COURSE TITLE
BUILDING TECHNOLOGY

Chapter 9 - (Week 9)
Temporary Construction

LECTURE – 9

Temporary Construction

Ar. Ranju Kamal
Lecturer
Advanced college of engineering and management, Nepal
Affiliated to Tribhuvan University


Thailand, Bangkok (photo credit:Abhinay Kushwaha)

LEARNING OUTCOMES

1 Scaffolding and it types

2 Formwork for excavation & trenches and formworks for RCC construction

3 Shoring and its types

4 Underpinning and its procedure

At the end of the session students will get acquainted to:

Figure: Temporary Construction(source: *Yakubu*, P. 2023, June 23:Online), *https://www.archdaily.com/1003231/the-architectural-language-of-scaffoldings-in-cityscapes-exploring-the-impact-of-these-temporary-structures*

Scaffolding:

- Those temporary structures, constructed very close to the wall which are in the form of timber or steel framework are called scaffolding. [1]
- Also known as staging.
- It is temporary rigid structure for the purpose of facilitating masons as "platform to work" as the building increases its height.
- When the height of wall or column or other structural member of a building exceeds about 1.5 m, temporary structures are needed to support the platform over which the workmen can sit and carry on the constructions. [1]

Figure: Scaffolding(source: *Yakubu*, P. 2023, June 23:Online), *https://www.archdaily.com/1003231/the-architectural-language-of-scaffoldings-in-cityscapes-exploring-the-impact-of-these-temporary-structures*

Scaffolding is needed for:

- Maintenance of different components
- Construction
- Painting
- Inspection, etc.

Components:

1. **Standards**: These are the vertical members of the framework, supported on the ground or drums, or embedded into the ground. These are spaced about 2-3 m apart.
2. **Ledgers**: These are horizontal members running parallel to the wall which are vertically spaced at 1.2- 1.5m apart.
3. **Braces**: Bracing members are tied diagonally to stiffen the scaffolding. Braces are the poles tied by ropes.
4. **Putlogs**: Members that are placed perpendicular to the wall and is supported by the ledgers. These are generally 90cm long poles spaced at 1.2m apart.
5. **Boarding**: These are horizontal platform to support workmen and materials and these are supported on the putlogs.
6. **Guard Rail**: This is a rail, provided like a ledger, at the working level.
7. **Toeboard**: These are boards placed parallel to ledgers, and supported on putlogs to give protection at the level of working platform.

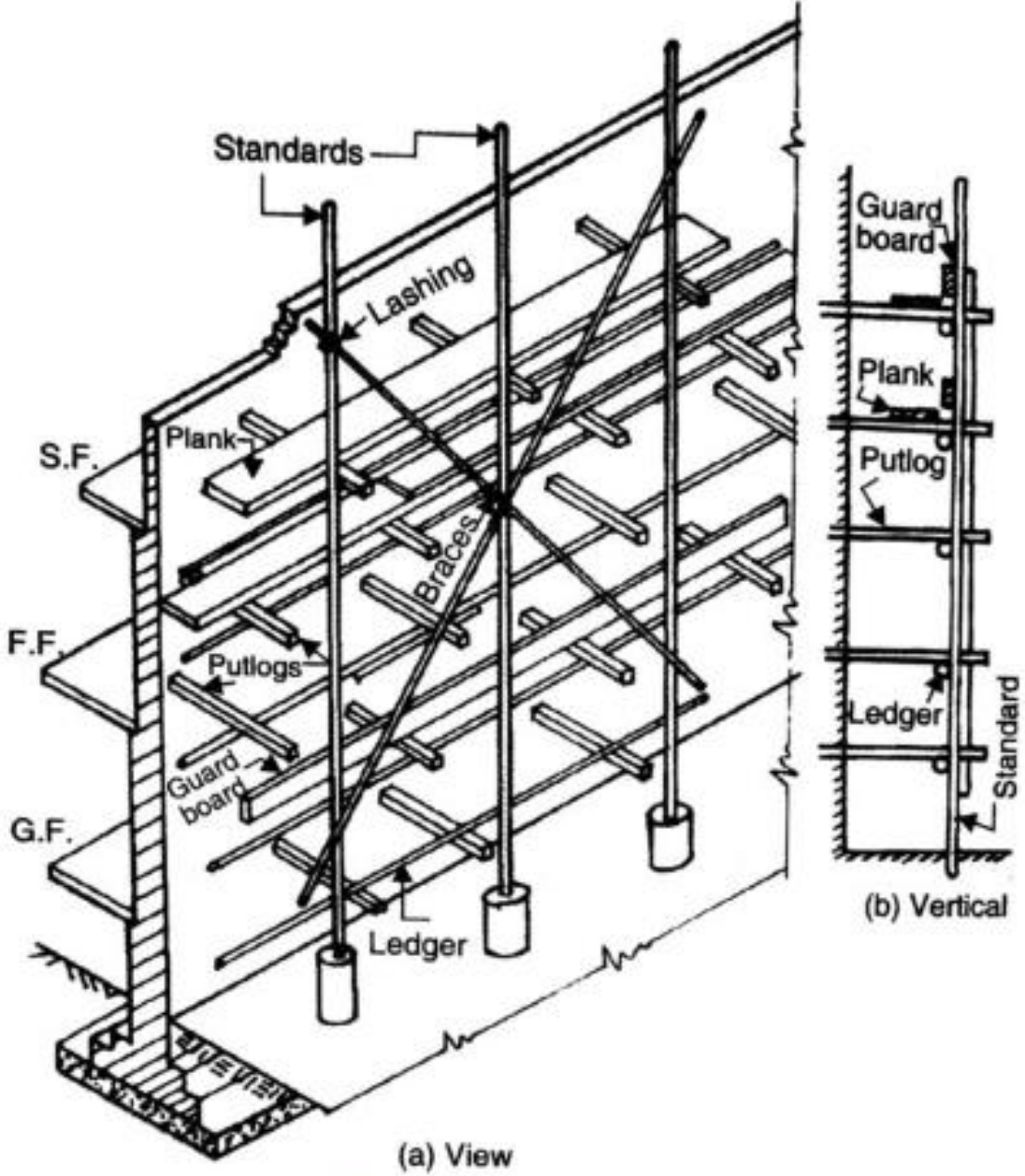


Fig2. Scaffolding and its components

Source:Civil Engineering Home. (2020). Retrieved from Cement concrete.org: https://cementconcrete.org/buildings/types-of-scaffolding-used-in-construction-parts/2120/

1. Single/Brick Layers Scaffolding

- Consists of single framework of standards, ledgers and putlogs, etc.[1]
- Distance of standard from the wall is about 1.2m at 2 - 2.5m interval.[1]
- Distance between two adjacent ledger is about 1.2 – 1.5m.[1]
- Putlogs are supported by ledger at one end and other end is adjusted in the hole made on the wall.[1]

Figure: Scaffolding(source: *The Constructor:Building ideas*, n.d:Online), https://theconstructor.org/building/types-of-scaffolding-in-construction/11845/

Figure: Scaffolding(source: *Yakubu*, P. 2023, June 23:Online), *https://www.archdaily.com/1003231/the-architectural-language-of-scaffoldings-in-cityscapes-exploring-the-impact-of-these-temporary-structures*

2. Double/Masons Scaffolding

- Such type of scaffolding is used in stone masonry works.
- Since it is difficult to leave holes into the stone masonry, so we use two frames of standards and ledgers.[1]
- The first frame is placed at 20-30 cm away from the wall and other one is about 1m away from the 1st frame.[1]
- Ledgers are provided to both frames.[1]
- In order to make such scaffolding more strong and durable, diagonal bracing is done.[1]
- Since, mason scaffolding is entirely independent of the stone wall, it is also called as Independent Scaffolding.[1]

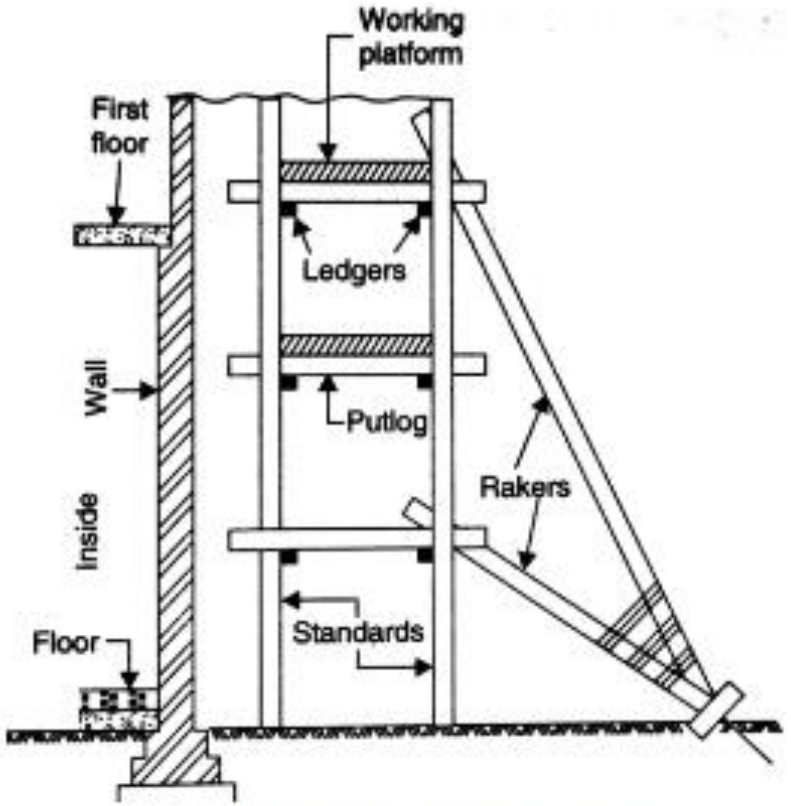


Fig3. Mason's scaffolding

Source: Civil Engineering Home. (2020). Retrieved from Cement concrete.org: https://cementconcrete.org/buildings/types-of-scaffolding-used-in-construction-parts/2120/

3. Steel Scaffolding

- Steel scaffolding is practically similar to timber scaffolding except that wooden members are replaced by steel tubes (40-60 mm dia.) and rope lashings are replaced by steel couplets or fittings.[1]

- Standards are spaced about 3m apart and the vertical spacing between ledgers is about 1.8m.[1]

- Such scaffolding can be erected and dismantled rapidly.

