



## A Concept Note to Prevent Construction Workers from Ergonomic Threats

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### Abstract

Construction industry is the most hazardous industry compared to mining, manufacturing and agriculture, etc. New hazards are arising daily in the form of chemical, physical, biological and ergonomics while performing different tasks. Hazards in construction industry affect the health and safety of workers and also the productivity of firms. Hazards associated with construction projects are worker tools, equipment's, materials and workplace environment. Ergonomic hazard can be physical, physiological, environment factors within the workplace that can harm the musculoskeletal system of the workers. The outcome of the ergonomics factors is musculoskeletal disorder injuries which affects the muscles, tendons and vessels of the workers body. The factors which affect the musculoskeletal system include repetitive work, awkward positions, static posture, contact stress, vibration and sudden force, etc. This is because of poor design of tools, materials, equipment and workplace of the construction. This paper suggests a design concept for ergonomic factors in construction projects to improve health and safety of workers. Design for Construction Safety (DfCS) concept is used in this paper to increase the health and safety related to ergonomic factors in construction industry. As a result, the design change solutions for ergonomic will reduce physical factors, eliminate unnecessary movement, increase workers health and safety and also suggests that will reduce the compensation cost of the workers. Many industries successfully implemented design concepts in different way for ergonomic solutions by purchasing new tools, modifying existing equipment's and making the workplace more sufficient to work without obstacles.

### Keywords

Ergonomics; Construction projects; DfCS; Hazards

### Introduction

Construction field is most hazardous industry where workers are exposed to a variety of hazards in site. New hazards are arising daily in site in the form of chemical, biological, physical and ergonomic hazard while performing different tasks. These types of hazards may cause various work related illness and also injuries. Bureau of Labor Statistics shows that overall days-lost by injuries and illness of construction was higher than any other industry sector [1]. In Great Britain, 3% of workers in construction industry suffer from work related illness which leads to 1.2 million days lost [2]. Annually,

around 69,000 construction workers in Great Britain were suffering from an illness in which 65% were cases of musculoskeletal disorders that are harmed by Ergonomic hazard and only 35% were cases are harmed by other hazards [2]. The current statistics illustrate construction labors to be at major threat of musculoskeletal injury; particularly linked to the job they do [3]. Countless injuries that happen in the construction industry are owing to the physical material handling that is necessary in the construction industry [4]. Workers illness and injuries leads to delay in project progress and decrease the productivity in construction [5]. Usually workers safety is not considered in the initial phase of the project [6]. To increase the health and safety of workers there is a need of improvement in design phase of the projects [7]. Institute for Safety through Design (ISTD) states that "addressing workers safety in design phase of the construction project will increase productivity and decrease the delays in construction with increase in workers' health and safety". It is believed that by addressing workers safety in conceptual phase, safety in different activities is determined much time before the persons and equipments gather at the construction site [7]. This paper gives an overview of ergonomic hazards which affects musculoskeletal system of workers in construction industry and also discuss about the design solutions related to ergonomic factors. Ergonomic hazard is a physical, physiological and environmental factor within the environment harms the musculoskeletal system. The outcome of the factors is musculoskeletal disorder injuries which affects the muscles, tendons and vessels of the workers body. The Physical factor which affects the musculoskeletal system includes repetitive work, awkward positions, static posture, contact stress, vibration and sudden force, etc. This may result in injuries to shoulders, knees, hands, wrists, back, hip and ankles of the workers body. As per UK labour statistics, 50% of workers compensation cost is covered by musculoskeletal disorder injury. This is due to poor design of tools, materials, equipment and workplace of the construction. To increase the health and safety of the workers and to reduce the compensation cost, many foreign industries successfully implemented Design Concepts in a different way for ergonomic solutions by purchasing new tools, modifying existing equipment's and making the workplace more sufficient to work without obstacles. This paper approaches a Design for Construction Safety (DfCS) concept to increase the health and safety for workers related to ergonomic factors in construction industry.

