Ergonomic Analysis of Job Heaviness and Development of Musculoskeletal Disorder for Selective Underground Coal Miners of India.

Funding Agency	**A DST-SERB FUNDED PROJECT**
Sanctioned Amount	37 Lakhs
Project Duration	3 Years
Project Status	Completed on Dec 2015

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Brief Description of the Project

Ergonomics deals with the betterment of the work and work procedure and helps to minimizing the risk factors at the workplaces while humanizing work and work environment (HWWE). Applications of ergonomics make a product easy to use, and also provide user friendly design providing a good comfort and making significant contribution to safety. The emphasis within ergonomics is to ensure that suitable designs extract the strengths and abilities of people and minimize the effects of their limitations, rather than forcing them to adapt. Ergonomics has a major role to play with mining industries. Workers engaged with mining industries are supposed to dealing with continuous repetitive working posture within hostile and challenging working environment, which needs ergonomic intervention so far it's practicable. The nucleus of the project is designed on the determination of important causes to identify job heaviness and possible responsible postures leading to musculoskeletal disorder.

The main objectives for the research project are-

1. To record environmental condition and compared with WHO recommendation
2. To measure and calculate job heaviness of selective categories of underground mines
3. To work out for the development of proper work schedule to control the health related

Keywords: *Ergonomics, job heaviness, Musculoskeletal disorder, Workload.*

Methodologies/Approaches Adopted

The design of experimentation comprises major work elements to formulate methodology so as to achieving the objectives as conceived in the project. It shows the complete skeleton of the division of the project work which is depicted below in the form of flow models.

Design of Experimentation

The conceived modalities to do the project work to arriving out expected results in line with the objectives set for the purpose are shown in the form of a flow diagram in Figure 1.

Recommendations suggested:

From the work stress measurement of all categories of workers from ECL and CCL it has been found that job stressors are very much effective into the miner's health. All the categories are having the high cardiac parametric value as compared to normal. Working postures are repetitive and occurring with a very fast frequency.

