FACTORS FOR MINE ACCIDENTS AND HAZARDS IN OPEN CAST AND UNDERGROUND COAL AND NON COAL MINES IN INDIA

Dr.R.Giri Prasad1, Dr.P.Brahmaji Rao2, E.Nandish Goud3,
Associate Professor, Professor, Assistant Professor
Dept. of Petroleum Technology,
Aditya Engineering College (A), Surampalem, India.

ABSTRACT
At a time when multiple agencies are involved in the rescue of 15 miners trapped in a rathole mine in Meghalaya, data tabled in the Lok Sabha earlier this week revealed that 377 workers involved in **mining** of coal, minerals and oil were killed in accidents between 2015 and 2017.
Of the 377 deaths, 129 occurred in 2017 alone. As many as 145 died in 2016, while the figure was 103 in 2015.
Coal mines have accounted for the highest number of casualties due to accidents in mines. Of the 377, more than half, 210, were killed in coal mines. These figures were provided by the Labour and Employment Ministry on December 31, 2018 .Jharkhand, which recorded 69 deaths (11 in 2015, 46 in 2016 and 12 in 2017) in the three years, has accounted for the highest death of coal mine workers in accidents inside mines. Goda in Jharkhand witnessed one of the biggest open cast mine accidents in 2016 when 23 workers died in December that year. Telangana recorded 32 deaths in these three years while Madhya Pradesh registered 29.
During the period, 152 persons died in accidents in metal mines across the country. Rajasthan, one of highest mineral producing States in the country, accounted for 48 deaths (20 in 2015, five in 2016 and 23 in 2017) while Andhra Pradesh recorded 29 deaths. During this period, 15 deaths were reported in oil mines, most of them occurring in Assam and Gujarat.

INTRODUCTION

For any industry to be successful it is to identify the Hazards to assess the associated risks and to bring the risks to tolerable level. Mining activity because of the very nature of the operation, complexity of the systems, procedures and methods always involves some amount of hazards. Hazard identification and risk analysis is carried for identification of undesirable events that can leads to a hazard, the analysis of hazard mechanism by which this undesirable event could occur and usually the estimation of extent, magnitude and likelihood of harmful effects. It is widely accepted within industry in general that the various techniques of risk assessment contribute greatly toward improvements in the safety of complex operations and equipment.

Hazard identification and risk analysis involves identification of undesirable events that leads to a hazard, the analysis of hazard mechanism by which this undesirable event could occur and usually the estimation of extent, magnitude and likelihood of harmful effects. The objective of hazards and risk analysis is to identify and analyze hazards, the event sequences leading to hazards and the risk of hazardous events.

Mining is a hazardous operation and consists of considerable environmental, health and safety risk to miners. Unsafe conditions in mines lead to a number of accidents and cause loss and injury to human lives, damage to property, interruption in production etc. The following section presents the different hazards in surface and underground mines, their precautions and statistics of accidents in coal and non-coalmines.

