

# STUDY ON CAISSON FOUNDATION

<sup>1</sup>B.KRISHNA KUMARI, <sup>2</sup>M.HASANTHIKA<sup>3</sup>H.NAGHINA BAANU

<sup>123</sup>DEPARTMENT OF CIVIL ENGINEERING, PANIMALAR ENGINEERING COLLEGE, BANGALORE TRUNK ROAD, VARADHARAJAPURAM, NAZARETHPET, POONAMALEE, CHENNAI-600123.

## ABSTRACT

Caisson foundation construction works as observed by the engineers are considered as the most difficult and complicated work in construction field. Caissons are sunk through ground or water to exclude water during the process of excavation of foundations and which becomes a part of substructure. In this paper, a brief description of the caisson foundation is done which is used nowadays in construction. The general description of all types of caisson foundation in detail, its new technical aspects, improvement in new techniques and also its advantages and disadvantages are discussed. The aim of this paper is to focus on a new type of substructures based on caisson foundation, to learn about new technique based on this type of foundation.

**Keyword: Caisson foundations, Types of caisson, open caisson, box caisson, pneumatic caisson**

## 1. INTRODUCTION:

Construction of Caisson is a type of well foundation or pier foundation. Caisson foundation is used for the Construction of a Deep foundation near water bodies. Caisson foundation is a water retaining structure used as a bridge pier, construction of the dam, etc. It is used in structures that require foundation beneath a river or any water bodies. The reason for the caisson is that it can be floated to the desired or required location and then sunk into place where it is required. Caisson foundation is a pre casted long hollow cylinder depressed into the soil up to the desired level and then filled with concrete, which acts as a foundation. Caissons are complicated to construction procedures and lack construction expertise. Caisson foundation is highly cost consuming substructure and it lack expertise.

## 2. MAIN FUNCTIONS OF CAISSON FOUNDATION:

Caisson foundation is used in building bridge piers as it is used in underwater construction. Caisson foundation is constructed in connection with excavation of soil for the foundation of piers and even used in rivers and lake abutments, bridges breakwater dock structures for the shore protection etc. It is also used for pump house which is subjected to large horizontal forces. It is sometimes used for high raise and multi-storied buildings. Pneumatic caisson foundation is used in railway bridges across rivers or lakes, garbage pits, water supply system, sewage and sewer facilities etc. Caisson serves as an impervious core wall on earth dams when placed adjacent to each other. Caisson provides an access to the deep long tunnel. Caisson also provides an enclosure below water level for installing machinery, pumps in underground etc.

## 3. MATERIALS USED FOR THE CONSTRUCTION OF CAISSONS:

The common materials used in construction of a caisson are:

The cast-iron is used for caissons of open-well type of foundation. Cast-iron are bolted as the caisson sinks. Cast iron material is not used for pneumatic caissons it may cause failure. Compressed air may cause tension in pneumatic caisson. The cost is also less comparatively to steel or R.C.C. The reinforced cement concrete is usually used for caisson shoes.

R.C.C has more weight and because it causes some complication and problems in early stage of construction or sinking stage or transporting stage.

RCC becomes economical and easy to construct a steel caisson with concrete filling. The steel is the most common material for the construction of a caisson. It is usually in the form of steel plating and the hollow space is then filled with cement concrete. The timber was used as a material for the construction of a caisson in the olden times before caisson was developed. But timber is now is not used in caisson because it has a risk of fire and its bulk ness to transport.

## CAST-IRON



## REINFORCED CEMENT CONCRETE



## STEEL



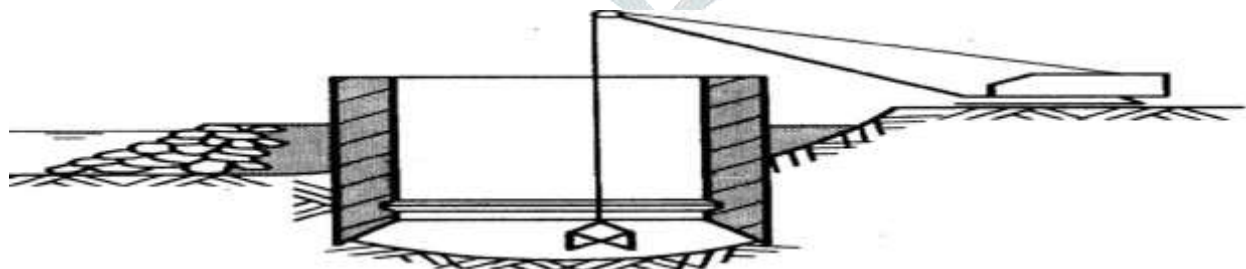
**TIMBER****3. TYPES OF CAISSON FOUNDATION**

The Shape and the size of the Caisson is depended on the structure for which it is use based on, Caissons are classified mainly into three types.

