MODULE 3

Safety Issues in Construction

Introduction to construction industry

- 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

Safety issues in construction

- Safety issues at construction site involves safety during
  - excavation
  - scaffolding
  - formwork
  - working at heights
  - material handling and stacking
  - housekeeping works.
- The recommendations mentioned for safety in construction is based on Occupational Safety and Health Administration(OSHA)

Major safety issues at construction site

Major areas considered for safety consideration at construction site are:

1. Excavation work at construction
2. Housekeeping
3. Scaffolding issues
4. Working at heights

Safety issues with housekeeping at construction site

- Poor housekeeping can result
  - slipping wet or dirty surface
  - accidents from falling objects
  - Presence of loose objects on floors, platforms and stairs

Safety issues in working at heights

- Unstable working surfaces
- failure to use fall protection equipment and accessories
- Human errors

Major hazards of construction

- Falls
- Electrocution
- Being struck by falling objects
- Trapped during excavation

Fall Protection

- Falls are the leading cause of fatalities in the construction industry
- Conditions that required use of fall protection
- A fall from as little as 4-6 feet
  - Can cause loss of work
  - In some cases death

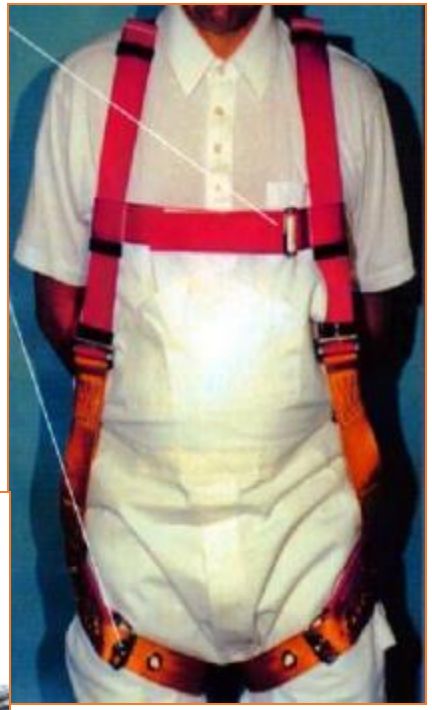
When fall protection is needed?

- Walkways & ramps
- Open sides & edges
- Holes
- Concrete forms & rebar
- Excavations

- Roofs
- Wall openings
- Bricklaying
- Residential Construction

Fall protection and prevention options

- Safety Nets
- Hand Rails
- Safety Harness (PFAS)
- Equipment guards
- *Fall protection systems must be in place before work start*



Personal Fall Arrest System, PFAS

- Must be properly trained
- Key requirements
  - No free fall more than 6 feet
  - Must be inspected prior to use
  - Safety line must be able to support 5000 lbs

Guardrails

- Top rail between 39 to 45 inches tall
- Toeboards at least 3 inches tall
  - Top rail
  - Mid Rail
  - Toe board

Toeboard

- a low protective barrier that is designed to prevent materials, tools, and equipment from falling to a lower level, and protect workers from falling.

Safety Nets

- Used to catch falling workers
- Placed not more than 30 FT below work area
- Placed not more than 8-13 ft from edge of working area

Falling Objects

- Hardhats are required
- Use of canopies is authorized
- Barricade the area to prevent unauthorized entry

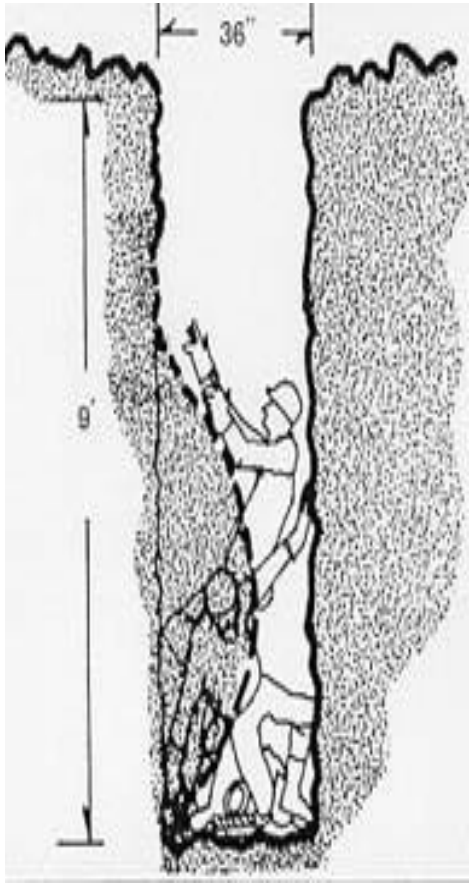
SAFETY ISSUES FOR EXCAVATION AND TRENCHING WORKS

TRENCHING & EXCAVATION HAZARDS

- Risks of excavation
- How to protect employees from cave-ins
- Factors that pose a hazard to employees working in excavation
- Role of competent person

EXCAVATION HAZARDS Risks

- Most hazardous construction operation
- Cave-ins are the greatest risk
  - walls can suddenly collapse without warning, workers do not have time to move out of the way, and cubic yards of dirt can fatally crush and suffocate.
- Most accidents occurred in 5-15 ft deep



EXCAVATION HAZARDS
Employee Protection

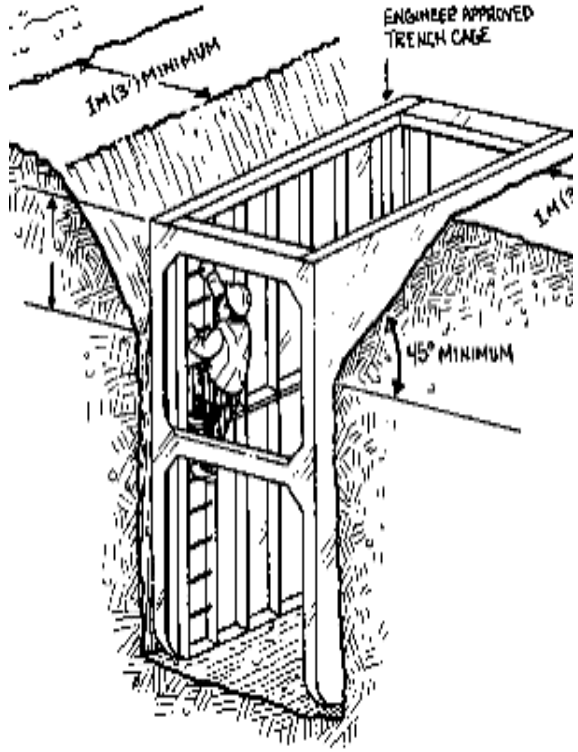
- Employees should be protected from caves-in by using a well designed protective system
- Systems must be able to support expected loads to the system

EXCAVATION HAZARDS
Protective System Design

- A well designed system will have a correct design of sloping and benching systems
- Correct design of support systems
- Handle materials and equipment

EXCAVATION HAZARDS
Employee Protection

- Protect employees from potential cave-ins
  - Slope or bench sides of excavation
  - Supporting the sides of excavation
  - Place shields between the side of the excavation and work area



Factors that pose hazards to employees

- Soil classification
- Depth of cut
- Water content of soil
- Changes due to weather and climate
- Other operations in the vicinity

Types of Protection -Trench Shield

A trench shield was built around this work area

Hydraulic Jacks

Hydraulic Jacks

- Easily dropped in place and adjusted
- Trench pins installed in case of hydraulic failure

Egress Systems

- A stairway, ladder, or ramp must be present in excavations that are 4 or more feet deep, and within 25 feet of the employees
- Must extend 3FT above excavation

EXCAVATION HAZARDS
Competent Person

- Must have given specific training in and be knowledgeable about:
  - Soils classification
  - The use of protective systems
  - The requirements of the standard
- Must be capable of identifying hazards, and authorized to immediately eliminate hazards

EXCAVATION HAZARDS
Competent Person

- A competent person must make daily inspections of excavations, areas around them and protective systems:
  - Before work starts and as needed
  - After rainstorms, high winds or other occurrence which may increase hazards
  - When you can reasonably anticipate an employee will be exposed to hazards.

Safety Practices in Excavation and Trenching Works

- The sides of the excavation must be sloped or benched for easy movement.
- The sides of the excavation must be supported
- The sides of the excavation and the working area must be separated by means of shields
- Protective barricades can be used to avoid falling of soil or rock over the workers
- When mobile equipment is operated adjacent to an excavation , proper a warning system have to be provided
- Keep the workers away during the loading and unloading of the heavy materials
- OSHA recommends the professionals to check the air quality levels during the cave ins

Safety Issues in 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 affect on the work actually being done, plus he needs to use special breathing equipment.
- Some of the work can be on bridges, power stations, ships, submarines, marinas, etc.
- Each type of job will have its own special requirements.
- Diving poses a unique risk, because if a problem arises the diver's life could be in immediate danger.

Safety Precautions

- Extreme familiarity with their diving 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.

