Module - 1

BARRICADING

Definition of Barricade

- Barricades are warning devices
- alerts others of the hazards created by construction activities,
- should be used to control traffic, both vehicular and pedestrian,
- ensure safely through or around the work site.

Purpose of this Standard

- To provide a safety guideline
  - for selection and
  - use of appropriate barricade

for various type of construction, demolition work.

Associated Hazards

- Fall.
- Injury.
- Damage to vehicle and equipment.
- Fire .
- Electrical hazards .

General Requirements

- Contractors are responsible for the installation of barricades.

- **Consultants, site-in-charge from E&P Division and Departments are responsible to ensure that the work site is properly barricaded by the contractors.**

General Requirements

Substantial barricades shall be provided

And for DEMOLITION site

General Requirements

Prevent trespassing into vital installations as per the requirement of prevailing laws

General Requirements

An opening measuring 30 cm or more in its least dimension, in any floor, platform, pavement or yard through which person may fall; such as hatch way, stair or ladder opening, pit or large manhole should be barricaded.

Man hole

Lift Well

Floor Opening

Types of Barricades

Barricades can be classified into two groups

Indicative Barricades

Safety Tapes

Cone

Road Runner

Protective Barricades

Guard Rails

Fencing

General Requirements

- All barricades shall be visible from a safe distance, to alert people well in advance.

- Caution board, division board, shutdown board to be displayed at both end of barricade.

- No material to be projected beyond barricades.

- Only authorized persons shall remove the barricades once the job is complete.

Barricading Construction Sites

- Wherever construction debris is dropped the area is to be barricaded.

These drawings are attached to the standard for easy access.

- Areas with temporary wiring operating at more than 600 volts shall be barricaded with indicative barricade comprising “Red-White” safety tape, if the job requires at most one day to complete.

If job requires longer time, then the site is to be barricaded with protective barricades.

Plastic barriers must not be used to barricade the work area.

Barricading Construction Sites

The swing radius of the rotating superstructure of cranes or other equipment is to be protected using 2 strands of minimum 50 mm wide 'Red-White' safety tapes.

One strand at 300 mm from ground

Another at 1000 mm from ground

Barricading Construction Sites

Excavations – A protective barricade of at least 1200mm high must be erected around a trench that is 1 metre or more deep.

This barricade is to be firmly fixed with the ground with the help of pegs.

Barricading Construction Sites

- Piling site is to be barricaded using indicative barrier for warning.

- Gas-cutting & Welding site shall be barricaded using minimum 50 mm wide 'Red-White' safety tapes for warning.

Barricading Demolition Sites

- All the roads and open areas adjacent to demolition site shall be barricaded with caution board. Unauthorized entry to demolition site must be prevented.

- Properly cover or securely barricade all floor or roof penetrations, lift shaft entrances and doorways where staircases are to be removed.

- When floors are being removed, the area underneath shall be properly barricaded to prevent any other workmen to work under the floor.

- All floor openings / wall openings shall be adequately guarded / barricaded and provided Danger caution notices.

- During night, red light and/or luminescent danger signs shall be placed on and around the barricades.

Barricading Roads

- Care should be taken to block only one-half of road width at a time. Caution board and division board is to be placed at both side of barricade.

- If entire road width is to be blocked, in addition to the caution board, the road diversion sign is to be prominently placed on both ends of the work area.

- Drum painted white with red stripes at the middle and barricade with red / white safety tape may be used as barricade.

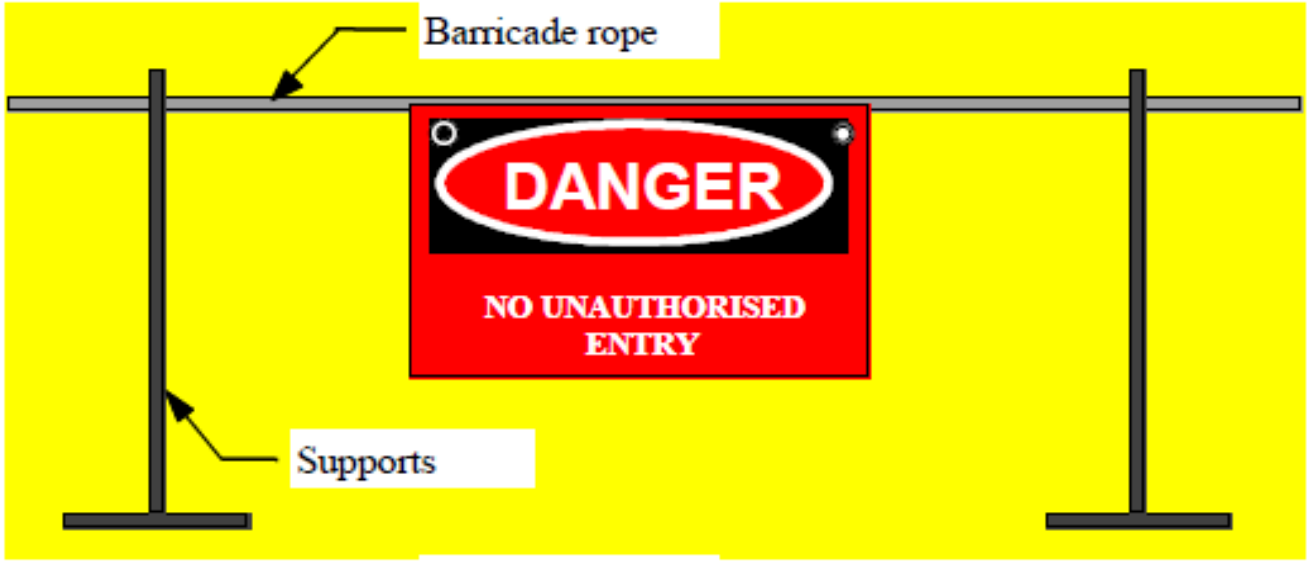
Barricading Roads

- Two persons with red / green flag and whistle to be deputed at both sides of the barricade to regulate traffic.

- Red light to be provided if job is to be done after sunset.

- No material to be projected beyond barricades.

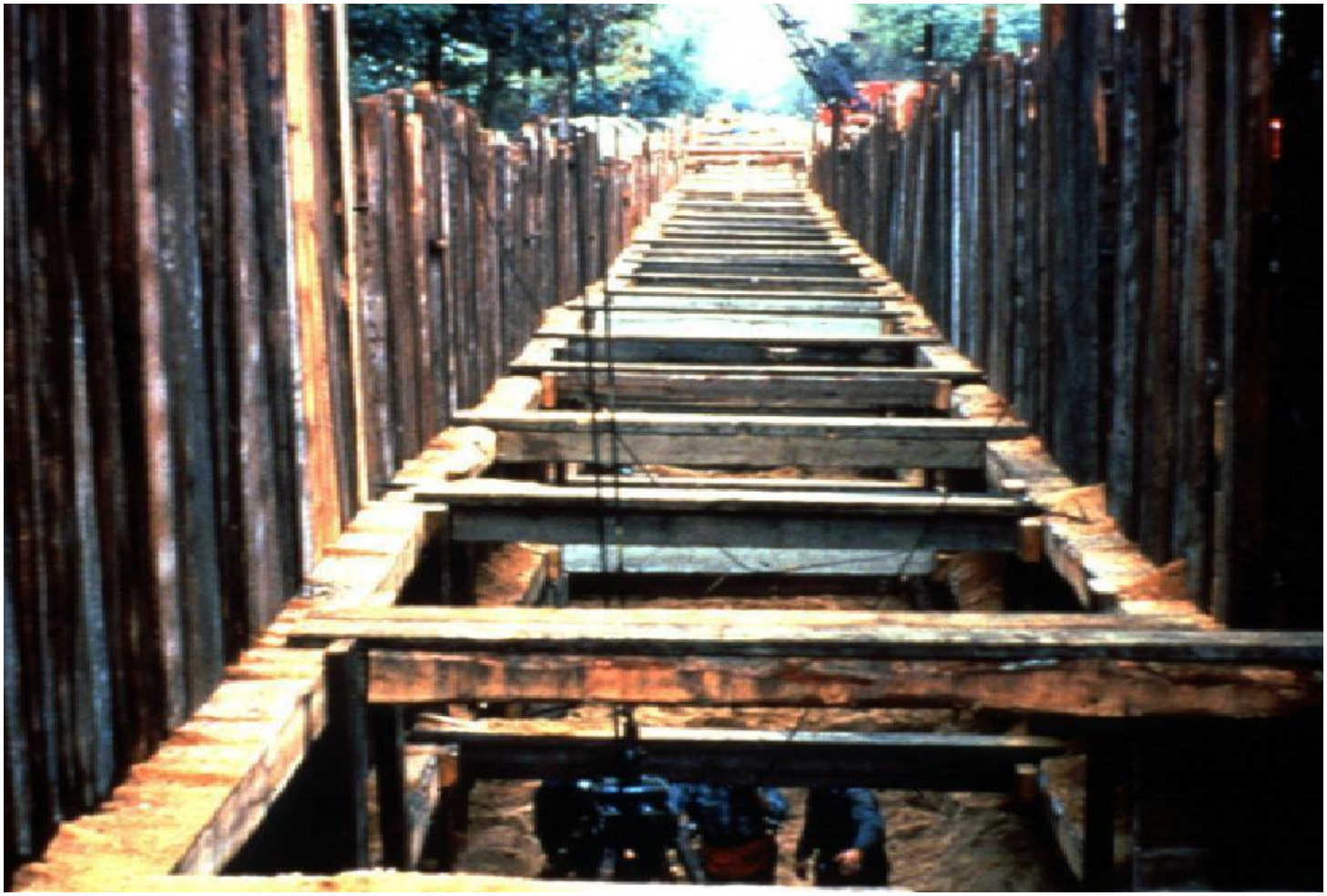
- Barricade is to be provided around if equipment is left unattended near a roadway at night.



Module - 2

Excavation

Excavations



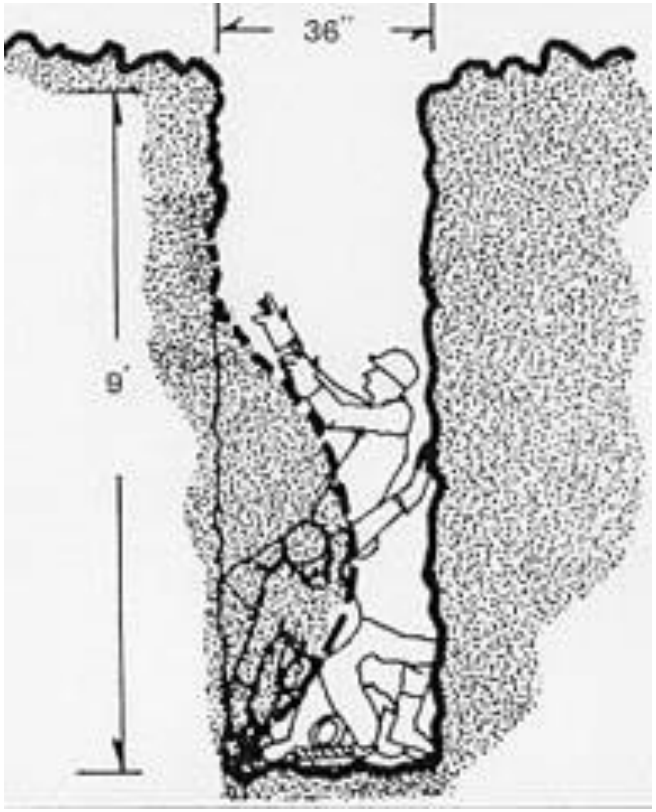
Training & Education- Safety Standards no- SS/Engg.-01

Excavation Safety?

- People die in excavations! Fatal Facts

- Damage to Utilities resulting in
✓ Time Loss
✓ Monetary Loss

- Understanding safety aspects during excavation



What we will cover

1. **Competent person**
2. **Hazards of excavations**
3. **General protection requirements**
   - •Planning
   - •Minimum precautions
   - •Underground installations.
   - •Access and escape
   - •Exposure to falling loads
   - •Hazardous atmospheres
   - •Emergency rescue
   - •Hazards associated with water accumulation
   - •Stability of adjacent structures
   - •Protection of employees from loose rock or soil
   - •Inspections
   - •Fall protection:
   - •Cathodic protection systems
4. **Requirements for protective systems**
   - •Shoring
   - •Sheet piling
   - •Berm, plant and machinery
   - •Cave-in hazards
5. **Attachments**

Competent Person

One who is capable of identifying existing and predictable hazards in the surroundings, or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

Must have had 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

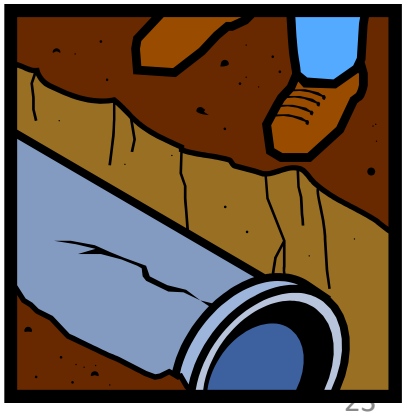
Excavation Hazards

Cave-ins are the greatest risk

- FALL
  - Persons
  - Material
- Collapse
  - Excavation Sides
  - Support Structures
  - Adjacent Buildings

Other hazards include:

- Asphyxiation due to lack of oxygen
- Inhalation of toxic materials
- Fire
- Moving machinery near the edge of the excavation can cause a collapse
- Accidental severing of underground utility lines



General Protection Requirements

1. Planning

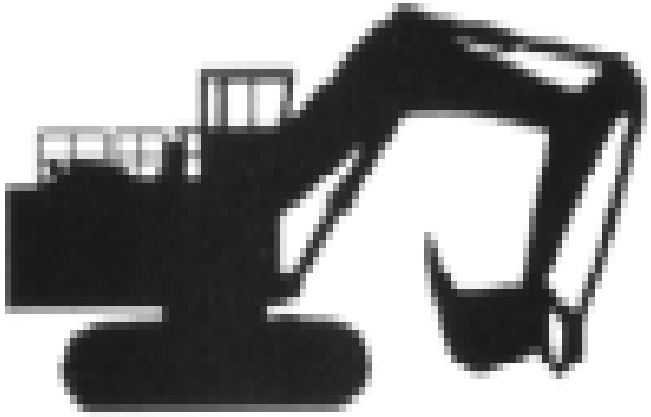
Construction engineer is responsible for planning the job. Before an excavation begins, the construction engineer must consider specific site conditions such as the following: –

- Presence of a competent person
- Traffics
- Vibrations in the vicinity of the worksite
- Proximity of structures and their conditions
- Soil
- Surface water and groundwater
- Chemical contamination of soil or water
- Water table
- Overhead and underground utilities
- Weather if desired, the construction engineer can use the attached sample safety checklist (see attachment) to help plan excavation safety.