- It has greater strength, greater durability and higher fire resistance. [1]

- Though its initial cost is more but its salvage value is higher.[1]

- Requires skilled labour.[1]

Figure: Scaffolding(source: *Yakubu*, P. 2023, June 23:Online), *https://www.archdaily.com/1003231/the-architectural-language-of-scaffoldings-in-cityscapes-exploring-the-impact-of-these-temporary-structures*

4. Cantilever or Needle Scaffolding:

- In this type of scaffolding, the working platform is over hung which is supported on the needle.
- Standards are not fixed in the ground. it is placed at some height above the ground on the needle.
- The needle is a timber member projected outside the wall.
- To prevent lifting up of the needle, the inside end of the needles are supported by a post, in between the floor.
- The outside hung portion of the needle is supported by a strut which rests on the window sill.

Figure: Scaffolding(source: *The Constructor:Building ideas*, n.d:Online), https://theconstructor.org/building/types-of-scaffolding-in-construction/11845/

Cantilever scaffolding is used under the following circumstances:

1. If the ground is too weak to support standards.
2. If the construction of upper-part of the wall is to be carried out.
3. If it is required to keep the ground near the wall, free for traffic.

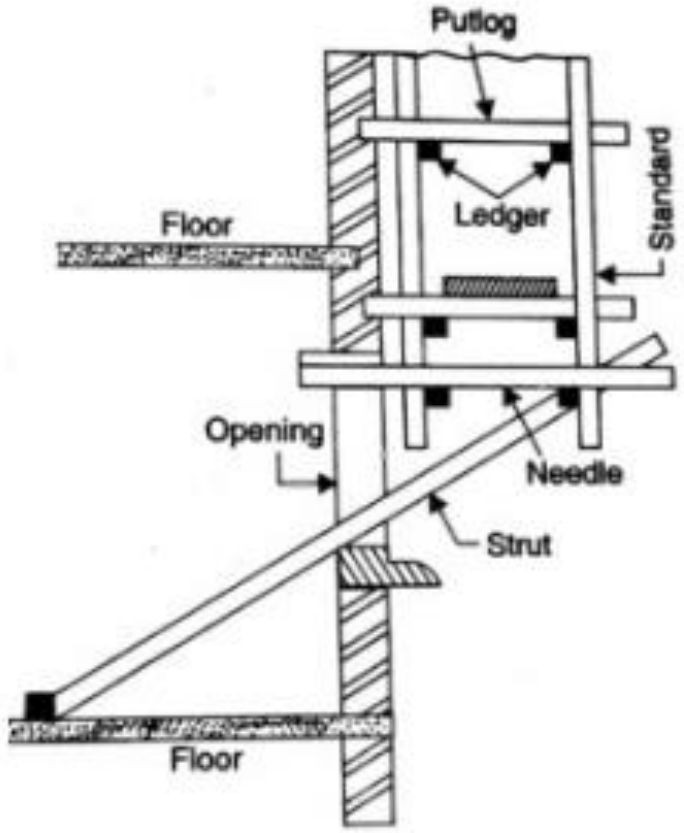


Figure: Cantilever Scaffolding(Source:Civil Engineering Home. (2020)). Retrieved from Cement concrete.org: https://cementconcrete.org/buildings/types-of-scaffolding-used-in-construction-parts/2120/

8. Patented Scaffolding

- Patented scaffoldings are made up of steel but these are equipped with special couplings and frames etc.
- These are readymade scaffoldings which are available in the market.
- In this type of scaffolding working platform is arranged on brackets which can be adjustable to our required level.[1]

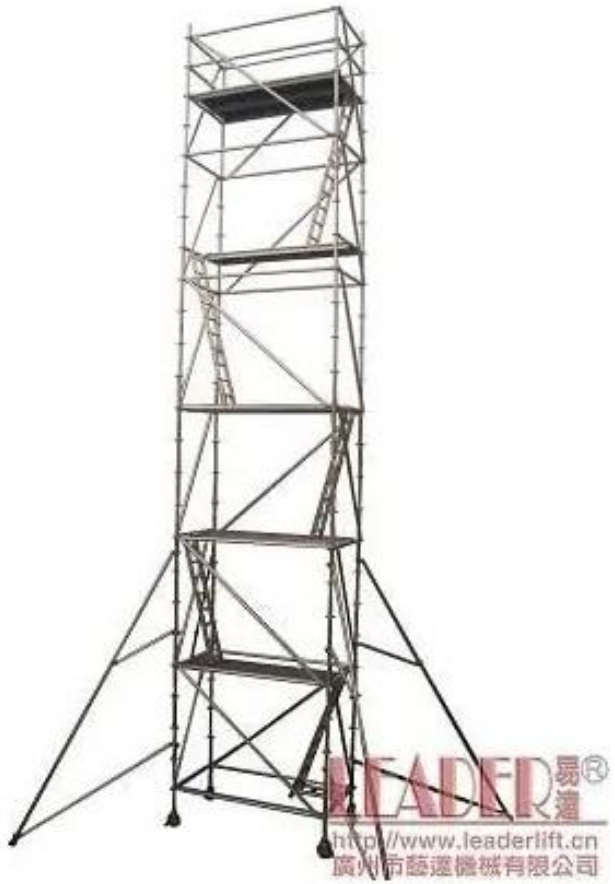


Figure: Scaffolding(source: *The Constructor:Building ideas*, n.d:Online), https://theconstructor.org/building/types-of-scaffolding-in-construction/11845/

5. Trestle scaffolding

- Working platform are supported on movable ladders.
- Such type of scaffolding is used for painting and repair works.[1]
- The platform can be raised or lowered at any desired level.[1]
- Suitable up to a height of 5m.[1]

Figure: Scaffolding(source: *The Constructor:Building ideas*, n.d:Online), https://theconstructor.org/building/types-of-scaffolding-in-construction/11845/

7. Suspended Scaffolding

- Working platform is suspended from the roofs or parapet walls by means of ropes, chains or wires.[2]
- The platform can be raised or lowered at any desired level with the help of rope.[2]
- Such type of scaffolding is used for maintenance works such as painting, pointing, distempering, whitewashing etc.

[2]

Figure: Scaffolding(source: *The Constructor:Building ideas*, n.d:Online), https://theconstructor.org/building/types-of-scaffolding-in-construction/11845/

Formwork

- It is a temporary construction used as a mould in which concrete is placed.[2]
- Also, formwork is the arrangement of timber planks in the trenches to prevent the collapsing of soil when the depth of trench is more. This is also called as timbering.[2]
- The cost of the formwork used in RCC construction varies from 20-25% of the cost of concrete work.
- **Type of formwork**
  - Wooden and
  - Steel

Use of Formworks

- Formwork for excavations and trenches.
- Formworks for reinforced concrete construction.

Figure: Formwork

Characteristics of a good formwork:

1. Strong enough to withstand load.
2. Leakage proof.
3. Perfectly flat and smooth.
4. Cheap and easily available.
5. Reusable.
6. Light in weight.
7. Easily removable without damaging the concrete.

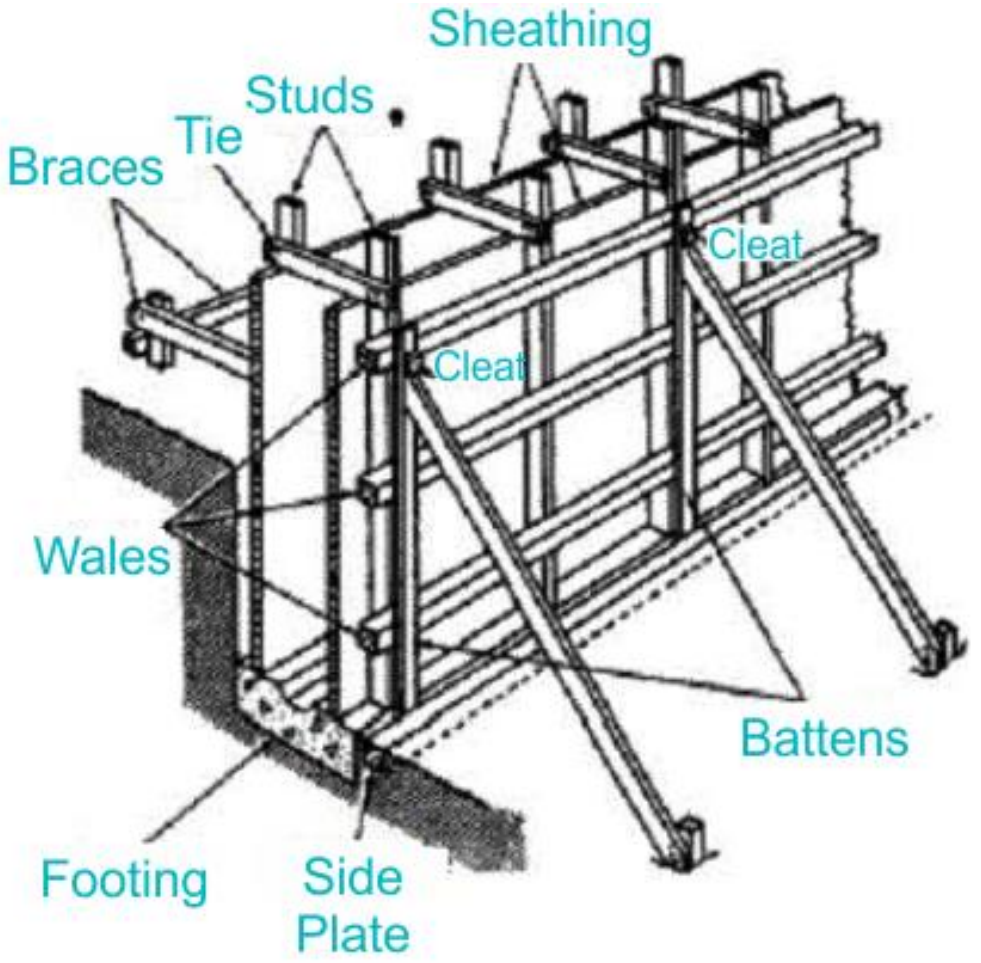


Figure: Components of Formwork (Source: testbook. (May 10, 2023). Retrieved from testbook.com: https://testbook.com/civil-engineering/formwork-meaning-types-and-materials

Need of timbering[2]

- To protect the worker working inside.
- To protect the completed work from being ruined by the falling debris.
- To keep the excavation open by acting as a retaining structure to hold back the sides of the trench.

