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AN ERGONOMIC STUDY ON RISK ASSESSMENT FOR MSD IN AWKWARD POSTURES AND LIFTINGS USING WISHA CALCULATOR IN BUILDING CONSTRUCTION INDUSTRY.

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Abstract:
Construction industry is a labour-based industry and behaviour of the people during their work, develop ergonomic challenges over a wide range. Ergonomic Hazards is one type of hazards mostly involved with construction workers perception, involvement, self-discipline. The study confines to the various awkward postures and awkward lifting in workplace in construction sites. The work mainly involved with continuous observations to identify the different postures during the field work. Fifteen positions which are most adopted by the workers in the sites was observed. This helps in identifying the activities with different body postures, in which joints and muscles are involved. Some of these Postures was observed in the works like Formwork, laying of bricks, transferring different types of loads to different floors, slabing and concreting, Glass – work, painting and Electrical works. Manual Lifting of objects like Bricks, concrete blocks, cement bags, lifting positions and their weights was recorded and analysed using WISHA calculators. Based on the amount of weight of the material and lifting position, the output of the work was measured. This study mainly helps to improve the administrative and engineering controls during the initial stages of assessment of Hazard risk assessment of the project.

Keywords:
Awkward posture, Awkward Position, construction activities, materials transferring.

1.Introduction:

At the workplace people involved with several risk factors develop serious work-related injuries known commonly as ergonomic risk factors. Repeated work, awkward postures, excessive noise, and temperature exposures, forceful motion, frequent change in the body positions develops wear and tear among the worker's body. The International Ergonomics Association, or IEA defines ergonomics is scientific discipline focused on understanding the interactions occurring between human beings and other elements in a system as a disciplinary user-centered integrating science (3). The deviation of the body position from neutral to while performing the various tasks the body position deviates from neutral known as awkward postures. Every activity in the construction sector involves physical strain and repetitive tasks. Every work requires difficult postures that might lead to weariness, permanent impairment, and injuries (6)(5)(4). The result of frequent and repetitive, involving awkward postures causes Work – related Musculoskeletal disorders (WMSDs). Numerous studies demonstrated that heavy lifting and carrying jobs combined with repetitive hand and wrist movements led to the development of musculoskeletal diseases. A variety of jobs, such lifting and carrying a platter full of bricks or concrete, carrying sacks of cement loading and unloading materials from vehicles and carts, are involved in construction operations significantly contribute to the development of WMSDs (7).RULA (Rapid upper limb assessment), REBA(Rapid Entire Body Assessment), OWSA (Ovako Working Posture Assessment System),WISHA (Washington Industrial Safety and Health Act.) are the various tools used to assess the MSD risk associated with various construction activities . MSD

commonly known as cumulative trauma disorders (CTDs) are a painful disorders occurs in tendons, muscles, joints, ligaments)(1).

2.Review of Literature:

Bamfo-Agyei E et al. (2018) identified the types of musculoskeletal injuries and the effect of musculoskeletal injuries among construction workers to determine the impact of ergonomic interventions with a purposive sampling technique were used with a sample size of 37 respondents. It was found that some of the factors of musculoskeletal injuries among construction workers are awkward posture, repetition, vibration, force, and extreme temperature. Report that the most and frequent factor that caused musculoskeletal injuries is force, followed by awkward posture with respective means of 5 and 3.6.

Bhandare et al. (2013) described that REBA and RULA are techniques to analyse the fatigue for lifting of loads involved with the workers manually. The assessments were carried by body posture involved in procedural analysis. The fatigue involved in a each suitable operation was studied and suitable changes in the work method for system improvement was discussed.

Lee et al. (2013) used Ovako Work Posture Analysing System (OWAS) to analyse the working postures of construction workers in building the foundations of a log cabin. Eight elementary jobs of building the foundations of a log cabin were videotaped at a construction site and analysed later in the laboratory. For an overall distribution of trunk postures, OWAS identified that a bent and twisted trunk posture (34%), which fell into action category 3, was the major poor posture for construction workers. This study concludes tying beams with steel bars, assembling column templates, and cement grouting of the ground were the 3 principal jobs in which workers building the foundations exhibited poor working posture.

Moradi, B et al. (2020) explained Musculoskeletal injuries can result from manual material handling, which is a high-risk task. The study adopted QEC method and the WISHA index to examine the relationship between manual load lifting duties and the ergonomic risk factors of musculoskeletal illnesses. Descriptive-analytical study was conducted on 52 employees with simple census method. The study concludes manual material handling tasks increased the risk of musculoskeletal disorders and work absenteeism and reported 53.8% of the workers lifted heavier loads than the allowable weight obtained by the WISHA index.