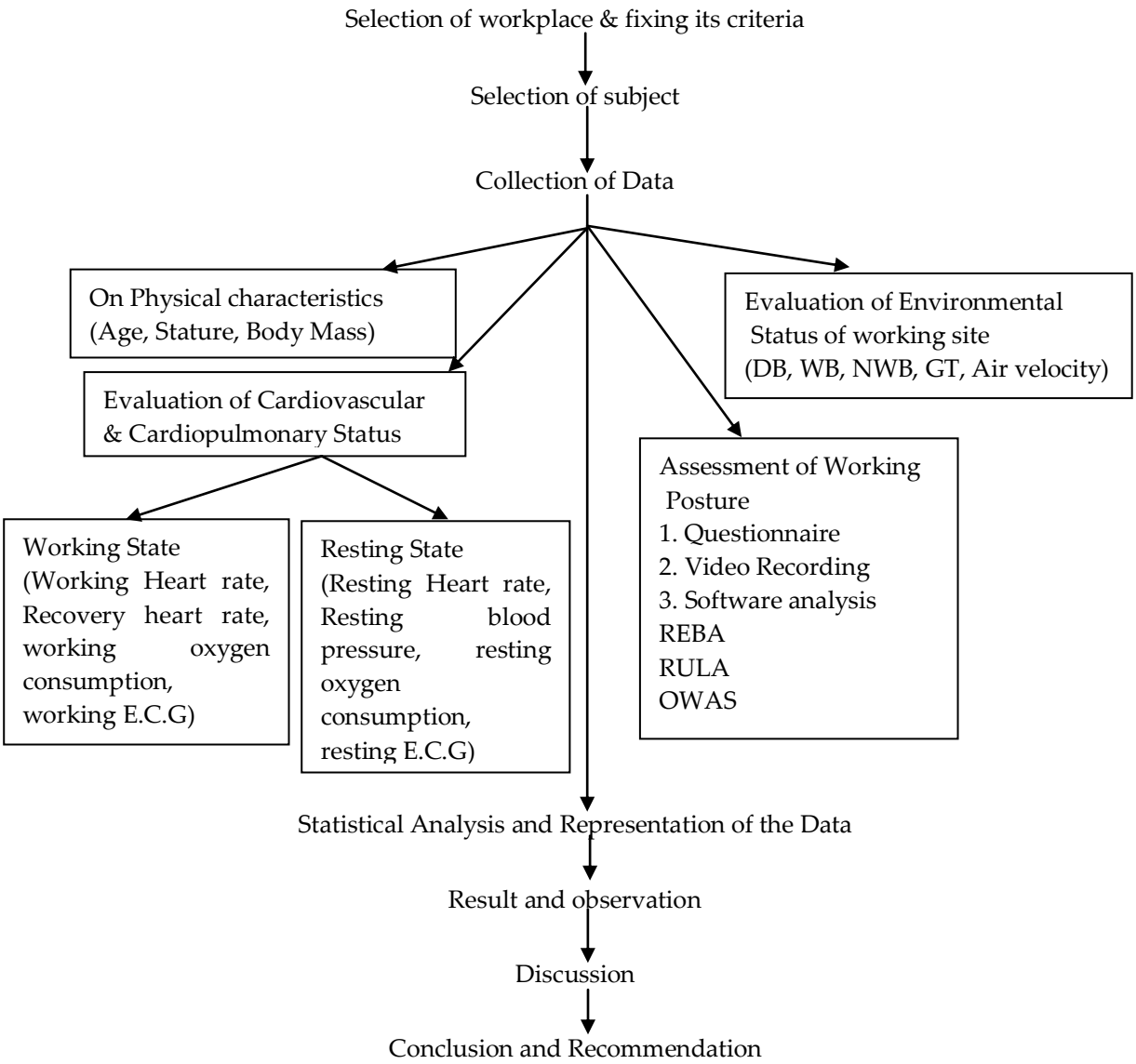


Figure 1: Flowchart of methodology of the project scheme

By looking into all possible findings, following recommendations have been made to reduce strain and making the workplace safer and accident free from ergonomic point of view.

