

ERGONOMICS PRINCIPLES AND UTILIZING IT AS A REMEDY FOR PROBABLE WORK RELATED INJURIES IN CONSTRUCTION PROJECTS

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ABSTRACT

Nowadays, the costs of Musculoskeletal Disorders (MSDs) are considered as the main proportion of workers compensation related costs in construction industry. Lack of paying attention on reducing work related MSDs also known as Cumulative Trauma Disorders and establishing remedial program will lead to injury gradually to some significant parts of the human body such as nerves, tissues, tendons or joints. Ergonomics is known as a science of designing the job to fit the workers which makes the job easier, safer and more pleasant for them and also leads to save money. Development in establishing ergonomics program can be achieved by focusing on all essential principles of ergonomic science. For example the common ergonomics risk factors at site, the problems associated with them and the remedial programs needed to eliminate and/or mitigate them. All key elements of successful ergonomic program in a workplace will be met by executing an appropriate ergonomic design by providing all essential pillars of ergonomic design wisdom. The purpose of this paper is to investigate all significant factors which should be taken into account in an ergonomic program to develop the best remedial method against the costly, harmful and irreversible work related injuries. It also intends to motivate owners, contractors and workers to consider simple but essential solutions to adapt them to their own occupation and work site.

KEYWORDS: *Musculoskeletal Disorders, Cumulative Trauma Disorders, Ergonomics, Ergonomics risk factor, Ergonomics program*

I. INTRODUCTION

Construction is considered as a demanding job where a large number of workers are working in. It is often classified as a high risk industry since it has historically been plagued with much higher and unacceptable injuries such as strains, sprains, Musculoskeletal Disorder (MSDs) and etc when compared to other industries.

According to the International Labor Organization (ILO), MSDs account up to 40 illnesses and reduce productivity in most of the countries all over the world [1]. They are the most common work-related problem in US construction industry. 90% of disabled older worker has MSDs [2]. MSDs are also called Cumulative Trauma Disorders (CTDs). Cumulative is referred to occurring gradually over a period of week, months, or years. Trauma is pertaining to bodily injury to nerves, tissues, tendons or joints and Disorder is referred to the physical ailments or abnormal conditions. It means that MSDs cause injury to such parts of the body such as muscles, nerves, tendons, ligaments, joints, cartilage and spinal discs by prolonged exposure to multiple ergonomic risk factors. So a remedial program is essential to mitigate damages caused by poor designed construction works. Safety and health of all workers should be a top priority to prevent extra time and cost of injuries and leads to smooth running of the projects.

Ergonomics program in construction is known as a program to design the job efficiently to fit the workers instead of forcing the workers to fit the job [3]. The better the fit the higher the level of safety

and worker efficiently [4] It is considered as a remedial program to fit the various construction works to human physical and psychological capabilities and limitations. Regarding its effectiveness, it makes ergonomic professionals trying to design a safe and proper work environment or modify the specified work situation to a comfortable, efficient and healthful work environment.

Ergonomics program should emphasize on removing barriers to quality, productivity and safe human performance by fitting products, tasks, and environments to people instead of forcing the person to adapt to the work [5]. It can evaluate the adjustment between a person and his/her work by considering the worker, the workplace and the job design [6].

The purpose of this paper is to investigate all significant factors which should be taken into account in an ergonomic program to develop the best remedial method against the costly, harmful and irreversible work related injuries. It also intends to motivate owners, contractors and workers to consider simple but essential solutions to adapt them to their own occupation and work site.

II. WHAT IS ERGONOMICS?

Ergonomic term, which has been derived from the Greek ergon and nomos, means consideration of laws into the work [7]. It is the strategy of designing the work in a way to make the job easier for involved workers. In fact, ergonomics strategy can release the workers from the pain etc related to their job which can lead to increasing the quality and development of the work.

There are many definitions regarding ergonomics. According to OSHA it is defined as designing the job to fit the workers, instead of forcing the worker to fit the job [3]. It means that in the time of designing a place for a particular job besides designing and considering the prettiness, propensity and financial aspect, some other significant factors such as human anatomy and physiology should be taken into account for improving the level of work, as we cannot expect the workers or other person in charge to work efficiently in the uncomfortable work situations.

