

## SAFETY IN TUNNELING AND EXCAVATION

### TUNNELING

- 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 TUNNELING 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 provided.
- 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 be 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 TUNNELING:

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<sup>0</sup>C dry and 29<sup>0</sup>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.
7. Periodical medical check up of the workers at least once in three months to be done and recorded .
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 be 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.

## **EXCAVATION**

1. Construction work involves excavations for foundations, sewers and underground services.
2. Trenching and excavations work can be highly dangerous , as workmen are caught by the sudden and unexpected collapse of the unprotected sides of a trench.
3. Due to pressure of soil on the chest , workmen are unable to breathe resulting in suffocation and loss of life.
4. The possibility of flooding presents an additional hazard .
5. Cracks are caused by pressure release as soil is removed, or drying out in hot weather.
6. No soil can be relied upon to support its own weight and precautions need to be taken to prevent the slides of the sides of excavations of more than 1.2 meters in depth to cave in.

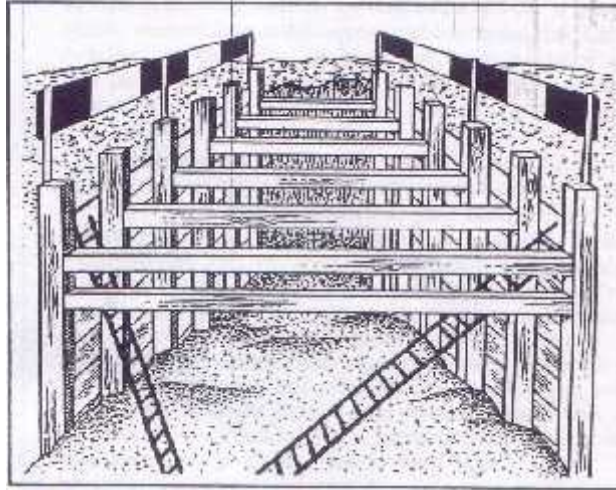
## **COMMON CAUSES OF ACCIDENTS IN EXCAVATION**

The main causes of accidents resulting from excavation work are as follows:

- Workers trapped and buried in an excavation owing to the collapse of the sides;
- Workers struck and injured by material falling into the excavation;
- Workers falling into the excavation;
- Unsafe means of access and insufficient means of access in case of flooding;
- Vehicles driven into or too close to the edge of an excavation, particularly while reversing, causing the sides to collapse;
- Asphyxiation or poisoning caused by fumes heavier than air entering the excavation, e.g. exhaust fumes from the diesel and petrol engines.

## **SAFETY PRECAUTIONS**

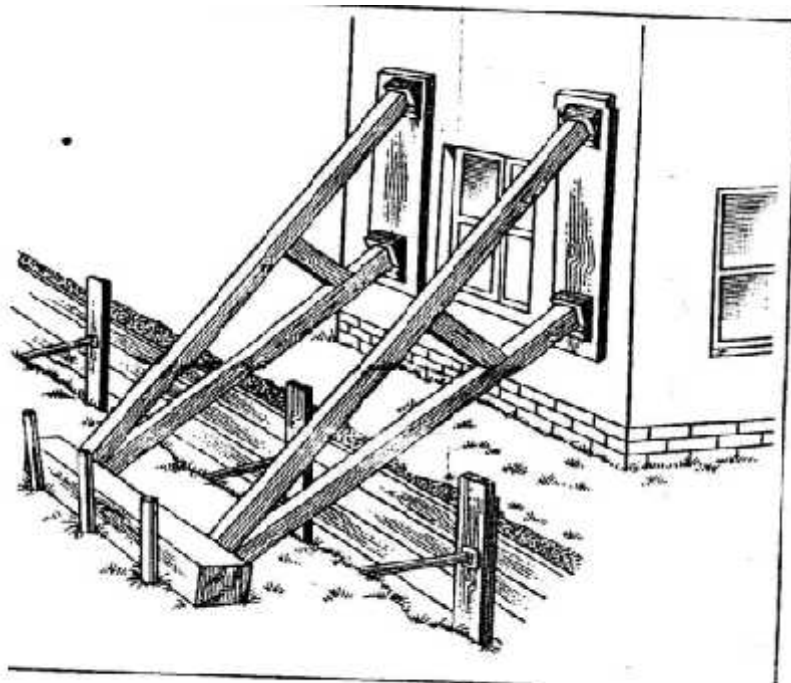
1. All excavation work shall be done under supervision of responsible person.
2. The sides of the excavation or trench should be sloped or battered back to a safe angle of repose, usually  $45^{\circ}$ .
3. To prevent collapse of excavations, the sides shall be supported by timbering or side sheet piling and shoring or other suitable means.
4. The type of support necessary will be depending on type of excavation, the nature of ground and the ground water conditions.
5. Trench support must be installed without delay as the excavation progresses.
6. Excavations of 1.2 meter or more in depth should be provided with adequate timbering or side sheet piling and shoring.
7. The excavation and installation of shoring should proceed by stages until the full depth is reached.
8. The dismantling shall be done under supervision of responsible person.
9. A competent person should inspect at least once a day where work is in progress.



