

A Review of Chair Lift Man Riding system Effectiveness in Underground Coal Mines with reference to Ballarpur Colliery 3&4 Pits using Rank-Weight Method.

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Abstract: Recent increase in the demand of the energy has led to a considerable technological development in the underground mines. Rise of large and extensive mines has increased the travel distance of workers from mine mouth to the working place leading to decrease in the energy levels of the miners. Hence, a solution to this problem is the installation of chair lift man riding system. The Committee on Safety in Mines (Report published by Dept. of Coal in August, 1979) recommended that “Man Riding facilities should be introduced by 1985 wherever feasible”. During the course of time, there have been several advantages and disadvantages associated with the working of chair lift man riding system. A review of the effectiveness of Chair Lift Man Riding system in the underground mines and its further analyses and subsequent suggestions have been attempted in this paper.

1. Introduction

India is the THIRD LARGEST producer of coal after China and United States with 123.2 billion tonnes of proven coal reserves out of total geological reserves 298.9 billion tonnes as on the 1st April 2013. BP Statistical Review of World Energy 2013 estimates recoverable coal reserves of India as 60.6 Billion Tonnes, that is, 7.1% of World's 860.94 Billion Tonnes recoverable reserves. India has the fifth largest coal reserves in the world.

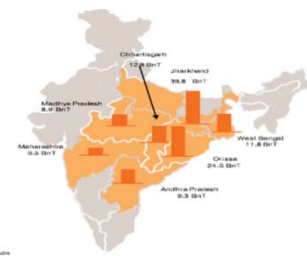
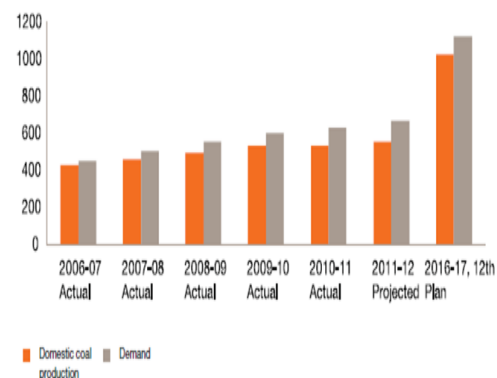


Figure 1. Coal Reserves (Source: Geological Survey of India)

Indian Coal sector has a robust demand which requires that the growth rate in Coal production is increased to 9% plus.



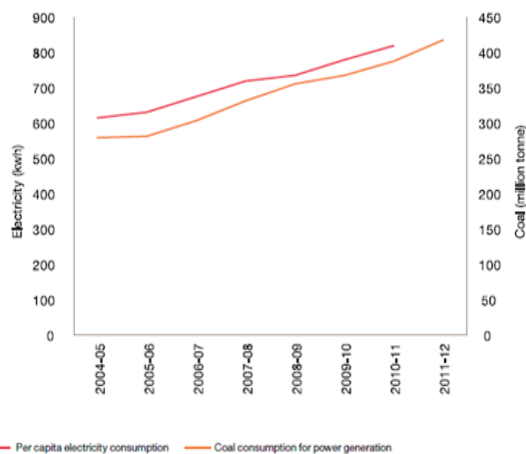


Figure 2. Demand Supply Scenario of Coal (Source: India Energy Book, 2012, World Energy Council, Indian Member Committee)

The growing demand of coal has led to the large and extensive mines. For the purpose of meeting the growing demand of high production, the workers need to work in the mines with utmost efficiency. From the Human Energy Balance analysis and availability analysis of the miners working in the mines it is found that miners are doing their respective jobs with only 44% Human Effectiveness. From detailed analysis of the problem it was found nearly 30% of the Human Effectiveness was being wasted in the travelling of the miners to the work places. Hence, the installation of the Chair lift Man Riding system reduces this waste of energy leading to an increase in the Overall Human Effectiveness of the miners from 44% to 74% (Ade E.M., 2012).