According to Tayyari & Smith [8] it is defined as a branch of science that focuses on obtaining optimal relationships between workers and their work environment. Lee [9] described it as fostering compatibility between humans and systems. Some other interpretations used instead of ergonomic can be Man-Machine Systems, Human-System Interface and Human Factors Engineering [10]. It can be revealed, in each of these terms, humans are in the center of consideration. The scope of ergonomics surrounds the physical, cognitive and organizational aspects which all of them should be taken into an account.

Table 1 demonstrates some definitions and the scope of ergonomics and the critical factors which should be taken into consideration in each scope.

Table 1: Definition and scope of Ergonomics

Ergonomics		
Definition	Investigating the relations among individuals and systems	
	Principles of optimizing of human and overall system efficiency	
	Redesigning and modifying the job toward more pleasant work environment	
	Making tasks execution easier and comfortable for user	
	<table border="1" style="width: 100%;"> <tr> <td style="text-align: center;">Examples</td> <td> <ul style="list-style-type: none"> ➤ Using appropriate posture for sitting ➤ Using appropriate posture for lifting ➤ Establishing equipments in more standard </td> </tr> </table>	Examples
Examples	<ul style="list-style-type: none"> ➤ Using appropriate posture for sitting ➤ Using appropriate posture for lifting ➤ Establishing equipments in more standard 	
Scope	Physical: Human anatomy, physiological and biomechanical	
	Working posture	
	Repetitive movement	
	Material handling	
	Safety & health	
	Cognitive: Mental	
	Mental workload	
Decision making		
Skilled performance		
Work stress		

	Organizational: Optimizing socio-technical system	Quality Management
		Communication
		Work design
		Team work
		Work time

III. THE NECESSITY OF APPLYING ERGONOMICS PRINCIPLES

Nowadays, ergonomic program is considered as one of the effective plan taken into account by many employers to bring safety and health factors for the work environment to maximize work performances. Indeed ergonomic has enormous benefits and can increase efficiency of the organization. It is a significant principle, since the overall system can be influenced by existing stress on the workers and/or employees body due to inappropriate posture, extremely high or low temperature. Poorly design working environment can cause the injurious outcome on three various systems on humans' body such as musculoskeletal system, cardiovascular system and mental system.

Injuries caused by ergonomic risk factor known as ergonomic injuries can also affect cost of the projects due to loss of time, treatment and compensation claims. Compensation claims returns to injury related costs incurred to workers which can be mitigated by applying effective ergonomics program. Injuries can also cause to reducing the productivity of the project, as one and/or some workers get injured at the work site may cause them to be away from work for at least one day. According to OSHA, fulfillment of those ergonomic standards costs about 4.5 billion dollar per year while the saving is something like 9.1 billion dollars [3]. These figures indicate that the cost saved by the benefits caused by ergonomics program are much more than those cost incurred by putting it into action. There are two types of cost imposed to employer and/or contractor: direct cost and indirect cost. Direct cost is pertaining to medical and worker's compensation cost. Indirect costs are considered as some latent costs related to downtime, loss of production, damaged tools/equipment, hiring, poor efficiency due to break-up of crew, overhead \$ while work disrupted and etc. At first look, direct cost seems to be higher but if we go to detail, it is specified that indirect costs are usually higher than direct cost. Ergonomics also brings benefits through the savings associated with low employee turnover, absenteeism, and poor incentive. Table 2 shows some benefits of ergonomics and the reasons why they provide these benefits.

Table 2: Advantages of Ergonomics

Ergonomic advantages	Reducing discomforts	by reducing the ergonomic risk factors
	Increasing productivity	by providing job satisfaction for workers
	Reducing absenteeism	by making workers to be more engaged and productive by feeling more health and pain-free
	Cost & time savings	Minimizing injuries by Improving productivity of employees Reducing workers' compensation claims
	Increasing morale	by making employees pleasant & feel valued due to safer work environment

IV. ERGONOMICS RISK FACTORS & PROBLEMS ASSOCIATED WITH THEM

Risk is a usual term used in ergonomics concept. There may be a misunderstanding between hazard, risk and danger. Hazard is anything or activity which may cause injury or harm to the health of person, for instance unguarded machinery or flammable materials. Ergonomic related circumstances such as prolonged similar task, lifting, pulling, pushing, twisting, sitting posture, eye strains, etc are identified as the kind of hazard in safety concept. Risk is referred to the chance or probability (big or small) of harm actually being done, while danger is relative exposure to a hazard as a hazard may be present but there may be little danger because of the control precautions taken.

