ANALYSIS & IMPROVEMENT OF ERGONOMICS IN REFRACTORY TILES ASSEMBLY AND REMOVAL

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1. ABSTRACT:

Ergonomics normally are known to be related to human and their job. In larger scope ergonomics examines human behavioural, psychological, and physiological capabilities and limitations. Professionals in the field of ergonomics normally will design new work environments or modify established work environments based on the studies on the human capabilities and limitation.

The basic premise of ergonomics is that job demands should not exceed workers' capabilities and limitations to ensure that they would not be exposed to work stresses that can adversely affect safety and health as well as the company's productivity. Therefore, the objective of an ergonomics program is to provide a safe and productive workplace to the worker's comfort to fulfil the goals and objectives of the organization.

The focus of ergonomics implementation should removes barriers to quality, productivity and safe human performance by fitting products, tasks, and environments to people instead of forcing the person to adapt to the work.

Assembly process is manual process with high ergonomic risks and this project is aimed for quantitative risk analysis at assembly process using REBA procedure and to reduce Ergonomic risk and improving workplace of Assembly section

2. INTRODUCTION:

- The word ergonomics is a science of fitting the jobto the worker rather than enforcing the worker to fit the job.
- Ergonomics an applied science concerned with designing and arranging things people use so that the people and things interact most efficiently and safely.
- Major ergonomic factors are body posture, workstation, duration of work, tools used, machinery used, human body dimension, nature of work and working environment.
- Ergonomics deals with human comfort.

This paper describes the development of a posture, forceand muscle use assessment tool called REBA (rapid entire body assessment) this tool has undergone initial validation and reliability studies which are also reported upon here.REBA study was done to investigate the exposure of individual workers to risk factors associated with work related ergonomic disorders. Ergonomic risk is very high in the assembly area due to the continuous nature of manual work.

- Assembly area has the following manual operations like
    - Titling of Trucks forward for fixing of tongs
    - Stooping forward while leading blocks
    - Squatting down to fix the block
- Ergonomic Risk will lead to MSD (Musculoskeletal Disorders)

3. LITERATURE SURVEY

Himanshu Chaudhary et al., 2013 published a paper on **A Literature Review On MSDs Using Ergonomic Body Assessment Tools: RULA And REBA,** which says that Rapid Upper Limb Assessment (RULA) is a survey method developed for use in ergonomic investigations of workplaces where work related upper limb disorders are reported. RULA is a screening tool that assesses biomechanical and postural loading on the whole body with particular attention to the neck, trunk and upper limbs. McAtamney and Corlett (1993) introduce RULA, The basic idea of REBA is similar to that of RULA: positions of individual body segments will be observed and the more there is deviation from the neutral posture the higher will the score of each body part be. REBA has been developed to fill a perceived need for a practitioner's field tool, specifically designed to be sensitive to the type of unpredictable working postures found in health care and other service industries. REBA is a sensitive tool for musculoskeletal risks by classifying the bodies to the parts (wrist, upper arm, lower arm, neck, trunk, and legs). REBA is useful for manual tasks risk assessment. REBA proposes the prioritization for corrective measures according to risk assessment and risk level.

Sue Hignett et al., 2000 published a paper on **Rapid Entire Body Assessment (REBA)** which says, REBA assessment is done by analyzing trunk, neck, legs, upper arm, lower arm, and wrist. Based on the movement of these parts of the body according to the working operation the deflection of body parts are noted in angles. Generally in REBA the whole body assessment is divided into the divisions, group A and group B. Group A consist of neck, trunk, and legs. Group B consists of upper arm, lower arm and wrist. The rated REBA score is from 1 to 15 which indicate the level of risk in the particular task.