V S Kulkarni et al. (2017) The PATH (Posture Activity Tools and Handling) and RII(Relative Important Index) both identified that the shoulders, knees, legs and back were at a high risk for developing CTDs due to the abducted lower body postures, the repeated actions, and the flexion and extension of the wrists involved when the workers perform task. The outcomes of both the PATH and RII assessments indicate that there was a high risk of developing Cumulative Trauma Disorders (CTDs) and musculoskeletal disorders (MSDs).

3.Methodology:

The study was performed in various construction sites mostly preferred with manual load, lifting was preferred. The methodology followed is continuous monitoring of the worker while performing the task from the initial point to the destination point during load carrying. In some cases, recording was also done to correctly identify the variations in positions. Male and female workers are involved in some activities. While performing work activities, the deviation of the body position from the neutral position is known as awkward posture. Examples like kneeling, working overhead, squatting. Improper lifting, carrying, and setting down of heavy weights (or) frequent change in body positions is one of the leading causes of injury in construction sites. Twisting during centring, bending (or) turning with heavy loads, during bricks laying process causes strains, wrist injuries, sprains .Cumulative trauma and overexerting are the effects of awkward lifting.Physical observation was done for awkward

postures and WISHA calculator was used to analyze awkward Liftings. In the study different awkward postures were identified during various construction activities.

Table 1: Different awkward postures involved in different construction activities(14).

Position numbering	Wok-place Characteristics	Construction activity involved
Position 1	Handling loads above shoulder height or below the knee height	Transferring loads like lifting bricks, steel rods cement bags, painting, form work etc
Position 2	Handling over –size objects, regardless of weight	Transferring loads like lifting bricks, cement bags, Brick work, form work etc
Position 3	Working with body twisted and bent	During centring or tying Binding wire for slab preparation
Position 4	Working with neck- bent at more than 15 angles	Painting work, formwork
Position 5	Work with one or both arms above shoulder –level	Painting work, form work, electrical work
Position 6	Hand tools with sharp edges	Works involved with glass, demolishing works, carpentry
Position 7	Work with hand bent twist	electrical work, bar bending
Position 8	Excessive heat and humidity	Work during formwork or painting outside.the buildings
Position 9	power hand tools that are not balanced and difficult to hold.	Demolishing works or working with vibrating tools in Drilling, Floor works
Position 10	Working with half bent trunk	Laying bricks, plastering, painting, preparing formworks, mixing cement concrete
Position 11	Working with knee –bent and leaning on knee	Painting, formworks, plastering
Position 12	Working with bent on the knee –with improper support	formwork
Position 13	Standing or sitting for long-periods	Painting, formworks, concreting
Position 14	tablework with trunk bending position repeatedly	Carpentry, glass work, preparing stirrups
Position 15	Moving or vibrating loads for long periods	Flooring, Demolishing works, drilling works

Table 2: various positions explaining different awkward postures .


position 1


position 2


position 3


position 4


position 5


position 6


position 7


position 8


position 9


position 10


position 11


position 12

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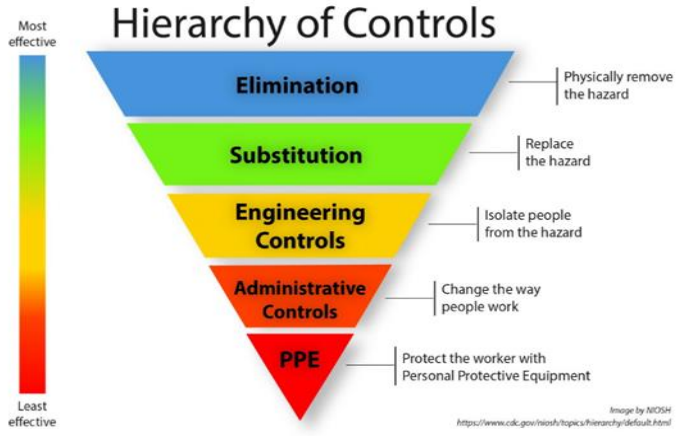
position 13

position 14

position 15

In the present study the WISHA LIFTING calculator was used to assess the risk involved in material handling and awkward postures involved in the construction activities. WISHA Lifting Calculator is a risk assessment tool for material handling tasks. It is based on scientific research, the cause of back injuries involved while performing the task. This can be used as a basic screening tool used in assessment of the likelihood of causing MSD in the manual lifting of different loads in construction industry. some parameters like weight limit & limiting index helps the engineer in designing the lifting task properly to decrease the work-related injuries to the workers in performing certain tasks and helps to prioritize the ergonomic improvement. From the Hierarchy of controls the engineering control and administrative control can be implemented by assessing the risks involved in various activities. The awkward postures attained by the worker and weight limit help to analyze the maximum load lifted by the worker. This helps to assess the timeline of the work and helps the project to be successfully completed in time and safely.