Risk factors are defined as actions or circumstances that enhance the probability of injury to the musculoskeletal system. Ergonomics Risk Factors (ERF) is situations that exist or created intentionally or unintentionally that could or might contribute to results contravene or against the principles or

philosophy of ergonomics that could or might harmful to the health and well-being of workers or users at work or after work [11]. Applied ergonomics literature identifies a small set of common physical risk factors across many occupations and work settings [12]. Since the prolonged, repeated or extreme exposure to multiple Work Musculoskeletal Disorders (WMSD) risk factors can lead to damage to a worker's body, these factors, their causes and implementing remedial programs against them should be taken into consideration seriously. Risk management process can be so effective in identifying, eliminating or reducing these WMSD risk factors. The process consists of hazard identification, risk assessment, risk control and reviewing risk control in such circumstances where there are changes in the work environment, new technology is introduced, or standards are changed.

At the initial stage, the meaning of WMSD risk factors, their causes and parts of human's body in which they have harmfully affect are better to be identified and then some remedies should be designed and recommended to eliminate or reduce the consequences.

Ergonomics risk factors can be divided into seven categories as follows:

- Forceful strains
- Awkward and static postures
- Vibration
- Repetition
- Duration
- Excessive pressure on nerve or soft tissue
- Extreme temperature

In this part each ergonomic risk factor, problems associated with them and the factors caused to those problems are indicated through figures to show them clearer and in detail.

4.1. Forceful Strains

Force is the amount of exertion needed by a person to carry out a task or maintain control of tools or equipments [13]. It is so crucial to know how to apply this effort to complete our activity. Humans such as workers at construction site need to be educated and informed the way they should do during applying force in their activity. Lack of information regarding it can lead to damages to workers such as stress on the muscles, tendons and joints. For instance, in the activities need to be done by grip, more force is produced on the tendons in the wrist by applying a pinch grip compared to a grip with the whole hand. It is obviously clear that in pinch grip, all forces is focused on the wrist while in the grip with the whole hand, applied force is distributed in all parts of the hand, so the pressure in particular area can be reduced. Table 3 indicates how forceful strains lead to harmful effects on various parts of the body such as muscles, tendons, ligaments, joint, and disks.

Table 3: Various situations lead to forceful strains

Forceful Strains		
	Affect on	Caused by
Placing high loads	Muscles	Lifting items
		Carrying load
	Tendons	Forceful grip
		Long term holding one position
	Ligaments	Poorly designed tools
		Poorly maintained tools & equipment
	Joint & disks	High load weight
		Fast movement

4.2 Awkward and Static Postures

Posture is the position of a part of the body relative to an adjacent part as measured by the angle of the joint connecting them. It is considered as one of the most frequently cited occupational risk factors [14].

Awkward postures refer to a situation where the body is under uncomfortable and away from neutral position. Neutral considered as the safest and most efficient position in which to work is the optimal position of each joint that provides the most strength and control. Awkward or unsupported postures can be caused by stretching or shortening of the connective and nervous tissues. So due to that, it can lead to diminishing the functional capacity of muscles and imposing a greater risk of injury. It is just harmful whenever they are carried out in the long time.

Regarding static postures, it can be considered as the situations where the entire body is kept for a long time e.g. staying in a same position for a long period of time without movement. It can cause to fatigue muscles due to the restriction of blood flow led to reducing blood supply in some parts of the body and increase the injury risk. Figure 1 indicates several causes lead to awkward and static postures.

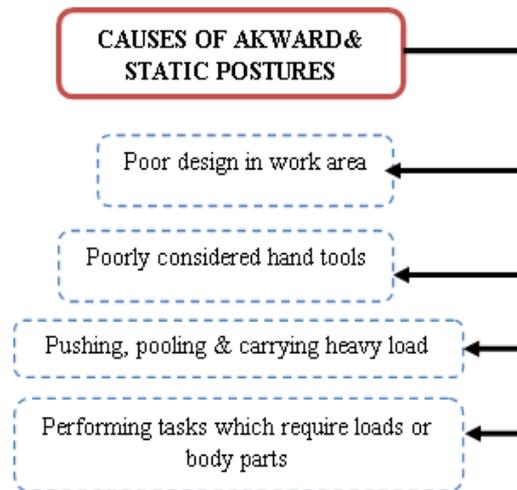


Figure 1: Probable causes of awkward and static postures

4.3 Vibration

Vibrations occur when an object oscillates or rapidly moves back and forth about its stationary point, like a swinging pendulum. Vibrations are defined by the frequency (how fast the object is moving) and the magnitude or amplitude (the distance of the movement). Frequency is measured in cycles per second or hertz (Hz) [15].

