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Investigation of Work-Related Disorders by Rapid Upper Limb Assessment

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Ergonomics is considered as one among the major problematic issues faced by the manufacturing industries, which causes musculoskeletal disorders there by affecting the normal health of employees. The paper emphasizes on the ergonomic aspects in bearing manufacturing industry where heat treatment, grinding, honing, assembly, inspection and packing are done. The study and analysis of various ergonomic issues are done by the help of ergonomic tools. Many ergonomic issues are being emerging from different manufacturing industries, which have both direct and indirect effect on the industries and the society. Rapid Upper Limb Assessment (RULA) is used for analyzing the different human body postures by observing the task, providing scores for the postures, processing the scores, & determining the final score. ErgoFellow software is used for consolidating the results of RULA. NIOSH lifting equation is used for analyzing ergonomic risks involved in the lifting procedure.

Keywords: Rapid Upper Limb Assessment, NIOSH Lifting Equation, Ergonomics, Musculoskeletal Disorders,

Introduction

The ergonomic professionals usually will modify the existing work environment or will design a new work environment with respect to human limitations and capabilities[4]. The two main issues in ergonomics are awkward postures and musculoskeletal disorder[5]. Major ergonomic factors are body posture, workstation, duration of work, tools used, machinery used, human body dimension, nature of work and working environment. There is an increased likelihood of injury while working in uncomfortable static position to muscles and tendons. Main ergonomic risk factors are working in extreme temperature conditions and repetitive tasks which use same muscles and tendons[5].

Methodology

The need for the acceptance of human factors or ergonomics is increasing[10,12] Developing a competence which corresponds to the real world should be the prime strategy for Human Factor/Ergonomics (HFE). Most of the HFE practices are inherited practices[3]. If there is a lack of awareness of HFE, then the practitioners have to cost HFE interventions[8]. Understanding the possible benefits in applying the HFE in designing is not adequate, rather conceptual innovation for tracking HFE problems is needed[6]. The HFE has a higher potential in shaping working and living environments. Neuroscience, technology, physiology and social science have a connection with HFE[7]. Most of the modern manufacturing sectors emphasis on ergonomics as it is one of the highly discussed issues[11]. The ergonomic hazards should be identified and controlled in order to protect workers, helping for an effective ergonomic program[9]. Manufacturing refers to the process of producing products from raw materials by the help of tools, machineries and methodologies. There are many manufacturing industries in the modern world. Bearing manufacturing industry manufactures different types of bearings like plain bearing, roller element bearing, flexure bearing, fluid bearing, magnetic bearing and jewel bearing. Roller element bearing consist of ball bearing and roller bearing. Roller bearing consists of cylindrical roller bearing, spherical roller bearing, gear roller bearing, tapered roller bearing, needle roller bearing and toroidal roller bearing. Tapered roller bearing can carry high load than ball bearings as they are having higher contact area. The tapered roller bearing has four parts shown in below (cup, cone, roller and cage). The tapered roller bearing manufacturing includes heat treatment, face grinding, hard turning, laser marking, Outer Diameter (OD) grinding, Inner Diameter (OD) grinding, honing, Magnetic Particle Inspection (MPI), slushing, assembly, inspection and packing. Slushing

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is completely done automatically. Figure 1 shows Tapered roller bearing assembly. This study is done among 327 employees in whom 264 are directly involved in physical operations. There are three shifts. 88 employees are directly involved in physical operations per shift. made a study among construction workers in South-western Nigeria on manual lifting tasks methods for analyzing the level of addition of ergonomics in the work systems. It is observed that 63% of the workers do not have regular ergonomic training. Study and analysis of various ergonomic issues in various industries and areas (construction, assembly line, virtual environment, automotive industry and manufacturing industries) are found, but a detailed ergonomic analysis on bearing manufacturing industry is very less. This paper aims at providing a clear picture of ergonomics by analyzing the body postures of employees in bearing manufacturing industry.

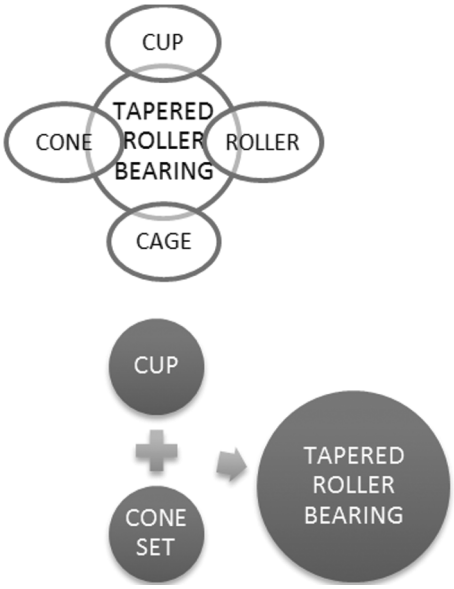

Fig. 1 — Tapered roller bearing assembly

Investigation and consultation technique

The employees are informed on the significance of the study. All systematic procedures were followed, which was initially approved. Before starting the study, got permission from the concerned departments, all respective supervisors are informed, and personal permission from each and every employee is made to make them more comfortable during the study.