Underpinning of foundations of existing building

- **Definition**
  - It is a process of improving and strengthening existing foundation
  - It facilitates to support structure and assist in transferring loads to better soil strata
- **Necessity**
  - Occurrence of excessive settlement
  - Increasing load bearing capacity of foundation
    - Change of functional use
    - Addition in loading pattern
  - Permitting to lower adjacent ground below existing foundation
  - Construction of new basement nearby

Underpinning

- **Operation to be carried out before underpinning**
  - Survey of structure
  - Marking of Settlement if any
  - Noticing neighbors (adjacent building)
  - Setting indicators to identify probable cracks while underpinning
  - Carrying out corrective measures for cracks etc.
  - Investigate sub-soil

Underpinning

- **Sequences of operation**
  - Suitable holes driven through the wall and a needle beam is inserted & supported on the jack
  - Excavation is started below foundation and footing of the foundation is reached
  - The offset of the foundation is cutoff and removed & excavation is reached to the defined depth
  - New foundation is laid in the desired depth up to the underside of the existing foundation
  - This process is repeated in stages
  - Final layer of pinning work just underside of existing foundation should be done with the mortar from rapid hardening cement
- **Precautions**
  - Excavation in one time done for less than one fourth of length, for weak soil it is done for less than one fifth to one seventh of length, normally length of one bay is taken as 1.5 m
  - To be carried out slowly in stages and not at a time

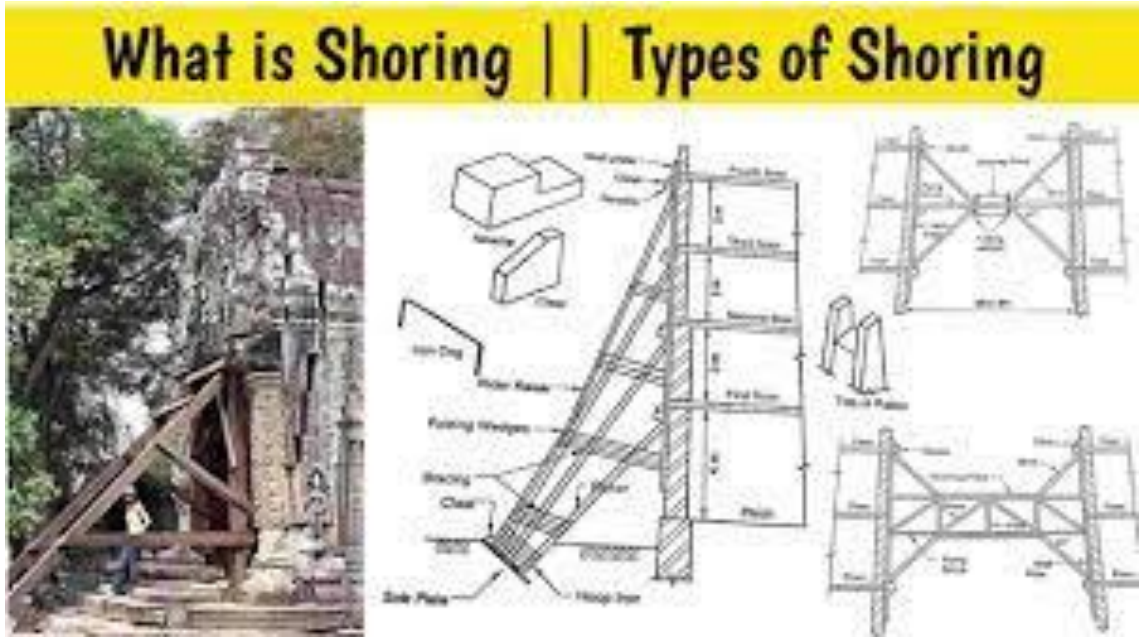
PRECAUTIONARY MEASURES

Before implementing appropriate underpinning measures the following important points should be carefully attended:

- The existing structure should be fully examined carefully and appropriate underpinning method should be adopted.
- All poor masonry work, such as joints, cracks, plastering should be rectified before.
- Necessary shoring and struting should be done such that existing structure is safe.
- Urgent repair like grouting of cracks, insertion of rod between walls , etc. should be carried out before commencing underpinning.
- Adequate care should be taken to ensure that there should be no movement of structure for which levels should be marked.
- Underpinning process is not a science but an art should be exercised depending on the situation.

Basics of Shoring Safety

- Shoring systems are used to support structures to prevent them from collapsing during construction.
- Shoring is most commonly used during the earliest phases of construction; when walls or structures are undergoing reinforcement, during excavation, or when a nearby structure needs to be demolished
- Shoring systems usually support either buildings or trenches. For buildings, a shoring system such as piles and lagging support the surrounding loads until the underground levels of the building are completed and can bear the weight of the rest of the building.
- For trenches, the shoring system steadies the trench walls to prevent cave-ins and keep workers safe.



General guidelines that cover the basics of shoring safety:

When installing and using shoring, it's vital to follow all state, provincial, local, and federal regulations to ensure worker safety.

1. **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.
2. Plan the shoring's installation in advance.
    - This includes ensuring that the **right equipment is available to safety finish the work.**
3. **Inspect all equipment before use.**
    - If a defect is found, the affected item should be removed and repaired. Defective equipment should never be used.
4. **Obtain a shoring drawing from a qualified professional.**
    - The drawing should be used onsite at all times.
5. Handle the shoring equipment with care, and **only use the equipment as it was intended.**

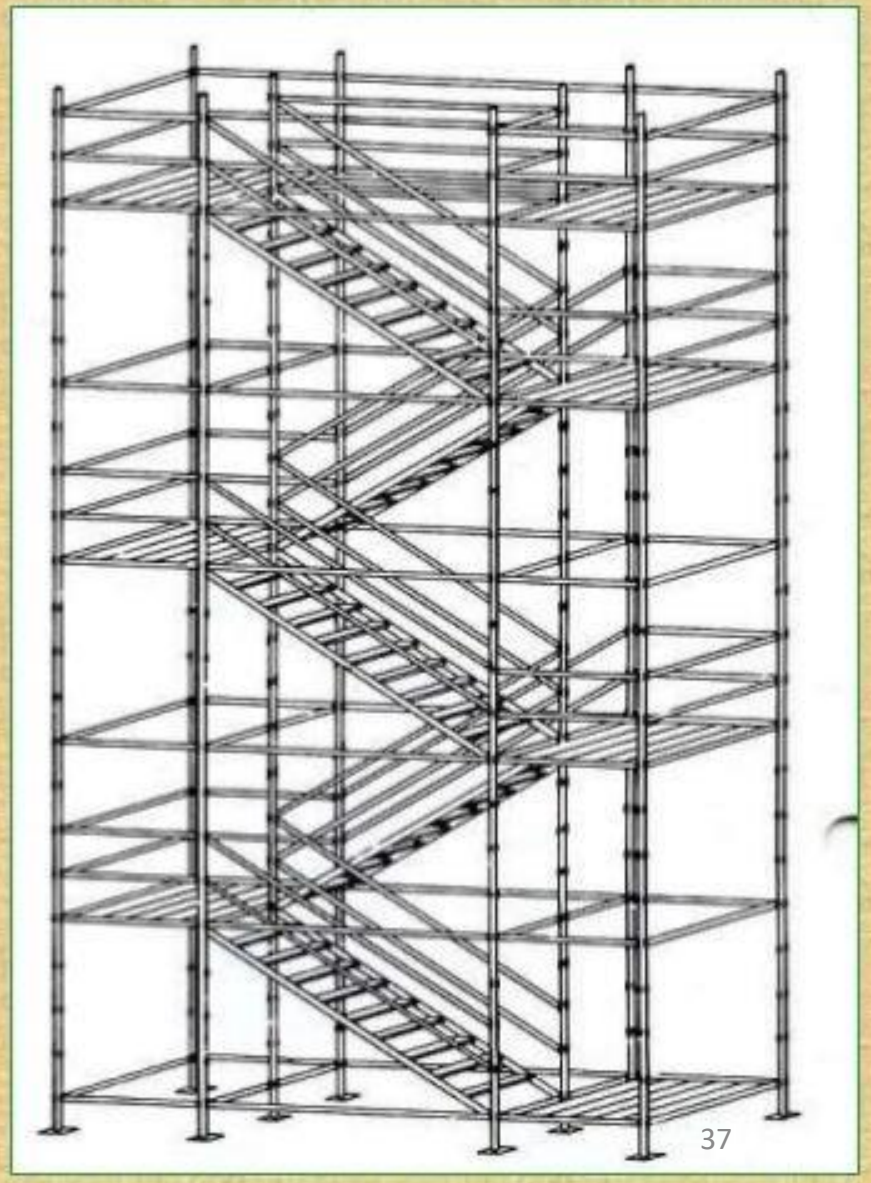
6. Don’t erect, dismantle or alter the shoring equipment without the approval of a qualified supervisor.
7. Inspect the shoring system through the duration of a project. If there’s any doubt about the safety of the shoring, **stop use immediately and contact a qualified supervisor.**
8. **Shoring systems should not be used for fall protection.** Workers should not use shoring systems if they feel dizzy or lightheaded.
9. Do not climb on the cross braces.
10. Periodically adjust uneven grade conditions, and plumb and level shoring frames as the erection proceeds. Do not force braces on frames; level the shoring towers for the proper fit.
11. **Follow proper safety practices during dismantling.** Nothing should be