Surinder Singh et al., 2013 published a paper titled **A Proposed REBA on Small Scale Forging Industry**, which says Musculoskeletal disorders (MSDs) are common health problem throughout the world. Work related musculoskeletal disorders are group of painful disorders of muscles, tendons and nerves. The low back or lumber area, serves a number of important functions for the men in working area many occupational tasks in industrial area still associated with strenuous working postures and movement .Assessment of exposure levels to MSD risk factors can be an appropriate base for planning and implementing interventional ergonomics programs in the workplace. Combined with a heavy physical workload, it results in a high frequency of work-related musculoskeletal disorders. Study was conducted on 102 workers of a forging industry using the posture analysis tool REBA Method. The results of REBA showed that about 7.63% of the workers were under very high risk levels and required immediate change. About 44.6% of the workers were at high risk levels which required changes soon and 45.03% of the workers were at medium risk levels .About 2.67% of the workers were at lower risk levels. The present Study recommended the awareness and proper ergonomics training to the workers. The operators are working in an inadequate working environment with awkward postures the results are supported by the subjective assessment of discomfort.

4. METHODOLOGY

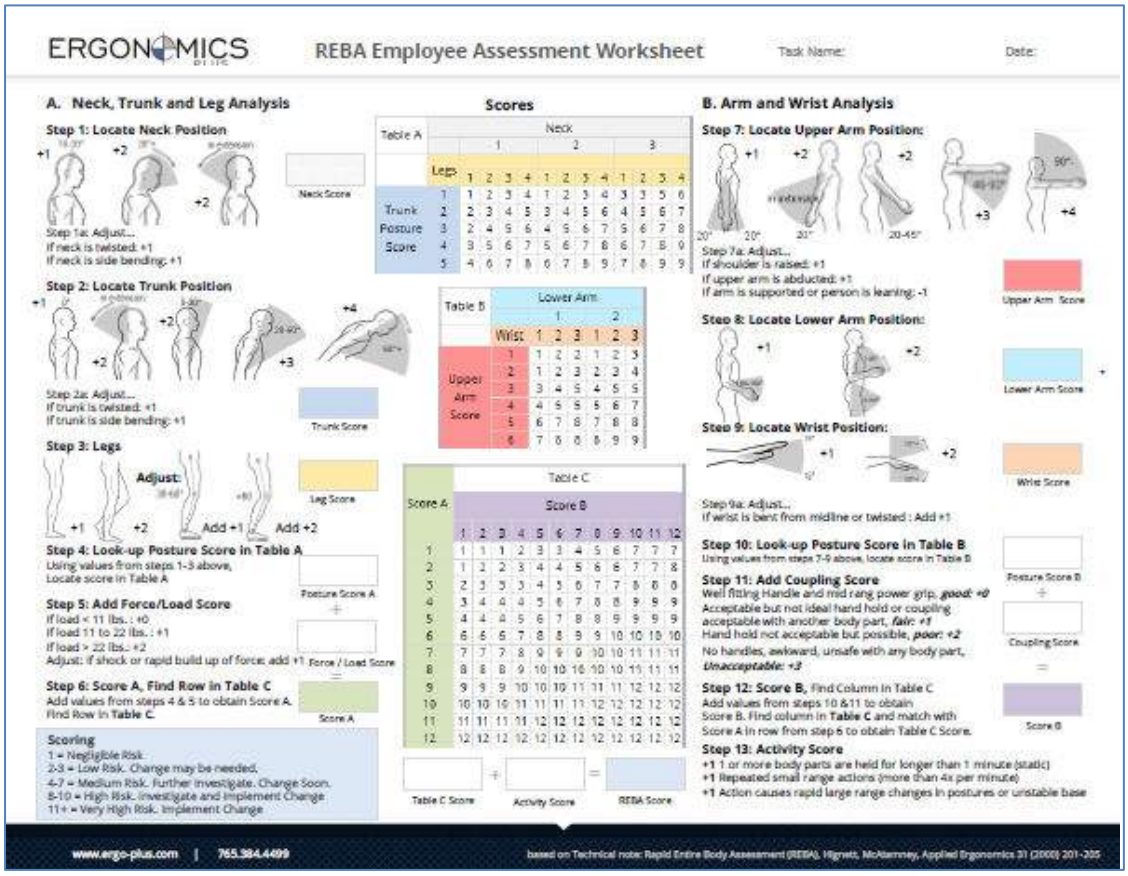
The assessment of the ergonomic risk is done using **Rapid Entire Body Assessment [REBA]**

- It is a postural analysis which is sensitive to musculoskeletal risks.
- 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 postures**.**
- Whole body -- Wrist, Upper arm, Lower arm, Neck, Trunk and Legs

