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MODULE 3 : SAFETY IN CONSTRUCTION

The Industrial Plants and Equipments are installed, tested and commissioned at site. The Safety Aspects involved during Project construction phase are different from those during regular operation and maintenance phase.

The various stages of project Construction include:

- Civil Works.
- Receiving and Storage of materials and equipment, spares.
- Erection
- Testing, Commissioning.
- First Energizing.
- Trial operations
- Handing over to operating staff

Safety is important during every stage of the Project Construction. Some activities (Civil, Mechanical, Electrical, Storage, etc.) are carried out simultaneously and therefore the chances of accidents are more.

During various stages of project construction, different hazards gain significance. For example, during Civil works, pit-falls, falling of objects, collapse of structures may happen. During erection work; falling of persons from heights, failure of cranes/slings, falling of equipment, fires caused during welding etc. are possible. During testing / commissioning: electrically caused shocks/fires/explosions are quite possible. During storage of equipment prior to erection; fire hazards are possible.

Field Quality (Site Quality) Management. Ensures good quality of Site Work at every stage of construction. Good Field quality ensures higher reliability and safety of plant and equipment during operation. Construction. Quality has long term effects on safety. Poor quality during construction enhance possibilities of equipment failure, fire hazards and accidents during regular operation of the plant and equipment.

Main reasons for accidents at construction sites are:

- Falling persons.
- Falling materials.
- Transport machinery accidents.
- Lifting equipment.
- Excavation, etc.
- Following are the common hazards during the project construction:
- Accidents due to pitfalls in trench, excavations.
- Fall of persons from height.

- Accidents due to failure of cranes, slings, ropes or shackles.
- Falling of objects on human body.
- Explosions / Fires.
- Road accidents.
- Collapse of structures, walls or slabs.
- Electrical accidents.
- Equipment failures.
- Lightning.

The accidents at site may occur due to one or more of the following:

- Lapse in Management.
- Human error or negligence or ignorance.
- Failure of Plant or Machine component or
- Subsystem. Unavoidable natural causes (floods/storms/lightning).

EXCAVATION AND FILLING

The serious hazards in excavation jobs are due to falls and falling objects. A cubic meter of earth weighs more than one tone and falls of the size are all too often fatal to workers involved.

Here excavation means a man-made cut. Cavity, trench or depression formed by earth. Removal for the purpose of constructing the road, rails, canals. Dams, buildings, etc. Excavations is also required to be carried out for borrow pits and quarries.

The primary concern in exaction related work is cave-in. Cave-ins are much more likely to be fatal to the employees involved than other construction related accidents.

To ensure the safety of those involved, excavation work has to be properly planned, managed, supervised and executed in order to prevent accident. Persons involved at all stages should be aware of the hazards involved and the procedures in place to control the risks associated with this type or work.

Common Excavation Hazards (Causes of Collapse)

- Failure of the soil because it cannot support its own weight. Loose rocks or soils are responsible for this.
- Breakdown of the strength of the soil by moisture usually caused by heavy rain or frost.
- Failure caused by vibration from the movement of vehicles nearby.
- Failure due to the weight of loads placed near the edge of excavation.
- Failure due to the variation in the nature of the soil, such as pockets of sand.
- Failure due to the sides of excavations being struck by heavy loads such as pipes, when they are lowered
- Unsuitability of adjacent structure on excavation near its foundation.
- Falling of any person/equipment in the pit.

Safety Provisions during Excavation

- The position of underground installations such as sewers, water pipes and electrical cables should be verified and in case of their existence, they must be isolated. If they cannot be isolated or removed or shutdown, they should be fenced, hung up or otherwise protected.
- On every part likely to be visited by persons or where transport vehicles ply, the area should be suitably fenced, guarded or barricaded to barricaded to prevent fall of persons, vehicles or live stock into the excavated area.
- Warning signs should be erected and in the night hours the area should be illuminated to warn pedestrians and vehicular traffic.
- Arrangements should be made to prevent external vibrations due to rail/road traffic.
- On steep slopes, workers shall not be permitted to work on above the other.
- No excavation of earthwork below the level of any foundation of a building or structure shall be commenced un less adequate steps are taken to prevent danger
- Additional precaution be taken to prevent slides, slip or cave-ins when excavations are made in locations subject to vibrations from rail-road or highway traffic, etc.
- In all trenches 1.5 m or more in depth, ladders should be provided.
- Excavation areas should be adequately lighted for night work.
- During hours of darkness all public sidewalks should be adequately illuminated and warning about the excavation should be provided.

- A flagman should be posted to warn the public or approaching trucks and to direct the trucks in and out of the site of excavation.
- Arrangements shall be made to save other structures in the affected zone or in the vicinity of the area of excavation, from collapse.
- The sides of every excavation, where there is a danger of fall or dislodgment of earth, rock shall be securely supported by adequately braced to any timber of suitable quality material.
- All loose stones, projecting clumps of earth and unstable material that may come down on workers in trench should be removed and the excavated sides should adequately have braced and trench suitably guarded.
- Stockpiles of loose materials should not be located in the immediate vicinity of overhead power lines and materials should not be piled against walls as it may endanger the walls.
- Excavated materials should not be stacked within 1/3 rd of depth of the pit or 1 m whichever is more, away from the edge of any excavation and should be stored and retained so as to prevent it from falling or sliding back into the excavation and to prevent excessive pressure upon the side of the excavation.
- Where pumping is being carried out to lower the ground water level, subsidence of adjacent structure may result. The characteristics of the supporting soil may be changed by pumping.