Protection from Falls, Falling Loads, and Mobile Equipment

2. Minimum Precautions

- Provide warning vests for employees exposed to vehicular traffic.
- Install Barricades
  - Warning or Protective barricades
  - hand or mechanical signals, or timber blocks
  - minimum distance of 1.5 meters from the excavation edge
  - A spoil pile at least 3 feet 1 meter high can be used as a barricade on one side of the excavation
  - marked with warning lights if they are in or near walkways or roadways



Underground Installations

1. Obtain excavation clearance from E&P division or other concerned department
2. Steps

- Examined by cable/metal detector to identify underground cables/utilities
- Trial trench of 1.5 meter depth shall first be cut, below the ground surface manually
- Examined by cable/metal detector to identify underground cables/utilities
- Presence of cables/utilities is not detected- 1.2 meter mechanized excavation

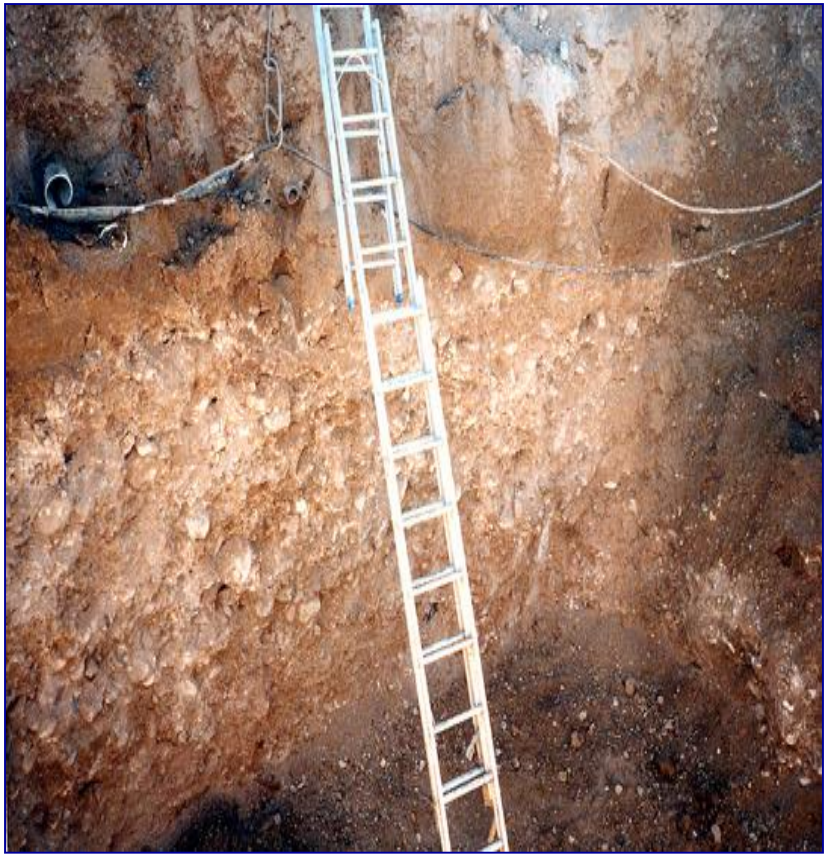
This sequence shall be continued till the final depth of excavation is reached

Access/Egress

•**Note:** Poor Housekeeping
-#1 cause of slip, trips and falls on construction Projects

✓ Debris kept clear from work areas
✓ Mark Hazards
✓ Barricade or cover holes
✓ Pathways/Gangways should be cleaned

•**Egress provided as-**
✓ Ladders
✓ Ramps
✓ Stairs



These two ladders which are lashed together are not an adequate means of egress

Access/Egress

- **Ladders shall –**
  - ➢Be provided for every length of 15 m or fraction thereof,
  - ➢30 m intervals for hazardous and less hazardous excavations
  - ➢Extend 1 m above the top of the cut

- **Pathway**
  - ➢Strong enough to withstand the intended use
  - ➢Free from mud, sand & gravels

The ladder should extend 1 m above the excavation

Hazardous Atmosphere

Hazards are

- Oxygen deficiency
- High combustible gas concentration
- High levels of other hazardous substances
- Explosive mixed gases

Atmosphere is hazardous when

O_2	< 19 %	by volume
CO_2	> 1%	by volume
CO	> 01%	by volume
H_2S	> 0.0025%	by volume
N_2O	> 0.002%	by volume

Precautions

- Dust suppression
- Displace hazardous gases and vapors
- No I C engines in excavation without permission

Excavation Rescue

- **Workers must be made aware of:**

✓Field personnel
✓First Aid box
✓Competent First Aider
✓OHS centre / Hospital of Tata Steel
✓Fire Department

- **Rescue equipment for Hazardous atmospheric conditions**:

✓Breathing apparatus
✓Safety Harness/line
✓Stretcher

Water is Hazardous

When water is present in an excavation it is extremely hazardous to enter

Note that these workers are not wearing hardhats to protect them from materials falling into the trench

- Protection from hazards associated with water accumulation:

✓ Protection against Cave-in

✓ Water removal (pumping)

✓ Run-off protection

✓ Consider temporary shut-off of water lines

Water is Hazardous

Water = Cave-in Hazard

These workers must be protected from cave-in. Note the water in the bottom of the trench. This is a very hazardous condition!

Adjacent Structures

Ensure structure stability for the protection of employees by

✓ Shoring
✓ Bracing
✓ Underpinning

• **For excavation below footing-**
✓ Use designed support system and protective system
✓ Written approval from Site In-charge

•Sidewalks, pavements, and appurtenant structure shall not be undermined unless a support system or another method of protection is provided to protect employees from the possible collapse of such structures.

Loose Rock and Soil

- **Protection of employees from loose rock or soil**

✓ Scaling to remove loose material

✓ Protective barrier

✓Nets as necessary on the face to stop and contain falling material

✓ No work on slopes above workers

Fall Protection

- **Any surface 2m or more above a lower level shall be protected by:**

✓ Adequate barricading

✓ Personal fall arrest system

- **Wells, Pits and shafts must be**

✓ Barricaded /covered

✓ Backfilled after completion

Excavation Inspection

• Daily inspections of all excavations by Competent Person
• Start of shift, as needed, following rainstorms or other hazard increasing events
✓ Possible cave-ins
✓ Protective system failure
✓ Water accumulation
✓ Hazardous atmosphere
•Competent Person has authority to remove workers from excavation

Note: Use the Checklist for inspection attached with the standard

Cathodic Protection Systems

These systems are used to prevent corrosion of certain underground piping. Special cathodes and/or anodes are used to circumvent corrosive damage to the pipeline by use of electrical currents. If these systems are in the vicinity of an excavation, they must be de-energized.

Protective System

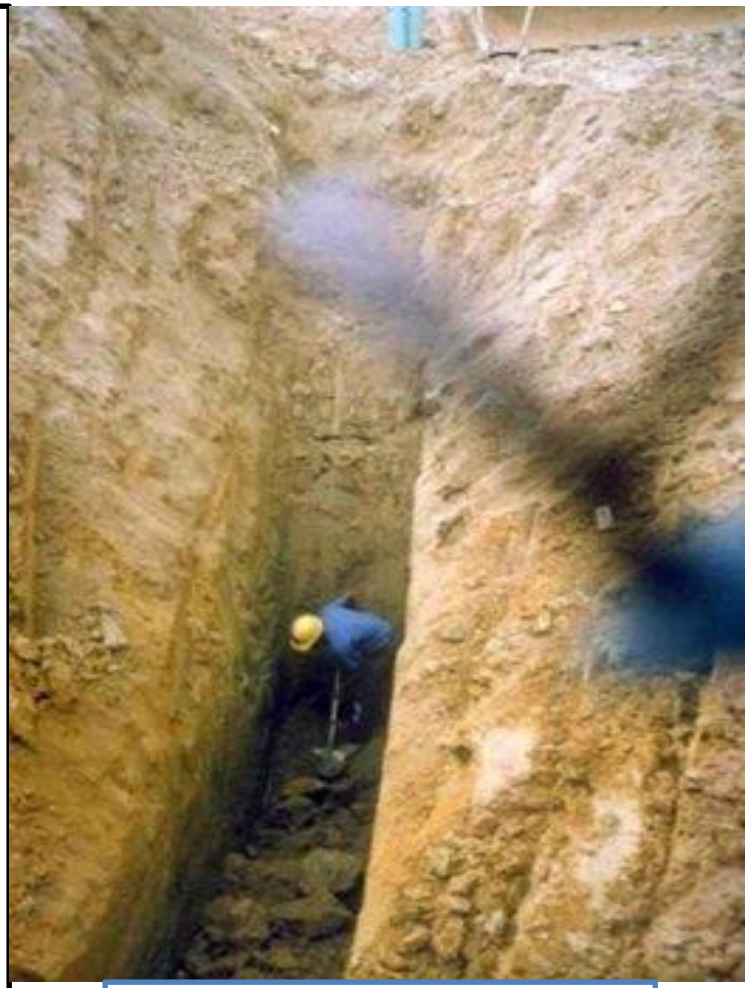
Protection from Cave-in requires a systematic approach including:

•Loose material shall not be kept close

•Safety helmet and shoes

•Warning notices shall be displayed at the site

•All excavations must be provided with guard rails or steel structural framed barricading with wire mesh (sketch number STD/020065



No protective system

Protective Systems

- All trenches in soil more than 1.5 m deep shall be securely shored and timbered. In case of extremely loose soil shoring may be required even for depth less than 1.5 m.

- All trenches in friable or unstable rock exceeding 2 m in depth shall be securely shored and timbered.

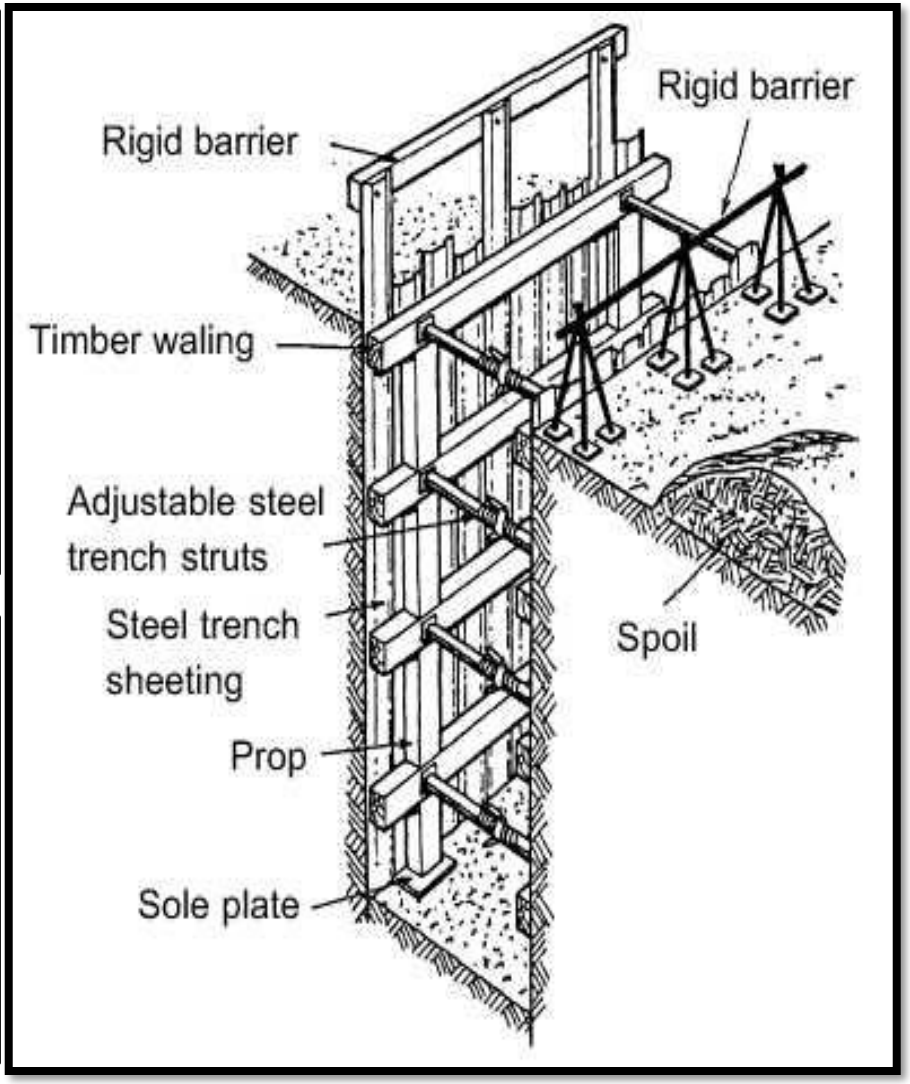
- The above requirements do not apply in cases, where the sides of the trenches are sloped to within 1.5 m of the bottom. The slope that is provided for such purposes shall be inspected and certified for its stability by the person in charge of work in all cases.

Inadequate protective system

Shoring

The erection of shoring and timbering shall be as per IS:3764 for Hard Soil, Soil which may crack or crumble, loose sandy or soft soil or soil which has been previously excavated, soil under hydraulic pressure respectively.

- As per IS specifications
- Based on manufacturer's data
- Designed by Engineer
- Based on depth and width
- Based on soil type and condition



Sheet Piling/Shielding

Sheet Piling

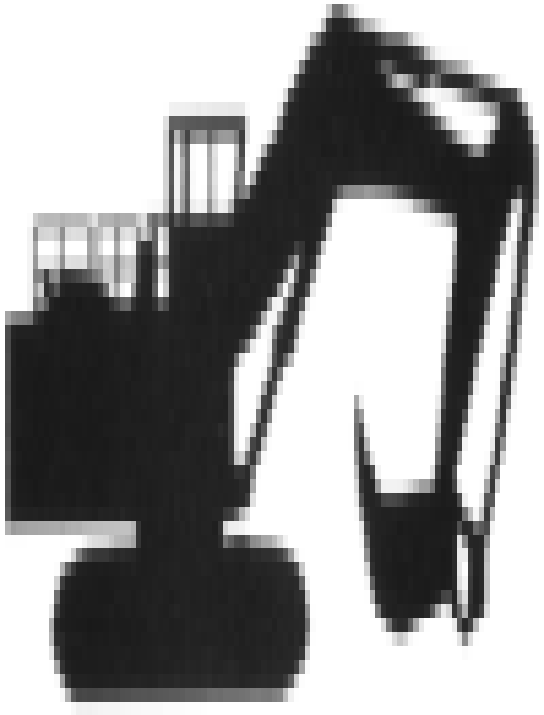
In case of deep and wide open cut excavation, sheet piling may be followed for side protection. The piles may be of timber, concrete or composite material depending upon the depth of excavation and life of sheet piles required

- As per IS 2314: 1986
- Based on manufacturer's data

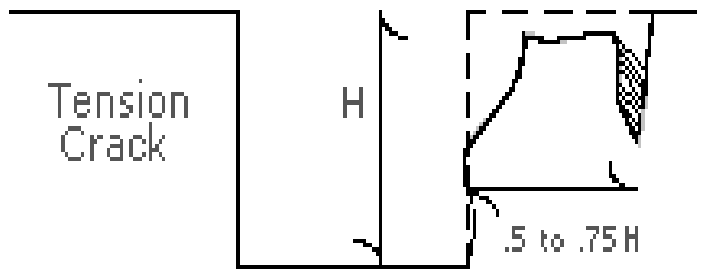
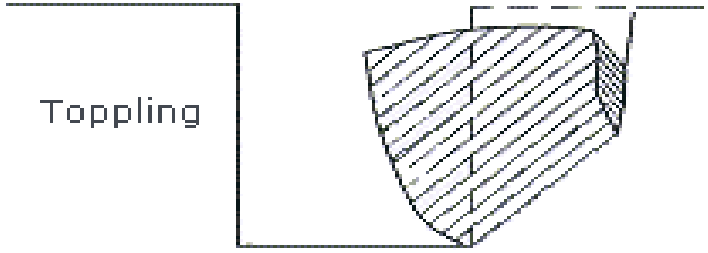
A trench shield

Berm, Plant and Machinery

- Berm width not less than one-third of the final depth of excavation is recommended to keep away the excavated material from falling into the trench.
- In areas where this width of the berm is not feasible, the reduced berm width of not less than 1 meter should be provided.
- Equipment should be parked at distance of not less than the depth of the trench or at least 6 m away from excavated sides for trenches deeper than 5 m.

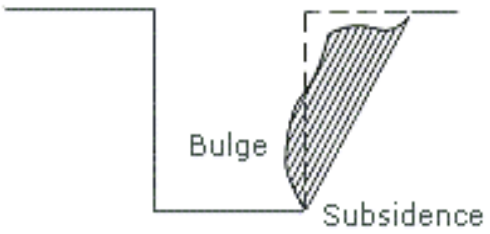


Cave-in Hazards

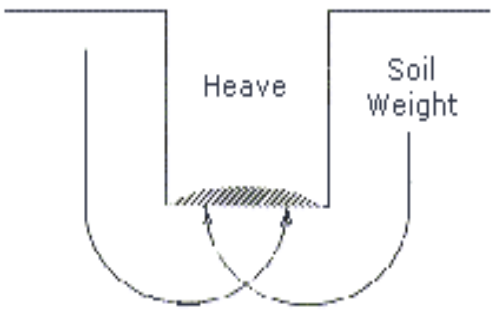
a)TENSION CRACKS. Tension cracks usually form at a horizontal distance of 0.5 to 0.75 times the depth of the trench, measured from the top of the vertical face of the trench.	
b) **SLIDING** may occur as a result of tension cracks	
c) TOPPLING. In addition to sliding, tension cracks can cause toppling. Toppling occurs when the trench's vertical face shears along the tension crack line and topples into the excavation.	

Cave-in Hazards

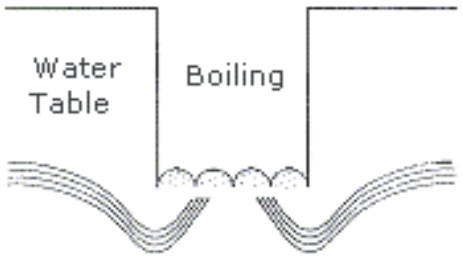
d) SUBSIDENCE AND BULGING. An unsupported excavation can create an unbalanced stress in the soil, which, in turn, causes subsidence at the surface and bulging of the vertical face of the trench. If uncorrected, this condition can cause face failure and entrapment of workers in the trench.



e) HEAVING OR SQUEEZING. Bottom heaving or squeezing is caused by the downward pressure created by the weight of adjoining soil. This pressure causes a bulge in the bottom of the cut, as illustrated in the drawing above. Heaving and squeezing can occur even when shoring or shielding has been properly installed.



f) BOILING is evidenced by an upward water flow into the bottom of the cut. A high water table is one of the causes of boiling. Boiling produces a "quick" condition in the bottom of the cut, and can occur even when shoring or trench boxes are used.