Methods of Timbering[2]

1. Stay bracing
2. Box sheeting
3. Vertical sheeting
4. Runners
5. Sheet piling

1. Stay Bracing:

- This method is used for supporting the sides or a bench excavated in fairly firm soil, when the depth of excavation does not exceed about 2 m.[3]
- The method consists of placing vertical sheets or polling boards opposite each other against the two walls of the trench and holding them in position by one or two rows of struts.[3]
- The sheets are placed at an interval of 2 to 4 meters and generally, they extend to the full height of the trench.
- The polling boards may have width of about 200 mm and thickness of 40 to 50 mm.[3]

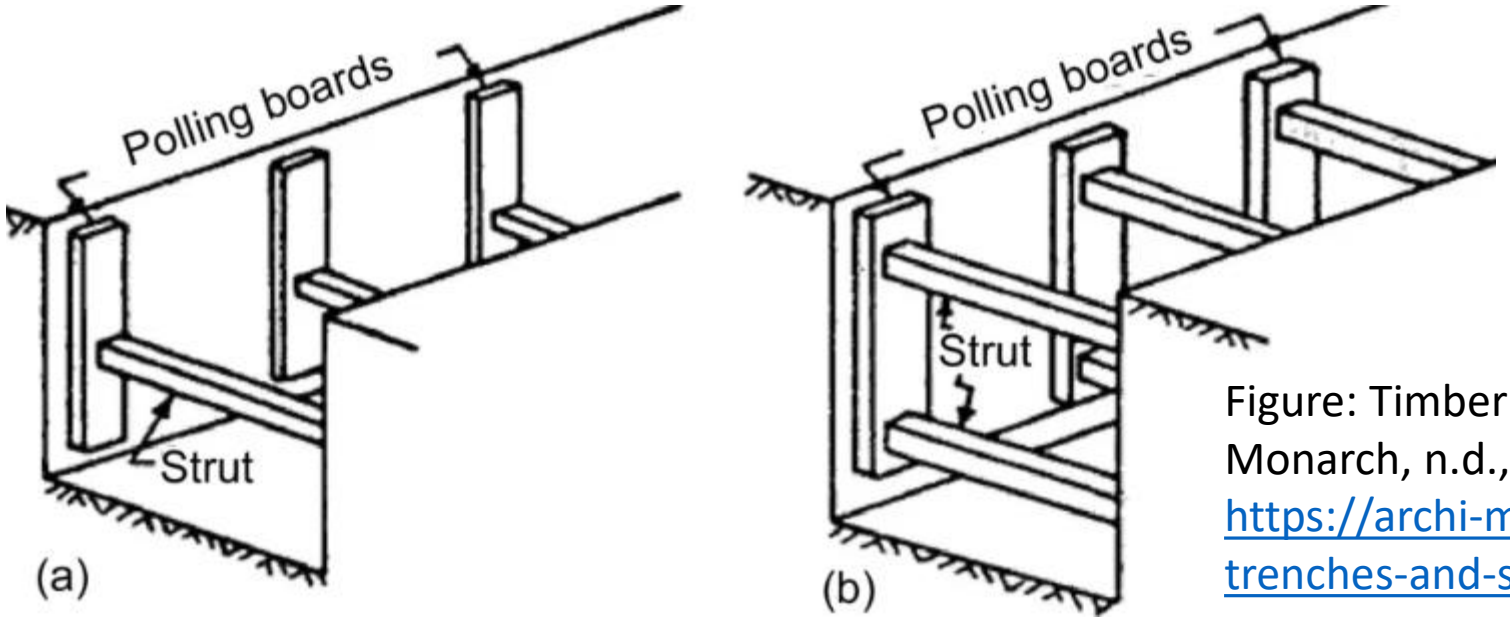


Figure: Timbering in trenches(source:Archi-Monarch, n.d.,Online), https://archi-monarch.com/timbering-of-trenches-and-shoring/

Box sheeting:

This method is adopted in water-logged area and in loose soils, when the depth of excavation does not exceed 4 m.

1. In water-logged area:

- Vertical sheeting is provided which are very close to each other, binding them with horizontal boards called wales.
- Struts are then adjusted against the wales.

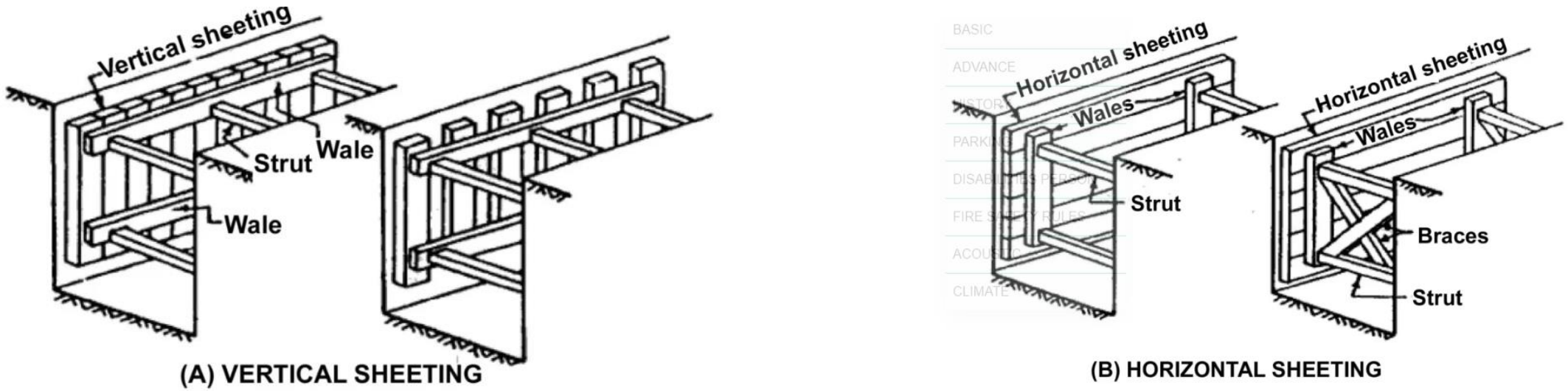


Figure: Timbering in trenches(source:Archi-Monarch, n.d.,Online), https://archi-monarch.com/timbering-of-trenches-and-shoring/

2. In loose dry soil:

- Here, instead of vertical sheeting, horizontal sheeting is provided.
- Those horizontal sheeting is supported by vertical wales.
- Now, the vertical wales are supported by the struts.
- Bracing is done incase the soil is too loose and if the depth of excavation is more.

3. Vertical sheeting:

- This system is adopted for deep trenches **(up to 10 m depth)** in soft ground.[3]
- The method is similar to the box sheeting except that the **excavation is carried out** in stages and at the end of each stage, an offset is provided, so that the width of the trench goes on decreasing as the depth increases.[3]
- Each stage is limited to about 3 m in height and the offset may vary from 25 to 50 cm per stage.
- For each stage, separate vertical sheeting, supported by horizontal waling and struts are provided.[3]

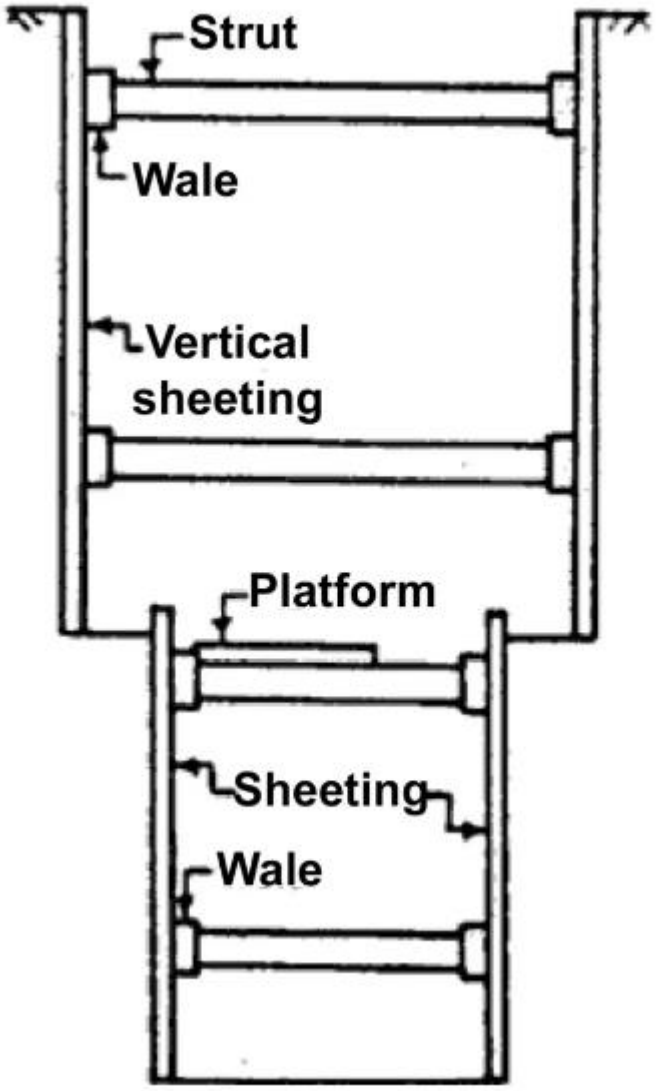


Figure: Timbering in trenches(source:Archi-Monarch, n.d.,Online), https://archi-monarch.com/timbering-of-trenches-and-shoring/

4. Runners

- This system is used in extremely loose and soft ground, which needs immediate support as excavation progresses.[3]
- The system is similar to vertical sheeting of box system, except that in the place of vertical sheeting, runners, made of long thick wooden sheets or planks with iron shoe at the ends, are provided.[3]
- Wales and struts are provided as usual. These runners are driven about 30 cm in advance of the progress of the work, by hammering.[3]

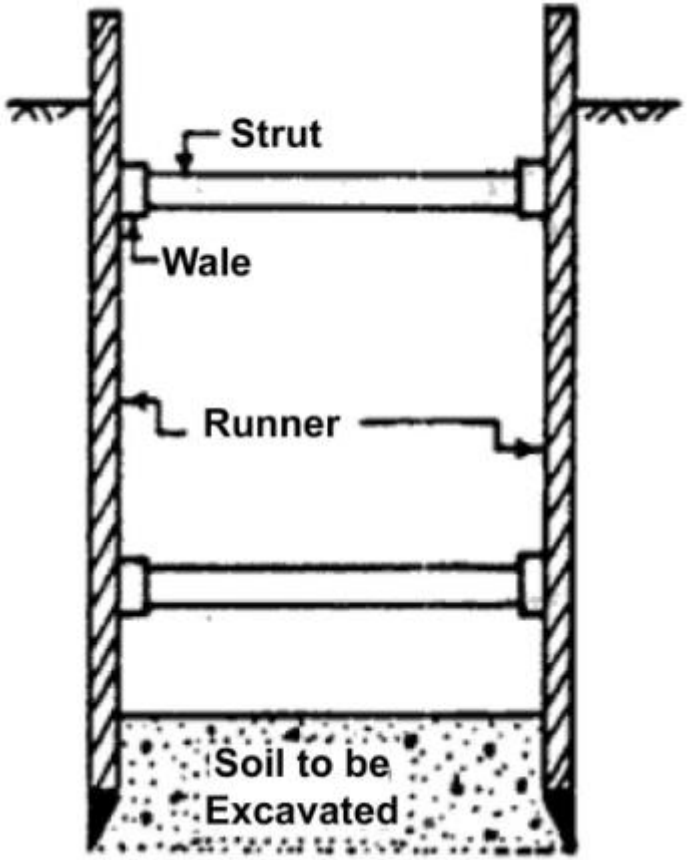


Figure: Timbering in trenches(source:Archi-Monarch, n.d.,Online), https://archi-monarch.com/timbering-of-trenches-and-shoring/

5. Sheet Piling:

This method is adopted when

(i) soil to be excavated is soft or loose

(ii) depth of excavation is large

(iii)width of trench is also large

(iv) there is sub-soil water.

