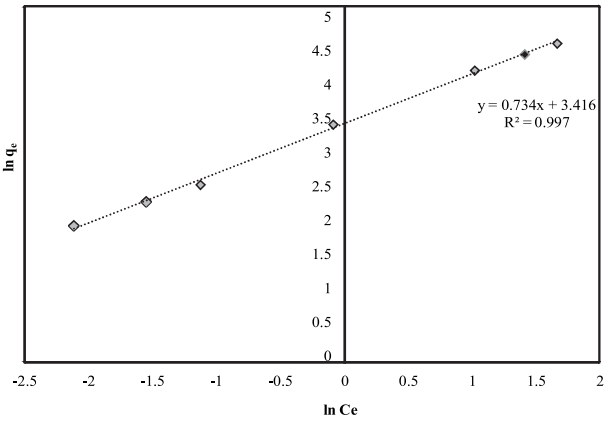

Fig. 10 Freundlich isotherm plots of chromium adsorption on TiO_2

5.6.2 Langmuir Isotherm

Langmuir adsorption isotherm model assumes that adsorption energies are uniform over homogenous sites (identical sites having equal affinity for adsorbate). It presumes occurrence of monolayer adsorption of adsorbent on the outer surface and considers nil lateral interactions and transmigration amongst adsorbed molecules in the plane of the surface [47]. Once adsorption take place the adsorbate molecules become immobilized, and no adsorption takes place after that. In this model, the energy of adsorption is considered to be constant [48].The relation between the Cr (VI) uptake capacity Qe (mg/g) of adsorbent and the residual Cr (VI) concentration Ce (mg/L) at equilibrium is given by

$$Q_e = \frac{Q_o b.C_e}{1+b.C_e} \qquad (5)$$

For solid liquid systems, the isotherm is expressed in the linear form as

$$\frac{C_e}{Q_e} = \frac{1}{bQ_o} + \frac{C_e}{Q_o} \qquad (6)$$

$$\text{Or} \quad \frac{1}{Q_e} = \frac{1}{Q_o} + \frac{1}{bQ_o} + \frac{1}{C_e} \qquad (7)$$

Where, Q0 is maximum adsorption capacity in mg/g, b is Energy constant = Langmuir Isotherm constant in L/g, this value corresponds to energy of sorption. Values of Q0 and b were computed by plotting graph between 1/Qeand 1/Ce. The experimental records were set with Langmuir model, which is presented in Fig. 11. The isotherm diagram showed a linear pattern. Values of important features like Q0 and b were evaluated from slope and intercept respectively and are reported in Table 5. The computed value for R2 is which illustrates a good fit and reveal monolayer type adsorption. The value of Q0 in (mg/g) and 'b' was calculated to be 90.91 and 0.61 respectively. Spontaneity or feasibility can also be determined by evaluating RL with the help of following equation:

$$R_L = \frac{1}{1+bC_o} \qquad (8)$$

Where, b is Langmuir constant and C0 is the initial concentration of Cr (VI) in mg/L. RL signifies the separation factor. RL value between 0 and 1 points to favourable adsorption and if it is greater than or equal to 1 it means adsorption is unfavourable. RL=1 suggests that adsorption is of irreversible nature.Thecalculated RL value was equal to 0.098, which substantiates favourable adsorption.

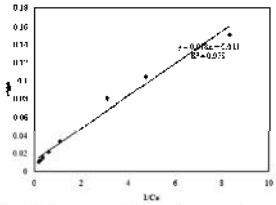

Fig. 11: Langmuir isotherm plots of chromium adsorption on TiO_2

5.6.3 Temkin Isotherm

Temkin isotherm model assumes that decrease in heat of adsorption of adsorbate molecules in the layers is linear rather than logarithmic. Such linear decrease with coverage develops due to interactions between adsorbent and the adsorbate. Adsorption sites with high energies are occupied first [49]. The model also presumes that there is uniform distribution of adsorbate among the layers. It is represented by following equation [50]:

$$Q_e = \frac{RT}{b_t} 1n(K_t.C_e) \text{ or } Q_e = B_1 1n K_t + B_1 1n C_e \quad (9)$$

and

$$Q_e = RT/b_t \quad (10)$$

Where,bt is Temkin isotherm constant, R is the universal gas constant (8.314J/mol/K), T is absolute temperature at 298K, Kt is the equilibrium binding constant (l/mg) corresponding to the maximum binding energy and the constant B1 is linked to the heat of sorption (KJ/mol). Binding energies in the range 8-16 KJ/mol point to ion exchange mechanism for adsorption whereas lower values (<8 KJ/mol) predict weak van der Waals interactions supporting physical adsorption. A plot of Qe versus ln (Ce) is depicted in Fig. 12. Values for Kt and B1 were derived from intercept and slope respectively and are quoted in Table 5. Lower binding energy (in present case) hints at occurrence of physical adsorption. The computed value for R2 is 0.925 which illustrates a good fit. The values of Kt in(L/g) and B1 in (KJ/mol) was calculated to be 6.57 and 23.92 respectively.

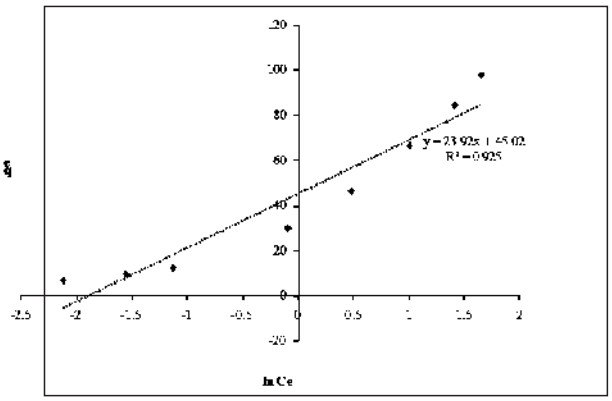

Fig. 12 Temkin isotherm plots of chromium adsorption on TiO_2

Table 5 : Adsorption Isotherm Parameters

Model	Parameters	Values
Langmuir	Qo (mg/g)	90.91
	b (L mg^{-1})	0.61
	R_L	0.098
	R_2	0.979
Freundlich	n	1.36
	K_F (mg/g)	30.45
	R_2	0.997
Temkin	k_T(L/g)	6.57
	B_1 (KJ/mol)	23.92
	R_2	0.925

7. Important Outcomes Of The Present Work

Following outcomes has been listed in the present work:

- Importance of ultrasonic as well as green processing of Nanomaterials for wastewater treatment has been assessed.
- The synthesized TiO_2 nano particle drastically changed from 0.1-10μm to 35.79nm which is obvious from the XRD-data.
- The calibration curve value of 0.9958 indicates an excellent fit to the data, suggesting that most of variability in instrument response can be explained by concentration. The high R_2 value implies accurate prediction and suggests reliability and robustness for quantifying analyse concentration based on measured.
- The efficiency of chromium (Cr) removal using TiO_2 in water treatment was found to be 84.55%. This demonstrates the effectiveness of TiO_2 photo catalysis in degrading and removing chromium contaminants from water.

ARTICLE-10

REQUIREMENT OF SLOPE MONITORING & ITS PRINCIPLES

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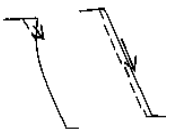
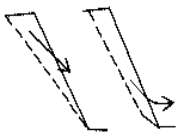
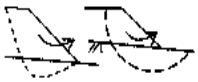
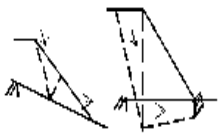
Introduction

Dump slope and bench slope instability is one of the major concerns for the mining industry/mine owner, government regulators/statutory bodies, and environmental groups keeping in view the damage of surface infrastructure/loss of property, sustainability of mines, safety of personnel, economic, and environmental impacts. So, accurate assessment of the dump slope and bench slope stability is utmost importance for its proper and effective management. The depths of open-pit mines have been increasing in the last few decades. This transformation generates a vast amount of waste rock material per unit mining area imposing a significant economic, social and environmental liability on the mine operators. The waste dump material is accommodated as internal dumping within the mined-out area or external dumping outside the mined-out area but within the leasehold area of the mine. The external dumps are less efficient in land use and handling of dump material as compared to the internal dumps. However, it reduces the adverse impacts of the mining process and operation but increases the risk to the social and environmental domains, upon its failure. The stability of bench slope and dump slope is affected by the combined effect of various parameters. These parameters are related to either manmade activities namely blasting, excavations, HEMM induced vibrations or naturally occurring phenomena like earthquake, presence of geological discontinuity within a mine (eg. faults) or in the vicinity of the mine area, development of tension crack near the top of a slope, rainwater seepage etc.

Dump slope and bench slope instability can be assessed by two ways: 1) using various analytical approaches (FEM, DEM and LEM) in prevalent Geo-mining conditions. 2) using various monitoring techniques (geodetic and non-geodetic). Further, accuracy of predicted movement of dump slope and bench slope surface using different analytical approaches remain a concern due to their own limitations in terms of detailed inputs required (especially geological and Geo-technical parameters) for better prediction of slope surface movement. Hence, dump slope and bench slope surface are required to be monitored during mining or post mining operation using suitable monitoring techniques to accurately assess any possible movement of dump slope and bench slope surface and to check the accuracy of predicted instability.

Failure Mode	Description	Illustrations	Key Factors Contributing to Instability	Stability Analysis Methods
Edge slumping (Crest slumping surface or silver failure)	Shallow failure involving down slope translation of material from the crest area parallel to the dump face. Failure does not extend up to the foundation		-Over steepening of the crest due to pressure of fine or metastable steep response angle of coarse rock blocks -Slacking of materials which form low permeablity layers parallel to dump face -Heavy precipitation -Rapid rates of crest advancement -Most likely occure in dumps constructed by end-dumping in thick lifts or by dozing materials over dump's crest	Infinite slope analysin
Planer failure (Biplanar failure)	Sliding along a single plane of weakness within the embankment. May also sharing through the toe if the weakness plane does not slumping, but failure is generally deeper within the mass and result in substantially more crest break back		-Creation of a weakness plane which daylights on or parallels to the dump face possibly due to a zone of poor quality waste. -High pore pressures within dump -Other factors similar to edge slumping	Plane failure analysis Biplanar or slab analysis Wedge analysis
Rotational failure (Circular arc, creep)	Mass failure along a circular or curved surface within the dump material. Creep failure involving wide spread rotational slip charactered by bulging at the dump toe.		-Homogenous dump consisting of weak fine-graned materials -Excessive dump height in cohesive materials -High pore pressure within dump -Lack of lateral confinement support (i.e., three dimensional effect)	Slip circle Methods of slice Y=0 method

Failure Mode	Description	Illustrations	Key Factors Contributing to Instability	Stability Analysis Methods
Flow failure (Debris flow, flow slides)	Shallow failure involving slumping of saturated or partially saturated dump materials. Slump materials flow down the dump face in a semi fluid date		-Concentrated surface flows discharging over the dump crest -Heavy precipitation, high infiltration, and/or development of a perched table, resulting in saturation of near surface sump materials	Infinite slope analysis with inclusion of seapage forces
Rotational failure (Circular arc)	Mass failure along a circular or curved failure surface, which extends into the foundation soils		-High pore pressure in foundation soils	Slip circle Methods of slices Y=0 method Bearing capacity analysis
Noncircular rotation (Base spreading)	Similar rotation failure except that part of slip surface occurs along a weak base plance		-Occurrence of a weakness plane at the base of the dump or in the foundation soils -High pore pressures in foundation soils -Steep foundation slope -Adverse geological structure -Overfilled gullies	Method of slices generalized for non circular failure geometries Y=0 method
Wedge failure (Multiple wedpage, biplanar, base spreading, three dimensional extended wedge)	Embankment fails as series of interactive blocks or wedges separated by planar discontinuities. Part of the failure surface occurs along a weak basal plane.		-Occurrence of a weakness plane at the base of the dump or in the foundation soils -High pore pressures in foundation soils -Steep foundation slope -Adverse geological structure -Overfilled gullies	Wedge analysis Methods of slices generakized for non circular failure geometries Y=0 method three-dimensional wedge analysis Plane failure analysis
Base translation (Planar sliding)	Sliding of bulk of dump as a rigid block along a weak base plane.		-Occurrence of a weakness plane at the base of the dump or in the foundation soils, or a discontinuity in the bedrock -High pore pressures in foundation soils -Steep foundation slope	Plane failure analysis

Monitoring Techniques

A common technique to determine slope stability is to monitor the small precursory move-ments which occur prior to collapse. Monitoring of slopes must be done in accordance with DGMS (Tech.) circular no. 2 Dhanbad dated 09.01.2020 and DGMS (Tech.) circular no. 3 Dhanbad of 2020 dated 16/01/2020.

Monitoring can be done using following measurement techniques:

1. Geodetic Measurement Technique
   It includes use of instruments such as Total Stations, Terrestrial Laser Scanners, GNSS (Global Navigation Satellite System) receivers.
2. Geotechnical Methods
   It includes use of instruments such as Extensometers, piezometers, tiltmeters and accelerometers.
3. Geophysical Methods
   It includes use of seismic surveys and electrical resistivity of soil.
4. Remote Sensing
   Remote Sensing often operates from aircraft or spacecraft platforms and uses electromagnetic waves emitted, reflected or diffracted by the sensed objects. It includes the use of instruments like radar, Lidar and Optical Camera

Monitoring Techniques

Slope System Monitoring	Type	Advantages	Disadvantages	Range	Slope wall Coverage	Accuracy
Visual Monitoring		-Production personnel can be involved. -No technology is required. -Inexpensive	-Labour intensive -Limited to safe slope areas	Limited (20-50m)	Small area	Not applicable
Surface Measurement	**Tension Crack Mapping**	Economical and simple to use	-Dangerous to install in unstable areas. -Measures displacement of discrete points -Errors can be caused by long wire length due to sag or thermal expansion. -Alarm can be triggered by falling rocks or animals	Not applicable	Discrete points	$\pm$0.2%F.S.
	Survey Network	-Automatic operation is available -Valuable for identifying long term displacement trend.	Suitable only for monitoring discrete points. -Prism installation is time consuming and dangerous on unstable slope. -Damaged prisms are difficult to replace on steep slope with no access. -Displacement data is affected by atmospheric variation in temperature and pressure. -Displacement data is affected by human error.	1500 m	Discrete points	$\pm$ 5.0 mm
	Global Positioning System (GPS)	Easy automation Higher accuracy Less labour intensive	-High cost of placing a permanent GPS receiver at each monitoring points. -Satellite signals can be obstructed by tall vegetation. -Usage for slope monitoring is still relatively new and expensive. -Slope surface can create signal multipath error.	4,000 to 20,000 m	Discrete points	$\pm$10 mm
Sub surface Measurement	**Piezo meters**	-Simpletoinstall - Function well in shallow and deep holes	-Care ful handling is required for proper installation. -Requires periodic replacement of batteries. -The electronic units are susceptible to damage by lightning. -Bore hole drilling for installation can be expensive. -Requires conversion of frequency reading to pore pressure.	500 m	Discrete points	0.5 mm

Slope System Monitoring	Type	Advantages	Disadvantages	Range	Slope wall	Accuracy
Sub surface Measurement	**Inclino meters**	Subsurface displacement measurement of both shallow and deep-seated failure planes. Economical and simple to use	- Manual reading is time consuming and labour intensive. -If not properly installed, erroneous displacement readings may be recorded	100 m	Discrete points	± 2.0 mm
	Seismic Monitoring	-Provides early warning of the development of deformation -Detects displacement that cannot be identified by surface measurement.	Expensive to set-up.	2,000 m	Discrete points	0.001mm
Remote Monitoring Technologies	**Time Domain Reflectometry (TDR)**	-Rapid and Remote Monitoring is possible. -Slope displacement can be determined immediately. -Lower cost of installation. -Readings take minutes -Can be installed at great depths.	-Cable must be destroyed before displacement can be located. -Cannot measure deformation below the water surface because of changes in electrical properties of cable from water infiltration. -Cannot determine the magnitude and direction of slope movement.	100 m	Discrete points	± 0.5 mm
	Laser Scanner	-Prisms not required for slope monitoring. -Portable and can be moved around easily. -Continuous and automatic operation. -Large area monitoring Valuable for identifying long term displacement trend.	-Not commonly used for slope monitoring compared to radar monitoring. -Lower accuracy compared to radar monitoring. -Scan processing time is too great for effectiveness. -Accuracy impaired by differences in the reflectivity of the rock, the angle of the rock face, weather, vegetation. -Cannot provide early warning of failure.	2500 m	Large area	50 mm
	Radar	-Continuous and automatic operation. -Operates in all- weather condition. -Geo- referencing is possible. -Sub-millimetre displacement measuremen -Large area and point monitoring.	-Expensive to procure and maintain. -Uncontrollable down-time.	1000m to 4000m	Large area	± 0.2 mm

In-addition, for comprehensive monitoring, satellite-based radar interferometry techniques may be added with above mentioned techniques.

General guidelines:

1. Points undergoing movement of 0mm to 2mm per day are monitored once per month.
2. Points undergoing movements of 2mm to 5mm per day are monitored once per week.
3. Points undergoing movements of 5mm to 10mm per day are monitored once every 2 days.
4. Points undergoing movements of 10mm to 50mm per day are monitored once per day.
5. Points undergoing movements of greater than 50mm per day require continuous observation.

ARTICLE-11

HEALTH AND SAFETY TRAINING

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Abstract

The main aim of health and safety training is to improve and enhance a person's skills and/or knowledge in order to enable that person to work safely. Health and Safety training is an essential element in the formation of safe systems of work. Not only can training help prevent injuries and ill health, but it should also prove a useful investment; for example, it can reduce the likelihood of errors being made, reduce the risk of accidents and their associated costs, contribute towards greater morale, and assist in the defence of negligence claims. Furthermore, most health and safety training can be provided in-house, thereby keeping expenses to a minimum. Training benefits from a planned, systematic approach. The first stage is to identify the training needs that exist within the company, which involves looking at the activities that employees carry out in order to determine the training they require to work safely. Once identified, the training needs should be prioritised. The next stage is to develop training programmes to address each of the training needs. Clear objectives should be set within each programme which, when achieved, will meet the training needs. The content of the training can then be planned with the aim of ensuring that each of the objectives is satisfied. It is important to ensure that the training methods and techniques adopted are appropriate for the type of training and the people being trained. The next stage is to carry out the training. The trainer must have adequate knowledge and presentation skills to deliver the training effectively. Finally, it is strongly recommended that all training provided is recorded. The effectiveness of the training, in terms of meeting the training objectives, should be evaluated. There are a variety of options for doing this, for example, examinations or tests, observing any changes in behaviour after training, examining subsequent trends in accident statistics, and obtaining the views of the employees who were trained.

Introduction

The primary aim of health and safety training is to improve and enhance a person's skills and/ or knowledge to enable that person to carry out their work safely. This will help to ensure that an individual is competent to perform the work required of them. In addition, training can be used to help produce positive attitudes to safety in employees at all levels of the organisation, which will assist in fostering what is commonly referred to as a positive safety culture. In such a culture, safe behaviour is encouraged and expected. Thus, used properly, training can assist both directly and indirectly in achieving high standards of health and safety in the workplace. The provision of adequate training is an essential part of effective health and safety management and, for training to be successful, a considered, planned approach is necessary. Training should be viewed as an investment which in the long term will benefit the company. It can, for example: (1) Enhance an individual's performance of a task, reduce the likelihood of error, and hence contribute to greater efficiency and productivity; (2) Reduce the risk of costly accidents, injuries, and incidents causing damage to plant and equipment; (3) Contribute towards greater confidence and improved morale in employees; and (4) Assist in defending negligence claims, for example, where it is alleged that an employee's lack of competence contributed towards an accident. An important point to be aware of is that training and the production of competent employees will not, on its own, be sufficient to achieve high standards of health and safety or indeed comply with the law. Training has its limitations and is no substitute for the provision of adequate physical controls and safe systems of work. It should be remembered that an organisation is only as effective as the people who work in it. Comprehensive training on all aspects of an employee's work is, therefore, critical to the effective running of the organisation. The guidance contained in this paper can be used to help meet all of the organisation's health and safety training needs.

Identifying Training Needs

A systematic and planned approach should always be taken to training in order to ensure that adequate training is provided to all employees in relation to the work activities that they undertake and the environment in which they work. Figure 1 illustrates such an approach, which is based on: (a) identifying training needs; (b) developing a training programme; (c) carrying out the training programme; and (d) evaluating the training programme.

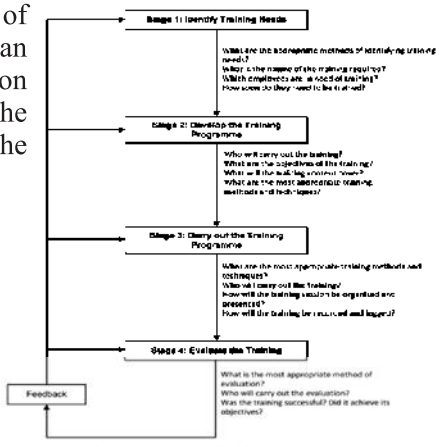

Fig-1 : The training processes

Identifying The Types Of Training Required

Before a training programme can be developed, it is necessary to clearly identify employees' training needs. The most effective way of identifying such training needs is to carry out a training needs assessment. This is a comprehensive analysis of the specific training needs of all employees based on the work activities undertaken and the risks to which they are or may be exposed. Employers and the self-employed should include themselves in the assessment, and all managers should be included. For larger organisations, it may be easier to carry out generic assessments by grouping employees who undertake the same work activities rather than looking at a large number of individuals. If individuals within a large group undertake some specialist duties, separate consideration should be given to their training needs. There are various methods of examining work activities to identify training needs, the most important being risk assessment. Where risk assessments have already been carried out, consulting the findings should help determine which work activities require some form of training for the employees involved, as part of the preventative and protective methods needed to control the risk. Further risk assessments should be carried out if necessary. In addition, there are specific techniques such as job/task analysis which can be useful in identifying training needs. Job/task analysis involves breaking a work activity down into its component parts and observing employees to determine how the work is done, and where necessary questioning them as to why it is done in a particular way. This should enable the risks and the appropriate control measures (such as training) to be identified.

In addition to examining employees' work activities, training needs can also be identified through the following: (a) Consulting relevant legislation - Reviewing the legislation and any Approved Codes of Practice relevant to the tasks being carried out may reveal specific requirements for certain types of training to be provided; (b) Consulting records Examining accident and ill-health statistics may reveal a training need; (c) Forecasting Potential training needs can be identified by looking ahead at likely changes in the tasks carried out by employees, the equipment they use, changes in systems of work, and the introduction of new technology; (d) Consulting employees/employee representatives Employees' (and their managers') views on what their training needs are, and any requests from employees for health and safety training, should be taken into account; and (e) Health and safety policy The health and safety policy may state specific training requirements which the company expects to be met, and which may be more stringent than the legal minimum. The policy should also state the health and safety responsibilities of managers, who may require additional training in order to discharge those responsibilities effectively.The training needs assessment should indicate: (a) the work activities undertaken; (b) the appropriate risk assessment reference numbers (if applicable); and (c) crucially, the training required for anyone involved in the work activity or within the work environment and/or exposed to the associated risks. The training needs assessment will only provide an outline as to what training will be required. It should identify the specific subjects to be covered. The details of the training needed can be identified later in the process when the training programme is developed.Table 1 outlines the types of health and safety training that are typically required in an organisation. In the table, the training has been categorised according to the different types of recipients, i.e.: (a) induction training; (b) ongoing training for employees; (c) ongoing training for managers; and (d) training for non-employees.

TABLE 1: Types of training commonly required

Type of training	Training points to be included
Induction Training	General induction training should include: 1. Arrangements for first aid, fire, and evacuation (these should be covered on an employee's first day); 2. The accident reporting procedure and who to contact in the event of a health and safety problem or concern; 3. Introducing the company safety policy, including employees' legal responsibilities; 4. Arrangements for consultation between employers and employees on health and safety matters; 5. Relevant health and safety legislation; 6. Workplace safety rules; 7. Welfare arrangements; 8. Conditions of employment relevant to health and safety, e.g. hours of work. Health and safety training in matters specific to the tasks employees are expected to perform will often be required during induction as: 1. Information on relevant hazards; 2. How the risks presented by those hazards can be minimised; 3. Specific training may also be required to comply with legal requirements. Particular attention and priority should be given to any new recruits who are young employees, as young people tend to be more vulnerable to workplace accidents. If the new recruits are managers, additional training will usually be required on relevant subjects as: 1. The safety management systems and any quality systems in operation; 2. legal responsibilities of the company and individual managers; 3. Training arrangements; 4. The company's risk assessment arrangements, and how risks relevant to the manager's area of responsibility are controlled; 5. Disciplinary/grievance procedures relating to health and safety.

Type of training	Training points to be included
Ongoing training for employees	Such training could involve any of the subjects listed under induction training. Other training which may be identified could involve: 1. Safe working methods; 2. Training in technical matters; 3. The safe use of new machinery, equipment, and technology; 4. How to follow a new work procedure, such as a permit-to-work system; 5. Specialised training for appropriate personnel. Training may be required in circumstances where an employee experiences a change of job role or takes on additional responsibilities, where such changes have health and safety implications.
Ongoing training for managers	It is important to ensure that managers and supervisors receive adequate training as they will not only be responsible for supervising work activities but will also have specific responsibilities that they must fully understand such as: 1. Liaison and consultation on health and safety with individuals and groups within the company; 2. Liaison and cooperation on health and safety with individuals and groups external to the company such as enforcing authorities, suppliers, customers, contractors, or the public; 3. The manager's duties and role in internal accident reporting and investigation, and statutory reporting of injuries, diseases, and dangerous occurrences; 4. Effective training and supervision of employees (managers need an appreciation of the risks present and control measures required); 5. Recruitment and selection of employees who are suitable for the tasks required of them; 6. Checking that work areas and work carried out under their control adhere to the company safety policy and procedures and legal requirements; 7. How to carry out or organise a risk assessment.
Training for non-employees	It is vital that managers are given sufficient information, instruction, and training to enable them to discharge their health and safety responsibilities effectively. The level of training required will vary according to the extent of the responsibilities assigned to individual managers, the size of the company, and the complexity of its operations. Information about health and safety risks on the premises and the precautions required may need to be provided to a range of visitors, such as members of the public, contractors, and the self-employed working for employers. Over and above that, instruction and training may also need to be provided, for example, to temporary workers and contractors, to ensure that the risks they may encounter arising from the activities of the host company, and the risks that their activities may present to the company employees, are adequately controlled. Some issues that may need to be included are: (a) risks to non-employees' health and safety that exist on site; (b) emergency procedures; (c) safe working practices; (d) persons responsible for evacuation; (e) risks to employees from the activities of non-employees. The employer must also ensure that, where necessary, the contractor provides information and training where their activities may affect the health and safety of others.

Establishing the Current Level of Training

Having determined what types of training are required in relation to the different work activities and risks present, the next stage of the training needs assessment is to decide which employees are currently in need of that training. An employee has a training need where there is a gap between the knowledge and skills required in order to work safely and avoid unnecessary risk, and the employee's existing level of knowledge and skill. A review of employees' current training records may reveal that a considerable amount of the necessary training has already been provided although it may be worth considering the adequacy of such training, whether it is sufficient for the employee to work safely and whether it needs to be refreshed. Employees or their representatives may, therefore, need to be consulted to determine whether their training has covered the subjects identified by the training needs assessment, and whether they are in fact competent. If records are not kept, and there is any doubt about the employee's competence, then training should be given.

Refresher Training

Competence can be lost as well as gained. It will be lost particularly where the skills and knowledge acquired through training are rarely used, such as for emergency procedures. Training must therefore be repeated periodically, and arrangements will need to be established to provide such training. Refresher training is essential in keeping persons at the correct level of competence. The frequency of such refresher training should be at the discretion of the employer who has two main options for action:

(a) Retrain at pre-determined intervals: this may seem the easiest option to manage although it does have the disadvantage of being difficult to gauge the correct frequency as individual employees' capacity will vary; and

(b) Retrain when needed, for example, in relation to requests received from managers or employees, or where there are signs of deterioration in work performance: this is the most flexible option but requires a very high level of monitoring and supervision to ensure that any deterioration is not sufficient to cause a risk to health and safety.

Provision of Training

There are a number of options available to employers when considering how training should be provided. The most suitable in any given situation will depend on:

(a) The training objectives;
(b) The time and resources available for training;
(c) The availability of in-house expertise;
(d) The preferences of the trainees;
(e) Whether the nature of the training required is specific or general, practical or theoretical.

Various types of training are available, and careful consideration will be needed in order to choose the most suitable type for meeting a particular training need. Training may be run in-house or externally.

1. In-house: where employees of the company have the necessary expertise in terms of knowledge, skills, and experience to competently deliver the training, then this should normally be the preferred route. If the necessary expertise does not exist in-house, it may nevertheless be worthwhile providing training for selected employees so that they are able to acquire the necessary expertise to deliver the training. The advantages of inhouse training include the fact that it can easily be tailored towards the specific needs of the company, can lead to increased buy-in from employees, and is usually the cheapest option.
2. Externally: if the necessary expertise is not available in-house, it may be necessary to seek specialist assistance from external sources such as health and safety training organisations and consultants, trade associations, trade unions, and institutions of further education. Such options may be suitable where only a small number of employees require the particular type of training concerned, and facilities are not available internally. An advantage is that employees may view external courses as being of greater importance than those run internally.

TABLE 2: Common problems associated with health and safety training

Problem	Solution
Safety training can be seen to be irrelevant and boring	1. Make the training relevant to the trainees' particular tasks. 2. Use actual examples of accidents and incidents that have happened in the workplace. 3. Illustrate with examples of safety suggestions put forward by employees and the benefits obtained. 4. Keep the audience involved. Change presentation methods.
There may be too much information to take in at once	1. Provide a larger number of shorter-length training sessions. 2. Plan sessions to follow a natural progression of subjects. 3. Get trainees to carry out a practical exercise and report back to the group. 4. Provide assignments for trainees to complete. 5. Provide supplementary information. 6. Check to ensure that it has been understood.
"Safety is not my problem"	1. Reinforce the company's safety policy (i.e. that safety is everyone's responsibility). 2. Get trainees to carry out a practical problem-solving exercise. 3. Get trainees to carry out a risk assessment of their work activities and identify control measures. 4. Get trainees to make a presentation on a safety topic of their choice. 5. Obtain group and individual feedback.

Evaluating the Effectiveness of the Training Programme

The purpose of evaluation is to determine how effective the training has been in terms of meeting the training objectives (i.e. was the training successful?). For the majority of topics in which training may be provided, some form of evaluation of the training should be carried out. This can be achieved by:

1. An examination or test at the end of the training session - even after short courses, a simple test can prove useful;
2. Observing employees' behaviour in the workplace (are trainees demonstrating that they understood the training by following the correct procedures and working safely?) and undertaking workplace inspections/audits;
3. Examining accident, injury, and near-miss statistics to see if there are any improvements (it should be appreciated, however, that some training courses can lead to a short-term rise in accident figures as a result of employees being made aware of the reporting procedures);
4. Examining whether there has been an improvement in efficiency and/or a reduction in errors made by employees;
5. Post-training evaluation of employees' knowledge, skills, and/or awareness through the use of questionnaires or discussion;
6. Obtaining the opinions of employees – did they find the training useful? – and of their supervisors. Employees could be asked for any suggestions they may have for improving the training arrangements and whether they feel they need any additional training in the subjects covered;
7. Assessment of any course work.

It can be seen that a meaningful evaluation of the training period may take some time, depending on the methods used. The evaluation should seek to identify whether and where improvements can be made, particularly where there are indications that the training was not entirely successful. The results of the evaluation should be recorded and examined to see where improvements can be made to the training arrangements. The training arrangements should also be reviewed periodically to identify whether modifications are necessary, for example as a result of changes in work methods or new legislation.

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ARTICLE-12

WHY WORKERS SAFETY IS IMPORTANT IN THE MINING INDUSTRIES?

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Introduction

The mining industry is known worldwide for its highly risky and hazardous working environment. Technological advancement in ore extraction techniques for proliferation of production levels has caused further concern for safety in this industry. Research so far in the area of safety has revealed that the majority of incidents in hazardous industry take place because of human error, the control of which would enhance safety levels in working sites to a considerable extent.

Key Factors

High-Risk Environment: Mining is one of the most physically demanding and perilous industries in the world. Miners work in environments characterized by unpredictability and inherent dangers. These risks are further compounded by the depth of mining operations, the remoteness of mining sites, and geological uncertainties.

Preservation of Human Lives: It's essential to remember that behind each miner is a life filled with meaning and connections. Miners are not just employees; they are parents, children, siblings, and friends. Prioritizing worker safety is not merely a legal obligation; it's a commitment to preserving the lives of those who brave these challenging conditions to support their loved ones and communities.

Regulatory Compliance: Governments around the world have established strict safety regulations for the mining industry. These regulations are not arbitrary; they are the result of hard-earned lessons from past accidents and tragedies. Compliance with these regulations is not just a legal requirement; it is a social contract between the mining industry, governments, and society at large. These laws exist to protect both the individuals working in these hazardous conditions and the surrounding environment.