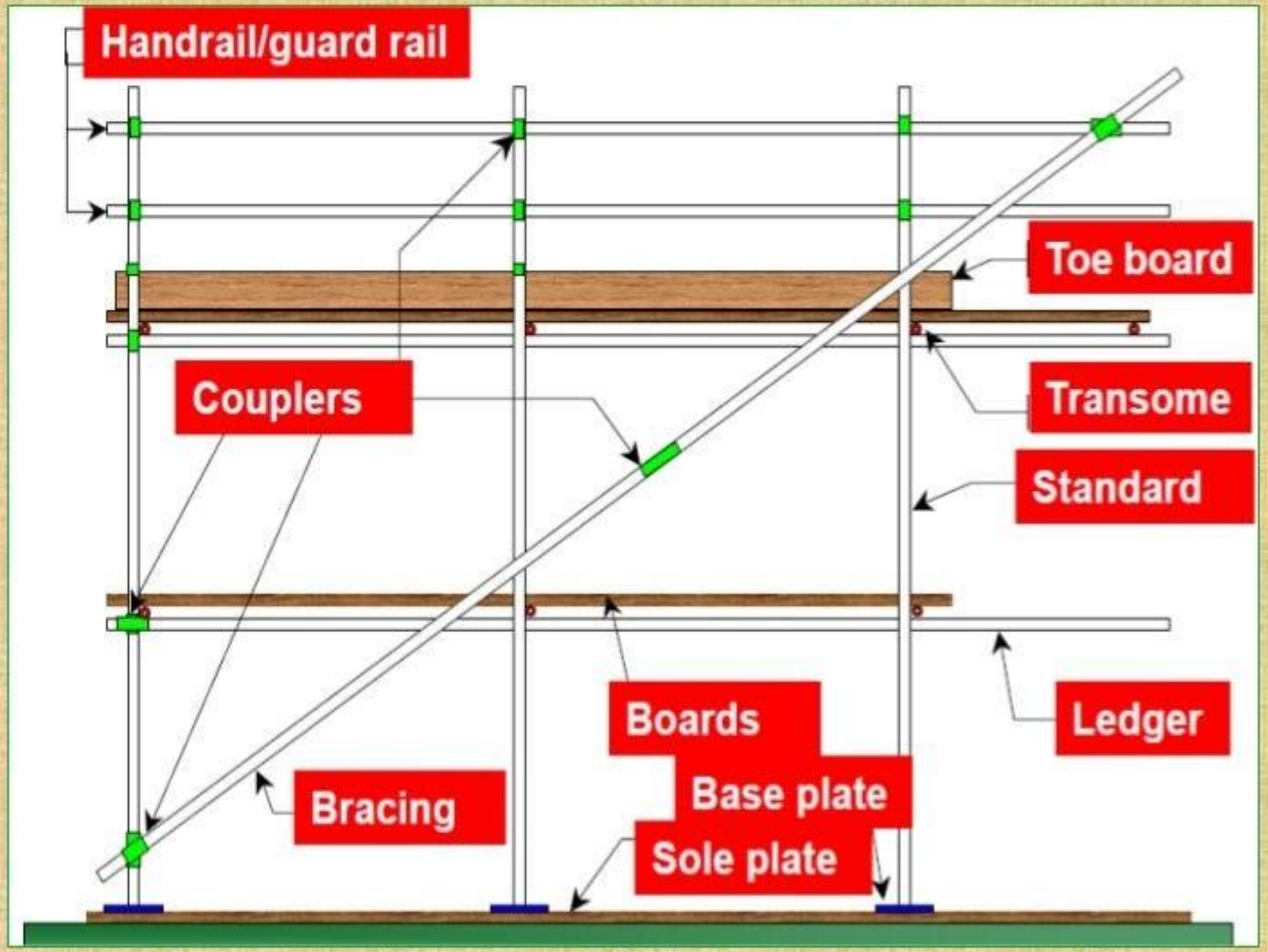
Definition of Scaffolding

Definition:
A scaffold is any temporary, elevated work platform and its supporting structure used for holding people, materials, or both. Scaffolding is used in new construction, renovation, maintenance and repairs.

OSHA categorizes scaffolds into three basic types:

1. Supported scaffolds
2. Suspended scaffolds
3. Other scaffolds





1. Supported scaffolds:

Platforms supported by rigid, load bearing members, such as poles, legs, frames, & outriggers

2. Suspended scaffolds:

Platforms suspended by ropes or other non-rigid, overhead support

Introduction of Scaffolding

- It should be understood that scaffolding is an extremely important precise structure in which intelligence will never fail.
- A lot of this misuse could be avoided by stricter supervision on site.
- Safety should be every one's business from management down to workers.
- Accidents not only cause injury and pain, they can also kill.
- And there is always the loss of productivity to be considered.
- The accident involving scaffolding are not always due to faulty construction but also misuse and by being tampered with inexperienced people.

Hazards In Scaffolding

The major faults that arise are the following:

- Removing boards from working platforms
- Taking braces out at the platform levels.
- Removing handrails and toe boards.
- Taking ladders away from their original locations.
- Failing to stack materials properly.
- Employees working on scaffolds are exposed to these hazards:
  - Falls from elevation
  - Struck by falling tools /debris
  - Electrocution
  - Scaffold collapse
  - Planking failure

Safety Practices in Scaffolding Works

- The scaffolding must be erected on a solid footing with proper foot bearing plates
- The scaffolding used must be strong and rigid
- The scaffolding must carry its dead weight and almost 4 times the maximum load coming over it. This must be carried without any form of displacement or settlement.
- Scaffolding must not be supported by means of boxes, loose bricks or any other unstable objects
- Any repair or damage to the scaffolding accessories like braces, screw legs, ladders or trusses have to be repaired and replaced.
- Access to the scaffolding is provided through ladders and stairwells
- The natural and synthetic ropes used in suspension scaffolding must not interrupt with heat or electricity producing sources.
- A minimum of 10 feet have to be maintained between the scaffolding and the electric lines.
- Scaffolding construction must be inspected by a competent person. The unit must be erected, moved or dismantled with the guidance and supervision of this competent person.

Safety In Scaffolding

- Be Wise
- Be Safe And Never Sorry
- Ignorance Is No Moral Defence
- Do Not Stand:
  - On Ties,
  - Guardrails,
  - Or Extensions
- Do Not Overreach Outside The Guardrails
- Stay Off Scaffold During Loading Or Unloading
- Replace Guardrails After Loading Or Unloading
- Use 3-point Climbing
- Don’t Hang Tarps Without Evaluation
- Exit Mobile Scaffolds Before Moved
- Always Wear Fall Protection To Avoid Accidents

Scaffolding General requirements

1. Footing or Anchorage

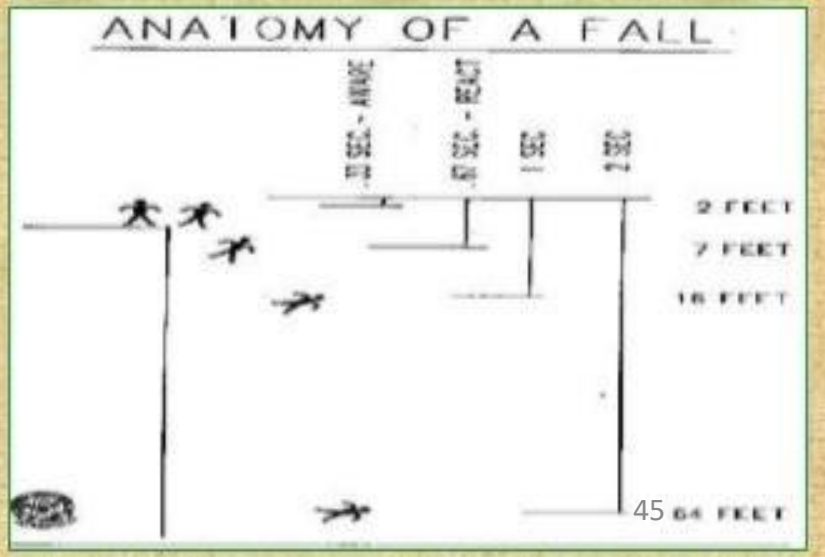
- The footing or anchorage is to be on a solid foundation; sound, rigid, and capable of carrying the maximum intended load without settling or displacement.

- The use of unstable objects to support planks or scaffolds is prohibited.

Scaffolding General requirements Cont…

2. Guardrails

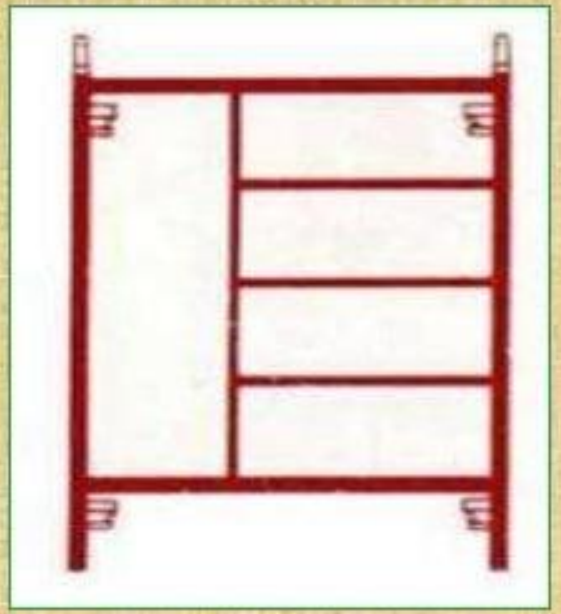
- The use of guardrails is very important, preventing workers from falling. Nearly 3/4 of the reported scaffold accidents are caused by improper guarding.
- Open-ended or open-sided platforms must have standard guardrails and toe boards.
- The guardrails are to be 2 X 4 and about 42” high with a mid rail whenever needed. The supports for the guardrails are to be at intervals no more than 8 feet.



