3.4 CAISSON

Caisson has come to mean a box like structure, round or rectangular, which is suck from the surface of either land or water to some desired depth. Caissons are of three types:

(a) Box caisson

(b) open caisson

(c) Pneumatic caissons

Box caisson

A box caisson is open at top and closed at the bottom and is made of timber, reinforced concrete or steel. This caisson is built on land, then launched and floated to pier site where is suck in position. Such a type of caisson is used where bearing stratum is available at shallow depth, and where loads are not very heavy.

Open caisson

A small cofferdam that is set in place, pumped dry, and filled with concrete to form a foundation (as for a pier)

Pneumatic caisson

A caisson in which air pressure is used to keep out the water a pneumatic caisson is a watertight box or cylinder-like structure that is closed at the top and open at the bottom, resting on the bed of the water body. They are used for underwater construction of foundations for bridge piers, abutments in rivers, and foundations for large multi-story buildings. They are designed to keep water out of the construction zone and act as a seal that keeps the inside of the caisson dry for workers to carry out work safely.

The inside of the caisson is kept dry by using compressed air to force water out of the structure. This process creates an airtight working chamber where construction activities, such as excavations, can be carried out safely. Pneumatic caissons are ideal for challenging situations where it is not possible to carry out wet ground excavations in the open. However, this method is complex, time-consuming, and relatively expensive when compared to other types of caissons.

SHEET PILES

Sheet piles are thin piles, made of plates of concrete, timber or steel, driven into the ground for either separating members or for stopping seepage of water. They are not meant for carrying any vertical load. They are driven into ground with help of suitable pile driving equipment, and their height is increased while driving, by means of addition of successive installments of sheets.

Functions of sheet piles

1. To enclose a site or part thereof to prevent the escape of loose subsoil, such as sand, and to safeguard against settlement.
2. To retain the sides of the trenches and general excavation.
3. To protect river banks.
4. To protect the foundations from scouring actions of nearby river, stream etc.
5. To construct costal defense works

3.5 COFFERDAM

Types of cofferdam

1. Cantilever sheet pile cofferdam
2. Braced cofferdam
3. Embankment protected cofferdam
4. Double wall cofferdam
5. Cellular cofferdam

Grout anchors used in constructions

In most cases, however anchorages may be embedded below ground level, with backstays connecting them to adjacent towers, or they may constitute the end abutments of the end spans. In addition to stability sliding, the anchorage structure must also be checked for stability against tilting and overturning.

Methods o f ground water control

Following methods of ground water control are adopted

1. Pumping from open sumps
2. pumping from well points
3. Pumping from bored wells

(1) Pumping from open sumps

This method is most commonly used where area is large enough for allowing excavation to be cut back to stable slopes and where there are no important structures close to the excavation to effect their stability by settlement resulting from erosion due to water flowing towards the sump. This method is also applicable for rock excavations.

This method costs comparatively low for installation and maintenance. In this method one or more sumps are made below the general level of the excavation. In order to keep the excavator area clear of standing water, a small grip or ditch is cut around the bottom of the excavation failing towards the sump. For grater depths of excavation the pump is used or submersible deep well pump suspended by chains and progressively lowered down. Pumps suitable for operating from open sumps are:

- Pneumatic sump pumps
- Self-priming centrifugal pumps
- Mono pump sinking pumps

Pumping is simple and less expansive, but has serious limitations. When fine sand or cohesion less soil lie below the water, this type of pumping removes the fine material from the surrounding soil and results in settlement of adjacent structures. To product it sumps lined with gravel filter are sometimes used.

(2) Pumping from well points

This system comprises the installation of a number of filter wells generally 1m long, around the excavation. These filter wells are conducted by vertical riser pipes to a large dia header main at ground level which is under vacuum from a pumping unit. The water flows to the filter well by gravity and then drawn by the vacuum up to the header main and discharged through the pump. This system has the advantage that the water is filleted as it removed from the ground and carries almost no soil with it once steady discharge conditions are attained. This system has the limitation of limited suction lift. Therefore for deeper excavations the well points are installed in two or more stages.

The filter wells or well points are usually 1m long and 60 to 75mm diameter gauge screensurrounding a central riser pipe. The capacity of a single we;; point with 50mm raiser is about 10 lit/min. Spacing between two well points depends on the permeability of the soil and on the time available to effect the drawdown. In fine coarse sand or sandy gravels a spacing of 0.75 to 1m is required, while in silty sands of low permeability a 1.5m spacing is sufficient .In permeable course gravels spacing should be as low as only 0.3m.A normal set of well point system comprises 50 to 60 points to a single 150 or 200mm pump with a separate 100mm jetting pump.

