DISASTER MANAGEMENT IN COAL MINE INDUSTRY OF BALOCHISTAN

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Abstract

The room and pillar mining method is responsible for high death toll and disability rate of coal mine workers in Baluchistan. The frequent incidents of roof falls day to day accidents, and suffocation due to sufficient emission of methane are the main causes of increased death rate. Substantial increase in injuries are also causing complications in the life of poor coal workers

Keywords: Threshold limits, exposure limits, death toll, partial disability, complete disability, obsolete mining methods

Introduction

The basic causes of accidents and injuries in mines are unsafe conditions, unsafe acts, or both Rosen and James, 2005. Disasters occur in mines as a result of large mine fires, obsolete mining method, powerful mine explosions, violent rock gas outbursts Sernia and Hwang, 2007. Fatality rates reveal that even though there are variations in the fatality rates per 1000 persons employed, however, it is found that accident rate in Baluchistan coalmines in high as compared to other countries. All operating mines have to contend with the real danger of being overtaken by one or more disasters at some point of time during their lifespan. Plans for disaster management are, therefore, drawn by the mine managements. Due to the large number of high-risk industrial activities, Baluchistan coalfields are highly disaster prone. Underground fires are quite frequent phenomena. The need for strengthening disaster mitigation efforts at national level has been felt.

Objective of the Study

To point out the reasons for higher death toll in underground coal mining of Baluchistan and suggest the disaster mitigation plan to overcome the frequent accidents in underground coal mine.

Subjects and Methods

Two types of data were collected. Primary data was obtained through topographic survey and questionnaire while Secondary data about the health issues, medical facilities and other allied facilities of coal mine workers of Baluchistan were collected from; Mine& Mineral department of Quetta, hospitals and medicals facilities in coal mine fields. Three mine fields i.e. Mach, So-range-Degari, and Chamalong coal fields were selected for research purpose.

Results

The average emission of Methane (CH4) and Carbon monoxide (CO) in coal mine fields was 11.8m3/ton and 36ppm respectively which exceeded the permissible limits of 1-10m3/ton and 30ppm.

The concentration of coal dust (Carbon and Quartz) was 4-5mg/m3 and 0.35mg/m3 respectively which excedes the threshold limits of 2mg/m3 and 0.05-0.1 mg/m3 and are the source of heath degradation and increase death toll.

Conclusion

Government of Baluchistan and coal mine owners should take concrete steps to improve the adverse mining conditions.

Material and Methods

To investigate the reasons for high death tolls in coal mine industry the concerned departments like mine and Mineral, Hospitals, Dispensaries, Environmental protection agency, were approached for the collection of data. Whereas the high quality analytical equipment of Baluchistan Environmental Protection Agency (BEPA) was mobilized and used on selected coal mine sites to find out the reasons for disaster in coal mines. For the simplicity three sub-mines from each selected coal fields were selected and marked as M_1, M2, and M3 at Mach coal field; SD1, SD_2 and SD_3 at So-range-Degari and C_1, C_2 and C_3 at Chamalong coal fields. Approximate 10%sample size (n = 228 coalmine workers), 65 coalmine workers from Mach (M_1, M_2, M_3), 77 coalmine workers from So-range-Degari (SD_1, SD_2, SD_3), and 86 coalmine workers from Chamalong (C_1, C_2, C_3) were selected for this research study (Table-1).The coalmine workers were divided into age group ranged between 15 years and 45 years and above with medium age of 32 years. The

percentage of coal drillers, helpers, coal loaders (laborers) and coal transporters were 60%, 15%, 20% and 5% respectively. The total strength of coal workers was further divided into four age groups (Table-2)

MS excel and Statistical Package for the Social Sciences SPSS 20 was used to examine the data collected from the questionnaire. The reliability of data was also conducted with the help of a test i.e. Cronbach's Alpha. To verify the data being parametric or non-parametric Shapiro-Wilk Normality Test was used, to identify weather the data is normally distributed or not. To identify the variances in perception Kruskal-Wallis test was conducted. The significance level was considered to be 5% to show the statistically significant relationships. Barriers to sustainable building of Pakistan were assessed using mean value method.