Scaffolding General requirements Cont…

3. Safe Access

- Must have safe access
- Cross-braces prohibited as means of access
- Bottom rung no more than 24’ high
- Rest platforms required at 35’ intervals
- Slip-resistant treads on all steps and landings
- Hook-on attachable ladders
  - Specifically designed for type of scaffold
  - Lowest rung no more than 24 inches above level on which scaffold is supported
  - Rest platforms at 35 foot intervals when more than 35 feet high
  - Minimum rung length 11 ½ inches, and a maximum space between rungs 16 ¾ inches



Ladder and Access Platforms

- Ladders
- Foundation must be firm and level
- Angle of about 75 degree
- 4 vertical to 1 horizontal
- Projecting at least 1.05 meter

Scaffolding General requirements Cont…

4. Protective Screening

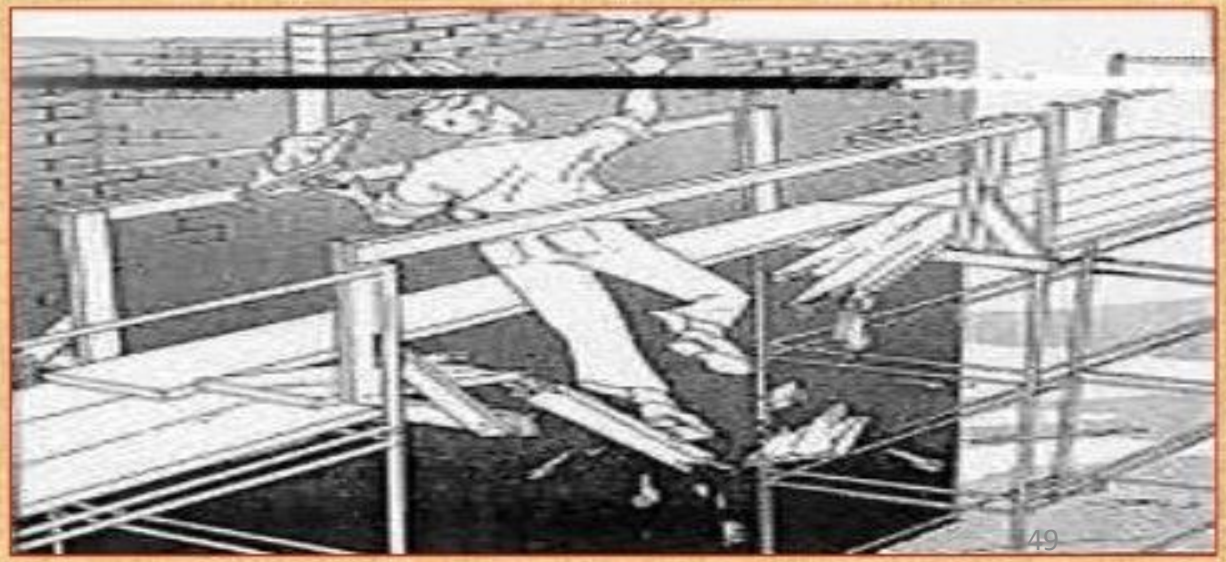
- Overhead protection shall be provided for men on scaffolds and, in the same sense, a screen is to be placed below the scaffold where persons may in danger of falling objects.

Scaffolding General requirements Cont…

5. Safe Platforms

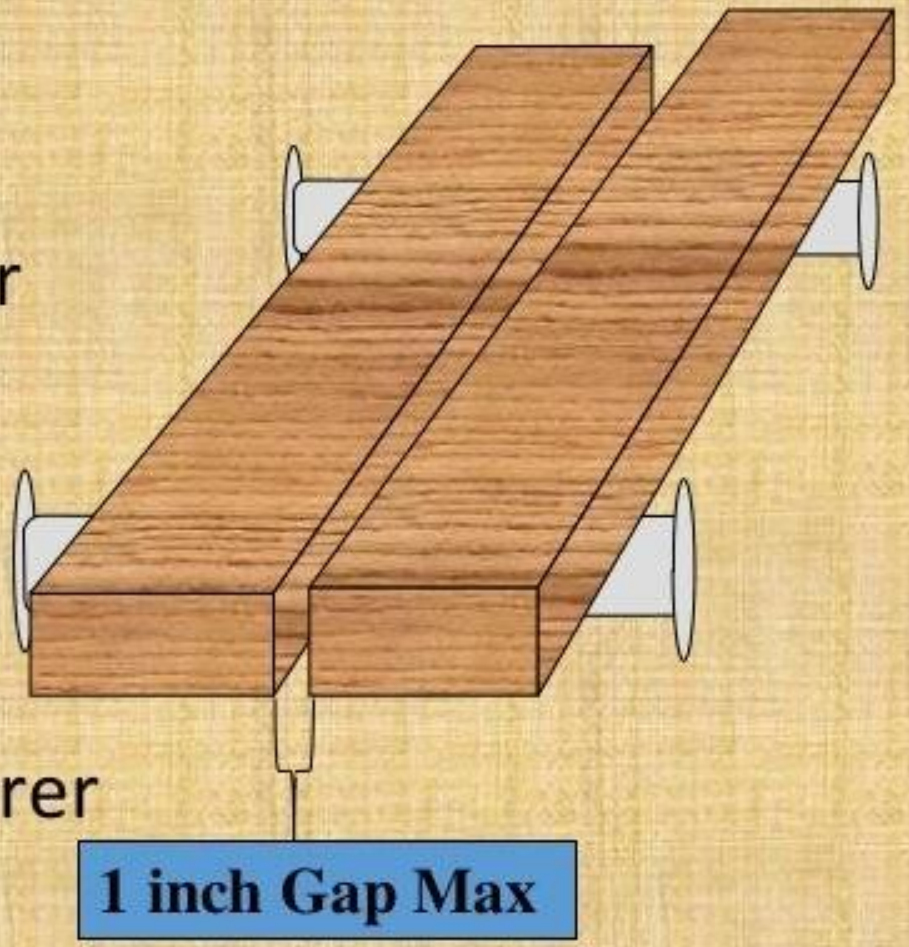
- The planking is to be of Scaffold Grade wood or metal, free of defects that may contribute to an accident.

- The planking shall be overlapping or secured from movement, extending not less than 6 nor more than 12” over their end supports



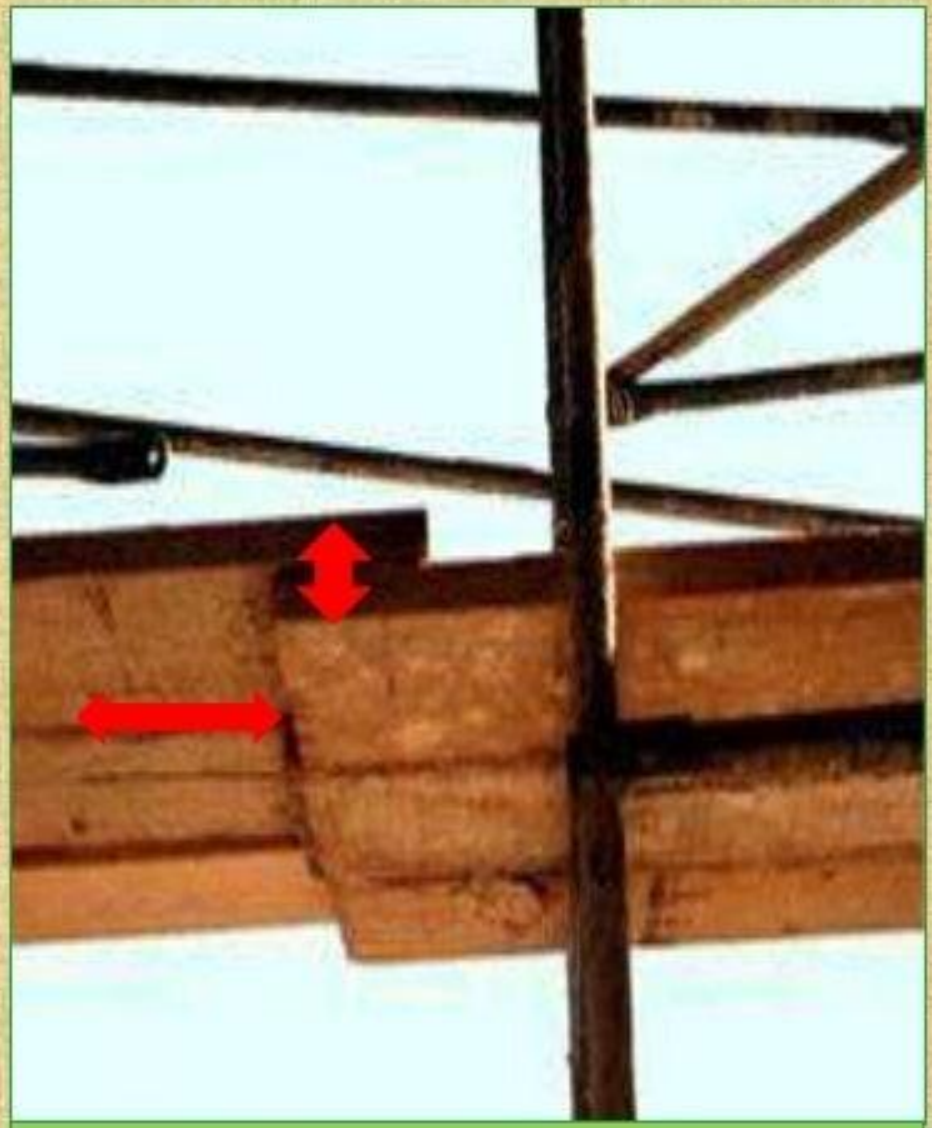
Scaffolding General requirements Cont…

- vertical members standing perpendicular to horizon
- Fully planked or decked with gaps no greater than 1 inch
- Able to support its weight and 4 times the maximum load
- At least 18 inches wide
- Scaffold should design by temporary structurer



