Analysis of Body Postures of Employees in Manufacturing Industry by Using Ergonomic Tools

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Many operations which are involved in manufacturing have a higher level of ergonomic risk. Most of these ergonomic risks can be reduced or controlled by providing an administrative control and an improvised workplace arrangement. Providing suitable and sufficient equipment (both power equipment and non-power equipment) helps in making an ergonomic friendly workplace, thereby reducing the ergonomic risk level. The current paper aims at providing an ergonomic investigation in a bearing manufacturing industry and for examining the various ergonomic risk levels.

Keywords: Ergonomics, Musculoskeletal Disorders, Rapid Entire Body Assessment, Bearing Manufacturing Industry

Introduction

Ergonomics is a scientific discipline which deals with the study, analysis and improving the human wellbeing by the help of certain principles, data and methods. Ergonomics is inquisitively viewed by the modern world3. The word ergonomics means work-law, is a science of fitting the job to the worker rather than enforcing the worker to fit the job. The principals involved in ergonomics are working in neutral postures (neck alignment, elbow positions, wrist position), excessive force reduction, arrangement of the workplace (normal working area, maximum working area), working at proper height, reduction/elimination of excessive motions, minimizing static load, minimizing pressure points and avoiding static postures9. Human physiological limitation and psychological limitations are examined in ergonomics1,4.

Methodology

Questionnaire and interview technique

Questionnaire which comprises of different questions including body postures, awkward postures, trunk, shoulder, neck, wrist, legs, elbow, workstation, duration of work, tools used and machinery are used for studying and analyzing the body postures of employees2. Questions relating to general ergonomics and health are also included which helps in understanding the level of ergonomics among employees7,8. All procedures were approved before conduction of the study.

Rapid Entire Body Assessment (REBA)

Rapid Entire Body Assessment is a postural analysis which is sensitive to musculoskeletal risks. Full body postures can be assessed by REBA3. It divides the whole body into segments with regards to movement planes. A scoring system is provided for muscle activities which include unstable postures, dynamic postures and static postures10. Coupling is also considered in case of load handling. An action level with level of risk and the necessity of action required is provided. The REBA divides the whole body into two groups, group A and B. Group A consists of neck, trunk and legs; Group B consist of upper arm, lower arm and wrist. The movement/position of each body part has assigned a particular score along with the change of score. The different positions of the trunk are upright, 0° – 20° flexion, 0° – 20° extension, 20° – 60° flexion, 20° extension, and >60° flexion, the respective scores are 1, 2, 2, 3, 3, and 4. A score of +1 is added if twisting or side flexed is involved. The different positions of the neck are 0° – 20° flexion and >20° flexion or in extension, the respective scores are 1 and 2. A score of +1 is added if twisting or side flexed is involved. The different positions for legs are bilateral weight bearing, walking, or sitting; and unilateral weight bearing, feather weight bearing, or an unstable
posture; the respective scores are 1 and 2. A score of +1 is added if knees between 30° and 60° flexion and +2 is added if knees are >60° flexion. Group B consist of upper arms, lower arms and wrist. The different positions of the upper arms are 20° extension to 20° flexion, >20° flexion, 20° –45° flexion, 45° – 90° extension and >90° flexion, the respective scores are 1, 2, 3 and 4. A score of +1 is added if the arm is abducted, rotated and if the shoulder is raised. –1 is added to the score if leaning, supporting weight of arm or if posture is gravity assisted. The different positions of the lower arms are 60° –100° flexion and <60° flexion or >100° flexion, the respective scores are 1 and 2. The different positions of the wrist are 0° –15° flexion/extension and >15° flexion/extension, the respective scores are 1 and 2. A score of +1 is added if wrist is deviated or twisted (Hignett & McAtamney, 2000). 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. A final REBA score sheet along with the risk level and action level is created (Table 1).

Ergo fellow

ErgoFellow 2.0 software is used for analyzing the Rapid Entire Body Assessment. This software is intended to evaluate the work place and to reduce occupational risk. It takes and analyses the related factors and will produce a score relating to the level of risk existing. The scores from 1 to 11(or more) represent very high risk. Required input data is fed into the software which ultimately provides a final result for REBA.