(7)

The primary output of the WISHA calculators are wight /Lifting limit and Lifting index . The WISHA calculator has some limitations where coupling, vertical distance, Distance traveled was not focused. To achieve the output the basic variables are

1) Weight: Actual weight being lifted by the worker should be mentioned in lbs
2) Vertical Hand position: hand position of the worker raised by the worker from knee to waist to shoulder to above the shoulder.
3) Horizontal Hand position: midpoint of the body deviated during grasping the object.

0-7" = Near, 2) 7-12" = Middle, or 3) >12" = Extended

4) Frequency: the number of lifts /tasks that worker done in a minute or a certain period.
5) Duration: The Duration was categorized into 3 options

a) 1 hour or less b) 1-2 hours c) 2 hours or more

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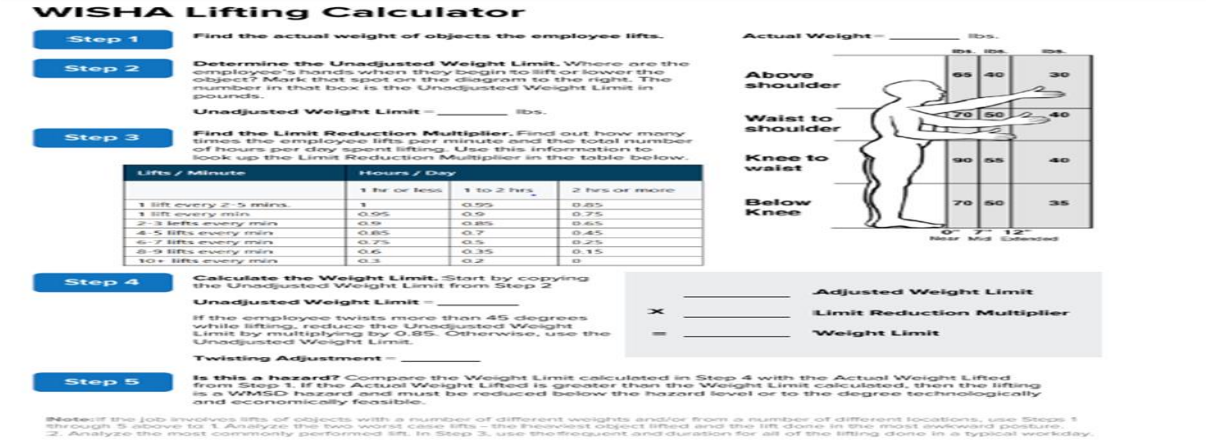
6) Twisting: Twisting is the angle that the trunk and shoulder rotates in the task. If body slightly deviates <45 degrees and deviates >=45 degrees .the position of the trunk and rotation Determines the twisting .

Fig 1: Steps involved and related data involved in WISHA calculator



The following are the assessment results of the task.

1) Unadjusted weight limit
2) Twisting adjustment
3) Adjusted weight limit
4) Limit reduction multiplier
5) Weight limit
6) Lifting index

The following are the Sample calculations using WISHA calculator:

Figure 2: Handling Over-sized objects above the shoulder.

Figure 3: sample calculations using WISHA calculator.

