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AN OVERVIEW OF SAFETY IN INDIAN MINING INDUSTRY

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ABSTRACT

There is a growing concern for the health and safety of workers and nearby residents as well as the environment. Pressure from trade unions, human rights and environment protection activists have resulted in imposition of stringent safety regulations on mining industry. In this paper, while focusing on the Indian mining industry, the activities related to the mining process and the hazards associated therewith is discussed. Major accidents have been analyzed and safety measures aimed at minimizing the occurrence of accident as well as the impact of accident is also discussed.

KEYWORDS: Mining industry, process, hazards, accident analysis, safety management.

INTRODUCTION

Overview of Indian Mining Industry: This industry contributes significantly to the Indian economy and employs over one million persons on a daily average basis. India is the largest producer of mica (60 % of world production), 3rd. largest producer of iron ore, 3rd. largest producer of coal, 5th. largest producer of bauxite, 7th. largest producer of manganese, produces 12 % of world's thorium. India also produces other fuels (lignite, natural gas, petroleum), other metals (copper, gold, lead, zinc) and other non metals (diamond, gypsum, limestone, marble, phoshorite, sulphur) for domestic use as well as export.[1] The Chota Nagpur plateau (Jharkhand, Orissa and West Bengal) contributes about 100 % kyanite, 93 % iron ore, 84 % coal, 70 % chromite, 70 % mica, 50 % fire clay, 45 % asbestos, 45 % china clay, 20 % limestone, 10 % manganese along with production of bauxite, copper, beryl and apatite. The central belt (Chattisgarh and parts of Andhra Pradesh, Madhya Pradesh and

Maharashtra) contributes significantly to uranium, limestone, manganese, marble, coal, gems, mica, bauxite and graphite production.

Earlier mines were privately owned and operated under the Mines Act of 1901. After independence, these were nationalized and merged with Central Governmental agencies like Eastern Coalfields Ltd. (ECL) and have been operating under the Mines and Minerals (Development and Regulation) Act of 1957 (amended in 1999 as per the guidelines of National Mineral Policy of 1993). Overseeing all mining activities and regulating the use of all mineral resources (except natural gas, petroleum and atomic minerals) is done by Indian Ministry of Mines. Systematic surveying, prospecting and exploration for minerals as well as preparing feasibility report is undertaken by the Geological Survey of India (GSI), Central Mine Planning and Development Institute (CMPDI), Oil and Natural Gas Corporation (ONGC), Mineral Exploration Corporation Ltd. (MECL), National Mineral Development Corporation (NMDC), Indian Bureau of Mines (IBM), Bharat Gold Mines Ltd. (BGML), Hindustan Copper Ltd. (HCL), National Aluminium Company Ltd. (NALCO) and the State departments of Mining and Geology.

The Indian mining industry has been facing sociological issues like large scale population displacements, resistance of locals, conflict with tribals for land rights; human rights issues like child labour and forced labour; environmental issues like pollution, deforestation, encroachment of forest area and endangering animal habitat; corruption issues like scams involving allotment of mining blocks, IT and royalty revenue frauds. The root cause appears to be the Central Government's mining policy, particularly its policy of land acquisition as well as its fairly recent policy of auctioning mineral rich blocks and issuing mining rights therein to privately owned companies; as such, this probably needs to be reviewed. Safety is a major concern in the light of numerous major accidents. The mining process and associated hazards, analysis of major accidents and safety measures is discussed below.

The Mining Process and Associated Hazards

Mining is the process of extracting geological material from the earth's crust in order to obtain various metals, gemstones, limestone, gravel, fossil fuels etc. The mining process involves several phases;[1] these are discussed below along with the associated hazards.

A) Prospecting: This is basically exploration work conducted at several prospective sites, in order to identify the specific location of the ore body, its depth from the earth's surface,

estimate the grade/purity of the ore and quantity of ore therein. It involves aerial survey, extensive geological surveys and testing of soil samples from surface borings. People involved in prospecting and feasibility study activity normally have to live in tents/base camps and work in remotely located, inhospitable jungle/rugged terrains, with portable equipment, drills and explosives, which is very hazardous.

B) Feasibility study: This involves performing comparative study of prospecting reports from different sites, assessing the technical risks, excavation costs and socio-economic benefits associated with each of the proposed sites, deciding whether to excavate/reject a particular site and planning for excavation at the selected site. Although there is no hazard involved in this phase, the final output is extremely crucial for the success/failure of subsequent mining activities.

C) Excavation: This involves all activities related to physically reach the ore body, extract the ore and bring it to the surface along with the waste material (mud, sand, gravel, rock etc.). Depending upon the depth of the ore body from the earth's surface and the soil structure, excavation may be sub - surface (underground mine) or surface (open cast mine) type.