Enhanced Productivity: Investing in worker safety is an investment in the productivity and efficiency of mining operations. Safer working conditions lead to fewer accidents, less downtime, and a reduction in absenteeism caused by injuries. Miners who feel secure and valued in their workplaces are more likely to be motivated, focused, and committed to their tasks. The result is not only a safer environment but also enhanced overall performance, contributing to the success of mining operations.

Sustainable Reputation: In today's world, where social and environmental responsibility is increasingly emphasized, businesses are held accountable for their practices. This reputation is essential for fostering trust among investors, stakeholders, and the public, ultimately benefiting the long-term success of the business.

Cost Savings: While the initial investment in safety measures may appear costly, it is, in fact, a cost-effective strategy. Preventing accidents and injuries leads to substantial cost savings in the long run. Avoiding medical expenses, equipment repair costs, and reducing insurance premiums can significantly impact the bottom line. Safety is an investment that ultimately protects both lives and financial resources.

Continuous Improvement: Prioritizing worker safety fosters a culture of continuous improvement within mining companies. Through regular safety audits, incident reporting, and comprehensive training programs, potential hazards are identified and eliminated. This ongoing commitment to safety encourages a workplace where employees actively engage in making their environment safer for themselves and their colleagues.

Community & Environmental Well-Being: Mining companies play a significant role in the well-being of the communities in which they operate and the environment at large. Strong worker safety measures do not just protect employees but also benefit the regions surrounding mining sites and the environment. By minimizing accidents and environmental incidents, mining companies can contribute to the well-being and sustainability of these areas.

Long-Term Industry Viability: By prioritizing worker safety, the mining industry ensures its own sustainability and positive contributions to the global economy. Worker safety is not just a moral and legal imperative; it is a strategic move that benefits employees, companies, and society. A commitment to worker safety is a commitment to the future viability of the mining industry, ensuring that it remains a crucial contributor to the global economy while upholding the highest ethical standards.

KEY SAFETY MEASURES	TECHNOLOGICAL ADVANCEMENTS
1. Regular training & induction programs 2. PPE usage. 3. Hazard identification & risk assessment. 4. Implementing safety protocols & procedures. 5. Emergency preparedness & response planning.	1. Automation & mechanization. 2. Advanced monitoring system. 3. Predictive Maintenance. 4. Real time hazard detection. 5. Digital training platforms.
CHALLENGES & OPPORTUNITIES	**BEST PRACTICES**
1. Addressing human error & complacency. 2. Managing physiological health. 3. Implementing effective safety management systems. 4. Colaborating with stakeholders. 5. Embracing innovation & technological advancement.	1. Regular audits & inspection. 2. Encouraging employee participation. 3. Recognizing & rewarding safe behaviour. 4. Continuous improvement & learning. 5. Transparency & accountability.

Statistics

According to the International Labour Organization (ILO), the mining industry accounts for 1% of global employment but 8% of fatal occupational accidents.

The National Institute for Occupational Safety and Health (NIOSH) reports a 40% reduction in mining fatalities between 2007 and 2017.

References

- International Labour Organization (ILO)
- National Institute for Occupational Safety and Health (NIOSH)
- Mining Industry Council
- Occupational Safety and Health Administration (OSHA)

Conclusion

Safety and welfare are non-negotiable in the mining industry. By prioritizing these aspects, we can create a healthier, safer, and more productive work environment. Let us strive to make safety a core value, ensuring the well-being of all mining professionals.

ARTICLE-13

INNOVATIONS IN MINING SAFETY: TECHNOLOGY AND TRAINING

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Introduction

Mining, a critical sector in the global economy, has long faced challenges related to worker safety. The industry's inherent risks, from hazardous working conditions to the potential for accidents, necessitate a continuous evolution of safety practices. Fortunately, innovations in technology and training are paving the way for enhanced safety measures in mines. This essay explores the latest advancements in mining safety, focusing on how technology and training are interwoven to create safer working environments for miners.

The Importance of Mining Safety

Mining safety is paramount, as the industry has historically been plagued by accidents and health hazards. According to the International Labor Organization, mining is one of the most dangerous occupations, with a high incidence of fatalities and injuries. The nature of the work exposes miners to various risks, including cave-ins, equipment malfunctions, exposure to harmful substances, and health issues from prolonged physical strain. Therefore, improving safety measures is not just a regulatory requirement but a moral obligation.

Technological Innovations In Mining Safety

1. Automation and Robotics

One of the most significant advancements in mining safety is the increasing use of automation and robotics. Automated systems can perform tasks that are traditionally hazardous for human workers, such as drilling, blasting, and transporting materials. For example, autonomous haul trucks can navigate mines without human operators, significantly reducing the risk of accidents caused by human error. Companies like Rio Tinto and BHP have successfully implemented autonomous systems, leading to increased productivity and enhanced safety.

2. Wearable Technology

Wearable technology, such as smart helmets, vests, and wristbands, is revolutionizing safety in mines. These devices can monitor vital signs, detect fatigue, and track location in real-time. For instance, smart helmets equipped with augmented reality (AR) can provide miners with real-time data about their environment, helping them make informed decisions and avoid potential hazards. Wearable can also alert supervisors if a miner is in distress or in a dangerous situation, facilitating quicker responses to emergencies.

3. Drones and Remote Sensing

Drones are becoming increasingly prevalent in mining operations, offering a safer alternative to traditional surveying and monitoring methods. They can inspect hazardous areas, map geological features, and monitor environmental impacts without putting workers at risk. Additionally, drones equipped with thermal imaging can detect heat anomalies, which can indicate potential equipment failures or unsafe conditions.

Remote sensing technologies also play a crucial role in mining safety. By using satellite imagery and geospatial analysis, mining companies can identify potential hazards and assess the stability of mine sites before workers enter. This proactive approach helps mitigate risks and enhance overall safety.

4. Predictive Analytics and Big Data

The use of big data and predictive analytics is transforming the mining industry by enabling companies to anticipate and mitigate safety risks. By analyzing data from various sources, such as equipment performance, worker behavior, and environmental conditions, mining operators can identify patterns and potential hazards. Predictive maintenance, for example, allows companies to service equipment before it fails, reducing the likelihood of accidents caused by equipment malfunctions.

5. Enhanced Communication Systems

Effective communication is vital for ensuring safety in mines. Advanced communication systems, including two-way radios, satellite phones, and emergency notification systems, facilitate instant communication between workers and management. These systems can provide real-time updates on hazardous conditions, emergency protocols, and evacuation procedures, helping to ensure that all personnel are informed and safe.

Training Innovations in Mining Safety

1. Virtual Reality (VR) and Augmented Reality (AR) Training

Training plays a crucial role in enhancing mining safety. Traditional training methods often fall short in preparing workers for the complexities of real-world scenarios. However, innovations like virtual reality (VR) and augmented reality (AR) are changing the landscape of training in the mining sector.

VR simulations can immerse trainees in realistic mining environments, allowing them to practice safety procedures without the risks associated with actual operations. These simulations can replicate various emergency scenarios, helping workers learn how to respond effectively under pressure. AR, on the other hand, can provide real-time instructions and information over layed on the physical environment, assisting workers in understanding complex tasks and safety protocols.

2. E-Learning and Online Training Platforms

The rise of e-learning and online training platforms has made safety training more accessible and flexible. Miners can now complete safety courses at their own pace, which can be particularly beneficial for those working in remote locations. These platforms often include interactive modules, quizzes, and assessments, ensuring that workers retain essential safety knowledge.

3. Continuous Training and Skill Development

Mining safety training should not be a one-time event but an ongoing process. Continuous training programs ensure that workers are up to date with the latest safety practices and technologies. Many companies are implementing regular safety drills, refresher courses, and skill development workshops to foster a culture of safety and keep employees informed of new regulations and best practices.

4. Behavioral-Based Safety Training

Behavioral-based safety (BBS) training focuses on understanding and influencing worker behavior to promote safer practices. By analyzing how workers interact with their environment and identifying unsafe behaviors, companies can develop targeted training programs to address these issues. BBS encourages a proactive approach to safety, empowering workers to take ownership of their safety and the safety of their colleagues.

5. Mentorship Programs

Mentorship programs can be instrumental in transferring knowledge and experience from seasoned miners to newcomers. Pairing experienced workers with trainees allows for hands-on learning and the sharing of safety practices that may not be covered in formal training programs. This personalized approach can help instill a strong safety culture and ensure that critical knowledge is passed down through generations.

Integrating Technology And Training For Enhanced Safety

The integration of technology and training is essential for creating a comprehensive safety strategy in the mining industry. While advanced technologies can significantly enhance safety measures, their effectiveness relies heavily on the proper training of workers.

1. Technology-Driven Training Solutions

Training programs can leverage technology to create more engaging and effective learning experiences. For instance, incorporating VR and AR into training curricula allows workers to interact with the technology they will use on the job. This familiarity can increase confidence and competence when operating new equipment or responding to emergencies.

2. Data-Driven Insights for Continuous Improvement

By analyzing data collected from wearable devices, drones, and other technologies, mining companies can identify trends and areas for improvement in their safety training programs. This data-driven approach ensures that training remains relevant and effective, addressing the specific needs of the workforce and the challenges of the mining environment.

3. Collaborative Safety Culture

Promoting a collaborative safety culture requires the active involvement of all employees. Technology can facilitate communication and collaboration, allowing workers to share safety concerns and best practices. Training programs that emphasize teamwork and communication skills can foster a sense of community and shared responsibility for safety.

Challenges and Future Directions

Despite the promising innovations in mining safety, several challenges remain. The initial costs of implementing advanced technologies can be prohibitive for some companies, particularly smaller operators. Additionally, there may be resistance to change among workers who are accustomed to traditional practices.

To overcome these challenges, the mining industry must prioritize safety as a core value and invest in the necessary resources for training and technology adoption. Collaboration between companies, industry organizations, and regulatory bodies can also play a vital role in driving safety innovations and ensuring that best practices are shared across the sector.

Conclusion

Innovations in technology and training are transforming the landscape of mining safety. By embracing automation, wearable technology, drones, and advanced training methods, the mining industry is taking significant strides toward reducing risks and protecting workers. As technology continues to evolve, it is essential for companies to integrate these advancements into their safety protocols and training programs. Ultimately, a commitment to innovation in mining safety will not only enhance worker protection but also contribute to a more sustainable and responsible mining industry.

ARTICLE-14

THE RISK OF JEOPARDIZING WOMEN'S SAFETY IN THE WORKPLACE: ADDRESSING THE CHALLENGES

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Introduction

The workplace is a vital arena where individuals seek to thrive professionally and personally. However, for many women, this environment can also pose significant risks to their safety and well-being. Women's safety in the workplace is a pressing issue that transcends industries and sectors. Despite progress in gender equality, women continue to face various challenges that jeopardize their safety, unsafe working conditions including harassment and discrimination. Addressing these issues is crucial not only for the individuals affected but also for fostering a healthier, more inclusive workplace culture.This article explores the challenges surrounding this issue and highlights case studies that illustrate the real-world consequences when women's safety is compromised in the workplace.

Hostile or Unsafe Work Environments Beyond harassment, the physical safety of women in certain industries is often at risk due to unsafe working conditions. In factories, construction sites, or healthcare facilities, inadequate safety measures can result in harm to women.

Case Study: Bangladesh Garment Factory Fire (2012) In 2012, the Tazreen garment factory in Bangladesh caught fire, killing over 100 workers, many of them women. The building lacked proper fire safety measures, and many exits were locked, trapping the workers inside. This tragedy exposed the need for workplace safety regulations and monitoring to protect all employees, particularly women who make up the majority of the workforce in such industries.

The Scope of the Problem

There are several things that can put women's safety at danger in the workplace: disparities in power, toxic physical conditions, discrimination, and lack of reporting channels. Women may be put in danger physically, psychologicallyor emotionally if safety regulations are not followed, trained in, or executed. The repercussions are severe; they frequently lead to low output, high loss of staff, legal problems, and reputational damage to the organization.

- **Unsafe Working Conditions -** Safety dangers are typically encountered by women in some sectors, especially those that involve physical labor or high-risk locations. When businesses neglect to put in place suitable safety procedures or offer sufficient training, these situations worsen. Because of discrimination, women working in these areas may be more prone to mishaps, injuries, and health problems.
- **Harassment and Discrimination -** The problem of workplace harassment, especially sexual harassment, is still widespread. Many women say they were subjected to unwelcome advances, offensive remarks, or even physical assault. Women make up about 75% of workplace harassment complaints, according to the Equal Employment Opportunity Commission (EEOC). This can result in lower productivity and greater turnover rates in addition to having an impact on their mental and emotional health.
- **Mental Health Implications -** It is important to consider the psychological effects of workplace safety issues. Anxiety, despair, and stress can result from having to navigate a hostile atmosphere all the time. A loss of talent and experience in the profession may result from women feeling forced to quit positions they once loved. A cycle of pain and silence continues when people are discouraged from getting help because mental health disorders are stigmatized.

Addressing the Challenges

- **Promoting a Culture of Transparency -** The first step in tackling workplace safety risks is to establish an open culture. Without fear of reprisal, employees should be able to voice their concerns. Organizations can detect and resolve problems proactively by establishing anonymous reporting systems and frequent feedback methods.

- **Implementing Comprehensive Policies -** Putting Strong Policies in Place Clear anti-harassment and safety rules must be created and implemented by organizations. Organizations need to have comprehensive policies that put women's safety first in order to effectively address these concerns. This entails having strict anti-harassment policies, defined reporting guidelines, and comprehensive training initiatives for all staff members. It is the responsibility of the leadership to provide a secure atmosphere and guarantee that every voice is heard.

- **Providing Training and Education -** Regular training on topics such as bystander intervention, unconscious bias, and diversity and inclusion can help create a more informed workforce. Educational programs should also focus on empowering women to advocate for their rights and understand their options if they face harassment or discrimination.

- **Offering Support Services -** Women who are facing difficulties at work may find it quite helpful to have access to support services like counseling and legal aid. Businesses should think about forming alliances with institutions that offer these kinds of services so that workers can get the help they require to get through challenging circumstances. Supplying Resources for Support Women can be given the resources they need to confront dangerous situations through safe reporting procedures, legal support, and counseling. Employees feel more comfortable voicing problems when there is a support system in place at work.

- **Encouraging Leadership Diversity -** Organizational change can be facilitated by diverse leadership teams. Businesses may create policies and procedures that better represent the varied workforce they serve by putting women and people from different backgrounds in positions of decision-making authority. A more welcoming workplace where everyone's safety and wellbeing are given priority may result from this.

Sexual Harassment and Abuse Sexual harassment remains one of the most prevalent risks to women's safety in the workplace. According to a 2020 study by the International Labour Organization (ILO), nearly 1 in 3 women globally experiences some form of harassment at work. ***Harassment can take the form of inappropriate comments, advances, or even physical assault, making the work environment unsafe.***

1. The #MeToo Movement in Various Industries

Background: The #MeToo movement, which gained momentum in 2017, has had widespread implications across multiple sectors, from entertainment to corporate workplaces.

Key Issues: Many women shared their experiences of harassment and assault, prompting calls for accountability and systemic change in workplace policies.

Outcome: Numerous organizations have since revised their harassment policies, implemented training programs, and established clearer reporting mechanisms, reflecting a cultural shift towards greater awareness and prevention of workplace harassment.

2. Crisis in the Healthcare Sector During COVID-19

Background: Female healthcare workers faced increased risks during the pandemic, including harassment from patients and the public, alongside the pressures of working in high-stress environments.

Key Issues: Reports highlighted the challenges women faced, such as harassment and lack of support, particularly in emergency settings.

Outcome: Hospitals and healthcare organizations began to implement more stringent policies to protect staff, improve mental health support, and ensure that reporting mechanisms were in place for incidents of harassment.

3. Nike's Gender Discrimination Lawsuit (2021)

Background: Nike faced a class-action lawsuit alleging gender discrimination in pay and promotions. Female employees claimed they were systematically underpaid and overlooked for advancement compared to their male counterparts.

Key Issues: The lawsuit brought to light issues of inequity in a high-profile company, emphasizing the need for fair pay and promotion practices.

Outcome: Nike has since committed to improving gender equity in its workforce and enhancing transparency around pay practices, although the lawsuit is ongoing.

Conclusion

Women's safety in the workplace is a serious problem that has to be addressed right away. Organizations may make the workplace safer and more equal for all employees by addressing issues including harassment, hazardous working conditions, and the effects these problems have on mental health. This boosts general productivity, creativity, and morale in addition to benefiting specific personnel. Giving women's workplace safety top priority is a critical first step toward our goal of a more inclusive future.

ARTICLE-15

SAFETY CULTURE: A WAY OF LIFE

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Introduction

Safety seems so easy – just make sure people don't get hurt. In practice it is difficult to achieve a safe organisation that is capable of sustained safe performance. This paper will highlight the role of systematic management systems to ensure that organisations become safe perpetually. The adoption of a management system, no matter how thorough and systematic it may be, is not, however, sufficient to guarantee sustained performance. The need of the hour is an organisational culture that supports the management system and allows it to prosper. We will discuss the notion of a safety culture and how it might be constructed through this article. The bad news is that creating a management system and keeping it alive is not a an easy task. The good news is that it is worthwhile, both in terms of lives and in terms of profits. Finally the other good news is that it is not as hard as it may seem. Safety culture is an important topic, but time consuming to inspect (because of the sample required) and difficult to tackle. It is recommended that it is only be taken on where there is good reason to believe that there is a significant issue to address, such as a poor safety record over a period, and where the company is likely to be receptive to advice. An organisation's culture can have as big an influence on safety outcomes as the safety management system.

'Safety culture' is a subset of the overall company culture. Many companies talk about 'safety culture' when referring to the inclination of their employees to comply with rules or act safety or unsafely. However we find that the culture and style of management is even more significant, for example a natural, unconscious bias for production/sales over safety. Balancing both the aspects needs sincere efforts of an organisation.

- Symptoms of poor cultural factors can include:
- Widespread, routine procedural violations.
- Failure to comply with the company's own sms (although either of these can also be due to poor procedure design).
- Management decisions that appear consistently to put production or cost before safety. In inspection, it is possible to gather evidence about a company's culture, although this requires interviewing a suitably representative sample of people from all levels. (**ACSNI human factors study group,1993**)

We at Gandhamardan Iron Ore Mines (GIOM) have adopted a robust safety culture through implementing wide safety measures viz. Visible Felt Leadership that entrusts a person to observe an area and interact with the personnel deployed there to draw inference of any unsafe act and condition thereby assessing the severity and taking control measures to check the hazard. Reward and recognition scheme has been found to be more effective and one of the best motivating factor for the workmen for reporting of unsafe act (UA), unsafe condition(UC), Safe Act (SA), Safe Condition (SC), Near miss etc.

Safety card to all the workmen containing 10 life saving rules has been distributed to promote safety in all walks of life. Regular class room and onsite training is being imparted on General Mine safety, Lifesaving Rules, ISO:45001 to all the workmen.

To change the outlook of safety from a mere taboo to a habit, OMC declared FY:2021-22 as safety year with tagline, "Safety First, Avoid the Worst" with various monthly safety themes. All the employees celebrated the year with great enthusiasm.

To check any type of mechanical hazard, only mechanically fit vehicles are allowed inside the mine premises. Dedicated teams are deployed at various entry points to assess any fault.

Such measures with positive outlook will help in paradigm shift to adopt a safety culture in an organisation.

Safety Culture: Characteristics

What does an organisational culture that gives safety a priority look like? Reason (Reson, J.T. ,1997) has identified a number of characteristics that go to make up such a safety culture. These are:

- **An informed culture -** One in which those who manage and operate the system have current knowledge about the human, technical, organisational, and environmental factors that determine the safety of the system as a whole.
- **A reporting culture**: A culture in which people are willing to report errors and near misses.
- **A just culture**: A culture of 'no blame' where an atmosphere of trust is present, and people are encouraged or even rewarded for providing essential safety-related information- but where there is also a clear line between acceptable and unacceptable behaviour.
- **A flexible culture** : Which can take different forms but is characterised as shifting from the conventional hierarchical mode to a flatter professional structure.

❖ **A learning culture -** The willingness and the competence to draw the right conclusions from its safety information system, and the will to implement major reforms when the need is indicated.

The values associated with a safety culture are fairly straightforward. The beliefs are more complex. Taken together the five characteristics form a culture of trust. Trust is needed, especially in the face of assaults upon the beliefs that people are trying their best, such as accidents and near-miss incidents which all too easily look like failures of individuals to come up to the ideals of the organisation. This helps us to identify what beliefs are associated with a safety culture.

Safety Culture Component	Definition
Safety Values	The organisation regards as safety as sacrosanct and provide the licence to operate.
Safety Beliefs	The organisation believes that safety makes commercial sense; that individuals are not the sole causes of incidents; that the nest accident is waiting to happen.
Common Problem-Solving Methods	Risk assessment, cost-benefit analyses, accident analysis as well as investigation, proactive search for problems in advance of incidents.
Common Working Practices	Safety integral to design and operations practice, safety#1 on meeting agends up to Board level, chronic unease about safety

Safety Culture : Types

Safety cultures can be distinguished along a line from pathological, caring less about safety than about not being caught, through calculative, blindly following all the logically necessary steps, to generative, in which safe behaviour is fully integrated into everything the organisation does. A Safety Culture can only be considered seriously in the later stages of this evolutionary line. Prior to that, up to and including the calculative stage, the term safety culture is best reserved to describe formal and superficial structures rather than an integral part of the overall culture, pervading how the organisation goes about its work. It is obvious that, at the pathological stage, an organisation is not even interested in safety and has to make the first level of acquiring the value system that includes safety as a necessary element. A subsequent stage is one in which safety issues begin to acquire importance, often driven by both internal and external factors as a result of having many incidents. At this first stage of development we can see the values beginning to be acquired, but the beliefs, methods and working practices are still at a primeval stage. At such an early stage, top management believes accidents to be caused by stupidity, inattention and, even, wilfulness on the part of their employees. Many messages may flow from on high, but the majority still reflect the organisation's primary aims, often with 'and besafe' tacked on at the end.

Pathological	Bureaucratic	Generative
Information is hidden	Information maybe ignored	Information is actively sought
Messengers are “shot”	Messengers are tolerated	Messengers are trained
Responsibilities are shriked	Responsibility is compartmented	Responsibilities are shared
Bridging is discouraged	Bridging is allowed but discouraged	Bridging is rewarded
Failure is covered up	Organisation is just and merciful	Failure causes enquiry
New ideas are crushed	New ideas create problems	New ideas are welcomed

Key aspects of an Effective Safety Culture

Management commitment: this commitment produces higher levels of motivation and concern for health and safety throughout the organisation. It is indicated by the proportion of resources (time, money, people) and support allocated to health and safety management and by the status given to health and safety versus production, cost etc. The active involvement of senior management in the health and safety system is very important.

Visible management: Managers need to be seen to lead by example when it comes to health and safety. Good managers appear regularly on the 'shop floor', talk about health and safety and visibly demonstrate their commitment by their actions – such as stopping production to resolve issues. It is important that management is perceived as sincerely committed to safety. If not, employees will generally assume that they are expected to put commercial interests first, and safety initiatives or programmes will be undermined by cynicism.

Good communications between all levels of employee: in a positive culture question about health and safety should be part of everyday work conversations. Management should listen actively to what they are being told by employees and take what they hear

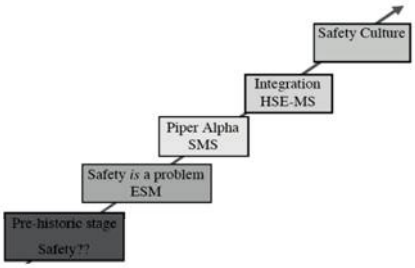

Fig. .4.1. The evolution of safety in Shell's Exploration and Production function

seriously. Active **employee participation** in safety is important, to build ownership of safety at all levels and exploit the unique knowledge that employees have of their own work. This can include active involvement in workshops, risk assessments, plant design etc. In companies with a good culture, you will find the story from employees and management being consistent, and safety is seen as a joint exercise.

Inspection

Inspection needs to involve interviewing a suitable cross-section of the company, particularly a reasonable number of employees, who need to be interviewed in a non-threatening manner. The number needs to be sufficient to take account of differing views and experience. Given this condition the open questions given in the question set will provide a helpful picture of the overall style of the company.

NB unless the inspector has significant personal experience of trying to tackle safety culture, it would be best to simply reflect back what has been found and give general rather than specific advice on how to improve it.

Specific documents

In addition to the general documents that should be requested prior to the visit (see chapter 'Aim of the Guidance') it is recommended that the following documents, which are specific to this topic, should also be requested:

- Results of climate/attitude/opinion surveys.
- Results of procedure surveys.

Safety started by being regarded as an individual's own problem in a dangerous business. Once safety was taken seriously in the early 80's the Enhanced Safety Management Principles (ESM) were introduced. After the Piper Alpha disaster the requirement for Safety Management Systems (SMS) eventually led to the realisation that SMS could be generalised to Health Safety and Environment-MS. The next stage is to develop an organisational culture within which all these developments flourish threatening manner. The number needs to be sufficient to take account of differing views and experience. Given this condition the open questions given in the question set will provide a helpful picture of the overall style of the company.

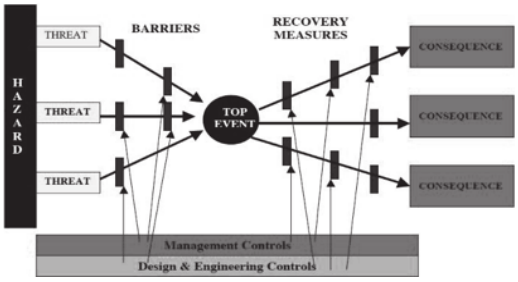

Figure 4.2. The Bow-tie Diagram

Hazards form the major ways in which damage or injury can occur.

- **Threats** are the ways in which hazards can be released.
- **A Top Event** is the event one wishes to avoid.
- **Consequences** are the outcomes that have to be avoided (See Risk Potential Matrix).
- **Barriers** are ways in which threats are countered to ensure that a top event does not occur.
- **Recovery measures** are what can be done to ensure that a top event does not result in the unwanted outcomes.
- **Management controls** are ways in which control is exercised by procedures, training etc.
- **Design and Engineering controls** are ways in which barriers and recovery and mitigation measures are built into the system.

SMS and it's Elements:

There are so many aspects to creating and maintaining a safe working environment that sometimes it's easy to get lost in it all. To truly succeed in creating a safe place of work, the key is to develop and implement an effective safety management system. A safety management system combines all the different elements in your workplace that need attention to ensure you provide a safe working environment for everyone who enters it. Safety management systems make health and safety an integral part of your business's core operations. By designing, developing and implementing an effective safety management system, you will have methods for managing reporting, responsibilities, planning and resourcing to create a safer workplace.

Safety management systems have six elements:

- a safety plan;
- policies, procedures and processes;
- training and induction;
- monitoring;
- supervision; and
- reporting

1. Safety plan

A safety plan is a strategic action plan that forms part of the business plan. It analyses the current and prospective risk for a company and charts how the risks will be eradicated and controlled over a calendar period (the safety plan must have a budget). This plan will ensure that there is a governance structure within your company that ensures every worker clearly understands their safety obligations (and how to comply) and is accountable to carry out those obligations.

2. Policies, procedures and processes

Policies, procedures and processes include all safety paper infrastructures within your company. This paperwork will describe all safety behaviour, expectations, record-keeping, incident reporting, and incident notification documentation.

3. Training and induction

Depending on the nature of your workplace (whether it is low-risk or high-risk), everyone who enters your workplace should receive training on:

- the rules of your company;
- the rules of the site; and
- the rules of the location they are visiting.

The training content will depend on the level of risk the person is exposed to.

4. Monitoring

Your obligations to monitor your workplace depend on circumstances and need. Always consider the level of risk. The higher the risk, the more frequent and detailed the monitoring needs to be.

Other times when monitoring will be necessary include:

- to ensure that all risk has been covered by a new risk assessment that has been carried out due to a change in process, e.g. the installation of new workstations; and
- when an investigation takes place following an incident.

5. Supervision

The only way to ensure your workers are carrying out their safety obligations is to have adequate supervision. The level of supervision required in your workplace will increase if the level of safety control put in place to reduce a risk is low, i.e. the less effective the control measure used, the higher the level of supervision necessary.

6. Reporting

The governance structure of your company needs safety reporting at all levels, not just at board level.

Management Responsibilities:

A safety management system is a series of policies and procedures organizations use to reduce accidents and illnesses among employees. According to OSHA, "Effective Safety and Health Management Systems (SHMS) have proven to be a decisive factor in reducing the extent and severity of work-related injuries and illnesses. SHMS will result in reduced injury-related costs. These savings, when properly administered, will exceed the cost of a workplace SHMS." Research shows that the successful adoption of a safety management system relies a great deal on the level of commitment from both management and employees, as well as an adequate commitment of resources to design and enforce the system. While each safety management system is unique, key components usually include hazard assessment, inspections, incident reporting systems, worker training and performance measuring tools. According to OSHA, "The best Safety and Health Programs involve every level of the organization, instilling a safety culture that reduces accidents for workers and improves the bottom line for managers. When Safety and Health are part of the organization and a way of life, everyone wins." Workers commitment to an organization's occupational health and safety and the adoption of a safety management system can be important issues for any company, no matter its size or what it produces. Presently, these safety processes are predominantly used in what are considered high-risk industries, such as the maritime and train transportation industries and most notably in aviation. It is clear that transportation companies, which move massive numbers of people daily, work under an added imperative to reduce accidents and ensure safety.

The Safety Management Process:

Process safety management is discussed below that contains fourteen steps:

1. Develop and maintain written safety information identifying workplace chemical and process hazards, equipment used in the processes, and technology used in the processes.
2. Perform a workplace hazard assessment, including, as appropriate, identification of potential sources of accidental releases, identification of any previous release within the facility that had a potential for catastrophic consequences in the workplace, estimation of workplace effects of a range of releases, and estimation of the health and safety effects of such a range on employees.
3. Consult with employees and their representatives on the development and conduct of hazard assessments and the development of chemical accident prevention plans and provide access to these and other records required under the standard.
4. Establish a system to respond to the workplace hazard assessment findings, which shall address prevention, mitigation, and emergency responses.
5. Review periodically the workplace hazard assessment and response system.
6. Develop and implement written operating procedures for the chemical processes, including procedures for each operating phase, operating limitations, and safety and health considerations.
7. Provide written safety and operating information for employees and employee training in operating procedures, by emphasizing hazards and safe practices that must be developed and made available.
8. Ensure contractors and contract employees are provided with appropriate information and training.
9. Train and educate employees and contractors in emergency response procedures in a manner as comprehensive and effective as that required by the regulation promulgated pursuant to section 126(d) of the Superfund Amendments and Reauthorization Act.
10. Establish a quality assurance program to ensure that initial process-related equipment, maintenance materials, and spare parts are fabricated and installed consistent with design specifications.
11. Establish maintenance systems for critical process-related equipment, including written procedures, employee training, appropriate inspections, and testing of such equipment to ensure ongoing mechanical integrity.
12. Conduct pre-startup safety reviews of all newly installed or modified equipment.
13. Establish and implement written procedures managing change to process chemicals, technology, equipment and facilities, and
14. Investigate every incident that results in or could have resulted in a major accident in the workplace, with any findings to be reviewed by operating personnel and modifications made, if appropriate.

Conclusions:

Safety management systems and associated safety cases can make a big difference. The systematic approach means that the hazards of the business are known, understood and demonstrably controlled. There is considerable evidence that those companies that are most safety-minded are also amongst the most profitable and the amounts of money that an effective safety management system can produce is considerable. But the problem with purely systematic management is that such activities can be carried out mechanically. The argument was that the next step is the development of a safety culture that makes a system come alive. The discovery that a safety culture pays, not just by reducing accidents, is crucial. One way a safety culture pays off, as the levels of trust improve, is in the quality of communication between management, and the rest of the company. As communication failures are always pointed to as a source of problems for organisations, having a definitive focus for improving communication can only result in improved performance at all levels. Another way a safety culture pays is in the reduction in time and paperwork devoted to checking whether elementary safety related actions are carried out. The other main reason why safety makes money lies in

the fact that, if one has the guarantee of safety that an effective management system provides, then one can devote resources more effectively and take (profitable) risks that others dare not run. What costs money is not safety, but bad safety management. Once the management of an organisation realises that safety is financially rewarding and that the costs incurred have to be seen as investments with a positive return, the road to a full safety culture should be open.

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ARTICLE-16

SCREEN SWAY: EXPLORING THE IMPACT OF SCREEN TIME ON MENTAL WELLNESS

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In the month of Shravan, many Indians give up on various foods or eat only once. Giving modern touch to that tradition, my physician friend vowed to use his mobile for social media only once a day during that month! Screen time has been a challenge not only for every individual and household but also for medical professionals. Covid 19 epidemic aggravated this due to forced home stays and the fact that children had to be given mobiles for their education.

Screen time refers to the time a person spends looking at a screen on a device such as a television, smartphone, computer, or game console. Thankfully, the worries about its impact on cancer seem to have been favorably settled as of now, but the worries about the effects on mental wellness esp. of children and adolescents continue. Though more negative, some positives have been reported.