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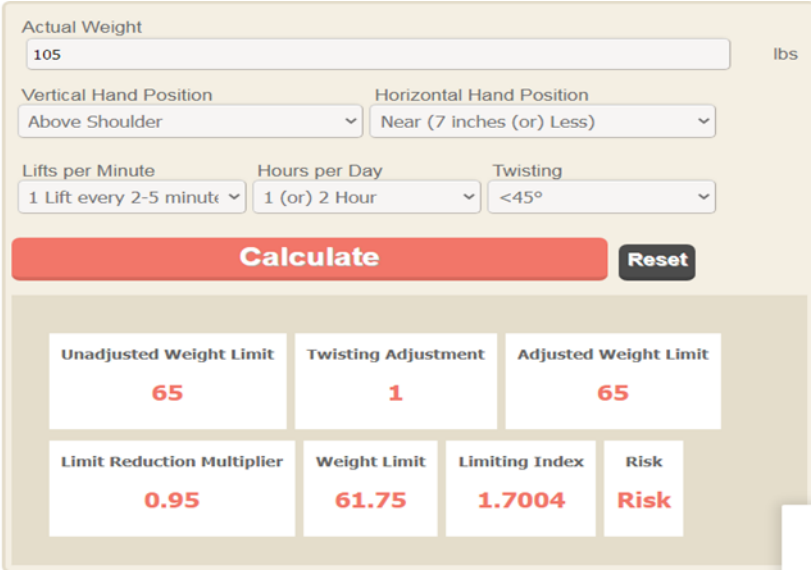

4.Results and Discussions:

Table 3: The following are the results of the risk assessment during lifting in various awkward postures in construction activities.

sl. no	positions	type of load lifting	work involved	weight handled by the worker in(lbs)	vertical hand position	Horizontal Hand position	unadjusted weight limit	Limiting index	Output of the work
1	position 1	cement bag lifting	materials transferring	110	above shoulder	near (7 inches)	65	1.7814	risk
2	position 2	bricks lifting	materials transferring	114	above shoulder	near (7 inches)	65	1.8462	risk
3	position 3	steel wires, cutting pliers	centring	2	below knee	mid (7-12)	50	0.0495	safe
4	position 4	painting brush	painting	1	above shoulder	mid (7-12)	40	0.0452	safe
5	position 5	drilling machine	electrical work	3	above shoulder	mid (7-12)	40	0.0789	safe
6	position 6	drilling machine	demolishing works	6	knee to waist	extended (>=12)	40	667	safe
7	position 7	steel bars	preparation of stirrups	2	waist to shoulder	mid (7-12)	50	0.188	safe

8	positi on 8	mortar transferrin g	brick work	2	knee to waist	mid (7-12)	55	0.0503	safe
9	positi on11 positi on12 positi on13	painting brush	painting	1	waist to shoulder	mid (7-12)	50	0.0308	safe
10	positi on14	glass cutting	glass cutting machine	6	knee to waist	extended (>=12)	40	0.1667	safe sa
11	positi on 15	Trimming machine	steel form work	1	waist to shoulder	mid (7-12)	50	0.0667	safe

From the above table position 1 and position 2 are involved with risk with WISHA calculator. The study continuous with position 1 and position 2 involved with material handling and material transferring in various construction activities. materials commonly used at construction sites are Bricks, cement, sand, concrete, large stones, hollow bricks, steel rods , tiles etc. Transferring of Materials vary from person to person and construction site to site. In the present study the maximum lifted by the worker taken for calculation.

Table 4: Risk assessment in materials handling and transferring at construction sites.

sl. no	**Lifting of type of material**	**work involved**	**weig ht hand led by the work er in Lbs**	**vertical hand position**	**Horizontal hand position**	**unadju sted weight limit**	**Limiting index**	**Risk invol ved**
1	cement bag	materials transferrin g	110	above shoulder	near (7 inches)	65	1.7814	risk
2	Bricks	materials transferrin g	114	above shoulder	near (7 inches)	65	1.8462	risk
3	Reinforceme nts bars	materials transferrin g	139	above shoulder	Near (7 inches)	65	2.25	risk
4	Concrete blocks	materials transferrin g	33	waist to shoulder	mid (7-12 inches)	50	0.69	safe
5	Large boulders	materials transferrin g	8	waist to shoulder	mid (7-12 inches)	50	0.1778	safe
6	Bricks	unloading bricks	6	knee to waist	mid (7-12 inches)	55	0.128	safe

7	Tiles	loading	40	above shoulder	near (7 inches)	65	0.6478	safe

5.Conclusions:

The study identifies fifteen awkward postures and seven awkward liftings involved with different building materials .Position 1and position 2 shows results work output as risk , mechanical methods of lifting may be adopted .Position 9 , position 15 are the works with power hand tools may result in vibration develops a white finger syndrome in long term ,this can be overcome by the use of suitable Personal Protective Equipment (PPE).In Awkward lifting assessment materials like cement bag , bricks , reinforcement bars above the shoulder , shows output of work as risk .The number of bricks lifting at one time can be decreased to reduce the risk levels .

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