

Ergonomic Health Assessment in the Blast Furnace Section of Steel Industry: A Comprehensive Study Using Reba and Rula Methodologies

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Abstract: Introduction: Blast Furnace is most hazardous section of any steel Industry [1]. All kind of physical hazards are present here. The aim of this study is to assess degree of ergonomic health issues exist in this area. Methodology: REBA and RULA scores are used for ergonomic assessment in thirty work stations of a blast furnace including control rooms. A questionnaire has been used to assess existing health issues related to ergonomics. Result and Discussion: Very high REBA score is observed in four jobs such as slag runner cleaning, cast house pit cleaning, mud gun cleaning and maintenance work. They all are very transient works and done on demand only. In other areas ergonomic health issue lies in light to moderate range. In office areas eye strain and low backache are major ergonomic issues. Lumbar support and good sitting posture are found helpful.

Keywords: Ergonomics, Blast Furnace, RULA, REBA, Posture, Office

1. Practitioner Summary

Doing strenuous work in abnormal position for long duration in highly hazardous area like blast furnace may result various Musculo - skeletal problems. An observational study was conducted and found many situations which are though transient, needs behavioral improvement and technical intervention. Behavioral modification is also required in office areas.

2. Introduction

Steel Making is a hazardous process. Blast furnace is the heart of a Steel Industry. Workers are engaged here in various activities where body posture is compromised. In long run these result many musculoskeletal diseases and some may require surgical intervention. These can be avoided with early detection of wrong working styles and application of ergonomic principles [2] in posture improvement and work station modification. The aim of this study is to assess degree of ergonomic health issues exist among the Blast furnace workers and to suggest them possible solutions.

3. Materials and Methods

Study Area

The Study of Ergonomic Health issues has been conducted in Blast Furnace of Tata Steel, Kalinganagar. [3] The Steel industry is of 3 Million Tons annual production capacity. It is India's largest single - location green field steel project. It is second largest Steel Plant in India, manufacturing high - end flat products. It is increasing its annual production to 8MT. In Steel Making Blast Furnace is the most important area. It is called heart of a Steel Plant. The processed iron ores are blasted here with natural gas in a high temperature of around 1500 - 1600°C. The final product Molten Steel is produced and transported through torpedo to Casting shop of Steel Melting Shop (SMS).

Study Type, Study Design and Study Population

It is an Observational type of study. Around seventy six workers have been observed working in thirty worksites. It is a cross sectional type of observational study. There is no retrospective data collected in the study. The study population includes seventy two male and four female workers found in Office work. All workers are in the age group of 30 to 50years. They have been working there for more than five years. In this study the other hazards such as heat, noise and vibration are not considered and only working postures are evaluated.

4. Result and Discussion

Furnace Proper: In the area of Charging system and Hot Blast Stove, manual handling of molten metals with a long heavy bar is a periodical activity. It produces strain on trunk, shoulder and arms that give rise to REBA score of eight. This can be improved with mechanization and reduction of bar weight. On shop floor, the operator has to stand during operation. The mismatch of height and switch platform creates strain on neck and shoulder. RULA score of this activity has been found to be five. This can be reduced by platform modification with height adjustment facility.

Cast House: Liquid iron and slag from the tap hole of blast stove flow down in a deep trench called a "trough". So trough preparation is necessary and done frequently. But dealing with heavy and hot slag is really strenuous. The manual handling job has a REBA score nine. But with introduction of Bob Cart, the Ergonomic risk is reduced to three. REBA score for the EOT Crane operators has been found six which can be improved by video observation and proper placement of working switches.

Stock House: To charge raw materials inside the BF there is an elaborate system for receiving & storing of raw materials. These are generally done with conveyors and associated with spillage. Cleaning of these spillage by shoveling put strain on flexor muscles of shoulder and spinal extensor

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group. This gives rise to REBA score seven which can be controlled through reduction of spillage and mechanization.

Fabrication and Maintenance Yard: A constant mismatch of height of sitting and working platform is observed in this area. That creates strain on waist, knee and neck. But where there is good height arrangement considering worker's height, the REBA score lies between four to seven.

Cleaning Work: Cleaning of shop floor, peripheral area and drains affect hand, shoulder and back that account to REBA score from eight to eleven. But use of vacuum and super sucker machine reduce REBA score to three.

High Risk Transient Jobs:

Slag runner cleaning in cast house involves handling a jack hammer weighing approximately 35kg for 30minutes. REBA score for this job is found 13. This score can be reduced by overhead support system and vibration protection.