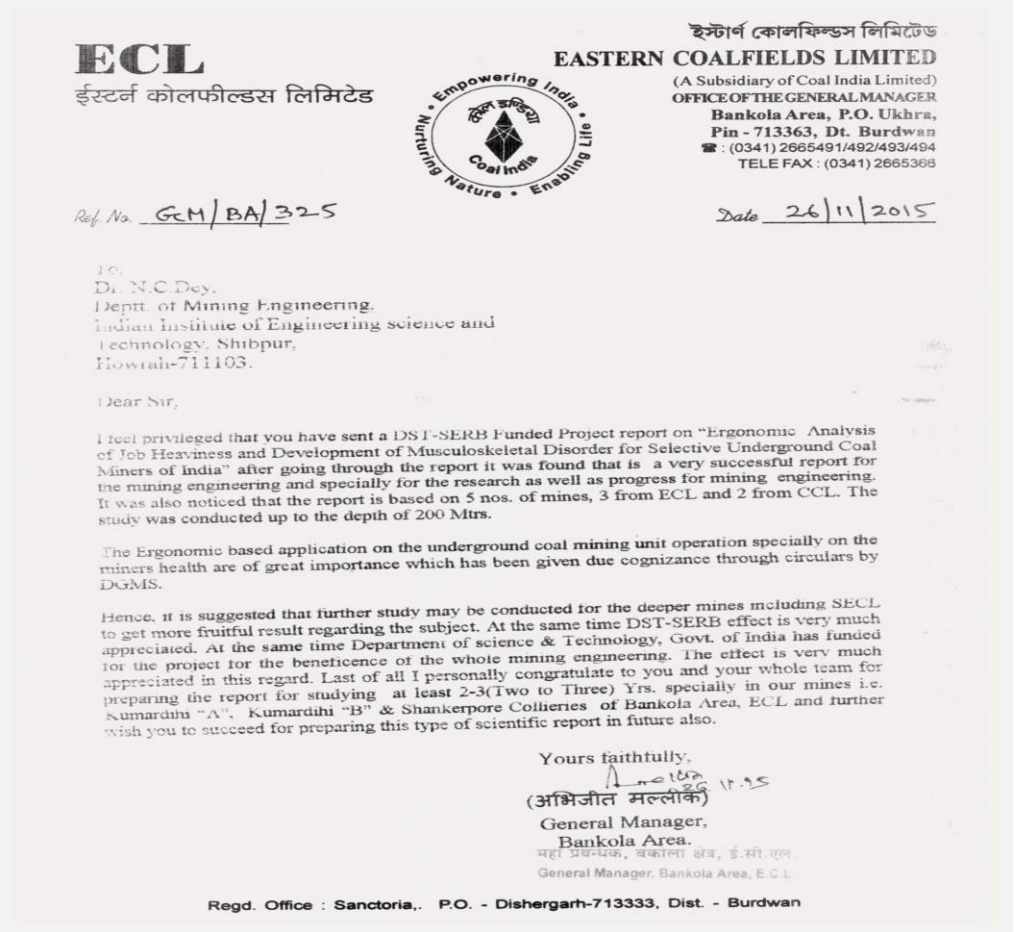
1. The workload categorization has been done for almost all section of people upto 200 m of mines from the surface which is certainly is a pioneering work in this field. That job allocation with a proper knowledge of workload requires a thorough job safety analysis (JSA). High job demand group should have younger personnel instead of older. Proper job rotation may also be a good choice for better productivity.
2. An all round attempt may be made to develop online health monitoring system involving assessing workload of the miners, adequacy in work-rest regimen of the allotted jobs, physical and physiological parameters (direct and derived), environmental parameters (direct and derived) determination etc. such that maximum job efficiency can be achieved with minimum occupational stress. This will reduce absenteeism in general and in work particular.
3. As per the stipulation given in **136 A of CMR 1957** that in every coal faces minimum air current should be 30 ft/min. But the present study hardly can find the stipulated limit while a very sluggish air velocity (12 ft/min) is seen in almost all mines under study. So, it is strongly

recommended to follow the guidelines as given in CMR 1957 involving adequate number of auxiliary fans and / or booster fans as and when necessary in the mines.

4. A proper work rest scheduling of every group of worker has been done to minimize the work strain. This will be facilitating comfort towards the workers in the mines and at the same time mine management would be able to engage workers for longer duration.
5. A comparison on the VO_2 reference mark with the maximum oxygen consumption level obtained from Cardio coach gives us a clear idea on the fact that there is hardly 25 % of worker who can be categorized in acceptable data range making it a serious concern for colliery officials. Therefore, a physical endurance programme is recommended for both acclimatized and non acclimatized personnel..
6. A proper workplace design with some corrective measure is required to minimize pain and discomfort as reported from different MSDs. A suitable guidelines has been given on the environmental parameters so as to harmonizing the work and work environment (HWWE).
7. As per the NIOSH lifting index guidelines workers should avoid the posture which is away from the center of gravity (CG). They are recommended to work in and around their L5-S1 so that their CG can remain very close to their body. Mechanization of mining operation can be better alternative to sort out the MSD related problems.

Project Achievements

The work study carried out in Bankola area of Eastern Coalfields Limited has been greatly appreciated by the senior mine management including General Manager (GM) of the concerned area. The GM has advised to further take up similar ergonomic study for some deeper mines under various subsidiaries.



ECL
ईस्टर्न कोलफील्डस लिमिटेड

ইস্টার্ণ কোলফিল্ডস লিমিটেড
EASTERN COALFIELDS LIMITED
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Ref. No. GM/BA/325 Date 26/11/2015

To,
Dr. N.C.Dey,
Deptt. of Mining Engineering,
Indian Institute of Engineering science and
Technology, Shibpur,
Howrah-711103.