### Backgrounds of ergonomics

Ergonomics can be defined in different terms; H&S Executive defined "Ergonomics is the study of people's efficiency in their work environment [8]. OSHA defined "Ergonomics is a way of designing workstation, work practices and work flow to accommodate the capabilities of workers. More significantly, ergonomics is the science of designing the job to fit the worker, rather than physically forcing the workers body to fit the job [9,10]. The objective of the discipline of ergonomics is to discover most excellent fit between employee and work circumstances. Ergonomic tries to approach with solutions to build sure workforce keep on secure, relaxed, and creative. These regularly engage altering tools, apparatus, resources, work technique, or the place of work itself. Ergonomics is a body of knowledge about human abilities, human limitations and human characteristics that are relevant to design [11]. Ergonomics is an innovative theme for

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the construction industry, but thoughts have been about for many years' [12]. Ergonomic design reduces risk factors contributed to occupational ergonomic injuries and illness, such as Spain & Strain, cumulative trauma disorders [10]. Ergonomic hazard is a physical, physiological, environment factors within the workplace that harms the musculoskeletal system of the workers. The outcome of the ergonomics factors is the musculoskeletal disorder (MSDs) injuries which affects the muscles, tendons and vessels of the workers body. 40% of workers in UK reported "working hurt" is the problem they faced by ergonomics. MSDs can result, when there is a mismatching between physical requirements of job and capacity of the workers. Ergonomics involves the appraisal of work tasks to recognize ergonomic threat factors and suitable engineering or job practices controls to decrease or get rid of the recognized threat factors. Usually, ergonomic changes are made to get better the fit among the demands of the work tasks and the capabilities of the labors [13]. Ergonomics seeks to reduce unfavorable effects of the surroundings upon populace and thus to allow every individual to make the most of his or her involvement to a given work. Ergonomic is the discipline of designing the work to fit the employee, slightly than physically forcing the labor's body to fit the work [14].

### **Ergonomic designs**

The ergonomic approach to labour place design must be identified at the former phase and be examined as one of the most necessary factors in designing a place of work as appropriate design will be the most effectual and it is the first choice for managing sources of place of work stress. Dias & Coble [15], believes that, design and appearance of events and functioning instructions in the easiest terms likely such as by association and manage of the operational surroundings, counting the workplace, right to use for preservation, illumination, sound and heating circumstances. It was hypothesized by Byrne that compared to employees who received an ergonomic assessment and customized modifications of accessible workplace, indicative employees who received both the ergonomic and job stress management involvement would have better development in end result [16]. It is significant to highlight that the focal point of the avoidance interference was modifying the obtainable workstations, alternative of supplying new fixtures or equipment. As for the space requirement in designing, Brooks described gap necessity as the quantity of gap each person employee's desires to do their work, storage space, gathering rooms, common areas and equipment space [17]. A desire catalogue may be pertinent to stakeholders in order to aid to know what the requirements of each person or section. Moreover, it can also obliging to inquire people to priorities their lists so that it can be distinguish among wants and pleasant to have. Absorbing what people's wants can make a real variation of the new environment and employees output.

### **Ergonomics in construction**

Ergonomics in workplace usually exist within three factors; tasks which workers should perform, workers who are performing the task and workplace environment. Some of the factor which affects the musculoskeletal system includes working in same position for long time, working overtime, carrying, lifting or moving heavy materials or equipments etc, working in awkward posture, inadequate training, performing same tasks over and over, mental stress, job satisfaction, poor work practices etc. This may result in injuries to upper and lower extremities of the workers body. The upper extremities of body include shoulders, necks, hands, wrists, and lower extremities of the body

