IJAET International Journal of Application of Engineering and Technology *ISSN: 2395-3594*

Vol-2 No.-2

ANALYSIS OF LOAD CONSTANT IN MANUAL MATERIAL HANDLING TASK BY TAGUCHI TECHNIQUE & MATHEMATICAL REGRESSION MODELING

Ranveer Singh Rana[1], B.Mudgal[2]

[1, 2] Assistant Professor, LNCT Group of Colleges, M.P. (INDIA)

Email Address: - rsrana2112@gmail.com

ABSTRACT

Now a day, working in the construction area is not a comfortable as they were in the earlier time. The manpower is decreasing day by day and new requirements are not in the same ratio as the reason leaving the construction area. This cause arise a question that how much weight is sage for manual lifting task in construction area. Although several Author has worked in this topic and give there important Author, but in the last NIOSH lifting equation is uniformly accepted, in this equation the recommended weight limit is calculated with the help of seven factors, the factors are. In this thesis we have worked on these one factors LC respectively and tried to show that the load caring capacity for the different persons in the construction area is not constant but it depend on the carious physical parameters of the person like age, fatigue, time, weight, height etc. For calculating the load constant we have applied the fuzzy logic approach and calculate the load constant to age capacity by Taguchi parametric optimizing technique for best possible combination of those three to achieve the appropriate weight for manual lifting task in construction area.

Keywords: - *(MMH) Manual Material Handling, Taguchi Techniques and (LC) Load Constant, women worker.*

I. INTRODUCTION

Manual Material Handling (MMH) including lifting, calculating load constant for the women worker which is assign for lowering, pushing, pulling, twisting, carrying and holding is the lifting work. For calculating the load constant researcher applied the there are kinds of injuries and disabilities associated with Taguchi Optimization Technique and calculates the load MMH tasks, among which Low back ach disorders (LBDs) are constant according to worker's age, worker's weight and the most common of all musculoskeletal disorders and are a strength of women worker. The Taguchi process helps to select or to determine the assignment of right workers on to the right lifted load by optimizing all the available factors. Many Authors developed many mathematical models to optimize these parameters to get the zero or minimum loss in target achievement by various processes. The variation in the worker age, worker weight and strength other factors affecting the Load constant. Here the Taguchi design of experiments is used to optimize the considered parameters.

Taguchi method is that it emphasizes a mean performance characteristic value close to the target value rather than a value within certain specification limits, thus improving the worker capacity. Additionally, Taguchi's method for experimental design is straightforward and easy to apply to many engineering situations, making it a powerful yet simple tool. It can be used to quickly narrow down the scope of a research project or to identify problems in a construction industry from data already in existence. Also, the Taguchi method allows for the analysis of many different parameters without a prohibitively high amount of experimentation.

II. REVIEW OF LITERATURE

Snook, el in 1964 the international labor organization (ILO) concluded a study "on the maximum permissible weight to be carried by on worker based on individual physiological capacities. The ranges of weights recommended by the ILO were 33-88 pounds for males

ISSN 2395-3594

and 22-44 pounds for females depending on age. Nachemson and Elfstrom (1970) Tichaure (1971) Park and chaffin (1974) Ayoub and EI – Bassoussi (1976) have shown that load lifting may produce excessively high forces on the low back . Because of the large variations within the population, the acceptable limits to the spinal forces (compressive and shearing) are difficult to establish Snook (1978) based on a sample of 191 compensable low-back injury claims, concluded that a worker is three more susceptible to low-back injuries if performing a manual handling task which is acceptable to less than 75% of the working population. Ajay Bangar, Manoj joshi, Ganesh Pal Singh Jadon, Rajan Sharma(2012), India have shown that have tried to calculate the maximum Recommended Weight Limit (RWL) for manual lifting task in industry on the basis of revised Load constant (LC), Manish Kumar Sagara, Manvendra Singh Kushwah*a and Shard Agrawal(2013) have shown that The women power is decreasing day by day; whose women workers work at manual material handling in the Construction Company and industries. They are not pleasure as comfortable as they were in the earlier time. New recruitments are not in the same ratio as anyone leaving Construction Company and industries. This in twist increases the work load on the present women workers. It has been seen that the women workers are not assigned to the proper load according to their physical aspects and strength.