Sub – surface excavation - here fairly wide network of tunnels/shafts have to be dug deep into the ground in order to reach and extract the ore body; operation being thus much more complicated, expensive and hazardous although the negative impact on environment is much less. Highly combustible and toxic gasses like methane, carbon monoxide, exist under high pressure in closed underground pockets and are suddenly released during excavation. In inadequately ventilated shafts, this causes gas concentration levels to surge so suddenly that sensors fail to give timely warning and any spark in the vicinity, either from an exposed faulty electric cable or from a mining equipment or a miner's lamp (specially the kerosene lamp), is sufficient to cause the gas to ignite, resulting in explosion within the tunnels and death of all miners in the vicinity. Such explosions or seismic activities or inadequate props may cause the roof/walls of large underground caves and tunnels to collapse, burying the miners working in the vicinity and entrapping miners working in more distal areas. Sometimes a tunnel may come too close to a water body and the roof/wall may collapse (possibly precipitated by an underground explosion/seismic activity) causing water from the nearby water body to rush in, flooding the tunnels and drowning all personnel working therein. The miner is exposed to gases like carbon monoxide, hydrogen sulphide, methane etc. which are not only highly inflammable, but also highly toxic and usually denser than air

resulting in displacement of breathable air and death due to asphyxiation. The miner has to work in a dusty environment which can cause long term lung problems like asthma, bronchitis and silicosis. Since they have to work continuously with heavy drilling equipment in narrow confined space, they are subjected to reverberating noise in excess of 110 dB and often suffer hearing loss. Strenuous working under very hot and humid condition occasionally results in heat stroke. Huge amount of ore and debris have to be dug, transported through winding underground tunnels to the surface and dumped in the ore processing area. Working in close proximity of heavy machinery like drills, trolleys, lifts, cranes, conveyors etc. increases the probability of occurrence of accident.

Surface excavation – this has greater negative impact on the environment but is otherwise comparatively 8.5 times less hazardous.[2] Here the ore body is close to the surface, so the top soil and layers of bedrock are stripped off in order to expose the ore body. Workers have to work outdoors in rugged terrains, under dusty and noisy condition using explosives and heavy equipment like bulldozers, excavators, dump trucks, overhead trolleys etc. In summer, working under the sun is extremely tiring; in winter, there is insufficient light and poor visibility due to fog specially in early morning and evening; in monsoon, the ground becomes treacherously slippery, with risk of landslide. These environmental factors increase the possibility of accident.

D) Processing: This involves screening out the mineral - rich ore portion and dumping residual large quantity of waste debris (mainly mud, sand and pebbles). The ore is passed through crusher, grinder, vibrating screens to remove much of the dirt. To further purify/concentrate the ore, depending upon the physical properties of the mineral, numerous methods like electrostatic/magnetic/gravity separators are used. Workers have to handle huge quantity of ore and debris, work outdoors in dusty and noisy conditions, with crushers, vibrators, conveyor belts, slurry ponds etc. and hazards are incidental thereto.

E) Mineral Extraction: The mineral has to be extracted from the concentrated ore. Depending upon the chemical composition of the ore as well as physical and chemical properties of the mineral, various methods like precipitation, distillation, adsorption, solvent extraction, electrolysis, oxidation, reduction techniques are suitably employed. Mineral extraction process is associated with the transportation, storage, handling and use of various harmful chemicals in bulk, conducting the oxidation/reduction reactions and disposing of the used chemicals, which poses a threat to the life and health of workers. A huge quantity of

toxic slurry waste (called tailings) are generated during extraction and is a serious concern for air, water and soil pollution. Detoxification, transportation and disposal of tailings is a very expensive and hazardous activity.

F) Mine closure and land reclamation: A mine is a non – renewable source. Once a mine is fully excavated or it becomes uneconomical/too risky to excavate further, mining activity is closed and the mine is abandoned. In case of open cast mines, the top soil has been completely stripped off and a large deep pit is left behind. Normally, this land is unsuitable for cultivation/residence purpose but may be used as water bodies or cattle grazing grounds. In case of underground mines, there is very little negative impact on the environment; entrance to the underground tunnels and ventilation shafts are carefully sealed off and fenced to prevent local children/cattle from wandering inside. The surface land may be subsequently reclaimed for residential/agricultural purposes, depending upon the size of the tunnels and their depth below the surface.