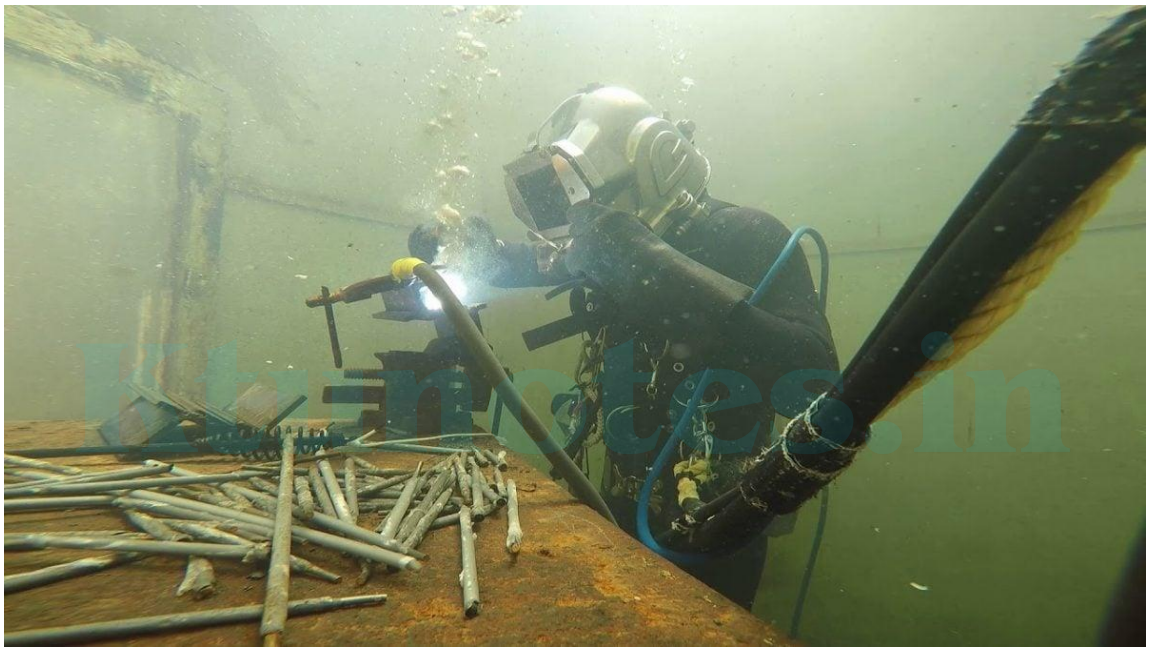
Protection of Employees and Public

- Fencing - Excavations carried out at any place to which the public or cattle's have or might gain access must be guarded to avoid danger to people. A fence 1 m high or a combination of signs, barriers, lights, makers, flags or sentries may be necessary to provide adequate protection for the public and employees. These safety devices must be properly maintained until the excavation is completed.
- Notices and Warning Signs - notice or warning signs must be placed at all exits and entrances to the work area to warn a person
- Protective helmets, Goggles, Hearing Protection -Where employees could be injured by objects falling from above, adequate overhead protection must be provided. Hard hats / Helmets must be worn both in the excavation and out of the excavation.Where there is a foreseeable risk of injury to the eyes, suitable eye protection must be worn. Windblown grit and dust are the most common sources of eye damage in excavation work.
- Illumination –Excavation areas shall be adequately lighted for night work. During hours of darkness all public sidewalks shall be adequately illuminated and warning lights about the excavation shall be provided to ensure safety of pedestrians and vehicular traffic.In case of power failure, all workplaces where excavation works are carried out should be illuminated through emergency generators.
- Glare from artificial lighting greatly increases the risk of falls from slipping or tripping, therefore suitable shades may be necessary to eliminate this problem.

- Use of Plant and Machinery –The excavation equipment should be parked at a distance of not less than the depth of the trench or at least 6 m away from excavated. These conditions should be watched and suitably remedied.
- The vehicles should not be permitted to be driven too close to the pit.

UNDER-WATER WORKS

Underwater construction work is an area which requires extensive training. Not only does the worker need to worry about the regular dangers that come with working with tools, now he is working in a different medium, water which has an effect on safety.



HAZARDS

- Compression & Decompression

The bends, also called decompression sickness. This is a condition when a diver rises too quickly. Nitrogen that is in his body, from breathing compressed air, needs time to leave the body. If this is not allowed, then the diver can experience the bends. The only cure for this is a decompression chamber, which must be present whenever scuba work is being done. Warning signs are; sore joints, itchy skin, vision and hearing difficulty, paralysis, and death.

- Nitrogen Narcosis

This is an affect similar to alcohol intoxication. This condition is caused because more gases are breathed, while underwater, from the oxygen supply. Because of the greater pressure, these gases are absorbed into the body easier than at sea level.

- Oxygen Toxicity

This is a condition where higher levels of oxygen are breathed. This has an affect on the body, and can result in; disorientation, trouble breathing, trouble with vision, lung damage, seizures, and death.

- Construction Related Safety

Laws of physics and chemistry function differently in underwater. This needs to be part of the training of anyone that will work underwater. Welding, for example, functions differently at underwater. Chemicals react differently. The weight of objects is less and things move slower in underwater. No one should be attempting any underwater work unless they have been properly trained.

Safety precautions

There are many conditions which contribute to making underwater work difficult. These include adverse currents, unstable footing, poor visibility and low temperatures. A constant source of danger comes from the falling or rolling of cut-away pieces. These, combined with the dangers involved in operating an electric are capable of producing fatal shock, severe burns and explosive gas pockets, create a situation where the diver must be extremely alert. The following precautions must be observed:

- Extreme familiarity with their diving equipment.
- Check working condition of equipment.
- Check working condition of equipment.
- Plan the dive: time, depth, work to be done and stick to the plan.
- Never dive alone. Always have at least one partner that you will stay close to.
- Have a rescue plan in place.
- Know where the nearest decompression chamber is located and how to get help.
- Descend slowly.
- Ascend slowly with the scheduled breaks.
- Monitor air supply regularly during the entire dive.

The best way to prevent decompression sickness is to avoid diving too deep, do not stay deep above the recommended time, ascend slowly with regular stops along the way, and limiting number of dives per day

Careful examination should be made before starting the cut to learn how the cut-away pieces will fall and whether there are any projections or cause a piece to swing around in an unexpected manner.

Be extremely careful when cutting tightly Be extremely careful when cutting tightly- bound wire rope e.g., wire wrapped in a ship's propeller. When severed, the wire can back- lash with spring-like force.

Before cutting, ensure that diving equipment will not be in the path of slag from the cutting operation.

Avoid cutting overhead if possible, since the falling molten material will seriously damage the diving helmet, dress and umbilical.

Never put down or carry an electrode holder while the power is on. Never change an electrode while the power is on.

The diver must never allow any body part or equipment to come in contact with the grounded work when the safety switch is closed.

Care should be taken with diver-carried large loose metallic items (i.e., wrenches and backpacks) to ensure no contact is made with a live electrode or the work.

UNDER-PINNING

In construction, underpinning is the process of strengthening and stabilizing the foundation of an existing building or other structure. Underpinning may be necessary for a variety of reasons:

- The original foundation is simply not strong or stable enough.
- The intended usage of structure has changed.
- The properties of the soil supporting the foundation may have changed
- The construction of nearby structures necessitates the excavation of soil

- Supporting existing foundations.
- It is more economical, due to land price or otherwise, to work on the present structure's foundation than to build a new one.
- The existing foundations of the building have moved – this is caused by poor soil or changes to the soil subsidence has occurred). Conditions (e.g. There Has been a decision to add another storey to the building, either above or below ground level
- The depth of the existing foundations is inadequate to support the modified building or load (weight) of it.

HAZARDS AND SAFETY MEASURES - UNDERPINNING

Most types of underpinning involve digging holes under buildings in confined spaces. The existing structure is expected to defy gravity and temporarily arch over the excavation. Collapses can occur and the following related risks must accordingly - be identified and managed

- Investigate services before starting excavation
- Always do excavation at angle greater than angle of repose of soil
- Check that underpinning pits cannot get flooded or be gassed
- Strengthen superstructure before digging
- Check that walls above are strong enough to support themselves enough to support themselves over pits
- Support sides of excavations
- Ensure that workers can escape from pits easily
- Use threaded couplers instead of dowel bars to connect reinforcement rods between sections of shallow mass concrete underpinning
- Ensure strengthening of nearby surrounding structures
- Provide all required PPE's (Safety Harness, Safety Helmet, Safety Shoes, Mask, Safety Goggles, Safety jacket)
- Ensure safe access and ventilation to pits

SHORING

Shoring is the process of temporarily supporting a building, vessel, structure, or trench with shores when in danger of collapse or during repairs or alterations. Shoring may be vertical, angled, or horizontal.

Proper installation, use and dismantling of shoring systems can help keep workers safe and prevent collapses during construction, renovation, and expansion. When installing and using shoring, it's vital to follow all state and central regulations to ensure worker safety. Here are a few general guidelines that cover the basics of shoring safety:

- A qualified person should survey the jobsite for hazards that could cause issues with the shoring system.
- If hazards are uncovered, they should be corrected as needed.
- Plan the shoring's installation in advance. This includes ensuring that the right equipment is available to safety finish the work.
- Inspect all equipment before use. If a defect is found, the affected item should be removed and repaired.
- Defective equipment should never be used.
- Obtain a shoring drawing from a qualified professional. The drawing should be used onsite at all times.
- Handle the shoring equipment with care, and only use the equipment as it was intended.
- Don't erect, dismantle or alter the shoring equipment without the approval of a qualified supervisor.
- Inspect the shoring system through the duration of a project. If there's any doubt about the safety of the shoring, stop use immediately and contact qualified a supervisor.
- Shoring systems should not be used for fall protection. Furthermore, workers should not use shoring systems if they feel dizzy or lightheaded.
- Do not climb on the cross braces.
- Periodically adjust uneven grade conditions. Do not force braces on frames:
- Follow proper safety practices during dismantling. Nothing should be removed from the shoring system until a qualified supervisor has given their approval.