- Open Caissons
- Box Caissons
- Pneumatic Caissons
- Excavated Caissons
- Floating caissons

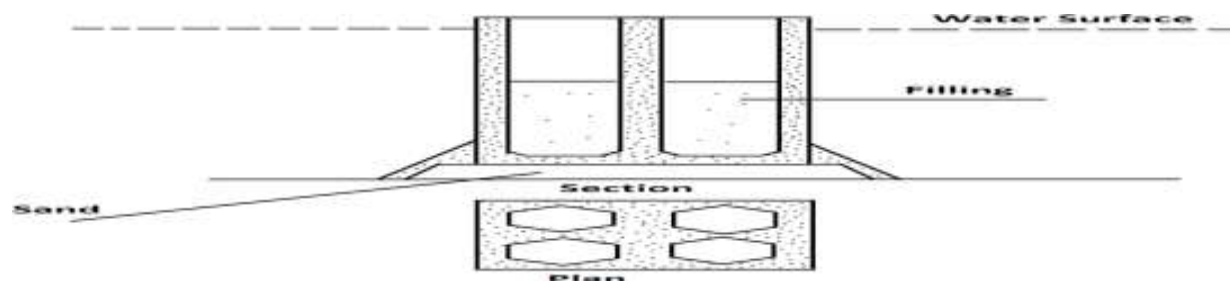
**A. OPEN CAISSON:**

The structure is open at the top and bottom and it is manufactured partially or fully at ground level. This type requires special care and experience for construct. Open Caisson is suitable only for the sandy soils, soft strata soils. Open Caisson is constructed in reinforced cement concrete (R.C.C) and filled with coarse sand or gravel. Open caisson used in soft soil grounds or high water tables areas, where open trench excavation which can be filled with concrete. The Construction of the Open caisson is usually preferred in the dry condition or waterless area. Open caisson comparatively needs less cost for construction.

**B. BOX CAISSON:**

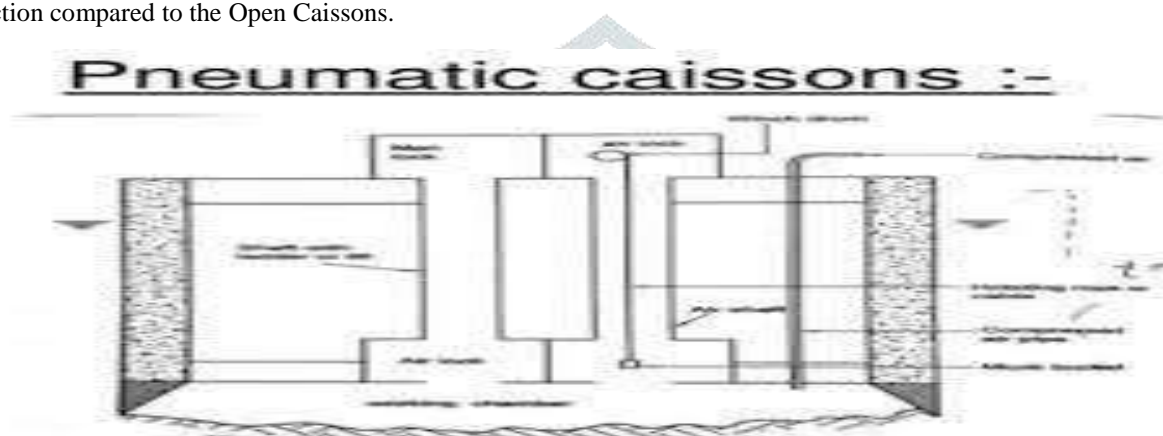
Caisson is a water based structure made up of timber, steel, and reinforced cement concrete and constructed in connection with the excavation for the foundation of piers, bridges, and dock structures etc. geotechnical engineering, a caisson borrowed from French caisson, from Italian caisson which means large box, an augmentative of caisson is a watertight retaining structure used, for example, to construct on the foundations of a bridge pier, for the construction of a concrete dam, or for the repair of the above mentioned structures. Box Caisson is used where the bearing stratum of the soil is available at the shallow depth.





### C. PNEUMATIC CAISSON:

Pneumatic Caisson foundation is open at the bottom side and closes at the top side. Pneumatic caisson is particularly used at the place where it is not possible to construct well. It is suitable where the depth of water level is greater than 12 meter. In the process of construction of pneumatic Caisson, the compressed air is generally used to remove water from the working area and the foundation work is carried out in the dry condition. The process of the Construction is the same as the open Caisson. The Quality Control in the Pneumatic Caisson is good because the work is done in the dry conditions. Pneumatic Caissons costs high in construction compared to the Open Caissons.



### D. EXCAVATED CAISSON:

It is known as a type of deep foundation which are constructed above ground level, then sunk to the required level by excavating or dredging material from within the caisson. Excavated Caissons are created by excavating a deep hole into the ground surface, and then filling it with concrete as desired excavated caissons are placed within an excavated site and are cylindrical in shape and with the concrete are backfilled.



