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# Lecture-22 Ergonomics and Health Issues with Concreting

Yeah, hi everyone. So, this is continuation to the previous lecture, in the last lecture we have discussed about health hazards, starting from physical hazards chemical hazards and biological hazards. And ergonomics is the one which we are going to discuss in this particular lecture. So, what is ergonomics and what is the risk related with ergonomics? And the primary risk is the effect is predominantly called as MSD which is nothing but musculoskeletal disorder. Sometimes it is also referred as WMSD which is also called work related musculoskeletal disorders.

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If you see the history from 2003 till 2009, many of the construction sites had many series of musculoskeletal disorders reported. And if you look at the body parts which are affected it starts from back, shoulder, abdomen, multiple body parts and so on. If you see in the same 2011, if you look at again statistics which talks about the cost of injury claims, most of the claim the number one claim primarily in terms of the maximum claim which was taken up, it is primarily called over exertion.

And then next is bodily reaction, then if you see it is primarily repetitive motions and so on. So, this is primarily on the safety. So, whether in construction or in any other industry, the musculoskeletal disorders are a major serious concern.

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Again, some more data which is from bureau of labour statistics, which talks about what is the overall percentage in the musculoskeletal disorder. This will give you an idea the seriousness of the health injuries. So, if you see here, over exertion and body reaction that is 33.2% which is even higher than the fatal four which we call false as number 1. False is only 27.4%, but the over exertion and body reaction is actually 33%.

And if you look at the distribution of injuries in the body parts again if you see upper extremities or 30%, lower extremities are 23% then back 17.3, multiple parts 11, head 7 and all other parts is something around 10.

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So, it shows a very clear message there is a serious level of attention or concentration is required with regard to health issues in construction. Now, again if you see the number of days any person has taken leave and so on. So, the rate of illness or health injuries or along with the safety and health, if you see. Again, this statistics in 2014 also shows a similar pattern, repetitive motion involving multiple tasks that is primarily having so many of lost days which implies absence from work, fall to lower level.

Then you have over exertion and bodily reaction, then again over exertion and lifting and lowering, then you have fires explosions, falls, trips, then again falls, trips. Then if you see again intentional injury, then so exposure to harmful substances or environment. So, there are a series of health accidents or injuries also along with the safety accidents and injuries which you should note down.

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# Ergonomics in construction Ergonomics is not a new concept It combines the knowledge of human abilities with those of tool design, equipment and the organization of work. It aims at making things more human compatible, which can bring improvement in productivity by making the operation user friendly. Occupational ergonomics has to do with the design or modification of the workplace and the origination of work to match the worker. As early as 18th century doctors noted that workers who required to maintain body positions for long periods of time developed musculoskeletal problems. Within last 20 years research has clearly established connections between certain job tasks and RSI or MSD. Construction work is physically demanding, requiring frequent nanual handling of heavy loads.

Now what is ergonomics? It is not a new concept, it is a very old concept, an ergonomics actually combines the knowledge of human abilities with the tool you work or the equipment and the organization of the work. So, primarily the aim of ergonomics is to make things more human compatible. So, the original concept was to improve productivity. Suppose if you strain yourself in doing a task, you quickly become tired and fatigue.

As a result, productivity is generally very minimal. So, in order to improve productivity this ergonomics was taken up as a study to analyze the stress level or the stress level of the body parts of a worker in the construction sites. So, occupational ergonomics has to do with the design or modification of the workplace and the organization of the work to match the worker. Sometimes you may have to do some modifications which may be easing the workers job, maybe a slight rotation of their tasks.

Today a worker may be helping a mason, tomorrow or after 1 week let him help a carpenter or a different person. So, that the job rotation will actually eases fatigue. And till 18th century doctors noted that workers who require to have a predominantly a perfect body positions are postures, they never faced a problem. But otherwise, there are a lot of musculoskeletal problems reported in the medical history.

So, in the last 20 years, there are so many researches which has been done and most of the research has established the fact that there are certain jobs which are closely linked with the musculoskeletal disorders. And if you look at construction work, it is generally physically demanding, it requires more frequent of human intervention or manual handling of heavy loads. Easily you can bring a cutting, bending and bar banding machining to the site and you can free the workers from the bending and cutting of reinforcement, which is a very simple task which we see in many of the construction sites.

But what happens is, bringing in an equipment you have to take care of the equipment safety. So, the hazards in construction sites are little changing and shifting, but you need really skilled operators to do all these cutting and bending. What happens, in many of the construction sites, we generally have unskilled workers and when we want to maintain with the unskilled workers, then we have to train the workers as to how to manage with them with the construction sites.