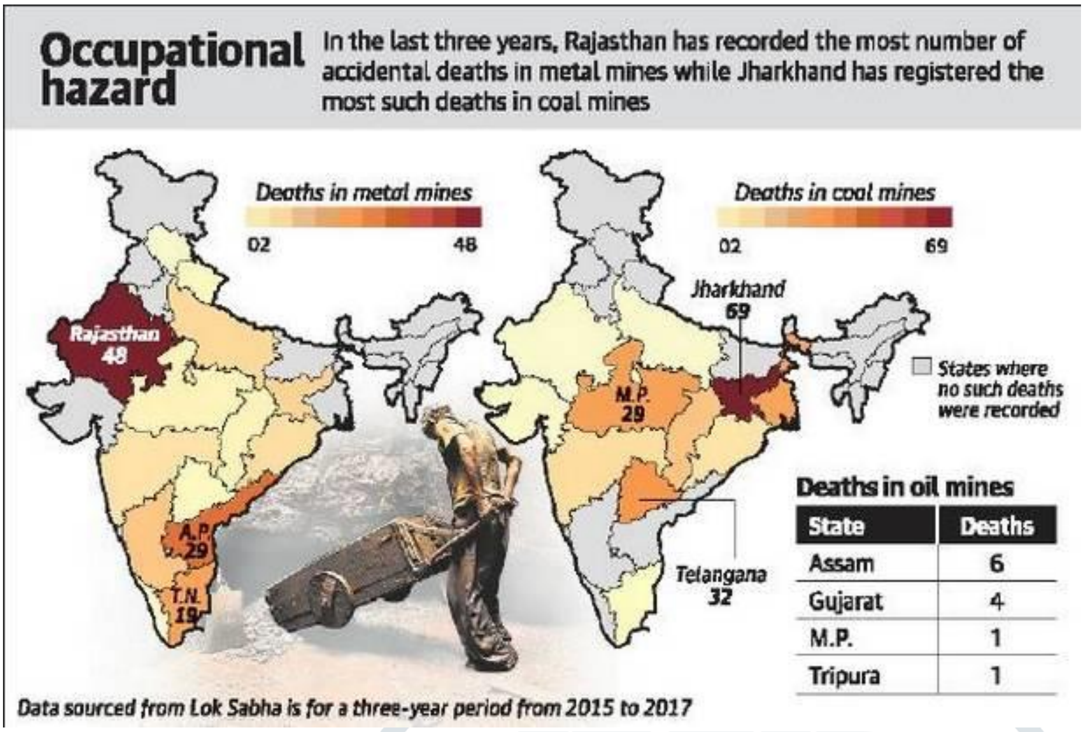

Fig.1 Mine accidents in India

HAZARDS IN DIFFERENT OPERATIONS AND PRECAUTIONS IN SURFACE MINES

Major Accidents in the Indian Coal Mines
The major accidents in the Indian Coal Mines (post Independence period) (1952-2005)

S.N.	Dates of Accident	Name of Mines	Fatalities	Cause
1	12/07/1952	Dhemomain	12	Roof fall
2	05/08/1953	Majri	11	Inundation
3	14/03/1954	Damra	10	Explosion of fire damp.
4	10/12/1954	Newton Chikli	63	Inundation
5	05/02/1955	Amlabad	52	Explosion of fire damp.
6	26/09/1956	Burra Dhemo	28	Inundation
7	19/02/1958	Chinakuri	175	Explosion of fire damp.
8	20/02/1958	Central Bhowra	23	Inundation
9	05/01/1960	Damua	16	Inundation
10	28/05/1965	Dhori	268	Coal dust explosion
11	11/04/1968	West Chirmiri	14	Premature collapse of workings
12	18/03/1973	Jitpur	48	Explosion of fire damp.
13	08/08/1975	Kessurgarh	11	Roof fall
14	18/11/1975	Silewara	10	Inundation
15	27/12/1975	Chasnala	375	Inundation
16	16/09/1976	Central Saunda	10	Inundation
17	04/10/1976	Sudamdih	43	Explosion of fire damp.
18	22/01/1979	Baragolai	16	Ignition of fire damp
19	24/08/1981	Jagannath	10	Water gas explosion
20	16/07/1982	Topa	16	Roof fall
21	14/09/1983	Hurriladih	19	Inundation
22	13/11/1989	Mahabir	6	Inundation
23	25/01/1994	New Kenda	55	Fire/suffocation by gases
24	26/09/1995	Gaslitand	64	Inundation
25	06/07/1999	Prascole	6	Fall of roof/collapse of workings
26	24/06/2000	Kawadi	10	Failure of OC bench
27	02/02/2001	Bagdigi	29	Inundation
28	05/03/2001	Durgapur Rayatwari	6	Collapse of partings/workings

29	16/06/2003	Godavari Khani-7LEP	17	Inundation
30	16/10/2003	GDK-8A	10	Roof fall
31	15/6/2005	Central Saunda	14	Inundation

Source: http://www.coal.nic.in

The major hazards due to different mining operations and their prevention and control are as outlined below:

Surveying

- Fall fromheights.
- Thrown from overturningvehicle.
- Since hazards are by ground formation it is unlikely to be removed.
- By the use of good properly constructedscaffolds.

Clearance

- Struck by falling tree and debris from demolitionbuilding.
- Can be avoided by using trainedoperator.
- Use of power saw or by other equipment used for removal of topsoil.
- Avoided by wearing full personal protection byoperator.

Laying out

- Hazards prevalent during construction ofbuilding.
- Single storey building is less hazardous than a larger higher storebuilding.
- Hazard during construction ofroadways.
- Roadways on level ground will involve fewer hazards than on inclined terrain.
- Overhead electricitylines.
- Falling while working atheight.
- Avoid driving at the edge of roadway underconstruction.
- Plant moving out ofcontrol.
- Well maintained plant and equipment reduces risk of injury.
- Individual struck by moving vehicle.
- Heavy earth moving equipment and vehicle drivers and those giving signals should be well trained.