Excavation Fatalities

TABLE 1. Number and percentage of excavation and trenching fatalities, by industry and SIC* code — United States, 1992–2001

Industry and SIC code	No.	(%)
Excavation work (SIC 1794)	141	(26.0)
Water, sewer, pipeline, and communications and power-line construction (SIC 1623)	131	(24.2)
Plumbing, heating, and air conditioning (SIC 1711)	59	(10.9)
Heavy construction, not elsewhere classified (SIC 1629)	27	(5.0)
General contractors, single-family homes (SIC 1521)	19	(3.5)
Highway and street construction, except elevated highways (SIC 1611)	16	(2.9)
General construction — nonresidential buildings, other than industrial buildings warehouses (SIC 1542)	14	(2.6)
All other industries	135	(24.9)
Total	**542**	**(100.0)**

Source: Census of Fatal Occupational Injuries (excludes New York City).
* Standard Industrial Classification.

Excavation Fatalities

TABLE 2. Number and percentage of excavation and trenching fatalities, by occupation — United States, 1992–2001

Occupation	No.	(%)
Construction laborers	236	(43.5)
Plumbers/pipe fitters	42	(7.8)
Excavation machine operators	38	(7.0)
Construction trades, not elsewhere classified	33	(6.1)
Construction supervisors, not elsewhere classified	27	(5.0)
All other occupations	166	(30.6)
Total	542	(100.0)

Source: Census of Fatal Occupational Injuries (excludes New York City).

Excavation Fatalities

TABLE 3. Number and percentage of excavation and trenching fatalities, by event — United States, 1992–2001

Event (OIICS* code)	No.	(%)
Excavation/trenching cave-in (041)	411	(75.8)
Struck by object (02)	35	(6.5)
Pedestrian struck by vehicle/equipment (43)	19	(3.5)
Caught in or compressed by equipment/objects (03)	14	(2.6)
All other events	63	(11.6)
Total	542	(100.0)

Source: Census of Fatal Occupational Injuries (excludes New York City).
*Occupational Injury and Illness Classification System.

BACK

Module - 3

PILING

What is piling ?

Piling is a technique used extensively to set a deep foundation for structures such as buildings. By driving and embedding piles of wood, concrete or steel into the deep soil of the ground, the Pliers are able to provide a strong support to the building structure at the foundation level - a pre requisite for any construction project.

Associated Hazards:

Slip, Trip, Fall, Hit, Impact, Breaking of Fly wheels, Noise, Vibrations,Body Intrusion and Abrasion, damage to existing structures, electrical hazards etc.

General Requirement:-

1. All Piling operations shall be carried out under the supervision of qualified and competent persons.

2. Prior to piling, contractors shall obtain clearance &Care must be taken, particularly for the underground live electrical cables.

3. The work site must be barricaded with appropriate fencing & all workers must wear tight fitting cloths or uniform, helmets, hand gloves, protective footwear and eye protectors.

4. For work during night, the work site shall be illuminated with at least 100 lux intensity.

5. No material shall be piled, dumped or stacked at random but only in areas specified for the same & mud / slurry coming out during pile driving, shall be channelized to a designated place.

6. All holes, which are left unattended, shall be adequately and securely covered or shall have an effective barrier placed as close to the edge as is practicable.

Piling Rig Installation :-

1. Pile rig and winch machine shall be placed on a firm level base.

2. The legs of the tripod shall be firmly spiked in the ground and shall be examined Frequently & shall be replaced, if any physical defects (splits, cracks, knots etc.) are identified / noticed.

3. The pulleys shall be checked frequently & nuts and bolts which are likely to be loosened due to vibration while piling, shall be checked regularly and tightened.

4. Pile drivers shall not be erected in dangerous proximity to electric conductors.

5. Access to the top pulley shall be provided by standard ladders with safety Precaution & exposed gears, flywheels, belts etc shall be fully enclosed by using wire Mesh of 1/2 inch or 12 mm size.

6. A competent person shall inspect pile driving equipment in use at regular intervals. A register shall be maintained at the site of work for recording the results of such inspection.

7. All lifting appliances shall be clearly marked with the safe working load & Where electricity is used as power for piling rig, only armored cable shall be used and the cable shall be thoroughly waterproof.

Operation of Equipment

1. Piling machine operators should be over 21 years of age and should have sufficient experience.

2. Piles hoisted in the rig shall be so slung that they do not swing around. A hand rope shall be fastened to a pile that is being hoisted to control its movement. While a pile is being guided into position in the leads, workers shall not put their hands or arms between the pile and the inside guide or on top of the pile, but shall use a rope for guiding.

3. All fitting appliances and lifting gear must have certificates of testing.

Protection to neighboring structures and underground services :-

1. During piling operation, vibration is set up which may cause damage to adjoining structures or service lines depending on the nature of soil condition and the construction standard of such structures and service lines. Accordingly, possible extent of all such damages shall be ascertained in advance by a competent person and operational mode of driving shall be planned with appropriate measures to ensure safety.

2. Measures shall be taken to ensure that there is no appreciable movement of soil mass into the bore hole which may cause subsidence to any existing foundation in the close proximity. In wet holes, where such possibilities are likely to be there the same shall be minimized by approved technique and the operation shall be planned.

3. All extended open bars at construction site as well as at plants , other projected bars ,valve spindle etc in the plants at man –height must be protected with **Bar-cap, to cover the sharp** projection of the bar

Module - 4

Storage of Material at Construction Site

General Requirements for storage

- **Materials stored at site shall not obstruct fire alarm boxes, fire extinguishers, first-aid equipment, lights, electric switches, approach to substation buildings, offices, workshops and plants. Materials for construction shall be placed at least 3 meters away from such emergency items.**
- **All construction materials shall be segregated and stored in respective designated places.**
- **Storage areas shall he kept free from accumulation of materials that constitute hazards from tripping, fire or explosion.**

- **The material storage area shall be appropriately barricaded and no material shall protrude beyond the barricade.**
- **No material shall be stored or remain on the pathway, to avoid tripping hazards. Aisles and passage-ways shall be kept clear to provide for the free and safe movement of material handling equipment or of employees**
- **Any pipe line (water supply, gas etc.) or electrical installation should not be used for supporting any material or hanging any load.**
- **Any pipe and other materials required for road-side construction purpose shall be stacked at least 2m away from the metal portion of the road and shall be barricaded, with red night lamps to eliminate traffic hazards.**

- **Material stored inside buildings under construction shall not be placed within 2 m of any hoist way or inside floor openings.**
- **All materials stored in tiers shall be stacked, racked, blocked or otherwise secured to prevent sliding, falling or collapse.**
- **Maximum safe load limits of floors within buildings and structures in all storage areas shall not be exceeded.**
- **Bagged materials shall be stacked by taking adequate precautions to prevent collapse of stack.**
- **Combustible materials such as packing boxes, fuel, lubricants, and gunny bags are to be kept separately on a designated area before disposal.**
- **All materials shall be stacked tidily and up to a safe height to prevent them from falling or causing some other pile to fall.**
- **Steel and other material shall not be placed on ground. Proper spacers (dunnage) should be used to separate the stored material from ground.**

Bricks and Masonry blocks

- Bricks shall not be dumped at site. For proper inspection of quality and ease of counting, the stack shall be 50 bricks longs and 1.5 meter high. Clear distance between adjust stacks shall preferably be not less than 0.8 meters.

- Brick must never be stacked for storage purposes on scaffolds or runways. This does not prohibit normal working supplies on bricklayers' scaffolds during actual bricklaying operations.

- When masonry blocks (PCC, stone) are stacked higher than 2 m, the stack shall be tapered back one half blocks per tier above 2 m level.

Cement Bag:

- **Cement shall be stored in a building or in a shed which is dry and leak proof / moisture proof as possible.**
- **Cement bags shall be stacked on wooden plank in such a way as to keep them 150 -200mm clear from the floor and a space of 450 mm minimum shall be left all around between the exterior wall and the stack.**
- **The height of the stack shall not be more than 15 bags; width of the stack shall not be more than 4 bags length or 3 meters.**
- **While stacking more than 8 bags high, the cement bag shall be arranged alternatively length-wise and cross-wise so as to tie the stacks together and minimizing toppling hazard.**

Pipes & bar stocks:

- **Pipes and bar stock shall preferably be stored on appropriately designed sills or racks, and must be safely blocked to prevent rolling or spreading.**

- **Alternately, pipes of diameter higher than 300mm may be stored on ground with maximum two layers high and with proper use of choker block and dunnage, in order to prevent rolling. When stacked in such fashion, the top most pipe is to be taken out first for use.**
- **When many small diameter pipes/rods are stored on ground, the pipes/rods are to be bundled into 3-4 units. Proper guards are to be provided to arrest any accidental rolling of the pipes.**
- **Stopping of rolling or sliding of pipes or bar stock with hands or feet is strictly prohibited .**

Fabricated Steel items

- **Fabricated material shall be checked for stability at ground level. It is to be ensured that there is not any chance of tilting, falling or rolling or slipping of material.**
- **The ground shall have sufficient strength to bear the weight of the fabricated items & it should not be placed on loose soil. The storage area must be properly barricaded.**

Sheet Metals

- **All bundles shall be separated by strips of wood to facilitate handling when the material is needed and to lessen chances of shifting or sliding of the piles of material.**

Scaffolding Material

- **All materials and parts of scaffold, when not in use shall be kept under good condition at designated place and these should not be mixed with unsuitable material and parts.**

Storage of Scrap Material

- **Scrap shall be removed from construction site and disposed off promptly. Before removal, scrap storage area shall be barricaded.**
- **Packaging material should be disposed off quickly and shall not be allowed to remain at construction site.**
- **Wooden material with projected nail shall not be stored for future use. If the wooden materials are needed, all nails are to be removed, by appropriate means.**

Storage of construction debris

- Debris shall not be thrown from upper storeys, but be removed either by machinery or enclosed tilted passage / enclosed chutes. Accumulated debris shall be appropriately barricaded.
- All waste material and rubbish shall be removed from the immediate work area as the work progresses.
- All solvent waste, oily rags and flammable liquids shall be kept in metal containers with lid. These wastes shall be kept away from other combustible material (such as wood, papers, tyres etc.)
- Waste bins shall be kept at designated places for collection of different wastes (ferrous / nonferrous / other waste categories as relevant and categorized by the contractor.

Any pipe and other material required for road side construction purpose shall be stacked at least **2 METER** away from the road and shall be barricaded with red night lamps to eliminate traffic hazards.

Materials not Kept at 2 Mtr distance from road SEVERITY RATING 3

Module - 5

Safe Demolition Practices

Associated Hazards:

- Collapse of structure, falling material, flying material, impact/hit by material,
- collapse of equipment/machinery, noise, entrapment, fall from height, electrocution,
- Fire, explosion etc.

Basics

Each item and member are to be removed, cut in such a way that the overall adequacy, strength and stability remain intact. Following situations, conditions lead to collapse/ failure of structure during dismantling.

- Lack of thorough study and conceptualization before dismantling.
- Dismantling of structures without any sequence.
- Inability of executor to assess behavior of the whole or part of the structure after removal of any member.

Basics …contd.

- No planning for re-routing of utilities and its new support system before dismantling.
- Inadequate crane, winches and other tools & tackles.
- Non availability of load data of the items to be dismantled.
- Lack of strengthening measures for the adjacent structures to be dismantled.

Basics …contd.

As a matter of fact, dismantling requires various Engineering aspects as depicted below.

- Type of building
- Structural pattern
- Condition of the building
- Loads on the building
- Weight of various parts of the building and their assessment
- Stability and strength requirements of the building

Basics …contd.

- Stability and strength requirement of adjacent retained building
- Condition of foundation of the adjacent buildings
- Re-routing of utilities & its supporting requirements
- Design and construction of new support system and structures.
- Design and construction of new foundation
- Assessment of probable structural behavior during dismantling
- Scheme development for dismantling of major items.

PREPLANNING & PRECAUTIONS

- Engineering survey to determine stability of parts during phase-wise demolition.
- Preplanned safe working procedures /SOPand sequence of dismantling.
- Advance notifications regarding diversions / disconnection of all utilities, viz. electric, gas, water, steam, sewer etc.

Preplanning & precautions …contd.

- Put up caution boards, barricade, danger signs (luminescent /red) along with emergency contact numbe
- Emergency exits (at least 2 nos.) for escape.

PREPLANNING & PRECAUTIONS …CONTD.

- Following work permits shall be obtained from appropriate authority.

- Power cutting clearance –
- Power clearance –
- Gas cutting / welding / working at height–
- Working in gaseous area –

Preplanning & precautions …contd.

Following clearances shall be obtained for utility diversion / isolation before commencement of demolition.

- Gas and steam pipelines – FMD
- U.G. storm lines, sewer lines and service water lines – Engineering services department
- Electrical utilities – Plant electrical department

Preplanning & precautions …contd.

- Ensure that all equipment, facilities and lines (electric, steam, gas etc.) are de-energized, drained or blanked before starting demolition.
- For demolishing structures, which have been damaged by fire or explosion, the walls and floors are to be judiciously shored or braced.

Preplanning & precautions …contd.

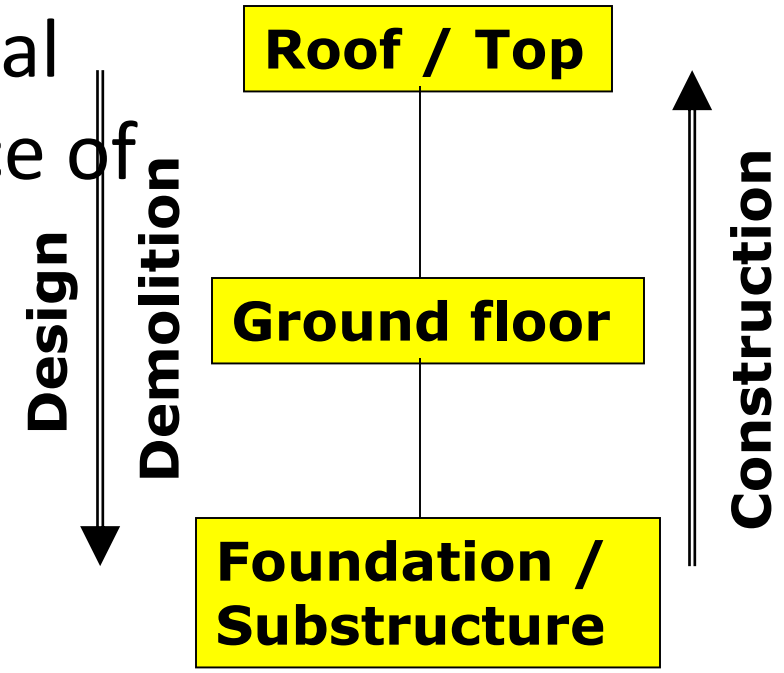
- Detect and clear off all hazardous materials, like asbestos, explosives, flammable material
- Barricade / block all external wall openings close to floor level
- While demolishing a floor or roof, workmen are not allowed to sit on the same slab, but on a separate platform supported independently.

Preplanning & precautions …contd.

- Provide guard rail and toe board around all floor openings those are not in use.
- Ensure that appropriate safety appliances (PPE) are being used.

Sequence of demolition

- Demolition is “Reverse construction”. This concept will help to form a general guideline about sequence of demolition.