Rapid upper limb assessment (RULA)

Rapid Upper Limb Assessment is used for ergonomic investigation where musculoskeletal disorders are reported and is a quick survey method[2]. RULA focuses mainly on position of the head, upper limbs of the body, use of arms and use of wrist. It is a simple and easy method that assesses postural loading on the body by focusing on trunk, neck and upper limbs. The RULA score shows the equal of Musculoskeletal Disorder risks. The RULA splits the whole body into dual groups, group A and B. Group A consist of upper arm, lower arm wrist and wrist twist, Group B consists of neck, trunk and legs. The different positions of the upper arms are: more than –20° extension, –20° extension to 20° flexion, 20° – 45° flexion, 45° – 90° flexion and >90° flexion, the respective scores are 2,1,2,3 and 4. A score of +1is added if arm is abducted, rotated and if the shoulder is raised. A score of –1 is added if leaning, supporting the weight of arm; is involved. The different positions of the lower arms are 0° – 90° flexion and >90° flexion, the respective scores are 1 and 2. A score of +1is added if working crossways midline of the body or working out to the side of the body. The different positions of the wrists are 0°, -15° – 15° flexion/extension and >15° flexion/extension, the respective scores are 1, 2 and 3. A score of +1 is added if wrist is bending away from the midline. The different positions of the wrist twists are twist in midrange and at or near end of twisting range, the respective scores are 1 and 2. The different positions of neck are 0° – 10° flexion, 10° – 20° flexion, >20° flexion and extension, the respective scores are 1, 2, 3 and 4. The different positions of trunk are 0°, 0° – 20° flexion, 20° – 60° flexion and >60° flexion, the respective scores are 1, 2, 3 and 4. If the legs and feet are well supported and in an evenly balanced posture the score is 1, in all the other cases the score is 2. Consolidated scores for different upper limb postures, neck, trunk and legs are made and a grand score is made. Table 2 shows the RULA action level with the score sheet. Now each body part of group A and group B has a score. A consolidated score for group A along with the load/force and a consolidated score for group B along with the coupling is made. An activity score is made by the consolidated result of group A and group B. A final RULA score sheet along with the risk level and action level is created (Table 1).

Ergo fellow software

Ergo Fellow software is used for analyzing the Rapid Upper Limb Assessment. RULA has scores ranging from 1 to 7 where 1 represents the existing posture is acceptable and 7 shows investigation and

Table 1 — RULA score sheet

Action level	Score	Action
1	1 or 2	Acceptable posture
2	3 – 4	Further examination needed; changes may be required.
3	5 – 6	Examination and changes needed soon
4	7	Examination and changes required immediately.

Table 2 — Consolidated RULA score Consolidated RULA Scores

Sl. No.	Operation / Section	Average RULA Score
1	0 - 8" OD Grinder	3.6
2	0 - 8" Face Grinder	3.6
3	8 - 12" Face Grinder	3.75
4	12 - 18" Face Grinder	5.8
5	0 - 8" Cone	3.2
6	8 - 12" Cone	3
7	12 - 18" Cone	5.14
8	0 - 8" Cup	3
9	8 - 12" Cup	5.22
10	12 - 18" Cup	4
11	18 - 24" Cone / Cup	5.6
12	Heat Treatment (RHF-1)	4
13	Heat Treatment (RHF-2)	4
14	Heat Treatment (RHF-3)	5
15	Magnetic Particle Inspection	5.4

changes are required immediately. Required input data is feed into the software which ultimately provides a final result for RULA and NIOSH Lifting Equation.

NIOSH lifting equation

In 1981 National Institute of Occupational Safety and Health (NIOSH) developed the lifting equation and were revised in 1991[7]. A series of parameters are used in the equation for calculating recommended weight limits and lifting index[7]. NIOSH lifting equation is widely used in industries in setting the acceptable lift limits of workers. NIOSH lifting equation is a very useful and an inexpensive methodology. The major product of the reviewed NIOSH lifting equation is RWL (Recommended Weight Limit).

Result and Discussion

An interview is also conducted among the employees relating to ergonomic conditions, awareness, the suitability of existing work station, tools used and physical problems (like body pain) by the help of a prepared questionnaire. The response from the employees was very positive as the intension was clear. It is observed from the interviews that employees who are directly involved in various physical operations do not have sufficient knowledge on body postures and ergonomic hazards. Some are aware of the acute effects but only a very few are aware of the chronic effects. The awareness on ergonomics among associates can be improved by periodic training[5]. Many employees' point-outs work pressure as one of the factors which provokes them to deviate the ergonomic path.

Rula

Ergonomic analysis is done by using RULA, among employees who are involved in various operations of bearing manufacturing. Average values for body positions or movements are considered for consolidating RULA scores.

NIOSH lifting equation

The lifting activity of employees in various activities like heat treatment, face grinding, laser marking, outer diameter grinding, inner diameter grinding, honing, assembly, inspection and packing are analyzed by NIOSH Lifting Equation. Visual inspection of 8 – 12" cone has a lifting index of 1.279, this can be reduced if H ≤ 35 cm and A≤ 35°.Face Grinding, Visual Inspection and keeping the work piece in hydraulic lift of 8 - 12" Face Grinder has lifting index of 1.267, 1.03 and 1.09 respectively. This can be reduced by making H≤ 30cm and A≤ 30°. Visual inspection and packing of match bearing assembly has lifting index of 1.177 and 1.164 respectively. This can be reduced by making H≤ 30cm and A≤ 35°.

Conclusion

There exist many ergonomic risks in different operations. The awareness on ergonomics is very less in employees who are directly involved in physical operations It is observed that the awareness on ergonomics among the employees who is directly involved in operations, in the lower part of the organizational structure is low. Visual Inspection (8 - 12" Cone), Face Grinding (8 - 12" Face Grinder), Visual Inspection (8 - 12" Face Grinder), Keeping the work piece in hydraulic lift (8 - 12" Face Grinder), Visual Inspection (MBA) and Packing (MBA) are having lifting index more than one, which signifies the higher ergonomic risk level during lifting. 12 - 18" Face Grinder and 12 - 18" Cone have the highest RULA scores of 5.8 and 5.14 respectively. A periodic ergonomic risk assessment has to be carried out in all

manufacturing industries periodically, which helps in enhancing the level of ergonomic aspect and identifying the ergonomic hazards which will affect the employees badly.

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