(3) Pumping from bored wells

Pumping from wells, for draw-down depth of than the meters can be under taken by surface pumps with their suction pipes installed in bored wells. When dewatering is required to be undertaken from a considerable depth, electrify driven submersible pumps are installed in deepbore holes with rising main to the surface. Since heavy boring equipment is used, installation of wells can be done in all ground conditions including boulders and rocks. Due to higher costs of installation, this method is adopted where construction period is long and other methods of dewatering are not possible. Installation of bore well consists of sinking of a casting having a dia of about 20-30 cm larger than the inner well casting. The dia of inner well casting depends on thesize of submersible pump. This inner well casing is inserted after complete sinking of borehole screen over the length where dewatering of the soil is required and it terminates in a 3-5 m lengthof unperformed pipe to act as a sump to collect any fine material which may be drawn through the filter mesh. Screen having slots are preferable to holes, since there is less risk of blockage from round stones.

Component parts of pipe jacking

Pipe jacking is specialist tunneling method for installing underground pipelines by assembling the pipes at the foot of an access shaft and pushing them through the ground with the minimum of surface disruption

Component parts of jacking systems

The pump unit has two distinct hydraulic systems

- A high pressure systems supplies oil for the main jacking cylinders and till intermediate jacking stations
- A low pressure system supplies oil, via hydraulic lines, for the boring head and conveyor. An auxiliary power pack may be easily installed to double the low pressure hydraulic flow. This may be necessary for larger and more powerful boring heads

Thrust yoke

The yoke is the frame that the main cylinders push against to advance the boring head and pipe. The ring provides a 360 degree surface against the pipe to minimize point pressure and reduce the chance of breakage.

Skid base

The skid base is the foundation of the pump unit and yoke. It also acts as a guide for launching the boring head and pipe into the ground.

Power packs

- Power packs with high and low pressure systems typically are matched with the multiple cylinder system.
- When tunneling, a lower pressure power pack may be selected to supply oil for the tunnelboring machine (TBM)
  - Power required depend on the size and features of the boring head
  - A mobile electric power pack may be positioned in the boring head/ TBM

Intermediate jacking stations

- Installing intermediate jacking stations is a simple economical way of adding and distributing thrust for pipe jacking
- The size and joint of the pipe, cost, length of push and versatility are important considerations that configure intermediate stations

Most popular design is effective with a variety of pipe sizes and design. Each design consists of ram segments. Each segment has 5 rams. All stations are supplied oil by one set of lines from the power pack and operated from one point in the jacking shaft.

Methods of providing shoring for the trenches

Methods for providing shoring for the trenches

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

(1) Stay bracing

- Carried out in moderately firm ground
- It is adopted when the depth does not exceed 2m
- The vertical sheets are placed opposite each other against the sides of the trench
- The vertical sheets are held in position by one or two rows of struts
- The sheets are placed at an interval of 3 to 4m and they extend to full depth of the excavation
- The normal sizes of
  - Polling boreds 200*40&200*50mm

- Struts 100*100mm (For trench width upto 2m)
- Structs 200*200 (For trench width more 2m)

2. Box sheeting

- Carried out in loose soil
- It is used when depth of excavation does not exceed 4m
- A box like structure is formed by providing sheeting, walls, structs and bracing
- In this arrangement, the vertical sheets are placed nearer and touching each other
- The sheets are kept in position by longitudinal rows of Wales, usually two andthen, structs are provided across the wales

3. Vertical sheeting

- Carried out in soft ground
- Adopted when the depth is about 10m
- This is similar to box sheeting except that the work is carried out in stages and at eachstage, an offset is provided
- For each stage, vertical sheets, wales, structs and braces are provided as usual
- The offset is provided at a depth of 3 to 4m and it various from 30 to 60cm per stages
- Suitable for laying sewers or water pipes at considerable depths

4. Runners

- Carried out in extremely loose and soft ground which requires immediate support as the excavation progresses
- The runners which are long thick wooden sheets or planks are used in this arrangement
- One end of runner is made up of iron shoe

- These are driven by hammering about 30cm
- The wales and struts are provided as usual

5.Sheet piling

- provided when large area is to be excavated for a depth greater than10m
- Used when the soil is soft or loose
- Provided when the width of the trench is large
- It is also provided when the subsoil water is present

Large reservoir construction with membranes and earth system

- The main problem in reservoirs is the loss of water due to seepage
- So even if the capacity of the reservoir is large much water by lost dueto it
- It can be made impermeable by construction of impervious membranes on the embankment
- The impervious membrane can be placed on

1. The upstream face of the dam
2. Core inside the embankment

- Most of the major earth dams constructed before 1925 were provided with central concrete core walls or concrete slabs on the upstream face
- The impervious advantages for the impervious membrane placement in the upstream side or core of the embankment

Concrete slab

- Concrete slab can be used successfully up to a height of 150ft
- The performance of concrete slab will directly on the quality ofconcrete
- Even though the earth earth embankment is not required to act as a water barrier, it shouldbe well compacted in order to minimize post-construction

settlement of the upstream

slope

- When single reinforced slab is adopted, some leakage will occur due to the hairline cracksso drains should be provided.