Table-1 Sample Sizes of Different Coalmining Fields

#	Mine Field	Sub-mines	Selected Miners
1	Mach Coal Fields	M_1,M_2,M_3	65
2	So-range-Degari Coal Fields	SD_1,SD_2,SD_3	77
3	Chamalong Coal Fields	C_1,C_2,C_3	86

Source: Field data.

Table- 2 Distribution of Selected Coal Workers into Age Groups (N=228)

Age Groups in years	Coal Workers (Nos.)	Sample Size (%)
Under-15	15	6.5
15-24	37	16.2
25-35	121	53.2
36-49	39	17 .1
50 & above	16	7
Total	228	100

Source: Field data.

Results and discussions

An accident can occur anytime and can disrupt the day to day life Ditya and Michael, 2004: carelessness, negligence, sudden roof collapse because of obsolete mining techniques Roet and Choi, 2004, suffocation due to high rate of emission of gases and inadequate training are the main causes of disaster Talli and Jiang, 2004, which could result in injury or even death in Baluchistan coal mine industry. The research has revealed that no death/ injury/disability record of coal workers was being maintained at any level like at coal fields by the coal mine owners or in the hospitals or government agencies like Mines and Mineral Department of Baluchistan etc resultantly no attention was drawn to this gray area and coal workers remained neglected. There are many reasons for high death toll in Baluchistan coal mine industry like using obsolete mining methods, suffocation, Exposure to over-emission of gases and coal dust etc. In this regard a comparison with

other coal producing countries and Baluchistan has been drawn in below mention table-3, 4 and 5;

Table -3 Deaths due to various Incidents in coal mine industry of Baluchistan

#	Cause	Death cases				
		2005	**2006**	**2007**	**2008**	**2009**
1	Roof collapse	1120	1050	1230	995	1110
2	Over exposure of Gases (Suffocation)	774	885	622	915	814
3	Over exposure of coal dust	77	46	180	345	278

Source: MMD of Baluchistan.

Table -4 Comparison in Coal Production and deaths

#	Country	Year	Coal Produced in Million Tons	Deaths in No
1	Pakistan **(**Baluchistan**)**	2004-2005 2005-2006 2006-2007 2007-2008 2008-2009	1.89 2.02 1.92 2.30 1.98	77 246 180 345 78
2	China	2004-2005 2005-2006 2006-2007 2007-2008	60.44 50.27 46.01 41.35	55 45 42 38
3	India	2004-2005 2005-2006 2006-2007 2007-2008	198.3 80.2 116.9 147	180 73 136 163

Source: MMD Baluchistan, EPA India and China

Table -5 Annual Comparison of death cases in Coal producing countries

#	Country	Death cases				
		2005	**2006**	**2007**	**2008**	**2009**
1	Australia	8	7	2	4	5
2	U.S.A	4	12	26	15	14
3	PAK **(Baluchistan)**	77	246	180	345	78
4	China	3938	3306	4746	3712	3302

Source: Respective EPAs of Coal producing countries

The above mentioned tables-3.4 and 5 show that although the amount of coal produced in Baluchistan is less as compared to other countries but the rate of causalities in mine industry of Baluchistan is more and the reasons which have been noticed during research are poor mining techniques . Efforts have also been made to work out how many coal workers die at the cost of production of million ton of coal so as to find out whether the production of coal at the cost of life is carried out or not. The table-6&7 clearly shows that the coal production in Baluchistan is very less while the death ratio and injury trend respectively is very high as compared to India and China. This all happens due to least interest of Government, Poor mining conditions and inadequate mining techniques;

Table-6 Annual rates of Injury Trends in Coal Worker of Baluchistan

#	Year	Source of Data	Injury Type	
			Major	**Minor**
1	2004-05	Civil Hospital Quetta	375	-
		Miss Fatima Jinnah T.B., Clinic, Quetta	520	-
		Bolan Medical Complex Hospital, Quetta	275	-
		Fatima Jinnah General & Chest Hospital, Quetta	745	-
		Sajjad Clinic, Quetta	175	-
		Akram Hospital, Quetta	429	-
		Dispensaries in the field	-	6,250
		Sub Total	*2,519*	*6,250*
		Grand total	**8,769**	
		Annual Injury Rate = (total number of injuries÷ total number of coal workers in Baluchistan) ×100 = (8,769 ÷ 40,000)×100 = 22%		
2	2005-06	Fatima Jinnah T.B., Clinic, Quetta	349	-
		Bolan Medical Complex Hospital, Quetta	494	-
		Fatima Jinnah General & Chest Hospital, Quetta	382	-
		Asthma Clinic, Quetta	714	-
		Sajjad Clinic, Quetta	109	-
		Akram Hospital, Quetta	382	-
		Dispensaries in	-	7,016

