**GOVERNMENT POLYTECHNIC FOR GIRLS**

**AHMEDABAD**

**COURSE: ADVANCE CONSTRUCTION TECHNOLOGY**

**COURSE CODE : 3350605**

**TOPIC: CAISSON**

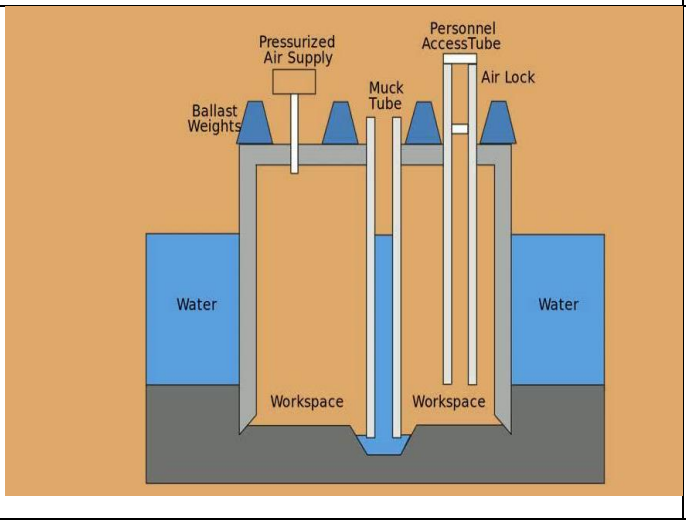
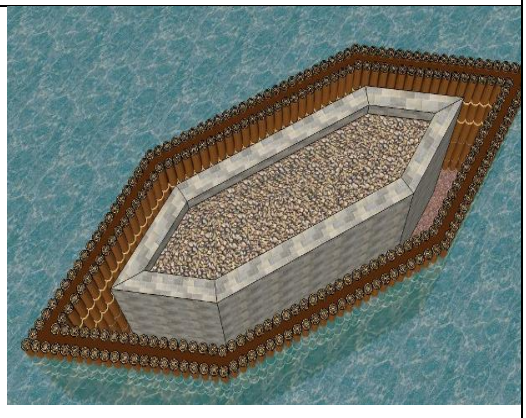
**PREPARED BY : H.S.PATEL LCE**

- The term caisson is derived from French word caisse which means a box.
- Caisson is defined as a watertight structure round or rectangular, which is sunk through ground or water to exclude water and semi fluid material during the process of excavation of foundations and which subsequently becomes an integral part of the sub structure.

***Uses of caissons :-***

- ✶ To reach the hard bearing strata for transferring the load of superstructure.
- ✶ For the excavation for foundations of bridges, piers, abutments in river and lakes.
- ✶ To serve as an impervious core wall of earth dams , when placed adjacent to each other.
- ✶ To provide an access to a deep shaft or tunnel.
- ✶ To provide an enclosure below water level for installing machinery pump, etc.

| **CAISSON** | **COFFERDAM** |
|---|---|
| • Caisson is a permanent structure, which subsequently becomes the part of the sub structure. | • Cofferdam is a temporary structure which is dismantled after foundation work is completed. |
| • Caisson may be constructed on the dry river bed launched and floated to the site of work. | • Cofferdam is constructed around the area to be covered. |
| • Caissons are preferred when work area is small and depth of water is more. | • Cofferdam is preferred when work is large and depth of water is small. |
| • The cost of caisson is more. | • The cost of cofferdam is less. |
| • Where foundation soil contains boulders and driving of sheet pile is | • Where sheet piles can be driven easily,cofferdams |

| | |
|---|---|
| impossible, caissons are preferred. | are preferred. |
| • It is used for the purpose of placing a foundation in correct position under water. | • It is used for the construction of foundations of piers and abutment of bridges, dams, locks etc. |
|  |  |

## MATERIALS USED FOR CAISSONS

The common materials used for the construction of caissons are:

1. Steel
2. Timber
3. Reinforced cement concrete
4. Cast iron

### Steel

- The steel is found to be the most suitable material for the construction of caisson.
- It is usually in the form of a double skin of steel plating and the hollow space is then filled with cement concrete.

### Timber

- The timber was use as a material for the construction of a caisson in the early stages of development of a caisson
- Now a days timber is practically not used because of its bulking effect and the risk of fire.