Scaffolding General requirements Cont…

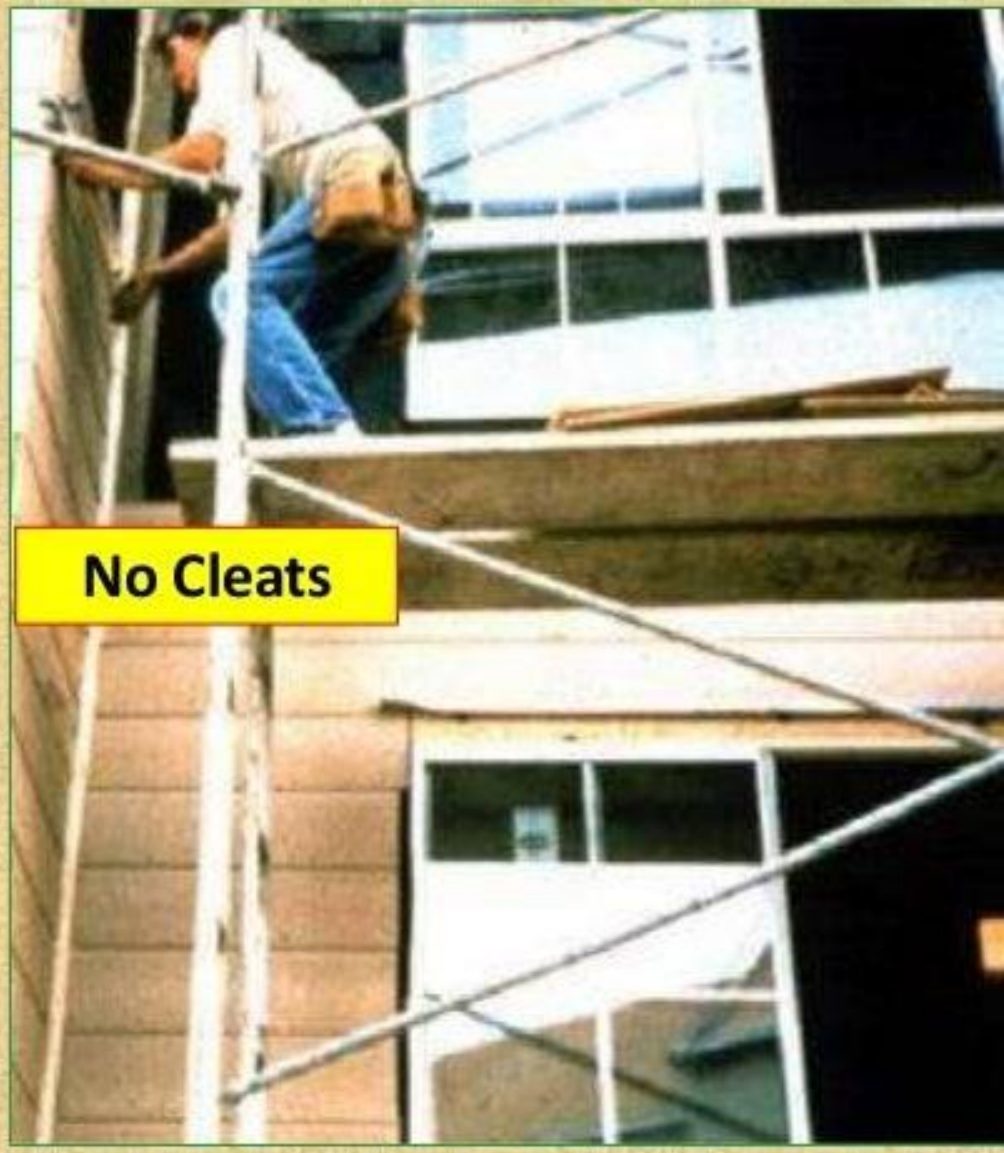
- No paint on wood platforms
- Use scaffold grade wood
- Fully planked between front upright and guardrail support
- Component pieces used must match and be of the same type
- Erect on stable and level ground
- It should be nailed properly, otherwise it maybe toppled.



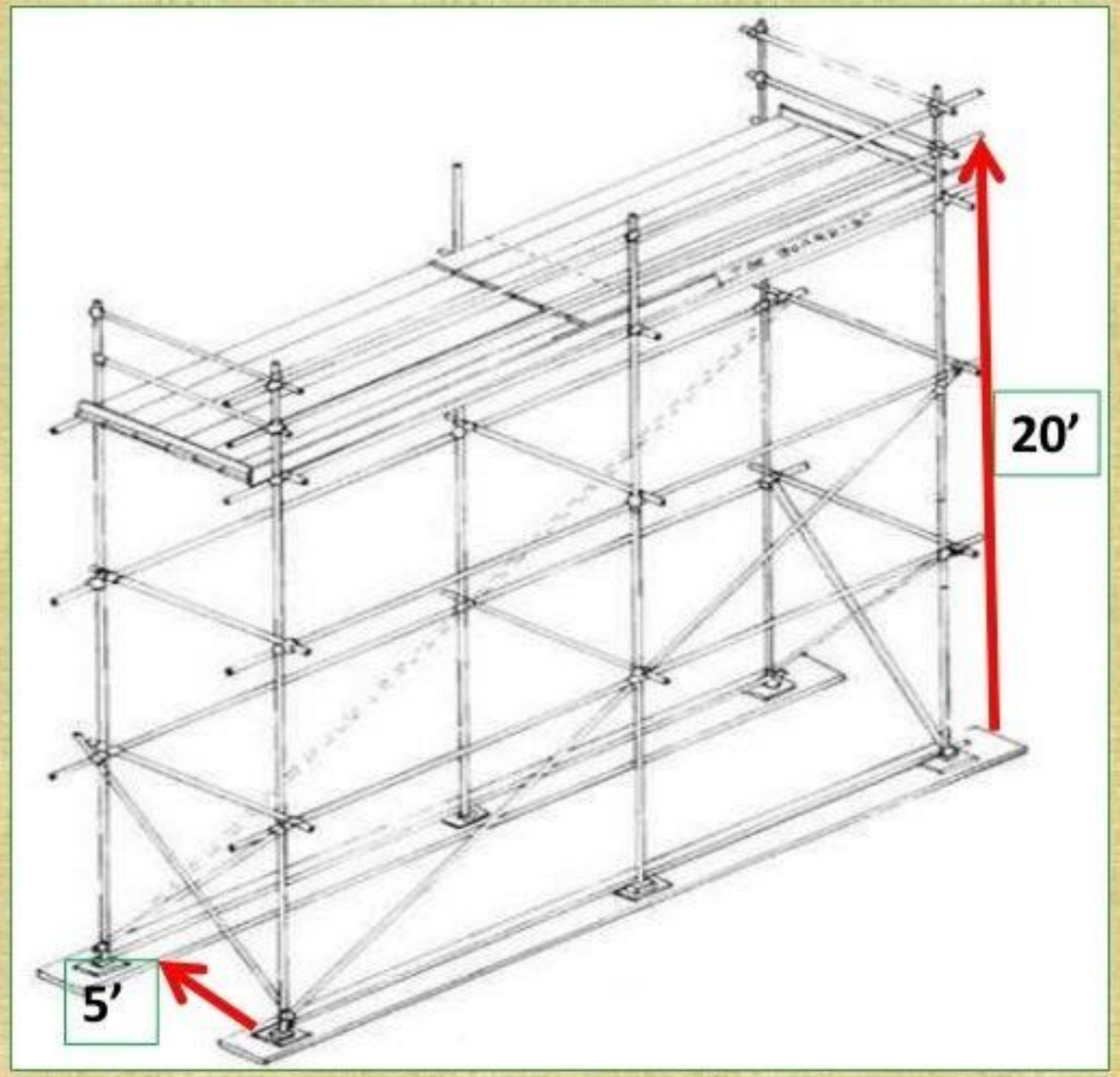
Planks not properly overlapped

Platform Ends

- Each end of a platform, unless cleated or otherwise restrained by hooks, must extend over its support by at least 6 inches
- Side and end brackets are designed to support people ONLY.
- Do not overload platforms with materials.