There are two kinds of vibration lead to musculoskeletal injuries which the construction workers may be exposed to it. These types are as follows:

- *Hand vibration*: Caused by the vibration produced from power tools such as road breakers, rock drills vibratory rammers, grinders, demolition hammers and etc which can place stress on the tissues of the fingers, hand and arms.
- *Whole body vibration*: Caused by the vibration produced from driving the machineries such as wheel loader, grader, scraper, excavator, dozer, compactor single drum and etc which can impose stress on the spinal tissues.

Table 4 indicates the causes and tools lead to different types of vibration and the impacts they have on human's body.

Table 4: Types of vibration, their causes and impacts

Vibration					
	Causes	Tools		Injuries	Disease
<i>Whole body vibration</i>	Contact with vibrating surface	Heavy vehicle		Lower back injuries	
		Pedal	Seat		
<i>Hand/arm vibration</i>	Working with air-operated, petrol powered tools, etc	Rammers, grinders, demolition hammers, etc		Damage to vascular, nerve tissue such as hand & fingers	Reynaud's syndrome Vibration white fingers

4.4. Repetition

Repetition means doing the same operation or being in the same type of movement over and over. The period of repetition can be short (less than 30 seconds) conducted for more than one hour [16] which can cause damages to the body due to using the same muscles and soft tissues constantly which makes them fatigue. For instance, using an input device such as keyboard in a steady manner for more than 4 hours in a work day causes the danger of repetition risk factor to human which can irritate tendons and increase pressure on nerves.

4.5. Duration

Duration factor is considered when the task is repeated without any break. The longer duration of the task, the greater the cumulative load on the tissues [17]. Without considering any break for extended period, the functional potential of those affected tissue is reduced and the likelihood of injury is increased. Some remedies such as changing footrest, rest breaks and etc can be effective in mitigating damages caused by this kind of ergonomic risk factor.

4.6. Excessive pressure on nerve or soft tissue (Contact stress)

Contact stress occurs when an object presses on soft tissue. The force imposed by excessive pressure on small areas reduces blood flow and nerve transition and can damage the soft tissue. It can occur from pressing against hard edges or sharp surfaces, supporting excessive weight and gripping tools.

4.7. Extreme Temperature

Temperature is also considered as an ergonomic risk factor. Working in extreme surroundings, makes workers to be fatigue much faster due to increasing the aerobic demand. Both extreme cold and hot temperature can impose injuries to the workers.

Cold temperatures diminish blood flow caused to decreasing sensation, muscle strength and agility. Gripping action is harder in cold temperature and as much more muscles need to be applied in this situation, thus the likelihood of injury will be increased. Persisting on working in the situation of hot temperature can bring fatigue and a variety of heat related illnesses to workers. Using PPE may increase the possibility of risk of suffering heat related illnesses [18]. Table 5 and 6 indicates the diseases caused by extreme cold and hot work environment, their injuries, and some remedial actions against them.

Table 5: Various diseases, injuries and some remedies for extreme cold temperature risk factor

Disease	Extreme cold temperature		
	Severity	Injuries	Some remedies
Hypothermia	Moderate: body temp <35°c	Disorientation & irrational behavior	Replacing wet clothing with warm & dry garments
		Slow & shallow breathing	
	Sever: body temp <30°c	Slow & weakening pulse	Bathing by warm but not too hot water
		Shivering & pale, cold and dry skin	
Trench foot			
Frost bite	Consequences		Some remedies
	Pallor followed by numbness		
	Suffering of skin		Placing the affected parts in warm water
	Freezing toes & fingers due to low temp`		Avoiding rubbing affected area which may impose damage
	Loss of sensation caused to death		

Table 6: Various diseases, injuries and some remedies for extreme hot temperature risk factor