### Reinforced cement concrete

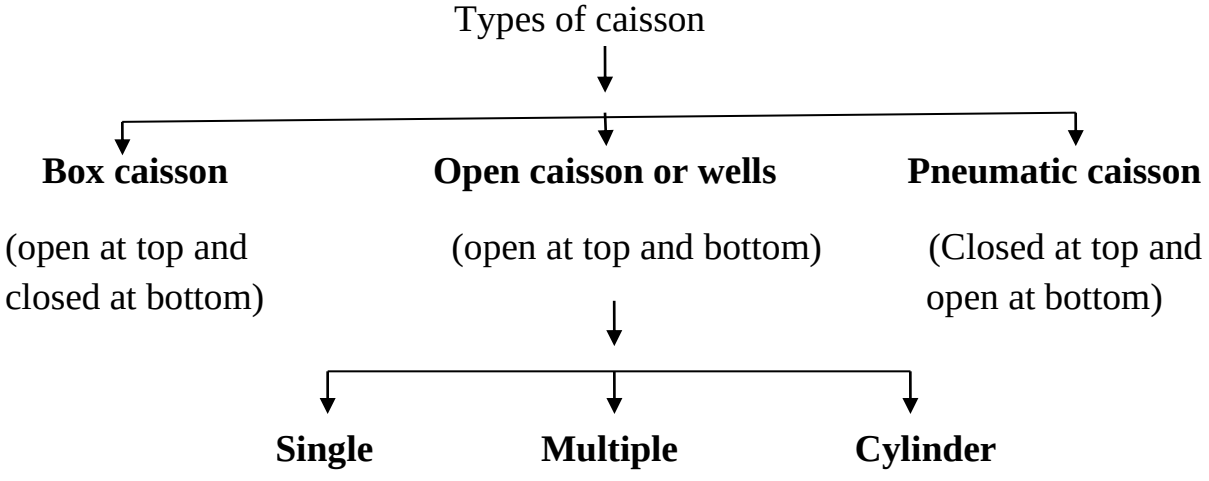
- The RCC is suitable for caisson shoes. RCC has more weight and there for it creates difficulties in handling
  And floating the caisson in the early stage of construction. It, therefore, becomes economical to construct a steel caisson with concrete lining.

### Cast iron

- The CI is suitable for caisson of open well type. New segment of CI are bolted as the caisson sink.
- The CI is unsuitable for pneumatic caisson as there is risk of failure due to tension developed by the compressed air.
- The cost of CI caisson is more is as compared to steel or RCC.

## TYPES OF CAISSONS

The term caisson is derived from the French word 'caisse' meaning a box. It is a box like structure, round or rectangular, which sunk from the surface of either land or water to some desired depth. It is used for the purpose of placing a foundation in correct position under water.



## Box caissons :

A box caisson is a strong water tight vessel open at top and closed at bottom. It is made of timber, reinforced concrete or steel.

This caisson is built on land, then launched and floated to pier site where it is sunk in position. Such a type of caisson is used where bearing stratum is available at shallow depth and where loads are not very heavy.

**Conditions favorable for the construction of box caisson**

1. Excavation for preparing the bed of foundation is not required. The bed of foundation can be previously prepared foundation.
2. The velocity of flow of water is slow so as to give stability to the caisson against scour.
3. The bed material is loose enough and it is possible to dredge out this material and from a levelled bearing surface.
4. The depth of water is about 6 to 8 m.

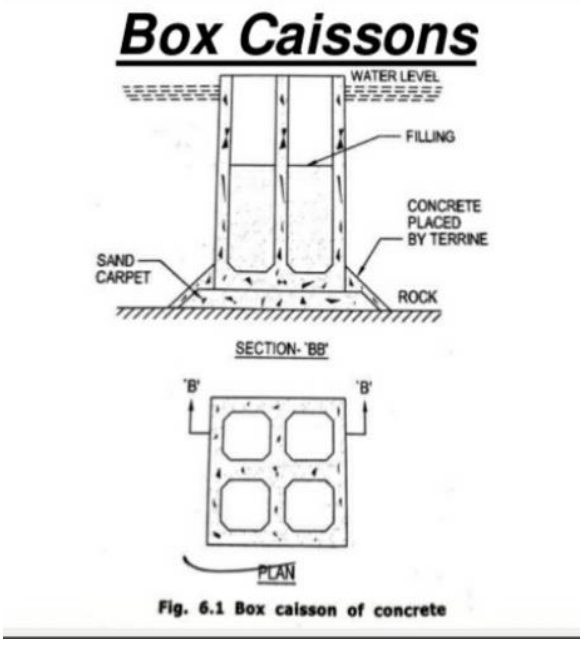


Fig. 6.1 Box caisson of concrete

## (2)Open Caisson or wells

An open caisson is a box of timber, reinforced concrete, steel or masonry which is open at the top and at the bottom. It is