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Now whenever you talk about ergonomic injuries, there are 4 different words which are unanimously looked into, and they are repeatedly used in construction sites and varied levels. And the most common we colloquially call MSD and MSD is generally referred as a common term which will identify all the four types of injuries. But there is slight difference between the four of them and which is reported in literature. Number 1 a CTD, CTD is nothing but cumulative trauma disorder, here injuries involve strain which develop or build up over time. RSI is repetitive strain injuries, injuries affecting muscles, nerves and tendons, by repetitive movement and overuse, the conditions mostly affect the upper body. The next one is MSD which we call it as a musculoskeletal disorder, injuries and disorders to soft body tissues which includes muscle, nerves, tendons, ligaments, joints, cartilage and spinal discs.

RMI is repetitive motion injury; it is an injury to the body that is caused by performing same motion over and over again and thereby straining a body part. So, in general we colloquially use MSD and we will proceed in the same lines.

Body part	Cause of injury	Health effects						
Lower back	Prolonged bending over squeeze the discs, pressing the spine.	Disc rupture or herniation						
Knee	Kneeled position, stooped position, continuous stress on knee	Bursitis, Tendinitis						
Shoulder	Arm raise above shoulders	Bursitis, Tendinitis, rotator cuff tear						
Neck	Neck bent forward or backward, or frequent bending	Sprain						
Arms, hands, wrist	Carry heavy objects with sharp edges, or are hard to grip and hold	Tendinitis, Carpel tunnel syndrome						

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Now, what are the health effects because of an improper working in a site? For example, and what are the body parts affected and what are the health effects as a result of the same and what is the nature of that particular health issue? So, first one is lower back, prolonged bending or squeezing, primarily pressing the spine. So, you have disc rupture or herniation. Knee, kneeled position, stopped position or continuous stress on the knees.

Stooped position is a different form of a bending position and you have bursitis or tendonitis. Then shoulder, arms raise above the shoulders or elbow raised above the shoulder, so here also you have bursitis or tendonitis or rotator cuff tear. Neck, neck bent forward or backward for prolonged period or frequent bending then you have sprain. Then arms, hands and wrist, carry heavy objects with sharp edges or are very hard to grip and hold maybe you carried for a long period of time, again tendonitis and carpal tunnel syndrome. These are common health hazards which you see in many of the sites.

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So, little known anatomy. So, nerves send signals to muscles to contract when you are working in excess. So, what happens is they become stiffer and then it is very difficult to do. A very simple thing is maintaining a healthy lifestyle by eating good food and little exercise and stretch and flex. Then obviously your body is actually working out along with you. Symptoms are pain, weakness, stiffness, sensitivity, swelling or burning sensation, sometimes tingling or drowsiness or maybe clumsiness and difficulty in moving.

So, this is also a picture to show which is from NIOSH to show on the different challenges or health effects as a result of inappropriate working in the construction sites.

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Sources, what are the different sources? Directly you will not get any particular health hazard immediately, primarily it depends on the work position, work postures, how often you are performing a same task may be given in a particular day itself or maybe in 1 hour how much time you are repeating the same task? And how much time and what is the level of effort? Sometimes even varying levels of effort are also not good.

What is the duration of those challenging tasks? All those you may have to analyze and some of the examples which lead to musculoskeletal disorders include exerting excessive force. Maybe while you are lifting heavy objects or when you are pushing or pulling heavy loads or when you are manually pouring materials in construction, whether it is concrete, soil and so on. You would have seen in the earlier lectures, everything is very heavy, maintaining control of equipment or tools.

So, primarily you are exerting too much of force, performing same task or maybe similar tasks repetitively. For example, if you want to construct a wall, you may have to lay the bricks and put the mortar. And as soon as the level of the building starts moving up and down, many of the situations you do not adjust the level of your working platform accordingly. Actually, you are supposed to adjust the level of working platform according to the height of the worker and the instruments and the equipment and material which the key.

But generally, they do not adjust very frequently, after a certain point of time they try to do. As a result, what happens is they try to reach too far, they try to reach too low or they try to reach too high, so then they become easily fatigue. The next is working in awkward postures or maybe the same posture for a prolonged period of time. Maybe when you are pouring concrete, you may have to hold the materials for a long period of time in the same position.

So, these are all actually are not good procedure for health hazards. So, prolonged or repetitive reaching above shoulder heights, kneeling, squatting or leaning over and bending also. And all these are primarily called as awkward postures and so on. Localized pressure in the body part, maybe you are pressing against something or maybe you are hitting against something in order to play something in position.