REBA Action Level

ACTION LEVEL	REBA SCORE	RISK LEVEL	ACTION
0	1	Negligible	Not necessary
1	2-3	Low	May be necessary
2	4-7	Medium	Necessary
3	8-10	High	Necessary soon
4	11-15	Very high	Necessary Now

REBA WORK SHEET



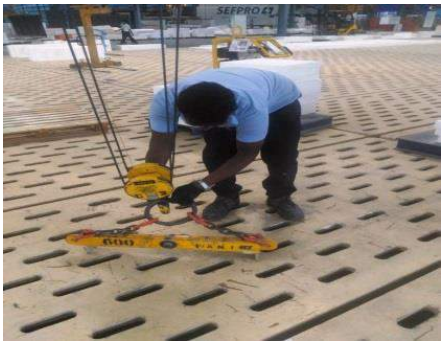
5. RISK ANALYSIS

5.1 TASKS IN ASSEMBLY PROCESS

Following are the tasks in the Assembly area:

1.TILE ASSEMBLY	**TILE ASSEMBLY**
1.1	Fixing of tongs to EOT Crane.
1.2	Positioning of tongs to the blocks
1.3	Leading of blocks to the assembly area.
1.4	Fixing of blocks in assembly pads
1.5	Hammering of blocks to pack closely and to remove the gaps created while placing blocks using tongs.
2. TILE REMOVAL	**TILE REMOVAL**
2.1	Create gap using levers
2.2	Positioning of tongs to the blocks
2.3	Removing of blocks from the assembly area.

TILE ASSEMBLY

Before (Tongs usage)	Task
	1.1 Fixing of tongs to EOT Crane. (Risk: Tilting of trunk- forward, more than 60 degree)
	1.2 Positioning of tongs to the blocks (Risk: Tilting of trunk- forward, 20-60 degree)
	1.3 Leading of blocks to the assembly area. (Risk: stooping down to lead blocks to the area)
	1.4 Fixing of blocks in assembly pads (Risk: squatting down to fixing the blocks)

	1.5 Hammering of blocks to pack closely and to remove the gaps created while placing blocks using tongs. (Risk: repetitive motion and stooping)

TILE REMOVAL

Before (Tongs usage)	Task & Risk
	2.1 Create gap using levers and (if in case the tile in the middle has to removed, all the tiles should be dislodged) create gap for tongs crane to enter in. (Risk: Tilting of trunk- forward, more than 60 degree)
	2.1 Positioning of tongs to the blocks (Risk: Tilting of trunk- forward, more than 15 degree)
	2.3Removing of blocks from the assembly area. (Risk: stooping down to lead blocks away from the area)

6. RESULT OF THE REBA STUDY ON TILES FIXING AND REMOVAL

SL NO	TASK	REBA SCORE
1.TILE ASSEMBLY	**TILE ASSEMBLY**	
1.1	Fixing of tongs to EOT Crane.	5
1.2	Positioning of tongs to the blocks	6
1.3	Leading of blocks to the assembly area.	6
1.4	Fixing of blocks in assembly pads	10
1.5	Hammering of blocks to pack closely	10
2. TILE REMOVAL	**TILE REMOVAL**	
2.1	Create gap using levers	12
2.2	Positioning of tongs to the blocks	8
2.3	Removing of blocks from the assembly area.	6

ACTION LEVEL	REBA SCORE	RISK LEVEL	ACTION
0	1	Negligible	Not necessary
1	2-3	Low	May be necessary
2	4-7	Medium	Necessary
3	8-10	High	Necessary soon
4	11-15	Very high	Necessary Now

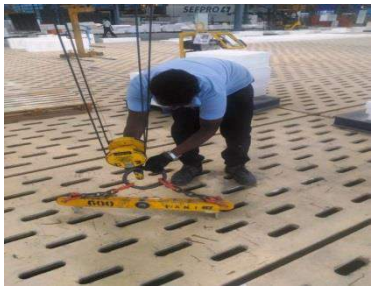
Table 5.3 Result of the REBA study

RESULT: Based on the REBA study, the ergonomic risks are higher and actions to minimize the risks are necessary.

7. ERGONOMIC IMPROVEMENT IN WORKPLACE

- Assembly work has high ergonomic risk as per the REBA study.
- To eliminate poor ergonomic postures, vacuum lifting is implemented for ergonomic benefits.