TAGUCHI METHODOLOGY

Taguchi method is a powerful methodology/ technique for preventing risk of(low back disorder) LBD is the most significant problem the design of high quality systems (Taguchi, 1990) and has complained by workers and it is still a hard topic for been widely used in engineering design (Ross, 1988). Many researchers have Taguchi design provides a simple, efficient and systematic developed tools and techniques for identify jobs which are approach to optimize design for performance, quality and cost over a variety of conditions. Taguchi steps are shown in figure 1 for present research work.

III. DESIGN OF EXPERIMENT

Once the experimental design has been determined and the trials have been carried out, the measured performance characteristic from each trial can be used to analyze the relative effect of the different parameters. To demonstrate the data analysis procedure, the following L9 array will be used. The experimental design was done according to L9 orthogonal array based on the Taguchi method. The use of Taguchi orthogonal array would evidently reduce the number of experiments. The L9 orthogonal array had three columns and nine rows, so it had six degrees of freedom to utilized in the research is larger the Better. Researchers manipulate three parameters with three levels as indicated in Table 1. Thus, in this investigation three parameters with three levels were indicated in Table 2.

IV. PROCEDURE AND STEPS OF TAGUCHI PARAMETER DESIGN

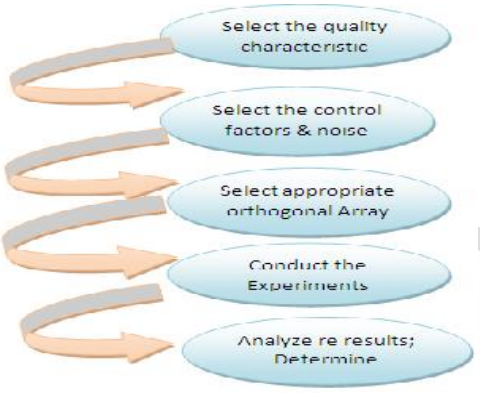

Fig. 1. Steps of Taguchi Method

SIGNAL TO NOISE RATIO (S/N RATIO)

From the quality point of view there are three possible categories of quality characteristic. They are: Smaller the better, Nominal is the best, Larger is better. The S/N ratio is computed from the mean square deviation (MSD) by the equations:

$$S/N = -10\log_{10}(MSD) \quad (1)$$

For the S/N ratio to be large, MSD must have a value that is small. If smaller is the best quantity characteristic:

$$MSD = [(Y_1^2 + Y_2^2 + \ldots\ldots\ldots\ldots + Y_n^2)]/N \quad (2)$$

Where Y1, Y2 ……..Yn are the quality characteristic
If nominal is the best quality characteristic:

$$MSD = [Y_1 - Y_0)^2 + (Y_2 - Y_0)^2 + \ldots\ldots\ldots (Y_n - Y_0)^2]/N \quad (3)$$

Where, Y_0 = target or nominal value

ISSN 2395-3594

If larger is the best quality characteristic:

$$MSD = [(1/Y_1^2 + 1/Y_2^2 + \ldots\ldots\ldots\ldots + 1/Y_n^2)]/N \quad (4)$$

The S/N ratio analysis is designed to measure quality characteristic. This is Taguchi's solution to Robust Product or Process Design.

SELECTION OF ORTHOGONAL ARRAY

Experiment	P1	P2	P3	P4
1	1	1	1	1
2	1	2	2	2
3	1	3	3	3
4	2	1	2	3
5	2	2	3	1
6	2	3	1	2
7	3	1	3	2
8	3	2	1	3
9	3	3	2	1

FUZZY LOGIC STEPS

- Defining Linguistic Variable
- Fuzzifying The Variables
- Determining Membership Function
- Appling If- Than Rule
- Defuzzification With Centre Of Gravity (Cog) Method