Sheet piles are designed to resist lateral earth pressure.

These are driven in the ground by mechanical means

(pile driving equipment).[3]

Figure: Timbering in trenches(source:Archi-Monarch, n.d.,Online), https://archi-monarch.com/timbering-of-trenches-and-shoring/

1. Timber Formwork

Timber for formwork should satisfy the following requirement:

It should be:

1.Well-seasoned

2.Light in weight

3.Easily workable with nails without splitting

4.Free from loose knots

Timber used for shuttering for exposed concrete work should have smooth and even surface on all faces which come in contact with concrete.

Figure: Timber Formwork (Source: testbook. (May 10, 2023). Retrieved from testbook.com: https://testbook.com/civil-engineering/formwork-meaning-types-and-materials

2. Plywood Formwork

Resin-bonded plywood sheets are attached to timber frames to make up panels of the required sizes. The cost of plywood formwork compares favorably with that of timber shuttering, and it may even prove cheaper in some instances given the following considerations:

1.It is possible to have a smooth finish in which case on cost in surface finishing is there.

2.By the use of large-size panels, it is possible to affect saving in the labor cost of fixing and dismantling.

3.The number of reuses are more as compared with timber shuttering. For estimation purposes, the number of reuses can be taken as 20 to 25.

Figure:Plywood Formwork(Source: testbook. (May 10, 2023)). Retrieved from testbook.com: https://testbook.com/civil-engineering/formwork-meaning-types-and-materials

Formwork for Beam and Slab:

The whole system consists of sole plates, wedges, vertical post, head tree, battens, etc.
Beam formwork rests on head tree.
Slab formwork rests on battens and joists.
If the height of the post is more than 8 feet, horizontal bracing is needed.

Figure: Formwork

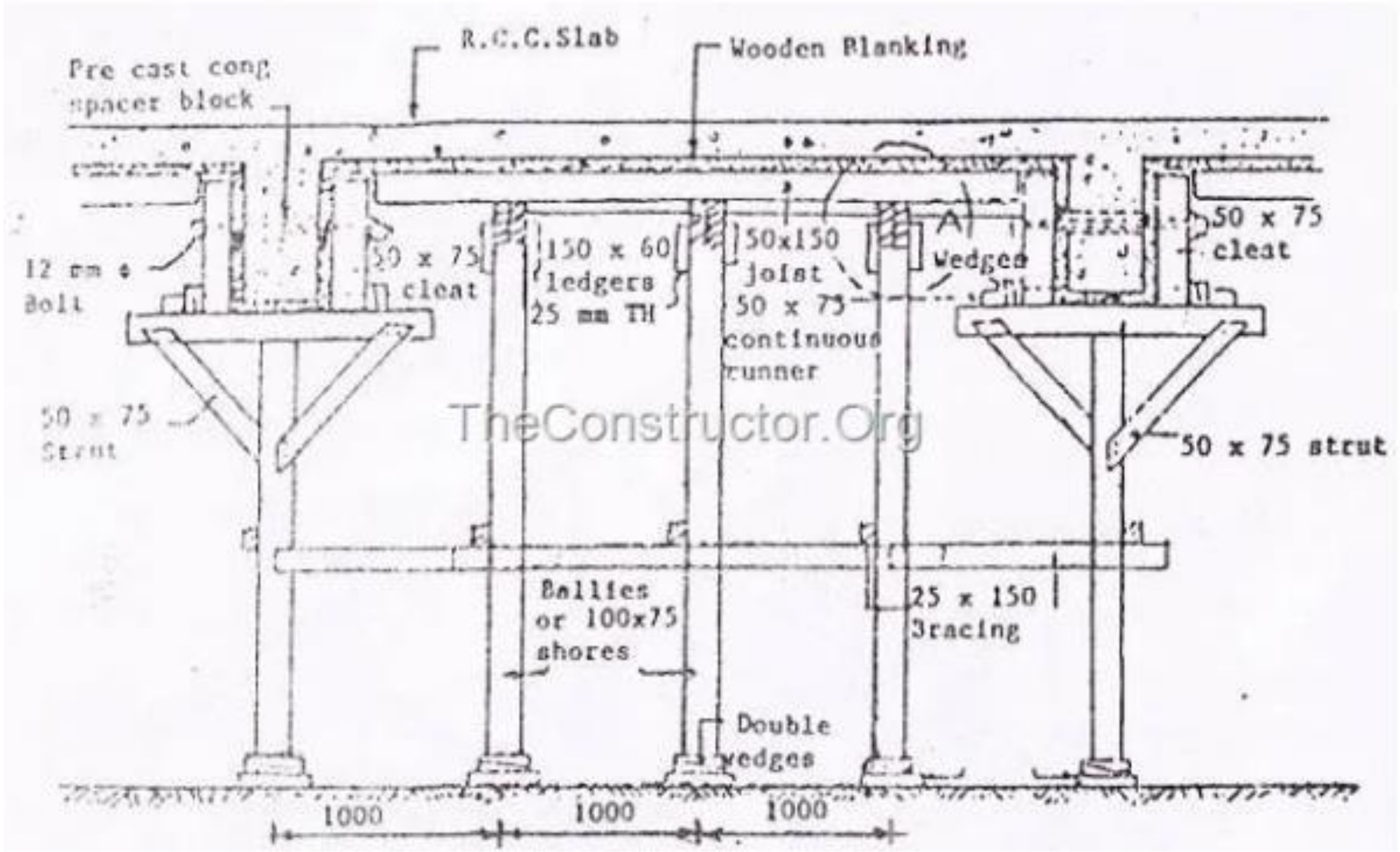


Figure: Formwork (source: *The Constructor:Building ideas*, n.d:Online), https://theconstructor.org/building/formwork-technical-functional-economical-safety-requirements/6833/