Dear Sir,

I feel privileged that you have sent a DST-SERB Funded Project report on "Ergonomic Analysis of Job Heaviness and Development of Musculoskeletal Disorder for Selective Underground Coal Miners of India" after going through the report it was found that is a very successful report for the mining engineering and specially for the research as well as progress for mining engineering. It was also noticed that the report is based on 5 nos. of mines, 3 from ECL and 2 from CCL. The study was conducted up to the depth of 200 Mtrs.

The Ergonomic based application on the underground coal mining unit operation specially on the miners health are of great importance which has been given due cognizance through circulars by DGMS.

Hence, it is suggested that further study may be conducted for the deeper mines including SECL to get more fruitful result regarding the subject. At the same time DST-SERB effect is very much appreciated. At the same time Department of science & Technology, Govt. of India has funded for the project for the beneficence of the whole mining engineering. The effect is very much appreciated in this regard. Last of all I personally congratulate to you and your whole team for preparing the report for studying at least 2-3(Two to Three) Yrs. specially in our mines i.e. Kumardihi "A", Kumardihi "B" & Shankerpore Collieries of Bankola Area, ECL and further wish you to succeed for preparing this type of scientific report in future also.

Yours faithfully,
(अभिजीत मल्लीक)
General Manager,
Bankola Area.
महा प्रबन्धक, बंकोला क्षेत्र, ई.सी.एल.
General Manager, Bankola Area, E.C.L.

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Project Staff

Gourab Dhara Sharma, Registered for PhD, will submit soon

Shibaji Ch Dey, Registered for PhD

List of Publication

1. Dey N C, Nath S, Sharma G D, Dey S C(2015): An Inventory Approach to Humanizing Work and Working Environment in Indian Underground Coal Mines :Research Updates in Medical Sciences (RUMS) 2015, Volume 3; Issue 3 page 10 - 18 Research Article.
2. Dey N. C., Sharma G D and Nath S, Mallik A (2014); "Environmental impact on physiological responses of underground coal miners in eastern part of India", Journal of Human Ergology, Japan, ISSN 35-4144; Vol 43, No.2.
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4. Dey N. C., Dhara Sharma G (2013), "A Critical Study on the Underground Environment of Coal Mines in India - an Ergonomic Approach" Springer Issue (Journal of the Institution of Engineers, India): Series D: Volume 94, Issue 1, April (2013), Pages 1-6.
5. Dey N. C., Dhara Sharma G, Dey S. C. (2015); "An ergonomic study of health of drillers working in an underground coal mine with adverse environmental conditions", Transactions (MGMI), vol. 111: April 2014- March 2015, Page: 58-65.
6. Dhara Sharma. G, Dey. N. C., Nath. S (2013); "A glimpse on job heaviness of roof bolt Drillers and face drillers in Eastern Coalfields of India: A comparative approach", CETAFC- An International Conference organized by the Dept of Mining Engg, IIEST, during Dec (15-17), 2013.
7. Dey. N. C., Dhara Sharma. G., Nath. S. (2013); "Adequacy of rest pause period of roof bolters in between spells of a shift in underground coal mine in India", National Symposium on Present Technology and Safety Scenario in Mining and Allied Industries, organized by the Dept of Mining Engg, BHU-IIT, during Feb 25-27, 2013, page No. (355-364).
8. Dey. N. C., Nath. S., Dhara Sharma. G. (2013); "A Study on Heat Stress Exposures and Interventions for Underground Coal Miners of West Bengal: An Ergonomic Approach"; National Symposium on Present Technology and Safety Scenario in Mining and Allied Industries, organized by the Dept of Mining Engg, BHU-IIT, during Feb 25-27, 2013, page No. (425-432).

Facilities Developed

Safety and Ergonomics Lab have been augmented with a number of modern equipment

Plan of Future Project Proposal based on the Current Project

1. An in depth future work on different mines with having depth of more than 300 m are required to establish a suitable scientific comparison of physical & physiological parameters of miners among the different subsidiaries of Coal India Limited.
2. Nutritional assessment and energy balance study has to be planned for neutralizing excess calorie demand & workload.
3. Development of an online Ergo-Health monitoring is to be developed to keep it handier for Colliery managers to choose a working personnel for a selective work.