DEFINING LINGUISTIC VARIABLE

Fig. 2 For defining the linguistic variables

FUZZIFYING THE VARIABLE

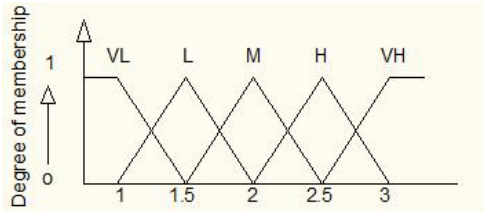

Fig. 3 For fuzzifying the variables

DETERMINING MEMBERSHIP FUNCTION

Following formula is utilized to compute the member ship value of antecedents. Degree of membership (DOM) for triangle:

$$\mu(x) = Min\begin{bmatrix} delta1 \times Slop1 \\ delta2 \times Slop2 \\ Max \end{bmatrix}$$

Where
Delta1 = Point x – Point 1
and
delta 2 = Point 2 – Point x
If delta $1 \leq 0$ or delta $2 \leq 0$
The degree of membership = 0

APPLYING IF – THEN RULES

The rules are generated based on expert's knowledge. For this purpose we discuss with experts team of Construction area.

DEFUZZIFICATION WITH COG METHOD

Centre of gravity method is applied to defuzzify the output.

DATA COLLECTED ACCORDING TO L9 ARRAY

ONLY FOR WOMENS														
WOMENS			LONG TERM LIFTING WEIGHT						SHORT TERM LIFTING WEIGHT					
AGE (YR.)	HEIGHT (ft)	WEIGHT (kg)	4.5 kg	F. TIME	6.5 kg	F. TIME	8.5 kg	F. TIME	4.5 kg.	F. TIME	6.5 kg	F. TIME	8.5 kg	F. TIME

ISSN 2395-3594

20	4.11	45.6	-	10.62	-	5	-	0.35	-	50.2	-	20.7	-	6.48
21	5.3	54	-	30	-	25	-	10	-	120.2	-	60.2	-	40.4
23	5	47.8	-	41.7	-	18.2	-	4.6	-	60.56	-	60.29	-	59
24	5.1	38	-	29.25	-	9.1	-	4.7	-	60.58	-	60.1	-	52.15
25	5	48.8	-	11.88	-	8.28	-	4.71	-	60.32	-	39.7	-	32.58
26	5.5	63	-	24.71	-	14.7	-	0.7	-	120.2	-	60.3	-	39.51
27	5.6	68	-	22.99	-	9.5	-	5.94	-	180.5	-	60.21	-	55.93
27	5.6	51	-	19.44	-	5.67	-	0.33	-	120.4	-	40.31	-	15.48
28	5.3	52	-	55.35	-	29.8	-	7	-	120.5	-	60.44	-	55.56
28	5.3	66	-	41.71	-	24.4	-	7.33	-	55.9	-	47.79	-	19.84