So, primarily you are using your hand as a hammer to press on something. All these are primarily localized pressure maybe on your wrist levels or on your knee levels and which will cost health hazards. And added risk happens when you are working in extreme temperatures, when your bodies also under vibration because of equipments which are running in the construction site.

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And other risk factors will aggravate the effect on your body, maybe the symptoms may be really small but it can start aggravating because of other hazards present in the construction site. So,

whenever you want to assess that risk of injury, you have to also understand the duration, the length of exposure, exposure which we have discussed right now. The frequency of exposure, maybe especially in loading and offloading of material, you may be loading continuously then you may be unloading continuously.

Then this task will keep on repeating, when you are typing in something maybe the shift between your keyboard and mouse you are frequently doing it. And, so these are all different sort of hazards to your fingers or to your body parts. The intensity of the exposure that also you may have to understand and what is a combination of risk factors.

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So, when you look at any of these activities, you may have to assess what are the different subtasks or operations to be done. And for each of them, what are the hazards prevailing you may have to really assess. So, number one is you may have to conduct job hazard analysis which we will discuss in the next class in the next week. And establish ergonomics program, training, feedback from all levels.

And also, there are a lot of work practices and so on, and one of the key issues is you should wear a proper PPE. And the proper PPE ranges from gripping gloves, knee pads, lifting straps, shoulder harnesses and lifting braces, these are some of the examples of the PPEs. Now let us start discussing about the different challenges or the health issues. Number 1, awkward body postures, it can be part of your body or the whole body.

So, primarily instead of a neutral posture which is we call it as a S curve. So, this is primarily some deviation from the S curve, it can be only to a specific portion of the body, maybe an upper portion or lower portion but generally awkward body postures.

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For example, working with the neck or the back bent forward more than 30 degrees or for more than 2 hours per day or squatting or kneeling for more than 2 hours per day, squatting is like half sitting as seen here. And this is primarily called kneeling; you are putting your knees fully and there. So, this is like more than 2 hours per day, you may have to sit there especially when you are doing finishing works and so on, in concreting.

Solutions, raise and or tilt the work for better access, maybe you can push the platform accordingly, so that you can stand and do the work. Or use a stool suppose if it is a ground level work, or use tools with longer handles when you have to reach a different posture like this. We can use a handle for reaching out or alternate between bending, kneeling, sitting and squatting; only continuously doing a same job we will create a lot of health risks.

So, you can switch over between different, different postures also, that can minimize the hazard you have with the body posture. Then reaching above the head or shoulder level, here again there are 2 issues. Working with the hands above the head level or your elbows above your shoulder levels for more than 2 hours per day, especially when you are working on ceiling or for plastering you may have to lift your hands or keep your hands above your head level for a prolonged period of time.

And what happens is, here you may have lot of pain in your hands and you may easily become fatigue. So, elevate the work areas, maybe you can use tilted platform, so that the workers can reach the ceiling at a very close reach. Then you can also keep items within close reach and utilize equipment or other items, so that you are able to access any part of the site very easily. Awkward grips, here there are 2 terms which comes in together, one is called pinching and the other one is called gripping.

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Gripping is like holding, holding an object with your full hand, so this is primarily called gripping. And pinching is like you are holding it only with the help of fingers. So, some statistics has been recorded here, your gripping will have 5 times as stronger capacity compared to your pinching. So, when you are lifting an object with only your fingers you may have to exert too much of energy and force compared to gripping an object.

Now hazards, gripping 10 or more pounds of force for 2 hours per day, pinching 2 or more pounds of weight for more pounds for maybe 2 or more hours per day. So, these two primarily, this is the difference 10 pounds and 2 pounds. And if you are gripping or holding it for more than 2 hours per day, then you may have so many issues with the hands. Solutions, design the work layout to reduce the hand carrying and reduce the number of items carried at one time or maybe you can do batch of carrying.

And use non-grip postures, non-pinch postures and preferably adopt the grip postures and use job task rotation. This is only one way with which you can easily avoid a health hazard. And your grip strength also decreases when you pick up slippery items or wear poorly fitting gloves or maybe you have cold hands or something. Then you may have to accordingly put the proper gloves, so that your gripping strength is maintained.

And when you are doing the repetition job, your risk actually aggravates and when you are repeating between gripping or pinching or gripping or pinching with bent wrist, instead of a straight wrist. If you are bending your wrist and then gripping or pinching or something like this. Then obviously you are actually putting more risk on to your health.



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Repetitive motions, repeating the same motion for more than 2 hours per day with hands, wrists or elbows, shoulders or neck. Intense keying more than 4 hours per day, that is a generic hazard

you see, you are keeping on typing for more than 4 hours per day is a very good example for repetitive motion. Solutions, arrange the work to avoid unnecessary motions and let the power tools and machinery to do the work.