The main purpose of the installation of the Chair Lift Man Riding is the Health and Welfare of the miners. The reduction in the fatigue, absenteeism and increase in the cohesiveness and subsequent increase in production and productivity are the additional advantages. The best way to review whether the Chair lift man riding system has served its purpose of installation or not is to take feedbacks from the miners involved in mines.

2. Methodology Adopted.

Rank and Weight methodology is adopted to analyze the feedback of the miners working in the mines where the chair lift man riding system is installed. Here, Ballarpur Colliery 3&4 Pits, Ballarpur is taken as the case study.

Feedback questionnaires are framed considering the different important aspects of the Chair Lift Man Riding system directly and indirectly affecting the miners working in the mines. Each aspect is ranked on 6 taking into consideration the degree of satisfaction the worker has with that factor. 10 persons are taken as a representative of the whole shift. Hence, in the three shifts, feedback is taken from 30 persons. Based on the ranking given by the miners, it is converted in to weights and then analyzed. The factor with highest weight is serving its part with maximum satisfaction of the workers and the factor with lowest weight is serving its part with minimum satisfaction of the workers.

Table 1: Ranking Sheet for recording ranks of different factors affecting the Miners using Chair Lift Man Riding system

Worker ID	Factors					
	Comfort Level	Safety	Time Saving	Energy Saving	Miners Health	Continuity of operation
SHIFT I						
101						
102						
103						
104						
105						
106						
107						
108						
109						
110						
SHIFT II						
201						
202						
203						
204						
205						

206						
207						
208						
209						
210						
SHIFT III						
301						
302						
303						
304						
305						
306						
307						
308						
309						
310						

The factors selected in the above table are elaborated below:

- a. Comfort level: It involves seating arrangement, back rest, foot rest, oscillations, jerk, seat comfort, holding arrangement, etc.,.
- b. Safety: over-speeding, backward travelling, over travelling, emergency braking arrangements for the traveller, alarms in case of emergency, emergency signaling, sufficiency of warning signals (Audio-Visual Alarms) during start and stop, etc.,.
- c. Time Saving: Sufficient time availability for working, time savings before and after man riding system, etc.,.
- d. Energy saving: Sufficiency of energy level at the work place, saving of energy consumed in travelling, zeal of working, cohesiveness at work, willingness, etc.,.
- e. Miners Health: Reduction in Fatigue, reduction in health problem e.g., travelling on foot under arduous conditions leading to knee joint pain, back pain, reduction in absenteeism, etc.,.

- f. Continuity of Operation: Breakdown frequency, mischievous stoppage of rider, hindrances on travel, maintenance cycle, etc.,.

The method of Ranking is as follows:

Ranking is based on the satisfactory level of the worker from that factor.

Table 2. Ranking Index

Satisfactory Level	Corresponding Rank
Bad	6
Poor	5
Fair	4
Good	3
Very Good	2
Excellent	1

3. Field Data

The feedback is taken from the miners of Ballarpur Colliery 3&4 Pits, Ballarpur from three different shifts of a day.

Table 3: Feedback Sheet for recording ranks of different factors affecting the Miners using Chair Lift Man Riding system

Worker ID	Factors					
	Comfort Level	Safety	Time Saving	Energy Saving	Miners Health	Continuity of operation
SHIFT I						
101	6	2	3	2	1	5
102	6	1	4	3	2	6
103	5	2	4	3	1	5
104	5	2	5	4	3	4
105	6	2	4	4	3	5
106	5	1	4	3	3	4
107	5	3	5	3	4	4
108	5	1	4	4	3	3
109	4	2	3	2	1	3
110	6	1	3	3	2	4

SHIFT II						
201	5	3	3	4	2	4
202	4	2	5	4	2	5
203	5	3	4	3	2	5
204	5	1	5	3	1	6
205	5	1	5	3	3	5
206	6	1	5	3	4	4
207	6	1	4	3	3	5
208	4	2	4	4	3	5
209	3	2	4	2	2	3
210	5	1	3	3	2	5
SHIFT III						
301	5	1	4	2	1	4
302	6	1	3	2	2	4
303	5	2	4	3	2	5
304	5	3	4	4	2	6
305	5	3	2	3	2	5
306	6	3	3	3	3	5
307	6	1	2	4	3	4
308	6	2	2	4	3	3
309	3	1	3	2	2	5
310	5	1	3	4	2	4

4. Field Data Analysis.

- a. Based on the Ranks given by the miners for the different factors, corresponding weights are calculated using the formula:

$$W = n - r + 1$$

Where, $W =$
 Weight of the factor in the cell.
 $n =$
 no. of factors.
 $r =$ rank
 given to the factor in the cell.