LADDERS, SCAFFOLDS, TEMPORARY STRUCTURES

SCAFFOLDS

A scaffold can be defined as "any temporarily provided structures on or from which persons perform work in connection with operations or works".

Scaffolds are the temporary wooden or metal framework platform for supporting or workmen/material during construction, erection, repair or painting of a building/structure. As far as possible, only steel scaffoldings should be used. The materials used on all scaffolds should be in sound condition suitable for the purpose and free from defect.

SCAFFOLDS HAZARDS

Accidents due to scaffold collapse are common. Apart from collapses the other hazards are:

- Unsecured ladders slip
- Use of unsuitable or faulty materials,
- Inadequately supported scaffold board, Inadequate or irregular platform width
- Omission of guards rails or toe-boards
- Failure to secure scaffolds to the building/structure or to brace it adequately

Safety Measures

In view of the above hazards, following safety measures should be taken to prevent scaffolding related accidents:

- The designer should ensure that drawings and instructions show sufficient details and that they are easily understood by erectors. Most of the entering are designed for vertical loads while lateral forces as a result of the dynamic effect are usually neglected during the design. Therefore, lateral stability is equally important.

- Horizontal bracings are essential at various levels to ensure that support struts and scaffolding tubes do not buckle under vertical load.
- Every scaffold including supports shall be of good constructions of suitable and sound material and of adequate strength
- Boards and planks used for the floors shall be of uniform thickness, butt jointed, closely laid, and securely fastened in place.
- Every scaffold shall be securely supports or suspended and shall, where necessary be sufficiently and properly strutted or braced to ensure stability.
- All scaffolds or working platforms of any nature shall be securely fastened to the building or structure, or if independent of the building shall be braced or guyed to prevent sway.
- In the construction of dams sufficient anchorage shall be provided in the dam itself at the time of construction.
- Persons should not be allowed to work from scaffolds during storms or high winds.
- Scaffoldings should be inspected at least every 7 days

The main items to be checked are:

1. The alignment and support of the standards (upright),
2. The straightness,
3. The adequacy of bracing,
4. The ties of the building,
5. The tightness of couplers,
6. The soundness, support and security of planks and platform,
7. The guard-rails and toe-bars,
8. The condition and security of the ladders
9. The ground supporting the baseplate.

When work is being performed above a scaffold platform, a protective overhead covering shall be provided for the men working on the scaffold.

Whenever workmen have to work or constantly pass under a scaffold on which men are working, a screen or other protection shall be provided to catch any falling material. Such protection shall extend outside the scaffold properly in order to catch any material falling off the edges of scaffold platforms. 12mm wire mesh netting of No. 18 gauge or better may be used for the purpose.

Side screens shall be provided on scaffolds erected along passageways

During dismantling of scaffolds, necessary precautions shall be taken to prevent injury to persons due to fall of loose materials, bracing and other members of the scaffold shall not be removed pre-maturely.

While the entire scaffold shall be maintained stable and rigid so as to avoid the danger of collapse. Nails from the planking and various members of the scaffold shall be carefully removed and all material carefully piled

LADDERS

Ladders should be of good construction, sound material and adequate strength. No ladders with defective or missing rung or with any rung which depends for its support solely on nails, spikes etc. should be used.

Wooden ladders should not be painted, as paint covers up the defects.

Whenever platform is 1.5 m or more above the ground ladder or stairway should be provided. Every ladder used for a vertical height of more than 9 metres should be provided with an intermediate landing with guard-rails.

The materials and tools should wherever practicable, be pulled up with a rope, and should not be taken by ladders.

A ladder should not be placed upon a box, barrel or other movable insecure object.

The slipping of ladders at either end should be carefully guarded against where the supporting surfaces vibrating.

Where a ladder is used as a means of communication or as a working place the ladder shall rise, or adequate hand-hold shall be provided, to a height of at least 1 shall be provided, to a height of at least 1 metre above the- place of landing

When using a ladder or a step ladder, the user should always face the ladder.

The transportation of materials by ladder should be reduced to the minimum.

The use of ladders for other than a means of access should be eliminated.

All ladders shall be periodically inspected.

The stability of ladders should be eliminated.

Portable ladders should be in a safe position before being climbed. The slipping of a ladder at either end should be carefully guarded against. especially where the supporting surfaces are smooth or vibrating.

If necessary, a person shall be stationed at the base of the ladder to prevent it from slipping.

A ladder should never be placed on slippery, oil surface or a vibrating footing unless the ladders is held by another person or securely fastened to prevent it from slipping or twisters.

Workers using ladders should

(i) avoid wearing slippery boots or shoes
(ii) avoid carrying heavy or bulky loads.

Metal ladders should not be used in the vicinity of exposed live wire.

Only one person at a time should be permitted to work from a ladder.

TUNNELING

Tunnelling is the physical process of constructing an underground passageway beneath the earth's surface, tunnels can also be created underwater. To be precise, a tunnel is a more or less a horizontal underground passageway constructed via excavation processes

HAZARDS

Hard physical labour can cause bodily injuries. Roof falls or cave-ins can cause head injuries, crush injuries, suffocation or death.

- Exposure to crystalline silica dust and cement dust can lead to respiratory, lung or skin problems.
- Exposure to chemical vapours can cause lung problems, including chemical pneumonitis, which can lead to respiratory failure and death if left unchecked.
- Exposure to radon can cause lung cancer.
- Oxygen-deficient atmospheres can contribute to breathing problems, such as asthma.
- General Safety Precautions in Tunnelling
- Make sure the tunnel's floor is clean and dry.
- Ensure proper covering for light and power lines to avoid open flames and electricity short- circuiting.
- Ensure that electric lines and light are insulated and secured completely.
- Always ensure the presence of doctors and medical equipment at the worksite.
- Always ensure the presence of sufficient water supply and firefighting equipment.
- Avoid storing unused tools, construction material and machines in the tunnel.
- Make sure that the tools and machines to be used are efficient and well-maintained.
- Make sure to visit working platforms and check them occasionally.
- Install an efficient communication system inside the tunnels to send and receive essential
- information.
- Ensure the workability and efficiency of power system, communication system, lighting and safety devices occasionally.
- Each worker should take essential precautionary measures for his safety by wearing a steel helmet, rubber gloves, goggles and protective clothing while working.
- Provide a double power supply to the tunnels to avoid safety hazards due to a power failure.
- During scaling, the stroke of the hammer should not be hollow, but hard. A hollow hammer stroke signifies a loose rock.
- Ensure proper ventilation and drainage system in the tunnel. Install signboards for safety on several occasions in the tunnel.
- No one should be allowed to enter the tunnel without permission.

BLASTING

Blasting is a process of reduction of rocks or Blasting is a process of reduction of rocks or hard soil into fragments with the help of explosives. The blasting operation involves drilling of holes, installation of a detonator and charge, detonating the charge, and removal of debris.