Instead of that maybe you can suggest a small equipment which can do. And spread the repetitive work throughout the day and no need to do continuous work at a stretch. And take passes in between, maybe take a break and rotate the task with co-workers if possible. And change the hands instead of left hand who can push the work to right hand, if suppose if it is a hand intensive work.

And for example, sit and work on computers that is primarily a static work. In static work you may have to be holding something or you may have to stand in a position for a prolonged period of time, it may be even a normal posture. But still, it is not advisable, even if it is a very comfortable posture, so it is not advisable in as from health perspective.

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Localize pressure on body part, maybe for example you are using your wrist and pressing on some hard object, or you are you are pressing on something with your knees, or you are pressing on something with your back, or you are pressing on with your elbows. So, wherever it is you are applying local pressure on any of your body parts, then there are hazards with regarding to that.

So, using hands on knees as a hammer for more than 10 times in 1 hour or more than 2 times per day which is like a long term, then you tend to have a lot of health issues. So, use tools with longer handles or paddle grips or alternate between bending, kneeling, sitting and squatting. And use wrist rest or anti fatigue mats or knee pads or shoe inserts or other items that can reduce stress on your body parts.

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Manual handling, lot of researchers have advised to go for a smart work compared to your hard work. Smart work in the sense instead of lifting or carrying or maybe even pulling or pushing objects, it is better to put 2 or 3 wheels and then it is easy to push and pull the loads. So, better to go for a mechanized way of handling objects or materials in the site rather than manual way of handling the objects in the site.

For example, you can see lot of workers carrying all the mortar or concrete in a mortar pan, and lifting on their head and carry walking or lifting it all the way through the construction site. Instead of that have a smaller equipment for pouring in the concrete, it can be crane and bucket system or it can be a pumping system or conveyor belts, so that it is easily handled in the construction sites.

Traditionally, they were limits placed on the weight of loads to be handled, but after sometime it was very difficult to find the threshold limit on what is a maximum limit and so on. Because

NIOSH has developed some equation, but they found there are so many issues with related to that, with regard to the age of the worker or gender with respect to male or female, what is the maximum capacity or load your person can carry?

And also, health, the general health of the worker also matters. So, under such circumstances, what is considered to be safe way to be left in a certain circumstance? What can be done to make things lifting safe or you can also need additional information to know what is the lifting capacity, the weight of the object being lifted, how the lifting is done, how long the lifting is done? The height of hand at the start and end of the lift, how far the hands are away from the body at the start and end of the lift?

And how good a grip the employee can get on the object and the degree of twisting on the body? So, all these are issues, better to go for lifting. But when you are doing lifting objects, there are something which is primarily called awkward lifting, that you may have to take care of.

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So, the hazards in lifting, so lifting more than 75 pounds once per day, or 55 pounds at least 10 times per day, or 10 pounds more than twice or a minute or more than for even 2 hours per day, 25 pounds above shoulders or below knees or at arm's length more than 25 times per day. All these are above this are not permissible limit. Along with that heavy lifting, frequent lifting and awkward lifting are also not a permissible solution.

So, there are lots of solutions and some guidelines are all given here, but let us see what is an alternate for lifting. Instead of bending your body and lifting something, there are certain steps given by safety researchers as 2. The ease of not doing an awkward lifting but still you are able to lift the object in the construction sites. Lean the packet or a sack or any object, into kneeling leg and this is step number 1.

Number 2, slide the sack onto your kneeling leg and then slowly lift it up close to your body, and the minute you stand up the material is actually close to your body. This way actually you are not creating an awkward posture or position and you are able to lift the object. But the only caution is this technique will be effective only when the loads are very small and lightweight, and when the load is able to be lifted between the knees otherwise this is not a viable solution.

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Frequent lifting, lifting more than twice per minute. Awkward lifting, lifting above shoulders, below knees or at arm's length. So, primarily what happens is, when you are lifting from too high, when you are trying to reach from below and then you are trying to lift from ground level or maybe even from below that or lifting when you are trying to stretch up to lift something which is above your head level and so on.

Or reaching too far away, maybe in the horizontal wise, you are shifting your body too much in order to reach over something; all these are called awkward lifting postures. Alternatives, you can use carts, hand trucks or hoists, conveyors and so on, or you can slide objects instead of lifting them, so push and pull technique you can still do. Store heavy items where you will not have to bend or reach to lift them.

Nor use forklifts or other mechanized equipments for lifting and pushing. And reduce the pushing and pulling for in the construction sites.