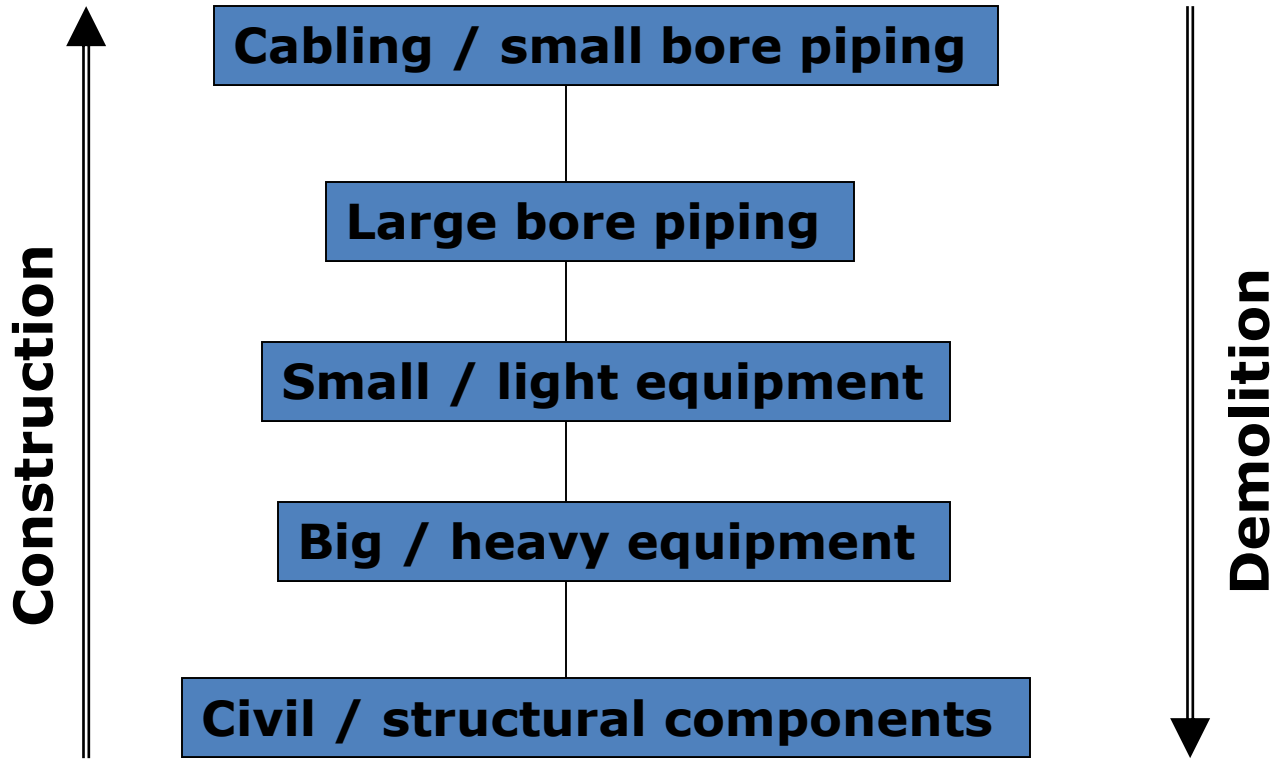


Sequence of demolition …contd.

- Demolition should proceed systematically storey by storey from top in descending order.
- Also, demolition can proceed in vertical sections of structure, provided stability of the parts are assessed and adequate measures are taken to prevent injuries.

Sequence of demolition …contd.

A generic sequence diagram *



* Some alterations possible based on Project Schedule.

Sequence of demolition …contd.

- Adjacent vulnerable structures are to be shored.
- Loose fixtures to be removed and loose plasters be stripped off.
- Remove all fragile material, e.g. glazed doors, windows.

Sequence of demolition …contd.

- Before demolishing superstructure, overhangs and chajjas shall be properly supported or demolished first.
- Stairs, railings, passageways and ladders (secured / fastened at top and bottom) shall be left in place as long as possible.

Demolition of walls

- Examine, if the wall is a load bearing masonry.
- If yes, then ensure that all the structures / loads supported on the wall are demolished and removed before breaking the wall.

Demolition of walls …contd.

- Ensure that wall or sections of masonry do not fall as single mass on the floor.
- Remove the walls part by part.
- Clean off the debris immediately to prevent overloading on floor.

Demolition of Walls …contd.

1. Concrete walls to be cut in handling sizes and to be lowered with the help of adequate capcacity cranes.

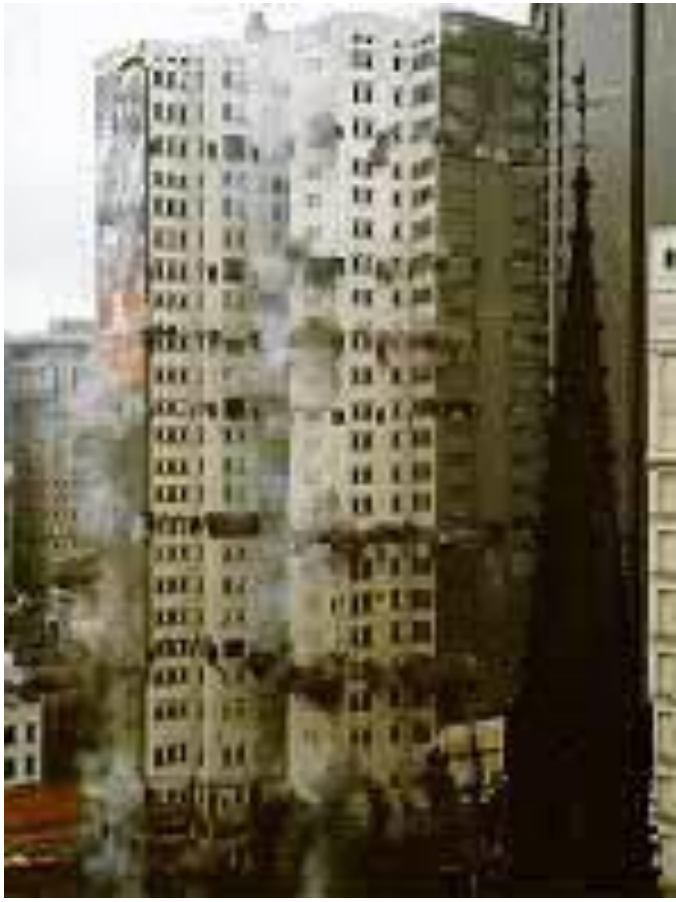
2. Manual operation at heights to be minimised as much as possible.

Demolition of floors

- Floor demolition shall be started only after the surrounding floor for a distance of 6m is cleared off persons, debris, unnecessary materials / loads.
- No work man should be allowed to work underneath the floor.
- Such areas shall be barricaded to prevent access.

Demolition of floors …contd.

- For one-way floor slab, at the first stage, a slit of 300mm (max) shall be cut in the in the direction of span. Then opening shall be increased to desired width in suitable installments.



Demolition of floors …contd.

- Planks supported on stringers of adequate strength shall provided wherever necessary.
- Planks of thickness 50mm (min), width 250mm (min), spaced @ 400c/c (max). Length of plank 2.0m (max).
- Ends of stringers shall be supported on the floor beams / girders

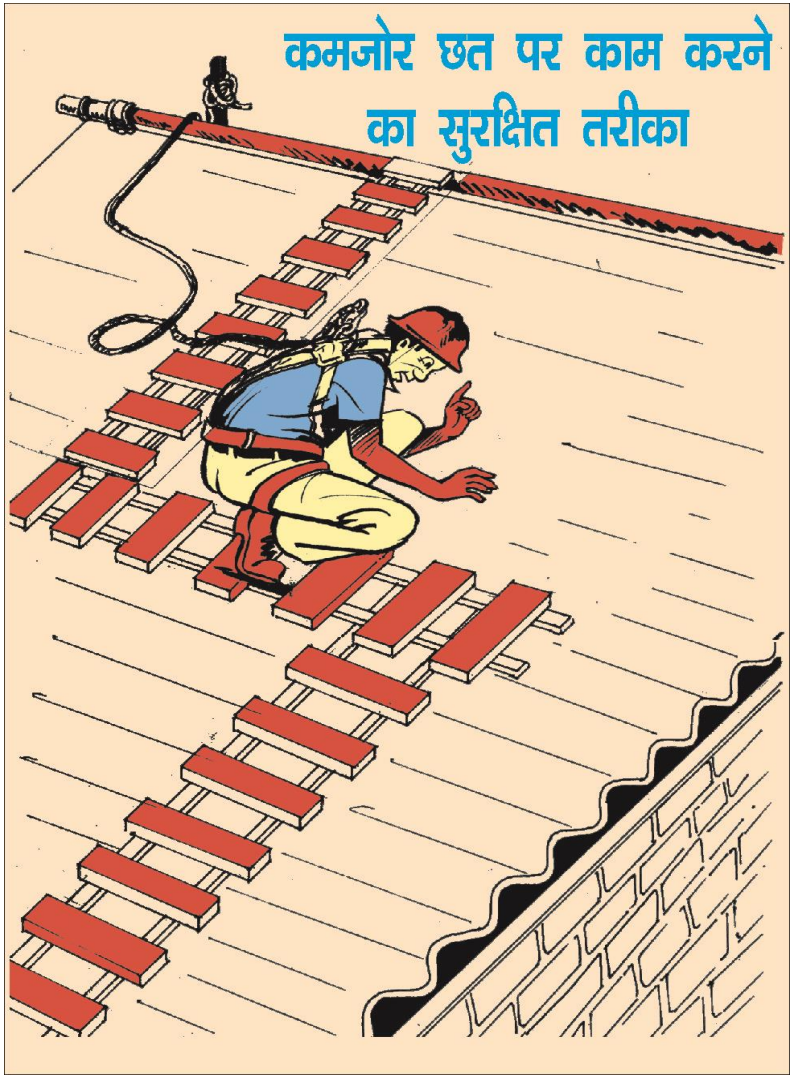
Mechanized demolition

When demolition is to be performed by mechanical devices, such as weight ball and power shovels, the following additional precautions may be observed.

- Building height should not exceed 25m.
- Barricade the surrounding area for a minimum distance of 1.5 times the height of the wall.
- While the mechanical device is in operation, do not allow workman to enter the building being demolished.
- The device shall be so located as to avoid falling debris.
- Ensure that mechanical device does not cause any damage to adjacent structure, power line, etc.

Removal of roof sheeting

- Workmen are not to step on the unsupported portion of metal sheet.
- In case of AC sheet he cannot stand on any location of the roof.
- A cat ladder can be kept on the sloping roof, supported from the ridge, for workmen to stand.



Removal of roof sheeting …contd.

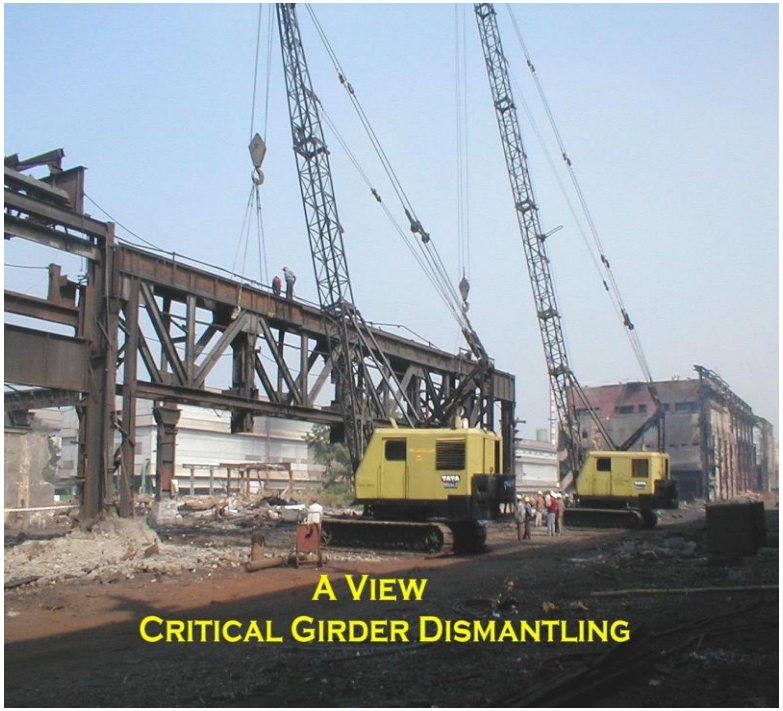
- A firm vertical ladder to be provided to climb on the roof.
- Caution board shall be fixed at the ladders leading to roof top.

Dismantling of Trusses
to be Planned as per type of building
and availability of adequate capacity crane.




Sequence to be made to minimise manual operation at heights as much as possible.

Dismantling Practices for critical items



Scheme to be made before dismantling of critical items

At the end…

There are three (3) attachments to this module :-

Steel building
Open Gantry
Conveyer gallery
EOT Crane

1. Dismantling sequence of various types of steel structures.
2. Recommended practice for dismantling and rearranging (D&R).
3. Planning checklist

These are "Must read" for D&R Engineers

REMOVAL OF MATERIALS/DEBRIS

1. Debris shall not be allowed to be thrown from height. Remove all debris promptly, using chutes or through internal holes.
2. Metal chutes may be provided for removal of materials. The chutes shall preferably be provided at the centre of the building for efficient disposal of debris.
3. Chutes, if provided at an angle of more than 45 degree from the horizontal shall be entirely enclosed on all the four sides, except for opening at or about the floor level for receiving the materials.
4. Opening for the chutes shall not exceed 1.2 m in height measured along the wall of the chute and in all stories below the top floor such opening shall be kept closed when not in use.

REMOVAL OF MATERIALS/DEBRIS contd.

5. To prevent the descending material attaining a dangerous speed, chute shall not be extended in an unbroken line for more than two stories. A gate or stop shall be provided with suitable means for closing the bottom of each chute to stop the flow of materials.
6. Chutes at an angle of less than 45 degree the horizontal may be left open on the upper side provided that at the point where such a chute discharges into a chute steeper than 45 degree to the horizontal. The top of the steeper chute shall be boarded over to prevent the escape of materials.

REMOVAL OF MATERIALS/DEBRIS contd.

7. Any opening into which workmen dump debris at the top of a chute shall be guarded by a substantial guard rail extending at least one meter above the level of the floor or other surface on which men stand to dump the material into the chute.
8. A toe board or bumper not less than 50 mm thick and 150 mm high shall be provided at each chute opening, if the material is dumped from the wheel barrows. Any space between the chute and the edge of the opening in the floor through which it passes shall be solidly planked over.

STAIRS, PASSAGEWAYS AND LADDERS

1. Stairs and stair railings, passageways and ladders shall be left in place as long as possible.
2. All stairs, passageways and ladders to be used by workmen during the process of demolition shall be maintained in a safe condition.
3. Ladders or their side rails shall extend not less than 1.0 m above the floor or platform to which such ladder gives access.
4. All ladders shall be secured / fastened against slipping / turning out at the bottom as well as top end.

DEMOLITION OF WALLS

1. When walls or sections of masonry are being demolished, it shall be ensured that they do not fall as single mass upon the floors of the building that are being demolished, so as to exceed the safe carrying capacity of the floors.
2. Overloading of floors shall be prevented by removing the accumulated debris through chutes or by other means immediately.
3. Walls shall be removed part by part. Stages shall be provided for the men to work in, if the walls are very thin and dangerous to work by standing over them.
4. No section of wall whose height is more than 1.5 times of thickness shall be permitted to stand without lateral bracing unless such wall is in good condition and was originally designed to stand without such lateral bracing or support.

DEMOLITION OF WALLS contd.

5. Structural or load supporting members on any floor shall not be cut or removed until all the storey above that floor have been demolished and removed.
6. Before demolishing any interior or exterior wall within 3m of the opening in the floor such opening shall be substantially planked over, unless access is denied to workman to that portion or the area on the floor immediately below the opening. In the floor of the storey being demolished, where any debris pieces through this opening may fall.
7. In framed structures, the steel frame may be left in place during demolition of masonry work. Where this is done, all steel beams, girders, etc. shall be cleared off loose materials as the demolition of masonry work progresses downward.

DEMOLITION OF WALLS contd.

8. Walkways shall be provided to enable workmen to reach or leave their work on any scaffold or wall. Such walkways shall neither be less than 3 planks, nor less than 0.8 m in width.
9. At the completion of each days work all installations shall be left stable to avoid any danger of getting overturned.
10. Foundation walls which serve as retaining walls to support earth or adjoining structure, shall not be demolished until such an adjoining structure has been underpinned or braced and the earth removed by sheet pilling

DEMOLITION OF FLOORS

- 1. In cutting holes in floor which spans in one direction, a slit of width not exceeding 300 mm shall be cut at the first stage for the entire length of the slab along which it spans. The opening shall thereafter be increased to the desired width by suitable installments.
- 2. Planks of sufficient strength, not less than 50 mm thick and 250 mm wide, shall be provided at spacing not greater than 0.4 m for the workmen to work. The length of planks shall not be less than 2 m. These planks shall be so placed as to give workmen firm support to guard against any unexpected floor collapse.
- 3. Stringers of ample strength shall be installed to support the planks where necessary and the ends of such stringers shall be supported by floor beams, girders and not by floor slab alone.

DEMOLITION OF FLOORS contd.

4. When floors are being removed, no workman shall be allowed to work in the area, directly underneath and such area shall be barricaded to prevent access to it.
5. The demolition of floor shall be started only after the floor in question and the surrounding floor area for a distance of 6 m have been entirely cleared of persons, and the debris and other unnecessary materials removed.

DEMOLITION OF STRUCTURES:

1. When a derrick is used, care shall be taken to see that the floor on which it is supported is amply strong for the loading so imposed, if necessary heavy planking shall be used to distribute the load to floor beams and girders.
2. Overloading of equipment shall not be allowed.
3. Tag lines shall be used on all materials being lowered or hoisted up and standard signal system shall be used. The workmen shall be instructed on the signals.
4. No person shall be permitted to ride the load line.
5. No beams shall be cut until precautions have been taken to prevent it from swinging freely and possibly striking any worker or equipment or any part of the structure being demolished.
6. All structural steel members shall be lowered from the building and shall not be allowed to drop.