Negatives:

1. Increased mental illness: Overuse of social media with its **cyber bullying** (Do this if you are young and virile or if you love your country/religion!), **social comparison and unrealistic portrayals** lead to negative self-perception (Oh, she looks so good! Wish I had her figure). This combined with constant **doomscrolling** (The world is coming to an end! Our religion will cease to exist), can lead to loneliness and cause anxiety and depression.
2. Sleep disturbance: Blue light exposure from screens interferes with melatonin production required for sleep. Late night gaming or watching intense videos cause overstimulation and disturb sleep. Constant alerts from notifications can also disturb sleep at night or cause distractions during daytime.
3. Physical issues - Excessive screen time causes sedentary behaviour, lack of outdoor physical activity and eating disorders which can all lead to lifestyle diseases.
4. Screen addiction (Kya karoo, control hi nahihota!), Escapism and FOMO (Fear of Missing Out – Sab karrahehain, main alagkaiserahu?) all contribute to Mental illness.

Positives:

1. Social connectivity – Aren't we lucky to be able to connect with our children, grandchildren and friends abroad and be in regular touch with our alumni friends?
2. Relaxation – Watching a favourite show or sport or playing a game for some time or expressing your creativity in some art form is relaxing and satisfying.
3. E-learning and access to information from search engines and artificial intelligence along with self-help apps have certainly made life easy.

Balance:

So, though there is no doubt about the harmful effects of excessive screen time, it's not all bad only. We can keep enjoying the good and reducing the bad by -

1. Setting time limits – both for ourselves and minor children can reduce the addiction and prevent mental fatigue. We can't only lecture the young - we must set an example too!
2. Encouraging physical activity and outdoor sports.
3. Promoting mindful use of the screen for educational activities, social interactions, and occasional entertainment.
4. And finally - as suggested in the beginning, a digital detox for some hours or days.

ARTICLE-17

BUILDING A CULTURE OF BEHAVIORAL SAFETY IN MINES: THE ALCHEMIST APPROACH

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Introduction:

Behavioral safety in mines is an evolving concept that goes beyond standard procedures and personal protective equipment. It emphasizes the role of individual behavior in creating a safe working environment. To foster a robust safety culture in the challenging setting of any mines, a strategic approach is necessary. The ALCHEMIST framework-Action, Learning, Confidence, Humility, Enthusiasm, Majestic Dreams, Innovation, Strategic Thinking, and Tinkering - provides a comprehensive guide to embedding behavioral safety into daily operations.

1. Action is the first step in making safety a tangible priority. In a mining environment, this means not only following safety protocols but also being proactive in identifying and addressing potential hazards. Workers and supervisors alike must take immediate and decisive action when unsafe behaviors or conditions are observed. A culture of action encourages everyone to be vigilant and responsive, preventing accidents before they occur.

2. Learning is continuous in the mining industry, especially when it comes to safety. Every incident, near-miss, or observation is an opportunity to learn and improve. Through regular training, safety drills, and debriefing sessions, workers can build a deeper understanding of safe practices and the rationale behind them. Learning from past experiences, whether successes or failures, is crucial to enhancing the overall safety culture in the mine.

3. Confidence in one's ability to perform tasks safely is key to reducing accidents. This confidence comes from thorough training, experience, and support from leadership. When workers are confident in their skills and knowledge, they are less likely to make mistakes that could lead to unsafe situations. Additionally, confident workers are more likely to speak up and take initiative when they notice potential safety issues.

4. Humility is essential in recognizing that no one is infallible. In a mine, where the stakes are high, it's important to acknowledge when mistakes are made or when there is something to learn from others. Humility fosters an environment where workers feel comfortable admitting when they don't know something and are open to guidance. This openness is crucial for continuous improvement in safety practices.

5. Enthusiasm for safety might seem like a stretch, but it's about creating an environment where safety is seen as an integral part of the job, not an obligation. When leadership and peers show genuine enthusiasm for safety, it becomes contagious. Workers are more likely to engage with safety initiatives, participate actively in training sessions, and take pride in contributing to a safe workplace.

6. Majestic Dreams represent the vision of a zero-incident workplace. While this may seem ambitious, setting high safety goals inspires the entire workforce to strive for excellence. These dreams should be communicated clearly by leadership, creating a shared vision of what the mine's safety culture can achieve. When everyone is working towards the same lofty goals, the collective effort can lead to significant improvements.

7. Innovation in safety practices is essential for staying ahead of potential hazards. Mines are constantly evolving with new technologies and methods, and safety practices must evolve with them. Encouraging innovation means looking for new ways to prevent accidents, such as adopting the latest safety technologies, refining procedures, or developing creative solutions to unique challenges. Innovation in safety should be celebrated and rewarded, motivating workers to think outside the box.

8. Strategic Thinking in behavioral safety involves anticipating potential risks and planning accordingly. It's about looking beyond the immediate task and considering the broader implications of every action. Strategic thinkers in the mine are those who foresee potential safety issues before they arise and work to mitigate them. This proactive approach to safety can significantly reduce the likelihood of accidents.
9. Tinkering refers to the continuous process of refining and improving safety practices. In a mining environment, where conditions and challenges can change rapidly, it's important to remain flexible and open to adjustments. Tinkering with safety protocols, based on feedback and observations, ensures that they remain effective and relevant. This ongoing process of evaluation and improvement is key to sustaining a strong safety culture.

The ALCHEMIST approach is not a one-time initiative but a continuous journey. To implement this framework effectively, it requires commitment from all levels of the organization, starting with leadership and extending to every worker on the ground. Regular training, open communication, and a shared vision are critical components in embedding these principles into the daily life of the mine. Leaders should regularly communicate the importance of each element of ALCHEMIST, demonstrating through their actions how these principles contribute to a safer work environment. Workers should be encouraged to embody these principles in their daily tasks, making behavioral safety a natural and integral part of their work.

Conclusion

As we delve into the principles of the ALCHEMIST approach, it's essential to recognize that each of us is a leader in our own right, regardless of our position or role within the mines. Leadership isn't confined to titles or ranks; it's about taking ownership of our actions, influencing those around us, and driving positive change. Whether you're operating machinery, overseeing a team, or conducting safety inspections, your actions set the tone for others. By embodying the principles, you contribute to a culture where safety is everyone's responsibility. Let's all strive to lead by example, making safety an unwavering priority in everything we do.

ARTICLE-18

SEE SOMETHING, SAY SOMETHING :BUILDING A CULTURE OF VIGILANCE

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Observe Something, Say Something is a straightforward and powerful technique that makes a big difference in preserving a secure work place. Every employee has a part to play in ensuring a safe workplace since safety is a shared responsibility.

Fig - 1

- Everyone contributes to safety when there is shared responsibility.
- Collective vigilance prevents hazards from going unnoticed.
- Actively speaking up about hazards promotes a culture of safety.
- A safe working environment benefits all employees.

The main theme of See Something, Say Something is this: If you see a hazard or unsafe act then fix it, do something, or report it, but do not ignore it. If you see an injury or incident occur, report it immediately. Encourage employees to be cautious and share anything even if they're not sure if they should! If minor issues are not dealt with right away, they might have disastrous results.

Active reporting eliminates little risks that, if ignored, could result in serious injuries or substantial property damage.

During safety meetings remind team members that they should report any hazards or unsafe conditions immediately. Being vigilant about identifying these issues can prevent accidents and injuries. Workers should speak up if they see hazards like:

Fig - 2

- Wet floors, loose or uneven flooring, or other slip and trip hazards
- Blocked emergency exits
- Damaged tools or equipment
- Poor lighting in walkways or work areas
- Missing or damaged PPE
- Unusual noises or smells
- Missing or malfunctioning safety guards
- Unstable scaffolding or ladders

Employees should also be reporting unsafe acts and suspicious activities. Observing and reporting these behaviors can prevent potential security breaches, hazardous situations, or injuries. This could include scenes like unauthorized persons in restricted areas, co-workers ignoring safety protocols, or someone exhibiting distracted behavior which can very quickly lead to accidents and injuries.

Of course, the hazards and unsafe acts listed above are only examples and not a complete list. Encourage employees to think about their workplace or jobsite and consider all the potential hazards that may need to be reported.

When employees notice a hazard or unsafe act, they should use available reporting channels to notify the appropriate personnel. To report a hazard, workers may need to speak directly to a supervisor or manager, use a dedicated safety hotline, or fill out a hazard report form. Understanding the reporting procedure guarantees that workplace dangers are quickly resolved. Make sure that all team members receive regular reminders about the procedures for reporting dangers, accidents, and near misses, as well as training on how to use them.

Fig - 3

Hazard reports should be specific and detailed. Employees should be providing the exact location of the hazard, a description of what was observed, and the time and date of the observation.

Providing the specific location helps in locating and addressing the hazard. Descriptions provide context for the severity and nature of the hazard. Time and date assist in tracking patterns or recurring issues.

Fig - 4

Fig - 5

Immediately after a work-related injury or incident occurs workers should be trained to follow the company's reporting procedure and quickly notify the appropriate personnel that an incident has occurred. It's important that all incidents are reported quickly to make sure that anyone who may be injured has the opportunity to receive the medical care they need, and the company can respond effectively to ensure the hazard is fixed before anyone else gets hurt.

Workers should take action if they come across a hazard that can be fixed easily and safely. This might include simple solutions like:

- Moving a trip hazard out of the way
- Cleaning up a minor spill
- Removing clutter from walkways
- Picking up and disposing of trash or debris
- Securing loose cables or cords
- Alerting someone if it seems like they are distracted
- Moving tools or objects that are a falling object hazard
- Closing drawers or cabinet doors that have been left open

Fig - 6

It's important that workers take quick action if there is an immediate threat or situation that requires a fast response. This might involve evacuating the area, using a fire extinguisher, or administering first aid. Alerting others to the danger helps ensure everyone's safety. Evacuation ensures safety from dangerous situations. Using a fire extinguisher can control small fires and prevent them from spreading. (Employees should only use a fire extinguisher if they are trained and confident; otherwise, they should evacuate the area.) First aid (by trained individuals) can stabilize injured individuals until professional help arrives. Promote a culture of safety by encouraging workers and new employees to adopt the "See Something, Say Something" mindset. This is particularly successful because leading by example sets a standard for others to follow.Early adoption of safety practices ensures new employees understand their importance. Training new employees on reporting methods prevents future hazards. Consistency is maintained by integrating new employees into the safety culture. When everyone is addressing or reporting dangers, it creates a good safety culture at work and minimizes the need for others to make decisions about when it is suitable to take action. By actively engaging in continuous improvement and fostering a proactive safety culture, employees will contribute to a safer and more efficient work environment for everyone.

Final thoughts that are helpful to share with employees during a safety meeting:

1. Participate in safety training sessions and drills that become available in order to stay prepared.
2. Share any new hazards you identify with your team to raise awareness.
3. Suggest practical solutions for recurring safety issues during team meetings.
4. Work together with colleagues to guarantee that everyone is following safety protocols and helping one another to keep the workplace safe.

ARTICLE-19

OCCUPATIONAL HEALTH HAZARDS IN INDIAN MINES & IT'S PREVENTION

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The workers working in the different mines, due to mining activities like drilling, blasting, shoveling, trucking, grinding and crushing etc., involves the potential occupational health hazards as follows;

Exposure to dust, Exposure to Noise, Vibration Hazards, Ergonomic Health problems, Exposure to heat, Accidents, Lifestyle disorders due to stressful living conditions.

Exposure to dust

1. Most of the mining operations like drilling blasting transportation and material handling produce dust. High levels of dust increase respiratory diseases while gaseouse missions contribute towards Global worming besides causing health hazards to exposed population.

Dust is loosely applied term for solid particles predominantly larger than colloidal and capable of temporary suspension in atmosphere depending on biological properties, the dust can be classified as; -

- **a) Fibro genic Dust**: - Mineral dust capable of causing an increase in the connective tissue of lung with permanent alteration of the lung structure. The increase may be nodular or irregular- Dusts are Silica, Asbestos and Coal Dust etc.
- **b) Nuisance Dust**: The dust is neither toxic nor fibro genic but when inhaled in large quantity can impair functioning of respiratory system like; Kaolin, Barium sulphate etc.
- **c) Toxic Dust**: Dust in having acute or chronic harmful effects on specific organs including and beyond respiratory tract like: Lead and Manganese compounds.
- **d) Respirable Dust**: It is the fraction of total dust which passes through a particle size having impact of respiratory system.

2. Occupational Lung diseases caused by breathing dusts fumes, gases or vapours in a place where a patient works.
   Dust size 10 -20 µm deposit in nose and upper airway
   Smallerparticles5-10µmdepositinTrachea,
   Bronchus Particles less than 5 µm reach the alveoli or air sac. Health hazards are aggravated due to following factors.
   Older age group with reduced CVS & Resp. function, Poor Health status, Poor Nutritional status, Immunological status, Genetic Factors, Pathological State: Stress, Anxiety and Chronic Diseases.
3. **Occupational Respiratory Diseases** (Size, location, Outcome)

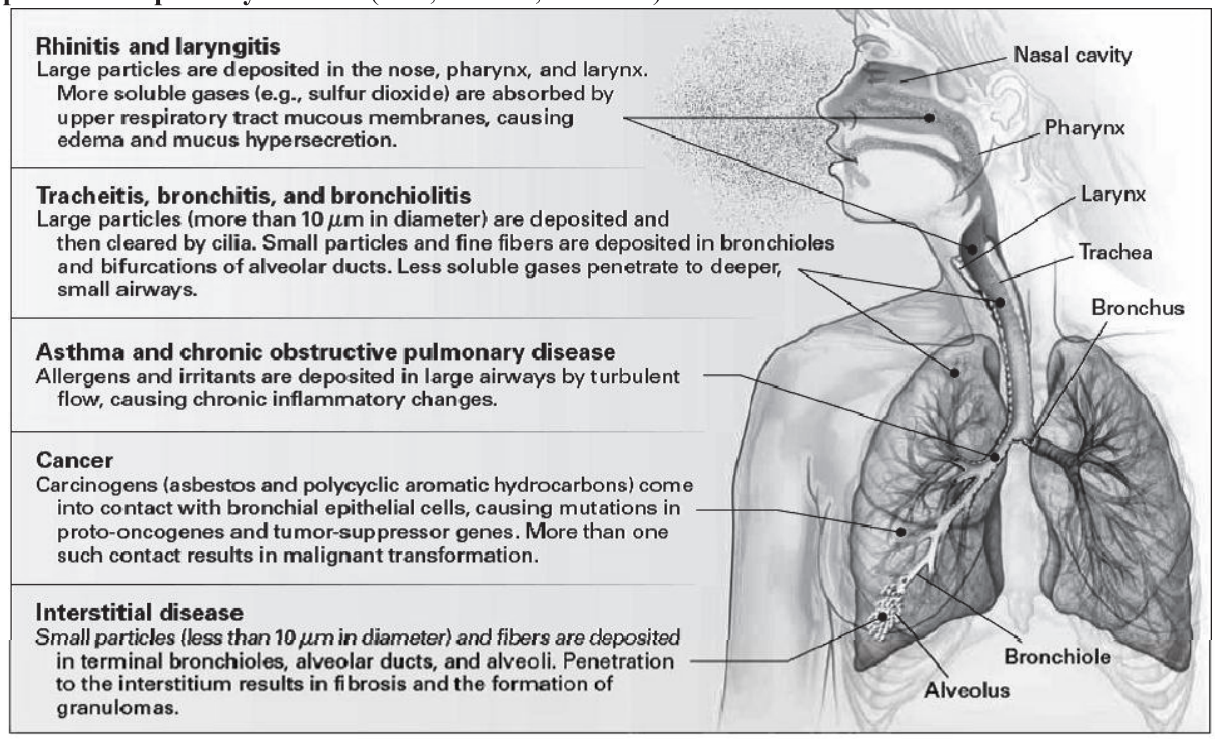

FIG - 1

4. Dust &its Health Hazards

Type of Dust	Main Health Impact	Target Organ	Notifiable Occupational Diseases
Free Crystalline Silica	Silicosis (Lung fibrosis) COPD, Lung Cancer	Lungs	Yes
Coal Dust	Coal workers Pneumoconiosis, Restrictive lung disease, Heart Failure	Lungs Branchiate & Alveoli	Yes
Asbestos	Asbestosis,Lungcancer	Lungs	Yes
Manganese	Parkinsonism	Nervous System	Yes
Cotton Dust	Byssinosis,C.O.P.D	Lungs	Yes
Sugarcane Dust	Bagassosis	Lungs	Yes
Chromium Dust	Lung cancer, Bronchial asthma, C.O.P.D, Kidney problems, Dermatitis, Chrome Ulcers	Lungs, Kidney, Skin	Yes
Bauxite Dust	Pneumoconiosis, Lung Cancer	Respiratory system	Yes
Iron Dust	Siderosis, Lung Cancer	Respiratory System	Yes
Occupational Asthma	Due to immunological Problems		No
Lead Dust	Systemic Intoxication, Blood, CNS problems, Gastric problems	Circulatory system, Respiratory problem, CNS	Yes

Noise & Health related issues

Noise seriously harms human health and interferes with people's daily activities at workplace at home and leisure time. The main health risk of noise identified by WHO are, Pain and hearing fatigue, Hearing impairment including tinnitus, annoyance, interfere with speech communication, sleep disturbances and its consequences on a long- and short-term basis, cardiovascular effects, hormonal responses (stress hormones) and their consequences in human health. Temporary/Permanent hearing loss.

Noiseinducedhearinglossisnotifiablecompensableoccupationaldiseaseasper Mines Act 1952.

Vibration Hazards

Prolonged exposure to vibration can cause temporary or permanent injury to muscles, joints, blood vessels and nerves, resulting in pain or disability. Common types of vibration include hand-arm vibration and whole-body vibration Different neurological problems are caused during work in mining machineries and hazard is known as vibration hazards which affect the nervous system of the workers

Ergonomical Health problems

Ergonomical health hazards like musculoskeletal problems, cervical spondylitis, Back pains are major health problems are identified.

Exposure to heat

Chronic exposure to heat due to continuous working in mines in summer may cause health hazards like heat exhaustion, heat syncope, heat cramps, and heat rashes, heat stroke or death.

Accidents

Due to different mining activities like drilling, blasting, shoveling, trucking etc. the workers may suffer from miner & major accident hazards.

Life style disorders

Lifestyle disorders now days is very common health issue due to stress full living conditions and OVEREATING, SMOKING, DRINKING, SEDENTRY LIFE, INSUFFICIENT SLEEP, LACK OF RELAXATION, FREQUENTLY TRAVELS, WORKLIFE IMBALANCE

COMPLICATIONS OF LIFESTYLE DISORDERS are OBESITY, GASTRIC PROBLEMS, OCCUPATIONAL STRESS, DIABETES, HYPERTENSION, and HEART ATTACK

OBESITY-Overweightisacrudeparameterofobesity.Abetterwayofexpressingthe degree of overweight is Body Mass Index which can be calculated as: -

Body Weight in Kg./ Height in Meter Square=BMI
Normal BMI-19–25, More than 28 is Obese.
Major Risk Factor for : High Blood Pressure, Heart Diseases, Arthritis, Diabetes, Hernia,etc.

DIABETES(HIGHBLOODSUGAR)
Diabetes is a common disease of elderly people although it can also affect any age group. Diabetes is increase in blood sugar caused by deficiency of insulin. Diabetes has a potential to damage vital organs like eyes, kidneys, heart and blood vessels, which may in a long run cause disability and premature death and Diabetes is mainly hereditary in nature but factors like lifestyle of an individual, high intake of carbohydrate, lack of physical activity or exercise, mental tension are some of the factors, which can cause Diabetes Mellitus. Diabetes can be controlled by diet restriction, regular physical exercise, regular medical checkup etc.

HYPERTENSION
Usually, hypertension is defined as blood pressure above 140/90, and is considered severe if the pressure is above 180/120. High blood pressure often has no symptoms. Over time, if untreated, it can cause health conditions, such as heart disease and stroke. Eating a healthier diet with less salt, exercising regularly and taking medication can help lower blood pressure.

STRESS
Everyone has different stress triggers. Work stress tops the list, according to surveys and work is the biggest source of stress in their lives. Causes of work stress include: Being unhappy in your job, Having a heavy workload or too much responsibility, Working long hours, Having poor management, unclear expectations of your work, or no say in the decision-making process, Working under dangerous conditions, Being insecure about your chance for advancement or risk of termination, Having to give speeches in front of colleagues, Facing discrimination or harassment at work, especially if your company isn't supportive.

PREVENTION OF OCCUPATIONAL HEALTH HAZARDS IN MINES

1. **Safety & Environmental management.**
   Regular monitoring of water quality, air quality, noise management, vibration survey and other scientific studies, Accident analysis and Accident prevention program by expert agencies as per the statutory norms and all parameters should be within permissible exposure level limit proactive prevention and correction measure taken by all mining companies.
2. **Management of life style disorder**
   To mitigate the lifestyle disorder health problems "**well ness at workplace**" should be introduced in different mines by formulating a Health Index Chart of all employees based on the criteria of BMI, BP, Blood Sugar, Blood Cholesterol as per standard guidelines and which also includes: -
   1. Life style Management
   2. Fitness Programme (Yoga, Walking, Cycling, Exercise)
   3. Regular Meditation Programme
   4. Stress Management
   5. Reduction of Calorie In take
   6. Reduction of Salt In take
   7. Alcohol & Smoking cessation programme
   8. Health education programme to workers & family members.
   9. Regular health check up camps.
3. **On site plan for work men**
   a. PPE, Firefighting, waters sprinkler, Ergonomically preparedness,
   b. Medical, First aid Training and Ambulance Facilities.
4. **Offsite Plan for Community**
   a. Treatment of discharge water.
   b. Sprinkling of water to settle down the dust.
   c. Widening of Road and Speed breakers.
   d. Massive plantation programme.

SPECIFIC HEALTH STATUS EVALUATION OF WORKERS

The detailed Occupational Health Status of the workers in the core zone has been regularly evaluated by conducting occupational health survey(IME/PME)tocomplytheMinesAct1952, MinesRule1955and7th-12th Conference of Safety in mines 2007 to 2020 as per the following guidelines.

SECTION 25 OF MINES ACT, 1952 NOTICE OF THE DISEASE

Following diseases have been notified to the statutory authorities in connection with mining operations, silicosis, Pneumoconiosis, Asbestosis, Manganese poisoning, Cancer of Lung or Stomach or pleura and peritoneum (i.e. mesothelioma).

Amended Notification S. O. 376 (E) dated8thApril, 1988 issued under Mines Rule, 1955 now requires -

Mandatory Medical Examination of every person seeking employment in mine and also periodic medical examination once in 3 years after attaining 45 years of age and once in5 years below 45 yrs of age, in the following categories.

- Persons employed below ground in a mine.
- Persons engaged in the operation of drag lines, shovels, dozers, scrapers, dumpers, power drills, boring machines, locomotives, winding engines, air compressors and other machinery installed or deployed or the surface on in the open case working in mines.
- Persons engaged in crushing, grinding, dressing, processing, screening, or sieving of minerals, ores or stones or in any operation incidental thereto in mine.

UNDER RULE 29F AND 29L

Lay down the manner and criteria for conducting medical examination requires that-

- Clinical Examination including vision testing.
- Chest X-Ray PA view (with 300 MAX - Ray Machine)
- Spirometry (LUNG FUNCTION TEST)

9TH CONFERENCE ON SAFETY IN MINES 1999

- Occupational Health services as recommended by 7TH conference wherever not yet established shall be established within a period of one year.
- Each mining company operating mechanized mines shall computerize all records of medical and environmental surveillance.
- Every PME Centre shall be provided with the facility for chest radiographs, lung function tests, arrangement for classification of chest radiographs and also wherever required facilities for audiometry.
- All chest radiographs of Initial and Periodical Medical Examinations shall be classified for detection, diagnosis, and documentation of pneumoconiosis in accordance with ILO classification for pneumoconiosis.
- The PME Medical Officer in every PME centre shall be trained in Occupational Health and use of ILO classification for pneumoconiosis.
- Each mining company operating mechanized mines shall set up an Occupational Diseases Board consisting of one occupational health Physician, one radiologist and one general physician.
- Occupational Diseases Board shall formulate guidelines for referral, re-evaluation, and classification of cases of pneumoconiosis and necessary remedial actions at work place as well as rehabilitation of affected persons.

Recent guidelines by Government of India (DGMS)

For X-Ray test of mines employee in IME/PME

1. No. DGMS-OH (Tech) Circular No. 04, Dhanbad dated 21.08.2024.
   Digital X-Ray can be used in IME/PME like conventional method, but it should be in DR system. During medical examination in IME/PME digital X-ray should be compare with Digital ILO Classification Reports and report should be produced in digital format.

Govt. of India [Atomic Energy Regulatory Board (AERB) Guidelines]

2. Mobile X-Ray guideline for occupational survey for a mines/factories site.
   During medical examination you must install the x-ray machine in a mobile van and it must obtained licence for AERB for vehicle mounted X-Ray(Circular of Govt. of India Atomic Energy Regulatory Board) for conducting X-ray at mines site.

Vehicle Mounted X-ray Equipment:

X-ray equipment installed in a mobile van or vehicle, shall be provided with an appropriate shielding enclosure to ensure adequate built-in protection for persons likely to be present in and around the vehicle. Shielding shall be provided around the equipment from all the sides upto height of 2m from external ground surface. Radiation warning symbols hall bed is played on all sides of the vehicle.

Regulatory Requirements for Diagnostic Radiology facilities

General Requirements

The 'Employer' and 'Licensee' of the organization as defined in Atomic Energy (Radiation Protection)Rules,2004,shallfulfilltheresponsibilitiesprescribedintheAERBsafetycodeon radiation safety in manufacture, supply, and use Of Medical diagnostic x-ray equipment [AERB/RF-MED/SC-3 (Rev. 2)].

Procurement of X-ray Equipment

The employer shall procure NOC validated/ Type Approved X-ray equipment from authorized suppliers and after obtaining procurement permission from the Competent Authority.

Operation of X-ray Equipment

No diagnostic X-ray equipment shall be operated for patient diagnose is unless Licence for operation is obtained from the Competent Authority. Pre-requisites for obtaining License for Operation of X-ray Equipment X-ray Room Layout and Shielding Requirement: The room housing X-ray equipment shall have an appropriate area to facilitate easy movement of staff and proper patient positioning. Appropriate structural shielding shall be provided for walls, doors, ceiling and floor of the room housing the X-ray equipment so that radiation exposures received by workers and the members of the public are kept to the minimum and shall not exceed the respective limits for annual effective doses as per directives issued by the Competent Authority. Appropriate overlap of shielding materials shall be provided at the joints or discontinuities. The control console of computed to mography equipment shall be installed in a separate room located outside but adjoining to computed tomography room and provided with appropriate shielding, direct viewing and oral communication facilities between the operator and the patient. The gantry and couch shall be placed such that it enables the operator to have the complete view of the patient from the control room viewing window. Interventional Radiology equipment room shall have an adjoining control room with appropriate facilities for shielding, direct viewing, and oral communication. In case of room housing radiography equipment, chest stand shall be in X-ray room such that no significant stray radiation reaches at control console/ entrance door/ areas of full-time occupancy such that the dose limits to radiation worker and members of public are not exceeded. Mobile X-ray equipment, when used as fixed X-ray equipment, shall comply with all the requirements of those of fixed X-ray installation. Movement of mobile X-ray equipment shall be restricted within the institution for which it is registered. A permanent radiation warning symbol and instructions for pregnant/likely to be pregnant women shall be pasted on the entrance door of the X-ray installation, illustrating that the equipment emits x-radiation.

Vehicle Mounted X-ray Equipment:

X-ray equipment installed in a mobile van or vehicle, shall be provided with an appropriate shielding enclosure to ensure adequate built-in protection for persons likely to be present in and around the vehicle. Shielding shall be provided around the equipment from all the sides up to height of 2m from external ground surface. Radiation warning symbols hall be displayed on all sides of the vehicle.

Staffing Requirements

X-rayinstallationsshallhave a radiologist/relatedmedicalpractitioner/ X-raytechnologist with adequate knowledge of radiation protection, to operate the X-ray equipment. The employees involved in these activities are considered as radiation workers and shall comply with the duties and responsibilities as prescribed in AERB safety code on radiation safety in manufacture, supply and use Of Medical diagnostic x-ray equipment [AERB/RF-MED/SC-3 (Rev. 2)]. The minimum qualification and training shall be as prescribed by the Competent Authority. All installations having X-ray equipment with fluoroscopy facility, computed tomography and all establishments performing special procedures, shall have the services of a qualified radiologist or related medical practitioner, with adequate knowledge of radiation protection for interpretation and reporting.

Radiological Safety Officer (RSO)

X-ray department shall have a RSO approved by the Competent Authority. The RSO may either be the employer himself/herself or an employee to whom the employer shall delegate the responsibility of ensuring compliance with appropriate radiation safety/regulatory requirements applicable to his X-ray installation. The minimum qualification and training shall be as prescribed by the Competent Authority.

Radiation Protection Devices

Appropriate radiation protection devices such as barrier, apron, goggles, and thyroid shields shall be used during operation of X-ray equipment. These devices shall be verified periodically for their shielding adequacy. The requirements for radiation protection devices are as specified in Appendix-II.

Personnel Monitoring Service

Personnel monitoring services shall be provided to all the radiation workers. Quality Assurance (QA) Requirements. The end user shall ensure that periodic QA of the equipment is carried out by AERB authorized agencies. Periodic Quality Assurance shall be carried out at least once in two years and also after any repairs having radiation safety implications.

Servicing

The end user shall ensure that servicing of the X-ray equipment is carried out by agencies authorized by the regulatory body.

Periodic Safety Reports

The utility shall submit periodic safety reports in the format and frequency specified by the regulatory body.

Renewal of License

TheLicenseaccordedbytheCompetentAuthorityshallberenewedbeforeitsexpiry. Decommissioning of X-ray Equipment. Decommissioning of the X-ray equipment shall be carried out by authorized agencies with prior intimation to the Competent Authority.

ARTICLE-20

CRITICAL MINERALS AND ENERGY TRANSITION: OPPORTUNITIES AND CHALLENGES

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Introduction

The global push for decarbonisation has placed critical minerals at the forefront of the energy transition. As countries seek to reduce carbon emissions and shift away from fossil fuels, the demand for renewable energy technologies & electric vehicles (EVs) is growing rapidly. These technologies, however, are heavily reliant on specific minerals, often referred to as "critical minerals." These include lithium, cobalt, nickel, rare earth elements (REEs), and others that are essential for batteries, wind turbines, solar panels, and other clean energy systems. While the shift to a greener economy brings tremendous opportunities, it also presents significant challenges that must be addressed to ensure a sustainable and equitable energy future.

The Role of Critical Minerals in the Energy Transition

Only 0.035% of Earth composition contains critical/Rare Critical minerals are integral to the energy transition due to their use in key technologies:

- **Lithium, Cobalt, and Nickel**: These are critical for lithium-ion batteries, which power EVs and store renewable energy. As EV adoption increases and renewable energy grids expand, demand for these minerals is expected to skyrocket.
- **Rare Earth Elements**: Neodymium, dysprosium, and other REEs are crucial for the manufacture of high-efficiency permanent magnets used in wind turbines and electric motors.
- Copper: Known for its excellent conductivity, copper is a foundational material in electrical systems, including those in solar power installations and electric vehicles.
- **Platinum Group Metals (PGMs)**: These metals are key components in hydrogen fuel cells and electrolysers, which are central to the growing hydrogen economy.

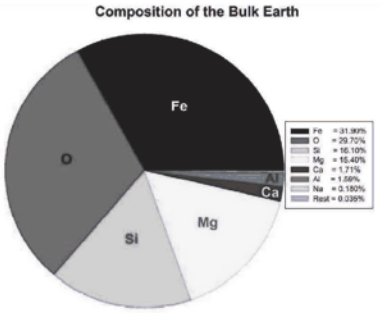

Fig.1

Opportunities in the Critical Minerals Space

1. **Economic Growth and Job Creation**: The rising demand for critical minerals presents vast economic opportunities for resource-rich countries. Developing mining projects and processing facilities can create jobs, stimulate local economies, and provide opportunities for international trade.
2. **Diversification of Supply Chains**: The need for secure and stable access to critical minerals is driving countries to diversify their supply chains. This diversification offers opportunities for emerging markets and under explored regions to develop their critical mineral sectors.
3. **Innovation and Technology**: The increasing demand for critical minerals is driving innovation in extraction, refining, and recycling technologies. Companies that develop more efficient and environmentally sustainable ways to source and recycle these minerals will be well-positioned in the evolving market.
4. **Strategic Partnerships**: Countries and companies are seeking to form strategic partnerships to secure critical minerals. Collaborations between governments, mining companies, and technology firms can facilitate knowledge sharing and investment in responsible mining practices and advanced technologies.

ANTIMONY (Ammunition)	**CADMIUM (Batteries, Radio, Aircraft)**	**BERYLLIUM (Electronics, IT, Nuclear)**
GERMANIUM (Fiber optics, IR optics)	**COBALT (Aircraft, Missile, Spacecraft, Aero engine)**	**TUNGSTEN (Detection & Navigation)**

Fig.2

Challenges Facing Critical Minerals and the Energy Transition

- **Supply Chain Vulnerabilities**: The concentration of critical mineral production in a few countries presents a significant risk to global supply chains. For example, the Democratic Republic of the Congo produces about 70% of the world's cobalt, and China dominates rare earth element processing. Any geopolitical tensions, trade restrictions, or local disruptions in these regions could jeopardize the global supply of these essential minerals.