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Vibration, the moderate vibration is more than 2 hours per day; we call high when it is more than 30 minutes per day, prolonged vibrations also there. Most of the equipment generally has a vibration, starting from forklift or any excavating equipment, cranes everything has a small sort of a vibration. So, the operator who is handling the equipment will be exposed to that vibration. Solutions, you can take adequate rest periods, rotate the jobs, or you can maintain the equipment, so that the vibrations are minimized and wear an appropriate PPE to minimize the hazard.

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So, how to prevent strains, sprains and musculoskeletal disorders? You can choose better material, better material can be lightweight, easy to be handle, maybe you can redesign the option, so that it is easy. Instead of going in for concreting which is really heavy, you can think of modular construction, paneled construction and so on. Better tools, tools which are fitting in your job or which is fitting for your body, maybe for your hand or for your body space.

And fits the workspace available and which reduces the force you need to apply, so such a tool you can easily choose, maybe the grip pattern or maybe the way with which you are handling the tool. If there is a slight modification, so you can really go for that rather than going for a cheaper or economical solution. Improved work methods, always elevate your platforms to the reach, use lifts and forklifts for lifting and pushing or carrying of heavy loads.

Use hoist or chain falls and carts or dollies for pushing or pulling or smaller and heavier loads. Better work organization, plan the work ahead of time and you can also choose works between your co-workers. And try to share the work among people or maybe even work rotation, so that the hazard is not too much of impact is not seen on the hazard. Training, risk factors in the activity, symptoms of all these musculoskeletal disorders and all should be properly communicated to the workers. Stretch and flex, the last one is maybe small short exercises on stretching and of your body can also ease the pain and relieve the spasms and the muscle tensions. PPE, you can think of using shoulder pads, knee pads or vibration reducing glove, so that you are actually little relieved of the pain.

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So, what are the symptoms for musculoskeletal disorders? So, report any sign or symptoms if any of your body part is paining, paining under persistent, severe or worsening pain. When the pain is radiating from a single spot or the symptoms when also includes numbness or tingling. And symptoms keep you from sleeping at night, fingers blanch or turning white, all these are symptoms of some health hazard. Why is it important to report signs and symptoms the early?

The early treatment is always better and it is you can there is a lot of chance for complete cure. And also, more savings in time and money rather than aggravate it and then take it very seriously and there is and generally it is not reversible.

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And what happens in construction sites? Many of these hazards do not come stand alone, they all come together. And most of these hazards are actually posed with physical, chemical and economic hazards all are seen together in the construction site.

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Now, let us discuss about some case studies and some ergonomic applications which we have discussed which we have really applied in a construction site. So, this is a primarily a small site layout, and so wherein this is primarily on loading and unloading of reinforcement. You can see the bars here, this is a bar bending machine and this is a bar cutting machine and all the scrap is lying here, and this is a parking space.

And the truck actually comes in through here, it goes to the weighing machine, does the weighing part and then comes here, and does the unloading portion and then it starts going back. So, this is a simple layout of the site and if you see here what are the ways with which you can really see how the workers are stressed out or exerted.





So, this is a string diagram, string diagram generally talks about the movement of workers. If you see in one particular day, the workers are moving from stirrups making machine to rebar loading at site to bar cutting machine, from there to scrap, then bar bending machine to scrap, then bar stored here after the cutting and bending. So, after this they may have to move, and then grooves forming machine and then bars after cutting and goes to machine.

If this layout can be arranged, the movement of workers along with the material they are actually lifting the steel, every time they are moving from one place to another. So, the movement can be really minimized, so some of the hazards can be minimized. And there are also different methods or techniques available to see how your body parts are stressed. So, these techniques are all in terms of improving on productivity and work study is primarily a broad concept which came in 1960s or even before that.

So, in construction, it is not too popular because it requires so much of data to do and some of these examples, we have done in construction only. So, which even partially even if you do you

may see a lot of benefits by applying these techniques. So, this is a simple two-handed chart which shows you a left hand and your right hand, how much stress you are putting on your left hand and your right hand?

A simple study on taking a rebar, putting in the machine and for cutting the bar alone, what are the different steps and how much is your stress level? You can easily recognize. Suppose the same task you are doing, you are taking like the reinforcement bar, putting on the machine, cutting like this maybe you are doing like 100 times continuously. So, what is a stress level or the fatigue of a person? You can really see and recognize.

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To the rebar, so these are the different symbols. So, this symbol talks about transportation, and this symbol talks about an idle situation. And this is primarily keeping in position which is nothing but called static and these are the storage diagonals are of the storages. So, to the rebar, left hand is only picking out, right hand is idle all the time, picking up the rebar then return to original position and then hold the rebar.