include back, hip, knees and ankles. As per UK labour statistics, 50% of workers compensation cost is covered by musculoskeletal disorder injury. This is due to poor design of tools, materials, equipment and workplace of the construction. The major risk factors associated with ergonomics in construction projects are repetitive works, external pressure, working in awkward postures and vibration. The workers feel external pressure, when they have contact with tools and sharp objects in site. The repetitive works in construction activities includes hammering, drilling, sawing, painting with brushes, cutting sheet metal, loading and unloading small pieces-tiles and bricks. Workers in site used to work in awkward posture while performing flooring work, drywall insulation, concrete work, masonry works, welding works and housekeeping. Workers feel vibration when they perform task like drilling or may be due to some environmental factors. This can be illustrated in simple example. As per H&S Executive, workers in workplace can carry manually if the weight of the load is less than or equal to 40 pounds. If it exceeds the load weight, then the worker should get help of others to carry manually or worker should use lifting equipments. In this case the workers may allow for carrying the load manually by not knowing the weight of load. This can affect the muscles of the workers and causes MSDs to workers who perform the task. This is due to lack of knowledge of workers in the workplace who performs the task. This case can be prevented if the worker knows the weight of load in the initial stage of the task they perform. In this way by addressing workers safety in the conceptual phase of the projects helps the workers to know the tasks before they do.

### **Designers impacts on construction ergonomics**

Behm examined 450 reports of construction labors' fatalities and serious injuries in the USA to decide whether labeling H&S in the scheme designs might have averted the incidents [18]. Behm finalized that in 151 instances (33.6%), the threat that contributed to the event might have been avoided or decreased if design-for H&S measures had been executed [18]. Hecker mentioned that a total of 58 LCS (Life Cycle Safety) evaluations took place moderate to the 22 work job [19]. These evaluations created 789 person remarks that were later reviewed and judged by the design side. A model of 235 (41%) of the remarks were examined, which analysis resolute that approximately partially were linked to the construction stage, 75% were linked to in some means to H&S, and 40% were straightly linked to H&S i.e. the key cause for the remark was a apparent health or safety threat. In situation of result the LCS arises to have influenced some early on and main programming conclusions that eventually enhanced access, decreased overcrowding, and thus decreased threat of both musculoskeletal and struck next to injuries. Also fall guard obtained more notice in thorough design than it possible would have with no LCS.

### **Design for ergonomics in construction**

The workers in construction are exposed to a variety of high risks related to ergonomics while performing masonry work, concrete work, flooring, framing, roofing, painting, welding, housekeeping and manual handling. The factors contributed to risks are over exertion, repetition of work, forceful and muscle effort, workers working in awkward postures, external pressure from tools and sharp objects, lifting heavy materials and equipments, pushing and pulling, vibration of body and many more unexpected factors. These factors affect the muscles and cause musculoskeletal disorder to workers who perform the tasks. H&S Executive shows that risk factors of ergonomics affects back (36%) of workers followed by shoulder and

knee (12%), ankle (9%), multiple (8%), arm (4%), wrist (3%), neck, hand and foot (2%) and others (9%) [2]. The causes of these factors are due to improper tools, equipment, materials which workers used to perform the tasks [15]. Even poor work practices and working environment also contribute to risk factors. Poor workstation design also leads to cause these factors. For example, if the floor is not even, the workers may expose to a hazard while handling a load manually.

Design for Construction Safety does not address methods to make construction safe, but how to move workers safely throughout the project. Design for ergonomics in the conceptual phase of the construction projects will improve the workers health and safety. The advantage of implementing design concepts in initial stage of ergonomics is, workers can know how to work or handle the task they perform before they reach and they can decide what kind of safety precautions should be taken while doing that task. To reduce the workers injury and illness, work tasks should be designed out in the initial stage of the project for ergonomic factors to improve the workers safety. Hierarchy of design is the best solution to design out risk factors for ergonomics. Control measures starts with most effective stage called engineering controls for ergonomics while it fit workers to working environment which can isolate people from hazards. OSHA recommended engineering control as the most desirable way to control ergonomic hazards in construction. Administrative controls and PPE are incorporated where engineering controls are not applicable. Triangle of hierarchy of control design for ergonomics recommended by OSHA is shown in Figure 1.