CATCH PLATFORMS

1. In demolition of exterior wall of multistoried structure, it is advisable to provide catch platform of heavy planking to prevent injuries to the worker working below and to the public, when the external walls are more than 20 m in height.
2. Such catch platform shall be constructed and maintained not more than 3 storeys below the storey from which exterior walls are being demolished. When demolition has progressed to within 3 stories of ground level, catch platform will not be considered necessary.
3. Catch platforms shall not be less than 1.5 m in width, measured in a horizontal direction from the face of the structure and shall consist of outriggers and planks/steel decks. These shall be laid tight together without openings between them and the walls. Catch platform shall be provided with a continuous solid parapet along its outer edge of at least 1 m height. The parapet shall be constructed of the same specifications as the platform.

CATCH PLATFORMS contd.

4. Catch platforms can be constructed of material other than wood also, provided such material is of equal strength.
5. Catch platform shall be capable of sustaining a live load of not less than 610 kg per square m.
6. The outriggers shall be of ample strength and shall not be spaced more than 3 m apart.
7. Materials shall not be dumped on catch platform nor shall such catch platform be used for storage of materials

REMOVAL OF WALLS, FLOOR AND MATERIAL WITH EQUIPMENT.

1. Mechanical equipment shall not be used on floors or working surfaces unless such floor or surfaces are of sufficient strength to support the imposed load.
2. Floor openings shall have curbs of stop logs to prevent equipment from falling over the edge.

REMOVING AC SHEET ROOFING

1. Before attempting the actual removal, a careful study should be made to find out the strength of the asbestos sheet. In any case, workmen should not be allowed to walk and stand on AC sheets.
2. A firm ladder should be provided for workmen to climb to the roof.
3. A cat ladder which can be kept on the sloping roof (supported from the ridge) should be used for the workmen to stand and remove the sheets.
4. Only experienced workmen should be engaged. They will never step on the unsupported portion of the sheets.
5. Caution boards should be fixed at the ladders leading to the roof top, DANGER: DO NOT GO ON THE ROOF TOP WITHOUT PERMISSION.

RECOMMENDATION FOR DEMOLITION OF CERTAIN SPECIAL TYPES AND ELEMENTS OF STRUCTURES

1 Roof Trusses

- If a building has a pitched roof, the roof structure should be removed to wall top level by hand methods. Sufficient purlin and bracing should be retained to ensure stability of the remaining roof trusses while each individual truss is removed progressively.
- Temporary bracing should be added, where necessary, to maintain stability. The end frame opposite to the end where dismantling is commenced, or a convenient intermediate frame should be independently and securely guyed in both directions before work starts.
- On no account should the bottom tie of roof trusses be cut until the principal rafters are prevented from making outward movement.

2 Heavy Floor Beams

- Heavy blocks of timber and steel beams should be supported before cutting at the extremities and should then be lowered to a safe working place.

3 In-Situ Reinforced Concrete

- Before commencing demolition, the nature and condition of the concrete, the condition and position of reinforcement and the possibility of lack of continuity of reinforcement should be ascertained.
- Attention should be paid to the principles of the structural design to determine which parts of the structure depend on each other to maintain overall stability.
- Demolition should be commenced by removing partitions and external non-load bearing cladding. It should be noted that in some buildings the frame may rely on the panel walls for stability.
- ·Where hand demolition methods are to be used, the following procedures should be used.

4 Reinforced concrete beams

- For beams, a supporting rope should be attached to the beam. Then the concrete should be removed from both ends by pneumatic drill and the reinforcement exposed. The reinforcement should then be cut in such a way as to allow the beam to be lowered under control to the floor.

5 Reinforced concrete columns

- For columns, the reinforcement should be exposed at the base after restraining wire guy ropes have been placed round the member at the top. The reinforcement should then be cut in such a way as to allow the column to be pulled down to the floor under control.

6 Reinforced concrete walls

- Reinforced concrete walls should be cut into strips and demolished in the same way columns.

7 Suspended floors and roots

- Before demolishing suspended floors and roofs, the type of construction should be ascertained.
- In solid slabs, the direction of the main reinforcement should be determined; the slab should then be cut into strips parallel to the main reinforcement and demolished strip by strip. Where ribbed construction has been used, the principle of design and method of construction should be determined before demolition is commenced. Care should be taken not to cut the ribs inadvertently.

8 Precast Reinforced Concrete

- Precast reinforced concrete units used in a structure are normally held in position by the strength of the joints made in-situ or on supporting walls, etc. As such, before starting on demolition, the joint structures and/or the supporting mechanisms shall be studied and understood.
- In devising and following the demolition sequences due precaution shall be taken to avoid toppling over of prefabricated units or any other part of the structure and wherever necessary temporary supports shall be provided.

- Before commencing of the demolition work involving such structures advice of an expert in such demolition shall be obtained and followed.

9 Chimney and Spires

- Before commencing the demolition work, involving such structures, advice of an expert in such demolition shall be obtained and followed.

10 Steel Structures

- Please see the attached procedure on “Recommended practice for sequential dismantling of steel structure”.

- # SECTION – 1

PRECAUTIONS TO BE TAKEN BEFORE DISMANTLING OF STEEL STRUCTURALS.

- Before any dismantling job is taken up, the Contractor shall officially identify a "Dismantling Leader" by a letter to Tata Steel authorities. The Dismantling Leader must have adequate knowledge and experience of structural dismantling and shall be responsible for safe dismantling work. Apart from other safety precautions, he will take particular care of the points, mentioned below:

1. Ensure that the structurals to be dismantled are not supporting any other structures. In case, it is supporting, the other structures should be suitably supported before dismantling work is taken up.
2. All service lines like Oxygen, Nitrogen, Compressed air, CO gas, BF gas, LD gas carrying lines supported on the structurals intended to be dismantled, should be re-routed. In case, it is decided that structurals will be partially dismantled to retain support of the service lines, adequate safety precautions should be taken while dismantling, to avoid fire hazards and puncturing of service lines.

3. All electrical lines supported on structurals intended to be dismantled, should be disconnected from source of power, and dismantling should start only after necessary clearance to that effect is obtained, in writing from concerned Electrical Power/Operation Department.
4. The condition of structurals intended to be dismantled shall be inspected for corrosion, to ensure that it does not collapse while dismantling.
5. All tools and tackles used for dismantling should be in sound condition and adequately strong. Lifting tools and tackles used should have test certificate, issued by competent authority.
6. Cranes, used for dismantling, should have necessary fitness certificate. The driver shall also have necessary health and eye test certificate.
7. If derrick is used in place of crane, it should be properly guyed for stability and should have specified lifting capacity. In no case, the specified lifting capacity should be exceeded.

8. All persons engaged in dismantling work should be given safety training and they should ensure

use of safety appliances. If the dismantling is near any gas line, then the workmen engaged should be given gas safety training.

9. While working at height, safety belt should be used. While climbing up or down, snatch ropes or

fall arrestor should be used. A wire rope may be tied at two rigid points to fasten the life line of safety belt, where other tying members are not available.

10. Job safety analysis should be done

- # SECTION – 2

GENERAL SEQUENCE OF DISMANTLING STRUCTURAL BUILDING

The sequence of dismantling should be such that the structure does not lose its stability at any time.

1. Ensure that all precautions, as indicated in Section – 1, are taken.
2. Remove all roof and side sheetings. Purlins should not be dismantled at this stage, but side girts can be dismantled.
3. If necessary, all purlins between monitor truss can be removed and monitor truss dismantled without damaging the roof truss.
4. Start dismantling from gable end, and work towards any intermediate braced bay. This braced bay is to be dismantled last.
5. Remove gable steel work except roof truss.
6. Remove alternate purlins between end roof truss and adjacent truss.

7 Hold the roof truss to be dismantled with crane or derrick and remove balance purlins, rafter bracings, bottom chord bracings and struts, if any, between this truss and adjacent truss.

8. Gas cut the truss members along the face of column on both sides, and lower the roof truss.

9. Sequence 6 to 8 to be repeated for dismantling subsequent roof trusses.

10. While removing the last two trusses, both the trusses should be held with crane before repeating sequence 7 and 8.

11. Dismantle gantry girder, surge platform, surge girder and outrigger girder between end column intended to be dismantled and adjacent column.

12. Remove longitudinal bracings and struts if any, between end column and adjacent column. Also remove any other structurals or platform. Dismantle end column.
13. Repeat sequence 11 and 12 for subsequent columns on both lines.
14. For multi storeyed building dismantle all floor beams and floor plates except the beams connecting the building column. These framing beams and parts of columns shall be dismantled floor wise, starting from top, maintaining the stability of structures at all time.
15. For bin house, dismantle all bin plates except the girder or bin plates connecting the building

16. Dismantle longitudinal bracings, struts, floor beams, bin plates etc., between end columns and adjacent columns on both rows. Also dismantle beam, bin plates etc. across the building for end column.
17. Dismantle end columns. For long columns, columns can be dismantled in pieces starting from top.
18. Repeat sequence 16 and 17 for subsequent columns on both sides.

- 19. Refer to sketch sheet no. 1 for identification of shed type building components.

20. If during dismantling, a situation is faced, where the remaining component to be removed is likely to loose its stability due to removal of other connecting members, the component must be stabilized with guy ropes.

Based on the above sequence of dismantling, for hazardous jobs, the components like columns, bracings, girders etc. may be given identifying marking at site to avoid wrong member cutting

SECTION – 3

GENERAL SEQUENCE OF DISMANTLING OPEN GANTRY.

1. Ensure that all precautions, as indicated in Section – 1 are taken.
2. Start dismantling from the end, where column bracing is not provided.
3. Hold the top of end column/A-frame using a crane/derrick.
4. Remove gantry girder, surge girder/platform, outrigger girder and any other structural between end column/frame and adjoining column/frame.
5. Dismantle end frame/column.
6. Repeat sequence 3 to 5 for all other frames/columns except for last two braced columns/frames.
7. For last two braced columns/frames, cut and remove all structurals except bracing between the columns/frames.
8. Cut and remove top portion of bracing strut and diagonals along with top portion of columns/frames.
9. Repeat sequence 8 for next lower portion of bracings and columns/frames, till complete column/frame is removed.
10. Refer to Sketch Sheet No. 3 for identification of structural parts of open gantry.

SECTION – 4:

GENERAL SEQUENCE OF DISMANTLING CONVEYOR GALLERY:

1. Ensure that all precautions as indicated in Section – 1 are taken.
2. Remove all mechanical parts like conveyor belt, idlers, deck plates, stringers etc. before removing the gallery structurals. Remove all cables, pipes and cable trays.
3. Remove all roof and side sheeting including purlins and side runners.
4. Hold the portion of conveyor gallery between two supports with crane/derrick. Depending on situation, slinging positions, crane position etc. must be planned and documented. Slings should be tied only at node points.
5. Gas cut the end connections without damaging the supports and conveyor gallery. Top end connections to be gas cut.
6. Lower the conveyor gallery to ground.
7. After lowering on ground, the structures can be removed in small pieces by gas cutting.
8. Refer Sketch Sheet No. 4 and 5 for identification of structural components of conveyor gallery.

SECTION – 5

GENERAL SEQUENCE OF DISMANTLING EOT CRANE:

Ensure that all precautions as given in Section – 1 are taken.

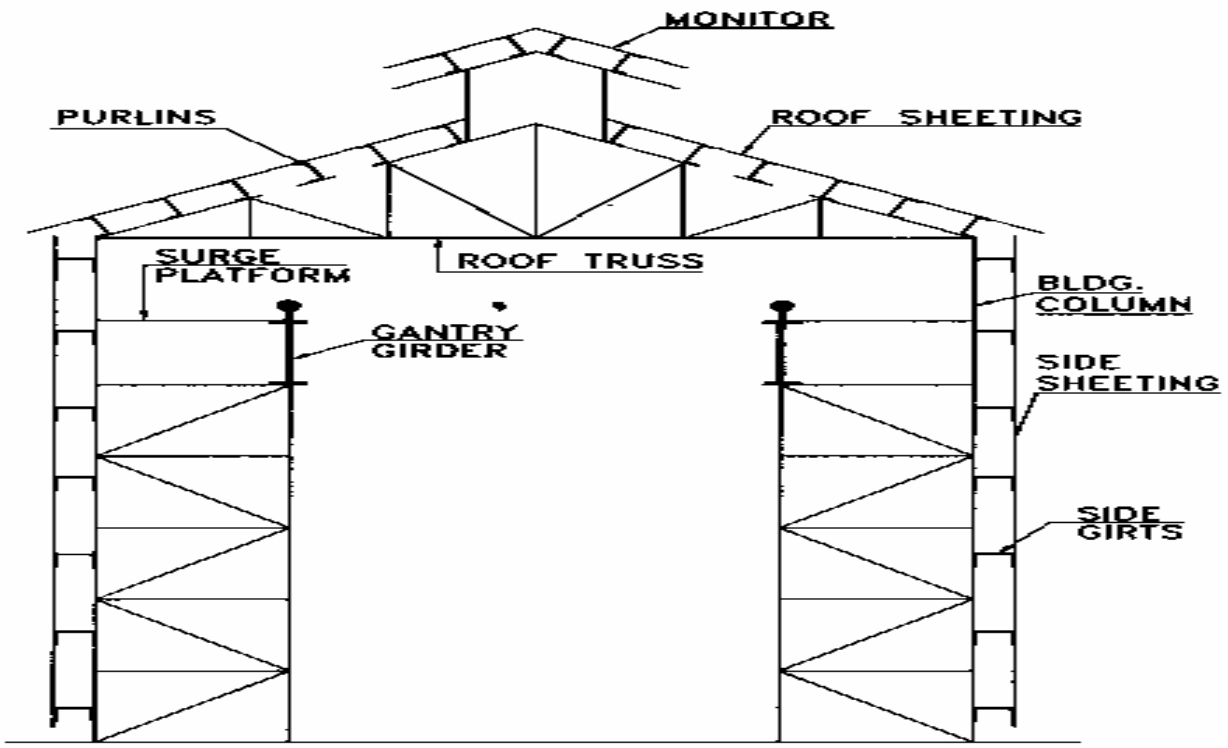
- Dismantle all gear boxes, motors, electrical panels etc. and bring them down to ground.
- Dismantle Trolley structurals and hook block using crane/derrick/Repair trolley. Trolley assembly may be dismantled as a unit if crane or repair trolley capacity is available.
- Dismantle driver's cabin using crane/derrick.
- Tie end carriage with existing gantry girder and building structurals.
- Dismantle bridge girders one by one using crane/derrick.