Then right hand is coming there for marking on the rebar, then your left hand is taking the rebar onto the machine and kept on the machine and left hand is only holding it, and your right hand is moving the button to press the button and you are receiving the cut part. This may look very simple, just putting the bar mark and cutting it. But suppose if the same task is repeated for several times throughout the day, you can imagine the fatigue stature of the above.

So, these are all some of the charts, suppose if he is a right-handed person, a greater number of tasks are done primarily with this left hand only. So, what you can do is, you can turn the table, so that his right hand is doing more operations compared to your left hand and he may find it normal. So, these are some of the suggestions you can do by doing all these charts in the sites. The next example, again this is also a site in Delhi only.

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So, if you see here.

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5.No.	Facility	Number	Area (sq m)	Duration (months)
1	First Aid Centre	1	15	36
2	EHS Department	1	15	36
3	Worker's Induction Room	1	15	34
4	Time Office	1	15	34
5	Visitor induction Room	1	15	34
6	Workers Rest Room	1	180	34
7	Workers Canteen	1	180	34
9	Stack Bins for Aggregates, Sand	4	120	33
10	Batching Plant 1	1	200	33
11	Batching Plant 2	1	200	33
12	Cement Storage	2	445	33
13	Concrete Testing	1	30	31
14	Quality Lab	1	280	33
15	Reinforcement Yard	1	700	35
16	Formwork yard	1	1536	35
17	P&M Yard	1	338	35
18	Store	1	430	34
19	Office	1	430	36
20	Vendors Room	1	360	34
21	Marble Cutting Yard		150	

This is also a site layout, primarily on temporary facilities; these are the different temporary facilities available, first aid centre, EHS department, workers induction room, time office and so on. All these temporary facilities where they primarily for facilitating the construction. (Refer Slide Time: 35:47)



What happens is, the same string diagram was modified into two issues, one is travel chart and the frequency chart. So, between each of the facility are all marked as F1, F2, F3, in the last one also we have seen the distance only with the string diagram. In this case you also you will be talking about the distance from F1 to F2, from F1 to F3, what is a distance? This is from and this is 2 and same way what is the number of times these people these workers have travelled?

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So, which will resemble like this, so batching plan to reinforcement yard at least 112 kilometers has been travelled by the worker, so, like this you can take out the statistics.

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And if you see the number of times, you will know what is the maximum, otherwise default it is 1 and what is the maximum number of times the workers have travelled are all calculated.

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And with this you can do a lot of analysis which I am not covering here. And reinforcement yard has been shifted here, so that the fatigue of the workers was minimized. Unnecessary movement, unnecessary lifting and moving of the materials and unnecessary worker movement itself in the site was minimized as a result of shifting of reinforcement yard. So, like this lot of applications are there in order to study on ergonomics.

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Occupations	Potential Health Hazards 31
Brickmasons, stonemasons	Cement dermatitis, and a memory, heavy loads
Carpenters, plasterers	Noise, second and the heavy loads, repetitive motion
Drywall installers	Plaster dust, heavy loads, mentant emitting
Electricians	Heavy metals in solder fumes, in Heavy postness, heavy loads, asbestos dust
Painters	Solvent vapors, toxic metals in pigments, paint additives
Pipefitters, plumbers	Lead fumes and particles, welding fumes, asbestos dust
Carpet layers	Knee trauma, minimul inmitim, glue and glue vapor
Drillers, earth, rock	Silica dust, whole-body vibration, noise
Roofers	Roofing tar, heat stress, working at heights
Insulation workers	Asbestos, synthetic fibers, www.ann.comm
Highway & Street construction workers	Asphalt emissions, heat stress, diesel engine exhaust
Excavating and loading machine operators	Silica dust, histoplasmosis, whole-body vibration, heat stress, noise
Hazar Jous waste workers	Heat stress, toxic chemicals

Now, this is a slide which I have shown in the previous lecture also which talks about different operations in the construction site and the different types of hazards which are seen in the construction site. If you see here, this slide I brought only to emphasize that each of these operations does not pose just one hazard but multiple health hazards in the construction site.

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So, an example that we are going to discuss today is on cement. Cement is a very versatile material which is used in construction site. And unanimously, if you look at any of the building construction people prefer cement. In the sense, concrete construction, because it is sturdy, safe, easy to do, we have a lot of experience and learning as to how to proceed with the construction. So, lot of positive advantages issues are there.