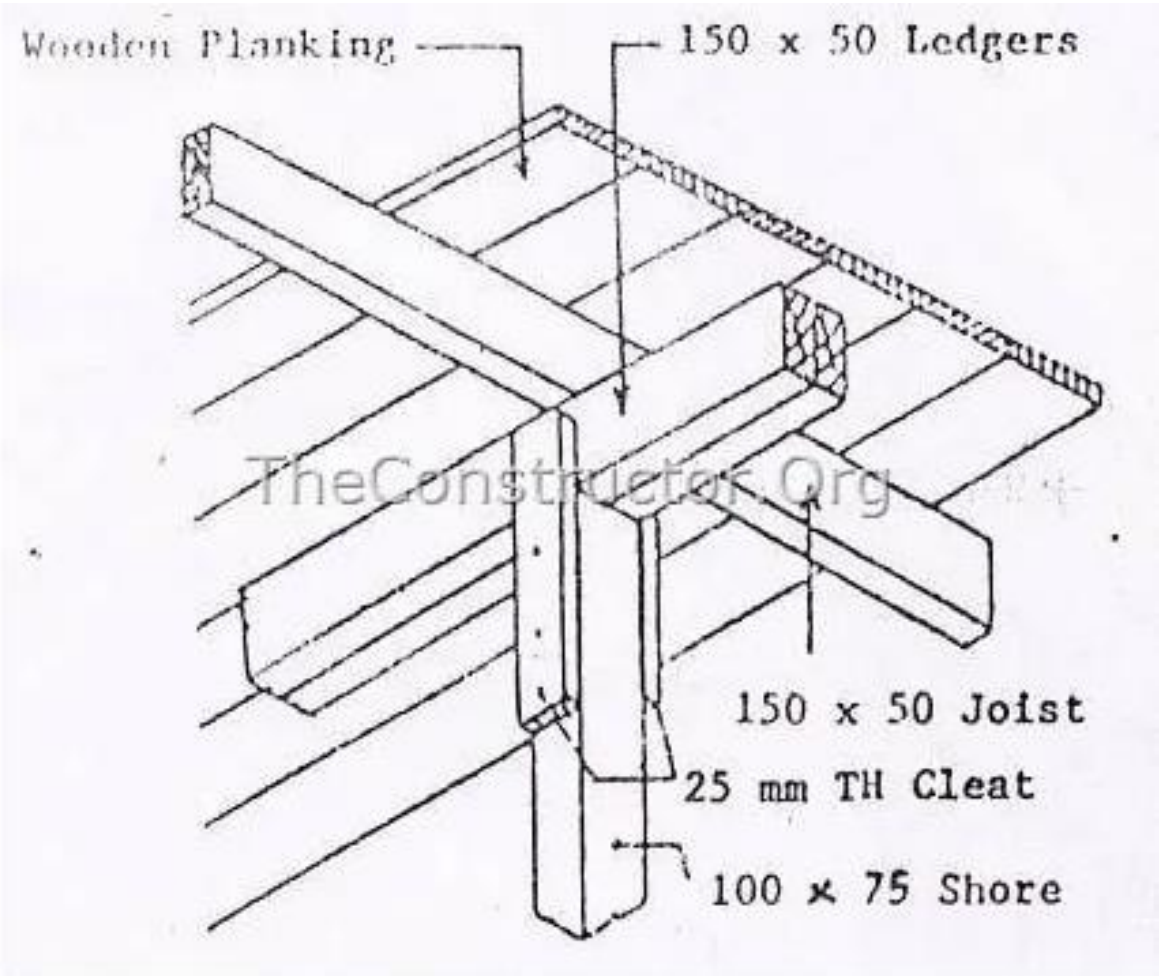


Figure 1(b): Details at Section (A) Shown in Above Figure

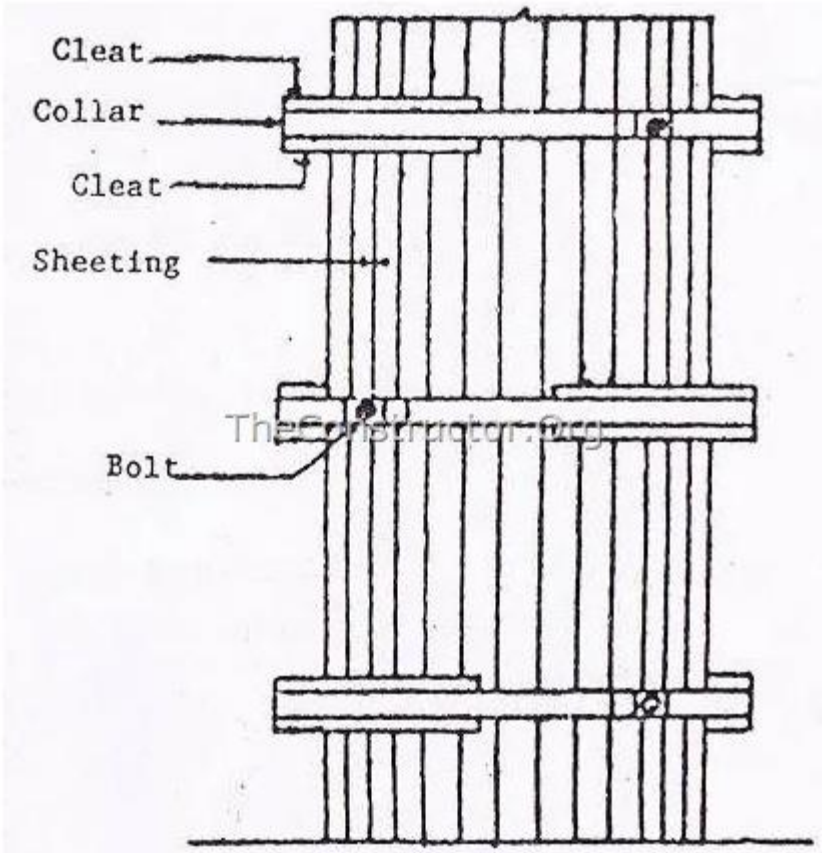


Figure 2(a): Elevation

Figure: Formwork (source: *The Constructor:Building ideas*, n.d:Online), https://theconstructor.org/building/formwork-technical-functional-economical-safety-requirements/6833/

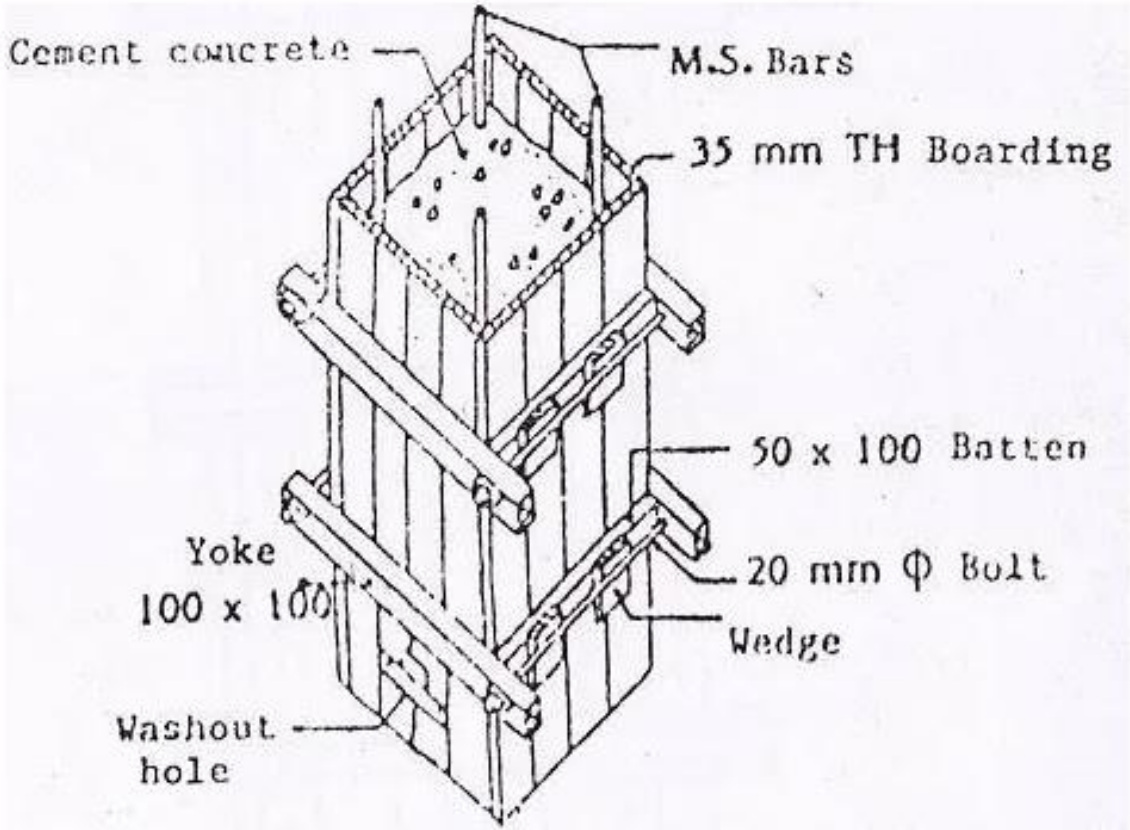


Figure 3(a): 150 3D View

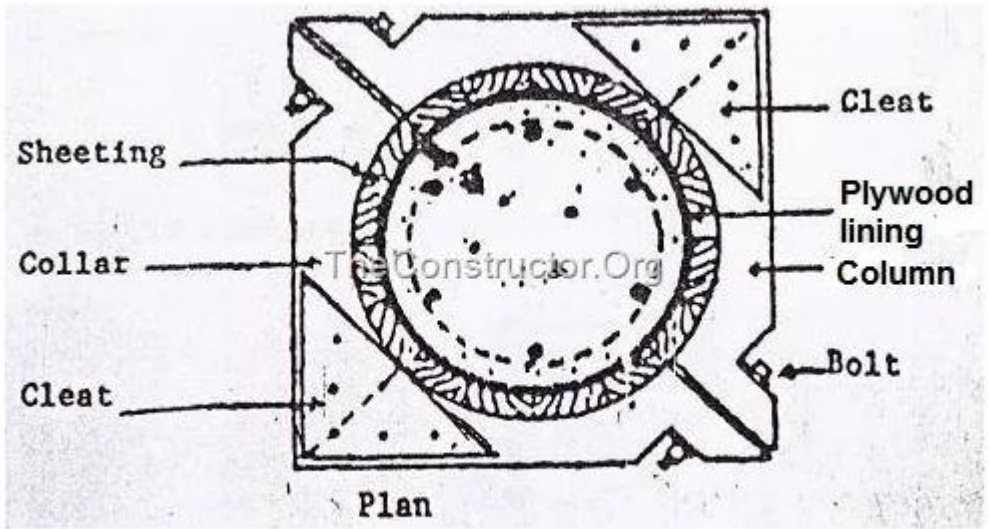
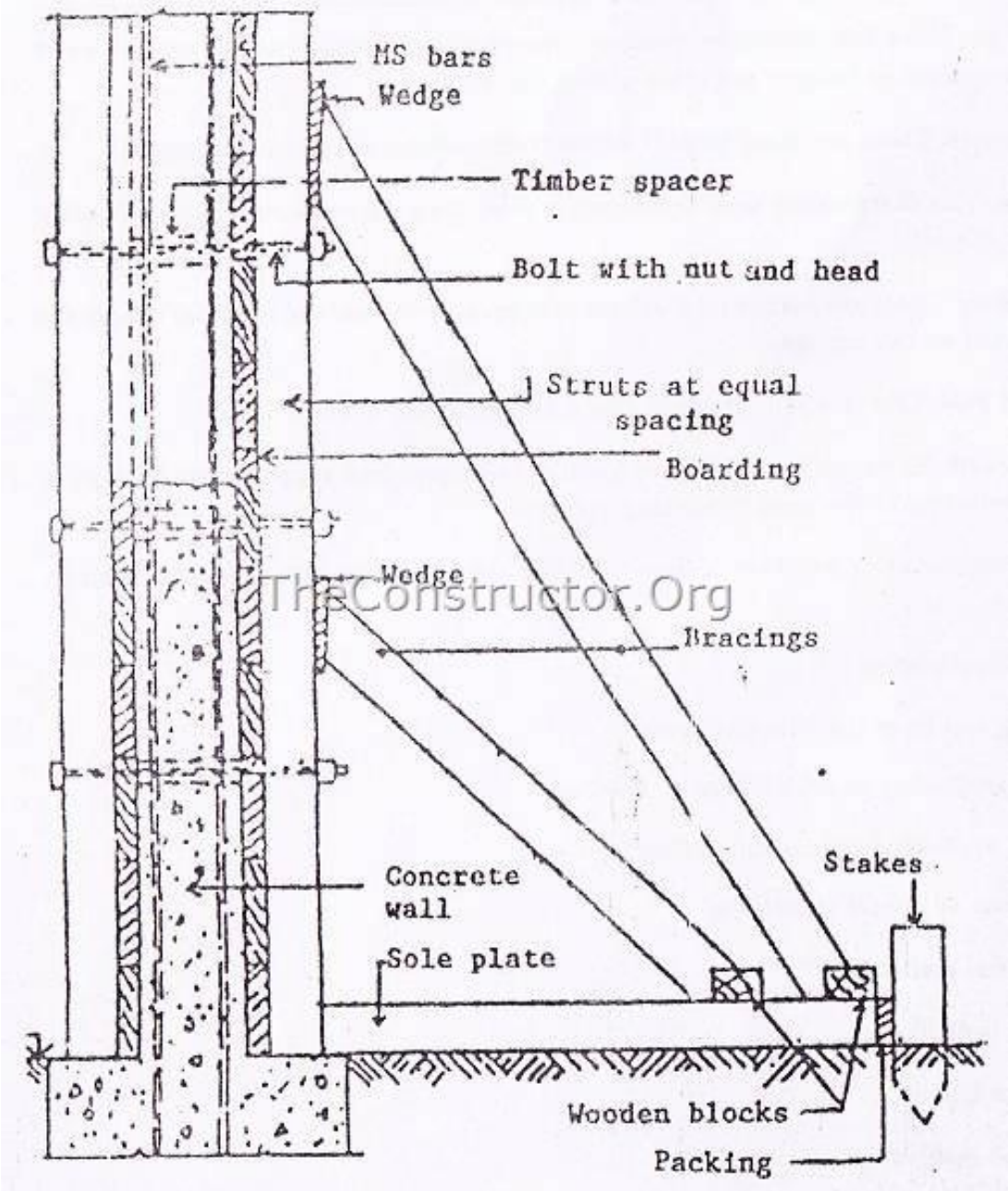


