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Research Article

Application of Ergonomics Principles in Construction Industry in Indian Scenario

Shweta Hire[1] & Pravin Minde[2]
[1]PG Scholar, Construction Engineering & Management, Dr. Vishwanath Karad MIT World Peace University, Kothrud, Pune, India-411038
[2]Assistant Professor, School of Civil Engineering, Dr. Vishwanath Karad MIT World Peace University, Kothrud, Pune, India-411038

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Abstract: The Indian construction industry still follows the primeval work pattern which generates low productivity, poor management in resources, poor waste management, lower quality, high energy consumption, over budgeting and time overrun, etc. Though the abovementioned problems need noteworthy thought and time, increased emphasis must be given to new project management strategies so the Indian growth story doesn't meet a hasty end. As construction is a physically demanding work environment, site workers are often at risk of long-term injury. This study focuses on the poor ergonomics is likely to result in a loss of worker productivity, higher rates of lost work days through illness, a lack of staff morale and motivation, and increase employee turnover. The ergonomics improvement process systematically identifies ergonomic hazards and puts in place engineering and administrative control measures to quantifiably reduce risk factors. The purpose of this research is providing proper guideline & education about risk and right posture to workers is given by carrying out workshop & training program on site is necessary for workers. Use of software platform like Ansys software for analysis.

Key words: Ergonomics, Musculoskeletal Disorder, Ergonomic Hazards, Risk Factor, Posture Analysis.

Introduction

Ergonomics is the science concerned with designing things that people use so that people will interact with the environment most effectively & safely. It is essentially the "laws of work" or "science of work". The construction industry of INDIA is an important indicator of the development as it creates investment opportunities across various related sectors 16% of nation product depends on the construction industry. On the construction work side ergonomics principles are being used to help adapt the job to fit the person, rather than force the person to fit to the job. In construction industry labor works in cleaning & preparing the site. Good ergonomic design removes incompatibilities between the work and the worker and creates the optimal work environment. Ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance. The aim of effective ergonomics is to apply learning about human abilities and limitations to improve interaction with environments and products and prevent or limit the risk of illness or injury. Studies have shown that poor ergonomics is likely to result in a loss of worker productivity, higher rates of lost workdays through illness, a lack of staff morale and motivation, and increase employee turnover.

As construction is a physically demanding work environment, site workers are often at risk of long-term injury. Back sprains and strains are the most common disabling injuries, often due to overexertion and bodily motion. Ergonomics draws on many disciplines to optimize the interaction between the work environment and the worker. The goal of ergonomics is to reduce your exposure to work hazards. A hazard is defined as a physical factor within your work environment that can harm your body. Ergonomic hazards include working in awkward or uncomfortable postures and using excessive force or high repetition to complete a task. The ergonomics improvement process systematically identifies ergonomic hazards and puts in place engineering and administrative control measures to quantifiably reduce risk factors. According to the international labor organization (ILO) Musculoskeletal Disorder (MSDs) accounts up to 40illnesses & reduce productivity in most of the countries all over the world. MSDs are also called as Cumulative Trauma Disorder(CTDs).

The purpose of this paper is to investigate all significant factor which should be taken into account in an ergonomic program to develop the best remedial solution against the costly, harmful & irreversible work related injuries.

Objectives

The objective of the study is 1.to identify the ergonomic risk factors which are facing by workers in construction industry & suggest them suitable solution to reduce the risk of injury.2. Anlysis of posture by using ANSYS Software.

Need of the Study

Ergonomics puts people / worker first, taking account of their capabilities & it aims to make sure that task, equipment, information & the environment fit each worker. Ergonomics is the way we use our body to work & fit the job or task to reduce risk of injury. The best ergonomic solution will often improve productivity. The need for ergonomics consideration on site is felt more because there is lack of awareness of proper posture & working environment to workers. To eliminate discomfort & risk of injury due to work ergonomics study is needed.