### Suggestions/Recommendations

Ergonomics factors can be removed or minimized through engineering controls which require design or redesign of tools, equipments and workstation and work methods. Engineering controls for ergonomics eliminate/reduce the hazards on the task by implementing physical change to the workplace. Workstation can be designed to accommodate workers to work without any obstacles. Ensure functioning and position of lightning so that obstacles and spills can be clearly seen. Poor housekeeping cause slips and trips to workers so remove rubbish regularly in site. Keep routes visible and access for workers. Workers needs should also be prioritized and it can be considered for keeping them away from ergonomic hazards. Equipments should be designed and it should be easy for workers to access. Working methods must be designed within the workers abilities so that repetitive movements, static and awkward posture and external forces can be minimized. Use alternative methods or equipments where workers are not able to load or unload manually, so that it can avoid risks to upper extremities of body. Tools which workers used to perform tasks must be in less weight and easy to access for them. In simple words, the tools should fit for workers

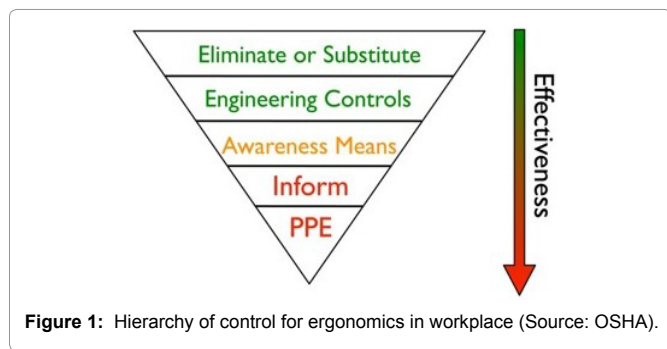
which can reduce the risk of cumulative trauma disorders (CTDs). Administrative controls establish efficient process or procedures in the workplace related to ergonomic. Administrative control reduces duration and frequency of exposures to work stressors [15]. Workers should be allowed to do their tasks in rotations to reduce fatigue and also it reduces static postures, unnecessary movements and repetitive motions of workers. The rotation of the workers will also increase the rotation of the different muscles group of the workers. Work load for an overloaded task should be distributed by increasing a number of workers. Employer should conduct stretching and strengthens program for workers before and after they perform the tasks. Annual training and daily pre-task planning are the educational training of administrative control will increase the workers knowledge about tasks. Personal protective equipment's will reduce ergonomics related risk factors. Using proper gloves, wearing good clothes can protect them from unexpected ergonomic hazards. By addressing workers safety in design, the worker will come to know about risks from task and they can take safety precautions before they reach it, to keep them away from hazards. Employer can come to know what kind of cloths or gloves that worker are allowed to wear for safety precautions and workers can also know what type of risks might occur in tasks they are going to perform.

### Summary

Occupational health risks arise when workers are exposed to a variety of hazards in site. Hazards may leads to injuries and illness to workers in site and decrease productivity of the project and also cause project delays as well as cost overruns. In this paper, the factors associated with ergonomic hazards are discussed and its effects on workers have also been discussed. In addition, DfCS concept is approached in this paper for ergonomic hazards to improve the workers safety. The successful implementation of 'Design for Construction Safety' concept will increase the workers safety and will decrease the compensation cost of the workers related to MSDs and also increase the productivity of the firms. Considering the workers safety and workers need, many foreign industries successfully implemented design concepts in different way for ergonomic solutions. Some of them stated that change in design gives a positive result to the workers safety and also improves the workers productivity. In this paper, hierarchy of design for controlling ergonomic hazards in workplace is approached. As a result, addressing workers safety in conceptual phase of the project will make the workers to know about the tasks earlier. This paper will give a support to designers in Indian construction industry. However, addressing workers safety in initial phase has not become a part of designer's responsibility in many countries. Future research is needed to describe barriers for designers to address workers safety and also to describe the designer's attribute towards ergonomics safety in construction.

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