Disease	Extreme hot temperature	
Heat Stroke	Injuries	Some remedies
	Rapid & weak pulse	Applying fans & air conditioners
	Brain damage & death	Cooling the victims down with a cool bath
	Hot, red & dry skin	
Sever sun burn	Headaches	Medical attention
	Fever	
	Blister	Take a shower with soap to remove any oil
	Swelling	
	Skin redness	
Heat cramps	Painful muscles spasm	Avoid drink alcohol & caffeine
		Message the affected muscles
		Go immediately to a cooler location
		Spinning of glass of cool water each 15 min
Heat exhaustion	Some remedies	
	Move the victims to a cooler location	
	Lessening the victims clothing	
	Applying medical attention	

V. TYPES OF ERGONOMICS INJURY

Types of ergonomics injury are referred to physical and psychological [19]. Those factors such as body size and shape, fitness and strength, posture, the senses, stresses and strains on muscles, joint and nerves are considered as the most significant ones related to physical ergonomic injuries, while the aspects such as mental abilities, personality, knowledge and experience should be taken into account in psychological ergonomics injury. As mentioned before, the most common type of ergonomic injuries and illnesses is known as musculoskeletal disorders (MSDs) relating to physical injury [1]. MSD's have been associated with those work related tasks including reaching, awkward postures, lifting heavy objects, using continuous force, working with vibrating equipment, and performing repetitive motions. Table 7 demonstrates some injuries, their causes and consequences caused by MSDs.

Table 7: Various injuries caused by MSDs

Injuries	Musculoskeletal disorders		
<i>Muscle injuries</i>	<i>Consequence</i>		
	Muscles contraction → reduction of blood flow → Pain		
<i>Tendon injury</i>	Causes	Types of affected tendons	Disease
	Frequent work	Tendons with sheaths	Tenosynovitis
		Tendons without sheaths	Bursitis
	Awkward Postures	Tendons with sheaths	Tenosynovitis
Tendons without sheaths		Bursitis	
<i>Nerve injury</i>	Causes	Consequences	
	Repetitive motion	Muscle weakness	
		Numbness	
	Awkward posture	Dryness of skin	

VI. HOW TO AVOID ERGONOMICS INJURIES

In fact, preventing the ergonomics injuries at the site is the most preeminent way to control and minimize those non-compensable consequences. Engineering control which may include some modification to tools, machinery and equipment for workers at the work site can be also used as a fairly effective method. One the most fundamental action which should be done is designing job in an

effective and standard way. Implementing job design needs to be based on some criteria and aspects. Furthermore, safety and healthy work practices at the site can be also impressive which should be considered in ergonomics program [20].

Meanwhile, considering some preventable actions may mitigate the probability of imposing ergonomic injuries on workers and/or employees at the site. Table 8 demonstrates some fundamental solutions for preventing ergonomic injuries. As can be seen, appropriate work practice and job design can be considered as the fundamental solutions for impeding ergonomic injuries.

Table 8: Fundamental solutions for preventing ergonomics injuries

Fundamental solutions for preventing ergonomics injuries	
<i>Work practices</i>	<i>Job design</i>
Procedures for safe & proper work	Mechanization
	Job rotation
	Job enlargement
	Team work
	Work place design
	Equipment design

For establishing a program to prevent ergonomics injuries, first of all the main problems should be specified and then quantified. With problems quantification, those observation regarding problems can be managed in a more proper way. After managing the results based on observations, some remedial changes in work processes should be considered to improve the work standard potentially. At the next stage these improvement must be compared against the baseline.

Finally after quantifying the results based on some critical factors such as time, money and efficiency, they can be shared with the company’s leadership for considering in the company’s development program in terms of preventing ergonomic injuries. Figure 2 shows the hierarchy of establishing of the development program based on those problems quantified.