- **Environmental and Social Impacts**: Mining and processing critical minerals often come with environmental costs, such as habitat destruction, water pollution, and high energy use. Moreover, poor labour practices and human rights violations in mining regions, particularly in cobalt mining, raise ethical concerns. Developing more sustainable mining practices and improving working conditions are essential to balancing the environmental and social trade-offs of the energy transition.
- **Resource Nationalism**: As the strategic importance of critical minerals becomes clear, some countries may prioritize domestic control over resources. This could lead to resource nationalism, where countries restrict exports or impose higher taxes and royalties on minerals, potentially increasing the cost of clean energy technologies and complicating international supply chains.
- **Technological Bottlenecks**: Although the demand for critical minerals is increasing, processing these minerals into usable forms remains a technological challenge. Many countries lack the infrastructure and technology for refining critical minerals, which prolongs reliance on a few processing hubs. Scaling up these technologies will be crucial for meeting future demand.
- **Recycling and Circular Economy**: While recycling could alleviate pressure on primary mineral supply, current recycling rates for critical minerals are low. Battery recycling, for example, is still in its infancy and is costly. Developing efficient recycling processes and promoting a circular economy for critical minerals will be critical in reducing waste and securing a sustainable supply.

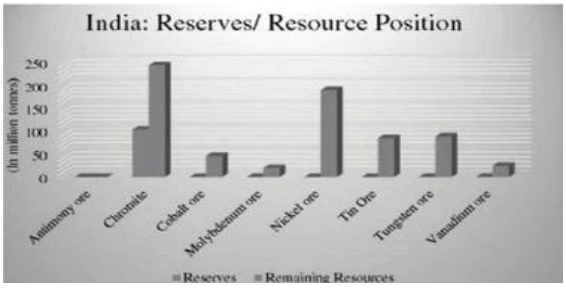

Fig.3

Strategic Pathways Forward

To overcome the challenges and seize the opportunities presented by the energy transition, governments and industries must adopt a multi-faceted approach:

1. Invest in Exploration and Innovation: Increased investment in mineral exploration and technological advancements in extraction and refining are essential for expanding the supply of critical minerals. Governments should support research and development (R&D) initiatives that focus on sustainable mining and processing techniques.
2. Strengthen Recycling and Reuse: Expanding recycling infrastructure and promoting policies that incentivize the reuse of critical minerals can help reduce the environmental impact and enhance supply security. For example, end-of-life EV batteries can be recycled to recover lithium, cobalt, and other valuable materials.
3. Diversify Supply Chains: Encouraging the development of new mining and processing hubs, particularly in regions that are currently underexplored or underdeveloped, can help diversify global supply chains. Building partnerships with resource-rich countries and creating stable and transparent markets will be key.
4. Enhance Regulatory Frameworks: Governments must implement regulatory frameworks that ensure environmentally and socially responsible mining practices. Stringent environmental standards, protections for workers' rights, and transparency in supply chains will build trust and reduce the risk of resource-related conflicts.
5. Global Collaboration: The energy transition is a global challenge, and international cooperation will be critical in addressing supply chain risks, improving sustainability, and ensuring equitable access to critical minerals. Collaborative efforts through multilateral organizations, such as the International Energy Agency (IEA) and the United Nations, can help harmonize standards and encourage responsible mineral sourcing.

Conclusion

Critical minerals are indispensable to the energy transition, offering both immense opportunities and significant challenges. Securing a stable and sustainable supply of these minerals is essential to achieving global decarbonization goals. However, this must be done in a way that balances economic growth with environmental stewardship and social responsibility. By fostering innovation, encouraging responsible practices, and promoting international collaboration, we can unlock the full potential of critical minerals and accelerate the transition to a greener, more sustainable energy future.

ARTICLE-21

THE ROLE OF TECHNOLOGY IN ENHANCING BLASTING ACCURACY IN IRON ORE OPEN-CAST MINING

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Abstract
In open cast iron ore mining, precise blasting is essential to effective extraction and risk reduction. Precision in blasting has been greatly enhanced by technological innovations like as blast design software, electronic detonators, mechanized drilling rigs and drones, and. Real-time monitoring, artificial intelligence, and data analytics all work together to maximize results while improving safety, ore recovery, and environmental effect. This piece examines these developments and identifies emerging themes to show how technology is making blasting a safer, more environmentally friendly, and economical procedure.

Introduction

Blasting is a fundamental operation in open cast mining, which breaks apart rock to release precious ore. Traditional blasting methods, however, frequently present problems like ineffective ore recovery, severe ground vibrations, and heightened environmental impact. Technological developments in the last few years have revolutionized blasting precision, resulting in notable increases in safety and operating efficiency. Modern mining operations are now reliant on technologies that enable for accurate blast patterns and decreased errors, such as mechanized drilling rigs, electronic detonators, drones, and blast design software. An additional layer of blast performance optimization is being achieved through data-driven methods such as big data analytics, artificial intelligence, and real-time monitoring systems.

Purpose of Blasting : In blasting operation, uses controlled explosives to fracture rock formations and make lucrative metal deposits more accessible. Splitting massive rock masses into smaller pieces is the main objective in order to facilitate effective extraction, transportation, and processing. When blasts are carried out correctly, they maximize ore recovery, use less energy for crushing and grinding, and improve mining operations overall productivity. Blasting also aids in revealing concealed seams in the ore, guaranteeing optimal extraction with the least amount of waste.

Blasting essentially lays the groundwork for subsequent mining operations, which have an impact on cost, safety, and productivity.

Challenges in traditional Blasting - Many obstacles that affect productivity, security, and the environment face traditional blasting techniques in open-pit mining. Unwanted rock fragmentation, wasted energy, and higher expenses are the results of Over-Blasting, the use of excessive explosives. Conversely, Under Blasting causes partial rock breakage, necessitating further blasting or mechanical methods, which makes activities take longer. Misfires, flying debris, or fly rock, and vibrations in the ground are sources of Safety Concern that endanger workers and machinery. To make traditional blasting less sustainable, consider the additional Environment Impact of excessive dust, noise pollution, and ground vibrations that can harm neighboring infrastructure and disrupt local ecosystems.

Over Break

Partial rock Breakage

Fly Rock

Dust Generation

Technological Advancement in Blasting

Drilling and blasting, which were formerly considered an art, are now scientifically conducted. For drilling and blasting, these can offer feedback loops. Blast-improvement efforts can benefit from starting with basic concerns like selecting the right delay duration, keeping the intended hole spacing in drill patterns, and choosing the right explosive. Using one or more of the several blast design and analysis software packages currently on the market—some of which include post-blast analysis of fragment size distribution and pre-blast bench face profiling—is another cost-effective method. To enable new technologies and data-collection capabilities, the majority are regularly updated. To improve blasting operations and lessen their negative effects on the environment, it is important to examine some of the technology that the mining sector is using.

Blasting Software -

Because it facilitates accurate blast design and execution, blasting software is essential to contemporary mining. It makes use of sophisticated algorithms to determine the right explosive charge for different geological conditions, optimize hole placement, and simulate blast patterns. Mining engineers can use this technique to limit fly rock and ground vibrations, forecast fragmentation, and avoid over- or under-blasting. In order to dynamically modify designs, blasting software also incorporates real-time data from sensors and drones. An indispensable instrument in open-pit mining operations, blast accuracy maximizes ore recovery, minimizes environmental effect, and boosts operational safety.

SHOT Plus is a powerful software application for designing, analysing, and visualizing blast initiation sequences in surface mining, quarrying, civil, and oil and gas operations. It features a 3D design environment, blast timing and simulation management, single-click diagnostics for potential misfires, and advanced visualization tools for developing firing sequences. SHOT Plus supports streamlined data import/export and allows the creation of loading rules considering layer intercepts within blastholes. With plan and cross-sectional views of blast patterns, it enhances safety, productivity, and environmental performance in blasting operations.

Blast Manager, Blast IQ and there are some more Blasting Software, help in management, design and evolution of blast cycle and other blasting parameter.

Seismographs - For Vibration and Air Disturbance Monitoring seismographs are precise instruments that are used in the mining and construction industries to identify air overpressure and vibrations in the ground caused by controlled explosions. Its major responsibility is to keep an eye on seismic waves to make sure they don't exceed safety thresholds, safeguarding neighboring towns and structures. Typically, the gadget has a geophone to monitor the frequency and intensity of ground vibrations as well as a microphone to detect changes in air pressure. By taking these measurements, one may evaluate the blast's effects, increase operational effectiveness, and guarantee that safety and environmental regulations are being followed. Additionally, the data facilitates regulatory reporting and helps optimize blast designs.

Seismograph

Electronic Detonators - A Smart Explosive Technology , which gives Precise timing of each hole's explosion during blasting will improve fragmentation and lessen the negative effects of the blasting, such as fly rocks and ground vibration. By using an electronic detonator, we may have more precise and adjustable timing, improving safety and fragmentation.

By streamlining the loading and hauling cycle and minimizing the need for secondary breaking and oversized handling, electronic detonators can reduce costs. The usage of lead in cable will be eliminated through the use of remote programming and remote initiation of the explosion design via radio frequency, increasing the safety distance between the blast and the firing point.

WipFrag - software program utilized in rock pile analysis and particle size distribution in mining, quarrying, and blasting activities. WipFrag processes and computes the size of individual rock fragments using digital photographs of blasted material. This provides vital information for optimizing blast designs and enhancing overall operating efficiency. Precise fragmentation analysis lowers energy usage, improves crusher efficiency, and reduces downtime. By providing real-time feedback on blasting outcomes, Wipfrag also helps to ensure better material handling and processing by assisting operators in making educated decisions about future blast adjustments and optimizing production efficiency.

Autonomous Drilling Rigs - Autonomous drilling rigs are advanced mining equipment that can function with little assistance from humans. Modern technologies like artificial intelligence (AI), machine learning, sensors, and GPS are used by these rigs to execute drilling tasks with extreme efficiency and precision. Drilling operations can be completed by autonomous rigs in dangerous or distant locations, increasing worker safety and worker safety and minimizing the requirement for manual labor. can be used to analyze, optimize, and monitor upcoming drilling operations. They provide improved drilling efficiency, quicker drilling times, and reliable performance, which raises output and lowers operating expenses. Additionally, real-time data from autonomous rigs.

Environmental and Safety Benefits

Technological advancement in blasting have considerably improved mining's environmental and
safety outcomes. Precise control, using instruments like as electronic detonators and seismic monitoring, reduces ground vibration, air blast, and pollutants, lowering the environmental impact on neighboring residents and ecosystems. Eco-friendly explosives and better blast design tools further reduce dust, hazardous gasses, and waste rock production. On the safety front, automation, such as remote-controlled and digitalization in equipment's, lowers human exposure to blast dangers, while real- time monitoring and predictive analytics improve blast control and risk management. These advancements also enable compliance with environmental and safety requirements by automating reporting and reducing air, soil and water pollution. Furthermore, enhanced ore recovery and energy-efficient fragmentation increase resource efficiency and reduce energy usage in following mining processes. Overall, technological developments are making mining operation more safer, more sustainable and environmentally responsible.

Cost and Efficiency Gain

Innovations in blasting have greatly improved the cost-effectiveness and efficiency of mining operations. Key enhancements include enhanced rock fragmentation, which decreases the need for further blasting and lowers energy usage in downstream processes such as crushing, milling, and transportation. Tailored blast designs and improved explosives, such as bulk emulsion, provide more precise deployment with less explosive use, lowering material costs. Drilling and blasting automation has cut labor expenses while increasing operational efficiency by speeding up procedures and reducing human exposure to dangers. Enhanced control via electronic detonators and automated systems reduces equipment wear and maintenance costs by reducing overbreak, resulting in fewer mechanical failures and lower fuel usage. Drones and other real-time monitoring technologies, such as sensors, guarantee precise blasting, cutting down on rework and project delays. By lowering ore loss and dilution, precision blasting also enhances ore recovery and increases cost- efficiency. Additionally, improved blast control lowers the possibility of fines, limits waste rock and emissions, and complies with environmental requirements. Because of these advancements, mining operations are now more economical, efficient, and sustainable overall due to savings in energy, fuel, and resources.

Success Story

In Narayanposhi Iron and Manganese Ores Mines, the implementation of technical advancement like, Seismograph and Wipfrag, technologies have resulted in significant improvements in safety, environmental protection, and overall operational efficiency. The successful use of these technologies results a cutting-edge blast design and, has allowed for precise and controlled blasting, monitor ground vibrations in real-time has been instrumental in maintaining safety standards preventing over blasting and ensuring that vibrations remain within permissible limits, this technology helps protect surrounding infrastructure and reduces the risk of structural damage. The positive outcomes of these efforts contribute to safer working conditions for miners. Together, these software applications have fostered a more sustainable mining operation, contributing positively to both the environment and the overall productivity of the Narayanposhi Mines.

Conclusion

The reduction of blasting fumes, fly rock, dust, air overpressure, blasting vibrations, and nitrate levels is a goal shared by the mines with the environment and their neighboring populations. Technological advancements have brought about a significant reduction in costs and improved precision in iron ore open- cast mining blasting operations. More controlled and effective blasts have been made possible by innovations like GPS-guided drilling, 3D modelling, precise sensors, and real-time data analytics, which have decreased over breaks and underbreaks. Lower explosive use, less equipment wear, and a reduced requirement for reblasting are all results of this optimization, which also cuts operating expenses. Furthermore, by reducing downtime and human mistake, automation and remote monitoring enhance productivity and guarantee safety. The combination of cost-effectiveness and blasting accuracy will continue to propel open-cast mining operations' sustainability and profitability as technology develops.

ARTICLE-22

NOISE MAPPING - AN EFFECTIVE METHOD FOR TRACKING NOISE-INDUCED HEALTH RISKS CAUSED BY NOISE IN OPERATING MINES

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Abstract

In order to give a status of noise-free occupational noise exposure, DGMS in India recognized the dangers of noise and vibrations and established noise limitations based on the ILO code of practice. It was further emphasized in the 11thConference on Safety in Mines, which was held during the 4thand 5thof July 2013 in New Delhi, where it was stipulated that noise mapping of various places in the mine premises should be made mandatory based on the various machines being used in concerned mines. DGMS has circulated recommendations from the 10th National Conference on Safety in Mines, held on the 26thand 27thof December 2007 in New Delhi. The safety of workers exposed to high levels of noise in mines was emphasized throughout these conferences along with safety aspects of various mining activities. The primary method for visualizing noise influence and propagation in the form of noise contours in the area under examination is noise mapping. It is possible to locate the locations where noise levels are above the permitted values by using detailed noise mapping. For noise mapping, Lday, Levening, Lnightand Lden(day-evening-night) are the primary noise indicators. Wecan create and put into action preventive control measures in the future by mapping the likely effects of a noisy environment. The mining industry must therefore identify and manage occupational health risks effectively in order to either completely eliminate or significantly reduce them so that they do not pose a serious threat to the health, productivity, and overall quality of life of both miners and the surrounding community.

Noise as Occupational Hazards in Mines

Mining has had a significant role in the development of modern civilization. By supplying the essential raw materials, mining ensures development, safety, and human comfort.Thisneeded activity has hazards affecting occupational health as the most significant. Noise pollution is prevalent in the mining sector. When compared to other industries, the mining community has the greatest and most persistently dangerous amount of noise exposure to which workers are exposed. This is a result of the different noise sources found in mines, such as blasting, ventilation fans, excavators, dumpers, dozers, and loaders. For the health and safety of mine workers, the noise generated by various extraction operations and the use of Heavy Earth Moving Machinery (HEMM) is a critical concern.Practically every mining activity involves some level of noise, which is typically categorized as occupational noise when considering how it affects people. These sectors frequently expose their employees to excessive noise doses, putting them at risk for both adverse auditory and non-auditory effects.According to surveys made by several governmental authorities, the majority of mining activities expose workers to noise levels above the recommended limit of 90 dB(A). The noise levels in a number of the processes are as high as 115 dB(A), with peak levels frequently exceeding 140 dB(A).According to a recent study on occupational noise exposure at opencast iron ore mines in India by Deshmukh et al. (2018), workers in the crushing plant and the surrounding area were subjected to 81.64 dB(A), and operators of HEMM equipment were exposed to 86.10 dB(A). Similar to this, workers were exposed to 83.76 dB(A) in the loading plant, 87.62 dB(A) in the screening plant, and 84.92 dB(A) in other mine activities and workshops (Deshmukh et al. 2018).A significant number of mining workers may be afflicted by NIHL, according to several research carried out by DGMS. Depending on how exposed miners are, this percentage could range from 25 to 75%. NIHL was listed as a notified ailment under the Mines Act of 1952 by the Central Government in a notification that was released in February 2011.Based on DGMS surveys completed in various mines, it was found that individuals using pneumatic jackhammer drills, rock breakers, shovels, mechanical loaders, and those in nearby regions are exposed to sound levels above those recommended by DGMS (Table 1).

Table 1
Noise levels measured in Indian Mines (DGMS Circular, 2013)

Sl No	In an opencast mine	Noise levels
1	Near drill	111 dB(A)
2	In dumper cabin while moving	103 dB(A)
3	Diesel shovel (in cabin)	89 dB(A)

Legal Frameworks for Ambient and Noise Exposure

DGMS came to the realization that noise limits needed to be set in order to accomplish the following goals based on research done in many parts of the world regarding the detrimental effects of noise exposure: 1. Eliminate mental/fatigue tiredness; 2. Reduce the likelihood of hearing issues; and 3. Reduce communication interference.The following standards and guidelines [DGMS Circular No.18 (Tech), 1975] have been tentatively proposed based on the aforementioned objectives and the International Labour Organization ILO Code of Practice (Directorate General of Mine Safety 2013): 1. An eight-hour exposure warning limit of 85 dB(A); 2. The danger threshold for an eight-hour exposure is 90 dB(A); 3. This daily dose, however, may be allowed to exceed during emergencies and unanticipated technical reasons only if the maximum weekly dose does not exceed the value stated above; 4. Without appropriate ear protection, workers should not be subjected to noise levels of 115 dB(A) or higher; 5. Employees must not be exposed to noise levels above 140 dB(A); 6. A key noise measuring criterion should be speech comprehension at a distance of 50cm or less; and 7. When designing equipment and machinery, noise and vibration control requirements should be taken into consideration.If noise and vibration levels cannot be reduced below the danger limit by adequate design or installation, precautionary measures may be adopted as follows: 1. Availability of appropriate, partially or fully soundproof booths; 2. Availability of an appropriate vibration-reducing device and hearing protection; 3. Providing a working platform with anti-vibration; or4. Shortening the exposure time.Ambient noise pollution did not, in fact, receive the proper level of attention in India. The Air (Prevention and Control of Pollution) Act, 1981 (the "Air (Prevention and Control of Pollution) Act 1981") classified noise as an air contaminant. This was emphasized even further in the 1986 Environment Protection Act. The Environment (Protection) Rules, 1986 were created by the Central Government based on this Act, and with the notice No. G.S.R. 1063(E), dated 26th December 1989, the ambient air quality criteria for noise were established in Schedule III (Rule 3), as shown in Table 2. The Ministry of Environment, Forest, and Climate Change (MoEFCC) issued the aforementioned criteria via notification on June 28, 1999, in accordance with the Environmental Protection Act (EPA), 1986.

Note:

a. Daytime is reckoned in between 6 am and 9 pm.
b. Nighttime is reckoned in between 9 pm and 6 am.
c. Silence zone is defined as an area up to 100 m around such premises as hospitals, educational institutions and courts. The silence zones are to be declared by competent authority. Use of vehicular horns, loud speakers and bursting of crackers shall be banned in these zones.

Table 2 - Ambient air quality standards in respect of noise

Area code	Category of area	Limits (Leq) in dB(A)	
		Day time	Night time
A	Industrial area	75	70
B	Commercial area	65	55
C	Residential area	55	45
D	Silence zone	50	40

d. Mixed categories of areas should be declared as one of the four above mentioned categories by the competent authority and the corresponding standards shall apply.

Traditional Noise Monitoring Techniques

Mine noise levels are measured using a variety of approaches. Mining companies conduct area and personal noise monitoring to measure the amount of noise produced by large earthmoving equipment or the noise dosages that mine workers are exposed to.

A. Ambient Noise (Community Noise) Monitoring:

Objectives-1. To ascertain the current noise status and to contrast it with the current noise standards or norms established by statutory organizations; and 2. To determine the potential causes or reasons why the noise level is higher than the established noise standards.

Monitoring technique: 1. Determining sensitive, strategic, and residential locations inside mining complexes; 2. Monitoring of noise levels in all four major directions at each location. According to CPCB standards (The Noise Pollution (Regulation and Control) Rules 2000), the monitoring should make it easier to assess daytime and nighttime noise levels. Therefore, it is advised to take at least six sets of readings over the course of a 24-hour period - the Maximum Peak Level (MaxP), Maximum RMS Level (MaxL), Minimum RMS Level (MinL), and Level of Energy Equivalent (Leq), with a four-hour break between each set of data; 3. Calculating the average Leq values [Leq(d) and Leq(n))] for daylight and midnight at each site; 4. Calculating the value of Ldn using the average of Leq(d)and Leq(n); 5. Monitoring of meteorological factors, such as wind speed, wind direction, humidity, and temperature levels, as these factors affect the density of sound waves at the monitoring locations as well as the propagation of sound; 6. Toidentify the main noise sources and their positions, including their general direction and distance from the monitoring location; and 7. Analysis of the community noise's 1/1 octave frequency spectrum to determine its ability to annoy or irritate.

B. Work Zone Noise Monitoring:

Objectives-1. To ascertain whether the current level of equipment/machinery noise exceeds the current warning level [85 dB(A)] established by DGMS; 2. Characterization of existing machinery and equipment noise to assess noisy parts of machinery and equipment; and 3. Analysis of the frequency spectrum to find alarming and dominant frequencies so that suitable management actions can be taken.

Monitoring technique:1. The selection of different noise machinery and equipment for the mine, industrial complex, workshop, material handling plant, etc; 2. Choosing the ideal location for a noise monitoring device (the operator's position, within 1 to 3m of the noisy equipment);3. Calculating the Leq level for each piece of equipment or machine; 4. Analysis of the frequency spectra of the apparatus where the Leq level reaches 85 dB(A). The first step is to perform a 1/1 octave band analysis to locate frightening sound frequencies with relatively high sound levels. Following this, a 1/3 octave band analysis is performed within these worrying frequency ranges to determine dominant frequencies. This makes it easier to choose the right preventative actions; 5. A noise dosimeter apparatus is used to analyze the noise dose of machinery operators exposed to excessive noise levels. Dosimeters are helpful when workers move between different regions of a plant or mine throughout a shift or in places with variable noise levels; and 6. The percentage of an acceptable or criterion noise dose is used to express the noise dose. It is based on the employee's exposure time as well as the levels of noise at different frequencies. To comprehend the potential implications of noise exposure in a particular context, the exposure index expressed as a percentage noise dosage should be connected with research on hearing loss or hearing threshold change.Audiometry can be used to estimate hearing loss carried on by noise exposure.Audiometry - An audiometer is a device used to assess a person's hearing threshold in relation to frequency (pure tone). These evaluations are conducted to find any potential hearing loss or problems. When evaluating hearing capacity, an audiometric exam using an audiometer is used to measure air conduction. Pure tones at specified frequencies and intensities are used in the test, which is conducted in an acoustical space. With a minimum level of 15 dB linear and sound frequencies spanning from 0.5 to 8 kHz, the test is carried out using headphones.

Noise Mapping: Its Purpose and Method

Existing noise monitoring methods are designed to assess a subject's exposure to either ambient noise or personal noise, both of which can be easily altered. Without carefully monitoring a large number of samples, this can significantly alter the results. Several noise sources are active at once in mines. Moving or static noise sources are both possible. We cannot declare with certainty that all of these noise sources are correctly differentiated or how much noise is being created by each noise source in a certain location using the approaches that are currently available. It is impractical to precisely describe all significant environmental characteristics that could affect local sound speed along all potential sound propagation paths between source and receiver due to the complexity of atmospheric circumstances. As a result, it is necessary to use a sound propagation model that takes into account each of these variables when estimating noise propagation. Therefore, modelling of sound propagation backed by pertinent information about noise sources, meteorological data, and other influencing aspects can offer an efficient solution in the dynamic scenario.

As a result, according to Probst et al. (2010), noise mapping serves as a valuable link between the technical factors and the resulting noise exposure of those affected. By taking into account acoustic phenomena such multi-reflections, diffractions, and absorption that develop due to the complex topography configurations, noise mapping illustrates not only the current noise level but also increased noise levels owing to projected expansion or continual change in mine workings.Comparing noise mapping to conventional techniques is a paradigm shift. Noise mapping provides the necessary visualization and assessment of noise pollution in a specific area, allowing for the identification of the place or locations where noise levels are in excess of the permitted values. Lday, Levening, Lnight, and Lden (day-evening-night) are the noise indicators for noise mapping. According to END (Environmental Noise Directive 2002/49/EC), "noise mapping" is a crucial method for presenting information about a current or potential noise situation in terms of a noise indicator. The number of individuals impacted, the number of affected residences, or any relevant violations of the law are also indicated through noise mapping (EU 2002; Murphy and King 2010).

The mining industry has a larger demand for noise mapping because of current DGMS directives. It is absolutely necessary to standardize the technology in order to comply with the directive because doing so would make it easier for India to develop its noise environmental control strategy.

DGMS Guidelines for Noise Mapping in India

In Section 4.1 of the recommendations from the 10thand 11thNational Conferences on Safety in Mines, which were held in New Delhi on December 26-27, 2007, and July 4-5, 2013, it was stated that (DGMS 2008): Noise Mapping should be made mandatory of various places in the mine premises based on the various machines being used in concerned mines, as well as personal noise dosimetry of individual workmen exposed to the noise level above 85 dB(A).

Specified Process for Conducting Mine Noise Mapping

Documenting noise sources, their type, and their position is the first step in the noise mapping process. Moving and stationary sources make up the majority of machine and installation classifications. The sources must then be classified as point, line, or area sources. To take safety precautions when assessing the SPL surrounding any source, obstacles, or hindrances for measuring noise, if any, must be properly documented. The geographic locations of the sources should be noted so that they can later be included to the mapping software. The in.dwg format of surface designs is very beneficial for simple implementation. For noise mapping, satellite photos of the research region can be downloaded from Google Earth or Bhuvan (an Indian service) in the event that such drawings are not updated or are discovered to be inaccurate in some way.

Step-by-step procedure for Noise Mapping:

1. Sound sources in and around the mine are identified and a noise inventory is built.
2. Plants such as crushers are identified as area sources, dumpers moving on haul roads were taken as moving sources. Shovels and drilling machines are identified as point sources. Belt conveyors are treated as a line source in the noise model.
3. Noise measurements are carried out according to ISO 8297:1994 (Acoustics Determination of sound power levels of multisource industrial plants for evaluation of sound pressure levels in the environment- Engineering method), ISO 9613-2:1996 (Acoustics-description, measurement and assessment of environmental noise) and ISO 6395:2008 (Earth Moving Machinery-Determination of sound power level-Dynamic test conditions) and other related standards (ISO 9613-1:1993 1993; ISO 9613-2:1996 1996; ISO 6395:2008 2008; ISO 8297:1994 1994).
4. Noise measurements are to be taken with the help of a Sound Level Meter (SLM) using A-weighting scale and at the same location's coordinates are to be taken with a GPS device.
5. Meteorological parameters like wind direction, temperature and humidity are to be collected from the mine office. The surface plan of the mine leasehold areas is taken from the mines in DWG file format.
6. The surface plan (DWG file format) is imported to ARCMAP10.2 software. Coordinates of noise sources taken with the help of GPS are imported on the surface plan. Shape files of noise sources (crusher plant, dumper, haul roads, shovels and drills) are digitized and stored as shape files (Environmental System Research Institute (ESRI)).
7. Noise prediction software uses sound power levels of the noise sources for the calculation of noise levels at the receiver points. The sound power levels are calculated in the Acoustic Determinator taking the sound pressure level of noise sources as input data.
8. Then all these data are imported in Predictor LimA and used as attributes to corresponding noise sources.
9. The surface plan of the mine is imported in Noise Predictor software as a background image before implementing the evaluation procedure for ascertaining noise propagation.
10. All the shape files created in ArcMap10.2 are now imported as noise sources in the project within Predictor LimA.
11. Individual attributes contain a description of the source, type of source, coordinates, emission level (power level data) and working hours.
12. Computed sound power level data are then added as attributes to the respective individual sources.
13. Considering all these parameters, the propagation of noise levels at usually 10m × 10m grid intersections are calculated using the Harmonoise calculation method and noise maps are produced.
14. Noise maps are generated with different indicators like Lday, Lnight and Lden.
15. Different colours may be assigned to indicate different noise levels in dB(A) in a noise map.
16. The above description is based on the use of ArcGIS 9.0 (ESRI) and Predictor LimA (B&K) software.

Conclusions

Noise mapping is predicted to be very helpful in the setting of Indian mining industries because a vast community is typically affected by the noise caused by mining operations, given a situation where noise management is confined to noise measurements and dosimetry. Acoustic laws can be used to simulate noise propagation once the source, its properties, and its surroundings have all been identified. It will eventually become a potent instrument for managing and controlling noise propagation in mining zones. Using the most up-to-date tools and technologies and the quick processing power of contemporary computers and software created with an integrated development environment, we need to regulate noise for mining community.

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ARTICLE-23

MINES SAFETY, HEALTH & WELFARE
A COMPREHENSIVE APPROACH TO SUSTAINABLE MINING

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Introduction

Mining, as one of the most vital industries in the world, plays a crucial role in the extraction of essential resources that fuel economic growth. However, the industry is also fraught with risks, given the hazardous working conditions and the potential dangers associated with mining activities. Ensuring safety, health, and welfare in mines is not only a legal and ethical responsibility but also a key component of sustainable mining practices. The protection of workers from harm, provision of health benefits, and maintenance of welfare standards contribute to both the well-being of employees and the overall success of the mining industry.

Importance of Mines Safety

Mines, by nature, present significant hazards such as cave-ins, explosions, equipment accidents, and exposure to harmful dust and gases, and other occupational hazards. These risks necessitate robust safety measures to prevent injuries and fatalities. Mines safety is essential for:

1. **Protection of Life**: The primary goal of mines safety is to protect workers' lives. Safety regulations and practices ensure that mining operations minimize the risks of accidents and health hazards.
2. **Compliance with Legal Standards**: Every country has stringent laws and regulations regarding mine safety. Complying with these laws is not just about avoiding penalties but about upholding human rights and ethical standards.
3. **Business Continuity**: Accidents and unsafe working conditions can lead to mine closures, operational delays, and financial losses. Ensuring safety is an investment in the stability and continuity of the mining business.
4. **Improved Productivity**: A safe work environment leads to greater efficiency. Workers who feel safe are more focused and productive, knowing that their well being is a priority.

Key Elements of Mines Safety:

To ensure safety in mines, a comprehensive safety program typically includes:

- **Safety Training**: Continuous training for workers to handle equipment safely, recognize hazards, and respond to emergencies is crucial. Specialized training for rescue operations, fire drills, and evacuation procedures is mandatory.
- **Risk Assessment and Mitigation**: Regular inspections, safety audits, and risk assessments help identify potential hazards. Early detection of risks allows for preventive measures, such as installing support systems in unstable areas or improving ventilation in gas-prone zones.
- **Safety Equipment and Gear**: Proper use of personal protective equipment (PPE) such as helmets, respirators, gloves, and steel-toed boots is critical to safeguarding workers from potential dangers.
- **Monitoring and Technological Advances:** The use of modern technologies such as automated equipment, drones, and real-time monitoring systems allows for early detection of hazards, reducing human exposure to dangerous environments.

Health in Mining

Mining can have adverse effects on workers' health due to exposure to dust, chemicals, noise, and other harmful elements. Addressing health concerns in mining is equally important as ensuring physical safety. Key health challenges include:

- **Respiratory Diseases:** Exposure to silica dust and coal dust can cause lung diseases such as silicosis and black lung disease. Proper ventilation, dust control, and use of respirators help mitigate these risks.
- **Hearing Loss:** Continuous exposure to loud machinery and explosions in mines can lead to hearing loss. Implementing noise control measures and providing hearing protection equipment is essential.
- **Ergonomic Hazards:** The physical demands of mining, such as lifting heavy loads and operating machinery, can cause musculoskeletal injuries. Ergonomic solutions, equipment modifications, and rest breaks are essential to reducing these injuries.
- **Mental Health:** The isolated and often stressful nature of mining work can lead to mental health issues, including anxiety, depression, and fatigue. Mining companies need to promote mental health awareness and provide access to counseling and support.

Welfare in Mining:

Welfare programs in the mining sector are designed to improve the overall quality of life for miners. This goes beyond physical health and safety to include mental well-being, social security, and other forms of support. Welfare initiatives in mines typically involve:

- **Housing and Living Conditions:** Providing miners with safe, clean, and comfortable housing facilities is vital, especially in remote mining locations. Access to potable water, sanitation, and healthy food is equally important.
- **Medical Facilities:** On-site medical facilities ensure immediate attention in case of injuries or illnesses. Regular health checkups and preventive care help maintain the long-term health of workers.
- **Social Security:** Providing insurance, pension plans, and compensation for workrelated injuries and illnesses is crucial for ensuring financial stability for miners and their families.
- **Work-Life Balance:** Offering reasonable working hours, vacation time, and recreational facilities helps in maintaining a balanced life for workers who spend long hours in remote and challenging environments.
- **Educational and Skill Development Programs:** Mining companies that offer training and educational programs not only improve their workforce's skills but also contribute to long-term career development and job satisfaction.