SAFETY PRECAUTIONS

- For the safety of workers, red flags shall be prominently displayed around the area where blasting operations are to be carried out.
- All the workers at the site shall withdraw to a safe distance of at least 200 meters from the blasting site.
- An audio warning by blowing whistle shall be given before igniting the fuse
- The blasting operation shall be carried out under the supervision of trained personnel.
- The blasting shall not be done within 200m of an existing structure unless permitted explicitly by the engineer in writing.
- All procedures and safety precautions for the use of explosives, drilling, and loading of explosives before and after shot firing and disposal of explosives shall be carried All procedures and safety precautions for the use of explosives, drilling, and loading of explosives before and after shot firing and disposal of explosives shall be carried out corresponding to government rules

DEMOLITION

Problems, hazards and uncertainties are much greater during demolition since it is frequently carried out by the unskilled workers. The design engineers have the responsibility not only for the safe design and construction but Problems, hazards and uncertainties are much greater during demolition since it is frequently carried out by the unskilled workers. The design engineers have the responsibility not only for the safe design and construction but also for the safe demolition of the structure at the end of its designed life.

Common Safety Hazards and Environmental Aspects in Demolition

- Unintentional collapse of structure or part of it.
- People and objects falling from heights.
- Striking overhead or underground services. Manual handling activities associated with demolition and material movement.
- Generation of Demolition debris.
- Hazardous substances in debris.
- Dust emission.
- Generation of noise.
- Effect on climate.
- Segregation of the generated debris into hazardous and non-hazardous debris.
- Actions to be taken before work is taken up: any demolition
- It should be preceded by a site survey which should be comprehensive and cover the position of screens, scaffolds etc.
- Protection of the public shall be ensured and also methods to ensure the stability of surrounding buildings/structures from the danger of collapse due to withdrawal of support or undermining of the foundations shall be paid attention
- The electric power to all services within the structures to be demolished should be shut off or
- discontinued at outside the building.
- All gas, water and steam service lines should be shut off or otherwise controlled outside the structure to the demolished.
- The structure to be demolished should be adequately fenced and cordoned off and suitable board shall be prominently displayed to warn the public.
- Measures for dust suppression / control shall be in place.

NATIONAL BUILDING CODE OF INDIA (NBC) GUIDELINES

The National Building Code (NBC) is a document that provides guidelines for construction of structures – residential, mercantile, institutional, educational, commercial, assembly, storage spaces or even hazardous buildings. It is important to follow these guidelines that are meant to protect the overall health of the construction and ensure the health and safety of the public and the residents. In this article, we are going to talk about the NBC guidelines for residential buildings. These standardised codes were first published in 1970 and revised later in 1983. The latest revision was in 2005.

The NBC defines residential buildings as constructions 'in which sleeping accommodation is provided for normal residential purposes, with or without cooking or dining or both facilities. As per the National Building Code of India, residential buildings include any building that is equipped with sleeping accommodation for normal residential purposes, with or without cooking and dining facilities.

Residential buildings are classified into the following categories:

- Lodging or rooming houses.
- One or two-family private dwellings.
- Dormitories.
- Apartment houses or flats.
- Hotels.

NBC guidelines related to kitchens

- Every kitchen must have provision for washing utensils, with proper connection to drainage.
- The kitchen must be provided with an impermeable floor.
- The kitchen must open into an interior or exterior open space and should not be less than one sq metre.
- The kitchen should not open into a shaft.
- No chutes to be used in buildings above 15 metres.

NBC guidelines related to bathrooms

- One of the walls should have an opening to the open air. Minimum ventilation or window space should be provided measuring up to 0.37 sq metres.
- A bathroom must always be over another bathroom or washing place or the terrace space and not over another room. Watertight floors can be an exception to this rule.
- The seat should be made of non-absorbent material.
- Bathrooms should be enclosed by partitions/walls, provided with an impervious surface with a height prescribed as not less than one metre.

- The floor covering should be impervious too but sloping towards the drain and not towards any other room or balcony space.
- A room provided with a water closet is to be used as a toilet only. These rooms must be provided with flush cisterns.
- If there is a toilet on the terrace with a height of 2.2 metres, it should be counted in the Floor Area Ratio (FAR).
- In the absence of a sewage outlet, a septic tank must be provided.

NBC guidelines related to lofts

- Apart from shops, lofts are permitted in residential buildings only.
- The area of the loft should be restricted to 25% of the covered area.
- The height between the loft and ceiling should not be less than 1.75 metres.

NBC guidelines related to basements

- The minimum height of the basement should be 2.5 metres and the maximum height 4.5 metres.
- The ceiling height should be a minimum of 0.9 metres and maximum of 1.2 metres above the road surface.
- Ventilation is must for the basement and could be in the form of blowers, exhaust fans, air-conditioning, etc.
- Surface drainage should not enter the basement.
- The basement's walls and floors must be water-proof.
- The basement should not be accessed directly from the road. It should be accessed only from the main entrance or an alternative staircase that provides access to the building.
- Only when a projecting basement is flush with the ground, or if the authority allows, can the basement be permitted to touch the adjacent property.

NBC Guidelines related to building exits

The NBC has guidelines for the entry, as well as exit points in buildings.

- An exit must be provided in every building, so as to permit safe escape of residents in times of fire or earthquakes, etc.
- Exits are compulsory and these should be clearly visible to all and must be illuminated. These cannot be reduced in number, width or by any other means. The requisite number is dependent on occupancy load, capacity, travel distance, etc.
- Alarms are necessary to ensure those in danger are evacuated promptly.
- Exits should be continuous, leading to the exterior of the building.
- Exits can be horizontal or vertical.
- Lifts and revolving doors are not exits.

NBC guidelines regarding fire safety

In large-sized buildings where accidents due to fire may not be easily noticed, automatic fire detection and alarm facilities are a must and should be provided. Not just this, such buildings should be provided with and protected by fire extinguishers, wet risers, automatic sprinkler installations, etc. These shall be in accordance with the set standards.

NBC Guidelines for staircases in residential buildings

- For group housing, where the floor area does not exceed 300 sq metres and the height of the building is not over 24 metres, a single staircase may be acceptable. In buildings that are identified in Bye-Laws No 1.13 VI (a) to (m), a minimum of two staircases are compulsory.
- In a residential low-rise building, the minimum width for the stairways is 0.9 metres.
- For flats, hostels, group housing, guest houses, it is 1.25 metres.

Guidelines for stairways in residential structures

- The interior stairs must be constructed of non-combustible material only.
- It must have one side adjacent to an external wall and should be completely enclosed.
- It is the chief fire officer who needs to approve of the staircase's location.
- The minimum height of handrails should be 100 cms.
- The minimum width of treads, staircase, its arrangement, headroom, needs to follow the standards as prescribed by the NBC.
- Living spaces and stores cannot open up into the staircase.
- The main staircase and fire escape staircase must be continuous from ground floor to the terrace level.
- No electrical shafts or AC ducts and gas pipelines can run through the staircase.
- Nothing that is combustible can be used for decoration or panelling of the staircase.
- Beams and columns should not reduce the headroom or width of the staircase.

RELEVANCE OF ERGONOMICS IN CONSTRUCTION SAFETY.

Ergonomics is the way you use your body to work and fitting the job or task to you to reduce your risk of injury. Ergonomics refers to creating the best atmosphere for any given occupation to prevent musculoskeletal disorders (MSDs). These disorders affect muscles, blood vessels, nerves, ligaments, and tendons in the body and can be caused by repetitive tasks, like lifting, bending, and reaching. These musculoskeletal injuries develop slowly over time and occur in the soft tissues of your body like the nerves, tendons, muscles, ligaments and joints.

What is ergonomic hazard?

Ergonomic hazard refers to conditions in a work environment that can lead to MSDs. Ergonomic hazards can exist in any workplace and can have a lasting impact on employees. These hazards can result in back pain, carpal tunnel syndrome, tendonitis, sprains and other debilitating injuries. Ergonomic hazards can cause consistent pain to workers, who often choose to work through that pain. According to OSHA, "working hurt" is among the largest problems facing construction workers today, as working hurt can not only lower productivity, but can cause lifelong pain and disability.