Scaffold Height



- The height of the scaffold should not be more than four times its minimum base dimension unless guys, ties, or braces are used.
- With a width of 5’, this scaffold cannot be higher than 20’.

Supported Scaffolds

- Platforms supported by legs, outrigger beams, brackets, poles, uprights, posts, & frames.
- Restrain from tipping by guys, ties, or braces.
- Scaffold poles, legs, posts, frames, and uprights must be on base plates and mud sills or other firm foundation

Good support

Not so good support

Unacceptable support foundation.

Ladder safety

- Ladders can pose serious potential for a fall if used improperly or in an unsafe manner.

- OSHA estimates that, for general industry companies, falls from ladders account for 20% of fatal and lost workday injuries.

Ladder setup

First, choose the right ladder.

Questions to ask

- What height will I have to reach and work at?
- What should I check before using the ladder?
- What type of material should it be made of?

Ladder setup

Ladder inspection

Ladder label

Skid resistant footing

Free of defects

Free of slipping hazards

Ladder inspection

- Check the label for maximum standing height, whether or not they are made of conductive material and the ladder duty rating listed on the label to determine whether the ladder is stable and strong enough to support the job.

- Also, ladders should have skid resistant footing such as cleats or rubber pads.

- Ladders with loose, broken, or missing rungs, split or bent side rails or other defects, must be discarded immediately. If you simply tag a defected ladder it may be put back into use at some point and the tag removed.

- Additionally, ladders should be free of any oil, paint or other material that makes a complete inspection impossible. If it’s not, do not use the ladder.

Safe use of ladders

Ensuring the ladder is secure

Folding ladders

- Folding or A-frame ladders should be fully extended and the arms locked into place.
- Be careful of pinch points which are any places where parts come together and present a possibility for injury.
- Never use a step ladder as an extension ladder

Safe use of ladders

Ensuring the ladder is secure

- Extension ladders need to have non-slip bases or spikes.
- The proper use of straight or extension ladders requires the user to place the ladder in such a manner as to prevent the ladder from sliding/falling.
- The ladder base should be 1 foot out for every 4 feet up; it should extend 3 feet above the roofline.

Extension ladders

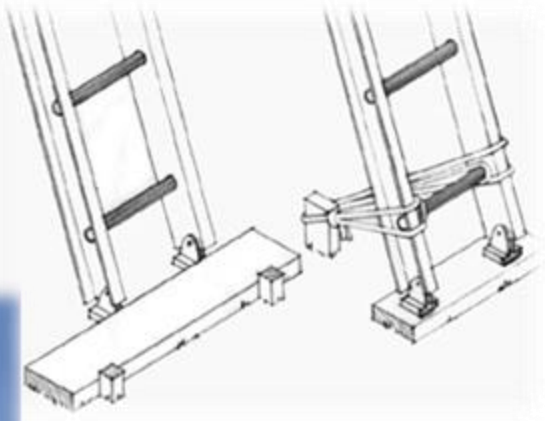
Safe use of ladders

Working safely from ladders

- Never step above the labeled maximum height on your ladder.
- The “belt buckle rule”; keep your body centered between the rails of the ladder at all times.
- Always face the ladder and use the 3 point rule when climbing or descending.

Additional safety tips

- The base of a ladder must rest on a firm, level footing.
- If working on uneven levels, use an extension to level out your ladder.
- Ladders must be tied, blocked, or otherwise secured to prevent them from slipping.
- Avoid setting up a ladder in a doorway or other high traffic areas.
- Additionally stabilizers can be used to secure them while working



Additional safety tips

- Do not leave a ladder unattended.
- Never try to combine or tie ladders together or stack them on anything other than the ground.
- Ensure all ladder locks are engaged before using.
- Never climb an extension ladder while hand-carrying tools or material

TUNNELLING

- Tunneling work is widely carried out in the construction of railway, road projects and irrigation
- This work is specialized and hazardous because of cramped working space wet and slippery flooring, artificial lighting. Usually characterized by inadequate, ventilation, obnoxious gases, unseen weaknesses of rock, handling of explosives, hauling muck, etc, leading to accidents.

HAZARDS IN TUNNELLING AND UNDERGROUND WORKS

The hazards involved in tunneling and underground works arise due to the following operations:

i. Drilling ii. Explosives and blasting

iii. Mucking plant and equipment. iv. Supporting the excavation

i) Drilling Operations:

- Drilling equipment has to be kept in good condition.
- Only wet drilling shall be permitted.
- Drill platforms shall be built and maintained to provide safe working conditions.
- Suitable railing around the top deck Drill platforms
- To make sure that there are no misfired charges, which the drill may strike drill, drilling shall not be resumed after blasts .
- Charging of drilled holes and drilling shall not be carried out simultaneously in the same area.

ii) Explosives and blasting:

- All precautions are to be taken as specified in Handling of Explosives .

iii) Mucking plant and equipment:

- After blasting inside a tunnel or a shaft, the roof and walls of the tunnel and sides of the shaft should be inspected by a tunnel foreman.
- Scaling shall be performed only by the experienced crews under the direct supervision of a competent supervisor.
- Adequate support (rock bolts or timber or steel supports with proper lagging) to be provided , if the structure of the rock is weak, poor or structurally defective.
- Prolonged time interval between the two operations to be avoided as the risk of accidents increases with such delays.

iv. Supporting the excavation:

- After the mucking operation is over, the profile of excavation should be examined by an experienced person who should decide whether the support in the form of rock bolts, steel ribs or shot-concrete is required before any further operation is carried out.
- In case of rock bolts, safety measures for drilling the holes should observed before the bolts are fixed. The normal precautions for the erection of steel works including those of welding, should be taken in the case of steel ribs.

GENERAL SAFETY PRECAUTIONS IN TUNNELLING

1. Guidance of competent foreman is a must for all operations to be carried out inside the tunnel.
2. Adequate ventilation is required to remove polluted air, gases and smoke produced.
3. Temperatures of not more than 40^{0}C dry and 29^{0}C wet at the working place to be ensured.
4. The tests shall be carried out once after every blast or a major rock-fall or at least every 24 hours once.
5. Tests of gases and for temperature measurements and ventilation measurements shall be recorded properly maintained.
6. Adequate steps shall be taken to prevent the liberation, accumulation and the propagation of air-borne dust.

8. Adequate supply of pure and hygienic air to be maintained .
9. The volume of air required shall depend on the following:

   a) Length of heading b) Size of tunnel. c) Type and amount of explosives used, d) Frequency of blasting, and e) Temperature and humidity.

10. Electric power shall used. Whenever diesel engines are used, they shall be provided with suitable filters, scrubbers, etc, to remove all carbon monoxide and oxides of nitrogen, etc. Petrol engines shall not be used.
11. Rocker or cradle type dump cars shall be provided with a positive type lock to prevent accidental dumping in mucking yards.
12. The trolley tracks to be laid with points, crossings and junctions and also adequately maintained.
13. Blocks or buffers shall be provided at end of each track.

14. Trains shall be operated with care and at a speed under control of the operator at all times.
15. A man shall ride in the front equipped with a whistle and a flash light for warning men along the track and for signaling the locomotive operator, If the locomotive is pushing a string of cars .
16. Head light on each end and a whistle or horn with a tone of sufficient volume shall be provided for locomotives.
17. The scaffolding supporting the pipe shall be designed to carry the pipe when filled with concrete plus 100 percent overload plus the estimated weight of the maximum number of workmen that may work on the pipes while the pump is operating. A factor safety of 4 shall then be used.
18. The pipe line shall be anchored at all curves and near the end.
19. Proper system of communication should be maintained.
20. Adequate fire protection facility to be provided.
21. Shelter places for workmen shall be provided at suitable intervals in long tunnels.

BLASTING

- 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 before Blasting

1. The blasting operations shall be carried out under the supervision of a responsible authorized blasting engineer.
2. In case of blasting with dynamite, the position of all the boreholes to be drilled shall be marked in circles with white paint.
3. The boreholes shall be of a size that facilitates the easy passage of cartridge.
4. After the drilling operation, the engineer shall inspect the holes to ensure that only the marked locations have been drilled, and no extra hole has been drilled.
5. The engineer shall then prepare the necessary charge separately for each borehole.
6. The boreholes shall be cleaned thoroughly before the insertion of the cartridge.
7. For tamping, only cylindrical wooden tamping rods shall be used. Metal rods with pointed ends shall never be used for tamping.
8. Each cartridge shall be placed in the borehole and gently pressed but not rammed down.
9. Cartridges shall be added as required to make up the necessary charge for the borehole.
10. The topmost cartridges shall be connected to the detonator, which shall, in turn, be connected to the safety fuses of the required length.

11. The fuses of the required length shall be cut and inserted into the holes.
12. The fuses shall be free of joints but if found unavoidable, a semi-circular nitch shall be cut off from one piece of fuse from the end and inserted into the notch of the other fuse.
13. The joint pieces of the fuse shall then be wrapped together with string.
14. All joints of the fuses exposed to dampness shall be wrapped with rubber tape.
15. The maximum of eight boreholes shall be loaded and fired at one go.
16. The charges shall not be fired simultaneously but successively.
17. Immediately before firing, a warning shall be given, and the engineer shall see that all the workers have retired to a place of safety.
18. The safety fuses of the charged holes shall only be ignited in the presence of the engineer.
19. The required count before each blast shall be set by the engineer and others.
20. After all the charged boreholes have exploded, the engineer shall inspect the site for anomalies.