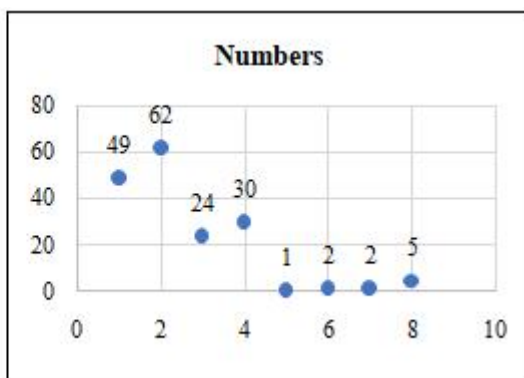
Cast House Pit Cleaning - It is done after every one lakh ton of molten metal is produced. Here the worker gets over flexed. It gives REBA score of 10. It can be improved through mechanization.

Mud gun cleaning: It is a physically high intensive job with a high velocity jerk to the hand and wrist, that gives REBA score 10. This can be reduced through mechanization.

Health Issues: About 206 workers participated in this survey through a questionnaire. Most of them about 32% suffer from Eye strain or Headache, 30% suffer from low Back ache, 20% have neck pain, 11% have shoulder pain, and 7% complaint of pain in wrist.

Sitting Chair: Sitting chair in work site has significant contribution for ergonomic wellbeing. An ideal chair must have five legs with wheels, arm support, neck support, lumbar support, height adjustment and foot rest etc. Out of 206, 43 employee have lumbar support in their chair and only 8 of them complains of low backache. Out of 98 employees having complain of low back ache only 8 have lumbar support in their chair. Therefore chair with lumbar support has a big advantage in relation to low back ache with p value of 0.000019.

Sitting Posture:



Sitting correctly is also important ergonomically. Employees have been asked to chose from above pictures as their most common sitting posture.175 employees responded to this question and out of which 59 have health issues. Ergonomically position 1, 2, 4 and 8 look acceptable with respect to position 3, 5, 6, and 7. It is validated in Chi Square Test with p value 0.00001 (<0.05).

stretches the body beyond acceptable range. In this study 30 employees complain of shoulder pain. Out of them 16 do not have all required items at an approachable distance. So they have to frequent get up from sit or have abnormal twist in body and abduction and extension of shoulder that result pain. It is validated with p value 0.0023 (<0.05).

Position of Neck and Angle at wrist: Position of Neck and Fore arm hold immense value in ergonomics. Any abnormal range may result neck pain and complication like Carpal Tunnel Syndrome in hands. The angle between eyeline and horizontal at top margin of desktop or laptop screen decides strain factor on eyes. According to RULA worksheet 48 employees maintain more than 30 degree angle at top of screen and 107 people makes less than 30 degree. With respect to bending at neck, 91 and 41 employees have acceptable (<10 degree) and unacceptable (>10 degree) angle at neck respectively. Similarly 66 and 48 employees have acceptable (<15 degree) and unacceptable (>15degree) angle at wrist respectively.

Awareness level: For improvement of ergonomic health conditions awareness is utmost important. It can make behavior modification successful. There are few rules that need to be followed such as:

- 1) Rule of 20 - 20 - 20: In Every 20 minutes look at an object 20 feet away for 20 seconds.
- 2) Every 30 minutes, move at least one muscle: A static posture creates fatigue in the body.
- 3) Every 1 hour, Stretch complete body or walk around.

In this study it is observed that only 10% employees are aware about rule of 20 and 44 walk around or stretch at regular interval and 46.11 % employee are unaware of these rules.

Work Station Design: Frequent movement in the worksite or cubicle also hampers body posture. Often it twists and

5. Conclusion

In this Ergonomic study of Blast Furnace 30 different worksites/work styles have been analyzed. Four high risk work styles are detected having very high REBA score such as slag runner cleaning, cast house pit cleaning, mud gun cleaning and maintenance work. They all are very transient works and done irregularly on demand only. Ergonomic upgradation of them can be achieved through mechanization/robotics/ job rotation. Among office workers the most common ergonomic health issue are eye strain and low backache. Lumbar support provides biggest ergonomic advantage for low backache. Maintaining a good sitting posture reduces chances of many ergonomic health issues. Keeping all necessary items in approachable distance reduces shoulder pain. Health education and behavioral modification are necessary to reduce ergonomic health issues.

Ethical Statement

The Study has been conducted confirming with the “National Ethical guidelines for Biomedical and Health Research involving Human participants” published by Indian Council of Medical Research (ICMR) 2017. [4]

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