Ergonomic Risk Factors

Ergonomics strives to create a balance between human, equipment, and environment. It takes into account human physiology and the demands on it by the processes, products, and systems. It strives to enhance performance and productivity by minimizing human error keeping into account the safety and comfort of the user. Whether we work in office or work in the comfort of our homes, we need to take into account ergonomic principles and apply them to the tasks, the way we do the tasks and the equipment we use during the task. It will optimize human well being and overall performance.

Ergonomic risk factors or hazards are physical factors within the environment that may pose risk to the body's musculoskeletal system. It can cause injuries which over time can lead to permanent disabilities and loss of function. Disabilities and injuries of the musculoskeletal system can arise from ligaments, tendons, tendon sheaths, muscles, bones, joints, spinal discs, nerves or blood vessels. Injuries can be on wrists, arms, hands, legs, knees, feet, neck back shoulder, eyes, etc. Examples of musculoskeletal injuries are carpal tunnel syndrome, epicondylitis, tendinosis, ligament injury, joints injury etc. Over time, exposure to risk factors or hazards can lead to musculoskeletal disorder. We need to understand these risk factors to avoid injury and loss of productivity. The risk factors can be divided into: 1) Physical Risk factors: Force, fixed or awkward postures, repetitions, contact stress, and vibrations. 2) Individual Risk factors: Psychosocial, level of physical fitness, and gender. Here I am listing 7 Ergonomic Risk Factors you should definitely know about. We will be covering both physical risk factors and Individual risk factors.

Force

Force refers to the amount of effort made by the muscles, and the amount of pressure on different body parts due to demands of the Job. All tasks as we know requires the body to use muscles to exert some force. Damage occurs when muscles generate moderate to a high level of force repeatedly, for a long duration and or with the body being in an awkward position. Forces can compress the muscles, nerves, blood vessels, tendons and nerves leading to damaging the tissues and joints. When a task requires one to exert a level of force that is too high for any muscle, it leads to damage to the muscles or the related joints, tendons and other soft tissues. While it is important to consider how much force is being exerted, what is equally important is to know how long the worker needs to keep exerting this force, how many times it is exerted in a fixed period of time, and the posture used while exerting this force. Low levels of force also lead to injury if the force is being exerted repeatedly for a long duration and also when the posture used is awkward.

Fixed or Awkward Postures

Posture is another name for the position of various parts of the body during an activity. For most joints, a good or neutral posture means joints are being used near the middle of the full range of motion. The farther a joint move towards either end of its range of motion, or the farther away from the neutral position, the more awkward or poorer the posture becomes. The strain is put on the muscles, tendons, and ligaments around the joint. For example, when the arm is fully stretched out, the elbow and shoulder joints are at the end of their range of motion. If a worker pulls or pushes repeatedly in this position, there is a higher chance of injury. It is important to consider how long the worker needs to hold this posture, how many times the awkward posture is used in a given period of time and the amount of force being exerted when an awkward position is used. As muscles get no opportunity to relax in this task, it leads to muscle fatigue even if forces applied are very low.

Repetitive Motion

Highly repetitive tasks lead to pain and tissue damage. Risk increases when the same parts of the body are used repeatedly, with few breaks and chances of rest. Many work tasks and cycles are repetitive in nature and are frequently controlled by daily or hourly production targets and work processes. The joints are more susceptible to repetitive motion injuries, especially the wrists, fingers, shoulders and elbows, feet and knees. When the job involves a high number of repetitions per minute, the greater the strain and more the chances of injuries. Research shows the tendons and muscles in the wrist may not be able to recover where repeated task cycles are less than 5 seconds in length. That is when they are more than 12 times per minute. It should be noted however that the recovery time of muscles varies for different body parts. For example, shoulder injury chances are high even though tasks are 3 times per minute.