But when we come to health issues, there are some serious threats while we have to use cement and cement byproducts which can be mortar, which can be concrete and so on. Few of the hazards in concreting like for example scaffolds or with formwork, etc., we have discussed along with the false hazard itself. Now, I am going to restrict only to health issues with the concrete and cement only.

So, Portland cement is one of the most widely used materials in construction and thousands of construction workers are exposed to the concrete each and every day and without knowing how much harm it causes to them. Starting from handling cement, loading of, unloading of cement bags, pushing it in the godown then unloading it for moving in to the site. So, lot of steps are there and each and every day all these workers are actually facing the cement and concrete issues each and every day.

So, now hazards in cement, it starts from alkaline compounds such as lime are very corrosive to human tissues. Trace amounts of crystalline silica, is abrasive to the skin and can damage lungs. Few of these we have discussed in the last lecture itself. Trace amounts of chromium, can cause allergic contact dermatitis and occupational asthma. Skin or allergy problems are there, especially while mixing cement, mortar or concrete.

Respiratory irritant and lung disease, primarily are there, the cement dust while you are cutting or drilling or even handling a dry cement. And, the wet cement is highly alkaline in nature, so it can start from small rashes to serious ulcer or even a skin burn which can be even till third degree burn. And you may have to go for proper treatment maybe a skin craft or maybe sometimes a limb also can get amputated because of that.

And cement dermatitis is a common problem which you see with the as a result of cement issues. So, some administration controls in the sense some ways to minimize the hazard you can think of wearing a proper PPE.

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Again, do not think the minute to wear a proper PPE; it can safeguard you from the hazard. But this PPE can also become a serious issue, suppose if cement has got trapped in between the workers body and the PPE itself. By mistake some of the cement or concrete has entered into your gloves, what happens is till you finish the work that concrete will be staying into your hand, inside your contacting your skin and the gloves in between the gloves and it can be a real hazard.

So, what are the different PPEs recommended especially when you are working with concrete? Number 1 is gloves, so try to put on waterproof gloves and also the gloves should be properly fitting in your when your wrist and hand, so that it is not letting in any of the cement or concrete to enter into your body or contacting your body. Next, knee length board is preferred or even sturdy boots, so that your cuts or puncture is also prevented.

And also, it is not even when the surface of concrete is slippery; it should also be preventing you from false hazards also. So, choose a right type of shoe wherein the concrete is not actually entering into your boots and getting in contact with your legs. Always choose a proper overall and also a waterproof dress, so that when you are kneeling on for finishing works or something the concreting is not touching in your body and getting ingress into and coming in contact with your skin.

Especially when you are doing screeding works or finishing works, so or you can also think of wearing a knee pad or knee board, so that you are actually safe. And also minimize the time spent in kneeling and so this can help you to prevent hazards with the health hazards as well. Also, suitable respiratory equipment you should be wear to prevent the cement dust entering by mistake you are inhaling the cement dust.

Eye production, maybe a splash of concrete can flash on to your eyes. So, primarily while pouring, mixing or doing any operation with the concrete, so better to have a proper eye protection also. Some of the work practices, think of having different size of concrete blocks, so that you can avoid cutting off concrete in the construction site. Wherever possible, wet cut compared to dry cut, splash water.

So, that your dust with the cement settled and it is not mixing in the air. Make sure to work away from the wind sources and wherever possible use RMC ready mix concrete compared to manual handling of mixing in the site. When kneeling on fresh concrete, try to be safe that concrete is

not getting in contact with your knees and with your skin. Remove the jewelry or something if you are wearing, so that the cement or concrete does not get entrapped within your skin. And clothing if it is contaminated with the wet cement or concrete should be immediately removed and you should be changing it. Wash hands and face at the end of the job or before eating and drinking.

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Now again looking at all the hazards, hazard analysis with regard to cement mortar, concreting all has same hazards only. What is a problem with the dust? Number 1, we will start discussing one after the other. Number one is construction dust, especially when you are mixing the cement along with your aggregates you will have the cement dust coming up to prevent that you can use ready mix concrete.

This is the only easy solution but what happens by mistake if you inhale the cement dust, fumes which mixes with the air, you may have lot of chronic bronchitis and other issues. The next one is skin contact with the cement, so workers who mix the concrete may face lot of skin problems.

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And the skin problems can also range from cement dermatitis or it can also go till a worst case as to on skin ulcers or maybe even skin burns. So, the portland cement contains hexavalent chromium which also causes allergic dermatitis. And prolonged contact with the wet cement can cause skin irritation and burns.