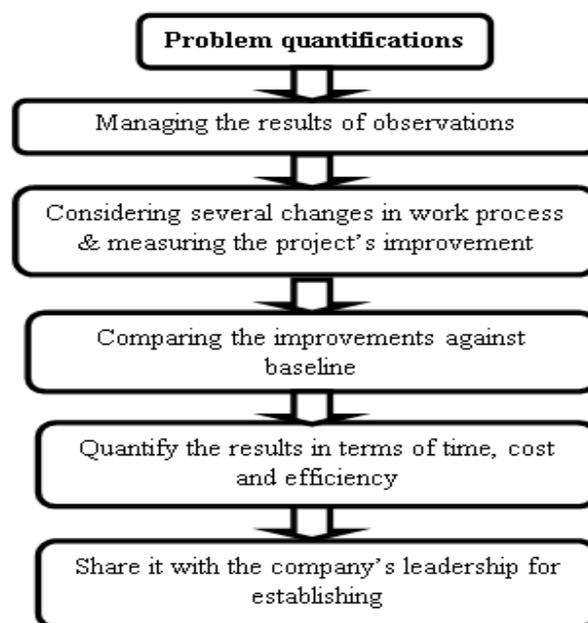


Figure 2: Hierarchy of establishing the ergonomics program of the company

VII. KEY ELEMENTS OF SUCCESSFUL ERGONOMIC PROGRAM IN A WORKPLACE

The purpose of the safety program is to minimize injuries by eliminating their causes. Regarding ergonomic hazard, injuries prevention can be achieved through insisting on decreasing the likelihood of worker's exposure to circumstances which can lead to WMSDs. Having successful ergonomic program is substantial in achieving this aim.

There are several elements required for achieving a successful ergonomic program in a workplace. Amongst them, training and education are considered as critical element of a successful ergonomic program [21], as it can familiarize workers with such principals such as risk identification, risk reduction, injuries management etc, which are essential for ergonomic improvement process. It can increase the worker's potential regarding skills, abilities and knowledge to execute their intended obligations. Besides training and education, management, employees' participation, development of solutions and program evaluation are also essential elements of successful ergonomic program. Table 9 indicates the essential factors for each element.

Table 9: Key elements in successful ergonomic program

Key Elements	Successful ergonomic program
Management	<i>Can be effective by:</i>
	Focusing the employer's belief on necessity of ergonomics program
	Appointing persons in charge for ergonomic program execution
Training	Establishing goals
	Increasing knowledge of ergonomic Improving skills & abilities in reducing ergonomic hazards
Employee participation	Enhancing job satisfaction
	Enhancing motivation
	Creating team
	Improving communication
Program evaluation	Auditing of targeted performance
	Evaluating of program efficiency
Development of solutions	Ergonomic hazards identification
	Controlling development to mitigate hazards
	Appropriate engineering
	Appropriate work practice controls
	PPE (Personal Protective Equipment)
	Administrative controls

VIII. PILLARS OF ERGONOMIC DESIGN "WISDOM"

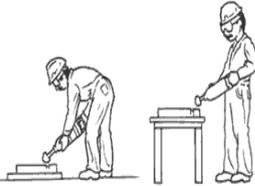
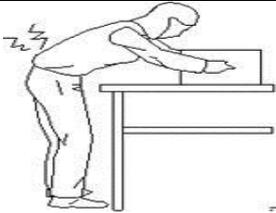
The main purpose of ergonomic is not only making interaction between work and workers pleasantly to increase productivity, but also providing safe and healthy work environment for the workers. Designing ergonomics program is a significant matter that if done appropriately, it can enhance efficiency for the project. Considering some substantial design elements are mandatory for achieving more efficient and better ergonomic program in workplace, the elements such as user orientation, diversity, effects on humans, objective date, scientific method, and systems. Table 10 demonstrates effective pillars of ergonomic design. It clearly shows that human factors should be taken into account as a main element in ergonomic design process.

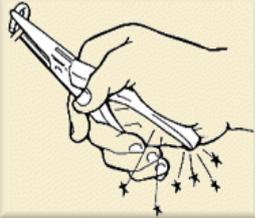
Table 10: Effective pillars of ergonomic design

Pillars	Ergonomic design wisdom
<i>User orientation</i>	Tools, procedures & system should be user oriented rather than just task oriented
<i>Diversity</i>	Recognition of diversity in human capabilities & limitations
<i>Effect on humans</i>	Tools, procedures & system do influence on human behaviors

<i>Objective data</i>	Using empirical information & evaluation in design process rather than just use of common sense
<i>Scientific method</i>	Checking hypothesis with real data rather than good estimates
<i>System</i>	Interconnecting objects, procedures, environments and people together