Steel plates

- Steel plate can be used where reinforced concrete is used
- The life is approximately the same as that of concrete
- It can be directly placed on the soil containing appreciable percentage of silt or clay
- It is expansive but it has two advantages
- It is watertight
- It is more flexible and can adapt to differential settlement in a better manner

Asphaltic concrete

- They are less costly than concrete or steel
- They are more flexible than reinforced concrete and can adapt to differential settlement better
- They can be constructed quickly
- Under certain circumstances the leaks development are self-sea line
- The portion above the reservoir level are easy to repair than either concrete or steel

Advantages of upstream membrane

- When the membrane is on the upstream side optimum stability condition are produced ,sothe volume of embankment can be reduced
- Since the upstream slab is exposed ,damage can be inspected and repaired easily
- The upstream membrane can be built after the embankment is completed

- Foundation grouting can be carried out while the dam is being built
- The membrane can serve a secondary function as wave protection

Internal impervious membrane

- Concrete is used mostly for internal membrane steel is used rarely
- Since it is not exposed for investigation very little reliable performance is available
- It is less influenced by embankment settlement and less likely to crack as a result

Advantages of internal membranes

- The area of the membrane is smaller than that of an upstream facing, so less material is required
- The surrounding embankment protects the internal membrane
- The core can be made almost watertight even if cracking develops, by placing thin layerof clay upstream
- A vertical extension of the core membrane below the base of the dam can be usedthrough soil deposits in the foundation
- The length of the grout curtain in is shorter.

Well sinking operation procedures

1. **Laying the well curb**

If the river bed is dry, lying of well curb presents no difficulty. In such a case, excavation up to half a meter above subsoil water level is carried out and the well curb is laid. If, however, there is water in the river, suitable cofferdams are constructed around the site of the Well and is lands are made. The sizes of the island should be such to allow free working space necessary to operate tools and plane for movement of labour etc. When the island is made, the center point of the well is accurately marked and the cutting edge is placed in a level plane. It is desirable to insert wooden sleepers below the cutting edge at regular intervals so as to distribute the load and avoid setting of the cutting edge unevenly during concrete.

2. **Masonry in well staining**

The well staining should be built in initial short height of about 2m only. It is absolutely essential that the well staining is built in one straight line from the bottom to top. To ensure this staining must be built with straight edges preferably of angle iron. The lower portions of the straight edges must be kept butted with the masonry of the lower stage throughout the building of the fresh masonry. In no case should a plumb bob be used to build more than 5m at a time. The well masonry is fully cured for at least 48 hours before starting the loading or sinking operations.

3. **Sinking operations**

A well is ready to be set in after having cast the curb and having built first short stage of masonry over it. The well is suck by excavating material from inside under the curb. In the initial stage of sinking, the well is unsuitable and progress can be very rapid with only little material being excavated out. Great care should therefore be exercised during this stage, to see the well sinks to true position. To sink the well straight it should never be allowed to go out of plumb.

Excavation and scooping out of the soil inside the well can be done by sending down workers inside the well till such a stage that the depth of water inside becomes about 1m.As the well sinks deeper, the skin friction on the sides progressively increases. To overcome the increased skin friction and the loss in weight of the well due to buoyancy, additional loading known as Kent edge is applied on the well.

Pumping out the water from inside the well is effective in sinking of well under certain conditions. Pumping should be discouraged in the initial stage. Unless the well has gone deep enough or has passed through a ring of clayey strata so that chances of tilts and shifts are minimized during this process. Complete dewatering should not be allowed when the well has been sunk to about 10m depth.

4. Tilts and shifts

The primary aim in well sinking is to sink them straight and at the correct position. Suitable precautions should be taken to avoid tilts and shifts. The precautions to avoid tilts and shifts are as follows

1. The outer surface of the well curb and staining's should be as regular and smooth as possible.
2. The radius of the curb should be kept 2 to 4 cm larger than outside of well staining
3. The cutting edge of the curb should be of uniform thickness and sharpness since the sharper edge has a greater tendency of sinking than a blunt edge.
4. As soon as tilt exceeds 1 in 200, the sinking should be supervised with special care and rectifying measures should be immediately taken.

5. Completion of well

When the well bottom has reached the desired strata, further sinking of the well stopped .A concrete seal is provided at the bottom. The bottom plug is made bowl shaped so as to have inverted arch action. As generally under watering concerting as to done, no reinforcement can be provided. Under watering concreting is done the help of tremie. However, if it is possible to dewater the well successfully, the concrete can be placed dry also.

After having plugged the well at its bottom, the interior space of the well is filled either with water or sand. It may even we kept empty. The well is capped at its top, with help of reinforced concrete slab. If however sand has been filled inside, top plug of lean concrete is interposed between the wall cap and sand filling.