The Role of Regulatory Bodies and Organizations:

Various international and national organizations set the standards for safety, health, and welfare in mines. In many countries, **Ministry of Mines** or similar regulatory bodies oversee mine safety by enforcing laws and regulations. Organizations like the **International Labor Organization (ILO)** and the **World Health Organization (WHO)** also play a significant role in establishing global safety norms for the mining industry.

Moreover, mining companies themselves are increasingly recognizing the importance of corporate social responsibility (CSR) and the need for sustainable mining practices. By integrating safety, health, and welfare into their core business strategies, these companies not only protect their workforce but also enhance their reputation and operational resilience.

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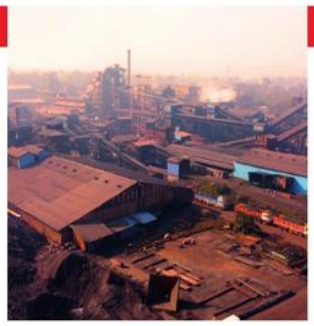
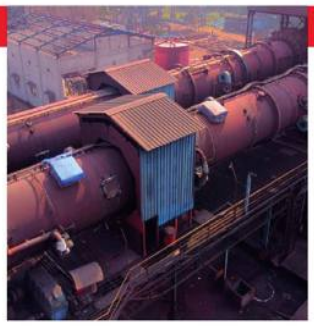
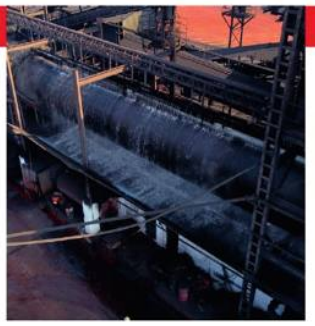


FROM THE DEPTHS OF THE EARTH
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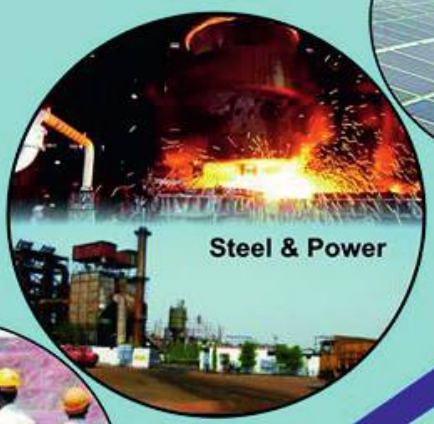

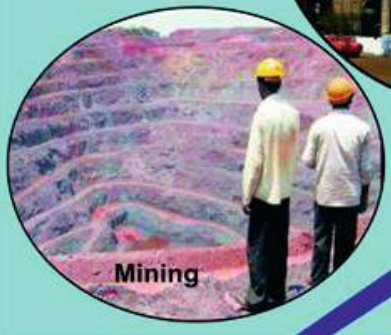

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ARTICLE-24

MITIGATION MEASURES FOR DUST DURING BLASTING

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Introduction

Blasting is commonly used in mining, construction, and quarrying to break up rock and other materials. However, it generates significant amounts of dust, which can have environmental, health, and safety implications. Dust generated during blasting contains particulate matter that can be harmful when inhaled, and it may spread over large areas, affecting air quality and vegetation. Thus, implementing effective dust mitigation measures is critical. Below are common strategies for controlling dust emissions during blasting operations.

1. Water Sprays and Misting Systems:

One of the most widely used methods for controlling dust is the application of water sprays or misting systems. These systems can be deployed before, during, and after blasting to dampen the material and prevent dust from becoming airborne.

- **Pre-blast water spraying:** Applying water to the area before blasting helps suppress dust generation by adding moisture to the material being blasted.
- **Post-blast misting:** Immediately after blasting, misting systems can be activated to reduce the spread of dust by binding with the airborne particles and causing them to settle.

Misting systems can be placed around the blast zone, ensuring coverage of the area. The key to success with water systems is ensuring that enough water is applied without over saturating the material, which can lead to other operational issues.

2. Blasting Mat Covers:

Blasting mats, usually made of rubber or wire mesh, are placed over the area being blasted to contain dust, flying debris, and noise. These mats serve as physical barriers that prevent dust from becoming airborne. When the explosion occurs, the mats absorb some of the energy, reducing the velocity at which dust and debris are thrown into the air.

Blasting mats are particularly effective in urban or environmentally sensitive areas, where dust and debris control is essential for protecting nearby residents and ecosystems.

3. Use of Dust Suppressants:

Chemical dust suppressants can be applied to the surface before blasting to form a crust that holds dust particles in place. These suppressants include polymers, salts, or surfactants that bind to the dust particles, preventing them from becoming airborne during and after the blast. While these products can be more expensive than water, they are often more effective in areas where water resources are limited, or where environmental regulations restrict water use.

4. Controlled Blasting Techniques:

The method and timing of the blast can significantly influence dust generation. Controlled blasting techniques, such as:

- **Sequential blasting:** Involves detonating small sections of the blast zone in stages rather than all at once. This reduces the amount of dust generated at any given moment.
- **Timing adjustments:** Altering the timing of the blast (for instance, during less windy periods) can also minimize the spread of dust to surrounding areas.

Using controlled techniques also reduces the vibration and noise associated with blasting, making it a preferred option in populated areas.

5. Windbreaks and Barriers:

Erecting physical barriers around the blasting site can help to contain dust. These barriers can be in the form of berms, windbreak walls, or vegetation. Such structures prevent dust from traveling far by reducing the wind velocity near the ground.

Barriers are particularly effective when blasting occurs in areas with strong winds, which can carry dust particles over long distances. Windbreaks may also be combined with water sprays or chemical suppressants for enhanced effectiveness.

6. Air Monitoring and Real-Time Dust Detection:

Monitoring dust levels is essential for ensuring that mitigation measures are working. Real-time dust monitors can be installed around the site to measure the concentration of airborne dust before, during, and after blasting. These systems can provide alerts when dust levels exceed permissible thresholds, prompting immediate action.

Incorporating weather monitoring (e.g., wind speed and direction) into air monitoring systems can help to optimize the timing of blasts to minimize dust spread.

7. Proper Blast Design:

The design of the blast itself plays a crucial role in controlling dust. Proper blast design involves:

- **Optimizing the amount of explosive used:** Overcharging (using too much explosive) can cause excessive fragmentation and dust.
- **Burden and spacing:** Adequate spacing and burden (distance between the blast and the rock face) ensure efficient energy transfer, reducing dust generation.
- **Blast hole stemming:** Using appropriate materials, such as gravel or sand, to stem blast holes can reduce the amount of dust escaping from them during detonation.

Careful planning and design by experienced professionals are essential to minimizing the dust produced by a blast.

8. Personal Protective Equipment (PPE):

For workers on-site, the use of personal protective equipment, such as dust masks or respirators, is essential to safeguard health. While PPE does not mitigate dust emissions directly, it reduces the impact of inhalation exposure for individuals working in close proximity to the blast.

Conclusion:

Dust control during blasting operations is vital for reducing the environmental and health impacts associated with particulate matter emissions. A combination of techniques such as water sprays, chemical suppressants, controlled blasting, and barriers, coupled with proper blast design and air monitoring, can help manage and mitigate dust. Effective implementation of these measures ensures compliance with regulations, reduces environmental impacts, and enhances worker safety.

ARTICLE-25

IMPORTANCE OF QUALITY AWARDS FOR SERVICE COMPANIES

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Introduction

To implement quality management, quality models have proven themselves in recent decades that were developed within the framework of so-called quality awards. Originally, these models were used primarily to assess the quality management of service companies and to award quality prizes. Fig. 10.1 Classification of selected national and international quality awards (Figure 1). Meanwhile, they also serve service companies as a reference framework for implementing and improving their own quality management. This paper presented and critically assessed with the EFQM Model. By quality awards incentives are set to promote the holistic view of quality management systems and thus to drive their implementation within the company. Quality awards are to be understood as prize awards by special institutions which are awarded for the proof of the promotion of quality, the understanding of quality in the whole company as well as its successful internal and external implementation. The focus on improving competitiveness is achieved by awarding companies for outstanding quality management and outstanding performance. The quality awards reflect two significant influencing factors for competitiveness: the provision of constantly improved services for customers and the comprehensive improvement of the overall performance of the company. Another important goal of quality awards has didactic reasons: The awards promote the knowledge transfer with regard to competitiveness and expand the knowledge base, so that a broad knowledge base is created. The awareness of and understanding of the importance of quality improvements in the company can be promoted and an exchange of information on successful quality strategies can be initiated. The large numbers of quality awards have, first and foremost, the comprehensive evaluation criteria in terms of quality management in common, which take into account the following areas in particular:

1. Customer satisfaction
2. Business results
3. Employees
4. Processes
5. Leadership
6. Resources (finance, information and technology)
7. Politics and strategy
8. Influence on society

The steps to obtaining a quality award include the application by the service company, the formal and practical examination of the management system, and the central award by a significant institution. In this context, the "Malcom-Baldrige Award", the "EFQM Award" and the "Deming Prize" are the three best known quality awards worldwide. Furthermore, the currently best known quality awards are mentioned in the classification given in Fig. 1. The presentation is limited to national prizes as the smallest geographical reference level. Another group is other quality awards that - like the Topit Quality Award - award excellent quality oriented initiatives and projects. However, the classification made in Fig. 1 does not make a distinction between the institutions involved in the award, but the respective prize categories, so that a classification based on the criteria "performance independent" and "service specific" quality awards is appropriate.

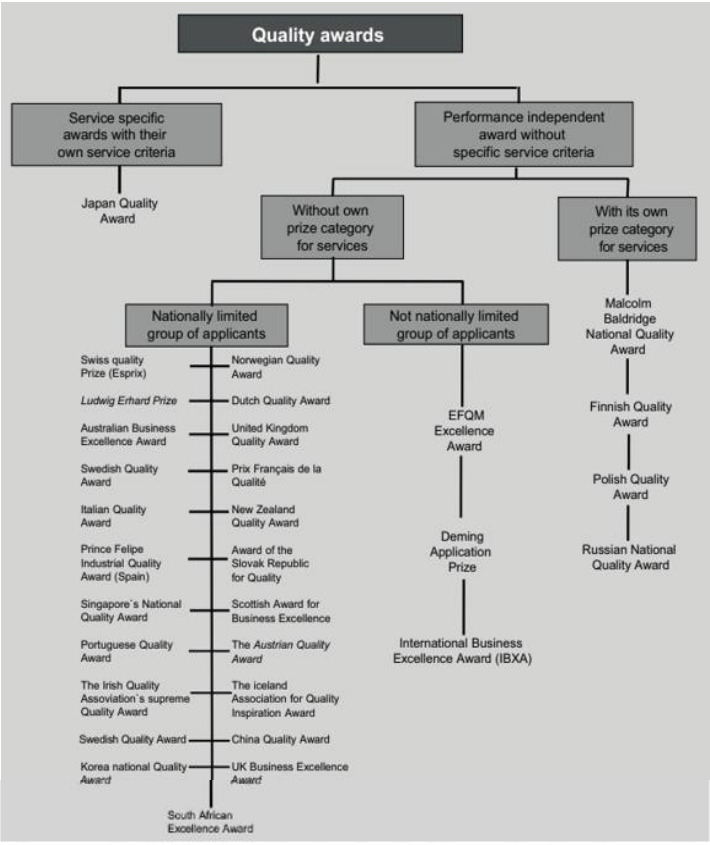

Figure 1. Classification of selected national and international quality awards.

In this context, the EFQM Excellence Model, on the basis of which the EFQM Excellence Award is awarded, is a management model developed for European companies for the holistic implementation of quality management. In November 2019, the model was fundamentally redesigned, so that there are currently two models, which are to be subsumed under the terms EFQM Excellence Model 2013 (classic model) and EFQM Model 2020 (newly designed model).

1. EFQM Excellence Model 2013 - The original basic idea of the EFQM Excellence Model was to improve the quality of entrepreneurial performance. It can therefore be used for the implementation of a quality management system. It continuously integrates checked "best practice" of leading companies, thus allowing companies to carry out a benchmarking beyond their own industry. In addition to that, it has developed into a comprehensive leadership model that is successfully used by many companies and non-profit organizations. At the center of the EFQM Excellence Model are various components that enable service companies to compare themselves with other, sustainable companies, to assess themselves and to derive action implications for quality management independently. These are the following components of the EFQM Excellence Model: (a) The "basic concepts of excellence" as basic principles for sustainable excellence in the company; (b) The "criteria model" as the basic structure of the EFQM model; and (c) The "RADAR logic" as a dynamic evaluation framework for sustainable excellence. The evaluation of applicants for the EFQM Excellence Award is carried out within the framework of the EFQM Model with the RADAR logic. Here, each point is given attention individually. Thus, in an excellent organization, the results show positive trends and/or good performance over a longer period of time. The results from the criteria model are therefore evaluated, amongst other things, with regard to their long term relevance. Excellent organizations should also have sound procedures that integrate well-founded and well-defined processes. These procedures are also to be implemented systematically and as planned. Finally, as part of the evaluation, it is checked which measures the company implements to continuously review and improve its processes and results.

Experience report on the EFQM excellence approach in practice

The EFQM (European Foundation for Quality Management) as a European organization works closely with its partner organizations in the individual countries. They have the task of spreading the benefits of the EFQM approach to companies and organizations on the basis of the leadership and thinking model in the respective country.

a) Leadership-culture, management system and interest groups:
The leadership tools such as vision, mission and corporate identity are to be created and exemplified by all groups in the company. Here, a "values compass" or jointly developed leadership principles can be useful. The management is to define key figures that reflect the core business and are measured continuously. Cross-industry aids are a key figure cockpit, a balanced scorecard or an internal control system. Stakeholder orientation or stakeholder management can be profitably implemented with a partnership concept. The challenge in many service industries is to incorporate political, legal and operational aspects into the strategic process.

b) Employees -qualification, participation and recognition:
Increasingly, the labour market also needs to be taken into account in the area of personnel policy. The shortage of skilled workers and changing job profiles are in the focus here. "Internally", every entrepreneur needs to know the required competencies, use them for the success of the company, check them and continuously develop them. A central importance is attached to the participatory leadership style, which promotes the leadership philosophy at every level. Supporting tools and methods in practice are KAIZEN, LEAN - but also transparent and systematic information in the form of communication principles.

c) Partnerships and resources-successful networking, financial, supplier and knowledge management:
This criterion includes, in addition to sustainability in the form of economic, ecological and social principles (often referred to as a concept for corporate social responsibility), a regulation of the cooperation with suppliers and other market participants.

d) Processes, products and services-development, design, steering and improvement of processes:
This area is about creating optimum values for customers with marketable products and services, maintaining customer relationships, but also managing marketing concepts and surveys (including complaint management) in order to ensure the ongoing success of the company. A systematic CRM (customer relationship management) can be helpful here.

2. The EFQM Model 2020 - The EFQM Model 2020 was published in November 2019 and has been in the introductory phase since then. The following section presents the central components of the new model. Here too, the following components can be distinguished: (a) Principles of the model; (b) Segments of the model; (c) Criteria and sub-criteria of the

model, and (d) EFQM diagnosis tool RADAR. The EFQM Excellence model 2013 has made a distinction between the enablers (internal success factors) and the results (external success factors), each with a relative importance to the success contribution set at 50:50. The EFQM Model 2020 takes a fundamentally different approach here. Based on numerous expert interviews, workshops, research results, etc., the structure of the model has a logic that is aligned with the three questions of the golden circle: (a) WHY does the organization exist, what purpose and what strategy does it pursue? – This is the alignment in the model; (b) HOW is the purpose and strategy implemented by the organization? – This is the realization in the model, and (c) WHAT does the organization want to achieve with the strategy? – These are the results in the model. Figure 2 show the structure and logic of the EFQM Model 2020. If we compare the graphical representation between the 2013 model and the 2020 model, then the 2013 model had a comparatively "deterministic" character in that the relationships always go in one direction. The new EFQM model 2020 shows a stronger networking between the individual factors. The network idea is therefore given more consideration.

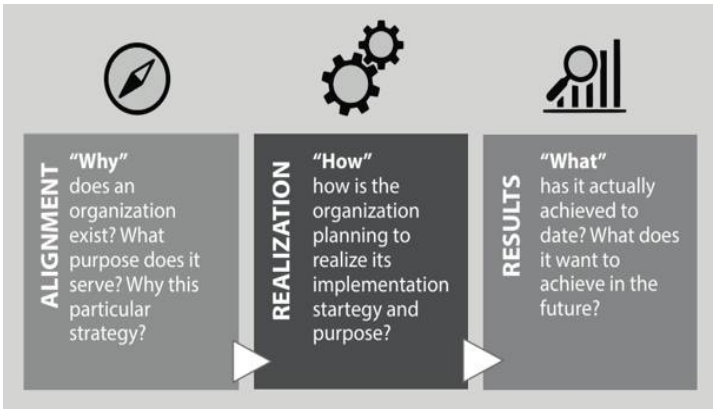

Figure 2. Structure and logic of the EFQM Model 2020

The EFQM Model 2020 has taken significant steps forward compared to the previous model and has not only based financial and other quantifiable figures, but also defined progress as performance related results in the areas of transformation, future orientation, etc. The ability to further develop the company plays a special role here and is of outstanding importance in view of the rapid changes in the framework conditions. The list of indicators mentioned here is not exhaustive; in individual cases, other indicators tailored to the situation of a service company can be used. The presentation of the EFQM Model 2020 (Figure 3) shows the segments as circles, with the criteria connected to each other by lines and arrows. This shows their mutual influence. This way, the dynamics of the relationships between the segments and criteria in an organization within a constantly changing environment can be reproduced. This is often referred to as an ecosystem. This represents a change from the model of 2013, which gave a more static impression optically. In the EFQM Model 2020, the emphasis on the ecosystem approach is of particular importance, which in the previous model was only marginally effective in the criterion of partnerships and resources. The changes in business models in the service sector caused by digitalization and globalization show the possibilities of cooperation despite existing competition relationships. This aspect in the tension between service cooperation and service coo petition is becoming increasingly important for service offerings and ensuring service quality. The EFQM Model 2020 emphasizes the importance of an active role in these ecosystems in order to learn and grow together with others. Figure 4 illustrates this relationship.

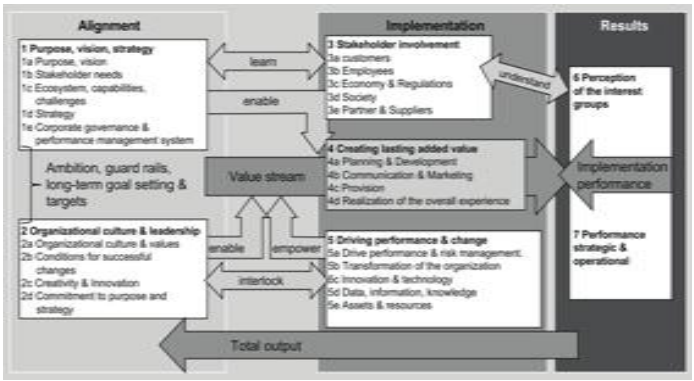

Figure 3. Relationships between the criteria of the EFQM Model 2020

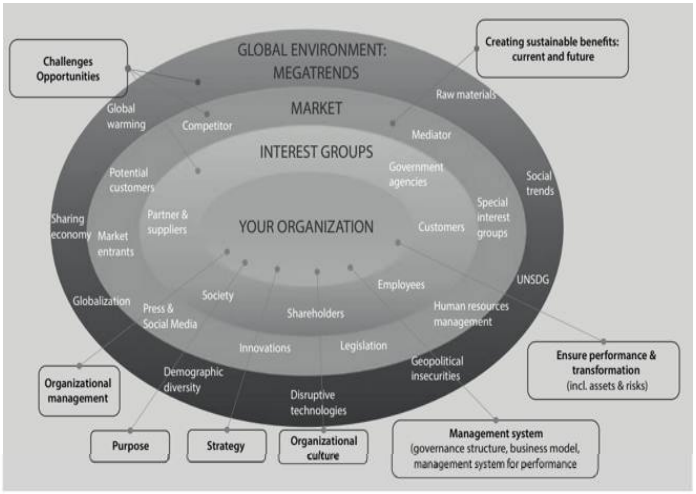

Figure 4. The emphasis on the eco-system in the EFQM Model 2020

In the EFQM Model 2020 they are used to evaluate the criteria in the segments orientation and implementation. In the old as well as in the new model, the criteria of the result measures are evaluated using the elements relevance and benefit as well as performance. Finally, the consolidated RADAR evaluation matrix to give an overall result between 0 and 1000 points. For the distribution of points over the seven criteria of the model, the EFQM has proposed a numerical evaluation system. This gives up the previous system between enabler (500 points) and results (500 points) and makes a new distribution over the three segments: (a) Alignment: 200 points; (b) Realization: 400 points; and (c) Results: 400 points.In order to receive external recognition of the achievements (e.g. in connection with the application for a quality award), an evaluation by an official assessor team is required. But even through a self-evaluation using the presented evaluation tables, organizations can gain valuable insights into the current development level of their maturity level. Organizations with little experience in dealing with the EFQM Model usually achieve results in the range of 200 to 300 points at first. Winners of the EFQM Award on the other hand achieve between 700 and 850 points.In a comparison between the EFQM Excellence Model 2013 and the EFQM Model 2020 shows Figure 5 that the new model has been extended. The inclusion of stakeholders, the creation of sustainable benefits and the need to adapt to the various changes through transformation processes are essential elements of the new model.

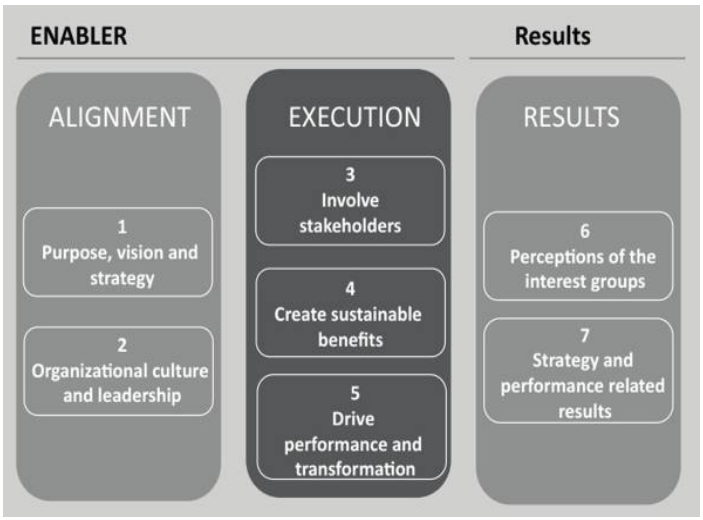

Figure 5. The EFQM Model 2020 in relation to the EFQM Model 2013

The European EFQM Global Award

Quality prizes and quality awards are awarded by specific institutions as evidence of the promotion and successful implementation of quality in organizations. They serve as an incentive for the implementation and sustainable improvement of a quality management at the organizational level. The motivational effect they have on the organization contributes to raising the level of performance and competitiveness. With the new 2020 model, the prize will be called the "EFQM Global Award." For companies, the following two requirements must be met in order to apply for the EFQM Excellence award: (1) Applications from former winners are excluded for the three years following the date of the prize, unless the application relates to a different business unit or brand. If this is the case, the entire company is nevertheless excluded from further applications; (2) The maximum number of applications for the EFQM Excellence award from the same organization or company is four. This means that up to two business units or brands can apply for each trophy (two for large and two for small business units). The assessment of an application is carried out by an examination team (so-called assessors) of experts from science and practice, from which typical assessment teams of four to six people are formed. In content, the RADAR logic is applied to each of the nine assessment categories of the EFQM Model and each of the eight basic concepts of excellence in the examination. After the completion of this examination, the examination teams make recommendations to the jury. In the end, the jury decides on the choice of finalists and awards the finalist status. Among the finalists, the companies that are considered best by the jury are awarded the status "prize winner". If a company stands out particularly among the prize winners, the highest award status, "award winner", is awarded.The evaluation of the applicants is based on two dimensions: one is based on the evaluation profile along the nine assessment categories, the other on the question of the type and strength of the role model character of an applicant for other companies within the EFQM network. If the basic concepts and the assessment criteria of the EFQM Model are integrated into the examination contents, the RADAR logic is used to evaluate the performance of the organizations. Each of the applicants receives a written examination report after the evaluation process, from which possible quality improvement potentials can be derived. In addition, the EFQM organizations offer recognition at four different levels (Figure 6). Depending on the maturity of the previous quality efforts and the willingness to invest in personnel and financial resources, organizations can achieve the following EFQM Recognition levels: (a) Validated by EFQM (formerly EFQM committed to excellence (C2E) validation); (b) Qualified by EFQM (formerly EFQM committed to excellence (C2E) assessment); (c) Recognized by EFQM (formerly EFQM recognised for excellence (R4E) assessment); and (d) EFQM Global award (formerly EFQM Excellence award).

"Validated by EFQM" - In order to validate, organizations that want to initiate improvement processes carry out a self-assessment based on the EFQM Model 2020, define improvement projects and implement them. The results of these efforts are summarized in application documents, based on which an external expert, called a validator, plans a one day visit to the

organization. During the visit, the organization's competitiveness is evaluated using the RADAR logic. In a subsequent feedback report, applicants receive recommendations for the next steps on their way to becoming an outstanding organization. In addition, the recognition "Validated by EFQM" is pronounced and published via the EFQM channels.

"Qualified by EFQM" - At this level of recognition by EFQM, it is possible to have a comprehensive analysis of the most important management practices of an organization carried out by external assessors of EFQM with relatively little time investment. Using the seven criteria of the EFQM Model 2020, applicants prepare an online self-assessment. This self-assessment serves directly as an application document. Subsequently, the one to one and a half day visit of two specially trained assessors is planned, prepared and carried out. The resulting report then provides an external view of the organization based on the EFQM criteria, information on the maturity level of the organization and extensive feedback to meet their specific challenges and increase value creation. The recognition "Qualified by EFQM" is awarded and also published by EFQM.

"Recognized by EFQM" - The most comprehensive assessment process of EFQM recognition is based on the seven criteria and the associated sub-criteria of the EFQM Model 2020. It includes a complete review of all relevant aspects of an organization and, in addition to extensive application documents, depending on the complexity of the organization, requires a two to four day visit on site by a multi-member assessor team. Accordingly, this level of recognition is reserved exclusively for organizations that already have solid experience in quality management and in the application of the EFQM Model and want to achieve further progress in this area with the help of a detailed, comprehensive feedback. The process is largely similar to the process for qualification, but is characterized by a much higher level of detail. The goal is the recognition "Recognized by EFQM", which is expressed with three to seven stars depending on the score achieved. In addition, organizations receive a detailed report on strategic challenges and goals, a complete assessment profile including strengths and improvement opportunities at the level of the seven criteria of the EFQM Model 2020 as well as food for thought for the next steps towards an "excellent" organization.

"EFQM Global Award" - The fourth and highest level of recognition is the EFQM Global award. It is awarded worldwide to outstanding private, public and non-profit organizations. However, the global award is reserved for organizations that can demonstrate an undisputed track record in the implementation of strategies into practice with continuous improvement of their performance. As a result, award candidates are thoroughly examined and evaluated; this is done by an international team of assessors consisting of three to seven EFQM trained and experienced experts. During a week on site, they interview individuals and groups and examine documents to assess the organization's effectiveness in implementing its strategic initiatives and achieving its strategic goals. The result is a detailed feedback report that is submitted to a independent jury for final decision.

Critical Assessment of Quality Awards - The opportunities of applying for a quality award are above all to be found in the following aspects:

1. Definition of company goals, clarity of goals
2. Disclosure and transparency of internal structures
3. Promotion of quality awareness
4. Improvement and securing of internal and external processes
5. Motivation of employees
6. Commitment of management
7. Creation of team spirit
8. Establishment of a pronounced attitude to competition
9. Readiness for change

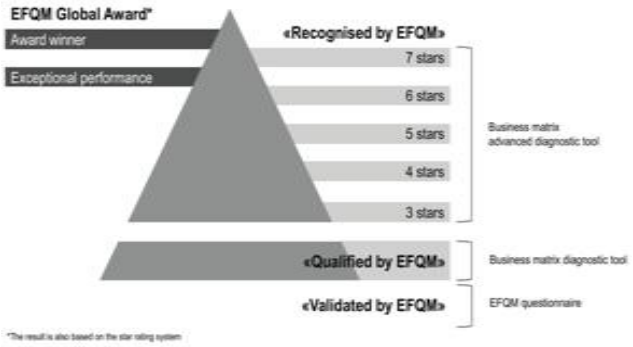

Figure 6. Levels of recognition by EFQM

The main problem areas of quality awards are initially in the practical implementation of the application and the completeness of the evaluation criteria. In this context, the question of cost-benefit aspects must be raised in the company and the commitment of high personnel capacities must be determined. In the case of an award by the jury, there is the danger that further improvement commitments in the company may be postponed and a continuous process of improvement is not promoted.

Acknowledgments

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ARTICLE-26

SAFETY IN OPEN CAST MINES

Ranjit Naik
Mines Foreman
Gandhamardan Iron Ore Mines

Introduction

Key Considerations and Practices Introduction Open cast mining is an extensive industrial process that involves the removal of large quantities of earth to extract ore from the surface. While this mining method offers significant economic benefits, it also presents a range of safety hazards. Ensuring the safety of workers and minimizing environmental impacts are critical components of open cast mining operations. This article outlines the key safety risks associated with open cast mining and the best practices to mitigate these hazards.

Hazards in Open Cast Mining:

Geotechnical Hazards open cast mines involve the excavation of large pits, which can result in steep slopes that may become unstable. If the stability of these slopes is compromised, landslides or rock falls can occur, posing a serious threat to miners. Machinery related risks mining operations use heavy equipment such as excavators, dump trucks and drills. The operation and movement of these large machines can result in accidents if proper precautions are not taken. Equipment failure or operator error can lead to collisions, falls or other accidents. Dust and particulate hazards open cast mining generates significant amounts of dust, which can lead to respiratory issues for workers. Prolonged exposure to mineral ore dust can cause diseases like pneumoconiosis (miner's lung), silicosis, or other respiratory conditions. Explosives and blasting hazards, blasting is often required to loosen ore for excavation. The use of explosives brings inherent risks, including misfires, fly rocks, and premature explosions. Proper handling, storage, and detonation of explosives are critical to minimizing these dangers. Environmental hazards, the disturbance of large areas of land can result in environmental hazards such as soil erosion, water contamination and loss of biodiversity. Managing waste materials like tailings is also crucial to avoid contaminations. Noise and vibration hazards, the use of large machinery and blasting operations creates high levels of noise and vibrations, which can harm workers' hearing and create stress, leading to accidents and health issues over time.

Best Safety Practices

Slope Stability Monitoring Regular monitoring of pit slopes is essential to prevent landslides or slope failures. Techniques such as geotechnical analysis, use of slope stability radar, and laser scanners can help detect early signs of instability. Implementing safe bench and overall pit slope angles is also necessary to avoid collapses. Equipment maintenance and operator training to reduce the risk of machinery-related accidents, operators should receive regular training on the safe handling of mining equipment. Regular maintenance schedules for machinery ensure that they are in proper working condition, reducing the risk of failure. Dust suppression systems effective dust control is essential to minimize respiratory hazards. Water sprays, misting systems, and dust collectors should be employed to reduce airborne dust in areas where drilling and excavation occur. Workers should also wear personal protective equipment (PPE) such as respirators. Safe blasting protocols blasting operations should follow stringent safety regulations. This includes securing the blast area, using the correct amount of explosives, and ensuring proper detonation procedures. Post-blast inspections are also essential to ensure no residual hazards exist. Noise and vibration control limiting exposure to noise and vibration is critical. Using soundproof cabins for machinery operators, enforcing ear protection, and maintaining equipment to reduce noise can help mitigate these hazards. Emergency preparedness and response every mining operation should have a well-established emergency response plan in place. This includes evacuation procedures, first-aid stations, and communication systems for accidents. Routine emergency drills can ensure workers are prepared in the event of an accidents. environmental management proper waste management practice, such as creating tailings dams and controlling water runoff, can reduce the environmental impact of mining. Restoring mined areas by re-vegetation and monitoring the impact on local ecosystems are essential practices.

Regulatory Compliance and Audits:

Ensuring compliance with national and international mining safety regulations is a fundamental part of maintaining safe operations. Regular safety audits and inspections by regulatory bodies ensure that mines adhere to safety standards. Implementing ISO safety management systems (such as ISO 45001) can help improve operational safety and reduce risks.

Technological Innovations:

For safety modern technological advances have made significant improvements in mining safety. Automation, remote-controlled machinery, and the use of drones for surveying can reduce the need for workers to operate in high-risk areas. Real-time monitoring systems for air quality, noise levels, and equipment performance also contribute to safer mining conditions. Conclusion open cast mining presents a range of safety challenges, from slope stability and machinery hazards to dust and noise exposure. However, through diligent risk management, adherence to best practices and the integration of modern technologies, the safety risks can be significantly reduced. Regular training, emergency preparedness, and compliance with regulatory standards are key to ensuring the safety and well-being of miners in open cast operations. As the mining industry evolves, the emphasis on safety must remain a priority to protect workers and the environment alike.