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Hazard analysis, kneeling and squatting. So, primarily the workers who do finish concreting work, they may face lot of hazards because they may be kneeling or squatting, so that is also one of the issues. So, as a result the effects can be bursitis or arthritis, so these can and also it can aggravate lower back pain. The next one is stressful hand and wrist activity, most of this concreting is related to hand or wrist activities only.

And especially seen in finishing of concreting work, so this can lead to tend an inflammation tendinitis in the hand, wrist or elbow or also on carpal tunnel syndrome. Lifting and carrying, manual materials handling, so primarily this is also with regard to pumping, pouring in of concrete. So, you will see lot your muscles getting stressed because of the lifting and carrying of materials.

For repetitive lifting can also lead to muscles strain, ligament sprain or bulging or herniated disc or lower back problems. The next one is overhead work, sometimes for pouring, pumping or vibrating concrete workers have to stretch primarily with an awkward posture or maybe while applying course of plaster, he can has to really stretch a bit. So, this can actually lead to tendinitis, tendinitis can occur when the tendon become inflamed.

So, this can happen in any part of your neck and shoulder. The next is stooped postures, stooped posture is actually is a different posture especially while you are mixing concrete, you bend as if like an inverted which you that is primarily called stooped posture. So, prolonged bending of this stooped posture can create problems to muscles, nerves, discs and ligaments of the back. And hand-arm vibration, whole-body vibration can also happen especially when you are vibrating the concrete to force the concrete into the reinforcements.

So, the next, if you look at together so far you have so many hazards with concrete, concrete is really a hazardous substance and we have not gone too far ahead of manufacturing of cement and so on, there also lot of health hazards are still there, but if you can slightly modify the slag which will not produce hexavalent chromium. For example, that hazard is really minimized, like this you can think of manufacturing a different form of a cement of concrete, so that many of the hazards can be minimized.

And again, a small case study which is reported in literature, this is primarily called brick laying. In brick laying you may have to handle bricks, handle cement or maybe leveling, finishing works and so on. And some researchers have also reported a brick layer has to bend up to 1000 times per day to pick up beck and a mortar to lay.

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And similarly, a brick worker frequently has to load and unload a wheel barrow. He has to handle a load of more than 12 kgs at least up to 75 times per day. So, now the hazard really is there are weights of brick, different weights of mortar, different reaches, different degrees of bending and twisting and so on. One thing is heightening the platform and adjust it, so that he is not really doing awkward position.

Lightweight blocks can be used, modular construction or semi automated mason as seen, that also is preferable, so that you have a you can really minimize the health hazards of the workers. (**Refer Slide Time: 49:08**)



Ergonomic risk, now a quick wrap up ergonomic risks in construction, job related activities and behaviors that increase the risk of musculoskeletal disorders in construction include. The frequency of doing a job, many jobs in construction involved repetitive movements starting from loading, unloading bricks that is what we have seen in the previous slide or maybe masonry work.

For example, laying the brick and putting the mortar that you may have to do repeatedly throughout the day. Amount of physical work that is used, muscles contraction, relaxation and so on. Objects can be made easier to work by changing their location, changing their orientation, this is what I explained with the case study on site lay out orientations. Need for lifting or moving heavy loads, activities that require the use of force to lift, lower, push, pull and so on.

Amount of prolonged static muscular tension, so when muscles or joints are maintained in a fixed static position. Primarily during concreting work, you may have to especially doing pouring working and so on. Working posture and position uncomfortable work postures or we call it as an awkward work posture. Vibration from tools and machinery which we call short form HAVs, hand-arm vibration syndrome which is cause due to pneumatic drills, jack hammers and power saws.

Need for working overhead or extreme ranges of movement, tasks involving working with hand above the shoulder level, ceiling fitters, plasterers, plumbers and so on. The easy way to managing ergonomic risk is to have a job rotation.

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This is again recap on cement the skin effects, so you have irritation, burns and dermatitis apart from all the other hazards, all the other ergonomic hazards. You also have MIOSHA fact sheet on ergonomics in construction. So, this is all the PPE recommended for usage, OSHA recommends workers who handle cement should wear the proper PPE, proper eye protection, proper full body protection, proper gloves.

So, that especially when you are handling concrete and cement, overall saw pant, so that your body is fully covered and no contact with cement happens. Rubber boots, so that this concrete is not entering into your body. Suppose if your cement makes contact with your skin, wash the hands, change out any wet gear it is there, wash everywhere especially when burns takes worst to form.

So, better to quickly wash and do not apply a strong alcoholic gel or a heavy chemical acid for washing, so which is not an advisable issue. And the other one is allergic contact dermatitis primarily with the result of hexavalent chromium.

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These are the different references which I have used. Thank you.