7.1 TILE ASSEMBLY

Before (Tongs usage)	Task	After (Vacuum lifting)	Task
	Fixing of tongs to EOT Crane. (Risk: Tilting of trunk- forward, more than 60 degree)		Vacuum lift is kept in stand and can be fixed in standing position. Vacuum lift is attached to EOT crane (Risk – Nil, tilting of trunk is avoided)
	Positioning of tongs to the blocks (Risk: Tilting of trunk- forward, 20-60 degree)		Blocks are vacuum lifted. (Risk – Nil, tilting of trunk is avoided)
	Leading of blocks to the assembly area. (Risk: stooping down to lead blocks to the area)		Leading of blocks to the assembly area. (Risk – Nil, stooping while leading blocks are avoided)
	Fixing of blocks in assembly pads (Risk: squatting down to fixing the blocks)		Fixing of blocks in assembly pads (Risk – Nil, fixing can be done at standing position, no need to squat/stoop low)

	Hammering of blocks to pack closely and to remove the gaps created while placing blocks using tongs. (Risk: repetitive motion and stooping)		Since there no gaps, adjusting /hammering is not required or very miniumum. (Risk – Nil)

7.2 TILE REMOVAL

Removal of tiles/blocks from the assembly area after assembling			
Before (Tongs usage)	Task & Risk	After (Vacuum lifting)	Task
	Create gap using levers and (if in case the tile in the middle has to removed, all the tiles should be dislodged) create gap for tongs crane to enter in. (Risk: Tilting of trunk- forward, more than 60 degree)		Vacuum lift can lift any tiles (even in the middle of assembled area), no manual work is required. (Risk – Nil)
	Positioning of tongs to the blocks (Risk: Tilting of trunk- forward, more than 15 degree)		Blocks are vacuum lifted. (Risk – Nil, tilting of trunk is avoided. Work can be done at standing position)
	Removing of blocks from the assembly area. (Risk: stooping down to lead blocks away from the area)		

8. BEFORE AND AFTER REBA SCORE OF THE ASSEMBLY PROCESS

SL NO	TASK	BEFOREINITIAL REBA SCORE	AFTERFINAL REBA SCORE
1.TILE ASSEMBLY	**TILE ASSEMBLY**		
1.1	Fixing of tongs to EOT Crane.	5	1
1.2	Positioning of tongs to the blocks	6	1
1.3	Leading of blocks to the assembly area.	6	2
1.4	Fixing of blocks in assembly pads	10	1
1.5	Hammering of blocks to pack closely and to remove the gaps created while placing blocks using tongs.	10	NIL – Activity avoided
2. TILE REMOVAL	**TILE REMOVAL**		
2.1	Create gap using levers	12	NIL – Activity avoided
2.2	Positioning of tongs to the blocks	8	1
2.3	Removing of blocks from the assembly area.	6	1

9. IMPROVEMENTS IN ASSEMBLY

- Vacuum lifting is enabled using vacuum pump and involves electricity for continuous vacuum. Even if the power switched off, vacuum will hold only for 2-3 minutes based on the material surface and porosity of lifting material.
- As a further improvement and low cost initiative, Instead of vacuum pump, vacuum is generated using compressed air using Venturi Principle.

Working Principle:

- Compressed air line which is available in lines are used to create Vacuum using vacuum generator, which works on Venturi Principles.
- The airline is connected the Vacuum generator.
- The Vacuum is generated by venturi and it is connected to lifting pad and hence materials are lifted.
- Advantages

✓ Compressed air is available in most of the industries

✓ Compressed air will be available in the air receiver for hours together for uninterrupted vacuum.

✓ Low cost

✓ No running parts and minimum maintenance

10. CONCLUSION

- Ergonomic Study and Risk Analysis was done using REBA methodology at the Assembly line of SEPR Perundurai plant and following are the benefits of the Ergonomic project undertaken;
- Ergonomic risk of Tiles Assembly and Tiles Removal is minimized / eliminated using vacuum lifting instead of using Tongs.
- Average tile fixing & removing time is reduced from 3.5 minutes to 1 minutes.

11. REFERENCES

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