Ergonomic hazard examples:

Failure to recognize the safe and efficient interaction with tools and tasks in construction can lead to multiple injuries, including musculoskeletal disorders such as strains and sprains, tendonitis and lower back injuries. The number one cause of disabling injuries in construction is a back injury that occurs from an acute incident of improper lifting or improper repetitive lifting.

Let's dive into some examples of some of the most common ergonomic hazards specific to construction sites:

- Heavy lifting

It's no secret that construction work includes a lot of heavy lifting. Lifting 50 lbs or more can be extremely tough on the body and is made tougher when the lifting is done improperly. On construction sites, workers are constantly lifting heavy equipment, lumber, metal, and are regularly opening and closing heavy container lids. These repetitive motions combined with the weight of the objects involved can create fatigue and strain that can lead to muscle tears, joint pain, and hernias.

- Improper grip & repetitive hand movement

While the way you hold your equipment may not necessarily seem like it matters, improper grip on tools such as hammers, nail guns, screwdrivers, drills, and others, can cause major damage to the hand and wrist. Workers who aren't trained to hold these instruments properly and repeatedly move their hands and wrists improperly can develop carpal tunnel syndrome, sprains, and muscle fatigue.

- Tool training and upkeep

Tools are, arguably, one of the most prominent pieces of a job in construction. That being said, proper training and usage make a world of difference in the safety of constructruction teams. Additionally, keeping tools properly maintained can help reduce the muscle strain and potential joint and tendon injury that can result from tools that require extra effort.

- Repetitive tasks

Projects that require repetitive motion, such as hammering, carrying and lifting materials, and even measuring, can cause pain and injury to your muscles and ligaments, especially in the hand. The longer these motions are repeated, the more wear and tear they can cause on bones, joints, ligaments, and more.

Ergonomic hazard prevention:

Construction work creates a dynamic, diverse and constantly changing environment which requires the diligent protection of construction workers. While we typically focus on helping to prevent the more dramatic physical hazards posed on a construction project (such as falls from height and dropped objects), it's important to note that less dramatic events on the job site can lead to ergonomic hazards as well. Follow these guidelines to help prevent ergonomic hazards.

- Promote correct posture that uses the legs with a straight back, and no twisting or bending over;
- Consider the overall weight and configuration of lifted items and stop to get additional assistance and use lift devices wherever possible;
- Break down heavy loads into smaller units to lighten the individual load;
- Use ergonomically-designed tools with specially-designed hand grips for repetitive tasks; and switch hands periodically as needed;
- Keep tools in top shape to avoid additional exertion when using them (e.g., sharpened knives and drill bits that are in good condition);
- Use the correct tools for the job (e.g., avoid actions such as using a screw driver rather than a knife because the tool was not easily accessible);
- Stretch to warm up before work;
- Get adequate rest; and
- Maintain proper hydration.

MUSCULOSKELETAL DISORDERS

Work-related musculoskeletal disorders (WMSDs) are a group of painful disorders of muscles, tendons, and nerves. Carpal tunnel syndrome, tendonitis, thoracic outlet syndrome, and tension neck syndrome are examples. Almost all work requires the use of the arms and hands. Therefore, most WMSD affect the hands, wrists, elbows, neck, and shoulders. Work using the legs can lead to WMSD of the legs, hips, ankles, and feet. Some back problems also result from repetitive activities

What are the risk factors for WMSDs?

WMSDs arise from arm and hand movements such as bending, straightening, gripping, holding, twisting, clenching and reaching. These common movements are not particularly harmful in the ordinary activities of daily life. What makes them hazardous in work situations is the continual repetition, often in a forceful manner, and most of all, the speed of the movements and the lack of time for recovery between them. WMSDs are associated with work patterns that include:

- Fixed or constrained body positions.
- Continual repetition of movements.
- Force concentrated on small parts of the body, such as the hand or wrist.
- A pace of work that does not allow sufficient recovery between movements.

Generally, none of these factors acts separately to cause WMSD. WMSDs commonly occur as a result of a combination and interaction among them. Heat, cold and vibration also contribute to the development of WMSD.

How do WMSDs occur?

This document discusses WMSDs that develop gradually as a result of repeated trauma.

WMSDs include three types of injuries:

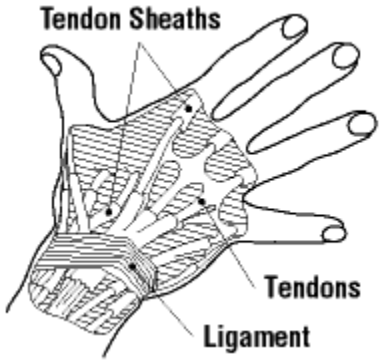
- Muscle injury.
- Tendon injury.
- Nerve injury.
- Muscle Injury

When muscles contract, they use chemical energy from sugars and produce by-products such as lactic acid which are removed by the blood. A muscle contraction that lasts a long time reduces the blood flow. Consequently, the substances produced by the muscles are not removed fast enough, and they accumulate in the muscles. The accumulation of these substances irritates muscles and causes pain. The severity of the pain depends on the duration of the muscle contractions and the amount of time between activities for the muscles to get rid of those irritating substances.

- Tendon Injury

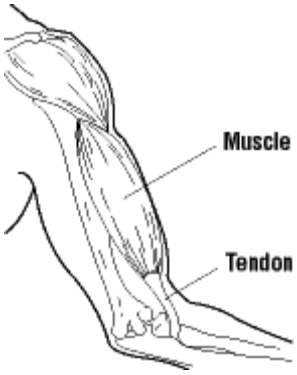
Tendons consist of numerous bundles of fibres that attach muscles to bones. Tendon disorders related to repetitive or frequent work activities and awkward postures occur in two major categories – tendons with sheaths found mainly in the hand and wrist; and tendons without sheaths generally found around the shoulder, elbow, and forearm.

The tendons of the hand are encased in sheaths through which the tendon slides.



Finger tendons and their sheaths

The inner walls of the sheaths contain cells that produce a slippery fluid to lubricate the tendon. With repetitive or excessive movement of the hand, the lubrication system may malfunction. It may not produce enough fluid, or it may produce a fluid with poor lubricating qualities. Failure of the lubricating system creates friction between the tendon and its sheath, causing inflammation and swelling of the tendon area. Repeated episodes of inflammation cause fibrous tissue to form. The fibrous tissue thickens the tendon sheath, and hinders tendon movement. Inflammation of the tendon sheath is known as tenosynovitis.



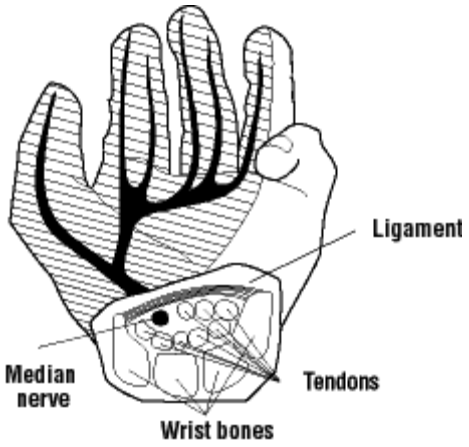
Tendon, muscle, bone unit

When inflamed, a tendon sheath may swell up with lubricating fluid and cause a bump under the skin. This is referred to as a ganglion cyst.

