POSTURAL ANALYSIS AND QUANTIFICATION OF FATIGUE BY USING RULA AND REBA TECHNIQUES

[1]ASHWIN BHANDARE, [2]PARITOSH BAHIRAT, [3]VISHAL NAGARKAR, [4]ANAND BEWOOR

[1,2,3,4]Student, Dnyanganga College of Engg. & Research, Pune.
E-mails:[1]ashwinbhandare5@gmail.com, [2]paritosh2891@gmail.com, [3]vishalnagarkar3609@gmail.com

Abstract: REBA (Rapid Entire Body Assessment) and RULA (Rapid Upper Body Assessment) are techniques to quantize the fatigue experienced by the worker while manually lifting loads. These assessments were carried out by a procedural analysis of body postures involved. The fatigue involved in a particular operation was quantified and accordingly changes in work method for system improvement were suggested. These techniques helped in process refinement by identifying actions causing high fatigue.

Keywords- Postural analysis, Quantification of fatigue. REBA, RULA.

I. INTRODUCTION

Postural analysis can be a powerful technique for assessing work activities. The risk of musculoskeletal injury associated with the recorded postures in the context of a full ergonomic workplace assessment can be a major factor for implementing change so the availability of the task-sensitive field techniques is of great assistance for ergonomics practitioner. A need was perceived within the spectrum of postural analysis tools, specifically with sensitivity to the type of unpredictable work postures found in various industries. This led to the development of the following postural analysis tool-Rapid Upper Limb Assessment, RULA (Mcatmney et al., 1993) and subsequently Rapid Entire Body Assessment, REBA (Mcatmney et al., 1995).

The methods REBA & RULA help as a tool to asses and quantify the fatigue involved in existing work methods which otherwise (fatigue) is a subjective variable. RULA investigates the exposure of individual worker's to risk factors associated with work related to upper limb disorders. RULA was developed through the evaluation of postures adopted and muscle actions of operators whose repetitive tasks are associated with upper limb disorders. On the same lines REBA was developed through the evaluation of postures adopted and muscle actions of operators whose repetitive tasks are associated with the entire body disorders, the only difference exists that REBA includes the assessment of legs along-with lower body and trunk. Numbers are used to represent postures and their extent. There is no need of any special equipment as assessment is based on standard charts and diagrams of body postures. The methods include direct observation or assessment through video recordings which can be done in confined workspaces without disrupting work. This paper reports Fatigue analysis using REBA and RULA method.

II. OVERVIEW OF THIS PAPER

This paper is divided into the following sections:

1. REBA and RULA are introduced in previous paragraph.
2. The description of work environment is given in the succeeding paragraph along with preliminary analysis of the process.
3. The detailed data collection and evaluation.
4. It is followed by discussion and conclusion.
5. References.
6. Annexure.

III. DESCRIPTION OF WORK ENVIRONMENT

Work done is carried out at *Vishay components India Pvt. Ltd, Loni Kalbhor,* which is a large scale industry located in western India. The work was carried out on *SPIRAL PRESS MACHINE* which is used for capacitor flattening. It performs the pressing operation by spiral motion of capacitor strip along the periphery of an empty circular core.

A. Preliminary Analysis

In this process the net weight lifted is 74.6 kg per 8 minutes considering allowance. But as per ILO Standards [annexure] the maximum permissible load to be lifted occasionally is approximately 24.4 kg per 5 minutes. For this process the weight lifted comes out to be 46.8 kg per 5 minutes, which is almost double than the permissible limit.

In an ideal shift of eight hours (480 minutes) and considering personal allowance of 15% equals 408 minutes. So the number of spools produced should be 51.But currently only 16 spools are produced per shift.

Therefore the productivity = (16/51)*100=31.37%

This preliminary analysis shows that there is scope to reduce worker fatigue and subsequently increase productivity.

B. Process Description

The entire process as performed by the operator on site is a follows:-

- A loaded steel tape cassette and empty core is loaded at their respective positions.
- The steel strip and capacitor strip is extended and fixed on the periphery of core.
- After adjusting the pressure and mounting cover plate on the core the arm is pressed against the core and machine starts.
- The core spindle rotates pulling the steel strip from cassette along with capacitor strip.
- As operation proceeds the capacitors are pressed spirally and a wound capacitor spool is generated which is unloaded to end the process.
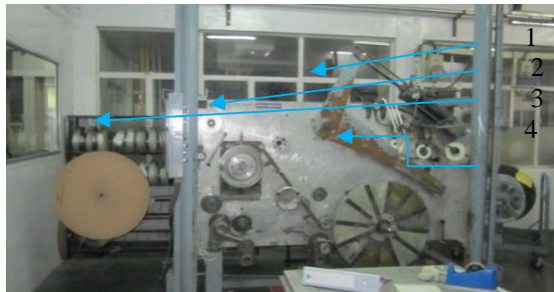
Fig.1 Actual picture of spiral press machine (1.Pressure Arm, 2.Cassette, 3. Capacitor Strip, 4.Spindle)