VIBRATION (Hand-Arm or Whole-Body)

Whole- body vibration causes musculoskeletal problems, digestive problems as well as prostate problems. Hand-arm vibration can damage the small capillaries that supply nutrients. Vibration can cause a worker to lose feeling in his hands and arms. Hand-arm vibration results in dysfunction of nerves reduced blood circulation especially in the fingers and degenerative disorders of bones and joints of the arms. The vibration of the whole body is generated by vibrating vehicles while traveling, and platforms such as earth moving machines etc. The vibration is transferred via the seats in the vehicles. Whole-body vibration can cause degenerative disorders especially in the area of the lumbar spine. The lower back injury is most common in repetitive driving injuries. The effects of vibration are intensified with duration and awkward position. Repetitive exposure to whole-body vibration, however, can cause pain and tissue damage even if the duration and vibration are less. This happens even if the posture is correct.

Individual Risk Factors (Psychosocial, Obesity & Gender)

High work stress increases muscle activity and puts a load on the musculoskeleta l system. The stress response can cause physiological changes leading to MSD. Important psychosocial risk factors include:

- Work demands and mental load,(like high workload, high information-processing demands, constant time pressure, the pressure to work overtime),
- Job control (like little or no opportunity to make own decisions, limited break opportunity),
- Social support(the poor relationship between co- workers, poor cooperation)
- Work stress (high level of fatigue, high level of emotional tiredness, high level of frustration, poor work- personal life balance)

Contact Stress/ Mechanical Stress

The parts of the body which come in contact with an outside element for a long period causes contact stress. This occurs when repeated exposure to the hard or sharp surface which digs into soft tissue. Examples are resting arm or wrists on the edge of the desk or work surface, leaning elbows on the desk while working. It results in irritation of the nerves and constriction of blood vessels. Tissue damage may occur as a result of a single event or to repeated exposure over time. Common areas of contact stress include hand, wrist, shoulder, elbow, and knee.

Ergonomics Hazards Control

Ergonomic risk factors are aspects of a job that can cause biomechanical stress on the employee, such as highly repetitive tasks, awkward postures, forceful exertions, static postures over a long period of time, cold temperatures, and localized pressure into the body part. Exposure to one or more ergonomic risk factors could cause or contribute to MSD. To reduce the chance of injury, work tasks should be designed to limit exposure to ergonomic risk factors. Engineering controls are the most desirable, where possible.

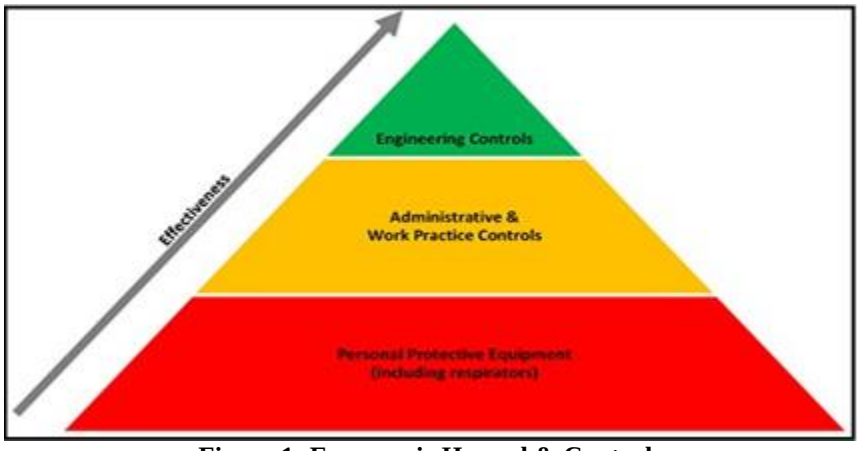

Figure 1: Ergonomic Hazard & Control.

Administrative or work practice controls may be appropriate in some cases where engineering controls cannot be implemented or when different procedures are needed after implementation of the new engineering controls. Personal protection solutions have only limited effectiveness when dealing with ergonomic hazards.