ARTICLE-27

SAFETY MANAGEMENT CONTROL

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Introduction

The management control function has eight steps: -

I - Identify hazards and assess the risk.
I - Identify the work to be done to control the risks.
S - Set standards of measurement.
S - Set standards of accountability.
M - Measure conformance to standards by inspection.
E - Evaluate conformances and achievements.
C - Correct deviations from standards.
C - Commend compliance.

Leading Safety Management Performance Indicators (Measurements of Control)

Leading or proactive safety performance indicators are measurements that record actions, activities, processes, and controls before the occurrence of accidental loss.

Definition

Leading safety performance indicators are measurements of management control. They are positive performance indicators and are proactive, leading, metrics that drive safety performance.

Safety Controlling

Safety controlling is the management function of identifying what must be done for health and safety, setting health and safety standards, inspecting to verify completion of work, evaluating, and following up with safety action. This is the most important safety management function and is vital to prevent downgrading events in the form of accidental injury, damage, or business interruption.

Risk-based, Management-led, Audit-driven Safety Management System (sms)

Based on risk assessments, a manager determines and schedules the work needed to be done to create a healthy and safe work environment and to eliminate high-risk behaviours of employees and high-risk workplace conditions. This would mean the introduction of a suitable risk-based, management-led, and audit-driven structured health and safety management system (SMS) based on world's best practices and aligned to the risks of the organization. The SMS is driven by health and safety standards, which are measurable management performance criteria. Each standard must set levels of performance and conformance that can be measured at regular intervals. All SMS should be based on the nature of the business and be risk-based, management-led, and audit-driven.

The management control function has eight steps: -

I - Identify hazards and assess the risk.
I - Identify the work to be done to control the risks.
S - Set standards of measurement.
S - Set standards of accountability.
M - Measure conformance to standards by inspection.
E - Evaluate conformances and achievements.
C - Correct deviations from standards.
C - Commend compliance.

Step 1 - Identify the Hazards and Assess the Risk

The hazard identification and risk assessment (HIRA) process will ensure that an undertaking has identified all the hazards, analyzed the risks, evaluated them, and ascertained which risk control methods to apply. These controls would form the basis

of the SMS. The frequency and quality of the inspections and hazard control actions are measurable, leading metrics of safety performance.

Step 2 - Identify the Work to be Done to Control and Mitigate Risks

Once the risks have been assessed, evaluated, and prioritized, it is now management's function to identify what work must be done to ensure the treatment of the risks. The risk assessment would have identified both physical and behavioural risks. Management can now implement certain control elements under the umbrella of the SMS to reduce the risk as much as is reasonably practical. The risks identified can be measured and their reduction monitored as a safety metric.

Measurable Performance Standards:

The above are a few components of a structured SMS and are driven by standards which can be measured and quantified. These are leading, positive indicators of safety performance.

Step 3 - Set Standards of Measurement

Managers get what they want, and once management sets health and safety standards, these standards are usually achieved by the organization. Setting standards of measurement clearly indicates how things must be in the work environment. Health and safety standards are measurable management performances. Standards must be in writing and should contain the following headings:

1. Title
2. Purpose.
3. Resources needed.
4. Authority, responsibility, and accountability.
5. Legal requirements.
6. General requirements.
7. Monitoring of activities.
8. Documentation control.

By setting standards of measurement, management defines the direction in which the organization moves. Should management set a standard for good housekeeping practices, this standard, a measurable management performance, will then dictate how housekeeping is managed in the future. What gets measured gets done. Standards give the company goals and directions and a definite focus on the end result. These standards can be of measurement and of performance and ask the questions, "What must the end result be?" and "What must be done, by whom, and by when?"

All SMS standards should be SMART, meaning that they should be:

a. Specific - The standard must specify exactly what must be done in detail. It should not be vague or generalize.
b. Measurable and manageable - The standard must be measurable and manageable.
c. Achievable and advantageous - The standard must be achievable considering costs and resources. It should be aligned with the organization's objectives and be advantageous to the organization.
d. Realistic and result-oriented - Standards must be realistic and result-orientated. An indicator such as "injury-free" sounds nice, is ideal, but is simply not realistic in a workplace setting. A measurable performance standard, such as the holding of safety committee meetings monthly, is achievable and realistic.
e. Time-bound - the standard must specify when and how often the actions prescribed must be carried out.

Standards of measurement should be set for all the elements, programs, and processes within the SMS. A comprehensive SMS would contain about 80 elements, programs, and processes. They would include:

a. Housekeeping.
b. Stacking and storage.
c. Hygiene monitoring.
d. Environmental conformance.
e. Safety committees.
f. Health and safety training.
g. Safe work procedures.
h. Risk assessments.
i. Plant inspections, etc.

Step 4 - Set Standards of Accountability

The next step in the control process is the setting of standards of accountability. A standard of accountability indicates who will do what and by when. Setting standards of accountability asks, "Who must do it and by when?" An example of setting standards of accountability is the follow up action after an accident investigation. The control steps to prevent a recurrence are what need to be done to prevent a recurrence of the accident. This should be followed by making people or departments responsible for the action, as well as committing those people or departments to a date for completion. There is often confusion about authority, responsibility, and accountability and it is opportune to define these concepts.

Safety Authority:

Safety authority is the total influence, rights, and ability of the position, to command and demand safety. Management has ultimate safety authority; therefore, it is the only level that can effectively implement and maintain an effective SMS. Leadership has the authority to demand the implementation of safety system elements and also the authority to take necessary remedial actions to ensure that standards, policies, and procedures are implemented and maintained.

Safety Responsibility:

Safety management system guidelines such as the International Organization for Standardization (ISO) ISO 45001-2018, Occupational Health and Safety Management Systems, and others emphasize that occupational safety and health are the responsibility of management, starting with the most senior managers. This cannot be overemphasized, as many still think that safety is the sole responsibility of the safety manager and the safety department. This is one of the biggest safety paradigms that needs to be changed. Safety responsibility is the safety function allocated to a post. It is the duty and function demanded by the position within the organization. This duty lies with all levels of management as well as with employees. The higher the management position, the higher the degree of safety authority, responsibility, and accountability. One cannot be held accountable for something over which one has no authority. The degree of safety accountability is proportionate to the degree of safety authority. Job descriptions are vital management tools and should clearly define the safety authority, responsibility, and accountability for all levels within the organization. The safety management system's safety standard must clearly define these relationships for the system to be a success.

Safety Accountability:

Safety accountability is when a manager is under an obligation to ensure that safety responsibility and authority are used to achieve both SMS and legal safety standards. Employees also have safety accountabilities, but in proportion to their safety authority. Leadership has the accountability to manage the SMS and its components and to provide the necessary infrastructure and training to enable the system to work. Employees should be held accountable for participating in the system and following company safety policies, procedures, and practices. Management at all levels is then held accountable to rectify the problems identified by the ongoing risk assessment process, as well as the management review and safety system audits, to ensure that the high-risk acts or conditions highlighted by these systems are rectified and do not recur. Setting safety standards of responsibility involves deciding who will do what and when. An example of a standard of responsibility is the role played by health and safety representatives. Health and safety representatives have been given the authority to inspect their immediate work area using a safety element checklist as a guideline. This inspection is carried out monthly as prescribed by the standard.

The standard of responsibility is:

1. Who? - The appointed health and safety representative.
2. Will do what? - Will carry out an inspection of his/her work area.
3. When? - This inspection will be carried out on a monthly basis.

One of the many safety myths is that “everybody” is responsible for safety. Individuals can only be responsible for items and people over whom they have authority and can thus be held accountable for only those conditions and people over whom they have authority.

Step 5 - Measurement against the Standard

This control function is when management measures what is actually happening in the workplace against the preset standards. To measure successfully, a walkabout inspection and control documentation review must be carried out. Employees doing

these inspections should be aware of and familiar with the standards. One of the greatest failings in most SMS is insufficient or inadequate inspections. An inspection is not an audit. An audit is not an inspection. An audit inspection forms part of an audit. The two concepts should not be confused.

System Standards:
Systems to enable ongoing measurement against standards are part of a SMS, and these could include the monthly inspections of local work areas by appointed health and safety representatives. Safety inspections are ideal measurement tools. Critical task observations also allow opportunity for measurement against standards. The setting of standards and constant measuring against those standards immediately identify the strengths and weaknesses of the SMS. Safety personnel should also conduct formal inspections on a regular basis and compare actual SMS processes and procedures with the standards. A checklist should always be used when doing these inspections, as it will serve as a constant reminder of what must be measured.

Measuring Performance
Safety management control and the measurement of the control process are not merely measuring and comparing injury statistics with other companies or industries. This is a management function that measures whether the organization is living up to the norms agreed to by management and employees in the form of SMS health and safety standards and the health and safety policy statement. Each element of the SMS has a protocol against which it is measured. Points are allocated to every standard, minimum standard, and minimum standard detail of the element to form an audit protocol. Measurements include reports of downgrading incidents, deviations from standards, and input and output metrics.
Critical Task Observation
Another form of measurement against standards is critical task observation. This involves observing an employee carrying out a critical task while following the steps of the written safe work procedure. The written safe work procedure is the end result of critical task identification (task risk assessment) and the critical task analysis process. The observation allows for the measurement of workers' performance during the critical task against the prescribed performance dictated by the procedure. The procedure sets a standard of performance.

Step 6 - Evaluate Conformances to SMS Standards and Achievements
The evaluation process is the quantification of the degree of conformance to the standards established. The legal health and safety requirements are viewed as the minimum standard to achieve. Evaluation of the achievement of standards is normally facilitated through the safety management system audit process. An SMS should be driven by SMS audits. These regular audits systematically quantify the degree of compliance with standards. They evaluate the management work being done to combat losses. What gets measured gets attention, and consequently, the evaluation of compliance with safety standards gives an indication of what is being done and what is not being done. The quantification of safety control actions is far more reliable and significant than the measurement of safety consequences, which are largely fortuitous.

External Audits
A number of health, safety, and risk-management organizations provide auditing services for clients. This external audit is of tremendous value to any organization as it is totally impartial and conducted by auditors who are thoroughly familiar with the company's audit protocol. It is again emphasized that a safety inspection is not an audit. The audit of an organization's safety system is a structured approach to the quantification of safety compliance and adheres to the following sequence:

1. Pre-audit meeting.
2. Audit facilities.
3. Audit team.
4. Physical inspection.
5. Compliance audit.
6. Systems audit.
7. Documentation review.
8. Verification of the disabling injury incidence rate.
9. Management close-out and audit results.
10. Audit report.

Retrospective

The audit results and percentage achievement are normally based on the SMS achievements during the preceding 12 months. Credit is not given for good intentions but rather for programs, processes, and procedures that have been in operation for at least six months.

Internal Audit

Internal audits of the entire SMS to evaluate conformance with standards should be carried out every six months. The internal audit system should follow the same guidelines as an external audit and will culminate in a percentage of conformance as well as a breakdown of conformance against standards for each element. Each element of the SMS that does not score 100% indicates a weakness in the element, indicating that the standards established for that element have not been fully met. This indicates to management which elements of the SMS require action and are positive indicators of safety management performance.

Step 7 - Correct Deviations from Standards

Corrective action is the safety management work that must be done to correct those activities that were not completely controlled. If any critical SMS element is evaluated at less than 100%, some action needs to be taken to ensure total conformance with standards. Management must do what it says it is going to do. The safety standards indicate what must be done. Deviations indicate that the safety objective has not yet been achieved.

Accident Investigation

An accident is caused by a failure in the management system, and after an investigation, certain action plans or controls are recommended to prevent the recurrence of a similar accident. This is corrective action and should be directed at the root causes of the problem, not merely the symptoms. Correcting high-risk behavior and high-risk conditions may provide temporary relief, but the real cause must be identified, and the problem solved.

Step 8 - Commendation for Compliance

One of the main failings in numerous safety processes and programs is the lack of commendation and recognition. Commendation should be given for the achievement of objectives. If a department meets and maintains the housekeeping standard, for example, the entire group should be commended. Commendation for pre-contact safety activities is far more effective than commendation for injury-free periods. If, as a result of the measurement and evaluation, a high degree of conformance to performance standards is found, commendation should be given. Safety, as a profession, has often been guilty of emphasizing the lack of control and not complimenting where good control exists.

Recognition for the Achievement of Proactive Objectives

People at workplaces and in other walks of life thrive on recognition and acknowledgment. Recognizing and acknowledging people for their safety work should be done as often as possible. Traditionally, safety recognition was only given to individuals for being "injury-free" or for having worked a certain number of days without a lost-time injury. That could just be the result of good luck. Maintaining good housekeeping and carrying out monthly inspections of ladders, portable electrical equipment, hand tools, personal protective equipment, etc. is an ongoing control system, and this effort should be recognized.

Management

It is good management practice to commend employees for their safety efforts. Bearing in mind that control is pre-contact accident control, this is more important than the recognition of no adverse consequence in the form of severe injury.

Conclusion

Only management has the authority to create a healthy and safe workplace. By implementing measurable management control measures in the form of a risk-based, management-led, and audit-driven SMS, hazards and their associated risks will be identified and reduced, making the workplace safer for all.

Acknowledgments

The authors would like to express their gratitude to the OMC Top Management, Regional Manager, Mines Manager, All Sectional Heads, Executives and Non-executives of GIOM for their continuous help and guidance in completing and enabling the work to be published, as well as to all individuals who assisted directly or indirectly in the preparation of the paper. The views expressed in the paper are those of the authors and do not necessarily reflect the views of Management, GIOM, OMC.

ARTICLE-28

SUCCESSFUL INCIDENT PREVENTION THROUGH EFFECTIVE ROOT CAUSE ANALYSIS

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FIG: 1

Analyzing and addressing root causes during an incident investigation can help an organization prevent similar incidents from recurring.

One or more fixable system failures can be found by identifying the fundamental, underlying cause of an incident. This is known as a root cause. An company must ascertain the contributing elements to the incident during an incident investigation. Instead of focusing on the immediate or general causes of an incident, a root cause analysis could determine the deeper or systemic causes. Simply addressing the immediate cause may alleviate the symptom, but it won't solve the main issue.

The most successful incident investigations involve managers and staff members working together since they each contribute unique views, knowledge bases, and levels of experience to the table. Supervisors typically lead these investigations. A successful root cause analysis identifies all root causes because there is often more than one.

Root causes typically come from deficits in staffing, management, training, organizational and cultural aspects, equipment maintenance, operating systems and procedures, and workplace design, according to OSHA (Occupational Safety & Health Administration). During a root cause analysis, organizational culture and behavior may be identified as contributing factors. Businesses may dramatically lower the risk of incidents by cultivating a strong safety culture.

FIG: 2

After a near-miss, a root cause analysis can also take place. Corrective and preventive action, or CAPA, is probably required if an incident comes dangerously close to happen again. What steps should be taken to prevent a near-miss turning into a catastrophic incident in the future can be ascertained with the use of a root cause analysis.

Understanding the reasons behind an incident or near miss, creating efficient remedial and preventive measures, and reducing or eliminating major consequences from recurring incidents all depend on addressing the underlying or root causes.

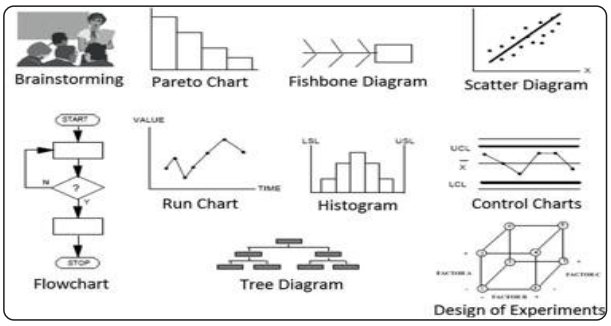


FIG: 3

There are many tools the incident investigation team can use to conduct a root cause analysis. Ideally, a combination of these or other tools will be used.

- Brainstorming
- Checklists
- 5 Whys Analysis
- FIG: - 3
- Logic/Event Trees
- Timelines
- Sequence Diagrams
- Causal Factor Determination

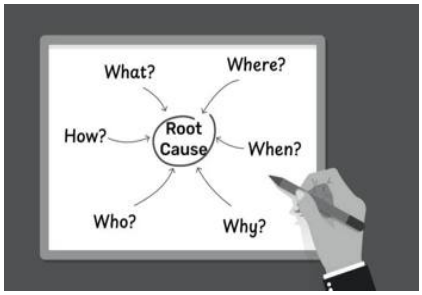


FIG: 4

Brainstorming and checklists might be enough to determine the core reasons of simpler situations. Applying logic or event trees may be appropriate for more complex situations. Supporting the logic/event tree tool are timelines, sequence diagrams, and causal factor identification.

A wide range of software tools are currently available on the market to help with and improve the accuracy and efficiency of the root cause analysis.

Whichever combination of root cause analysis techniques is used, make sure it addresses these four crucial.
questions:

1. What happened?
2. How did it happen?
3. Why did it happen?
4. What needs to be corrected so it doesn't happen again?

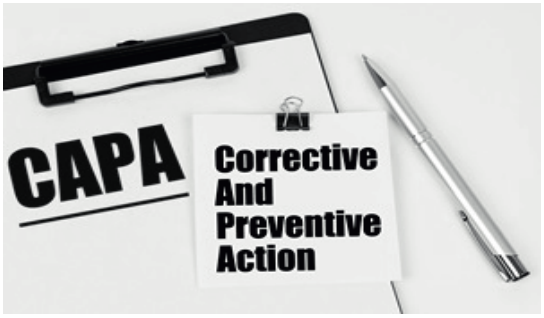


FIG: 5

It can be helpful to take human characteristics like tiredness, mental strain, and human mistake into account when doing the analysis. Even while these are probably not the primary root causes of the problems, they can make a big difference in figuring out what's going on when the inquiry goes further to find out what went wrong and why.

During the incident inquiry, interviews and document reviews-including of maintenance logs-may be helpful. To help prevent such events in the future, it will be very beneficial to involve employees in the root cause investigative process and to share the findings of those investigations.

Every accident investigation is a fact-finding process. The investigation should focus on identifying root causes, not finding fault or assigning blame to an employee.
One cannot attribute an incident's primary cause to a simple conclusion such as "employee failed to follow the procedure." Investigating further is crucial.
For instance,

1. Why wasn't the protocol followed?
2. Did the training inadequate?
3. Are we using an outdated procedure?
4. Is safety compromised in order to meet deadlines set by management?

For example, if the procedure is out of date and not sufficient for the current workflow, the investigation can recommend the corrective action to update the procedure and provide training to workers on the new procedure.
Then the investigation should go even further by asking: Why was the procedure out of date? Perhaps a preventive action might be to implement a review process of operating procedures on a defined periodic basis (example: annually) to ensure safety requirements are continuously updated.

Conducting a thorough investigation that identifies root causes will help to prevent similar events from happening again and reduce the risk of future injuries, property damage, and fatalities. Incorporating root cause analysis into a continuous improvement process, with regular reviews and updates, can further enhance its effectiveness and ensure ongoing safety improvements.
By using root cause analysis to prevent similar events, companies can avoid unnecessary costs resulting from business interruption, emergency response and clean-up, increased regulation, audits, inspections, and OSHA (Occupational Safety & Health Administration)fines.
A robust safety program that includes root cause analysis along with all incident investigations can result in more effective control of hazards, improved process reliability, increased revenues, decreased production costs, lower maintenance costs, and lower insurance premiums.

ARTICLE-29

SAFETY BUILDING CULTURE AT LANJIBERNA LIMESTONE AND DOLOMITE MINE (DALMIA CEMENT BHARAT LIMITED)

Chadaram Srinivasu Safety Manager)
Lanjiberna Limestone & Dolomite Mines
Dalmia Cement Bharat Ltd.

Introduction

Dalmia Cement is the only company with at least one plant in each of the four key eastern states of West Bengal, Bihar, Jharkhand and Odisha. The company offers a range of cement variants through its brand portfolio of three marquee brands: Dalmia Cement, Dalmia DSP and Konark Cement.

The Rajgangpurcement plant meets the limestone requirement from its captive Mines spread over a Mining Lease Area of 873.057 Ha located at villages - Alanda, Bihabandh, Jhagarpur, Kesramal, Raiberna, Katang, Dhauraada, Lanjiberna and Kukuda, Tehsil- Kutra and Rajgangpur, Dist - Sundargarh, Odisha.

Health and Safety Standards

We have successfully been able to regulate health and safety standards at our Mines for 13 critical jobs. These include Mines & HEMM Safety, Working at height, Scaffolding, Hot work, Material handling and Lifting operation, Fire risk management, Electrical safety, Road and Driving safety, Lock Out Tag Out Try Out (LOTOTO), Confined space, Rail safety, Hazard Identification and Risk Assessment (HIRA)& Machine Guarding.

Recognition Policy for Safety Improvements- At Lanjiberna Mines, we believe in celebrating our employees' achievements in meeting safety and health benchmarks by institutionalizing rewards for the following:

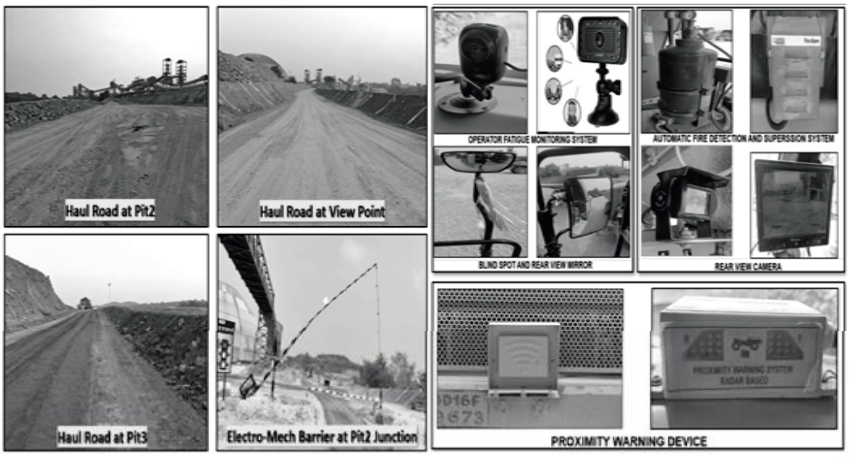
- Reporting maximum unsafe acts, unsafe conditions and near-miss incidents by our safety-conscious employees/workers
- Suggesting engineering controls
- Winners of safety competitions

KAVACH-My Safety My App- The App was developed in-house to report lead indicators and track compliance. Lead indicators are reported by all our employees through the KAVACH app. Department-wise lead indicators reporting and compliance is monitored daily during production meetings chaired by the Unit Head/Mines Head, in the presence of all Head of Departments. Lead indicators and lag indicators status is also reviewed during apex and central safety committee meeting.

Safety Awareness Campaigns- Every month we formulate unique theme-based Safety Awareness campaigns that tie in particular safety aspects to increase awareness amongst employees. These include the toolbox talk, conducting safety training, nukkad-natak, quiz competitions, safety audits, etc.

Regular Safety Gate Meeting- Our Monthly Safety Gate Meeting is held on the first week of each month to share our safety performance updates as well as honour employees who have exhibited exceptionally high levels of safety behavior at work. This meeting is chaired by the Mines Heads These sessions also comprise health tips by doctors, motivational speeches by Mines Manager and Mines Head and a recognition for our most safety-conscious workers.

Implementation of Mines Safety & HEMM Safety Standard



Implementation of Hot work, LOTOTO, Working at Height, Material handling by crane, Electrical safety at Mines

Monthly safety gate meeting, sharing best practices, Motivation & recognition of workers for best performance towards safety, Environment, Health, Innovation & Productivity at Mines

ARTICLE-30

MINING SECTOR, THE SEARCH FOR SUSTAINABILITY

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Sukinda Chromite Mine, Tata Steel Ltd.

Introduction

The concept that the Earth is the supporter of all life, and that human action should be care fulnot to destroy the balance. "Around the world, ancient civilizations have a rich history of understanding the symbiotic connection between human beings and nature". Mining has long been a critical industry, supplying the raw materials that fuel economies a modern life. From coal to copper, rare earth minerals to gold, the sector is integral to the production of everything from energy to electronics. However, this crucial role comes with a hefty environmental and social price. In recent decades, concerns over sustainability have increasingly shaped the mining industry, forcing it to confront the challenges of environmental degradation, social responsibility, and economic viability. The search for sustainability in mining is not just about improving operational efficiencies; it is a boutre defining the industry's relationship with the planet and its people.

1.1 Evolving global and Indian mining landscapes

Globally, the mining industry is experiencing grapid technological advancements in mining, increasing demand for minerals, and a pressing focus on sustainability. The sector must align with sustainable development goals(SDGs), necessitating minimized environmental impacts and equitable benefit distribution. Significant investments, approximately US$ 1 trillion over the next 15 years, are required to support the energy transition and meet global carbon emission targets. This immense financial commitment under scores the importance of sustainable practices and innovative technologies in shaping the future of mining. In India, the mining sector is rich in diverse minerals but faces substantial challenges, including stringent environmental regulations and slow technological adoption. However, initiatives like' Atmanirbhar Bharat'aim to enhance self-reliance by maximizing domestic mineral utilization and boosting coal production. The initiative emphasizes reducing import dependency and promoting indigenous production, which can be pivotalin addressing the sector's challenges.

1.2 Environmental Challenges

Mining operations have significant environmental impacts.

1. These included efore station, habitat destruction, soil erosion, water contamination, and air pollution. Large-scale mining can also disrupt ecosystems and contribute to the loss of biodiversity. The extraction process of ten leads to the release of harmful chemicals, such as Chromium VI, mercury, or cyanide, into the surrounding environment, further threatening wildlife and human communities.
2. There fore, to minimize these environmental impacts while maintaining prof it ability. This has led to the development of more responsible mining practices, including strict erregulations and improved technologies for waste management, water usage, and land rehabilitation.
3. One approach gaining traction is the use of renewable energy in mining operations. Traditionally, mining has relied heavily on fossil fuels, but some companies are now turning to solar, wind, and hydro power to reduce their carbon foot prints.
4. Renewable energy not only lowers emissions but can also lower long-term operating costs, especially in remote locations where fuel transport is expensive.

1.3 Technological Innovation and Efficiency

1. Technological advances are playing a critical role in making mining more sustainable. Automation, artificial intelligence (AI), and big data analytics are helping companies optimize their operations. For example, AI can improve efficiency by predicting equipment failures and reducing down time, while autonomous trucks and drills reduce human exposure to dangerous conditions and improve precision, which minimizes waste and environmental damage.
2. Another area of innovation is in mineral processing. Traditional methods of ore extraction and refining are energy-intensiveand of ten generate large amounts of waste. However, newer techniques like bio leaching, which uses bacteria to extract metals, or more efficient chemical processes, are reducing the environmental burden of processing minerals.
3. The concept of a circular economy is also emerging in the mining sector. This involves recycling and reusing materials to extend the life of resources and reduce the need for new mining. For example, urban mining-the process of reclaiming metals from electronic waste-has gained attention to recover valuable materials like gold, silver, and copper from discarded products.

1.4 Social Responsibility Community Engagement.

Sustainability in mining goes beyond environmental concerns; it also encompasses social responsibility. Mining operations often take place in remote or economically disadvantaged regions, impacting local communities. Issues liked is placement, poor working conditions, and lack of benefit-sharing have led to significant conflict between mining companies and local populations.

To address these challenges, many mining companies are working to build better relationships with communities. This can include providing fair compensation for land use, investing in local infrastructure, and ensuring that communities benefit economically from mining activities. Additionally, there is a growing emphasis on protecting the rights of indigenous peoples, who are disproportionately affected by mining activities.

The concept of "social license to operate" has become a key element of mining sustainability. This refers to the level of trust and acceptance that a company has from local communities and others take holders. Without this license, companies may face protests, legal challenges, or even be forced to shut down operations.

1.5 Regulatory Pressures and Global Standards

Governments and international organizations are increasingly imposing regulations on the mining sector to ensure more sustainable practices. In many countries, mining companies are required to carry out environmental impact assessments (EIAs) and adhere to strict guidelines on waste disposal, water usage, and land rehabilitation.

Global standards and certifications, such as the Initiative for Responsible Mining Assurance (IRMA) and the Extractive Industries Transparency Initiative (EITI), are also gaining importance. These initiatives promote transparency, accountability, and best practices in the mining sector. Many investors and consumers now expect companies to meet these standards, adding pressure for mining firms to adopt more sustainable practices.

1.6 The Role of Investors and Consumers

Sustainability in mining is increasingly driven by investors and consumers who demand higher standards of corporate responsibility. Investors are looking for companies that demonstrate a commitment to environmental, social, and governance (ESG) principles, and are wary of firms that could face costly regulatory or reputational risks due to un sustainable practices.

Consumers, too, are more aware of the environmental and social impacts of the products they buy. There is growing demand for responsibly sourced materials, such as conflict-free minerals or metals that have be enmined with minimal environmental damage. Companies that can meet these demands are better positioned to thrive in a market that increasingly values sustainability.

1.7 The Future of Sustainable Mining

The path to sustainability in mining is complex and fraught with challenges, but it is essential for the industry's long-term survival. Mining companies must balance the need to meet global demand for raw materials with the responsibility to protect the environment and support local communities. This will require continuous innovation, greater collaboration between governments, businesses, and communities, and a willingness to investing long-term solutions.

In the future, we can expect to seem or reemphasis on green mining technologies, greater use of renewable energy, and stronger regulations to enforces sustainable practices. The shift toward a circular economy, where materials are reused and recycled, will also be critical in reducing the over all demand for new mining operations.

While there is still much work to be done, the mining sector's search for sustainability represents an important step toward a more responsible and environmentally friendly future. By embracing change and committing to sustainable practices, the industry can continue to play its essential role in modern society without compromising the planet or its people.

ARTICLE-31

REVIEW OF PRESENT MINING SCENARIO AND CASE STUDY - DUMP MANAGEMENT

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Abstract:
India's mining industry is a cornerstone of its economic development, providing raw materials essential to numerous industries. However, the sector faces critical challenges in managing mine dumps sustainably. This paper examines the current mining scenario in India, focusing on dump management practices. It presents key challenges, statutory guidelines, and innovative strategies implemented by Tata Steel in managing dumps in hilly terrain, aiming to promote sustainable mining practices.

Introduction:
The Indian mining sector is vital to the country's economy, contributing significantly to GDP and providing employment opportunities. India produces 95 minerals, including fuel, metallic, non-metallic, atomic, and minor minerals, highlighting the sector's importance. However, mining activities, especially in hilly terrain, have led to significant challenges in managing overburden (OB) dumps, impacting the environment and safety. This paper explores current trends, challenges, and innovative solutions for dump management in the Indian mining industry.

Current Mining Scenario in India:
India is endowed with vast mineral resources, serving as essential raw materials for industries and a major resource for economic development. The mining sector is a critical segment of the economy, with the country producing a wide variety of minerals.

Number of Reporting Mines			
Sector	**FY' 20**	**FY' 21**	**FY' 22**
Metallic Minerals	602	608	545
Non-Metallic Minerals	783	767	774
Total*	**1385**	**1375**	**1319**

Of the 1,319 mines in FY'22, only 52 are underground, highlighting the predominance of opencast mining, which contributes to the accumulation of vast OB dumps, posing environmental and safety challenges. For sustainable mining, 2-3 times more non-mineralized area is needed for OB stacking, mineral rejects, and other peripheral activities.

Area wise Distribution of Operational & Non-Operational Mining Leases			
Area(ha)	**No. of Leases**	**% of leases**	
0-2	387	12	Smaller lease sizes exacerbate challenges, leading to higher dumps and the rehandling of OB.
>2-5	888	27	
>5-10	403	12	
>10-20	369	11	
>20-50	440	13	
>50-100	254	8	
>100-200	186	6	
>200-500	212	6	
>500	175	5	
Total	**3314**	**100**	

Major Slope Failures In India:

1. In Tollem Iron Ore Mine M/s. KundaR.Gharse in Goa on 09/12/2006 in which six persons were trapped and killed under the debris due to slope failure of 30 to 46m high Dump and benches in the mine.
2. In Jayant Opencast Project of M/s. Northern Coalfields Limited on 17/12/2008 in which a portion of the dragline dump measuring 135m (length) x 70m (height along the side of the slope) x 6 to 19m (height across the slope) failed suddenly and trapped 5 persons to death and buried a shovel at its bottom.

3. In Sasti Opencast Coal Mine of M/s.Western Coalfields Limited on 04/06/2009 wherein a dragline overburden dump of 73m height failed and slided down the pit resulting in deaths of two persons and burial of two excavators.
4. In another coal mine, a total volume of around 1,30,000 m3 of waste material slid from a height of 10m to 12m to the bench floor, without involving any casualty.
5. A deep-seated circular failure of an overburden dump about 62m high, made on the foundation of 10-15m thick soil, caused severe upheaval to an adjacent arterial road and damage to a 400 KV overhead line in a coal mine. The road got totaly blocked and power supply got disrupted.
6. Rajmahal Opencast Mines of M/s Eastern Coalfields Limited on 29th December, 2016 causing loss of 23 lives.