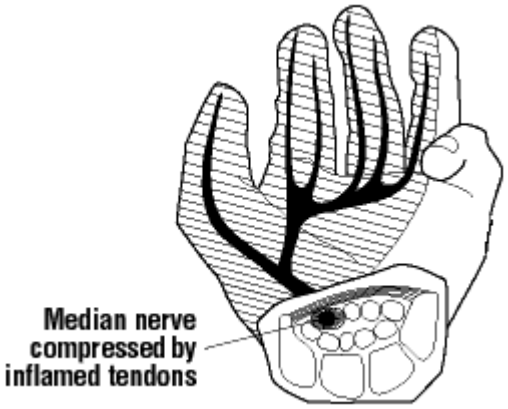
Tendons without sheaths are vulnerable to repetitive motions and awkward postures. In fact, when a tendon is repeatedly tensed, some of its fibres can tear apart. The tendon becomes thickened and bumpy, causing inflammation. Tendonitis is the general term indicating inflammation of the tendon. In some cases, such as in the shoulder, tendons pass through a narrow space between bones. A sac called the bursa filled with lubricating fluid is inserted between the tendons and the bones as an anti-friction device. As the tendons become increasingly thickened and bumpy, the bursa is subject to a lot of friction and becomes inflamed. Inflammation of the bursa is known as bursitis.

- Nerve Injury

Nerves carry signals from the brain to control activities of muscles. They also carry information about temperature, pain and touch from the body to the brain, and control bodily functions such as sweating and salivation. Nerves are surrounded by muscles, tendons, and ligaments. With repetitive motions and awkward postures, the tissues surrounding nerves become swollen, and squeeze or compress nerves



Wrist in natural condition



Wrist showing symptoms of Carpal Tunnel Syndrome

Compression of a nerve causes muscle weakness, sensations of "pins and needles" and numbness. Dryness of skin, and poor circulation to the extremities, may also occur.

What are the symptoms of WMSDs?

Pain is the most common symptom associated with WMSDs. In some cases there may be joint stiffness, muscle tightness, redness and swelling of the affected area. Some workers may also experience sensations of "pins and needles," numbness, skin colour changes, and decreased sweating of the hands.

WMSDs may progress in stages from mild to severe.

Early stage: Aching and tiredness of the affected limb occur during the work shift but disappear at night and during days off work. No reduction of work performance.

Intermediate stage: Aching and tiredness occur early in the work shift and persist at night. Reduced capacity for repetitive work.

Late stage: Aching, fatigue, and weakness persist at rest. Inability to sleep and to perform light duties.

Not everyone goes through these stages in the same way. In fact, it may be difficult to say exactly when one stage ends and the next begins. The first pain is a signal that the muscles and tendons should rest and recover. Otherwise, an injury can become longstanding, and sometimes, irreversible. The earlier people recognize symptoms, the quicker they should respond to them.

The table below outlines occupational risk factors and symptoms of the most common disorders of the upper body associated with WMSDs.

Identified disorders, occupational risk factors and symptoms		
Disorders	Occupational risk factors	Symptoms
Tendonitis/tenosynovitis	Repetitive wrist motions Repetitive shoulder motions Sustained hyper extension of arms Prolonged load on shoulders	Pain, weakness, swelling, burning sensation or dull ache over affected area
Epicondylitis(elbow tendonitis)	Repeated or forceful rotation of the forearm and bending of the wrist at the same time	Same symptoms as tendonitis
Carpal tunnel syndrome	Repetitive wrist motions	Pain, numbness, tingling, burning sensations, wasting of muscles at base of thumb, dry palm
DeQuervain's disease	Repetitive hand twisting and forceful gripping	Pain at the base of thumb
Thoracic outlet syndrome	Prolonged shoulder flexion Extending arms above shoulder height Carrying loads on the shoulder	Pain, numbness, swelling of the hands
Tension neck syndrome	Prolonged restricted posture	Pain

How can we prevent WMSDs?

Hazards are best eliminated at the source; this is a fundamental principle of occupational health and safety. In the case of WMSDs, the prime source of hazard is the repetitiveness of work. Other components of work such as the applied force, fixed body positions, and the pace of work are also contributing factors. Therefore the main effort to protect workers from WMSDs should focus on avoiding repetitive patterns of work through job design which may include mechanization, job rotation, job enlargement and enrichment or teamwork. Where elimination of the repetitive patterns of work is not possible or practical, prevention strategies involving workplace layout, tool and equipment design, and work practices should be considered.

JOB DESIGN

i. Mechanization

One way to eliminate repetitive tasks is to mechanize the job. Where mechanization is not feasible or appropriate, other alternatives are available.

ii. Job Rotation

Job rotation is one possible approach. It requires workers to move between different tasks, at fixed or irregular periods of time. But it must be a rotation where workers do something completely different. Different tasks must engage different muscle groups in order to allow recovery for those already strained.

However, job rotation alone will not be effective in reducing WMSDs if not combined with the proper design of workstations. And it will not be effective while the high pace of work persists.

iii. Job Enlargement and Enrichment

Another approach is job enlargement. This increases the variety of tasks built into the job. It breaks the monotony of the job and avoids overloading one part of the body. Job enrichment involves more autonomy and control for the worker.

iv. Team Work

Team work can provide greater variety and more evenly distributed muscular work. The whole team is involved in the planning and allocation of the work. Each team member carries out a set of operations to complete the whole product, allowing the worker to alternate between tasks, hence, reducing the risk of WMSDs.

Workplace Design

The guiding principle in workplace design is to fit the workplace to the worker. Evaluation of the workplace can identify the source or sources of WMSD. Proper design of the workstation decreases the effort required of the worker to maintain a working position. Ideally, the workstation should be fully adjustable, providing a worker with the options to work in standing, sitting or sitting-standing positions, as well as fitting the worker's body size and shape.

Tools and Equipment Design

Proper design of tools and equipment significantly decreases the force needed to complete the task. Providing the worker with the proper jigs or fixtures for tasks that require holding elements saves a lot of muscular effort in awkward positions. Good tools, maintained carefully and where necessary frequently changed, can also save a lot of muscle strain.

Work Practices

A well-designed job, supported by a well-designed workplace and proper tools, allows the worker to avoid unnecessary motion of the neck, shoulders and upper limbs. However, the actual performance of the tasks depends on individuals.

Training should be provided for workers who are involved in jobs that include repetitive tasks. Workers need to know how to adjust workstations to fit the tasks and their individual needs. Training should also emphasize the importance of rest periods and teach how to take advantage of short periods of time between tasks to relax the muscles, and how to consciously control muscle tension throughout the whole work shift.

Increased communication and support together with an increased ability of the worker to control his job (where possible) are work practices that improve worker's satisfaction and have a positive impact on reducing the risk of WMSDs.

RELEVANCE OF ERGONOMICS IN CONSTRUCTION SAFETY

Ergonomics is a science that focuses on designing spaces, workplaces, tasks, and processes to improve well-being and prevent strain and muscular injury.

In the context of construction, we can simplify the concept down to fitting the job to the employee rather than forcing the employee to fit to the job. That means avoiding unnecessary uses of force, reducing stress on the body, and eliminating tasks performed in awkward positions.

Proper ergonomic design and solutions can prevent and reduce the risk of musculoskeletal disorders (MSDs). While these disorders are generally short-term, they can develop into long-term, disabling conditions that will severely impact an employee's ability to perform their work and enjoy their life.

MAJOR ERGONOMIC RISKS

When a task isn't fit to an employee's capabilities and limitations, it can result in two types of ergonomic injury: cumulative trauma disorders (CTDs) and sprains or strains.