Safety Precautions while Blasting

1. For the safety of workers, red flags shall be prominently displayed around the area where blasting operations are to be carried out.
2. All the workers at the site shall withdraw to a safe distance of at least 200 meters from the blasting site.
3. An audio warning by blowing whistle shall be given before igniting the fuse.
4. The blasting operation shall be carried out under the supervision of trained personnel.
5. The blasting shall not be done within 200m of an existing structure unless permitted explicitly by the engineer in writing.
6. 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 the region and country code.

Demolition or Dismantling

- Refers to breaking up of buildings , structures either fully or partially.
- Precautions during demolition has three goals:
  1. specifically aimed at safeguarding the personnel on the site.
  2. safeguarding of persons not connected with demolition including the general public
  3. the protection of the property likely to be effected by demolition operation.

•The causes of accidents to workers involved with demolition are:

- Fall from heights, falling materials, inadequate access, over-fragile materials etc.

•Premature collapses due to incorrect dismantling, over loading or excessive pre- weakening feature particularly during demolition.

SAFETY PRECAUTIONS

Any demolition work should be proceeded by

(a) Site survey which should be comprehensive

(b) Decide on the location and position of screens, scaffolds etc.,

(c) Protection of the public

(d) Methods to protect surrounding buildings from the danger of collapse.

(e) Electric power to all services within the structures should be shut off. Similarly all)

(f) Gas, water and steam service lines should be shut off.

(g) The structure to be demolish should be adequately fenced and cordoned off

(h) Display boards to be displayed prominently warning the public of the danger.

(i) Glass in doors and windows, loose objects and projecting parts to be removed.

SAFETY MEASURES IN DEMOLITION OF THE BUILDINGS:

1. Workers should not be deployed at different levels unless adequate precautions are taken to ensure safety of them
2. Demolition work should begin at the top of the structure and proceed downwards. .
3. Masonry concrete and other dismantled materials should not be allowed to accumulate in quantities which may endanger the stability of any floor or structural support.
4. Part of the structures, where necessary should be adequately shored, braced or otherwise supported.
5. If the structure is to be demolished by explosives, all safety measures pertaining to explosives such as transport, storage, handling, loading firing etc. should be strictly adhered to.
6. Foundation walls serving as retaining walls to support of adjoining structures should not be demolish until the adjoining structure have been under pinned or braced or earth supported by sheet pilling.

7. Stairs with hand railing should be kept in place as long as practicable to provide access and egress.
8. If the work of demolition is continued in night, all passageways, stairs and other parts of the structure where the workers have to pass and also to work should be adequately lit.
9. Workers should wear strictly safety belts, safety belts, safety helmets and hand glove.
10. If the demolition is carried out by machines such as power shovels, bulldozers etc. the safety measures relevant to operation and use of such machines should be adhered to.
11. If swinging weight such as ball is used for demolition, a safety zone having a width of at least 1.50 times the height of the building or structure should be maintained.
12. Scaffolds used for demolition operations should be independent of the structure to be demolished.
13. If ladders are used for demolition, only travelling mechanical ladders should be used.
14. The hoists or chutes, whenever it is practicable, should be used to lower the materials. Materials chutes should have a gate at the bottom with suitable means for regulating the flow of materials.

Common confined space hazards

- Work in confined spaces can create a risk of death or serious injury.
- This could be from exposure to hazardous substances or dangerous conditions such as lack of oxygen or a build up of water.

Examples include

- pits and trenches
- sewers and drains
- vats, silos and tanks
- chambers and ducting
- unventilated or poorly ventilated rooms.

Hazards when working in confined spaces include

- lack of oxygen
- lack of natural light
- dusts in high concentrations such as flour
- liquids and solids suddenly filling the space
- hot working conditions increasing body heat.

There is a risk with gas, fumes or vapours filling the space as these can be flammable or poisonous.

Before you conduct any work in Confined Spaces

- Before conducting any work in potentially confined spaces, you should read and understand the Health and Safety Executive's regulations and guidance. If you are uncertain, seek professional help.
- You may need to appoint competent people to help manage the risks and ensure that employees are adequately trained and instructed.
- Carry out a risk assessment
- Where entry to a confined space is unavoidable, a thorough risk assessment should be carried out to devise a safe system of work. You should consider the

  - duration
  - task being performed
  - training requirements
  - physical effort required
  - suitability of those carrying out the task including their health
  - number of those involved, inside and outside the confined space, and rescue teams.

You should also consider the working environment, including

- access
- lighting
- lack of oxygen
- by-products of the task being undertaken, for example welding fumes
- communication methods for raising an alarm and any evacuation difficulties.

Working materials also need to be considered. This includes

- fire or spark risk
- waste removal
- fume ventilation
- tools needed and their access.

Confined Space Safety Precautions

- If practically possible, avoid entry to confined spaces.
- Establish if the work is really necessary or if it can be done in another way that avoids the need to enter.
- If entry to a confined space is unavoidable then you must follow a safe system of work.
- Have emergency procedures in place before work starts.
- The results of your risk assessment will help you identify the risks and necessary precautions.

Confined Space Safety Precautions (contd.)

Safe systems of work

- Make sure you have all the relevant information, knowledge and experience to carry out the work.
- There needs to be a site specific method statement in place for all employees to adhere to before the work is carried out.
- You may need to have a permit to work system in place.

Confined Space Safety Precautions (contd.)

Ventilation

- You will need to ensure there is suitable ventilation within the workplace. You may have to introduce temporary ventilation before you start.
- If the area has restricted or no natural air supply you may have to use breathing apparatus to provide an air supply to the user.

Isolation

You may need to isolate local utilities to allow your employees to work safely such as

- gas
- water
- electricity.

Confined Space Safety Precautions (contd.)

Personal Protective Equipment (PPE)

- Ensure all your employees have suitable PPE to undertake the work.
- Care should be taken to ensure that the PPE used does not introduce other hazards.

  These can include overheating or restricting communication or movement.
- Ensure your employees have proper
  - head, hand and foot protection
  - eye and hearing protection
  - waterproof and thermal clothing
  - respirators and breathing apparatus
  - appropriate safety harnesses.

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Confined Space Safety Precautions (contd.)

Emergency procedures

- Put emergency arrangements in place before any work starts.
- You must put suitable and sufficient measures in place to make sure employees can be rescued safely if required. You should also consider
  - first aid procedures
  - the safety of rescuers
  - liaison with emergency services.

They must be appropriate to the hazard presented by the activity.

- There must be an effective means of communication for raising the alarm both from the confined space and by someone outside.
- Work in confined spaces is often carried out at night, weekends and times when the premises are closed, for example holidays. Consider how the alarm can be raised.
- Provide rescue and resuscitation equipment. This will depend on the likely emergencies identified.
- It may be necessary to shut down any adjacent plant before attempting emergency rescue. Ensure access and a means to safely shut down is available.
- Consider how the local emergency services would be made aware of an incident. Plan what their route of access is. Also consider what information about the dangers need to be given to them on their arrival.

Confined Space Safety Precautions (contd.)

Rescuers

Those who are identified as rescuers need to be

- ready at hand
- properly trained
- fit to carry out their task
- protected against the cause of the emergency
- capable of using any equipment provided for rescue, for example breathing apparatus, lifelines and fire-fighting equipment.

Training

Training is critical in all work with confined spaces. Ensure that all employees are given suitable and appropriate training to carry out the workplace task. This will include emergency procedures and if required training in the use of breathing apparatus.

Safety in temporary structures

- Temporary works are constructions that will not be a permanent structure, but instead are necessary either to create infrastructure of the site (e.g. bridges, tunnels etc.) or as part of the construction of the permanent feature such as scaffolding or a necessary support structure.
- Temporary works usually fall under the category of earthworks, structures or the foundations or equipment such as cranes.
- Temporary works can also include structures which are only needed to be in place for a short period of time.
- Eg: temporary seating stands which are only needed for one-off event and then will need to be dismantled and removed once the event has taken place

Safety guideline for Construction of temporary structures

- Build the structure on a stable ground
- Use non-flammable fabrics
- Make sure there is sufficient time and resources available to build and dismantle the structure safely.
- Build the structure to the agreed design in accordance with a safe system of work.

National Building Code of India(NBC)

- NBC is a document that provides guidelines for construction of structures – residential, mercantile, institutional, educational, commercial, assembly, storage spaces 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 residents

Types of Residential Buildings

- As per NBC residential buildings include any building that is equipped with sleeping normal residential 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 provided with an impermeable floor
- The kitchen must open into an interior or exterior open space and should not less than one metre.
- The kitchen should not open into a shaft.
- No chutes to used in buildings above 13 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 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 enclosed by partitions/walls,provided with an impervious surface with a height 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 used as a toilet only.
  - These rooms must 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 Patio (FAR).
- In the absence of a sewage outlet, a septic tank must be provided.