The process was divided into the following elements (along with abbreviations)-

1. Core lifting(CORE LFT)
2. Cover lifting(CVR LFT)
3. Cassette carrying(CST CRY)
4. Core mounting(CORE MNT)
5. Cover mounting(CVR MNT)
6. Cassette mounting(CST MNT)
7. Spool shifting(SPL SFT)
8. Cover dismounting(CVR UMNT)
9. Cassette dismounting(CST UMNT)
10. Cassette shifting(CST SFT)

IV. DATA COLLECTION

Based on above divisions analysis was carried out step by step.

Step 1.A qualified worker [5] was selected.

Step 2.Equipments required like video recorder etc. for performing the operations were gathered.

Step 3.The domain experts were consulted and the process was carried out under their supervision.

Step 4.It was observed that the material handling is done manually by the operator, which included lifting of cassette, core, cover plate and finished spool.

Table 1: Individual weights of components, frequency of lifting per cycle and total weight.

Component name	Weight(kg)	Number of times lifted(per cycle)	Total weight(kg)
1.empty core	9.7	1	9.7
2.loaded cassette	10.5	1	10.5
3.cover plate	14.5	2	29
4.empty cassette	8.7	1	8.7
5.spool	17	1	17

Step 5.The postural analysis tools RULA and REBA were selected to quantify the fatigue of the worker.

Step 6.For analysis, human body was divided into two groups the first of which includes upper, lower arm and wrist and the other includes trunk and neck. The minimum value (+1) is assigned to working posture where risks are minimal, higher numbers are allocated to extreme postures indicating risk factors. The procedure followed is same as the standard procedure of RULA and REBA [annexure].

A. RULA

Table 2: Arm and wrist analysis for first five elements

	CORE LFT	CVR LFT	CST CRY	CORE MTG	CVR MTG
1.UA	3	3	2	3	3
2.LA	1	2	1	2	2
3.WR	1	2	1	1	2
4.WR-T	1	1	1	1	1
SCR-A	3	4	2	3	4
FL	2	3	2	2	3
SCR-A+FL	5	7	4	5	7

Table 3: Arm and wrist analysis for last five elements

	CST MTG	SPL SFT	CVR UMNT	CST UMNT	CST SFT
1.UA	3	4	2	3	3
2.LA	2	1	1	2	2
3.WR	1	3	2	4	2
4.WR-T	1	1	1	1	1
SCR-A	3	4	3	4	4
FL	2	3	3	1	2
SCR-A+FL	5	7	6	6	6

Table 4: Neck, trunk and leg analysis for first five elements

	CORE LFT	CVR LFT	CST CRY	CORE MTG	CVR MTG
1.NCK	2	2	1	1	3
2.TRK	3	4	1	2	4
3.LEG	2	2	2	2	2
SCR-B	5	5	3	3	6
FL	2	3	2	2	3
SCR-B+FL	7	8	5	5	9

Table 5: Neck, trunk and leg analysis for last five elements

	CST MTG	SPL SFT	CVR UMNT	CST UMNT	CST SFT
1.NCK	1	2	2	1	1
2.TRK	1	3	3	1	2
3.LEG	2	2	2	2	2
SCR-B	3	5	5	3	3
FL	2	3	3	2	2
SCR-B+FL	5	8	8	5	5

B.   REBA

Table 6: Arm and wrist analysis for first five elements

	CORE LFT	CVR LFT	CST CRY	CORE MTG	CVR MTG
1.UA	3	3	2	3	3
2.LA	1	2	1	2	2
3.WR	1	2	1	1	5
SCR-B	3	5	1	4	8

Table 7: Arm and wrist analysis for last five elements

	CST MTG	SPL SFT	CVR UMNT	CST UMNT	CST SFT
1.UA	3	4	2	3	3
2.LA	2	1	1	2	2
3.WR	1	3	5	2	2
SCR-B	4	5	5	5	5

Table 8: Neck, trunk and leg analysis for first five elements

	CORE LFT	CVR LFT	CST CRY	CORE MTG	CVR MTG
1.NCK	2	2	1	1	3
2.TRK	3	4	1	2	4
3.LEG	1	3	1	2	3
SCR-A	4	7	1	3	8
FL	2	3	2	2	3
SCR-A+FL	6	10	3	5	11