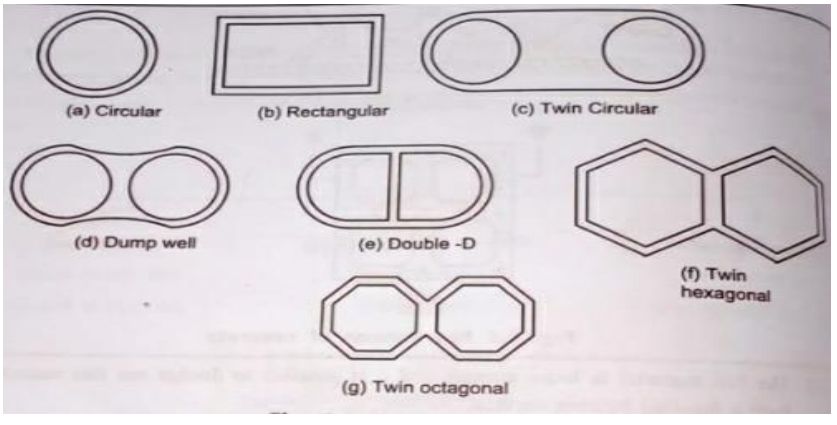
used for building and bridge foundations. Open caisson are also called well foundation.

They are used on sandy or soft bearing stratum liableto scour and where no firm bed is available for large depth below the surface. They form the most common type of deep foundation for bridges in India.

**Shapes of wells:**

The common types of well shapes are:

(a) Single circular
(b) Rectangular
(c) Twin circular
(d) Dumb well
(e) Double -D
( f) Twin-hexagonal
(g) Twin-octagonal




**SHAPES OF WELL**

**The choice of a particular shape depends upon the following factors:**

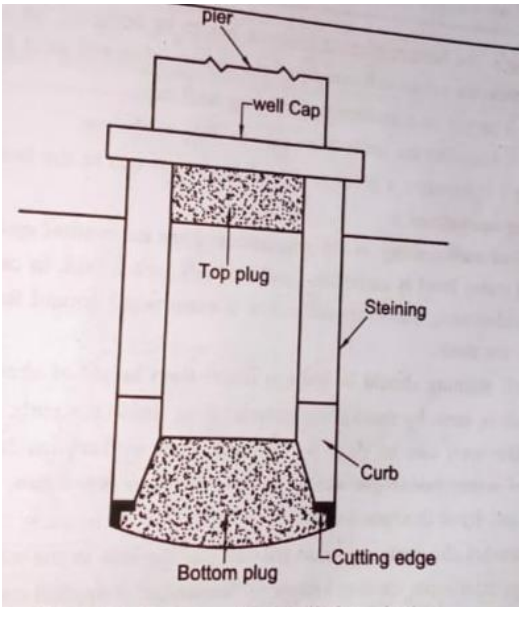
(1) The dimension of base of the pier or abutment.
(2) The ease of sinking.
(3) The cost of sinking and shuttering.
(4) The vertical and horizontal forces acting on the well.
(5) The considerations of tilt and shift during sinking.

In case of short span bridges up to about 18 m the best shape for foundation well is the single circular up to 6 m diameter or octagonal. The minimum size of circular well should be 1.5 m. The minimum size of a single well should be limited to 9 m for concrete steining and 6 m for a brick steining.

**Well foundation components and their foundations**:

The main components of well foundation are :

1. Cutting edge
2. Curb
3. Steining
4. Bottom plug
5. Top plug
6. Well cap
7. Sand filling




**SECTION OF A WELL FOUNDATION**

**1. Cutting edge** : It provides a comparatively sharp edge to cut the soil below it during sinking operation. It usually of a mild steel equal angle of side 150 mm.

**2. Curb** : It has two fold purpose. During sinking it acts as an extension of cutting edge and also provide support to the well steining and bottom plug while sinking. It transfers the load to the soil below. It is made up of R.C.C. of grade M20.