Table 1

Type of Control	Workplace Example
Engineering Controls (implement physical change to the workplace, which eliminates/reduces the hazard on the job/task)	• Use a device to lift and reposition heavy objects to limit force exertion • Reduce the weight of a load to limit force exertion • Reposition a work table to eliminate a long/excessive reach and enable working in neutral postures • Use diverging conveyors off a main line so that tasks are less repetitive • Install diverters on conveyors to direct materials toward the worker to eliminate excessive leaning or reaching • Redesign tools to enable neutral postures
Administrative and Work Practice Controls (establish efficient processes or procedures)	▪ Require that heavy loads are only lifted by two people to limit force exertion ▪ Establish systems so workers are rotated away from tasks to minimize the duration of continual exertion, repetitive motions, and awkward postures.
Type of Control	**Workplace Example**
	Design a job rotation system in which employees rotate between jobs that use different muscle groups ▪ Staff "floaters" to provide periodic breaks between scheduled breaks ▪ Properly use and maintain pneumatic and power tools
Personal Protective Equipment (use protection to reduce exposure to ergonomics-related risk factors)	▪ Use padding to reduce direct contact with hard, sharp, or vibrating surfaces ▪ Wear good fitting thermal gloves to help with cold conditions while maintaining the ability to grasp items easily

Methods & Procedure

To achieve the study objective, first of all injury & illness trends in the construction fields have been researched. This research was done through many different sources like books, scholarly journals, web site, videos & magazines. After completing the literature reviews field observation is made to find the current workplace ergonomic issues in the construction industry by visiting some sites, observing workers & their practices on doing their job & what ergonomics issues they exposed to & by taking some photos to the way the worker done their work. After that questionnaire survey interviews were carried out with some workers, engineers, supervisors & contractor at the end of each observation period critical decisions & problems made by workers during their work activity were reviewed. It is found that there is lack of knowledge & existing information about proper posture, egronomical risks & hazard in workers of our country.

Injuries

Some common injuries are occurred on work site. Questionnaire survey answers included sprain/ strain , knees, wrist & hand, shoulder , neck ,back injury, fractures, cuts, eye injury. Summary of answers are as follows;

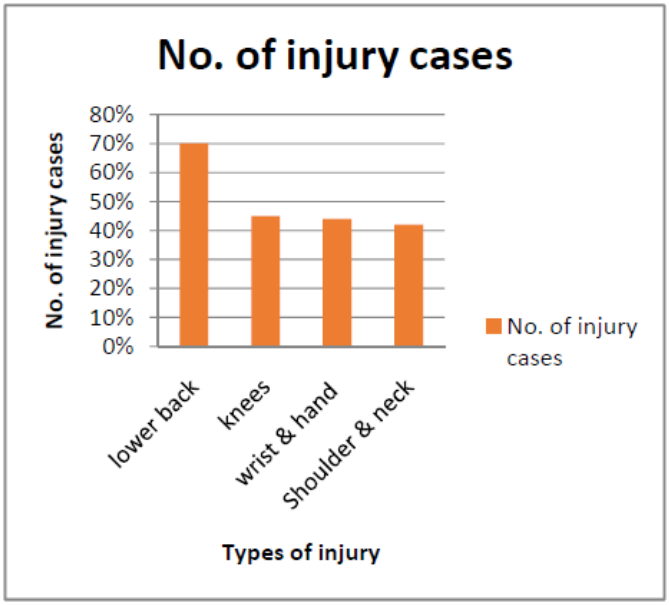

Figure 2: Graph for Type of Injury vs Percentage.

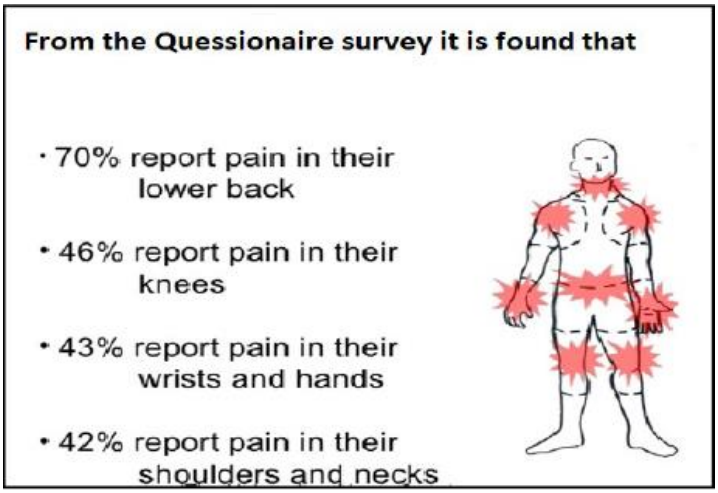

Figure 3 (a): Injury Percentage.