Drilling

- Falling from the edge of a bench.
- Part of training should include instructions to face towards the open edge of the bench so any inadvertent backward step is away from the edge.
- Provide suitable portable rail fencing which can be erected between the drilling operations and the edge of the mine.
- Attachment of a safety line to the drilling rig and provide harness for the driller to wear.
- Inhalation of dust created during drilling operation.
- Use water during the drilling operations.
- Providing a ventilation system on drilling rig with dust filter to remove harmful dust.
- Noise
- Risk is higher in older machines.
- Newer drill machines are provided with cabin which controls noise level within cabins.
- Providing operators with ear protection.
- Entrapment of being struck by a moving and revolving part of the drill equipment.
- Accidents will be lowered by properly guarding dangerous parts of the equipment.
- Operators must be well trained and supervised.

Explosives

- Poorly designed shots can result in misfires early ignition and flying rock.
- Safety can be ensured by planning for round of shots to ensure face properly surveyed, holes correctly drilled, direction logged, the weight of explosion for good fragmentation.
- Blast design, charge and fire around of explosives should be carried out by a trained person.

Face stability

- Rock fall or slide
- Regular examination of face must be done and remedial measures must be taken to make it safe if there is any doubt that a collapse could take place.
- Working should be advanced in a direction taken into account the geology such that face and quarry side remain stable.

Loading

- Rock falling on the driver.
- Plant toppling aver due to uneven ground.
- Failure of hydraulic system.
- Fires

- Fall while gaining access to operating cabin.
- Electrocution in Draglines.
- Failure of wire ropes in Draglines.
- Operator cabin should be of suitable strength to protect he driver in event of rock fall.
- Electrical supply to dragline should be properly installed with adequate earth continuity and earth leakage protection.
- Wire rope should be suitable for work undertaken and be examined periodically.
- Ensure that loaders are positioned sufficiently away from face edges.

Transporting

- Brake failure
- Lack of all-around visibility from driver position
- Vehicle movements particularly while reversing
- Rollover
- Vibrations
- Noise
- Dust and maintenance
- Visibility defects can be eliminated by the use of visibility aids such as closed circuit television and suitable mirrors.
- Edge protection is necessary to prevent in advertent movement.
- Seatbelt to protect driver in event of vehicle rollover.
- Good maintenance and regular testing necesary to reduce possibility of brake failure.
- Processing of mineral

Crushing

- Blockages
- High noise
- Dust
- Vibrations
- Use of hyraulic hammers to break up blockages.
- Provide noise isolators and provide mechanical ventilation systems designed to remove any harmful dust.

Grinding

- Noise
- Dust
- Entrapment
- Confineds paces
- Chemical additives
- Noise and dust hazards can be reduced by providing noise isolation devices and air filtration system.
- Chemical additives can be reduced by the adaptation of normal preventative measures such as substitution automated pipe feeds personal protection.

Screening

- Dust
- Noise
- Vibration
- Fall from height during maintenance
- Protective equipment to safeguard against inhalator of residual dust.

HAZARDS IN UNDERGROUND WORKING

- Fall of roof andsides
- Roof and side of working should be keptsecure.
- Support should be set as per systematic supportrules.
- Fencing should be provided in unauthorized area.
- Workers should not be permitted to work under unsupportedroof.
- Safety prop with drawers should beused.
- Temporary supports should be provided before clearingroof.
- Collapse of pillar in coalmines
- Stook left in depillaring must be kept of adequatesize.
- Air blast
- Extensive area of un-collapsed roof should not be allowed toexist.
- Seams with strong and massive roof rocks more no. of entries should be kept open.
- Shelters should be provided at suitablesites.
- Installation of warning system to warn people about imminent airblast.
- Rock burst and bumps

Rope haulage

- Runaway of tubs due to breakage of rope, failure of attachment to rope, failure of couplings anddrawbars.
- Rope should be selected properly and maintained withcare.
- Non functionality of safetydevices.
- Travelling along haulageroadway.
- Unauthorised travelling on haulage roadways should be strictlyprohibited.
- Uncontrolled movement of tubs.
- Derailment oftubs.
- Bad patches in the track should becorrected.

- Poor construction ofcurves.
- Haulage curves should be properly designed andconstructed.

Electricalhazards

- Electric shock and/orburn.
- Ignition of firedamp or coaldust.
- Fire arising from electricdefects.
- Inspect equipment regularly for signs of overheating, partial discharge and mechanicaldamage.
- Inspect earthing pointregularly.
- Use of flameproof and intrinsically safeapparatus.
- Cables should be provided with double wire armouring.