**3. Steining**: It is main body of the well. It also serves two purpose. It acts as a cofferdam during sinking and a structural member to transfer the load to the soil below afterwards. The steining may consists of brick masonry or reinforced concrete. The thickness of steining should not be less than 45 cm.

**4. Bottom plug** : The bottom plug of concrete has to be designed to resist an upward load equal to be the soil pressure minus self weight of the bottom plug and sand filling.

**5. Top plug** : It serves as a shuttering for laying well cap.

**6. Well cap** : It transfer the loads from pier to the well below.

**7. Sand filling**: It transfers a portion of load from well cap to the bottom plug.

**Well sinking operations:**

(1) IN case of well sinking on dry grounds, an open excavation up to half a meter above subsoil water level is carried out and the well curb is laid. In case the wells are to be sunk mid-stream, a suitable cofferdam is constructed around the site of the well and islands are made.

(2) The well steining should be built in initial short height of above 2 m only.

(3) The well is sunk by excavating material from inside the curb. Excavation of the soil inside the well can be done by sending down workers inside the well. When the depth of water inside the well becomes more than one meter, the excavation is then carried out by a dredger.

(4) To counteract the increased skin friction and the loss in the weight of the well due to buoyancy, additional loading known as “kentledge” is applied on the well. The kent ledge is comprised of iron rail, sand bags etc. supported on a timber platform.

(5) Pumping out the water from inside the well is effective when the well has gone deep enough. Complete dewatering should not be allowed when the well has been sunk to about 10 m depth. Sinking thereafter should be done by grabbing, chiseling and applying kentledge.

In case the well being sunk in sandy strata is struck up, frictional resistance developed on its outer periphery is reduced considerably by forcing jet of water on the outer face of the well around.

(6) When the well bottom has reached the desire strata, further sinking of well is stopped A concrete plug is provided at the bottom. The bottom plug is made bowls happed so as to have so as to have inverted arch action.

After having plugged the well at its bottom, the interior space of the well is filled with sand. The well is provided with top plug of lean concrete and well cap of R.C.C. A pier is constructed o the well cap.

## Multiple wells or monoliths

The monoliths are multiple wells which are sunk together. Each individual well has got a separate cutting edge and dredging in each of the well can be done separately. As the monoliths are of bigger dimension, they cannot be built on the site in the water.

Therefore, monoliths are to be constructed in dry, floated and placed in final position. All the wells of a monolith are cast as a single limit which prohibits individual sinking of any well. The dredging wells should be large enough to permit easy passage of excavating buckets.

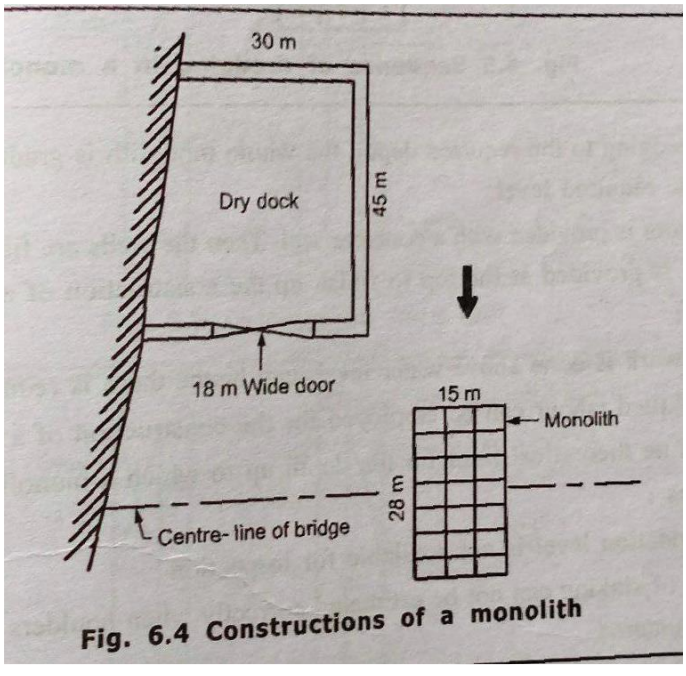



**Fig. 6.4 Constructions of a monolith**

## Construction procedure

1. A suitable site is selected on the upstream side of the proposed bridge in a river and a dry dock is constructed.
2. The dimension of the dry dock should be kept bigger than those of the monolith and it should be provided with a door of sufficient width to take out the monolith shown in fig.
3. The monolith is constructed in the dry dock up to such a height that it will remain above water level when it is sunk.
4. The gate of the dry dock is opened. The monolith is then floated and correct position.