Cumulative Trauma Disorders

CTDs, or repetitive strain injuries, are soft tissue injuries caused by repeated exposure to an ergonomic stressor. Many workplace tasks become risky when they are overdone. They can be performed safely for a limited amount of time and with adequate rest periods at regular intervals. However, when they are performed too often or for too long without allowing the body to recover, these tasks can result in a repetitive strain injury.
These injuries generally develop in smaller parts of the body, such as the fingers, wrists, elbows, or neck. In the construction industry, the three most common types CTD are tendon types of CID disorders, nerve disorders, and neuro-vascular disorders.

Tendon Disorders

These injuries are caused by the inflammation of the tendon or the tendon sheathing due to repetitive rubbing against ligaments or bone.

The most commonly known tendon disorder is called Lateral Epicondylitis, but we probably know it as tennis elbow. In this condition, the outer part of the elbow becomes painful and tender. The pain from tennis elbow can extend to the back of the forearm and affect grip strength.

Nerve Disorders

When nerves are compressed repeatedly against bones, ligaments, and tendons, it can make moving the affected part of the body extremely painful.One of the most well-known nerve disorders is carpal tunnel syndrome. With carpal tunnel, the median nerve that travels through the wrist is compressed, resulting in pain, numbness, and a tingling sensation in the thumb, index finger, and wrist.

Neuro-Vascular Disorders

These disorders occur when the blood vessels or nerves are constantly compressed due to exposure to vibration or temperatures cold enough to reduce blood flow to the extremities.

This condition is commonly known as Raynaud's disease. In the construction industry, the fingers are most affected by this. When a worker is afflicted with it, the fingers turn white and then blue if the exposure continues for too long. When the stressor is removed and the blood returns to the area, the fingers then turn red and the affected worker experiences a painful burning sensation.

Sprains and Strains

Unlike CTDs, sprains and strains are caused by a single forceful event and develop instantly.

Sprains and strains occur when a worker performs an activity that surpasses their physical limitation, like suddenly lifting a heavy or awkward object.

Sprains and strains typically affect larger segments of the body such as the back, legs, and shoulders. And the risk of injury increases with every additional ergonomic risk factor that present, such as static loading, repetition, force, contact stress awkward posture, and vibration.

While we tend to use the terms interchangeably, sprains and strains are actually different. Both are stretches or tears in body tissue, but sprains refer to injuries to the ligaments while strains refer to those that happen in a muscle or tendon.

Ergonomic Hazard Controls in Construction

Now that we know what kind of injuries we're dealing with and how costly they can be, we need to discuss solutions.

Every organization should assess the ergonomic hazards on its job sites, based on the scope of work, injury history, and the best business practices. This hazard assessment should be the foundation of the ergonomics program.
Moreover, it is important to note that there is no silver bullet for all ergonomic hazards. Employers must consider and implement multiple control methods, often in combination, to keep workers safe.
The following are a few simple and cost-effective solutions that construction operations can implement to solve common ergonomic problems in their industry.

a) Stooping, Bending, and Kneeling

Construction work can involve a surprising amount of stooping, bending, kneeling, and squatting, often for extended periods of time. Workers who are tasked with fastening or connecting construction materials are especially likely to spend a lot of time in these awkward positions.
One great solution to this problem is to ensure workers are provided with tools that allow them to perform their work in an position.

Here are some examples of these:

- Auto-feed screw guns with an extension to assist workers in securing subflooring, false floors, and decking and roofing materials.

- Powder-actuated fastening tools with a stand-up handle allows employees to make steel-to-steel connections, fasten metal tracks to concrete, or install plywood onconcrete without needing to constantly kneel and rise while doing the job.

- Manual or battery-operated rebar tying tools allow employees to tie rebar while standing and eliminate the need for the rapid and forceful hand motions used when performing the same task with pliers.

- Motorized screeds (or vibratory screeds) eliminate kneeling, reduce repetitive movement, and substantially reduce the force needed to level concrete.

- Kneeling creepers with cushioned knee support and chest support reduces stress on the knees and back when installing tiles or deck membranes - and does it without velcro or leather straps that can interfere with blood circulation.

- Split-level adjustable scaffolding keeps the bricks at waist level when doing masonry work, which reduces the need for stooping.

b) Overhead Work

Overhead work creates substantial stress on the shoulders and arms. Working with the arms up is never comfortable - add repetitive motion, forceful grip on tools, and twisting the body and we've got significant potential for an MSD. Some solutions include:

- Mechanical lifts reduce the need to reach overhead while holding and positioning objects. The lift will hold the object to be installed, leaving the worker's hands free to do the work under substantially less tension.

- Elevated work platforms provide a stable working surface that reduces the need for awkward postures while als eliminating the risks associated with ladders and scaffolding.

- Extension shafts for drills and screw guns allow workers to perform overhead installations while keeping their hands at waist level. The employee can push with their biceps instead of their shoulder, which is a less strenuous position.

- Extension poles for powder actuated tools avoids the exhausting work performed with hands above the head. The extension pole might also eliminate the need to work from a ladder, which is also strenuous.

- Spring-assisted drywall finishing tools reduce the force required to push the compound onto the wall by 75%.

- Pneumatic drywall finishing tools might not reduce the repetitive motion or eliminate all of the awkward positions involved in finishing drywall, but they do reduce the pressure required, thus decreasing the risk of ergonomic injuries.

c) Lifting and Handling Materials

Lifting and handling heavy and large materials puts a lot of pressure on the back, shoulders, and neck. Heavy objects can dig into a worker's hands and impede circulation. Holding them for extended periods of time can lead to conditions such as tendonitis or carpal tunnel syndrome.

Options to decrease these risks:

• Reduce the weight of the materials being handled. This can be achieved by buying smaller cement bags, packaging materials in several smaller boxes instead of a large one, or using lightweight concrete masonry blocks (which are 30-40% lighter than regular concrete blocks)

- Provide mechanical, hydraulic, or vacuum lifts to handle window panes ao drywall panels.
- Provide mechanical lifts or carts when handling large and panes or drywall panels. heavy objects, such as barrels.
- Special handles for handling large drywall panels reduce the grip force required to hold them as well as the effects that the sharp edges have on blood circulation.
- Powered and non-powered carts reduce the need transport heavy objects by hand, such as sheet material or pipes.
- Using pre-blended mortar and grout mixes instead of making them on site eliminates the need for lifting heav cement bags and mixing them by hand. Cement bags an around 100 pounds and the employees might need t handle hundreds of them each day on large jobs.
- Use skid plates to move concrete-filled hoses. Concrete filled hoses are heavy and awkward to handle, so the employees have to make jerking movements to drag them and they often get caught in re-bars. A skid plate makes the hose slide on the re-bar, reducing the amount of fore required them as well as the sudden movements required when the hoses get caught.

d) Hand Intensive Work

Employees in construction spend a lot of time gripping tools and materials, which places a lot of stress on the hand, wrist and elbow. In time, this can lead to serious muscle or joint injury.

Thankfully, there are solutions that will reduce these risks:

- ✓ Easy hold gloves for mud pans are a great way to reduce the hand force required to hold a drywall mud pan. glove attaches to the pan and holds it to the employee's hand without needing a forceful grip. Considering that the pan often weights up to 5 pounds and the employee does The the task all day long, this eliminates a significant amount of strain.
- ✓ Power caulking guns require a lot less force than the trigger on traditional caulking guns. Using them reduces the risk of carpal tunnel.
- ✓ Opt for low vibration power tools or provide workers with anti-vibration gloves. High vibration power tools can lead to reduced blood circulation, which is exacerbated by a forceful grip. This can lead to conditions such as "white finger" or "hand and arm vibration syndrome."
- ✓ Use power brushes instead of hand wire brushes when clearing rust or other materials. Power tools reduce the need for a forceful grip, as well as repetitive motions.
- ✓ Quick threading lock nuts can be positioned or slide on the rod to the desired location. This reduces the installation time and eliminates a lot of repetitive movements.
- ✓ Ergonomic tools can also help. While these are not always clearly defined or certified, here are some basic rules:

- ✓ Tools should conform to the geometry of the hand.
- ✓ Pistol grip and inline tools should have a handle about 5 inches long, and a handle diameter of 1 to 1.5 inches.
    - Handles that end in the palm of the hand (too short) are not recommended.
- ✓ Pliers and crimping tools should have a handle length of 4 inches minimum and a recommended handle span of 2.5 inches.