Case Study

The study of body postures of employees is done by direct observation by three safety professionals. Each employee is observed over a regular interval of time continuously for three working days. The team observed and recorded each and every body movements as required for REBA.

Result and Discussion

The study and analysis of body positions of employees are done in heat treatment, face grinding, laser marking, outer diameter grinding, inner diameter grinding, honing, assembly, inspection and packing by REBA methods with the help of ErgoFellow 2.0 software. The ergonomic issues of office employees are studied by direct interview with them.

REBA

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

Heat treatment

Heat treatment is done in Rotating Heat Furnaces (RHF). Heat treatment consists of RHF-1, RHF-2 and RHF-3. Operation involves Feeding of bearing rings to heating chamber (F) and moving the red hot bearing rings to quenching press (M). 10” cone with 5 kg is considered for conducting the assessment for RHF-1. 10” cup with 2.5 kg is considered for conducting the assessment for RHF-2. 8” cone with 9 kg is considered for conducting the assessment for RHF-3.

0 - 8” OD Grinder

0 -8” OD grinding has the following operations. Inserting the bearing rings (IR), Collection of bearing rings (CR) and Visual Inspection (VI). 5” cup with 0.300 kg is considered for conducting the assessment.

0 - 8” Face Grinder

0 -8” Face grinding has the following operations. Inserting the bearing rings (IR), Collection of bearing rings (CR) and Visual Inspection (VI). 5” cup with 0.250 kg is considered for conducting the assessment.

8 - 12” Face Grinder

8 -12” Face grinding has the following operations. Loading into the grinder (LG), Unloading from the grinder (UG), Inspection (I) and Moving from inspection table to output table (MO). 11” cup with 9 kg is considered for conducting the assessment.

12 – 18” Face Grinder

12 -18” Face grinding has the following operations. Loading into the grinder (LG), Unloading from

<table>
<thead>
<tr>
<th>Action level</th>
<th>REBA score</th>
<th>Risk level</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>Negligible</td>
<td>None necessary</td>
</tr>
<tr>
<td>1</td>
<td>2-3</td>
<td>Low</td>
<td>May be necessary</td>
</tr>
<tr>
<td>2</td>
<td>4-7</td>
<td>Medium</td>
<td>Necessary</td>
</tr>
<tr>
<td>3</td>
<td>8-10</td>
<td>High</td>
<td>Necessary soon</td>
</tr>
<tr>
<td>4</td>
<td>11-15</td>
<td>Very high</td>
<td>Necessary now</td>
</tr>
</tbody>
</table>
the grinder (UG), Inspection (I), Etching (E) and Moving from inspection table to output table (MO). 13" cone with 45 kg is considered for conducting the assessment.

0-8" Cone
0 - 8" Cone manufacturing has the following operations. OD grinding (ODG), Rib grinding (RG), ID grinding (IDG), Honing (H), Laser marking (LM), Inspection (I), Slushing (S), Roller filling (RF), Pressing (P), Vertical sound testing (VST), Slushing (S), Visual Inspection (VI) and Packing (P). 4.2" cone with 0.9 kg is considered for conducting the assessment.

8 - 12" Cone
8 - 12" Cone manufacturing has the following operations. OD grinding (ODG), OD Check (ODC), Rib grinding (RG), Rib Grinding Check (RGC), ID grinding (IDG), ID Check (IDC), Honing (H), Laser Marking (LM), Inspection (I), Magnetic Particle Inspection (MPI), Roller Filling (RF), Pressing (P), Slushing (S), Visual Inspection (VI) and Packing (P). 8" cone with 8 kg is considered for conducting the assessment.

12 - 18" Cone
12 - 18" Cone manufacturing has the following operations. OD Grinding (ODG), OD Check (ODC), ID Grinding (IDG), ID Check (IDC), Honing (H), Laser Marking (LM), Visual Inspection (VI), MPI, Slushing(S) and Packing (P). 13" cone with 8 kg is considered for conducting the assessment.