Lower end carriage using crane/derrick

SKETCH SHEET NO.1
SHEET '1' OF '2'

DETAIL OF SHED TYPE BUILDING

SHEET '1' OF '2'

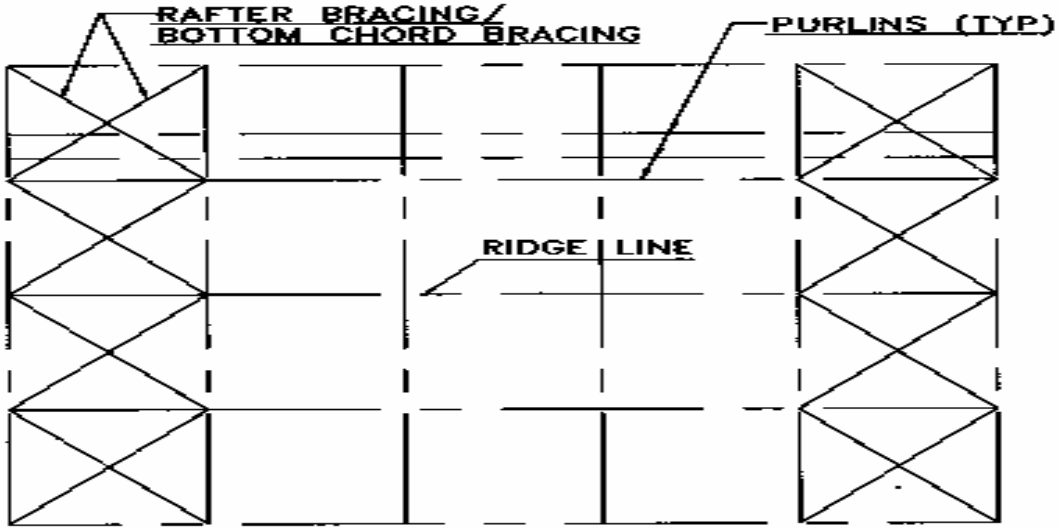


CROSS SECTION OF BUILDING

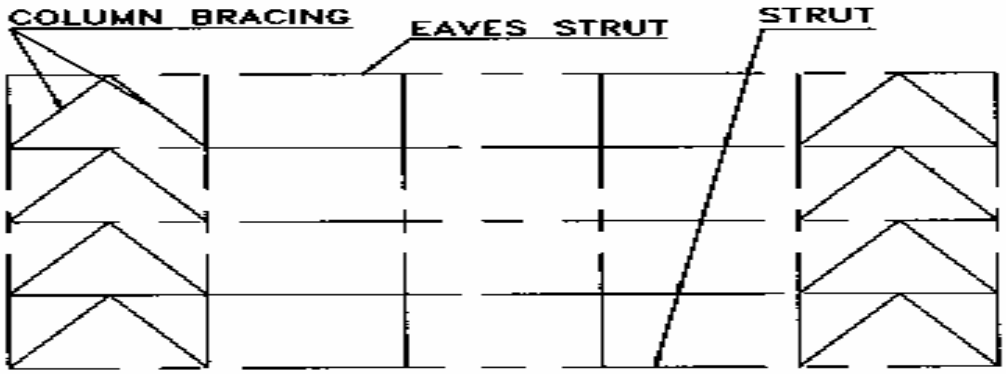
SKETCH SHEET NO.2
SHEET '2' OF '2'

DETAIL OF SHED TYPE BUILDING

SHEET '2' OF '2'



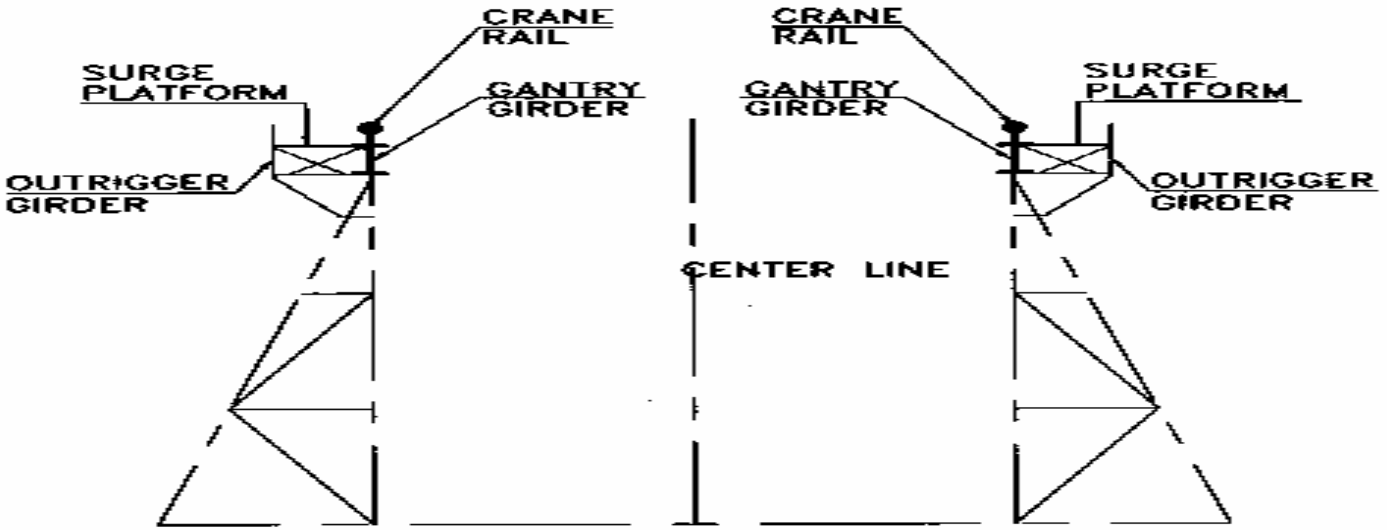
ROOF PLAN



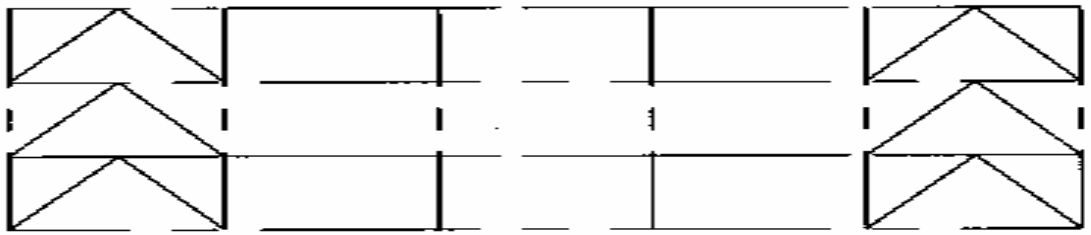
ELEVATION

SKETCH SHEET NO.3

DETAIL OF OPEN GANTRY



SECTION OF OPEN GANTRY

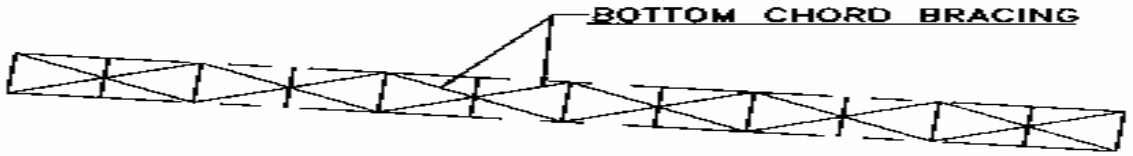


ELEVATION

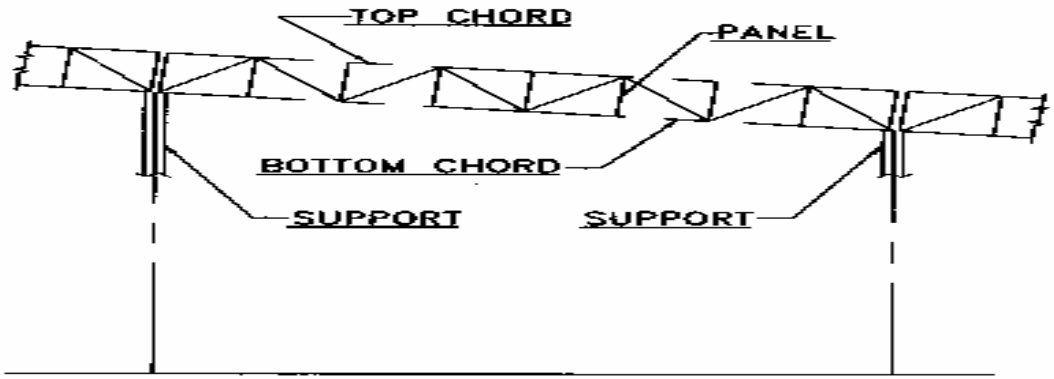
SKETCH SHEET NO.4
SHEET '1' OF '2'

DETAIL OF CONVEYOR GALLERY

SHEET '1' OF '2'

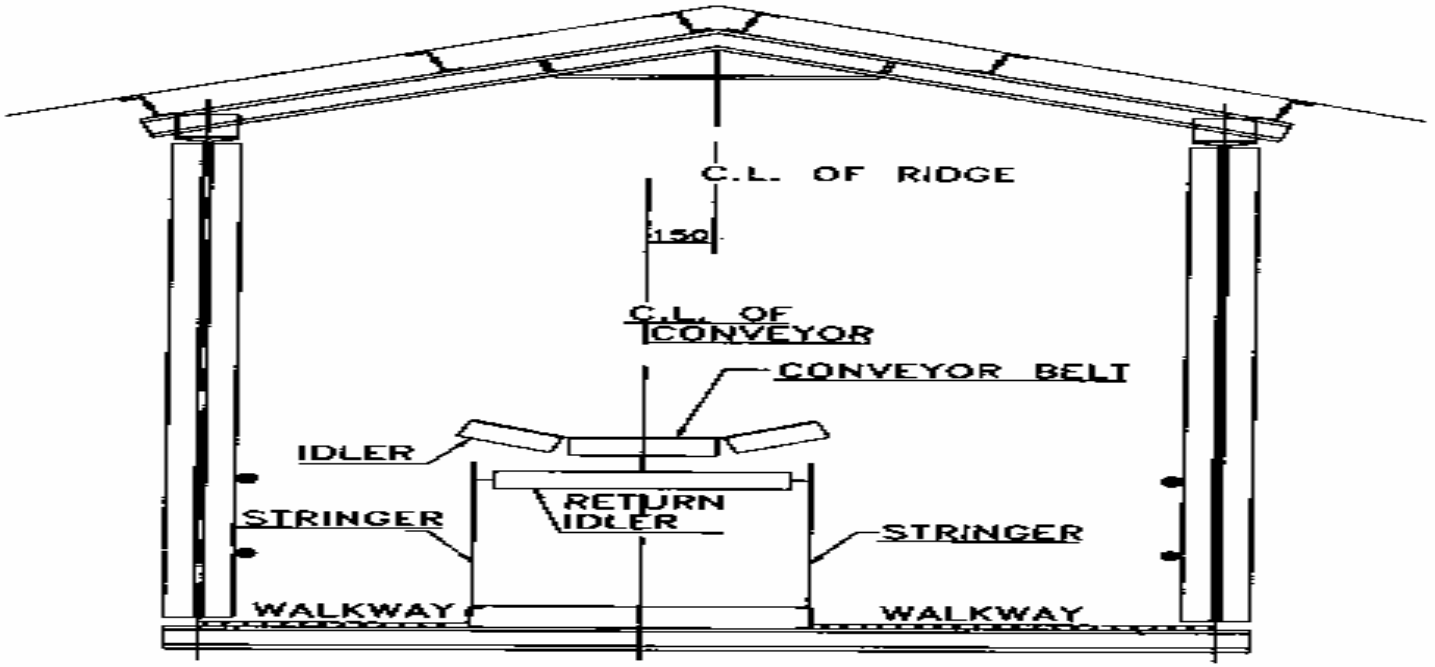


PLAN OF BOTTOM CHORD AND TOP CHORD BRACING



ELEVATION

SKETCH SHEET NO.5
SHEET '2' OF '2'



TYPICAL CROSS SECTION OF CONVEYOR GALLERY

Module - 6

Scaffolding

Scaffolds :Generic Information

- **Scaffolds are intended to provide safe working positions at elevations**.
- Ensure that scaffolds must have complete handrails, midrails and complete decking
- Do not use fall arrest equipment as a substitute for handrails, midrails, or a complete deck.
- No scaffold shall be erected or be substantially altered or be dismantled except under immediate supervision of a responsible and competent person.
- All material for any scaffold shall be inspected by a competent person before being taken into use. Contractors shall engage such competent persons and shall arrange for their training as necessary.

Scaffold-Generic Information

- Every scaffold shall be securely supported or suspended and shall, where necessary, be sufficiently and properly strutted or braced to ensure stability.
- Every platform, gangway, run or stairs shall be kept free from any unnecessary obstruction, material, rubbish and projecting rails. When surface become slippery, appropriate steps shall be taken by way of sanding, cleaning or otherwise to remedy the situation.
- All extended open bars at construction site as well as at plants or other projected bars must be protected with Bar-cap, to cover the sharp projection of the bar.

Related Hazards:

Electrical Hazards

- Care shall be taken to see that no un-insulated electric wire exists within 3 m of the working platform, gangways, runs, etc., of the scaffold.
- While carrying rods or pipes or any kind of conducting material more than 3 m. length in the vicinity of electric wires, special care shall be taken that these do not touch the electric wires.

Mechanical and Traffic Hazards

- Care shall be taken to see that no part of a scaffold is struck by a truck or other heavy moving equipment and no material shall be dumped against it.
- Scaffolds on thorough fares shall be provided with warning lights, if general lighting is not sufficient to make it clearly visible.
- Access to fire alarms, cable tunnels, hydrants, etc., shall remain free at all times. Care should be taken for underground cables and equipment when parts of scaffolds or other fasteners have to be driven in the ground.

Means of access

- There shall be suitable and sufficient safe access to and egress from every place at which any person at any time works.
- A safe and convenient means of access should be provided to all platform level of scaffolds. Means of access may consist of;

- ❑ **Ladder**
- ❑ **Ramp**
- ❑ **Stairway**

❑ **Ladder**: Portable ladders are not recommended for flights above 4 m. They should be placed at an angle of approximately 75^0 from the horizontal. Both top and bottom should be secured to prevent displacement, and the ladder rails should be extended at least 1 m above the top landing. Fixed ladders should be provided for flights above 4 m. Fixed ladder should have landings of minimum 600 mm width and intervals not greater than 6.0 m. The width of ladder shall not be less than 300 mm.

CONSTRUCTION OF PLATFORM, GANGWAYS & RUNS

- **No gangway or run with the slope, exceeding 1 vertical to 1.5 horizontal shall be used.**
- Gangways or runs must be fitted with stepping laths @450 mm c/c if the surface is slippery or if the slope is steeper.
- Corrugated sheets may be used as platform, gangway and runs provided they are designed for strength and stability, fixed properly and made up of good quality material. For a platform of maximum width 800mm, members directly supporting the corrugated sheet / board shall be minimum 25mm dia. rods @ 750mm c/c (max). Alternatively, 40NB Pipes can also be used up to 1250mm width of platform @ 750mm c/c (max).
- Platform shall rest securely and evenly on its supports and have at least 3 supports to avoid any sagging of corrugated sheet.
- Side of a working platform (more than 2 m ht.), Gangways, Stairs shall be provided with Guard rail to a height of 1.15 m above the platform or place.
- Toe board of at least 100 mm high.
- An intermediate guard rail at not more than 765 mm height.
- Platform shall be kept free from all rubbish and projecting nails

AVOIDANCE OF DANGER FROM COLLAPSE OF STRUCTURE

- Scaffolds must always be erected maintained and dismantled by competent & trained person
- Scaffold must be properly braced and when necessary tied into building or the structure.
- All platforms must be properly supported and they should not be overloaded.
- Guard rails and toe boards must always be fitted and be maintained in position.
- Loose packaging such as bricks should never be used below vertical members.
- Diagonal bracing parallel to the face of the building and full height of the scaffold should be provided at 3.0 m intervals.
- Bracings shall be provided to take care of the stability of scaffolds in both directions.

CONSTRUCTION AND MATERIAL

- Every scaffold and every part thereof shall be of good construction, of suitable and sound material and of adequate strength for the purpose for which it is used**. The Contractor/Sub-contractor shall be responsible for the design and safety of scaffold system**
- For scaffolding construction the individual tube or tubes forming part of the unit frame shall conform to the requirements **of IS: 1161:1968**.
- **The design of Steel Scaffold and all its components shall conform to IS: 2750:1964**
- The base plate shall have a level surface area of at least 15 cm x 15 cm or equivalent area, concentric with the axis of the shank to which it shall be securely attached.
- Before starting the scaffolding erection, the surface on which it has to be erected must be made firm and level.
- Once the surface is ready, sole plates have to be kept. It can be a timber sleeper or steel plate. Sole plates may be avoided in case the scaffold is erected on a firm ground like concrete floor etc.
- Base plates are a must, irrespective of where the scaffolding is erected. It should be 150 x 150 mm steel plate of thickness not less than 6mm. Sole plates and base plates support the entire load of the scaffolding. They distribute the load and prevent the scaffold from sinking.
- Do not use corroded / deformed couplers and make sure that threads are in good condition
- No Dropping or throwing materials from the top shall be allowed

SUSPENDED SCAFFOLD

- Every suspended scaffold shall be provided with adequate and suitable chains or ropes and winches or other lifting appliances or similar devices and shall be suspended from suitable outriggers, joists, run-ways, rail tracks or other equally safe anchorage.
- The winches or other lifting appliances or similar devices of a suspended scaffold shall be
- provided with a brake or similar devices which comes into operation when the operating handle or lever is released.

TRESTLE SCAFFOLD OR MOBILE SCAFFOLD BOATSWAIN'S CHAIRS, CAGES etc

- All trestles and supports used for the construction of any trestle scaffold shall be of –
- Good construction, suitable and sound material;
- Adequate strength for the purpose for which they are used and free from any defects.
- The width of the said platform is such as to leave sufficient clear space for the transport of material along the platform.
- The trestles or supports are firmly attached to the platform and adequately braced to prevent displacement.
- Boatswain's chair, cage, skip or similar plant or equipment not power operated, shall be used as a working place only when the work would not take long enough to make use of a suspended scaffold reasonably practicable.
- No scaffold, or Boatswain's chair, etc. shall be used unless –
- It has been inspected during the previous 7 days by a competent person;
- It has been inspected after a rough weather conditions likely to have affected its strength or stability or to have displaced any part.
- **T**he details of each inspection are recorded. Records are not required for scaffolds under 2 m in height or for ladder or trestle scaffolds.