- b. The calculated Weight represents the level of Satisfaction. Higher the weight more is the satisfaction.

Table 4. Calculated Weight for different factors

Factor	Weight
Safety	5.27
Miners Health	4.70
Energy Saving	3.90
Time Saving	3.30
Continuity of operation	2.50
Comfort Level	1.90

- c. From the calculated weights it is clear that, the satisfactory level of miners working in the mine is the most with the safety features of the man riding system. It has been also proved by the zero fatal accidents caused due to chair lift man riding system in the mines.
- d. The satisfactory level of miners with comfort of man rider system is found minimum as compared to the other factors.
- e. The different weights calculated for different factors here are representing the degree of satisfaction. The factors with lower weights require improvements and corrective measures.

5. Suggestions and Conclusion.

- a. The design of the chair of chair lift man riding system is such that if any person hooks the chair in the opposite direction on the rope than the vertical rod of the chairs may damage the suspension tubes provided at every 15 m. It also stops the whole system hindering the continuity of operation. If person is seating on that oppositely placed chair then he may also suffer some injuries.

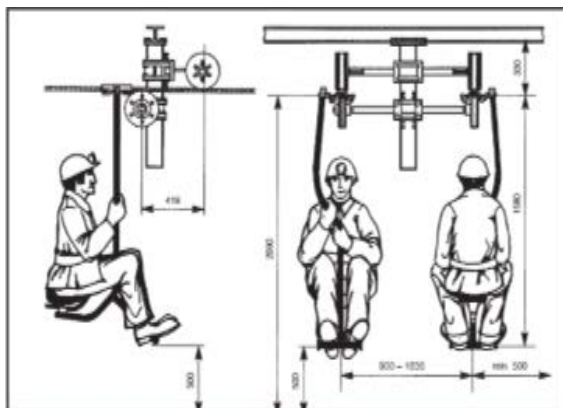


Figure 3. Chair Lift Man Riding System

- b. The Chair lift man riding system should be provided with an alarm system which will alert the Operator in the case of opposite placed chair on the rope. The operator will immediately stop the operation. And trace the chair, remove it and restart the system.
- c. The purpose of health and welfare is properly served by the man rider as the health problems associated with the traveling under arduous condition over the long distances is almost eliminated.
- d. Audio-visual alarms must be placed in adequate numbers to warn the persons travelling in the roadway in which the man rider is installed.
- e. Pager Phones with public address system should be provided to alert the persons travelling in the roadway on which the man rider is installed.
- f. Sufficient number of Telephones should be provided for better communication.
- g. If possible material carriage arrangement should be provided.
- h. The maximum speed of the Chair lift man riding system is 3 m/sec. The DGMS has approved the speed of 1.5 m/sec for the purpose of safety. But at the mine level it is being run at a speed of 1.25 m/sec which makes the whole journey slightly time taking and monotonous. Hence, the running speed of the man rider can be increased a little more so as to reduce the journey time as well as it will not make the journey tedious.
- i. The miners have weighted the comfort level of the Chair lift man riding system lowest mainly because of the problems associated with the sitting arrangements.
- j. The seats of the chair should be provided with cushions.
- k. The chair should be provided with the back rest so as to support the back at the time of journey.

- l. The foot rest should be little longer so that the foot is not in bent position at time of travelling.
- m. Handle should be provided for the support.
- n. Proper tensioning arrangement should be done to prevent the oscillations of the chair while travelling.
- o. The chair lift man riding system is a full proof system for the welfare of the miners in the mine which have led to various other advantages such as the high production and productivity, reduction in fatigue and absenteeism etc.

6. References.

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