5. The dredging operation now starts. The four dredging used simultaneously and the middle row is touched last.
6. After dredging to the required depth, the whole monolith is gradually sunk uniformly up to the required level.
7. The bottom is provided with a concrete seal. Then the wells are filled with the concrete and cap is provided at the top to finish up the construction of monolith.

## Advantage

1. All the work is done above water level, and hence there is reduction in cost.
2. The unskilled labour can be employed for the construction of a monolith.
3. There is no theoretical limit for the depth up to which a monolith can be sunk.

**Disadvantages**

1. The foundation level is not available for inspection.
2. The rate of sinking can not be estimated correctly when boulders or such obstruction are encountered.
3. It is difficult to have a through control over the sinking of a monolith.
4. The concrete is placed under water and hence it will not be as strong as concrete under conditions.

## Uses of monolith

1. Used for foundation work of bridge piers, quay walls etc.
2. The use of monolith is justified for such depth of water which will be unsuitable the cofferdam process or which will prohibit the use of pneumatic cassion.

## Cylinders :

An open cylinder can be conveniently used for the foundation used for the foundation of bridge piers. The cylinder is a

light shell which invariably becomes the part of the permanent structure.

Cylinders are used as a foundation when depth of water is more than 12 m or when it become essential to go deep to avoid exposure of foundation due to scouring action of following water.

The cylinders may be of cast-iron, cement concrete or mild steel. The reinforced cement concrete is used for large diameter and mild steel is used for small diameter.

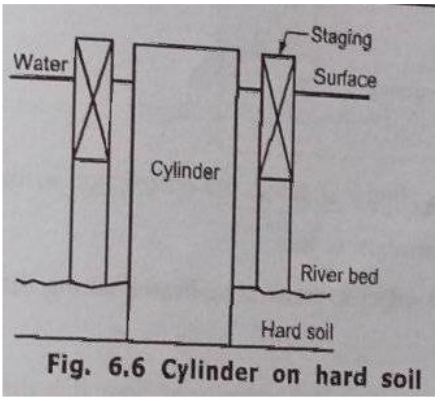


Fig. 6.6 Cylinder on hard soil

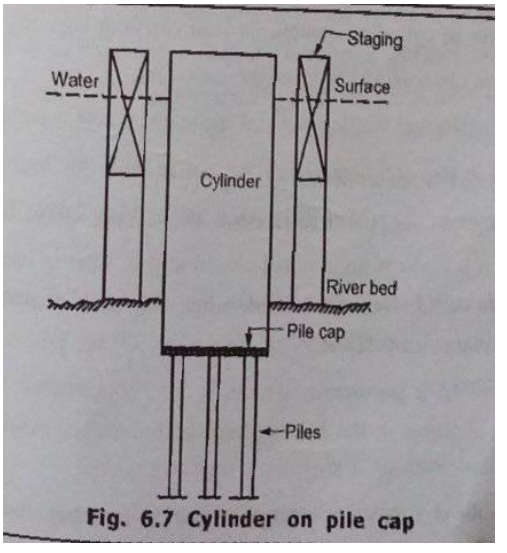


Fig. 6.7 Cylinder on pile cap

## Construction procedure

- The first section of cylinder is brought to the site of work and kept in vertical position for this purpose the staging is invariably used as shown in fig.
- The cylinder are normally taken in lengths 2 to 3 m. they are sunk by excavating the material from inside of the cylinder and sinking is facilitated by addition of weight on top of cylinder or by water jet or by driving the cylinder with pile driver.
- In case of cast iron or mild steel cylinder, the different lengths of cylinders are joined by bolting or welding. In case of metal cylinders, the bottom edge of cylinder itself act as a cutting edge. But, in case of cement concrete cylinders, cutting edge is required.
- The cylinder is sunk up to the desired bearing surface. It may also rest on a pile crap.

- After removing the inside material, the space is generally filled with concrete for full height of the cylinder.
- When cylinders are used for bridge of greater widths, two cylinder are sunk at some distance apart and suitable bracing is provided.

Courtesy Dr. R.P. Rethaliya Sir