ANALYSIS AND MEANS OF FATIGUE TIME

Table Analysis of fatigue time

	F. Time		
	L	M	H
Age	13.326	20.33	21.23
Weight	14.54	19.23	21.12
Load	23.54	26.33	5.02

Age

L= (10.62+25.00+4.36)/3 = 13.326
M = (6+28+27)/3 = 20.33
H = (27+4.7+32)/3 = 21.23

Weight

L= (10.62+6+27)/3 = 14.54
M = (25+28+4.7)/3 =19.23
H = (4.36+27+32)/3 = 21.12

Load

L= (10.62+28+32)/3 = 23.54
M = (25+27+27)/3 = 26.33
H = (4.36+6+4.7)/3 = 5.02

ISSN 2395-3594

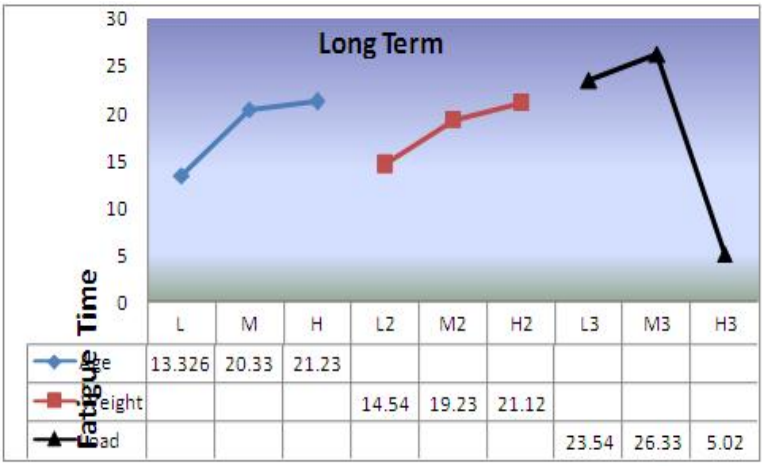

Fig. 4 Mean response graph

V. REASULT FOR LOAD CONSTANT ACCORDING TO DIFFERENT AGE GROUP & FATIGUE TIME

AGE	LOAD CONSTANT (LC)		
	LOW F. TIME (L_{FT})= 1.2 min.	MEDIUM F. TIME (M_{FT})= 1.8 min.	HIGH F. TIME (H_{FT})= 2.4 min.
20	19.2	12.97	10
25	20.26	16.32	15
30	25.35	20.59	20
35	20.57	16.97	15
40	16.97	12.48	10
45	13.48	8.04	5
50	13.48	8.04	5

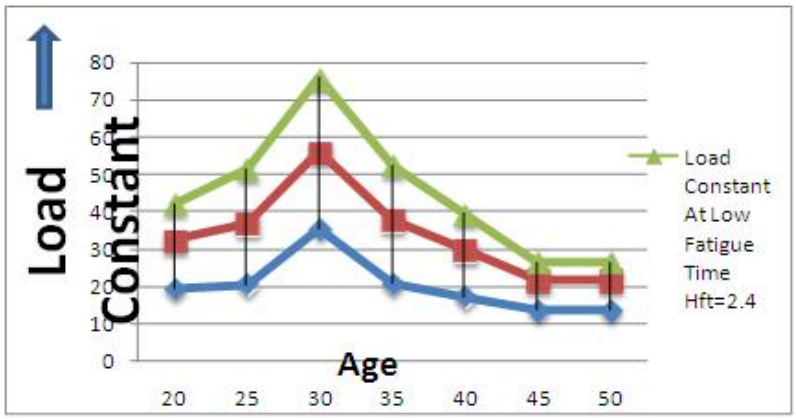

Fig. 5 For load constant

ISSN 2395-3594

REFERENCES

1. National Institute for Occupational Safety and Health (NIOSH) Muscoskeletal Disorders and Work Factors, Technical Report DHHS (NIOSH) Publication, 1997, p. 97-141 (Cincinnati, OH: NIOSH).
2. Dempsey P.G. Ayoub M.M., The Psychophysical approach to Manual Materials Handling task design, Ergonomics, 1999, 42(1) p. 17-31
3. Potvin J.R. Use of NIOSH equation inputs to calculate lumbosacral compression forces, Ergonomics, 1997, 40(7), p. 691-707.
4. Jorgensen M.J., Davis K.G. Kirking B.C. Lewis K.E. Maras W.S. Significance of Biomechanical and Physiological Variables during the determination of maximum acceptable weight of lift, Ergonomics, 1999, 42(9), p 1216-1232.
5. Karwoski W., 1982 A fuzzy set based model on the interaction between stresses involved in manual lifting tasks, PhD Dissertation Lubbock: Texas Tech University. 1982.
6. Dempsey P.G. A critical review of biomechanical epidemiological, physiological criteria for designing Manual Materials Handling tasks , Ergonomics, 1998, 42 (l) , p. 73-88.
7. Rodgers S.H. Yates J.W. Garg A., The Physiological basis for manual lifting guidelines National Technical information Service, Report Number 91-227-330, 1991.
8. Ayoub M.M. Selan J.J. Jiang B.C. Manual Materials Handling in Handbook of Human Factors Engineering Ed. SalvendyGavriel, Chischester, New York, John Wiley, 1987.
9. Samanta A., Chartterjee B.B. A Physiological Study of Manual Lifting of loads in Indians, Ergonomics, 1981, 24(7),P. 557-664.
10. Coleman A.E. Burford C.L., Aerobic Capacity in Sedentary adults participating in an adult fitness program, American Corrective Theraph Journal , 1971 25, p. 48-51.

ISSN 2395-3594