Shoring to prevent the collapse of the sides of an excavation consisting of timber or steel frames with close boarding between frames Barriers along the sides of an excavation to prevent workers falling into it.

### **PROTECTION OF ADJOINING BUILDINGS**

1. An excavation should not be so close and deep as to undermine stability of any adjacent structure.
2. To prevent any collapse or fall of a building or structure affected by excavation work precautions should be taken by shoring.



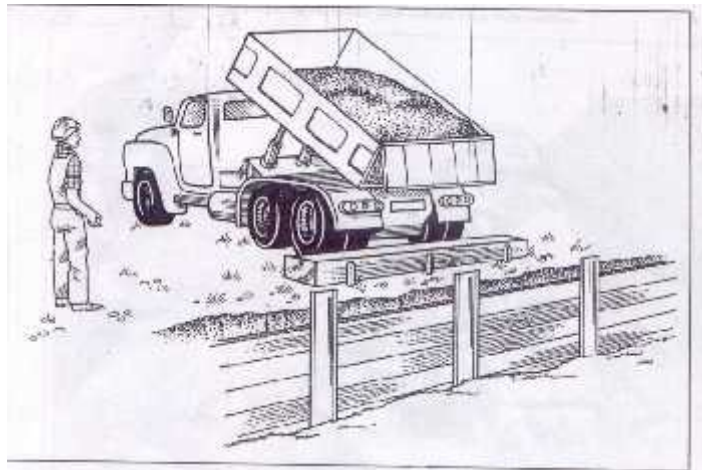
*Excavations near a building—shoring required to prevent collapse of the building*

## **PROTECTING THE EDGES OF EXCAVATION**

1. Storing or moving of materials and equipment near to the edge of an excavation should be avoided.
2. Danger caused by materials falling on those working below or by increased loading on the surrounding ground so as to cause the timbering or supports to the sides of the excavation to collapse should be avoided.
3. Accumulation of soil, waste heaps and debris should be kept well away from the edges of excavations.

## **PROTECTING THE VEHICLES**

1. Stop blocks (adequate and well-anchored) should be provided on the surface to prevent vehicles being driven into the excavation while tipping or when reversing.
2. The blocks should be placed at a sufficient distance away from the edges of the excavation to avoid the danger of it breaking away under the weight of the vehicles.



*Stop block to prevent vehicles being reversed into an excavation while tipping*

## **ACCESS**

1. If the depth of the excavation is more than 1.5 meter, there should be safe means of access and egress,
2. A properly secured ladder, if someone is working in an excavation. This is of particular importance when there is a risk of flooding and rapid escape is essential.

### **BURIED OR UNDERGROUND SERVICES :**

1. Before any digging is done, the underground services below the surface like , electrical cables, water services and sewers and gas pipelines are present . The hazards present are a.
2. Electric cables may cause death or severe injuries by electric shock or severe burns.
3. Broken gas pipelines will leak and may cause a fire or explosion.
4. Water and sewer pipelines if broken may create sudden risks by flooding an excavation or by causing its sides to collapse.

### **ESSENTIAL PREPERATIONS**

- Precautions that should be taken before any one is allowed in a trench or excavation.
- What conditions can affect the stability of the sides of an excavation?
- Why are a considerable number of the accidents in excavation work fatal?
- Outline the potential hazards that may be met meet in a deep excavation.
- If the sides of a trench collapse burying a fellow worker, what action would you take?
- What precautions are needed to be taken to avoid danger from underground services?

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