Fire hazard

- No petrol power equipment must be permitted.
- Hard held extinguishers should be provided in various places inmines.
- All underground equipment containing more than 100 litres of flammable hydraulic fluid must be fitted with an automatic suppression system with suitable manualactivation.
- Storage of flammable substances must be minimised.

Inundations

- No working should be done vertically below any river, lake or otherreservoir.
- If there is a river nearby entrance into a mine shall be constructed and maintained such that lowest point of its mouth is not less than 1.5m above the highest flood level at thatpoint.
- Shaft sites should be located away from faults and other geologicaldisturbances.
- All abandoned shaft and boreholes not required for any purpose should be filled up with debris and sealingmaterial.
- In case of presence of highly water bearing strata in the vicinity of the proposed working mining should be so planned as not to disturb the water bearing strata.

Ventilation

- Failing of coolingsystem.
- Oxygen deficiency
- Gas evolution fromcoal
- Presence of CO

- Presence of CO_2
- Presence of H_2S
- Presence of NO_X
- Increase in temperature due to rock temperature and heats from machines

Illumination

Insufficient illumination system

Permanent lighting should be provided in places where equipment can be hazardous.

Separate and independent emergency light source should be provided at all places where a hazard could be placed by failure if light.

RESULTS AND DISCUSSION

The high risk in the coal mine were due to the fly rock on blasting which can be reduced by the following the steps like planning of round of shots, holes correctly drilled, direction logged, weight of explosive suitable for good fragmentation and to ensure its safe use. The problem due to the operation of large number of transport vehicles which cause lots of noise, dust and may even affect people in an accident so the roads must be properly and evenly spread for safe and comfortable movement of machines and proper traffic signals and boards should be installed over certain distance. Improper use of personal protective equipment can be managed by appointing security specially to check if all are wearing personal protective equipment and if not the entry in the working are should be prohibited. The problem of inundation can be solved by making embankments to prevent mine from flooding and if possibility of happening is high then layout of seam wise working should be developed and anticipate its impact on surface features and structures and if the impact and dangers are excessive re-plan to bring them to minimum possible level.

REFERENCES

1. Duijm, N. J., (2001), Hazard analysis of technologies for disposing explosive waste, Journal of Hazardous Materials, A90, pp. 123–135.

2. Dziubinski, M., Fratczak, M. and Markowski, A. S., (2006), Journal of Loss Prevention in the Process Industries, Vol. 19, pp 399-408.

3. Khan, F. I. and Abbasi, S. A., (1998), Techniques and methodologies for risk analysis in chemical process industries, Journal of Loss Prevention in the Process Industries, Vol. 11, pp. 261-277.

4. Jeong, K., Lee, D., Lee, K. and Lim H., (2008) A qualitative identification and analysis of hazards, risks and operating procedures for a decommissioning safety assessment of a nuclear research reactor, Annals of Nuclear Energy 35, pp.1954–1962.

5. Jelemenesky, L., Harisova, J. and Markos, J., (2003), Reliable risk estimation in the risk analysis of chemical industry case study: Ammonia storage pressurized spherical tank, 30th International Conference of the Slovak Society of Chemical Engineering, Vol. 58, pp. 48-54

6. Khan, F. I., Husain T., and Abbasi S. A.,(2001), Safety weighted hazard index (Swehi) - A new, user-friendly tool for swift yet comprehensive hazard identification and safety evaluation in chemical process industries, Institution of Chemical Engineers Transactions, Vol. 79, pp. 65- 80.

7. Kecojevic, V. and Radomsky, M., (2004), The causes and control of loader- and truck-related fatalities in surface mining operations, Injury Control and Safety Promotion, Vol. 11, No. 4, pp. 239–251.

8. Kecojevic, V. and Nor, Z. Md., (2009) Hazard identification for equipment-related fatal incidents in the U.S. underground coal mining, Journal of Coal Science and Engineering, Vol.15, pp. 1-6.

9. Laul, J. C., Simmons, F., Goss, J. E., Boada-Clista, L. M., Vrooman, R. D., Dickey, R. L., Spivey, S. W., Stirrup, T. and Davis W., (2006) Perspectives on chemical hazard characterization and analysis process at DOE, Chemical Health and Safety, July/August, pp.6-39.

10. Lambert, J. H., Haimes, Y. Y., Li, D., Schooff, R. M. And Tulsiani V., (2001), Reliability Engineering and Safety System, Vol. 72, pp. 315-325.