		the field		
		Sub Total	*2,430*	*7,016*
		Grand total	**9,446**	
		Annual Injury Rate = (total number of injuries ÷ total number of coal workers in Baluchistan) × 100 = (9,446 ÷ 40,000) × 100 = 24%		
3	2006-07	Miss Fatima Jinnah T.B., Clinic, Quetta	396	-
		Bolan Medical Complex Hospital, Quetta	505	-
		Fatima Jinnah General & Chest Hospital, Quetta	392	-
		Asthma Clinic, Quetta	629	-
		Ali Clinic, Quetta	122	-
		Sajjad Clinic, Quetta	111	-
		Akram Hospital, Quetta	336	-
		Dispensaries in the field	-	6,829
		Sub Total	*2,491*	*6,829*
		Grand Total	**9,320**	
		Annual Injury Rate = (total number of injuries ÷ total number of coal workers in Baluchistan) × 100 = (9,320 ÷ 40,000) × 100 = 23%		
4	2007-08	Miss Fatima Jinnah T.B., Clinic, Quetta	442	-
		Bolan Medical Complex Hospital, Quetta	642	-
		Fatima Jinnah General & Chest Hospital, Quetta	407	-
		Asthma Clinic, Quetta	696	-
		Sajjad Clinic, Quetta	179	-

		Akram Hospital, Quetta	441	-
		Dispensaries in the field		7,410
		Sub Total	*2,807*	*7,410*
		Grand Total	**10,217**	
		Annual Injury Rate = (total number of injuries ÷ total number of coal workers in Baluchistan) × 100 = (10,217 ÷ 40,000) × 100 = 26%		
5	2008-09	Miss Fatima Jinnah T.B., Clinic, Quetta	439	-
		Bolan Medical Complex Hospital, Quetta	779	-
		Fatima Jinnah General & Chest Hospital, Quetta	326	-
		Asthma Clinic, Quetta	642	-
		Sajjad Clinic	182	-
		Akram Hospital, Quetta	453	-
		Dispensaries in the field	-	6,920
		Sub Total	*2,821*	*6,920*
		Grand total	**9,741**	
		Annual Injury Rate = (total number of injuries ÷ total number of coal workers in Baluchistan) × 100 = (7,941 ÷ 40,000) × 100 = 24%		

Source: field work.

Note: Approximate total number of coal workers in Baluchistan = 40,000

Table -7 Occupational Injuries comparison between Baluchistan and U.S.A

#	**Nature of Occupation**	**Injury (%age)**	
		Baluchistan	**U.S.A.**
1	Continuous Mine Operator	45.7	29.6
2	Mine Helper	44.9	32.7
3	Loader / laborer	46.2	45.4
4	Shuttle Car Operator (Belt Conveyor)	27.5	38.1
5	Load Haul Dump (Truck Loader)	34.5	26.5

Source: Field Work and EPA of U.S.A.

The trends in injuries due to occupation especially in underground mines are more pronounce and prominent in Baluchistan than the other mining countries. The comparison between Baluchistan and U.S.A has been given in table-7. It clearly shows that Baluchistan was leading in all steps of mining and this was just because of negligence from all stake holders. No one was ever bothered to force the mine owners to import the new mining and mine safety equipment, adaptation of new mining techniques, installation of coal dust and gases control devices or just to ensure the safety measures. If only pay and other allied benefits were increased, the working hours of coal workers would automatically reduce and resultantly, the injury rend would decline. The above mentioned statistics can also be represented in graphical shapes in Figures-1 and 2 whereas overall injuries trends in Baluchistan coal mines has been shown in Figure-3