NBC guidelines related to basements

- The minimum height of the basement should 2.5 metres and the maximum height 4.5 metres.
- The celling 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 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 road
  - It should be accessed only from the main entrance or an alternative staircase that provides access to building
- Only when a projecting basement is flush with the ground, or if authority allows, can the basement be permitted to touch the adjacent property

NBC guidelines related to building exits

- 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 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 for staircases in residential buildings

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

NBC guidelines regarding fire safety

- In large buildings where accidents due to fire may not be noticed, automatic fire detection and alarm facilities are a must and should provided.
- Such buildings should provided with and protected by fire extinguishers, wet risers, automatic sprinkler installations, etc,
  - These shall be in accordance with the set standards.
- The guidelines for fire drills and evacuations for high-rise buildings are specified in NBC Part 4. It mandates the appointment of a qualified fire officer and trained staff for significant occupancies.
- NBC Part 4 Fire and Life safety specifies the demarcation of fire zones, restrictions on construction of buildings in each fire zone, classification of buildings based on occupancy, types of building construction according to fire resistance of the structural and non-structural components and other restrictions
- According to the Part 4 of the NBC, "Every building shall be constructed, equipped, maintained and operated as to avoid undue danger to the life and safety of the occupants from fire,smoke,fumes or panic during the time necessary for escape

NBC guidelines regarding fire safety

- An emergency plan for orderly and systematic evacuation be prepared, and fire drills should be conducted at least once six months.
- The code says that no alterations should be in a building to reduce the number, width or protection of exits
- Automatic fire detection, and alarm facilities are a must as per the guidelines in fire and life safety part of the NBC.
- Based on the occupancy use and height, all the buildings have to be protected by fire extinguishers, wet risers, automatic sprinkler installations, water sprays, etc.
- The NBC regulations can be immediately adopted or enacted for use by various departments, municipal administrations, public, and private bodies.
- It lays down a set of minimum provisions designed to protect the safety of the public with regard to structural sufficiency, fire hazards and health aspects of buildings.

Relevance of Ergonomics in construction safety

- Ergonomics is a science that focuses on designing spaces, workspaces,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 employees ability to perform their work and enjoy their life

Ergonomic hazard

- 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 all contribute 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

Ergonomic hazard

- 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
- 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.

Ergonomic hazard

- 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 in the shoulders, neck, arms, and hands, these symptoms often lead to musculoskeletal disorders and can cause health complications in the employees experiencing 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 or equipment.

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 which can cause pain or discomfort in the employee's back or knees.
  - 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 solutions for these kinds of tasks and ergonomic hazards include raising the work on a work surface
  - Using tools with extension handles that allow the employee to work standing up could help eliminate the need to stoop and kneel.
  - Kneeling creeper could be used for tasks in which kneeling is required and it offers chest support during the task to offer more body support during tasks

Causes of ergonomic hazards in construction work

- Awkward posture
  - 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 ergonomic complications.
  - Another solution could be to use an extension pole for tools

Causes of ergonomic hazards in construction work

- *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.

Causes of ergonomic hazards in construction work

- *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.
  - 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 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 your body, lift with your legs and not your 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 (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.

Causes of ergonomic hazards in construction work

- *Repetitive motion*
  - There are 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 Syndrome (HAVS)
  - Vibrations from power tools can also cause injuries and long-term health effects.

  <u>Reduced by:</u>

  - Substituting tools that do not fit the employee, with more ergonomic 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.
  - Using reduced vibration power tools, or issuing employees anti-vibration gloves can help reduce health effects from tool vibrations.

Causes of ergonomic hazards in construction work

- High forces
  - High forces are forces that workers put to lift objects during 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.

Ergonomic Injuries

- Two classifications of ergonomic injuries
  - Cumulative Trauma Disorders (CTD's) – exposure driven
  - Strains/Sprains – instantaneous (event driven)

Ergonomic Injuries

- Cumulative Trauma Disorders (CTD's)
  - Injury to soft tissue caused by prolonged exposure to multiple ergonomic risk factors
  - Typically develop in small body segments (i.e. fingers, wrists, elbows, and neck)

- Examples of CTD's
  - Tendon disorders:
    - Inflammation of tendon and/or tendon sheathing caused by repeated rubbing against ligaments, bone, etc.
    - Lateral epicondylitis (tennis elbow)
  - Nerve disorders:
    - Compression of nerves from repeated or sustained exposure to sharp edges, bones, ligaments, and/or tendons
    - Carpal tunnel syndrome
  - Neurovascular disorders:
    - Compression of blood vessels and/or nerves from repeated exposure to vibration or cold temperatures
    - Raynaud's phenomenon (white finger syndrome)

Ergonomic Injuries

- Strains & Sprains
  - Injury to connective tissue caused by single forceful event: lifting heavy objects in awkward position
  - Common to large body segments (i.e. back, legs, and shoulders)
  - Risk of injury increases with the presence of multiple risk factors

Musculoskeletal Disorder

- Musculoskeletal Disorders or MSDs are injuries and disorders that affect the human body's movement or musculoskeletal system (i.e. muscles, tendons, ligaments, nerves, discs, blood vessels, etc.).
- 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.
- Injuries and pain in the musculoskeletal system caused by acute traumatic events like a car accident or fall are not considered musculoskeletal disorders.
- MSDs can affect many different parts of the body including upper and lower back, neck, shoulders and extremities (arms, legs, feet, and hands).

Musculoskeletal Disorder

- Common musculoskeletal disorders include:

- Carpal Tunnel Syndrome : A numbness and tingling in the hand and arm caused by a pinched nerve in the wrist.
- Tendonitis : **inflammation or irritation of a tendon**
- Muscle / Tendon strain
- Ligament Sprain
- Tension Neck Syndrome
- Thoracic Outlet Compression : **a group of disorders that occur when blood vessels or nerves in the space between your collarbone and your first rib (thoracic outlet) are compressed**

- Rotator Cuff Tendonitis
- Epicondylitis
- Radial Tunnel Syndrome
- Digital Neuritis
- Trigger Finger / Thumb
- DeQuervain’s Syndrome
- Mechanical Back Syndrome
- Degenerative Disc Disease
- Ruptured / Herniated Disc and many more.

The Cause of Musculoskeletal Disorders – Exposure to Risk Factors

- These risk factors can be broken up into two categories:

    1. work-related (ergonomic) risk factors
    2. individual-related risk factors

Work-related Risk Factors

There are three primary ergonomic risk factors.

- **High task repetition.** Many work tasks and cycles are repetitive in nature, and are frequently controlled by hourly or daily production targets and work processes. High task repetition, when combined with other risks factors such high force and/or awkward postures, can contribute to the formation of MSD. A job is considered highly repetitive if the cycle time is 30 seconds or less.
- **Forceful exertions.** Many work tasks require high force loads on the human body. Muscle effort increases in response to high force requirements, increasing associated fatigue which can lead to MSD.
- **Repetitive or sustained awkward postures.** Awkward postures place excessive force on joints and overload the muscles and tendons around the effected joint. Joints of the body are most efficient when they operate closest to the mid-range motion of the joint. Risk of MSD is increased when joints are worked outside of this mid-range repetitively or for sustained periods of time without adequate recovery time.

Individual-related Risk Factors

Human beings are multi-dimensional. Limiting ourselves to a singular cause of MSDs will limit our ability to create a prevention strategy that addresses the multi-dimensional worker.

- **Poor work practices.** Workers who use poor work practices, body mechanics and lifting techniques are introducing unnecessary risk factors that can contribute to MSDs. These poor practices create unnecessary stress on their bodies that increases fatigue and decreases their body's ability to properly recover.

- **Poor overall health habits.** Workers who smoke, drink excessively, are obese, or exhibit numerous other poor health habits are putting themselves at risk for not only musculoskeletal disorders, but also for other chronic diseases that will shorten their life and health span.

- **Poor rest and recovery.** MSDs develop when fatigue outruns the workers recovery system, causing a musculoskeletal imbalance. Workers who do not get adequate rest and recovery put themselves at higher risk.

- **Poor nutrition, fitness and hydration.** Workers who do not take care of their bodies are putting themselves at a higher risk of developing musculoskeletal and chronic health problems.

Cumulative Trauma Disorders (CTD)

- Cumulative trauma disorders (CTDs) are musculoskeletal disorders that form due to work-related activities wearing on the body.
- Also known as repetitive strain injuries, repetitive motion disorders, overuse syndrome and work-related musculoskeletal disorders.
- CTDs are injuries of the musculoskeletal system, which includes joints, muscles, tendons, ligaments, nerves, and blood vessels.

Cumulative Trauma Disorders

- CTDs are usually caused by a combination of the following risk factors
  - repetitive motions
  - forceful exertions - pulling, pushing, lifting, and gripping
  - awkward postures - body positions that are not the natural resting position
  - static postures - body positions held without moving
  - mechanical compression of soft tissues in the hand against edges or ridges, such as using tools or objects which press against the palm
  - fast movement of body parts
  - vibration, especially in the presence of cold conditions
  - mental stress
  - lack of sufficient recovery time (rest breaks, days off), which will increase the risk of developing a CTD by any of the above factors.

Cumulative Trauma Disorders

- Cumulative trauma disorders primarily affect the upper extremities and include such disorders as carpal tunnel syndrome, wrist tendonitis, ulnar nerve entrapment, epicondylitis, shoulder tendonitis, and hand-arm vibration syndrome.
- Common symptoms are pain, and swelling of the body parts that are performing the work duties.
- Some occupations have more risk factors than others for the possible development of CTDs
- CTDs are preventable