Training

- Employees involved in the erection, dismantling, moving, repairing, etc., of scaffolding shall receive training from a competent person. The purpose of the training is to recognize any hazards associated with the work in question. Training shall consist of:

– the correct procedures for erecting, disassembling, moving, operating, repairing, inspecting, and maintaining the type of scaffold in question

– the design criteria, maximum intended load carrying capacity, and its intended use

– Various hazards like electrical hazards, fall hazards, falling object hazards in the work area

– The correct procedures for dealing with electrical hazards and for erecting, maintaining, and disassembling the fall protection systems and falling object protection systems used

– The proper use of the scaffold and the proper handling of materials on the scaffold

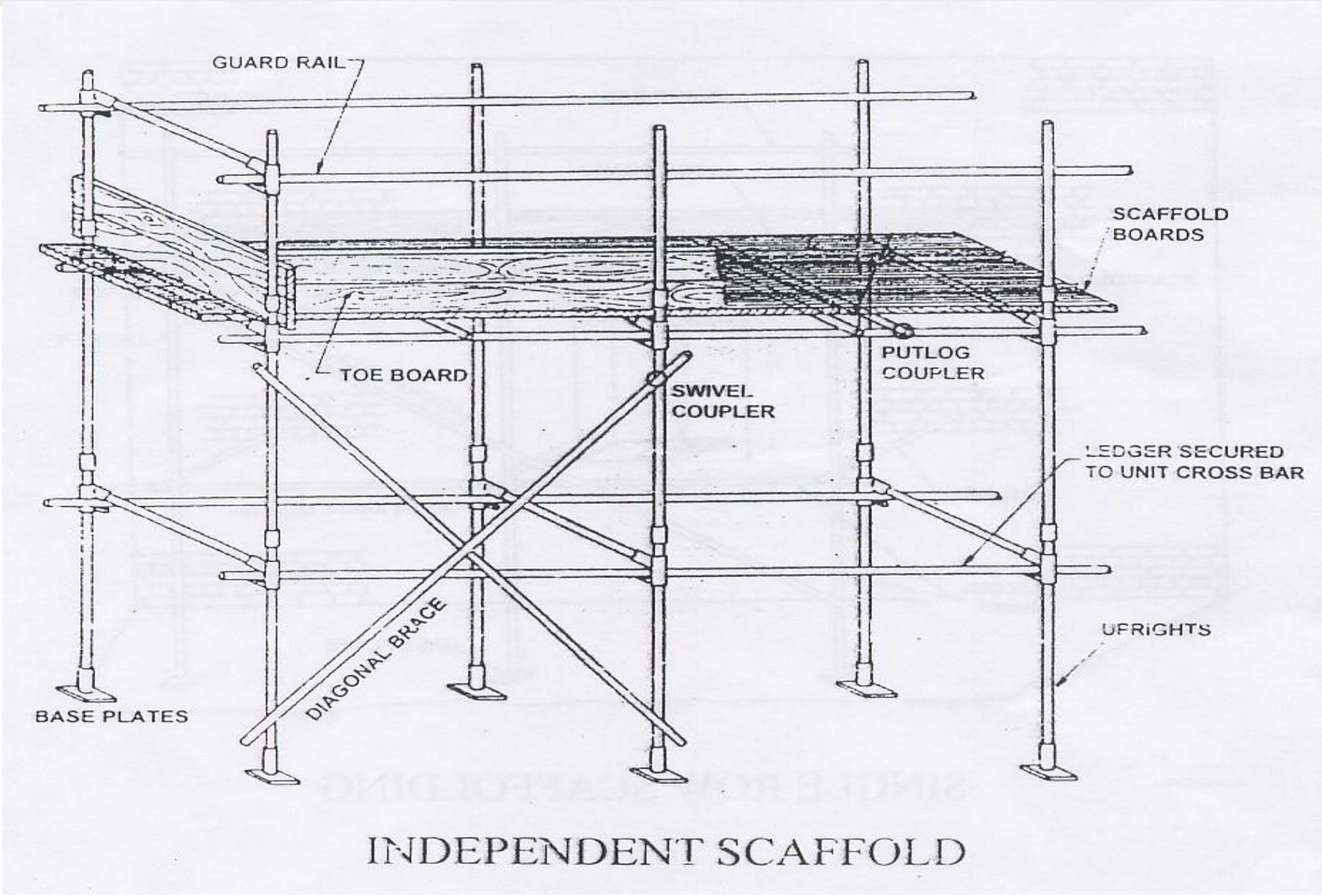
– The maximum intended load and the load carrying capacities of the scaffolds used

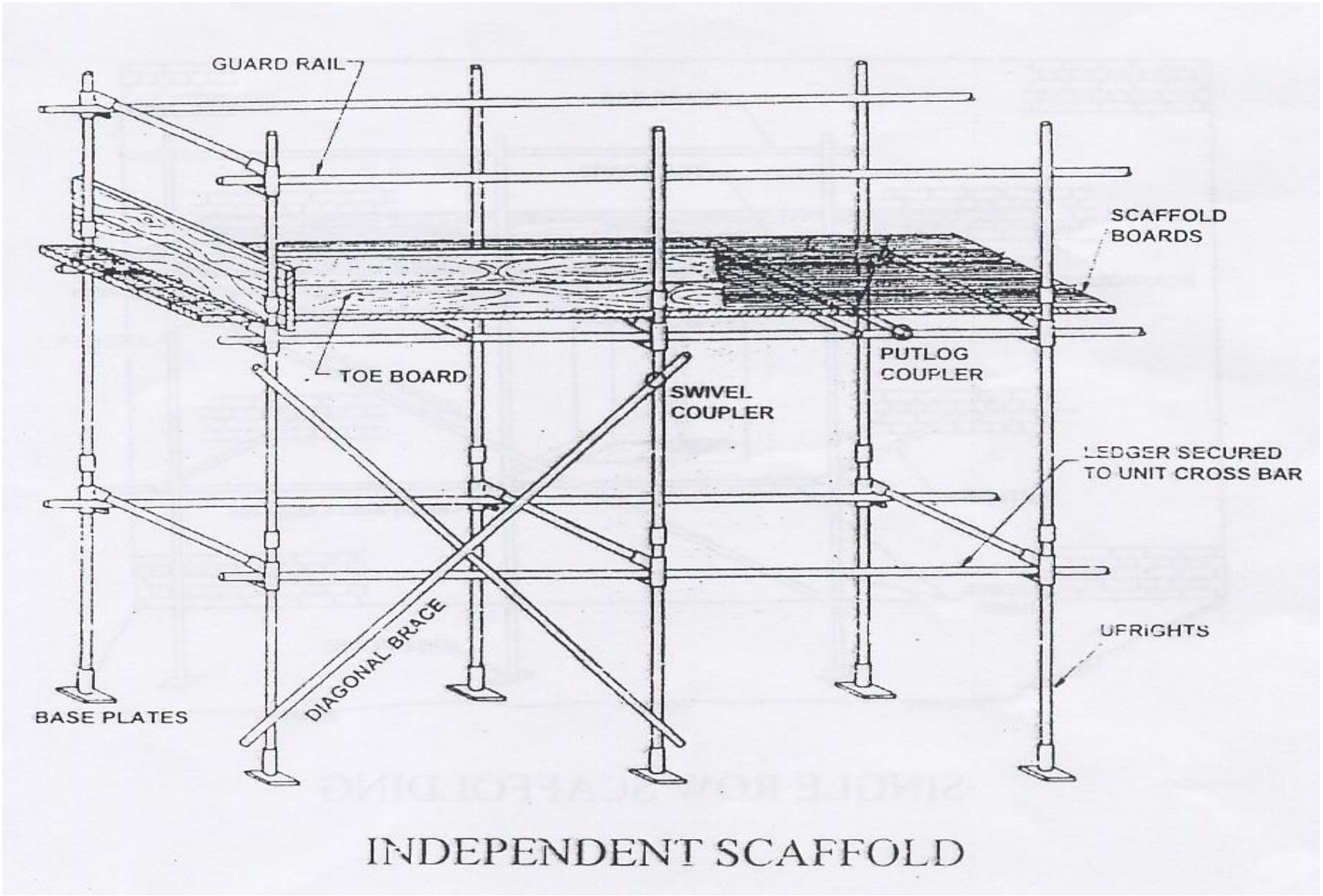
Check-list

Requirement of the standard

- Scaffolds are having handrails, mid-rails, and decking.
- Every scaffold is sufficiently and properly strutted or braced to ensure stability.
- The foot or base of any standard or upright shall be placed on an adequate base plate.
- No un-insulated electric wire exists within 3 m of the working platform, gangways, runs, etc..
- No opening in working platform is present.
- Working platform is free from rubbish and other unwanted materials.
- Toe board height is at least 100mm
- Suitable and sufficient safe access and egress are present
- All portable ladders are approximately at 75° with the horizontal.
- Ladder rails are projected by 1 meter beyond the top landing
- Ladders are properly anchored at top and at bottom.
- The gap between any two consecutive steps is less than 300mm and the spacing is uniform.
- Employees who perform work can recognize hazards associated with the type of scaffold being used and understand the procedures to control those hazards.
- Inspection register containing the inspection records is available at work site.
- Tags showing **“ Safe for use”, “Do not use” or “Erection /Dismantling is on progress” shall be displayed on all scaffolds at all time.**

Standard Scaffold





INDEPENDENT SCAFFOLD

TYPICAL SIGNS & TAGS

IDENTIFICATION NO:

SCAFFOLD INSPECTOR:

DATE OF ERECTION:

DO NOT USE

NO ACCESS

SCAFFOLDING ERECTION / DISMANTLING IN PROGRESS

SAFE FOR USE

Module - 7

Manually Propelled Mobile Ladder

Purpose:

To define the requirements for materials, fabrication and performance of manually propelled mobile ladder stands and scaffolds.

Associated Hazards:

- **Falling from height,**
- **Over head electric lines**
- **Exposed parts of components**
- **High velocity wind**

Compliance Requirement:

Permissible stresses on structural design of tubular steel / aluminum alloys scaffoldings as specified below -

Light : 25 lb/ft sq. (122 kgf/m sq.)

Medium: 50 lb / ft sq.(244 kgf/m sq.)

Heavy : 75 lb/ft sq.(366 kgf/m sq.)

Barrels, boxes, loose tile blocks or other unsuitable objects should not be used as supports for working platforms.

The platform edges should be equipped with toe board to eliminate hazard of tools or other objects falling from the platform.

The location where the manually propelled scaffold and ladder structure rests should be reasonably leveled.

□

The platform and stairs should be kept free from oil, grease & any unnecessary material.

The mobile Platform should be only used for which it has been designed.

Defective ladders should be promptly repaired or replaced.

Ladders leading to landing or walkways should extend at least one meter above the landing and should be secured at the upper end.

To prevent slipping, a ladder should be secured at the bottom end. If this cannot be done, a person should be stationed at the base whenever it is in use.

The pitch at which a lean-to-ladder is used should be such that the horizontal distance of its foot from the vertical plane of its top should not be more than one quarter of its length.

No ladder should be placed or leant against window-panes, sashes or such other unsafe or yielding objects, nor placed in front of door opening towards it.

If set up in driveways, passageways or public walkways, it should be protected by suitable barricades.

When ascending or descending, the user should face the ladder.

Ladder should not be overcrowded.

Employees should use at least one hand to grasp the ladder when they are climbing and descending.

In order to reach a larger area from a single setting of the ladder, the user should not lean more than 30 cm to side.

Men should not be allowed to work from portable scaffolds during storm or high winds.

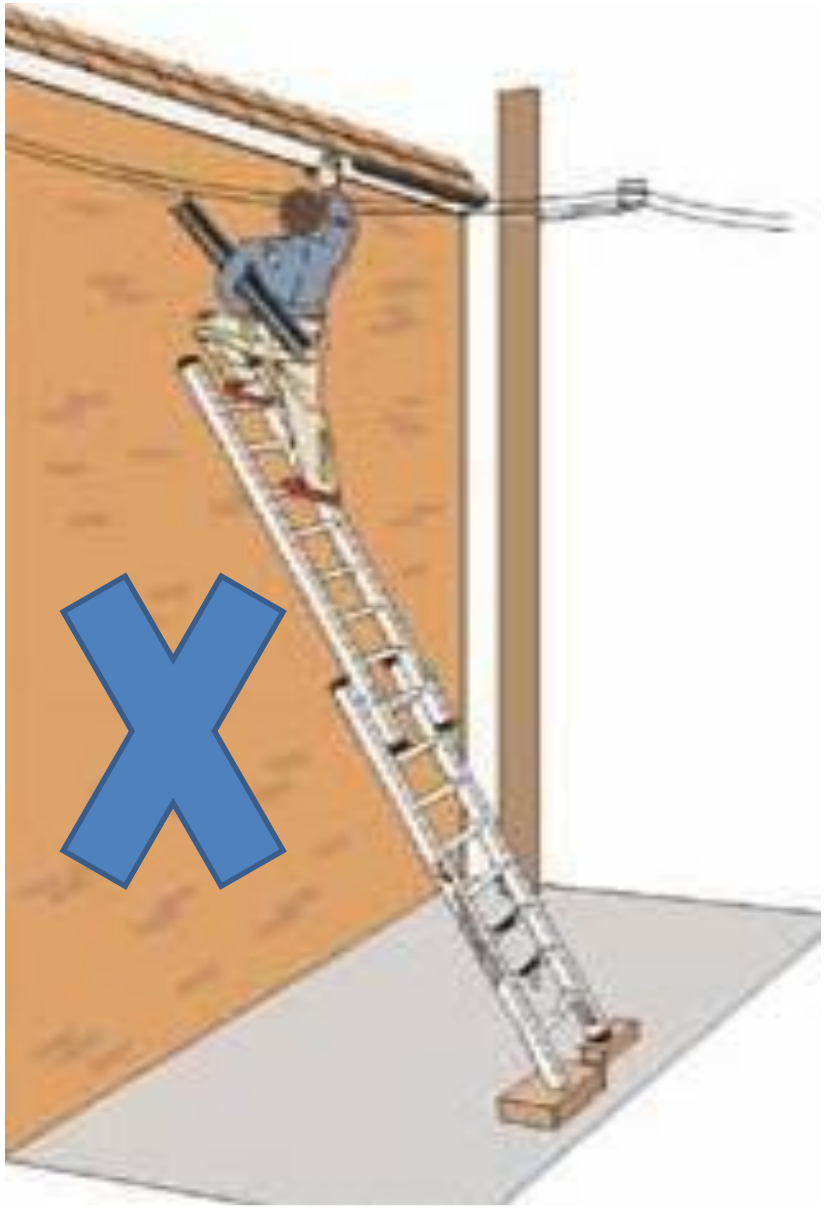
Trestle and extension trestle ladders should always be used in a fully spread position.

Electrical Hazards:

Work should be stopped in case of Un-insulated electric wire within 3 m of the working platform of the scaffold.

Special permission should be taken from the authorized person in case of presence of high tension line within 3 m working platform & positive isolation should be done.

Metal ladders should not be used around electrical equipment or circuits of any kind.