Analysis of Major Mining Accidents

Reports indicate that most of the major accidents world wide are associated with underground coal mines.[1] Surveys also seem to indicate that rate of occurrence of accidents (eg. accidents/million tones of production) is much higher in India compared to USA.[2] The most common cause seems to be an explosion due to ignition of methane, carbon monoxide and subsequently coal dust, which led to collapse of tunnels. In the Chasnala and Bagdigi colliery incidents in Dhanbad, Jharkhand, an explosion caused an overhead water body to break in, flooding the tunnel and drowning everyone. The Gastiland colliery incident in Dhanbad was caused by the Katri river which breached its embankments and inundated the mine tunnels. The Wankie colliery and probably the Courrieres incident occurred due to improper handling of explosives; in case of Coalbrook colliery incident, the roof supporting pillars disintegrated. In all cases, a large number of officials and workers were either buried in the debris or got entrapped and died of suffocation. The mine management is usually accused of flouting safety regulations, in connivance with politicians and regulatory officials, in order to cut costs/increase production rates. Several top officials are usually charged with criminal negligence, suspended, fined or imprisoned and the company has to pay huge amount of money as compensation and/ provide alternate job on compassionate grounds to the kin of deceased personnel. Buffalo Creek flood in Saunders,West Virginnia, USA, in February 1972, Val – di Stava dam disaster in Tesero, Northern Italy in July 1985 and Marcopper

copper mine disaster on Marinduque island of Philippines in March 1996 which resulted in death of thousands and extensive property damage was primarily due to improper disposal of excavation waste debris and/ extraction tailings.

Safety Management

An industrial accident is an unplanned, unwanted incident occurring during normal working, resulting in loss of life/damaging health of worker/neighbouring residents and or causing damage to property/environment. If the magnitude of damage/loss is substantial, the accident is termed as a man – made disaster. Industrial disaster management involves preparing contingency plans and emergency protocols as well as training all personnel to be well prepared, physically and mentally, to handle any adverse situation as per emergency protocol in order to minimize panic, loss of life and damage to property. Safety management involves planning, co-ordinating and monitoring all activities aimed at minimizing the probability of occurrence of an accident as well as minimizing its impact. Any work activity/work practice/working condition which involves a high risk of occurrence of an accident/disaster is called a hazard. These need to be meticulously identified and systematically eliminated/modified through use of improved mining technology, more reliable equipment and/or by adopting better working methods/habits. Safety measures include:

- Providing protective equipment like helmet, gloves, boots, gas/dust masks, torch to all officers and workers; conducting safety classes to educate workers about hazards, safe working habits, use of protective gear, first aid and disaster management protocol; conducting safety campaigns to instill safety consciousness amongst workers.
- Adopting improved mining methods by indigenous research or studying the technology and practices followed in other countries having lower accident occurrence rate.
- Conducting safety audit of the premises and equipment to ensure compliance with all statutory regulations and guidelines as well as ensure adequate, reliably smooth, hazard free working. In case of underground mines, special attention should be paid to the condition of tunnel walls, roof supports, ventilation shafts, air blowers, water sippage and its drainage pumps, wire ropes and conveyors, trolley and rails, drilling equipment, fire extinguishers, electric power lines, gas concentration sensors, warning and public address systems, etc. Specially constructed emergency refuge chambers (strong, fire resistant rooms, equipped with food, oxygen and first aid kit for 20+ people) may be placed at strategic locations inside the tunnel network to help reduce casualty in case of major accidents.

- Designing and rehearsing disaster management protocol to prevent panic in emergency situation.
- Ensuring detoxification of all extraction tailings before disposal to prevent soil/water pollution. Sites for disposal of excavation debris and extraction tailings should be properly selected to prevent formation of large water bodies that may rupture/overflow and cause flood in neighboring villages.

Following numerous accidents, trade unions, human rights and environment protection activists have compelled the Government to formulate stringent safety standards, norms, regulations and guidelines which all industry members must follow. In this regard, The Mines Regulation 2014 of UK appears to be fairly comprehensive and informative.[3] This 102 page compilation makes specific references to Personal Protective Equipment at Work Regulations 1992 , Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013, Lifting Operations and Lifting Equipment Regulations 1998, Control of Noise at Work Regulations 2005, Control of Vibration at Work Regulations 2005 , The Electricity at Work Regulations 1989, Provision and Use of Work Equipment Regulations 1998, Explosives Regulations 2014, Control of Substances Hazardous to Health Regulations 2002, Dangerous Substances and Explosives Atmospheres Regulations 2002 , Management of Health and Safety at Work Regulations 1999, Health and Safety (First Aid) Regulations 1981 , Health and Safety (Consultation with Employees) Regulations 1996, Workplace (Health, Safety and Welfare) Regulations 1992, etc.

CONCLUSION

Although underground coal mines are inherently prone to accidents, they have to be operated due to economic compulsions. Since rate of occurrence of accidents is much higher compared to other developed countries like USA, there is much scope for improvement in Indian mining industry. In this paper, an effort has been made to amply describe the mining industry and also highlight its major problem areas along with possible solutions. I sincerely hope that it will prove helpful to the engineering students and concerned decision makers.

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