Figure 2(b): Details of Timber Formwork for Circular RCC Column

Figure: Formwork (source: *The Constructor:Building ideas*, n.d:Online), https://theconstructor.org/building/formwork-technical-functional-economical-safety-requirements/6833/



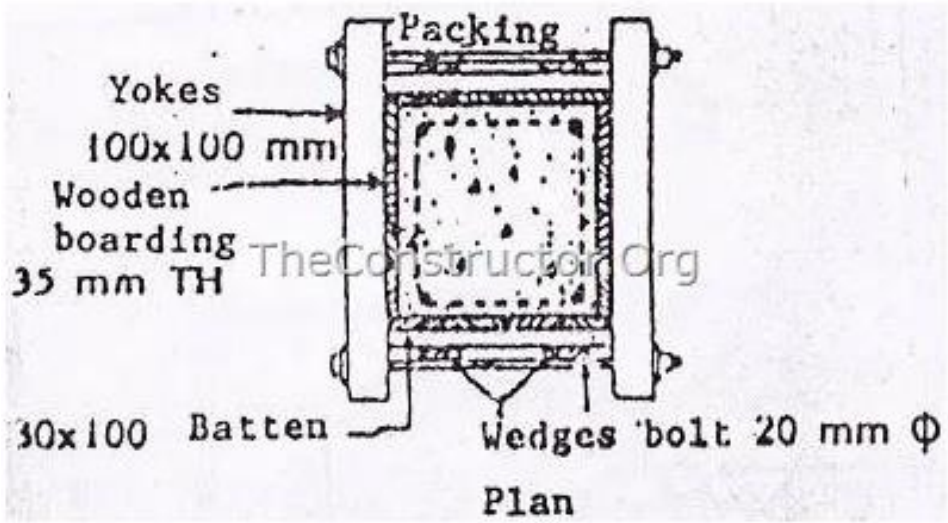
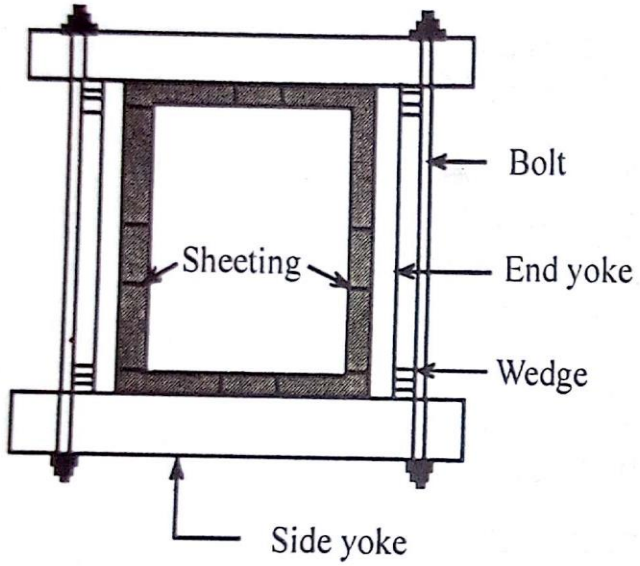


Figure 3(b): Details of Timber Formwork for Square or

Figure: Formwork (source: *The Constructor:Building ideas*, n.d:Online), https://theconstructor.org/building/formwork-technical-functional-economical-safety-requirements/6833/

Formwork for Column:

- Consists of side and end planks, yoke, bolts, etc.
- Two end and two side planks are joined by the yokes and bolts.



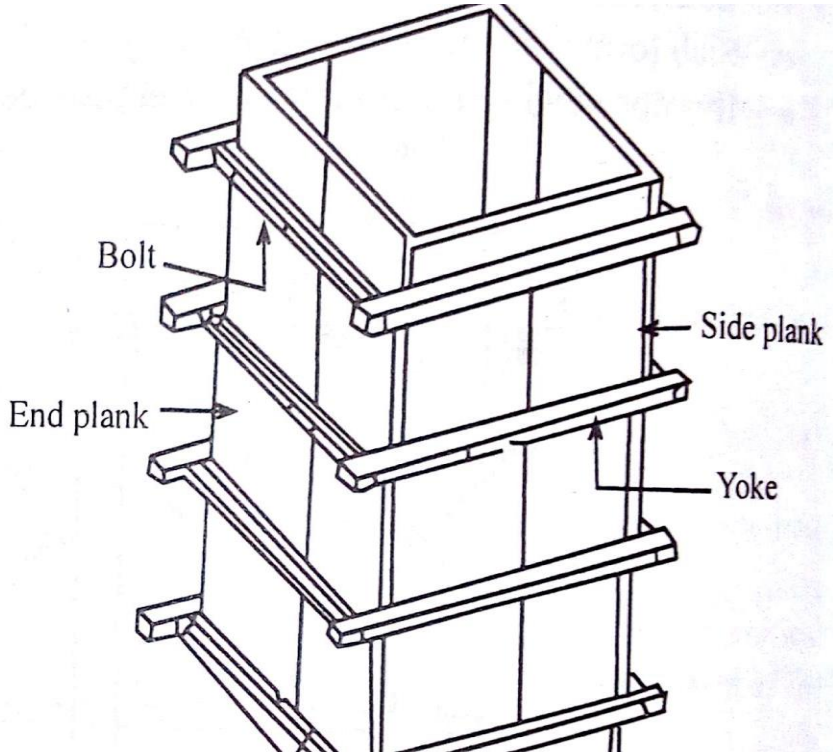


Figure: Formwork (source: *The Constructor:Building ideas*, n.d:Online), https://theconstructor.org/building/formwork-technical-functional-economical-safety-requirements/6833/

Figure: Formwork

Formwork for Staircase:

- Consists of vertical and inclined posts, inclined members, wooden planks, riser planks, etc.

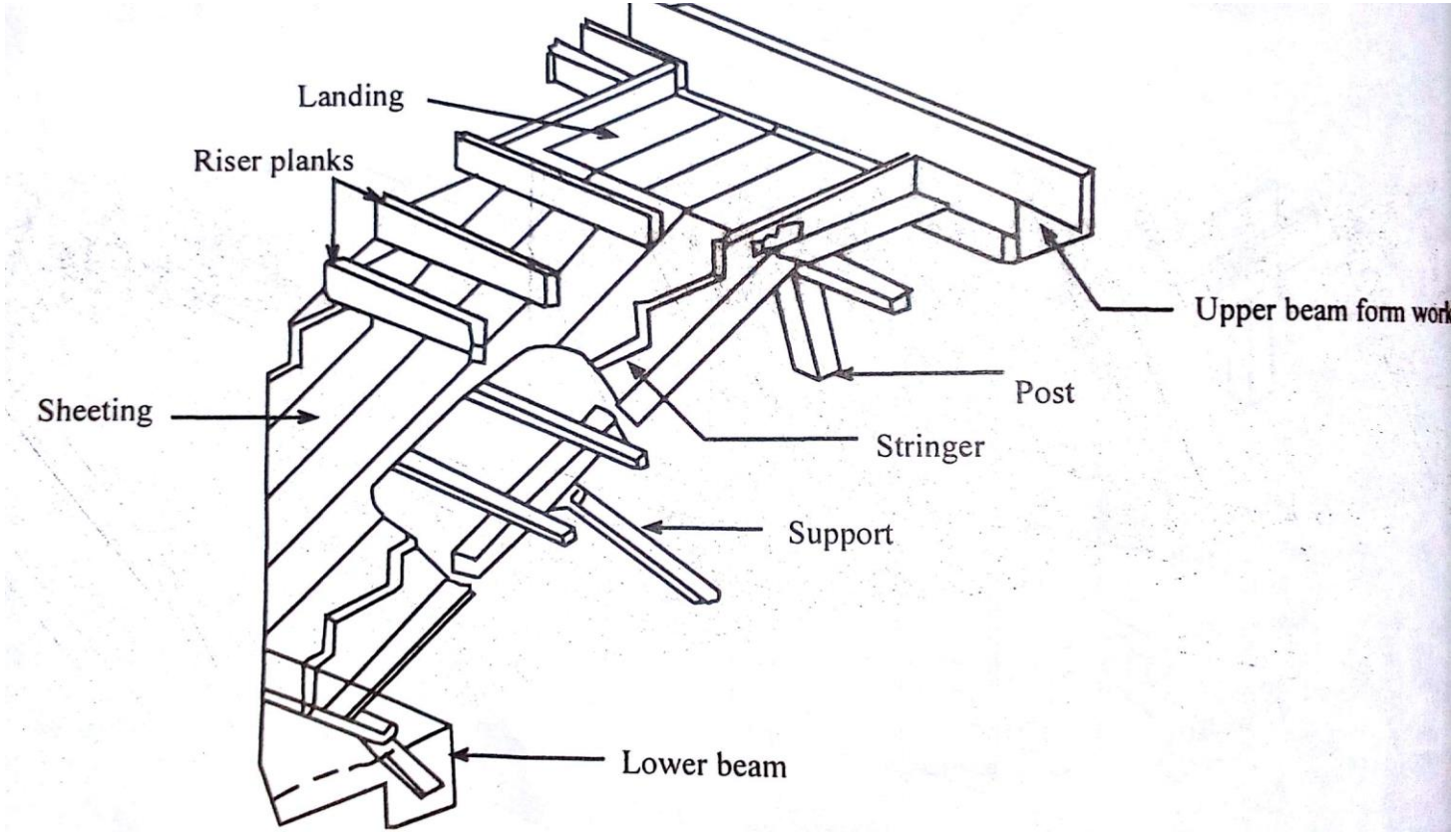


Figure: Formwork (source: *The Constructor:Building ideas*, n.d:Online), https://theconstructor.org/building/formwork-technical-functional-economical-safety-requirements/6833/

Shoring

- Construction of a temporary structure to support temporarily an unsafe structure. [1]
- These support walls laterally. [1]
- Shoring can be used when walls bulge out, when walls crack due to unequal settlement of foundation and repairs are to be carried out to the cracked wall, when an adjacent structure needs pulling down, when openings are to be newly made or enlarged in a wall.[1]

Types of Shoring:

1. Raking Shoring (slant or sloped shore)
2. Flying Shoring (horizontal shore)
3. Dead Shoring (vertical shore)

1. **Raking Shoring:**

- It is an inclined support to the wall.[2]
- Wall load is transferred through the inclined member to the ground.[2]
- Consists of wall plate, rakers, bracing, cleat, etc.[2]

2. **Flying Shoring:**

- Horizontal members are used to support two parties simultaneously.[2]
- Working space under the shoring is enough.[2]
- Consists of wall plate, raking strut, straining piece, wedges, etc.