Un- insulated electrical wire

Both hands engaged

High Pitch for ladder

Ladder placed on bricks

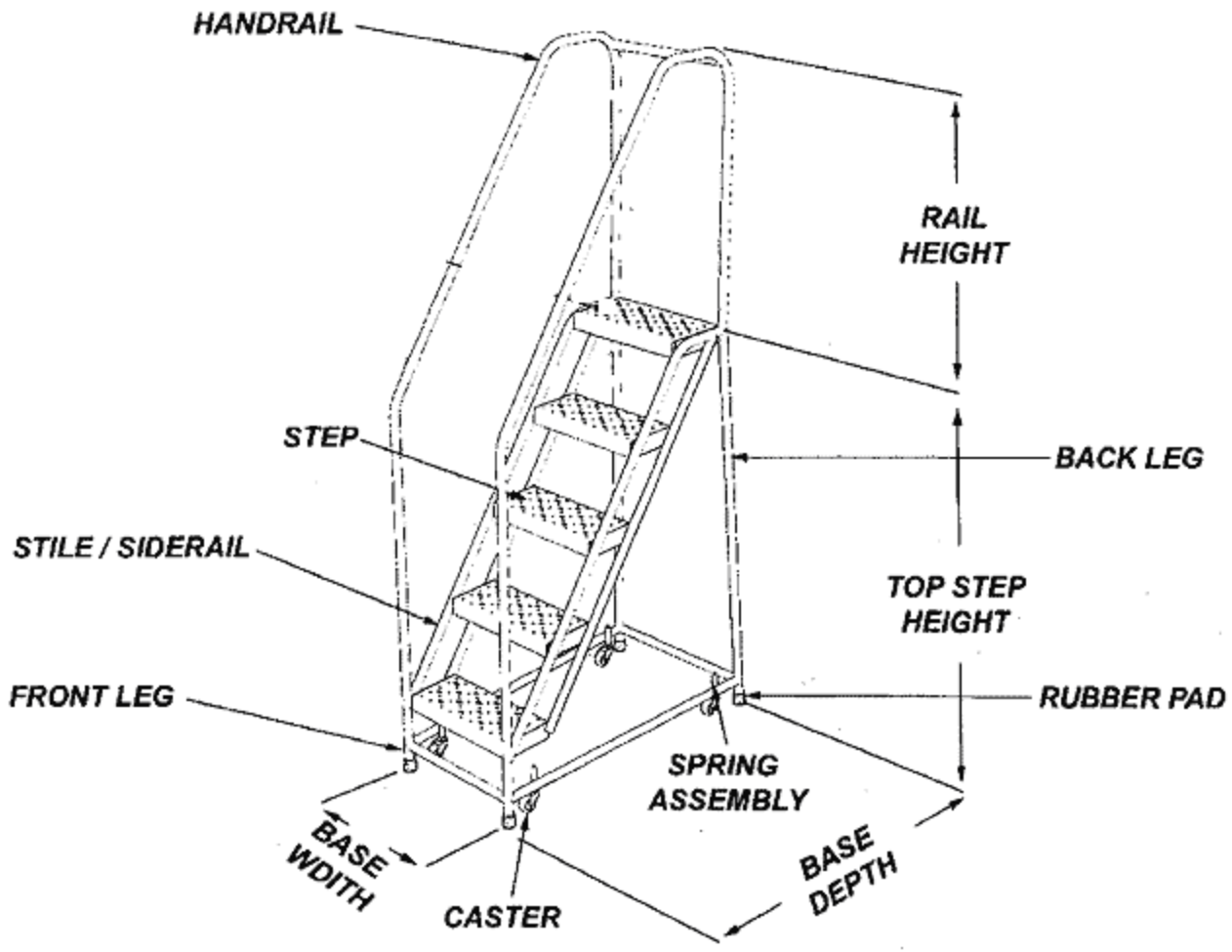
Inspection:

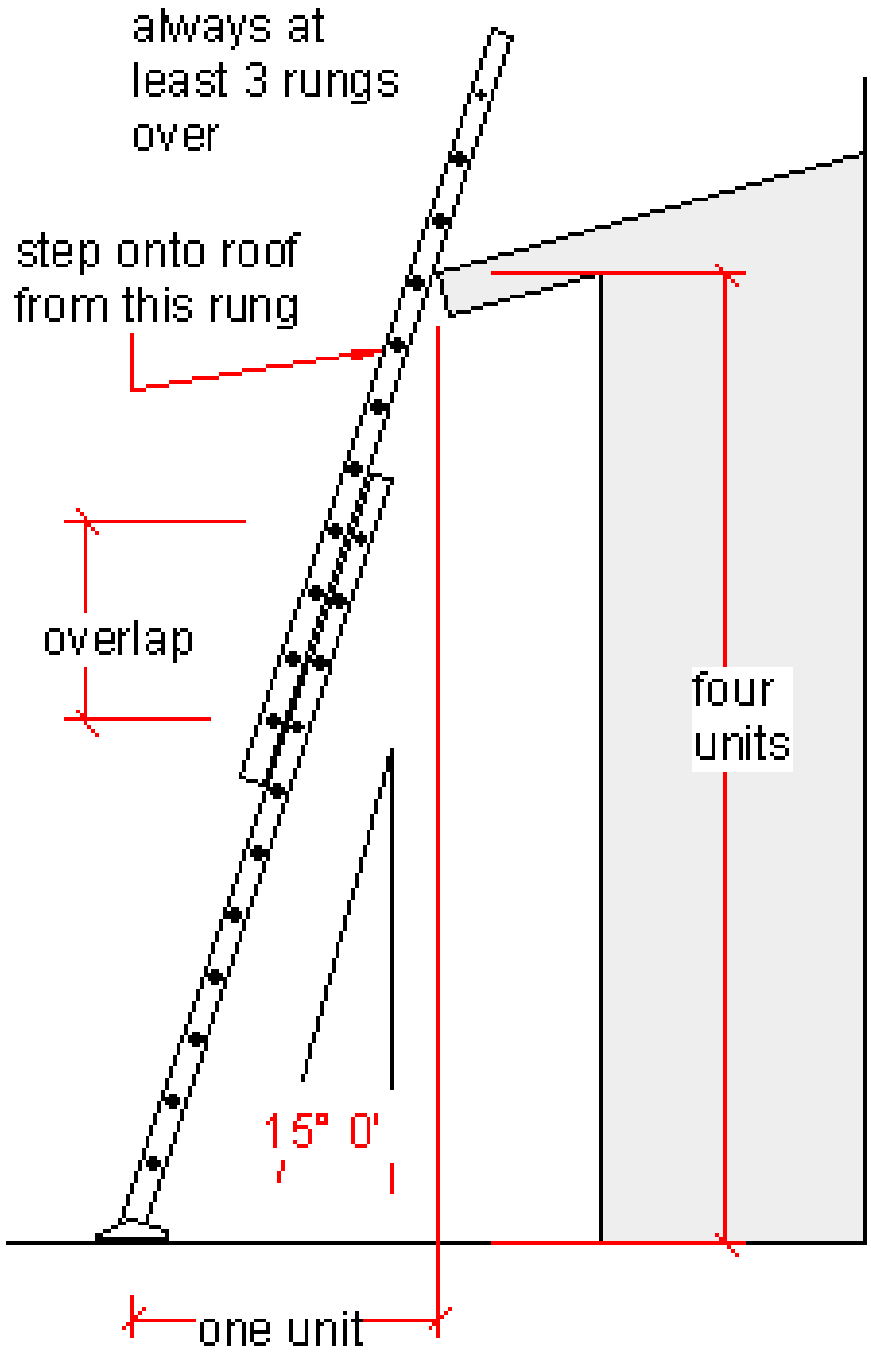
A competent person must periodically inspect ladders for defects and after any occurrence that could make them unsafe

Scaffolds should also be inspected **every fortnight, during use and again before starting use**

Records:

Records on checking and inspection shall be maintained by the User Department.


HANDRAIL
RAIL HEIGHT
STEP
BACK LEG
STILE / SIDERAIL
TOP STEP HEIGHT
FRONT LEG
RUBBER PAD
SPRING ASSEMBLY
BASE WDITH
CASTER
BASE DEPTH


always at
least 3 rungs
over
step onto roof
from this rung
overlap
four
units
15° 0'
one unit

Training module on

Working at height and fall protection SS / ENG / 03

Module - 8

Working at Height and Fall Protection

Purpose

To provide safety guidelines for working at height (>2.0m) and necessary protective measures against possible falling hazard.

CAUSES OF FATAL INJURIES IN THE CONSTRUCTION INDUSTRY

- 44% Falls from height
- 17% Struck by moving vehicles
- 17% Trapped by collapse or overturning
- 8% Struck by moving/falling object
- 17% Other

Glossary

Fall arrest system:

Consists of mainly an anchorage, connector, lifeline, lanyard and full body harness.

Anchorage:

A secure point of attachment to which lifeline or lanyard are affixed (Capacity > 2000 Kilogram).

Connector:

A device for attaching a lifeline / lanyard etc. to the anchorage. Carabineer is a oval or trapezoidal shaped connector with a gate / locking arrangement.

Glossary

Lifeline:

A flexible vertical or horizontal line secured to the anchorage to which a lanyard is attached.

Full body harness:

A device with straps fastened around the body to distribute the fall arrest forces over the upper thighs, pelvis, chest and shoulders.

Retractable lifeline:

A lifeline which allows free travel without slack rope but locks instantly when a fall begins. To be used by one person at a time.

Glossary

Safety net system:

- To be installed as close as practicable below the working surface.
- Shall pass drop test by 180kg bag of sand falling from minimum 1.1m height.
- Adequate projection from edge of working surface shall be maintained as follows:

Vert. distance	Horz. projection at edge
1.5m	2.4m
1.5m – 3.0m	3.0m
> 3.0m	4.0m

Most common and dangerous fall hazards

- Installation and painting of overhead cranes, monorails, conveyors, piping
- Insulation of overhead piping
- Erection and painting of tanks, chimneys
- Construction of exterior brickwork, finishing and cladding work
- Erection and dismantling of scaffolds
- Working on pile driving rig

Special attention shall be paid to this kind of job.

Work permit

- To be issued in prescribed form.
- Ensure the check points mentioned at the back of the form before issuance, e.g.

1) Whether a certified rigger?
2) Fit for working at height (No vertigo)? ..... Ask for medical certificate for working at height
3) Has got training for working at height?
4) Equipped with fall arrester / safety belt, safety helmet with chin strip?

Work permit (Contd…)

5) Whether proper approach like steps, ladder is in place? Assess their conditions.

6) Whether the working platform is properly made with handrails, toe boards etc.?

7) Whether the scaffolding is safe and as per standard?

Work permit (Contd…)

- Check clearance with any power line or mobile equipment in the vicinity?
- Communicate to the workmen about the possible hazards in the working area, like gas lines, power lines etc.

Records

- Concerned Site in-charge shall maintain the work permits for at least a year.
- Records of incident / accident shall be maintained at the working department and at the safety department for at least five years.

Before work starts….

- Ensure that the area below working platform is barricaded.
- Check that workmen and equipment are not exposed to adverse weather like high wind, storm, lightning etc.
- Ensure that the job is carried in presence of a competent Supervisor, who knows to deal with the emergencies.

At the end of the day….

- The working platform must be cleared off tools, equipment and debris etc.
- Power connection for the job is switched off.
- Working area should not accessible to trespassers.

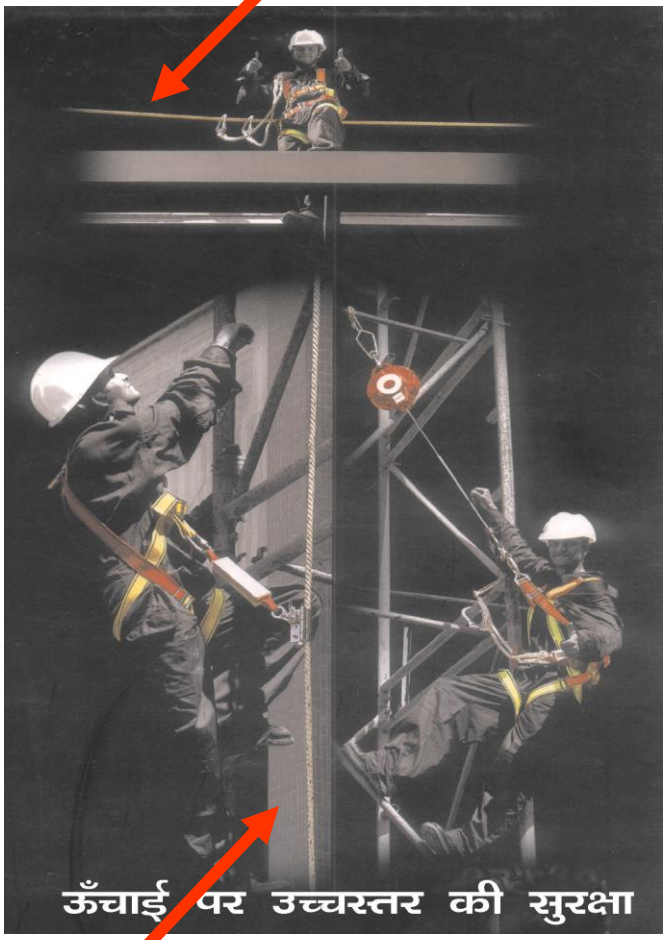
Mobile elevated working platform (MEWP)

- Safe access to height.
- Used in firm and level ground. Preparation required in advance.
- To be placed away from power line (>3.0m) and vehicular traffic approach.
- Fall protection necessary second line of protection.

Checklist

Lifelines:

- Minimum breaking strength 2000 Kilograms
- Protected from abrasive or cutting edge
- Workman should not hold it for balance
- Life line should be minimum 12 mm dia. wire rope.
- Not more than two persons shall be permitted to attach their lanyards to a single horizontal life line, at one time
- The lifeline shall be anchored between two posts/supports not more than six meter apart
- No more than one person may tie-off to a vertical lifeline



Checklist

Anchorage point:

- Must be independent of working surface
- Capable of supporting min. 2000 Kilograms
- Located at or above shoulder height

Checklist (contd..)

Lanyard

- Not longer than 1.8m
- Should have shock absorbing properties (227-272 kg)
- Tying of knots prohibited from lanyard to lifeline
- It shall not break under a minimum load of 2000 kg
- The lanyard shall meet the requirement of IS: 3521 (Or equivalent)

Snap hook

- Inspect regularly against wear, distortion etc.
- Two snap hooks shall not be connected to each other

Body harness

- Inspect regularly against abrasion, broken stitching, missing hardware
- Instruct the workers about the use and care of the same

Detailed inspection check list for working at height

ऊँचाई पर चलते समय सेफ्टी बेल्ट के लाईफ लाइन को गाई रोप में बाँधें

Sl. No	Points to Check (GENERAL)	Y	N	NA
1	All the workers have been explained safe work procedures?			
2	An effective communication system have been established and explained to the workers.			
3	Adequate illumination has been ensured.			
4	Work area inspected prior to starting of the job.			
5	Area below the work place barricaded, especially below hot works.			
6	Workmen provided with bag/box to carry bolt, nuts and hand tools.			
7	Arrangement for fastening of hand tools made			
8	All work platforms ensured to be of adequate strength and ergonomically suitable.			
9	Fabricated make shift arrangements are checked for quality and type of material ,welding, anchoring etc.			
10	Work at more than one elevation at the same segment is restricted.			

Sl. No.	Points to Check (ACCESS & EGRESS)	Y	N	NA
1	Walk ways provided with hand rails, mid rails and toe guards?			
2	All chequered plates, grating properly welded/bolted?			
3	Are ladders inspected and maintained in good condition?			
4	Are ladders spliced?			
5	Are ladders properly secured to prevent slipping, sliding or falling?			
6	Do side rails extend 1m above top of landing?			
7	Are built up ladders constructed of sound material.			
8	Rungs spacing should not be over 300 mm on centre.			
9	Metal ladders not used along electrical hazards.			
10	Ladders placed at right slope.			
11	Ladders, stair cases welded/bolted properly.			
12	Any obstruction in the stair			
13	Are landings provided with hand rails, knee rails, toe boards etc?			
14	Whether ramp is provided with proper slope.			
15	Proper hand rail/guards provided in ramps.			

Sl. No.	Points to Check (HOUSEKEEPING)	Y	N	NA
1	Walkways, aisles and all overhead work places cleared of loose material			
2	Flammable materials, if any, are cleared			
3	All shuttering materials are removed after de shuttering is done.			
4	Platforms and walk ways free of oil/grease or other slippery spillage.			
5	Collected scrap are brought down or lowered down and not dropped from height			
	Points to Check (PPE)			
1	Use of safety helmet, safety belts / full body harness ensured for all workers.			
2	Anchoring point provided at all places of work.			
3	Common lifeline provided where ever linear movement at height is required.			
4	Safety nets are in use where ever required.			
5	Proper fall arrestor system is deployed at critical work places.			
6	Crawler boards/safety system for work on fragile roof is used.			

Sl. No	Points to Check (Anchorage Points)	Y	N	NA
1	Do the workers know the appropriate anchorage points for each task			
2	Are all the anchorage points are capable to supporting at least 2000 Kilograms/person			
3	Are the anchorage points for body harness located at shoulder height and anchorage points for self retracting lifeline systems located overhead			
4	Are anchorage points independent of the working surface.			
5	Can a worker move from one station to another or climb up and down without exposure to a fall			
6	If the lifeline, lanyard, or self-retracting lifeline is not permanently attached to an anchorage point at the elevated work area, is the first worker up or the last worker down protected while climbing and traversing			

Sl. No	Points to Check (Vertical lifelines)	Y	N	NA
1	Does the lifeline have a minimum breaking strength of 2000 kilograms)			
2	Is the lifeline protected from abrasive or cutting edges			
3	Does the system provide fall protection as the worker connects to and releases from the lifeline			
4	Is the lifeline arranged so workers never have to hold it for balance (A lifeline should never be used for balance.)			
5	Is the vertical segment integrated with the horizontal segment to provide continuous fall protection?			

Sl. No	Points to Check (Horizontal lifelines)	Y	N	NA
1	Has the entire horizontal lifeline system been designed and approved by a qualified person			
2	Have the anchorages to which the lifeline is attached been designed and evaluated specifically for a horizontal lifeline			
3	Has the designer of the system approved the number of workers who will be using it			
4	Is the rope or cable free from signs of wear or abrasion			
5	Does the rope or cable have the required initial sag			
6	Have the workers been warned about potential falls			
7	Have the clearances been checked			
8	Is the hardware riding on the horizontal lifeline made of steel (Aluminum is not permitted because it wears excessively.)			

THANKS