Table 8: Neck, trunk and leg analysis for last five elements

	CST MTG	SPL SFT	CVR UMNT	CST UMNT	CST SFT
1.NCK	1	2	2	1	1
2.TRK	1	3	3	1	2
3.LEG	1	3	3	1	1
SCR-A	1	6	6	1	2
FL	2	3	3	2	2
SCR-A+FL	3	9	9	3	4

Table 9: Final Scores

Operations	REBA score	RULA score
CORE LFT	6	7
CVR LFT	10	7
CST CRY	2	5
CORE MTG	3	6
CVR MTG	12	7
CST MTG	3	6
SPL SFT	10	7
CVR UMNT	10	7
CST UMNT	4	6
CST SFT	5	6

Table 10: REBA scoring

1	Negligible risk
2 or 3	Low risk, change may be needed
4-7	Medium risk, further investigate, change soon
8-10	High risk, investigate and implement change
11+	Very high risk, implement change

Table 11: RULA scoring

1 or 2	Acceptable posture
3 or 4	Further investigate, change may be needed
5 or 6	Further investigate, change soon
7	Investigate and implement change

DISCUSSION AND CONCLUSIONS

By RULA and RELA assessment [annexure] and consultation with domain expert the suggestions given were:
A.   *process redesigning is required*
B.   *implementation of semi automatic material handling system like:*
- Jib headed crane.
- Trolley.
- Independent conveying system for cover.

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ANNEXURE

Table 1: Abbreviations used in RULA and REBA tables

Abbreviation	Meaning
UA	Upper Arm
LA	Lower Arm
WR	Wrist
WR-T	Wrist Twist
SCR-A	Score A
FL	Force load
NCK	Neck
TRK	Trunk
SCR-B	Score B

Table 2: Maximum permissible load as per ILO standards.

AGE	MEN	WOMEN
14-16	14.6	9.8
16-18	18.5	11.7
18-20	22.6	13.7
20-35	24.4	14.6
35-50	20.6	12.7
>50	15.6	9.8
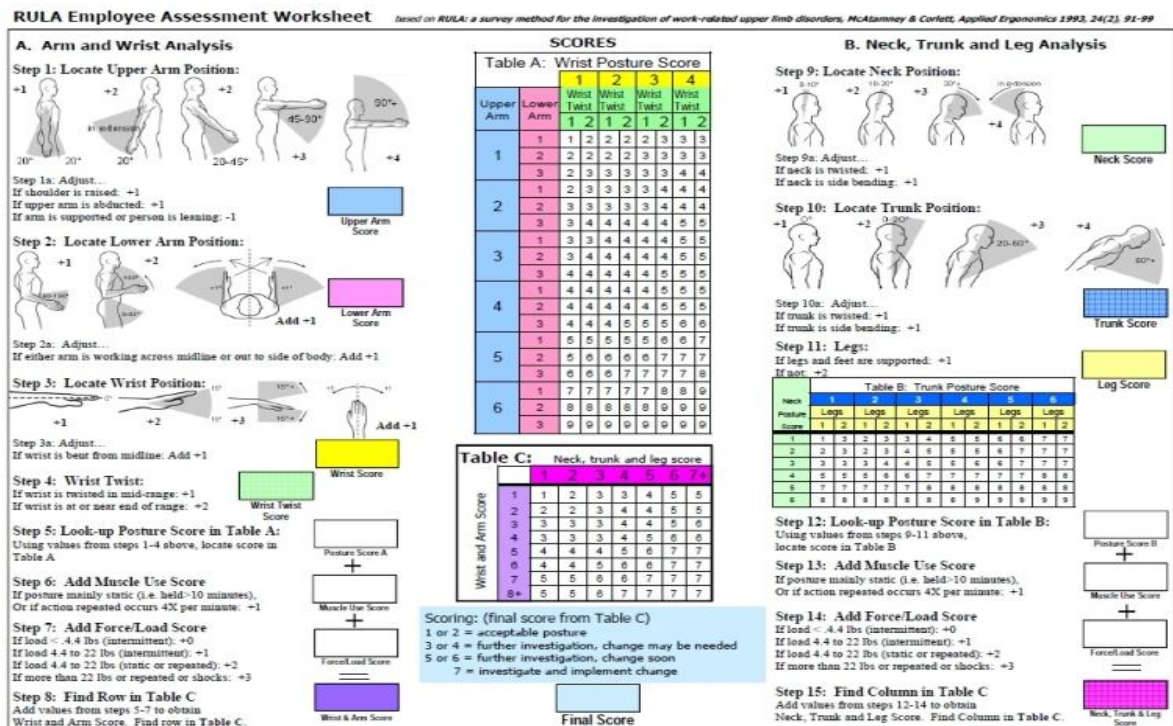
Figure -1 RULA analysis chart

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Figure-2 REBA analysis chart