Mining in Hilly Terrain: Mining in hilly terrain poses inherent challenges that extend beyond those encountered in flat or low-lying areas. The steep slopes, varied geological formations, and limited accessibility characteristic of hilly terrain require specialized approaches to mining operations. Traditional mining methods may not be feasible or environmentally sustainable in such areas, necessitating the adoption of advanced technologies and best practices tailored to the terrain's unique characteristics.

Challenges in Dump Management: Dump management particularly in hilly terrain presents specific challenges that must be addressed to ensure safe and sustainable operations:

1. Slope Stability: The steep gradients prevalent in hilly terrain increase the risk of dump instability and slope failure. Factors such as soil composition, weathering patterns, and seismic activity contribute to the dynamic nature of slope stability, requiring continuous monitoring and proactive management strategies.
2. Erosion Control: Intense rainfall, natural erosion processes, and high surface runoff rates common in hilly terrain can lead to soil erosion and sedimentation, affecting water quality and ecological balance in surrounding areas. Dump structures must be designed and managed to minimize erosion and sediment runoff, thereby preserving the integrity of the local ecosystem.
3. Land Use Conflict: Hilly terrain often supports diverse ecosystems and may be inhabited by local communities dependent on natural resources for their livelihoods. Mining activities must be managed to minimize land use conflicts and mitigate adverse socioeconomic impacts. Effective stakeholder engagement and community consultation are essential for fostering mutually beneficial relationships and promoting sustainable development.

Technological Advancements in Dump Management: To address the challenges associated with dump management in hilly terrain, mining companies worldwide are increasingly adopting advanced technologies and innovative practices:

1. Geotechnical Monitoring: Continuous monitoring of slope stability using advanced geotechnical instruments, inclinometers, and satellite-based monitoring systems allows for real-time assessment of dump conditions. Early detection of potential instabilities enables proactive mitigation measures to be implemented, minimizing the risk of slope failures and associated hazards.
2. GIS and Remote Sensing: Geographic Information Systems (GIS) and remote sensing technologies play a crucial role in terrain analysis and dump design optimization. High-resolution satellite imagery, LiDAR data, and digital elevation models facilitate accurate mapping of terrain features, geological structures, and hydrological patterns, enabling informed decision-making and risk assessment.
3. Geosynthetic Reinforcement: The use of geosynthetic materials, such as geotextiles, geogrids, and geomembranes, enhances the stability and longevity of dump structures. Geosynthetics are employed for slope stabilization, erosion control, and surface protection, providing cost-effective solutions to mitigate geotechnical risks and environmental impacts.
4. Drainage and Water Management: Innovative drainage systems, including surface water diversion channels, subsurface drains, and sediment retention ponds, are essential for managing water runoff and preventing soil erosion. Sustainable water management practices help minimize the impact of mining activities on local hydrological cycles and ensure compliance with regulatory requirements.

***Statutory Provisions*:**

DGMS (Tech) (S&T) Circular 02 06/07/2010

(i) Design mine and the pit as well as dump slope scientifically taking into consideration of geotechnical parameters of rock and the dumps including hydro geologic and weather conditions to ensure stable pit and Dump slope profile not only during

mining but also thereafter; and
(ii) Deploy Slope Stability Radar (SSR) with integrated visual imaging system or any similar such technology giving a real time monitoring of displacements of strata or dumps well in advance of any failure and providing mine management sufficient time to safety withdraw men and machinery from such prone areas.

DGMS (Tech) Circular (MAMID)/03 Dhanbad Dated 22/04/2014 Sub: Accident due to dump failure

1. Scientific Study to be made, in case planned height of dump is >30m. Width of any bench in waste dump shall not be less than its height.
2. The distance between the toe of dump and the nearby road (if exists) not < twice the height of dump.
3. The top soil and sludge shall not be dumped at the floor to create the base of the dump.
4. Provision of proper drainage system in the dump above phreatic surface for reduction of the ground water pressure
5. Fencing of dump area
6. Precautions to prevent spontaneous heating and fire in the carbonaceous shale & Coal dumped with overburden rock.

DGMS (Tech) Circular No 02 dated 09-01-2020 (3) - Guidelines for Systematic Monitoring of Slopes

1. Monitoring Methodology: Selection of monitoring method based on Scientific study
2. Recording & Analysis of Observation Data

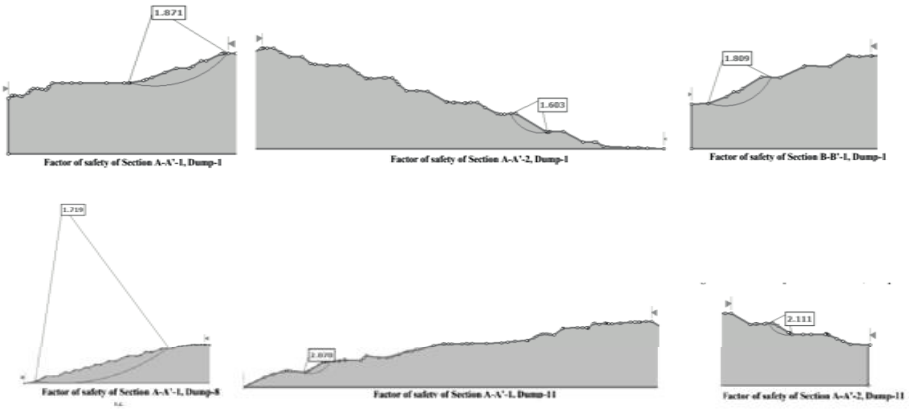
Organization for slope monitoring: Provision of slope monitoring officer & Geo technical cell
Spoil-banks and dumps (as per Reg. 108 of the CMR2017)

1. The slope of an OB dump bench shall be determined by the natural angle of repose of the material being deposited but, in any case, shall not exceed 37.5° from the horizontal. A steeper slope of OB bench can be planned if a scientific study recommends the same.
2. Any OB dump exceeding 30 m in height shall be benched so that no bench exceeds the height of 30 m and the overall slope shall not exceed 1 vertical to 1.5 horizontal.
3. The toe of an OB dump shall not be extended to any point within 100 m of a mine opening, railway or other public works, public road or building, or other permanent structure not belonging to the owner of the mine.
4. A suitable fence between any railway or public works or road or building or structure not belonging to the owner and the toe of an active spoil bank.

Case Study: Dump Management in Manganese Mines of Tata Steel:

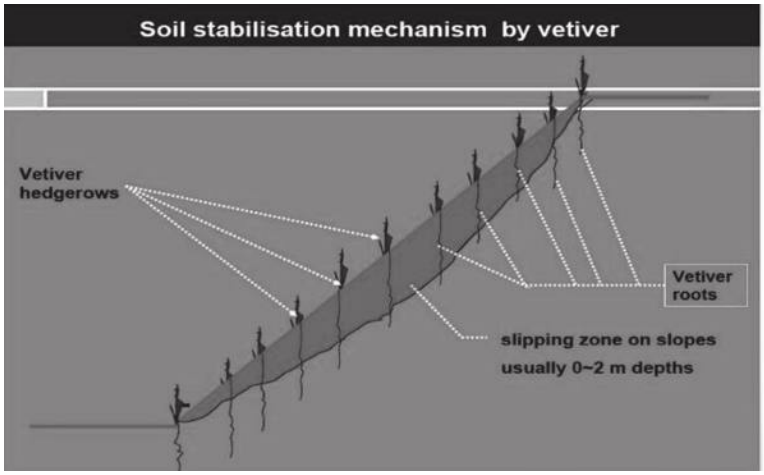
Tata Steel operates Manganese mines in the hilly terrain of Joda West, where the company faces numerous challenges related to dump management. To address these challenges, Tata Steel has implemented several strategies:

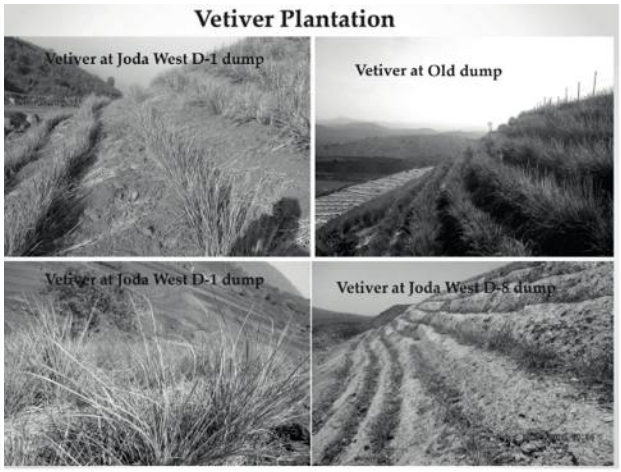
1. Comprehensive Risk Assessment: Joda West Manganese Mine conducts regular risk assessments to identify potential hazards associated with mine dumps, enabling them to implement appropriate mitigation measures. These assessments consider factors such as dump stability, geological characteristics, and environmental sensitivity.
2. Geotechnical Monitoring: Joda West Manganese Mine employs a comprehensive geotechnical monitoring program, periodic ground surveys, scientific study by NIT Rourkela to assess the stability of dump structures and identify potential hazards. Data are analyzed to detect changes in slope behavior.Standard laboratory tests are performed at NIT Rourkela to find the geo-mechanical properties of the area. The stability analysis is undertaken at NIT Rourkela using limit equilibrium simulations of the pit slopes.



Pic1: Factor of study in different sections of waste dumps

3. Terrain Analysis: Utilizing GIS software and remote sensing techniques, Joda West Manganese Mine conducts detailed terrain analysis to identify suitable locations for dump sites and optimize dump design parameters. Digital elevation models, slope maps, and land cover classifications are used to assess terrain suitability, minimize environmental impacts, and optimize land use planning.
4. Reinforcement of Dump: Joda West Manganese Mine incorporates reinforcements using Vetiver grass, into dump structures to enhance stability and prevent erosion.

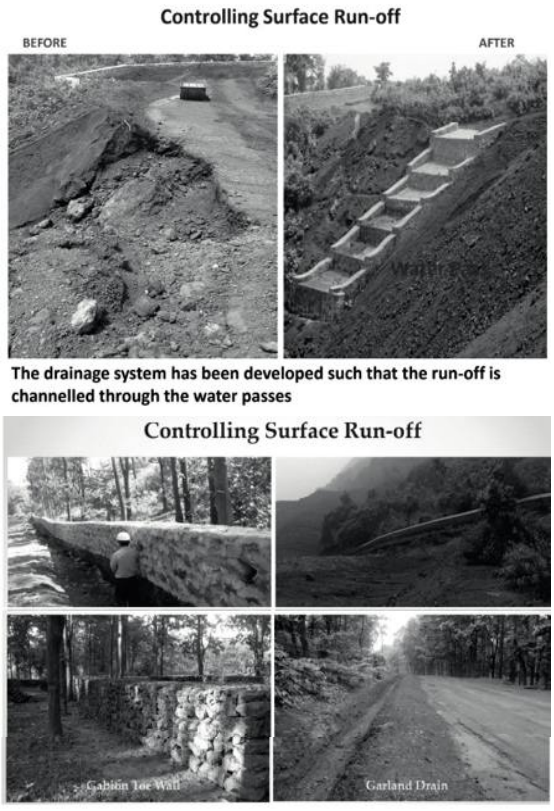




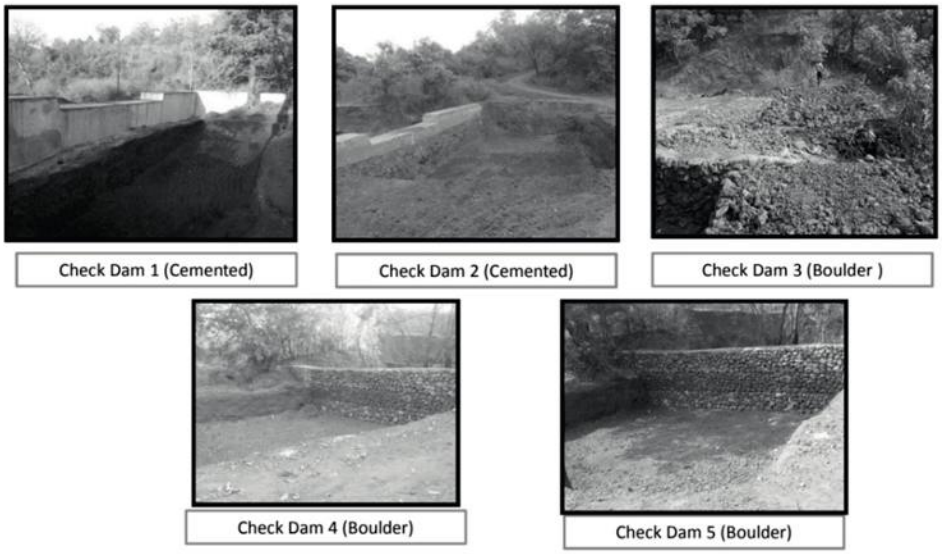
Pic-2: Soil stabilization mechanism by Vetiver Pic-3:Vetiver Plantation on mine dumps

5. Drainage & Water Management: Proper drainage systems, including surface water diversion channels, subsurface drains, and sediment retention ponds, have been made for managing water runoff and preventing soil erosion. Sustainable water management practices help minimize the impact of mining activities on local hydrological cycles and ensure compliance with regulatory requirements.

Pic-4: Drainage system on Mine dumps



Pic-5: Control of surface run-off in mine



Pic-6: Check Dams in mines

6. Community Engagement: Joda West Manganese Mine actively engages with local communities and stakeholders to address concerns related to dump management and environmental stewardship. Community is engaged using SHG in nurturing of Vetiver slips at Joda West Nursery (Joda West). Vetiver slips are procured from them and transferred to nursery beds.

Pic-7: Community engagement in nurturing of Vetiver slips

Conclusion:

Effective dump management is crucial for the safety of mining operations, environmental protection, and sustainable development. By leveraging technology, adhering to statutory guidelines, and engaging stakeholders, mining companies can overcome challenges and promote responsible mining practices in India.

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ARTICLE-32

APPLICATION OF THE SWISS CHEESE MODEL IN THE MINING INDUSTRY

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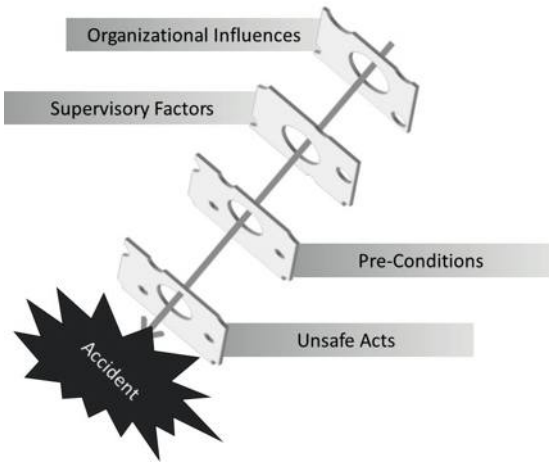
Abstract
The Swiss Cheese Model, introduced by James Reason, has proven to be a powerful tool in understanding and mitigating safety risks across various industries. This paper delves into its relevance and application in the mining sector, particularly for analyzing and preventing fly rock events. The model explains how organizational, supervisory, and individual failures can align to create accidents and underscores the importance of addressing both active and latent failures. This study demonstrates the model's potential to build resilient safety systems by identifying and mitigating vulnerabilities at all levels of operations.
Keywords: Swiss Cheese Model, Safety, Mining Industry, Fly Rock, Active Failures, Latent Failures, Resilient Systems

1. Introduction
Mining is an inherently high-risk industry, with safety being a critical concern for operators and stakeholders. Accidents, such as fly rock events, can have devastating consequences, including fatalities, injuries, and environmental damage. The Swiss Cheese Model is a systems approach that visualizes safety barriers as layers of cheese with holes representing system vulnerabilities. Understanding the dynamics of these holes can help identify and mitigate risks, enhancing safety protocols. This paper explores the application of the Swiss Cheese Model in the mining sector and its integration with the Human Factors Analysis and Classification System (HFACS).

2. Problem Statement
Despite significant advancements in safety measures, mining accidents continue to occur, often due to a combination of human errors, organizational inefficiencies, and equipment failures. Fly rock events are a prime example where multiple safety barriers fail simultaneously, resulting in adverse outcomes. Traditional root cause analysis methods, such as the "5 Whys," often fail to capture the complex, interrelated factors leading to such events. This calls for a more robust framework to analyze and address both active and latent failures within the system.



3. Methodology
The methodology involves the application of the Swiss Cheese Model and HFACS framework to identify, analyze, and mitigate safety risks in mining operations. The process is as follows:

1. Data Collection
Gather data on past mining incidents, with a focus on fly rock events.
Conduct interviews with personnel and review incident reports.
2. Layer Categorization
Categorize safety barriers into organizational, supervisory, preconditions, and unsafe acts levels.
3. Hole Identification
Identify active failures (errors and violations) and latent failures (organizational and supervisory deficiencies).
4. Root Cause Analysis
Use HFACS to analyze causal pathways and interactions across layers.
5. Risk Mitigation Strategies
Develop interventions to close or minimize holes in safety barriers.
6. Validation
Test the effectiveness of proposed measures through simulations or pilot programs.

4. Results and Discussion

4.1. Key Findings

Active Failures: Decision errors and skill-based errors during blasting operations were frequently identified.

Latent Failures: Organizational deficiencies, such as inadequate resource allocation and ineffective training programs, contributed to gaps in safety barriers.

Supervisory Lapses: Inadequate supervision and failure to correct known issues, such as equipment defects, were common.

Dynamic Nature of Risks: Holes in safety barriers opened and closed depending on the day-to-day operational pressures and environmental factors.

4.2. Applications of the Model

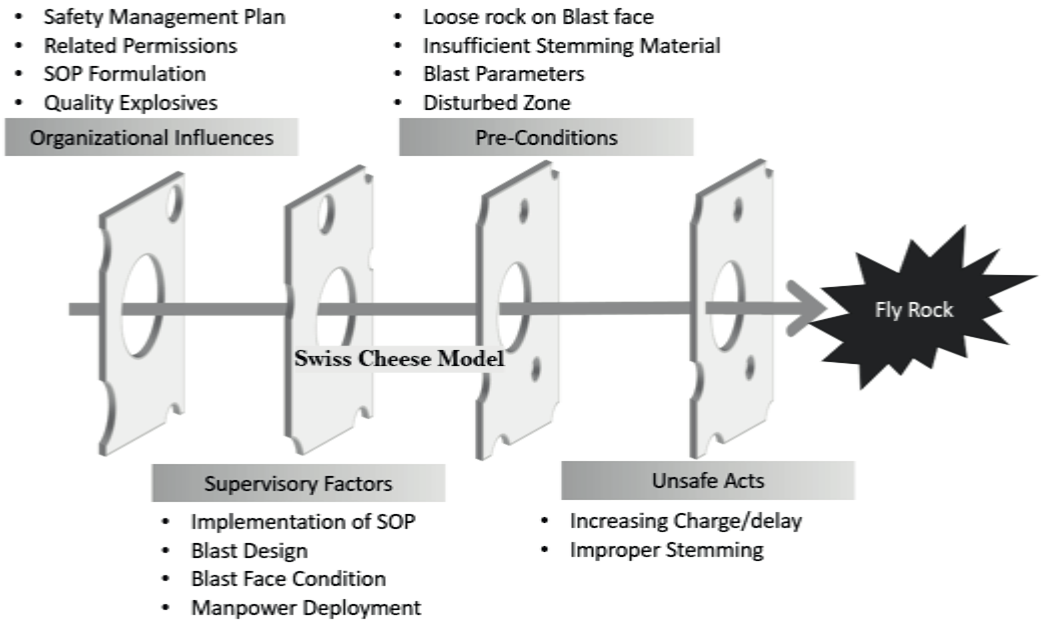
Enhanced incident investigation by mapping out failure pathways.

Improved communication and teamwork through the identification of leadership and coordination gaps.

Targeted interventions at both the organizational and operational levels to strengthen safety protocols.

5. Summary

The Swiss Cheese Model provides a comprehensive framework for understanding and addressing safety risks in mining operations. Its emphasis on both active and latent failures helps organizations adopt a proactive approach to safety management. The HFACS framework further refines this analysis by categorizing and linking failures across multiple levels.



6. Conclusion

The Swiss Cheese Model is an effective tool for analyzing and preventing accidents in the mining industry. By addressing vulnerabilities across all levels of the system, organizations can build resilient safety mechanisms. Future research should focus on integrating advanced technologies, such as machine learning, to predict and mitigate risks dynamically.

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ARTICLE-33

ENSURING ZERO HARM: SAFETY AWARENESS IN NEELACHAL MINES

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Introduction

Tata Steel Neelachal, a pioneering steel producer, has consistently prioritized safety in its mining operations. The company's unwavering commitment tosafety is reflected in its vision of "**Zero Harm**"- a goal that resonates throughout the organization. My aim is to highlight the significance of safety awareness in Tata Steel Neelachal Mines and the measures taken to achieve this vision.

Importance of Safety Awareness

Mining is a high-risk industry, and safety awareness is crucial to prevent accidents, injuries, and fatalities, Tata Steel Neelachal recognizes that safety is not just a statutory requirement but a moral obligation. By fostering a culture of safety awareness. the company ensures:

1. Protection of human life and well-being
2. Prevention of environmental damage
3. Minimization of production downtime
4. Enhanced productivity and efficiency

Tata Steel Neelachal's Safety Initiatives

To achieve Zero Harm, Tata Steel Neelachal has implemented various safety initiatives:

1. **Training and Development**: Regular training programs, workshops, and simulations to enhance employees' skills and knowledge.
2. **Risk Assessment and Management**: Systematic identification and mitigation of hazards.
3. **Safety Audits and Inspections**: Regular checks to ensure compliance with safety standards.
4. **Employee Participation**: Encouraging employees to report safety concerns and suggest improvements.
5. **Technology Integration**: Leveraging innovations like predictive maintenance, loT, and digital monitoring,

Best Practices

Tata Steel Neelachal's Mines adhere to international safety standards and best practices:

1. **Personal Protective Equipment (PPE)**: Mandatory use of safety gear.
2. **Emergency Response Planning**: Comprehensive plans for crisis management.
3. **Incident Reporting and Investigation**: Thorough analysis to prevent recurrence.
4. **Safety Recognition and Rewards**: Incentivizing safe behaviour.

Conclusion

Tata Steel Neelachal's unwavering commitment to safety awareness has yielded significant results:

1. Reduced accident rates
2. Improved employee morale
3. Enhanced productivity
4. International recognition for safety excellence

As a responsible corporate citizen, Tata Steel Neelachal continues to prioritize safety, ensuring a secure and healthy work environment for its mining personnel

ARTICLE-34

खनन सुरक्षा में नवाचार : प्रौधोगिकी और प्रशिक्षण

पटनाला चन्द्र शेखर
रसद विभाग
सानिन्दपुर लौह एवं बॉक्साइट खदानें
रूंगटा संस प्राइवेट लिमिटेड

परिचय

खनन उधोग लंबे समय से विभिन्न जोखिमों और खतरों से जुड़ा है, जैसे कि पत्थर गिरना, उपकरणों में खराबी, और विषाक्त गैस का रिसाव । इसलिए, क्षेत्र में श्रमिकों की सुरक्षा सुनिश्रित करना अत्यंत महत्वपूर्ण है । खनन सुरक्षा में प्रौधोगिकी और प्ररिक्षण के क्षेत्र में नवाचार ने इस उधोग के परिहश्य को महत्वपूर्ण रूप से बदल दिया है। यह लेख नवीनतम प्रगतियों, उनके कार्यान्वयन और उनके श्रमिको की सुरक्षा पर प्रभाव की जांच करता है ।

खनन सुरक्षा का महत्व

खनन संचालन अक्सर ऐसे चुनौतीपूर्ण वातावरण में होते हैं जो श्रमिकों की सुरक्षा के लिए गंभीर खतरों को पैदा कर सकता हैं। ऐतिहासिक रूप से, खनन में कई दुर्घटनांए और जिंसपजपमे हुई हैं। इसलिए, एक मजबूत सूरक्षा संस्कृति आवश्यक है। एक प्रभावी सुरक्षा कार्यक्रम निम्नलिखित लाभ प्रदान कर सकता है :

1. **दुर्घटनाओं और मौतों में कमी** : बेहतर सुरक्षा उपायों से दुर्घटनाओं की संभावना को काफी हद तक कम किया जा सकता है ।
2. **उत्पादकता में वृद्धि** : एक सुरक्षित कार्य वातावरण श्रमिकों के मनोबल और उत्पादकता को बढ़ाता है।
3. **नियामक अनुपालन** : सुरक्षा नियमों का पालन करना कानूनी परिणामों और जुर्माने से बचने के लिए महत्वपूर्ण है।
4. **प्रतिष्ठा में वृद्धि** : जो कंपनियां सुरक्षा को प्राथमिकता देती हैं उन्हे शेयर धारकों और जनता द्वारा सकारत्मक रूप से देखा जाता है।

खनन सुरक्षा के लिए प्रौधोगिक में नवाचार

1. वियरबेल तकनीक

वियरेबल उपकरण खनन सुरक्षा में एक क्रांतिकारी उपकरण के रूप में उभरे हैं। ये उपकरण, जैसे स्मार्ट हेलमेट और सेसर वाले जैकेट, श्रमिकों के स्वास्थ्य और सुरक्षा की रीयल - टाइम निगरानी करने की अनुमति देते है।

स्वास्थय निगरानी : वियरेबल उपकरण जैसे कि स्मार्ट हेलमेट श्रमिकों के जीवन संकेतों जैंसे कि हदय गाति, तापमान, और थकान स्तर को ट्रैक कर सकते हैं। यह डेटा पर्यवेक्षिकों को सचेत कर सकता है यदि कोई श्रमिक गर्मी के तनाव या थकान के जोखिम में है ।

स्थान ट्रैकिंग : GPS- सक्षम वियरेबल उपकरण रीयल - टाइम स्थान डेटा प्रदान कर सकते हैं, जिससे आपात स्थितियों मे श्रमिकों को जल्दी से ढूढना संभव हो जाता है।

2. ड्रोन और हवाई निगरानी

ड्रोन आधुनिक खनन संचालन में अनिवार्य हो गए हैं। वे साइट का परिप्रेक्ष्य प्रदान करते हैं, जिससे सुरक्षित निगरानी और निरीक्षण संभव होता है।

साइट निरीक्षण : ड्रोन खतरनाक क्षेत्रों का मूल्यांकन बिना किसी व्यक्ति को जोखिम में डाले कर सकते हैं। वे उच्च गुणवत्ता वाली छवियां और वीडियो कैप्चर कर सकते हैं ताकि संभावित खतरों की पहचान की जा सके ।

पर्यावरणीय निगरानी : ड्रोन वायु गुणवत्ता और जल स्तर जैसी पर्यावरणीय स्थितियों की निगरानी कर सकते हैं , जिससे सुरक्षा नियमों का अनुपालन सुनिश्रित होता है।

3. स्वचालित मशीनरी

स्वचालन ने खनन संचालन को क्रांतिकारी बना दिया है, विशेष रूप से सुरक्षा को बढाने में । स्वचालित मशीनरी उन कार्यों को कर सकती है जो सामान्यतः मानव श्रमिकों के लिए खतरनाक होते हैं।

दूरस्थ संचालन : ऑपरेटर सुरक्षित दूरी से मशीनों को नियंत्रित कर सकते हैं, जिससे खतरनाक वातावरण में चोट लगने का जोखिम कम होता है ।

पूर्वानुमानित रखरखाव : सेंसर और एआई का उपयोग करके, स्वचालित सिस्टम उपकरणों में खराबी को पहले से पहचान सकते हैं, जिससे डाउनटाइम और दुर्घटनाओं को कम किया जा सकता है ।

4. उत्रत संचार प्रणाली

प्रभावी संचार खनन संचालन में सुरक्षा सुनिक्षित करने के लिये महत्वपूर्ण है। नवाचारित संचार तकनीकों ने श्रमिकों के बीच रीयल - टाइम संचार को बहतर बनाया है।

दो-तरफा रेडियो : आधुनिक दो-तरफा शोर - निष्कासन के साथ सुरक्षित वातावरण में स्पाष्ट संचार सुनिश्रित करते हैं ।

मोबाइल ऐप्स : कई खनन कंपनियों ने मोबाइल एप्लिकेशन विकसित किए हैं जो उपदमे चंतपेंत म ईंत श्रमिकों को खतरो की रिपोर्ट करने, पर्यवेक्षकों के साथ संवाद करनं और सुरक्षा जानकारी तक पहुंचने की अनुमति देते हैं ।

5. सिमुलेशन और वर्चुअल रियलिटी (VR)

वर्चूअल रियलिटी और सिमुलेशन तकनीकें खनन में प्रशिक्षण और आपातकालीन तैयारी को बदल रही हैं।

प्रशिक्षण सिमुलेशन : VR श्रमिकों को वास्तविक खनन वातावरण और परिहश्यों का अनुभव प्रदान करती है बिना किसी वास्तविक खतरे के । यह समर्पित प्रशिक्षण निर्णय लेने के कौशल और आपातकालीन प्रतिक्रिया को बेहतर बनाता है।

आपातकालीन अभ्यास : सिमुलेशन श्रमिकों को विभिन्न आपात स्थितियों जैसे कि उपकरणों में खराबी या गैस रिसाव का सपना करने के लिए तैयार कर सकते हैं, जिससे उन्हें सुरक्षित वातावरण में अपनी प्रतिक्रियाओ का अभ्यास करने का मौका मिलता है।

खनन सुरक्षा के लिए प्रशिक्षण मे सुधार

जैसे-जैसे प्रौधोगिक विकसित हो रही है , प्रशिक्षण विधियां भी विकसित हो रही हैं । आधुनिक सुरक्षा प्रशिक्षण कार्यक्रम नए उपकरणों और विधियों का उपयोग करते हैं।

इंटरक्टिव लर्निंग : गेमिफिकेशन और इंटरएक्टिव मॉडचूल का उपयोग सुरक्षा प्रशिक्षण को अधिक आकर्षक बना सकता है, सिससे सीखने की दर में सुधार होता है ।

काम पर प्रशिक्षण : वास्तविक जीवन की स्थितियों को प्रशिक्षण में शामिल करने मे श्रमिकों को बेहतर तरीके से तैयार किया जा सकता है।

2. निरंतर सीखना और विकाश

सुरक्षा प्रशिक्षण केवल एक बार का कार्यक्रम नहीं होना चाहिए । निरंतर शिक्षा श्रमिकों को नवीतम सुरक्षा प्रथाओ और प्रौघोगिकियों के बारे में सूचित रखती है ।

कार्यशालाएँ और सेमिनार : नियमित कार्यशालॉए आयोजित की जा सकती है ताकि उभरती हुई सुरक्षा तकनीकों और सर्वोत्तम प्रथाओं पर चर्चा की जा सके ।

ई - लर्निंग प्लेटफार्म : ऑनलाईन प्लेटफार्म श्रमिकों को प्रशिक्षण साम्रगी तक उनकी सुविधा के अनुसार पहुंचने की अनुमति देते है, जिससे आत्म - गति से सीखने को बढाता मिलता है।

3. सुरक्षा संस्कृति का विकास

संगठन के भीतर एक सुरक्षा संस्कृत बनाना महत्वपूर्ण है। प्रशिक्षण कार्यक्रमों को न केवल कौशल पर ध्यान केंद्रित करना चाहिए, बल्कि एक ऐसी मानसिकता को बढ़ावा देना चाहिए, जो सुरक्षा को प्राथमिकता देती है।

नेतृत्व प्रशिक्षण : पर्यवेक्षकों और प्रबंधको को सुरक्षा नेतृत्व के बारे में शिक्षा देकर एक ऐसी संस्कृति बनाने में मदद मिलती है जहां सुरक्षा सभी की जिम्मेदारी होती है ।

सहकर्मी प्रशिक्षण कार्यक्रम : अनुभवी श्रमिकों को नए श्रमिकों को प्रशिक्षित करने के लिए प्रोत्साहित करना सहयोगत्मक सुरक्षा संस्कृति को बढ़ावा दे सकता है ।

दुर्घटना रिपोर्टिंग और विश्लेषण प्ररिक्षण

घटनाओ के कारणों को समइना भविष्य की घटनाओं को रोकने के लिए महत्वपूर्ण है। प्रशिक्षण कार्यक्रमो मे ऐसे घटक शामिल हाने चाहिए जो दुर्घटना रिपोर्टिंग और विश्लेषण पर ध्यान केंद्रित करते है।

मूल कारण विश्लेशण : श्रमिको को दुर्घटनाओं की गहन जांच करने के लिए प्रशिक्षित करना मौलिक मुदों की पहचान कर सकता है और प्रभावी समाधान की ओर ले जा सकता है ।

रिपोर्टिंग प्रोटोकॉल : सुरक्षा चिंताओं की रिपोर्ट करने के लिए स्पष्ट दिशानिर्देश श्रमिको को सुरक्षा बनाए रखने में सक्रिय भूमिका निभाने के लिए सशक्त बना सकते हैं ।