ERGONOMICS HAZARDS

Ergonomic hazards are physical conditions that may pose a risk of injury to the musculoskeletal system. Ergonomic hazards include awkward postures, static postures, high forces, repetitive motion, or short intervals between activities. The risk of injury is often magnified when multiple factors are present. Factors such as whole-body or hand/arm vibration, poor lighting, poorly designed tools, equipment, or workstations allcontribute to negative interactions with the worker/user. Some of the common body regions where injuries may occur include but are not limited to:

- ✓ Muscles or ligaments of the lower back.
- ✓ Muscles or ligaments of the neck.
- ✓ Muscles, tendons, or nerves of the hands/wrists.
- ✓ Bones and muscles surrounding the knees and legs.

Injuries in these and other parts of the body could result in Musculoskeletal Disorders (MSDs), which may be called Cumulative Trauma Disorders (CTDs) or Repetitive Strain Injuries (RSIs), and are estimated to account for about a third of all non-fatal injuries and illnesses and their associated costs.

Construction work can involve floor and ground-level work overhead work, lifting, holding, and handling materials, and hand-intensive work. Construction workers often experience backaches and pain the shoulders, neck, arms, and hands these symptoms often lead to musculoskeletal disorders and can cause health complications in the employees experiencing Jarms, and these symptoms. Employees have an increased risk of these injuries and health conditions if they often carry heavy loads, work on their knees, twist their hands and/or wrists, stretch to work overhead, use certain types of tools, use vibrating tools of

Ergonomic hazards occur in both occupational and non occupational settings such as in workshops, building sites offices, homes, schools, or public spaces and facilities. Finding ways to eliminate or reduce ergonomic hazards in any setting will ultimately reduce the risk of injury.

Causes of ergonomic hazards in construction work

- Awkward posture

For some construction jobs, stooping or kneeling is required for tasks like finishing slabs, decks, or floor coverings. Bending, stooping, kneeling, or squatting can cause pain or discomfort in the employee's back or knees. Not only can these activities cause pain and discomfort, but these physical positions can limit other job activities such as lifting, pushing, or pulling weights without substantial body stress. Some potential solutions for these kinds of tasks and ergonomic hazards include raising the work on a worksurface so it is no longer needed to be done on the floor, but on a surface closer to the worker. Using tools with extension handles that allow the employee to work standing up could help eliminate the need to stoop and kneel. A device called a kneeling creeper could be used for tasks in which kneeling is required. This device offers chest support during the task to offer more body support during tasks.

Working overhead is often required of construction employees. Drilling, driving fasteners, or finishing drywall are all tasks that would entail overhead work. This positioning could put stress on the neck, shoulders, and could reduce the ability for the employee to work safely. Using lifts or hoists would help the employee become closer to the work surface to reduce the frequency and intensity of lifting materials overhead. Attaching extension shafts for drills can help eliminate the need to reach overhead at all, and could help protect the employee from overhead to use an extension pole for tools. An extension pole is a fixed ergonomic complications. Another solution could be height pole attached to a powder-actuated tool, meaning the tool is out of the employee's hands, but they are still able to operate it.

- Static posture

Static posture is a posture that workers hold over a certain period of time while performing a job or a work. Static posture in construction is a rear thing to see because of the amount of movement needed to complete all the Construction process except in the office setting where planning is done.

- Contact stress

Many tasks on construction sites involve lifting, holding, and handling materials. This lifting and holding can strain the lower back, shoulders, neck, arms, hands, and wrists. Many tools are used today that are mechanical, but some tasks still need to be done manually. Using a power vacuum to lift large, lighter items such as a pane of glass can remove the need to lift items manually and can take most, if not all, of the strain off of the employee's body. Receiving proper lifting training can also help prevent complications from lifting materials. Best lifting practices include;

not reaching 10-in. away from the body when lifting or setting items down, not twisting the body, lift with the legs and not the back, lift items with two hands, instead of one Using substitution can help with lifting materials as well. Some construction materials are very dense and heavy, substituting these materials for lighter weight materials (such as lightweight concrete blocks) can help reduce body strain during work and lifting tasks. Using skid plates under a concrete-filled hose can help move the hose easily, and can prevent the need for bending and awkward postured on the employee's part.

- Repetitive motion

There are also more fine motor skills that are needed on a construction site and project, and these tasks can cause injuries such as tendinitis, carpal tunnel syndrome, trigger finger epicondylitis, and Hand-arm Vibration (HAVS Substituting tools that do not fit the employee, with moreergonomic tools. Take into consideration the handle, wrist position, handle diameter, and if the tool is spring-loaded. Automated tools such as power caulking guns can help when completing tasks where caulking is needed. Vibrations from power tools can also cause injuries and long-term health effects. Using reduced vibration power tools, or issuing employees anti-vibration gloves can help reduce health effects from tool vibrations.

- High forces

High forces are forces that workers put to lift objects during construction. In Construction, most of the work requires a certain amount of high force required to lift a heavy object. high forces in Construction is not only focused on heavy lifting but can be seen in the pushing, pulling, and gripping of tools. All these can lead to some ergonomic issues that might affect the work.

MUSCULOSKELETAL DISORDERS

Musculoskeletal disorders (MSDs) are injuries or pain in the human musculoskeletal system, including the joints, ligaments, muscles, nerves, tendons, and structures that support limbs, neck and back. MSDs can arise from a sudden exertion (e.g., lifting a heavy object), or they can arise from making the same motions repeatedly repetitive strain, or from repeated exposure to force, vibration, or awkward posture. MSDs can affect many different parts of the body including upper and lower back, neck, shoulders and extremities (arms, legs, feet, and hands). Examples of MSDS include carpal tunnel syndrome, epicondylitis, tendinitis, back pain, tension neck syndrome, and hand-arm vibration syndrome.

The workers maintain the same and often several years, even natural postures like standing can lead to MSDs like low back pain. Postures which are lessnatural, such as twisting of or tension in the upper body, are typically contributors to the development of MSDS due to the unnatural

biomechanical load of these postures. There is evidence that posture contributes to MSDs of the neck shoulder, and back. Repeated motion is another risk factor for MSDS of occupational origin because workers can perform the same movements repeatedly over long periods of time (eg typing leading to carpal tunnel syndrome, lifting heavy objects leading to herniated discs/slipped discs), which can wear or the joints and muscles involved in the motion in question Workers doing repetitive motions at a high pace of work with little recovery time and workers with little to no control ove the timing of motions (e.g. workers on assembly lines) are also prone to MSDS due to the motion of their work. Force needed to perform actions on the job can also be associated with higher MSD risk in workers, because movements which require more force muscles quicker which can lead to injury ance, cap fatigue muscles quicker and/or pain.

Additionally, exposure to vibration (experienced by truck drivers or construction workers, for example) and extreme hot or cold temperatures can affect a worker's ability to judge force and strength, which can lead to development of MSDS Vibration exposure is also associated with hand-arm vibration syndrome, which has symptoms of lack of blood circulation the fingers, nerve compression, tingling, and/or numbness