Figure-1 Yearly Injuries Trends in Coal Workers of Baluchistan

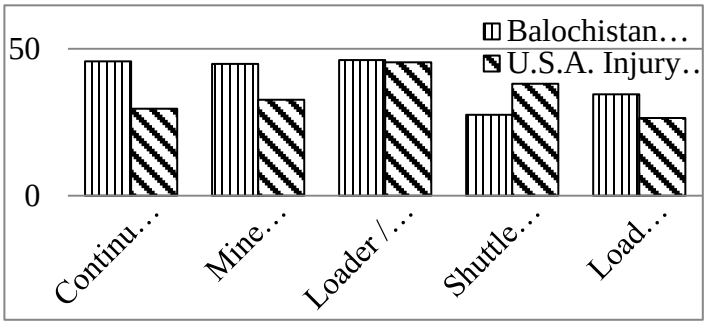

Figure -.2 Comparisons of jobs oriented Injuries in Coal Workers of

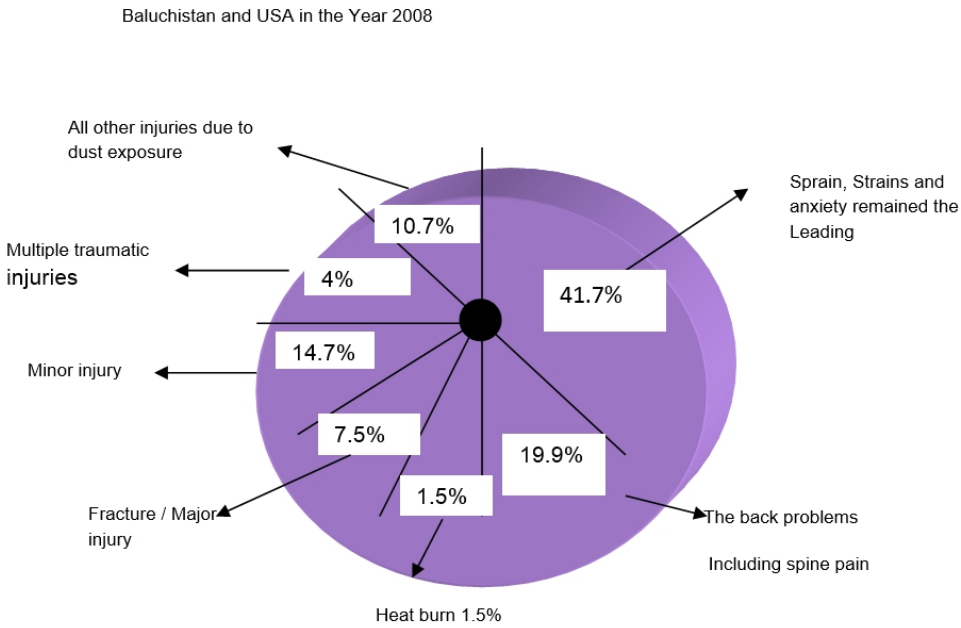

Figure -3 Injuries Reported from Coal Mine Fields of Baluchistan. (Data from different hospitals of Baluchistan)

The figure 3 shows that most frequently occurring injuries are due to strain/stress, and back problems due to working position in the coal mine. The main reasons were inadequate working facilities, non-availability of modern mining techniques and allied facilities. Another important factor which can lead us to evaluate the reason of high death/ fatalities rate in Baluchistan coal field is the age factor of coal worker. This indicates at what age the coal workers are more prone to injury/disability. A comparison between the Baluchistan and U.S.A has been shown in table-8

Table -8 Age Factor in Injury/Disability Trends in Coal Workers of Baluchistan and USA

#	Occupation	Coal Workers%age with respect to Occupation in Baluchistan	%age of Injury/Disability Amongst Various Age Groups in Baluchistan out of Total %age			Coal Workers%age with respect to Occupation in U.S.A	%Age of Injury / Disability amongst Various Age Group in U.S.A. out of Total %age			
			18-34	35-44	45 and above		18-34	35-44	45 and above	
1	(Continuous Miner)	45.7	4.7	12.5	28.5	29.6	6	7.4	16	
2	Mine Helper	44.9	3.9	11.2	29.8	32.7	7	10.9	1.9	
3	Mine (Loader)	46.2	7.5	13.2	25.5	45.4	3.10	16	21.3	