सफल नवाचारों के केस स्टडीज

1. BHP Billiton

   BHP Billiton ने अपनी सुरक्षा प्रोटोकॉल में वियरबेल और ड्रोन को शामिल किया है। कंपनी स्मार्ट हेलमेट का उपयोग करती है जो श्रमिकों के स्वास्थय और थकान की निगरानी करते है। ड्रोन का उपयोग हवाई सर्वेक्षण के लिए किया जाता है जिससे व्यक्तियों को खतरनाक क्षेत्रों में जाने की आवश्यकता नही होती ।

2. Rio Tinto

   Rio Tinto ने स्वचालन और दूरस्थ संचालन को अपने खनन प्रक्रियाओ मे अपनाओ है । अनकी स्वचालित ढुलाई ट्रकों का उपयोग करने से दुर्घटनाओं में कमी आई है और संचालन की दक्षता मे वृद्धि हुई है । इसके अलावा, उनकी VR प्रशिक्षण के प्रति प्रतिबद्धता ने उनके कार्यबल की आपात स्थितियों के लिए तैयारी में सुधार किया है।

3. Newmont Corporation

   Newmont ने एक व्यापक प्ररिक्षण कार्यक्रम विकसित किया है पारंपरिक प्रशिक्षण का VR सिमुलेशन के साथ मिलता है। इस कार्यक्रम ने वास्तविक जीवन की चुनौतियों के लिए श्रमिको को बेहतर तरीके से तैयार करके घटनाओं की दर को काफी कम कर दिया है ।

चुनौतियॉं और विचार

हालांकी खनन सुरक्षा में नवाचर कई लाभ प्रदान करते हैं उनके कार्यान्वयन में चुनौतियॉं भी होती है :

1. **प्रौघोगिक की लगत :** नई प्रौघोगिक में निवस करना महंगा हो सकता है विशेषकर छोटे खनन संचालन के लिए । बजट की सीमाएँ नवीनतम सुरक्षा नवाचारों तक पहुंच को सीमित कर सकती है।
2. **परिवर्तन के प्रति प्रतिरोध :** श्रमिको और प्रबंधन में नए तकनीकी या प्रशिक्षण विधियों के प्रति परिवर्तन का प्रतिरोध हो सकता है जो अज्ञात के डर या नए सिस्टम को अपनाने की अनिच्छा के कारण होता है।
3. **डेटा सुरक्षा :** प्रौघोगिकी के बढ़ते उपयोग के साथ मजबूत डेटा सुरक्षा उपायों की आवश्यकता होती है। संवेदनशील जानकारी को साइबर खतरों से बचाना आवश्यक है।
4. **मौजूदा सिस्टम में एकीकरण :** नई तकनीकों और प्रशिक्षण कार्यक्रमों को कार्यान्वित करना मौजूदा संचालन के साथ सावधानीपूर्वक एकीकरण की आवश्यकता है। यह प्रक्रिया जटिल और समय - लेने वाली हो सकती है ।

खनन सुरक्षा नवाचारों में भविष्य की दिशा

1. आर्टिफिशियल इंटेलिजेंस (AI)

AI खनन सुरक्षा को और अधिक बढ़ाने की क्षमता रखता है जो विशाल डेटा का विश्लेषण करके पैटर्न की पहचान कर सकता है और घटनाओं की भविष्यवाणी है। । AI संचालित सिस्टम जोखिम मूल्यांकन और उपकरण रखरखाव में मदद कर सकते है।

2. Iot (इंटरनेट ऑफ थिंग्स)

Iot उपकरण का एकीकरण रीयल - टाइम निगरानी प्रदान कर सकता है जिससे खतरो का बेहतर निर्णय लेना और तेज प्रतिक्रिया संभव हो जाती है।

3. सततता और सुरक्षा

जैसे - जैसे खनन उघोग सतत प्रथाओ की ओर बढ़ता है सुरक्षा नवाचरों को प्रर्यावरणीय विचारो के साथ मेल खाना होगा । ऐसे तकनीकों का विकास जो पर्यावरणीय प्रभाव को कम करते हुए श्रमिकों की सुरक्षा सुनिश्रित करें , महत्वपूर्ण होगा।

4. सहयोगात्मक सुरक्षा पहलो

सुरक्षा मानको सर्वोत्तम प्रथाओ , और साझा तकनीको पर ध्यान केंद्रित करने वाले उघोग - व्यापी सहयोग अधिक व्यापक सुरक्षा समाधान प्रदान कर सकते हैं ।

निष्कर्ष

प्रौधोगिकी और प्ररिक्षण में नवाचार खनन उघोग मे सुरक्षा को नाटकीय रूप से बदलने की क्षमता रखते हैं । इन प्रगतियों को अपनाकर, खनन कंपनियॉं अधिक सुरक्षित कार्य वातावरण , दुर्घटनाओं **की कमी , और सुरक्षा की एक संस्कृति बना सकती हैं। जैसे - जैसे उधोग विकसित होता है प्रौधोगिकी में निरंतर सीखना श्रमिको की सुरक्षा सुनिश्रित करने में महत्वपूर्ण होगा । खनन सुरक्षा का भविष्य नवाचारी तकनीकों व्यापक प्रशिक्षण कार्यक्रमों , और श्रमिको की भलाई को प्राथमिकता देने की अटूट प्रतिबद्धता के प्रभावी एकीकरण में निहित है।**

imfa

Expanding Horizons, Strengthening Ties

India's emergence as the global growth engine is the driving force for us at IMFA. To actively meet the nation's expanding requirements, arising from an emphasis on infrastructure development, we are increasing our ore raising and smelting capacity. As the largest ferro chrome manufacturer in the country, we are committed to 'Make in India' and supply value-added ferro chrome to leading stainless steel producers worldwide.

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Manufactured Sand

- Producing 250 Million BCM per AnnumofMinerals
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- Iron Ore, Coal, Baryte, Manganese, AggregateMining inIndia&Indonesia
- 26YearsOld Company
- 15000Team Strength
- 5000Mining Fleets

"Thriveni" is world class leading Mine Developer & Operator with a revenue of ~USD 1 Billion. We operate some of the largest mines in India, Indonesia and presence in DRC and Australia.

We currently handle and move more than 250 million bcm of minerals and associated Overburden per annum. We have wide experience across a wide range of minerals:

- Largest private iron ore producer in India (42 MTPA)
- Operating single largest coal pit for National Thermal Power Corporation Ltd (NTPC), India (18 MTPA)
- Operating largest Baryte mine in the world for APMDC, India (3 MTPA)
- Thriveni Rebuild Centre (TRC) equipment refurbishment and testing, one of the largest in Asia.
- Integrated Iron ore pellet plant (4MTPA) & Beneficiation plant (4.7MTPA) with underground slurry pipeline of 218Km, one of the largest in India.
- Operating Thermal Coal Mines in Indonesia with an annual production of 4 Million Tons of coal per year.

We have Invested in Lloyds Surjagarh Iron Ore mine, BRPL iron ore slurry pipelines and pellet manufacturing facility at Odisha and Gold mining concession at Jonnagiri.

Thriveni is also the mining service provider with ISO 9001:2008, ISO 14001:2004, BS OHAS 18001:2007

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hriveni Earthmovers

42ND ANNUAL
METALLIFEROUS
MINES SAFETY WEEK
CELEBRATION 2024

POEMS
&
SLOGANS

ସୁରକ୍ଷା ପଥେ

କେଉଁଝର ଠାରୁ କୋରାପୁଟ ଯାଏଁ,
ସବୁଠି ତୁମରି ପାଦ ଚିହ୍ନ
ତୁମେ ଗଢ଼ିଛ କାରିଗର ସାଜି
କେତେ କଳକାରଖାନା, ଖଣି ଖାଦାନ ।
ତୁମରି ବୁହା ଝାଳରେ, ଆମେ ବିଶ୍ୱ ବିଜୟୀ
ତୁମରି ଶ୍ରମରେ ଆମେ ଜିତିଛୁ ମହୀ ।
ତୁମେ ଗଢ଼ିଥିଲ କୋଣାର୍କର
ସୂର୍ଯ୍ୟ ମନ୍ଦିର ଧରମା ସାଜି,
ଆମେ କିନ୍ତୁ ଗଢ଼ିଛୁ ଆଜି
ଶହ ଶହ କଳକାରଖାନା, ଖଣି ଖାଦନ
ତୁମରି ଉତ୍ତର ଦାୟାଦ ସାଜି ।
ସୁରକ୍ଷାର ସବୁ ନିୟମ ମାନି,
ତୁମେ ସାଜିଛ ଆଜି ବିଶ୍ୱ ବିଦ୍ୟାଣୀ
ଧନ୍ୟ ତୁମ ଶ୍ରମ, ଧନ୍ୟ ତୁମ ଦାନ
ଆସନ୍ତା କାଲି ଇତିହାସ ପାଲଟିଯିବ
ତୁମେ ଗଢ଼ିଥିବା ଶ୍ରମର ମନ୍ଦିର ସବୁ
ସାକ୍ଷୀ ହୋଇ ରଚିବ କାହାଣୀ ।
ଧନ୍ୟ ହେ ମୋର ଶ୍ରମିକ ଭାଇ,
ପ୍ରଣତି କରୁଅଛି ତତେ ମଥା ନୁଆଇଁ
କାମ କରିଚାଲ ସୁରକ୍ଷାର ପଥେ
ହସୁଥାଉ ତୁମ ପରିବାର ତୁମରି ସାଥେ ।

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ସରୋଜ କୁମାର ବାଗସିଂହ
ଉପ ପରିଚାଳକ (ଖଣି)
ବାଂଶପାଣି ଲୌହ ଖଣି, ଓଡ଼ିଶା ଖଣି ନିଗମ

"ସୁରକ୍ଷାର ମହାନତା"

କେମିତି ବର୍ଣ୍ଣିବି କିପରି ବର୍ଣ୍ଣିବି ସୁରକ୍ଷାର ମହାନତା,
ଯାହାର ପାଳନେ ବଞ୍ଚେ ଧନଜନ ବଞ୍ଚଇ ଧରିତ୍ରୀ ମାତା ॥

ସୁରକ୍ଷା ଶିକ୍ଷା, ଅଟଇ ଅମୂଲ୍ୟ ଦିକ୍ଷା
ଆପଣାଇ ଭାଇ, ବଢ଼ାଓ ସ୍ୱଜୀବନ ରେଖା
ବିପଦ ସମୟେ ନ ବଞ୍ଚାଏ କେହି ତ୍ରାହି କରେ ଏହି ସୁରକ୍ଷା ॥

ସୁରକ୍ଷା ସାମଗ୍ରୀ ପ୍ରତିଟି ଅଙ୍ଗରେ କରୁଥିଲେ ବ୍ୟବହାର;
ସୁରକ୍ଷା ନିୟମେ କରୁଥିଲେ କର୍ମ ଦୁର୍ଘଟଣା ହୁଏ ଦୂର ॥

ଗାଡ଼ିର ଚାଳନା ଅବା ଖାଦାନ ହେଉ ସେ ନିର୍ମାଣ କର୍ମ;
ସୁରକ୍ଷା ସମଗ୍ରୀ ଅଙ୍ଗେ ଅଙ୍ଗେ ପିନ୍ଧି ମାନିବ ସୁରକ୍ଷା ଧର୍ମ ॥

ଟୋପି ଆଉ ଜୋତା, ଚଷମା, ଦସ୍ତାନା ନାକମୁଖା ଯଦି ଥିବା;
ଏ 'ପଞ୍ଚକବଚ' ଜୀବନ ରକ୍ଷକ ଦେଖି ଯମ ନ ଆସିବ ॥

ଖଣିର ସୁରକ୍ଷା ନିୟମ ମାନିଲେ ଅକାଳେ ଯାଏନା ପ୍ରାଣ;
ସୁରକ୍ଷାକୁ ଜଗି ଥିଲେ ଖାଦାନ ତିଷ୍ଠି ରହେ ଶିଳ୍ପାୟନ ॥

ବ୍ୟକ୍ତିତ୍ୱ ସୁରକ୍ଷା ହୋଇବ ସର୍ବଦା ଶାନ୍ତ ଶିଷ୍ଟ ଭଦ୍ର ପଣେ;
ନାରୀ ସୁରକ୍ଷିତ ହୋଇବ ସମାଜେ ଶୃଙ୍ଖଳିତ ଆଚରଣେ ॥

ମାଓ ଶିବିରରେ ସୁରକ୍ଷାର ଧ୍ୱନି କରାଇଲେ ଗୁଞ୍ଜରିତ;
ଆତଙ୍କବାଦର ବିଲୋପ ଘଟିବ ବିଶ୍ୱ ହେବ ସୁରକ୍ଷିତ ॥

ସୁରକ୍ଷାର ଧ୍ୱଜା ଉଡ଼ିଲେ ସୀମାରେ ଜାତୀୟ ପତାକା ପରି;
ସୁରକ୍ଷାର ବଳ ଲଭିଣ ସୈନିକ ଯୁଝିବ ସେ ସିଂହ ପରି ॥

ଧର୍ମ ଶିକ୍ଷାମାତ୍ର ଦିଏ ବାଇବେଲ ପୁରାଣ, କୋରାନ, ଗୀତା
'ସୁରକ୍ଷା ପୁସ୍ତକ' ବଞ୍ଚାଏ ଜୀବନ ଏହି ତା'ର ମହାନତା ॥

ସୁରକ୍ଷା ଦୀକ୍ଷାକୁ ଆପଣେଇ ନେଇ ପାଳରେ ସୁରକ୍ଷା ନୀତି
ଦୀର୍ଘଜୀବି ହୁଅ ଏ ବିଶ୍ୱ ବଞ୍ଚାଅ ବଞ୍ଚୁ ଏ ମାନବ ଜାତି ॥

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ରଘୁନାଥ ସାହୁ (ମାଇନିଙ୍ଗ ଇଞ୍ଜିନିୟର)
ଓଷ୍ଟାପାଳ ମାଇଁନ୍, ବେଦାନ୍ତ-ଫେକର ଲିମିଟଡେ

ସୁରକ୍ଷା କବିତା

ଆସିଲାରେ ନବ ଦିଗନ୍ତ
ଶପଥ ନେବାରେ ଆସ
ଧ୍ୟାନ ରଖରଲେ ସୁରକ୍ଷା ଦିଗେ
କ୍ଷତି ହେବନାହିଁ ଧନଜୀବନ ଅନ୍ୟ ହାତେ ।
ଆମ ଜୀବନ ଅଟେ ମୂଲ୍ୟବାନ
ଅସୁରକ୍ଷା ମହାକାଳ ଯମ
ଘରେ ବାହାରେ କାମରେ ଧନ
ସୁରକ୍ଷା ଦିଗରେ ରଖିବା ଧ୍ୟାନ ।
ମୁଣ୍ଡରେ ହେଲେମେଟ୍ ପାଦରେ ଜୋତା
ଆପେ ହେବା ଭାଇ ଜଗତ ଜିତା
ବ୍ୟବହାର କରିବା Safety PP କୁ
ଦୁର୍ଘଟଣା ସବୁ ଯିବ ଚୁଲିକୁ ।
ଜୀବନ ଅଟେ ରେ ଦୁର୍ଲଭ
ଜୀବନ ଥିଲେ ସଭିଏଁ ଆମର
ଡ୍ରାଇଭିଙ୍ଗ୍ ସମୟରେ ଫୋନ ନଧରିବା
Ear ଫୋନ କୁ ବାଏ ବାଏ କରିବା ।
ନିଶା ଦ୍ରବ୍ୟକୁ କରିବା ଜୁହାର
ଖଣି ଭିତରେ ହୋଇବା ହାଜର
କାର୍ଯ୍ୟ ସମୟରେ ନିଦ୍ରା ନ ଯିବା
ଯମ ରାଜା ଙ୍କୁ ପାଖ କୁ ନ ଡ଼ାକିବା ।
ଆସ ଭାଇ ଆସ ମିଳିମିଶି କାର୍ଯ୍ୟ କରିବା
ସୁରକ୍ଷା ପ୍ରତି ନ କରିବା ହେଳା
ମୁଖେ ଫୁଟାଇ ହସ କରିବା ଶପଥ
ଆମେ ହେବା ଭାଇ ଜଗତର ଶ୍ରେଷ୍ଠ ।

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ପ୍ରସନ୍ନ କୁମାର ଜେନା (ଖଣି ଯନ୍ତ୍ରୀ)
ମେସର୍ସ ଗୀତାରାଣୀ ମହାନ୍ତି

ଲୁହା ପଥର

ଈଶ୍ୱର ଙ୍କ ସୃଷ୍ଟିରେ ମୋହର ଜନ୍ମ
ପର୍ବତ ଶିଖର ଭୂମି ଗର୍ଭରେ ମୋର ସ୍ଥାନ
ସରକାରୀ ବେସରକାରୀ ସଭି ଙ୍କ ଆଦର
ନାମ ମୋର ଲୁହା ପଥର .....(୧)

ମୋ। ପାଇଁ ଆଜି ହସୁଛି ବିଶ୍ୱ
ନିୟମ ମାନି କରିବ ଉତ୍ତଳନ
ନହେଲେ ହେବ ପତନ ବିଶ୍ୱର
ନାମ ମୋର ଲୁହା ପଥର .....(୨)

ଜନ୍ମ ମୋ ପାଇଁ କେତେ ଯେ ନୂତନ ଶିଳ୍ପ
ସୃଷ୍ଟି ମୋ ପାଇଁ ବିଶ୍ୱ ଇଚ୍ଛିହାସରେ ଗଳ୍ପ
ହାଣ୍ଡିରେ ଭାତ ଦେଇଛି ଗରିବ ଦୁଃଖିଙ୍କର
ନାମ ମୋର ଲୁହା ପଥର .....(୩)

ଖଣି କୁ ମୋର ନେବ ମା' ପରି ଯତ୍ନ
ଶରୀର ଅଟେ ମୋର ମହାରତ୍ନ
ଗର୍ଭଭରୀ ରୋପିଦେବ ଚାରା ମଙ୍ଗଳ ବିଶ୍ୱର
ନାମ ମୋର ଲୁହା ପଥର .....(୪)

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ପ୍ରସନ୍ନ କୁମାର ଜେନା (ଖଣି ଯନ୍ତ୍ରୀ)
ମେସର୍ସ ଗୀତାରାଣୀ ମହାନ୍ତି

ସ୍ୱଚ୍ଛତା ପକ୍ଷ ପାଇଁ ସ୍ଲୋଗାନ

ସ୍ୱଚ୍ଛତା ପକ୍ଷର ଏହି ଆହ୍ୱାନ,
ସ୍ୱଚ୍ଛ ପରିବେଶ ସୁସ୍ଥ ଜୀବନ ।
ଆସ ମିଳିମିଶି ନେବା ଶପଥ,
ଗଢିବା ଆମେ ସ୍ୱଚ୍ଛ ଭାରତ ।
ବିଦ୍ୟାଳୟ ଆମ ମନ୍ଦିର ପରା,
ରଖିବା ତାହାକୁ ସଫା ସୁତରା ।
ପରିବେଶ ତାର ସ୍ୱଚ୍ଛ ରଖିବା,
ଆବର୍ଜନା ସବୁ ଦୂରେଇ ଦେବା ।
ସ୍କୁଲ୍, କଲେଜ ଓ ଡାକ୍ତରଖାନା,
ରଖିବାନି ଏଠି ଆବର୍ଜନା ।
ସର୍ବସାଧାରଣ ସ୍ଥାନ ଗୁଡ଼ିକୁ,
ସଫା ସୁତୁରାଟି ରଖିବା ତାକୁ ।
ପଚା ଗନ୍ଧମୟ ପରିବେଶଟି,
ଅଟେ ଭୟଙ୍କର ମହା ବିପତ୍ତି ।
ଏଥିରୁ ନିସ୍ତାର ପାଇବା ପାଇଁ,
ହୁଅ ସଚେତନ ଭଉଣୀ ଭାଇ ।
ନର୍ଦ୍ଦମାରେ ଜମେ ମଇଳା ଜଳ,
ନ ପକାଇ ମଇଳା ରଖ ନିର୍ମଳ ।
ଜମିଗଲେ ସେଠି ମଇଳା ଜଳ,
ସଫା କରିବାକୁ ନଥିବ ବେଳ ।
ପୋକ, ମଶା, ମାଛି ଜନ୍ମିବେ ସେଠି,
ଡେଙ୍ଗୁ ଓ ମେଲେରିଆ କରିବେ ସୃଷ୍ଟି ।
ପଲିଥିନ ଅଟେ ବଡ଼ ବିପଦ,
ହଜାଇଛି ଏହା ସବୁରି ନିଦ ।
ବ୍ୟବହାର ତା'ର ଏବେ ରୋକିବା,
ଆମ ପରିବେଶ ସ୍ୱଚ୍ଛ ରଖିବା ।

ଡଷ୍ଟବିନ୍ ରଖ ଘରେ ଘରେ ଟି,
ମଇଳାକୁ ନିତି ପକାଅ ସେଠି ।
ବ୍ୟକ୍ତିଗତ ପରିଚ୍ଛନ୍ନତା ପାଇଁ,
ହେବା ସଚେତନ ଭଉଣୀ ଭାଇ ।
ଆମ ପରିବେଶ ଆମ ସମ୍ପତ୍ତି,
ପହଁଞ୍ଚାଇବାନି ତାକୁ ବିପତ୍ତି ।
ପରିବେଶ କଥା କରିବା ଚିନ୍ତା,
ନ ହେଲେ ଜୀବନ ହୋଇବ ବୃଥା ।
ପରିବେଶ ଥିଲେ ସ୍ୱଚ୍ଛ ନିର୍ମଳ,
ବଞ୍ଚି ରହିଥିବା ଅଧିକ କାଳ ।
ଆସ ମିଶାଇବା ତାହାକୁ ହାତ,
ଦେଶକୁ ରଖିବା ମଇଳା ମୁକ୍ତ ।

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ଇତିସ୍ମିତା ମହାନ୍ତି (ନବମ ଶ୍ରେଣୀ)
ଶିଆଳିଯୋଡ଼ା
MGM Mineral Limited
Patabeda Iron Mines

सुरक्षा स्लोगन

- आपनो सुरक्षा अपने हाथ मे ।
- पहले सुरक्षा फिर सब काम ।
- सुरक्षा पर ध्यान दे, जीवन को सुरक्षित बनाऐ ।
- सुरक्षा को अपनी पहलो प्राथमिकता बनाऐं ।
- सुरक्षा हरदम पहनो उचित साधन ।
- सुरक्षित काम है, कर्तव्य हमारा सुरक्षित जीवन से जुड़ा है परिवार हमारा ।
- करना है बहुत काम पर सुरक्षा पर भी हो अपना ध्यान ।
- काम के बाद काम के साथ आपकी सुरक्षा आपके हाथ ।
- काम करो तन से सुरक्षा पालन करो मन से ।
- काम करते समय न करो बात नही तो दुर्घटनाओं से होगो मुलाकात ।
- जीवन तो है असली कमाई सुरक्षा से हो भलाई
- जो सुरक्षा से दोस्तों तोडेगा वहा एक दिन दुनिया छेडेगा
- यह इतिहास गवाही है बिन सुरक्षा तबाही है ।
- सुरक्षा जीवन का अर्थ है सुरक्षा के बिना सब व्यर्थ है ।
- सुरक्षित जब रहोगे आप तभी दे पायेंगे अपनो का साथ ।
- दुर्घटना पर लगेगा ताला जब पहनोगे सुरक्षा की माला

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ईतिस्मिता महान्त
(नवमीं कक्षा)
MGM Mineral Limited
Patabeda Iron Mines

खनन सुरक्षा में नवाचार

गहराइयों में जहॉ साया छाया
जहॉ कहानियॉ बुनती है फसना
मजदूर brave, दिलों में होंसला

पर खतरे छिपे हैं हर एक मोड़,
एक अंधरे सपने का सुनता शोर,
पर प्रौधोगिकी की किरण चमकीली,
अंधरे मे लाती है उजाला प्यारा ।

वियरेबल तकनीक, हेलमेट पर सजे,
स्वास्थय की निगरानी, आसमान में बहें,
सेसंर दिल की धड़कन को बताते,
गर्मी में सुरक्षा, सभी को समझाते ।

ड्रोन उडते हैं ऊँचाई पर,
सुरक्षित हष्टि से करते हैं वे सागर
अब उतरना नहीं होगा जोखिम मे,
हवा मे देखेंगे हर कोने में ।

स्वचालित ट्रक, आसान सफर ,
ओर ले जाते , बरसात या बर्फ ,
दूरी बनी रहे खतरा कम हो,
इस लोह की बाहों में , खतरे दबोचो ।

वर्चुअल दुनिया, जहॉ प्रशिक्षण मिले,
सिमुलेटेड परिहश्यो में वे जिंए
चुनौतियो का सफना , वे तैयार हों ,
आपात स्थितियों में, वे सेशक्त हो। ।

संचार की धारा एक सुहढ प्रवाह,
रेडियो की गूंज में, सुरक्षा का ध्वज,
खतरों की रिपोर्ट समाचार साझा,
एकता में है शक्ति ये सच का उजाला ।

हर उपकरण और नए प्रशिक्षण के संग,
संस्कृति बदलती , आत्मा है ऊची,
इस दुनिया में , जहॉ गिट्टी और पत्थर ,
सुरक्षा की रौशनी चमकीले चॉद की तरह ।

तो यहॉ उन पर, जो मेहनत करें ,
नवाचार के साथ , जो जीते रहें,
एक सुरक्षित मार्ग का वादा ,
खनन के दिल में , जहॉ छायाऍ खेले ।

पटनाला चन्द्र शेखर
सानिन्दपुर लौह एवं बॉक्साइट खदानें
रूंगटा संस प्राइवेट लिमिटेड

सेफ्टी स्लोगन

ध्यान में रखो एक बात,
अपना सुरक्षा अपने हाथ
सुरक्षा से अपना नाता जोड़ो,
दुर्घटनाओं से अपना मुँह मोडो
लापरवाही से अपना जान ना गवाए,
सुरक्षा को अपनाएं
खतरो को दूर भगाएं,
सुरक्षा को गले लगाए
सावधानी हटी, दुर्घटना घाटी
सुरक्षित जीवन का अर्थ हैं
सुरक्षा के बिना सब ब्यर्थ है
एक भुल करे नुकसान,
छीने खुशियॉ और मुस्कान
सुरक्षा से जो नाता तोड़ेगा,
वाह एक दिन दुनिया छोड़ेगा
खुद के जीवन को अगर है बढाना,
हमेसा सुरक्षा नियमों को अपनाना
काम के बाद काम के साथ,
आपकी सुरक्षा आपके हाथ
नसीब समझ कर छोडो मत,
सुरक्षा नियम को तोडो मत
लगाओ काम पर सुरक्षा का पहरा,
फिर ले जाओ घर मुस्कुराता चेहरा
जरा संभाल के करो काम,
कहीं ना हो जाये जीवन की शाम
काम करते समय ना करो बात,
नही तो दुर्घटनाओं से होगी मुलाकात
यह इतिहास गवाह है,
बिना सुरक्षा तबाही है
जरा देख कर रखो कदम,
जिदंगी नहीं मिलती हर दम
अपने कार्य की हरदम करो समीक्षा,
सुरक्षा से काम करने पर प्रबल होगी इच्छा
हर कार्य के पहले जानो,
सुरक्षा के हर मापदंड को पहचानो
सुरक्षित ढंग से काम हो,
सारे सपने साकार हो
सुरक्षा से बगावत,
दुर्घटना को दावत
काम से अगर नजर हटेगी,
तो भाई जरूर दुर्घटना घटेगी
कश्मीर हो या कन्याकुमारी,
काम में सुरक्षा है बहुत जरूरी

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सुजीत कुमार एक्का
सीनियर ईलेक्ट्रीशियन
लांजीबेडा लाईमस्टोन एंड डोलोमाइट मांईन्स
डालमिया सीमेंट

RHYMING SAFETY SLOGANS

Don't be a fool, use the proper tool
Dare to be aware
If you mess up, fess up
A spill, a slip, a hostes trip
Safety first, Avoid the worst
To avoid a Scent, Keep your work place clean
Do your work with pride, Put Safety in every Stride
Turn your attention to accident prevention
Be aware, Take care
With Safety glasses tight,
You will surely keep your sight
When in doubt, Get out
Don't be Safety blinded, Be Safety minded
Work Smart from the start
Be informed or be deformed
Safety is gainful, Accident is painful
When Safety is first, You last
Safety rules are your best tools
Don't be a fool, Inspect your electrical tools
A faulty wire can cause a fire
Make it a mission to address unsafe conditions

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SAFETY SLOGANS

Safety is no accident
Never forget about Safety
Best be safe Today
Stand up for Safety
Out goal - Zero Harm
We need you work Safety
Prevention is better than cure
Safety is free, Use plenty of it
Prepare & Prevent instead of repair & repent
Stop ! Think ! Then act !
KISS - Keep It Safe and Sound
Zero compromise towards Safety
Leave Sooner, drive Slower, Live Longer
Watch your Step - It could be your last
Failing to prepare, Prepare to fail
Just because you always did it that way,
doesn't make it right

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FUNNY SLOGANS

Safety First because injuries last
Machines and tools do not hare brain - use your own
If you lift with your back, you'll hear it crack
Your first mistake could be your last
Hearing protection is a sound investment
Don't learn Safety by accident
Your hands do not come with a life time warranty
If you think your job is hard now, try doing it without hands
Shortcuts cut life short
The only trip you take should be an vacation.

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Satya Ranjan Sahoo
Mining Foreman, NINL Mines

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MINES SAFETY

In the heart of the earth, where shadows creep,
Miners toil while the mountains sleep.

With pick and drill, they carve the way,
Bringing light to the darkest day.

But beneath the rock, danger hides,
In narrow shafts and shifting tides.

The ground may tremble, dust may rise,
Yet safety shines in watchful eyes.

A helmet strong, a sturdy boot,
Each step secured, each path astute.

For every miner, bold and brave,
A safe return is what we crave.

With every warning bell that rings,
It's courage safety always brings.

For in the mines, where treasures gleam,
A life protected is the dream.

So take your care with every breath,
Guard your path, and guard from death.

For in this world of iron and coal,
Safety is the miner's goal.

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Sasmita Behera
Jr. Professional (Forest & Environment)
Banspani Iron Ore Mines
M/s OMC Ltd.

Growing Happiness and Safety

In Odisha's hills, where treasures lie,
Odisha Mining Corporation reaches high.

With hard work and care, they dig the ground,
Bringing wealth and joy all around.

The workers arrive with smiles each day,
Knowing safety leads the way.

Helmets on, boots secure,
Their work is safe, their steps are sure.

But OMC does more than just dig deep,
They help the villages wake from sleep.

Through CSR, they lend a hand,
Building schools, roads, across the land.

In nearby blocks, districts grow,
With OMC's support, futures glow.

Arogya Bahini brings medicines near,
So, every heart can beat without fear.

Nature is loved, and cared for too,
Every step they take, they think it through.

Safety, health, and progress shine,
OMC spreads hope through every line.

With each stone they lift, and every plan,
Odisha Mining helps dreams expand.

Building futures strong and true,
OMC brings joy to me and you.

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Nahum Garada
Banspani Iron Ore Mines
M/s OMC Ltd.

Road Safety

Your brain is brilliant
Keep it safe and sound.
Stop, look and Listen,
Before You cross the Street,
Use your Eyes and use your Ears,
Before you use your Feet

What does Safety Mean to Me

I could have saved a life that day,
But chose to look the other way.
It wasn't that I did not care,
I had the time and I was there,
But I didn't want to seema fool,
On argue over a safety rule,
I knew he'd done the job before,
If I spoke up, he might get sore.

I never lose faith for I have strength

Sometimes I fall but brings me back up,
They bring me down, but I stay strong
I have the power to be brave, my strength is there to be.
I feel protected for my family is here
They are strong which keeps me aware,
But the danger still lurks out there
For Iam aware I will be brave
Strength is with me and never will I back down
I am warrior strong and proud.

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Pradeep Kumar Patra
Maliparbat Bauxite Mines

GUARDIANS OF THE DEPTHS

Patnala Chandra Sekhar
Logistics Department
Sanindpur Iron & Bauxite Mines
M/S Rungta Sons (Pvt) Ltd

In caverns deep where shadows dwell,
Beneath the earth's protective shell,
Brave souls descend, their hearts align,
With tools in hand, their quest divine.

With helmets bright and vests aglow,
They tread on paths where few may go,
Each echoing footstep, a promise made,
To honor the risks and the lives conveyed.

Through dust and rock, the whispers say,
"Safety first" is the guiding way,
For every shift, each day anew,
A sacred trust, they hold so true.

The hum of machines, a rhythmic song,
Where teamwork flourishes, brave and strong,
Innovations spark with a glowing light,
Drones in the sky, keeping watch in flight.

Wearable pulse with life's own beat,
Monitoring health, a protective feat,
Training in halls where knowledge flows,
Empowered minds, where safety grows.

Yet still they pause, with reverent grace,
For those who've gone, they hold their space,
In memory's light, their stories soar,
A reminder to guard what we all adore.

So here's to the miners, bold and wise,
Who brave the depths beneath the skies,
May safety guide their every way,
In the heart of the earth, come what may

SHIVA

A SUBSIDIARY OF JSW Cement

BUILDING INDIA'S FUTURE

1.5 MTPA in Sustainable Clinker Production

AM/NS INDIA

ArcelorMittal Nippon Steel India

REIMAGINEERING AVIATION

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SMARTER
STEELS
BRIGHTER
FUTURES