IX. SOME EXAMPLES OF COMMON ERGONOMIC RISK FACTORS AT CONSTRUCTION PROJECTS AND SOME REMEDIES FOR PREVENTING THEM

	Ergonomics Risk Factor	Remedies
	awkward postures	<ul style="list-style-type: none"> ➤ Adjusting the work area in an more optimum and comfortable way for the body parts
	awkward postures	<ul style="list-style-type: none"> ➤ Prevent of picking up many objects at a time ➤ Try to push rather than pull ➤ Use gravity to carry material easier ➤ Keep loads as close to the body as possible
	<ol style="list-style-type: none"> 1. Hand/arm vibration 2. Noise 	<ul style="list-style-type: none"> ➤ Limiting the time of exposure ➤ Using PPE such as gloves, earmuff to cover the ears against excessive noise
	1.Repetition (in laying paving blocks)	<ul style="list-style-type: none"> ➤ 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)	<ul style="list-style-type: none"> ➤ 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

	<p>1. long duration 2. Awkward posture</p>	<ul style="list-style-type: none"> ➤ Change orientation ➤ Foot rest ➤ Applying mechanical tools: For resting arm, wrist, spine and etc ➤ Rest break
	<p>1. long duration 2. Awkward posture</p>	<ul style="list-style-type: none"> ➤ Adjust the seat ➤ Change position ➤ Add fixture to tools to maintain the “S-Curve” of the spine ➤ Kept the neck aligned ➤ Keep wrists in neutral ➤ Keep elbows in and shoulders relaxed
	<p>Contact stress</p>	<ul style="list-style-type: none"> ➤ Minimize pressure points ➤ Add cushion/padding of tool ➤ Rounding out the edge
	<p>Excessive Force</p>	<ul style="list-style-type: none"> ➤ Reduce grasping force ➤ Using gloves but not too thick to reduce the force on the tendons in the wrist
	<p>Vibration (in concrete)</p>	<ul style="list-style-type: none"> ➤ Reduce Vibration ➤ Rest Break ➤ Limiting the time of exposure
	<p>Contact stress on Knees</p>	<ul style="list-style-type: none"> ➤ To use materials, building components, or work methods that are less labor-intensive, so the task takes less time and you therefore kneel and stoop for a shorter period ➤ Use tools with extension handles that let you stand up while doing a floor-level tasks

	<p>Excessive Force (Spreading concrete on the surface by shovel)</p>	<ul style="list-style-type: none"> ➤ Use a motorized screed (also called a vibratory screed).
	<p>1. Awkward posture 2. Static posture (Tying rebar by hand)</p>	<ul style="list-style-type: none"> ➤ Use a rebar-tying tool ➤ Some rebar tier allow you to work standing up, so there is less stress on your low back due to stooping and bending.

X. RESULT AND DISCUSSION

In previous section, some probable and common tasks and their related ergonomic risk factors and some remedies for them were investigated. In the center of most effective remedies, there are training and education. They can foster employee perception, perceptions prompt behavior, repeated behaviors become habits and the formed habits develop attitudinal labels and culture among workers. This culture development can be effective in shaping safety culture. Establishing safety culture develops the worker's attitude which is beneficial in reducing hazards and injuries and will dramatically reduce the direct and indirect cost of injuries. Informing about the various and common risk factors caused to injuries in the human's limbs helps in choosing the best and most effective remedies against them. Engineering control and design should be improved efficiently so that more effective and efficient equipment can be produced and designed to make the construction tasks easier and more efficient for the workers at site for the purpose of mitigating MSDs injuries.

XI. CONCLUSION AND RECOMMENDATION

There are still several limitations in providing reliable information on occupational diseases due to issues relative to case definition problems, lack of national statistics on occupational diseases, and lack of qualified occupational and safety professionals in the workplace, among others. Conducting an appropriate ergonomic program can be so effective in mitigating or even preventing the work related MSDs in various industries specifically construction industry. There should be several elements such as worker involvement, management commitment, sustainability, training, evaluation and etc. in and comprehensive ergonomics program.

Besides, forming a strong safety committee and holding regular safety meeting, can be so effective in conducting an appropriate and efficient ergonomic program at site. By attempting the members of safety committee and information shared in safety meetings, common risk factors can be identified easier and suggestion will be made to employees to avoid injury and work in a more efficient manner.

Finally, in a broader context, 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.

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