4	Shuttle Car Operator (Belt conveyor)	27.5	5.2	3.9	13.4	38.1	7.13	11.2	9.77
5	Dump Truck loader	34.5	2.7	14.9	16.9	26.5	3.9	3.2	14.4

Source: Research work and EPA U.S.A

The table-8 shows that the injury trends in old age coal workers of Baluchistan is more pronounce especially in 45 and above age workers. Reason was quite obvious that coal mining up to the age of 45 years and above, the coal workers remained exposed to coal dust, coal gases, and coal effluents for longer duration, and develop multiple diseases. Moreover, working under similar conditions/positions, make them prone to different types of stresses and strains that sometimes, made it hard for them to properly handle the equipment .Inadequate medical facilities and their financial position force them working without treatment and weaken them continuously

Mitigation Measures

In Baluchistan, the underground mining is carried out mostly with Room and Pillar method of extraction which is the oldest and most dangerous method and this mining technique has been rejected all over the world Nitish and Yardarshu, 2008. The most common form of subsidence from room and pillar mining are skin hole collapse Leckne and Zhang, 2001, and saucer shape depression Anderson and McLoren, 2006 following pillar failure and pillar mining surface subsidence can occur many years after mining is done Kalin and Feng, 2005. Timber remains too far from the face that creates more gaps between the face of mine and pillar, and becomes less sustainable and ultimately collapses Deulas and Giang, 2002. Miners work under loose roof Yohi and Wang, 2007. The strength of column support is not properly analyzed and designed for the dead load Alker and Julien, 2001. Timbering began to be seen as a critical bottle neck in the mechanical mining process Miller and Julien, 2005, which causes death and injuries Edward and Coln, 2008. some of the following mitigation measures can be suggested;

The emergency response plan and training should be made compulsory, so that prevention of fatalities and serious injuries through a systematic and comprehensive risk management based planning and designs process can be made possible. The plans specify the measures to be taken to address specific hazards at the mine. Incorporate the use of strategically located ventilation or escape shafts equipped with escape hoists when

feasible and consistent with a risk analysis as a strategy to reduce escape times from a mine during an emergency.

- Safety devices are to be ensured at each coal field and worn by all miners.
- Install life lines, preferably with metal core, to facilitate emergency communications, or other direction Indicating devices in all designated escape ways.
- Make tag lines available at strategic locations in a mine, including near the beginning of all designated escape ways.
- Locate oxygen supply device in substantially constructed or protected areas between adjacent designated escape.
- The minimum medical facilities which in case of emergency are required are to be maintained by the mine owner.
- The miner should have understanding how to overcome the stress and slow their pace when they encounter resistance to breathe.
- The department has quite sophisticated laboratory equipment but not used to measure the emissions of greenhouse gases through coal mining, effluent and hazardous waste, its disposal, health, and environmental effects due to mining activities are not reported by this agency.
- The pollution tax and penalty which is required to be imposed on excess emission of gases and coal effluent is not charged, since no physical monitoring is carried out. The reduction in emission is possible through implementing aggressive renewable energy and energy efficiency policies for the power generation.

Recommendations

During the research the main focus remained on the evaluation of those factors which are causing the numerous deaths and deleterious effects on the health of coal workers. In this regards the laid down criterion of the coal mining countries was compared with the prevailing situation of the coal mining in Baluchistan, especially the latest techniques and innovations which have been developed all over the mining countries to avoid and minimize the death, accident ratio and coal dust exposure. Although the mining industry in Baluchistan must be abreast with all new methodology as rest of the world, however following bear minimum recommendations are suggested for implementation

- It is recommended that the personnel safety and mine safety equipment like dust mask, goggles, safety lamps, respirator, good helmet, mine shoes, washable suite firefighting equipment, oxygen cylinder, gas concentration detection appliances**,** self-rescue kit, rescue station, Gravimeter and first aid equipment should be provided by mine owners to coal workers.

- Medical History Sheet of each coal worker should be maintained with all stake holders.

Mining methods to be revised

If Government cannot afford disability, injury and death benefits to the dependent family then efforts should be made to get all the coal workers insured at minimum premium rate.

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