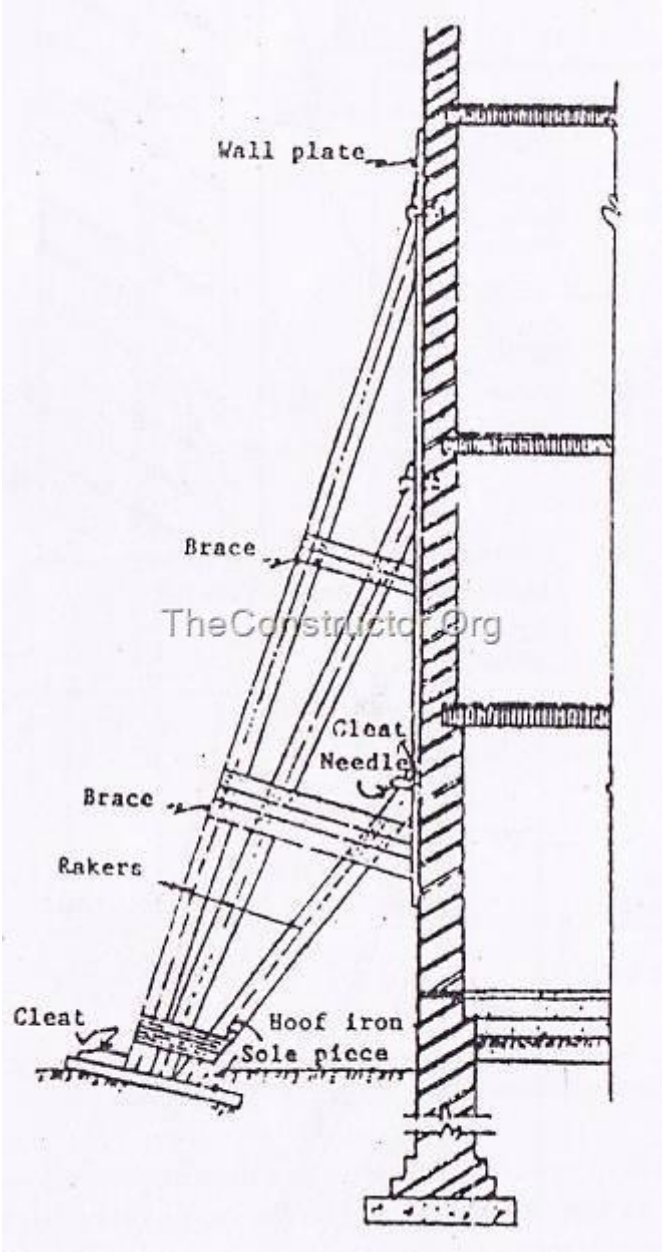


Figure: Raking Shores Wall Support(source: *The Constructor:Building ideas*, n.d:Online), https://theconstructor.org/practical-guide/shoring-types-uses/4633/

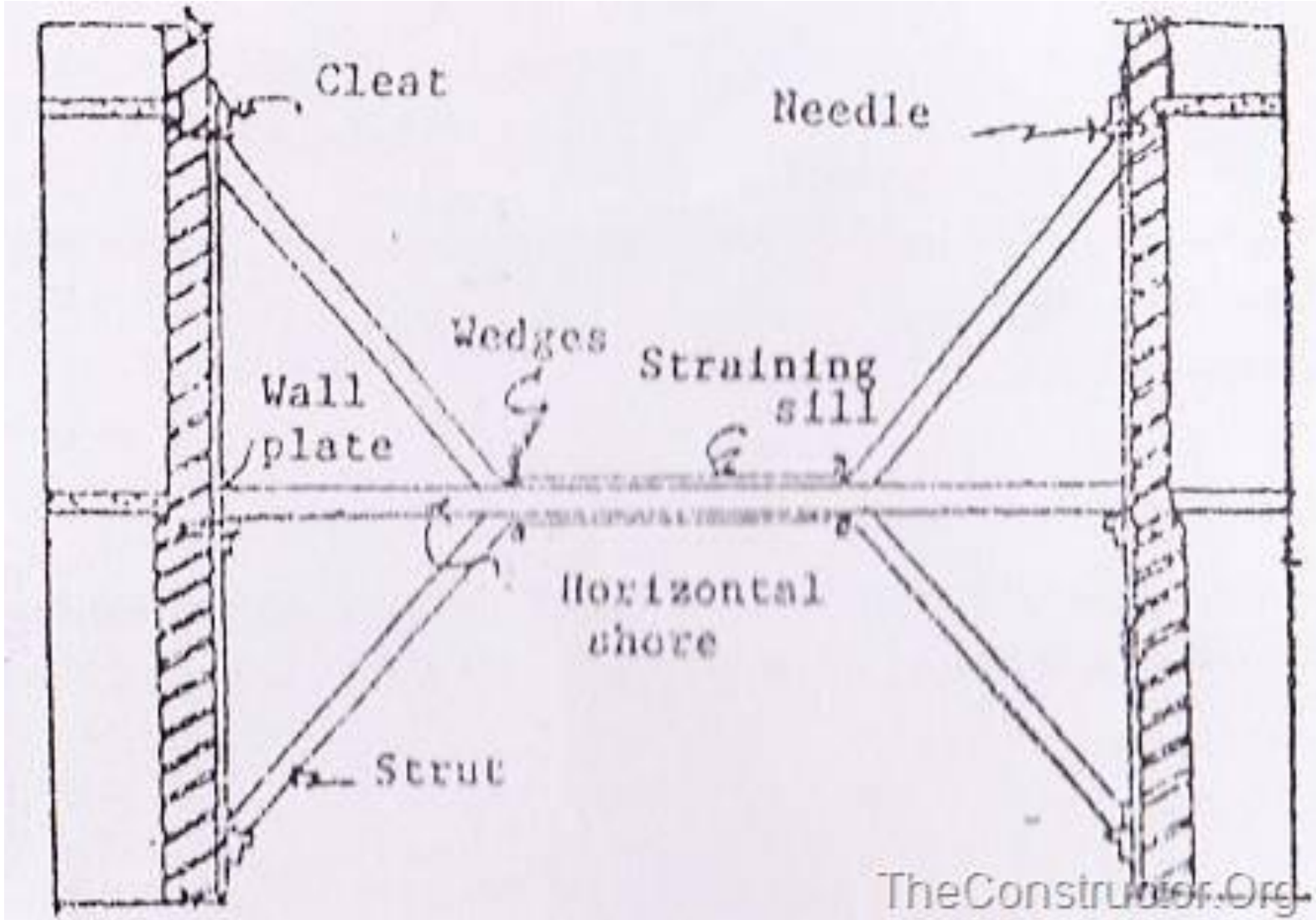


Fig.4: Flying Shore (source: *The Constructor:Building ideas*, n.d:Online), https://theconstructor.org/practical-guide/shoring-types-uses/4633/

3. Dead Shoring:

- Vertical member are used to support the upper part of the wall.[2]
- Used when the lower part of a structure has to be removed or strengthen.[2]
- Such shoring is provided to serve the following purposes:

- To rebuild the defective lower part of the wall.
- To rebuild or deepen the existing foundation.
- To make large opening in the existing wall at lower level.

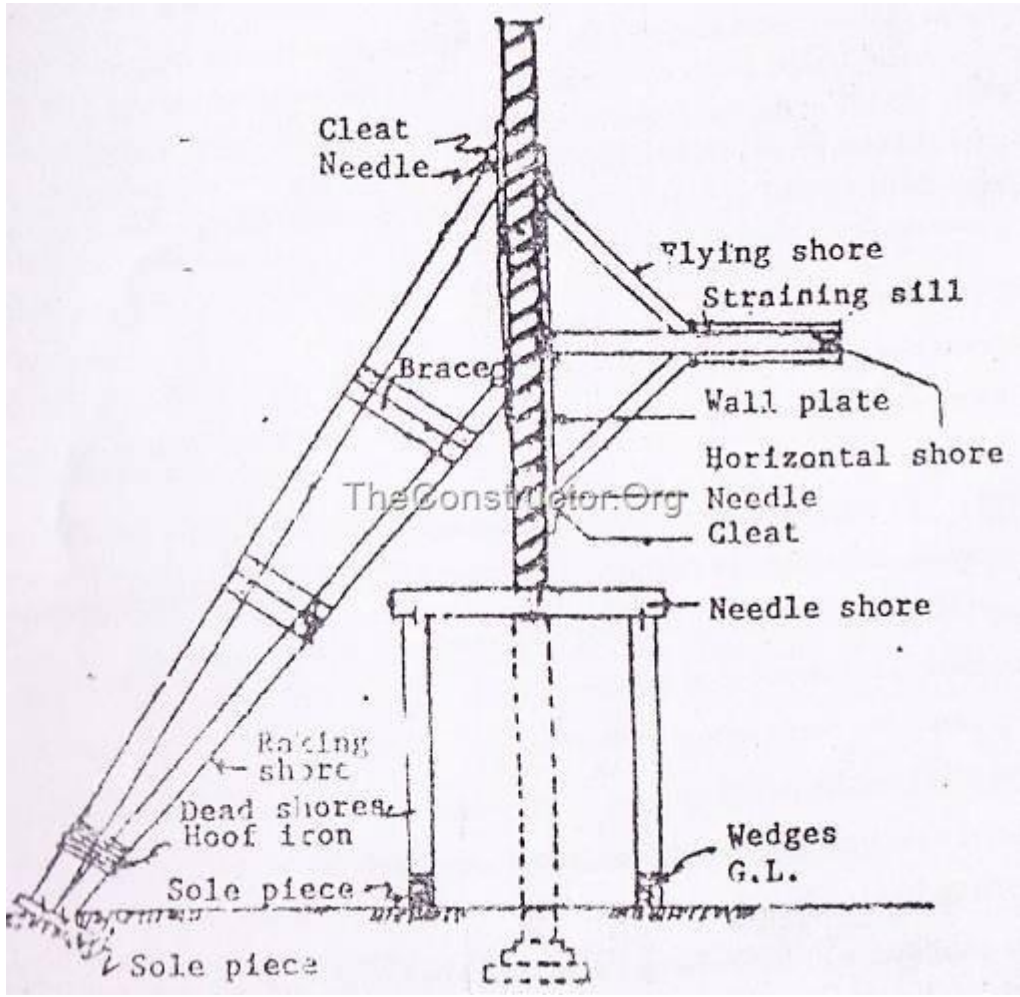


Fig.6: Dead Shore (source: *The Constructor:Building ideas*, n.d:Online), https://theconstructor.org/practical-guide/shoring-types-uses/4633/

Underpinning

- Underpinning is the process of placing a new foundation under an existing one or strengthening an existing foundation.[1]
- Underpining is required in following conditions:

1. If the existing foundation is not strong enough to transmit the loads.
2. If settlement and serious cracks are seen in the foundation.
3. If basement has to be constructed below the foundation.
4. If the purpose of building has changed.
5. If a new building adjacent to an existing building is to be constructed.