Software Analysis

In this analysis we found some posture of labor while doing their work on site and try to draft in software like Ansys with the help of this software analysis we can give movement to labor posture and give proper angle and position to worker for doing their work. Here are some line diagram images of position which is used on site while drafting proper position. From this we found that labor can stay 30 sec in one right position for certain work more than 30 sec is harmful for their body parts. One work is repeated 8 to 10 times in 5 -6 sec.

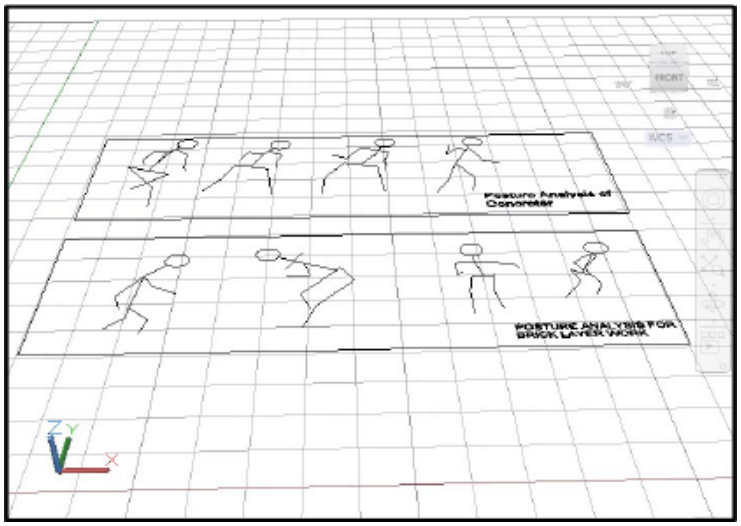

Figure 3 (b): 3D image design of postures

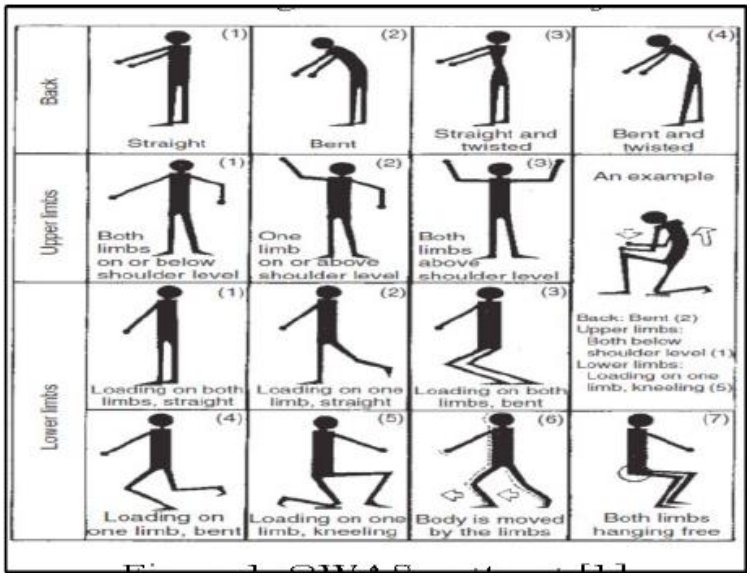

Figure 4: Proper Posture.