18 - 24" Cone/ Cup
18 -24" Cone/cup manufacturing has the following operations. Face Grinding (FG), Hard Turning (HT), Grinding (G), Honing (H), Laser Marking (LM), MPI, Roller Filling (RF), Assembly (A), Slushing (S), Inspection (I) and Packing (P). 18" cone with 48 kg is considered for conducting the assessment.

Magnetic Particle Inspection (MPI)
The entire process of MPI is divided into Moving the work piece from the trolley to work table (MT), Tevo testing (TT), Keeping the work piece in magnetic crack detector (KMCD), Magnetic Inspection (MI), Demagnetizer (D) and Demagnetized work piece to trolley (DT). 4" cone with 6 kg is considered for this assessment. Table 2 shows the consolidated score for REBA. 12 - 18" Face Grinding is having higher ergonomic risk with average REBA score of 6.2. Hydraulic lifter can be provided in 12 - 18" Face Grinder for keeping the finished goods. Job rotation can be done in 12 - 18" Face Grinder so that the ergonomic hazard of the associate will be reduced; currently single employee is employed in a shift, this can be increased to two per

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### Table 2 — Consolidated REBA score

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Operation / Section</th>
<th>Average REBA Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0 - 8&quot; OD Grinder</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>0 - 8&quot; Face Grinder</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>8 - 12&quot; Face Grinder</td>
<td>4.75</td>
</tr>
<tr>
<td>4</td>
<td>12 - 18&quot; Face Grinder</td>
<td>6.2</td>
</tr>
<tr>
<td>5</td>
<td>0 - 8&quot; Cone</td>
<td>4.6</td>
</tr>
<tr>
<td>6</td>
<td>8 - 12&quot; Cone</td>
<td>5.14</td>
</tr>
<tr>
<td>7</td>
<td>12 - 18&quot; Cone</td>
<td>6.07</td>
</tr>
<tr>
<td>8</td>
<td>0 - 8&quot; Cup</td>
<td>5.11</td>
</tr>
<tr>
<td>9</td>
<td>8 - 12&quot; Cup</td>
<td>4.55</td>
</tr>
<tr>
<td>10</td>
<td>12 - 18&quot; Cup</td>
<td>5.2</td>
</tr>
<tr>
<td>11</td>
<td>18 - 24&quot; Cone / Cup</td>
<td>5.5</td>
</tr>
<tr>
<td>12</td>
<td>Heat Treatment (RHF-1)</td>
<td>5</td>
</tr>
<tr>
<td>13</td>
<td>Heat Treatment (RHF-2)</td>
<td>5</td>
</tr>
<tr>
<td>14</td>
<td>Heat Treatment (RHF-3)</td>
<td>5.5</td>
</tr>
<tr>
<td>15</td>
<td>Magnetic Particle Inspection</td>
<td>5.2</td>
</tr>
</tbody>
</table>
shift. The existing number of employees in 12 - 18" Cone is 2 per shift; this can be increased to three. Hydraulic lifter can be provided to RHF-1 and RHF-2 for keeping the work piece, it reduces the associate’s effort on transferring of bearing rings from the work piece table to roller rail. Currently the demagnetization process for MPI is done manually, an automated demagnetized system helps in reducing the employees repetitive strain. Ergonomic training can be provided to employees, as many of them are unaware of ergonomics.

Conclusion
There exist many ergonomic risks in different operations. The major ergonomic risks are repetitive motion, awkward posture and improper lifting. It is observed that many work stations are not ergonomically designed. Anthropometry also has to be considered in workplace design and job rotation. The awareness on ergonomics is very less in employees who are directly involved in physical operations. Ergonomic issues can be reduced by ergonomically designed tools, work place and providing administrative controls like rest pause and job rotation. 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 shows the higher level of ergonomic risk during lifting. Mechanical lifting is more preferable as it saves time and reduces the physical stress. 12 - 18" Face Grinder has the highest REBA score of 6.2 which indicates the higher level of risk. This can be reduced by providing a hydraulic lifter for keeping finished goods and assigning two employees per (currently one per shift), which reduces the ergonomic stress. 12 - 18" Cone has a REBA score of 6.07 which is considerably high. This can be reduced by administrative control measures like providing more employees per shift which reduces the stress. Assigning an ergonomist in the industry will help to control or reduce the ergonomic risks.

References