Fig.1: Underpinning Method; Image Courtesy: Moretrench -Hayward Baker Company

Figure : Underpining (source: *The Constructor:Building ideas*, n.d:Online), https://theconstructor.org/building/underpinning-methods-procedure-applications/14480/

Pit Method (Mass Concrete Underpinning):

- Length of the foundation to be underpinned is divided into sections of 1.2 - 1.5 m lengths.[2]
- For each section, a hole is made in the wall, above the plinth level, and needle is inserted in the hole. Needles may be either of timber or steel section. [2]
- Bearing plates are placed above the needle to support the masonry above it.[2]
- Needle is supported on each side by a post.[2]
- The foundation pit is then excavated up to the desired level and new foundation is laid.[2]
- Needles and supports are removed and finally, back filling the earth is done.[2]

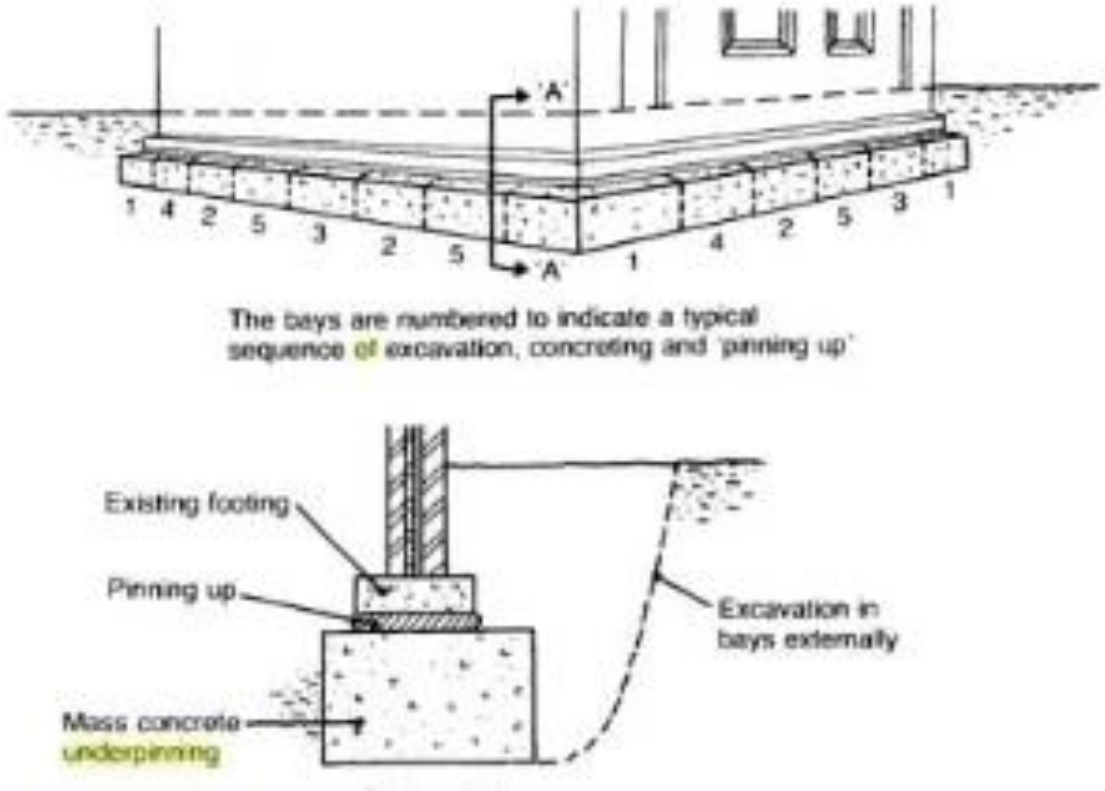


Figure : Underpining (source: *The Constructor:Building ideas*, n.d:Online), https://theconstructor.org/building/underpinning-methods-procedure-applications/14480/

Pile Method:

- There is no need of excavation in this method.[2]
- Piles are driven at regular interval along both sides of the wall.[2]
- Needle beam is inserted into the wall which rests on the pile. The needle acts as a pile cap.[2]
- Pile and needle beam becomes a permanent structure.[2]
- This method is very useful in clayey soils, and also in water-logged areas. The existing foundation is very much relieved of the load.[2]

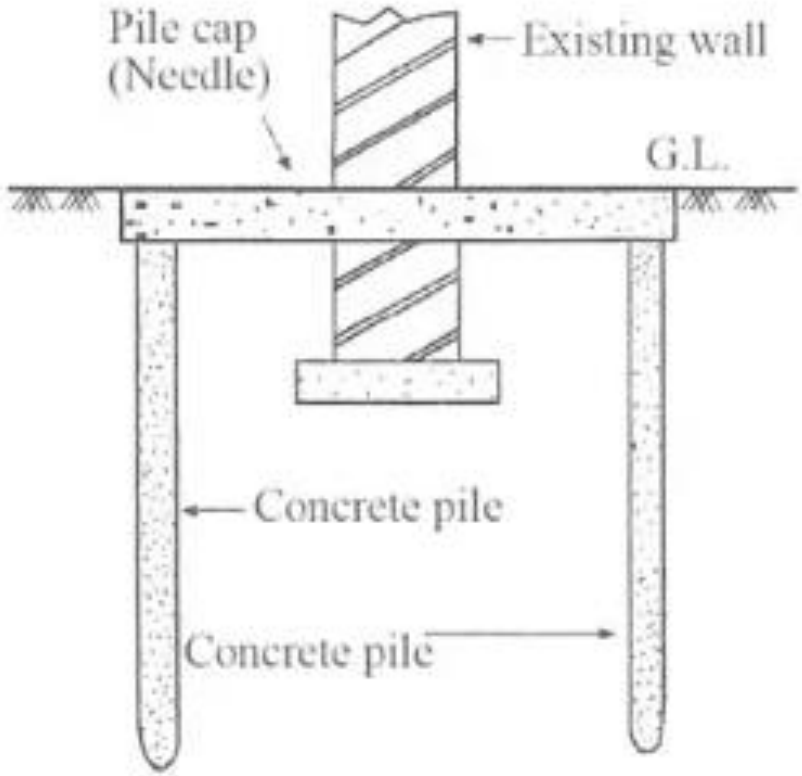


Fig.4: Underpinning by Pile Method

Figure : Underpining (source: *The Constructor:Building ideas*, n.d:Online), https://theconstructor.org/building/underpinning-methods-procedure-applications/14480/

Pier and Beam Underpinning Method:

- Also known as base and beam method of underpinning.[4]
- A beam arrangement is kept above the pier to distribute the load uniformly.[4]
- The size of the beam depends upon the ground conditions and applied loads.[4]
- This method is feasible for most type of soils.[4]
- Economical for depth shallower than 6m.[4]

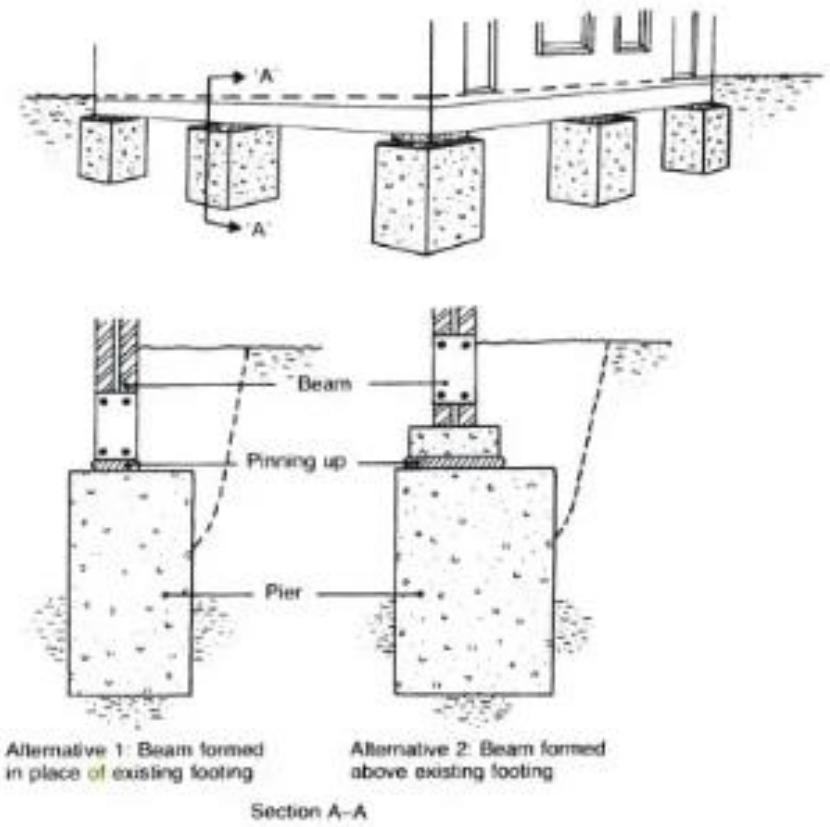


Fig.3: Pier and Beam Underpinning Method

Figure : Underpining (source: *The Constructor:Building ideas*, n.d:Online), https://theconstructor.org/building/underpinning-methods-procedure-applications/14480/

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THANK YOU