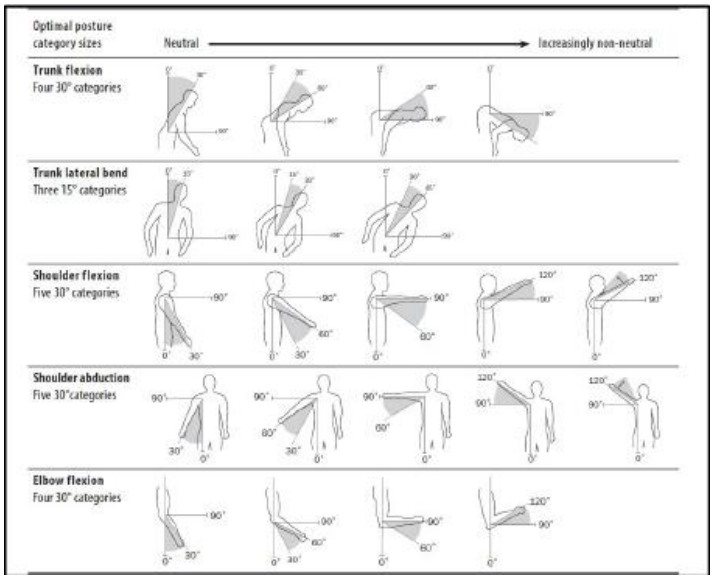

Figure 5: Proper Angle.

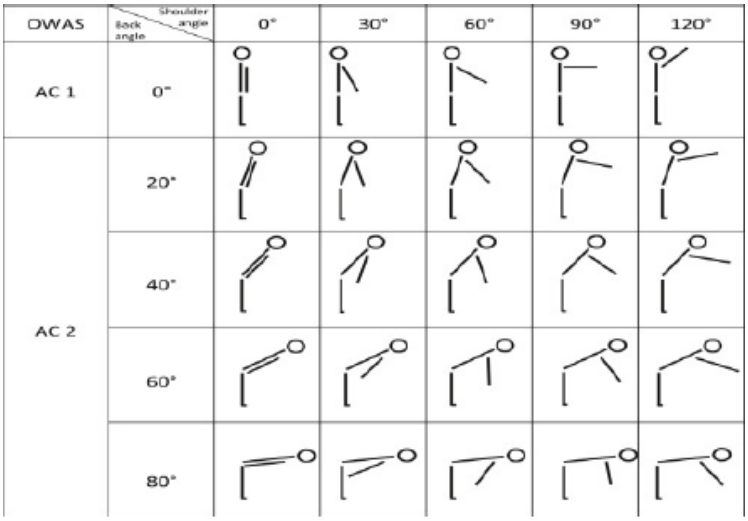

Figure 6: Stick Diagram.

Some Example of Common Ergonomic Risk Factor at Construction Project

	1. Hand/arm vibration 2. Noise	➢ Limiting the time of exposure ➢ Using PPE such as gloves, earmuff to cover the ears against excessive noise
	1.Repetition (in laying paving blocks)	➢ Modification the amount of work: To pace the worker ➢ Executing various tasks: To reduce putting stress & repetition on particular part of the worker's body
	Repetition (in shoveling road)	➢ Applying mechanical tools: For resting arm, wrist, spine and etc ➢ Modification the amount of work: To pace the worker ➢ Executing various tasks: To reduce putting stress & repetition on particular part of the worker's body

Conclusions

This research study is based on risk factor involve in ergonomics & its solution. The literature confirms that by increasing the knowledge and awareness of ergonomics, and training members to recognize the ergonomic risk factors in the work environment, this will lead to increasing of productivity, safety and health of employees in the construction industries. The purpose of this research is providing proper guideline & education about risk and right posture to workers is given by carrying out workshop & training program on site is necessary for workers. Use of software platform like Ansys software for analysis. To increasing of productivity, safety and health of employees in the construction industries. This study also concludes that there is a need for an increase in training programs to reduce the onset of Work related Musculoskeletal Disorder (WMSDs) amongst the construction workers. The workers should be reminded to be aware of their posture and step orientation to avoid twisting the trunk, to take adequate rest time during work, and to reduce the time spent in each poor posture.

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