### E. FLOATING CAISSON:

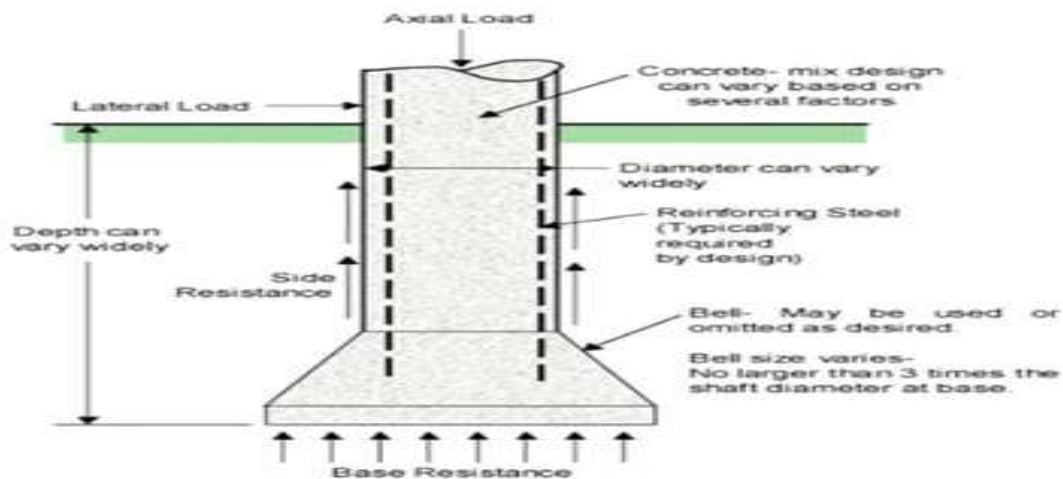
In some cities and even in some countries the demand for land and space is rapidly exceeding the supply. Maritime centers do not escape from this reality, Port and harbor facilities form the infrastructure that leads to marine traffic possible, facilitating the construction of vessels, its protection against wave action and, its loading and unloading activities, also they play an important

role in facilitating international commerce, a solution to this supply problem has been the expansion of ports. One of the methods in caisson that gives a fast paced construction of docks is based on the use of floating caissons. The floating caissons are prefabricated concrete box-like elements with cylinder cavities or cells that are built with the help of a special equipment called "Floating Docks." The floating caissons dimensions vary bases on each project requirements within certain limits. The floating dock fabrication equipment is a proprietary technology owned by DRAGADOS.



#### 4. CONSTRUCTION METHOD OF CAISSON FOUNDATION

Firstly, the Caisson are constructed, reinforced and cured on ground surface. After curing is done properly, it is floated to the desired location with help of tow boat, cables etc. To facilitate proper sinking process the self-weight of the caisson is increased by adding gravel or sand provides proper sinking process. The base location where caisson should be placed is excavated and leveled for sinking upto desired depth. To carry loads uniformly from the super structure, a caisson concrete cap is provided at the top.





## 5. TRANSPORTATION OF THE CAISSON

After some initial form work and concrete grade determination, Concrete is filled with steel forms built up in the box. When concrete placement is done, the box becomes heavier after concrete is filled and then sinks into the water along the caisson. The caissons are usually prefabricated near the Construction or suitable location near construction. After prefabrication process of the Caissons is completed, the tested for the water tightness is taken. In the tests, leakage of caisson is tested if it fails, caisson is repaired immediately. Then it moved to the desired construction location like rivers, lakes or similar water bodies. Then caisson touches the river bottom, earth is excavated through the long dredge well tubes and air domes are removed. The caisson sinks into the river bottom and placed. Excavation continues till it sinks till it reaches a determined depth of placement. And finally concrete is poured into the tops and bottom as well and resealed.



## 6. POSITIONING AND IMMERSION OF CAISSONS

- It is very important that Caisson should be properly transported and positioned at the required place.
- The final positioning is done by with the help of the floating equipment's with cables attached or tug boat or dead man boat or anchors
- When the caisson is ready to insert to the soil, the excavation work is done from the work chamber which causes the caisson depress to into the ground.
- Excavation of the ground is done by high efficient sand pumps or machinery nowadays in olden days it was done traditionally by the hands
- Hydraulic transport system clears the excavated soil from the site.



- The Caisson settle under its own weight then it can press for further depth.
- When the caisson has reached the desired depth, then the work chamber is completely filled with the Concrete. This prevents further sinking of the Caisson.



## 7. ADVANTAGES OF CAISSONS FOUNDATION

- Excavation can be done easily in dry condition.
- Caissons are good in axial loading capacity.
- Caisson is usually suited in different site conditions.
- Caissons are more economical since they have developed in many ways.
- Caisson can be depressed at any required place.
- It has more bearing capacity for the loads applied to the structure.
- Caisson is filled with concrete so cap pile is not required.
- Caissons can be extended up to the large depths in the ground.

## 8. DISADVANTAGES OF CAISSON FOUNDATION

- The Inspection of the Caisson is difficult.
- Caisson foundation has very less experts in construction.
- Caissons cannot be construed in the contaminated sites.
- Caissons are required to be constructed under the supervision of the Experts
- There may be a risk of the workers to getting affected during construction of caisson foundation.
- Caisson foundation has a limit of penetration up to a depth of 35 meters.

## 9. CONCLUSION

Caissons are a very efficient method of deep foundation, provided the ground conditions are favorable to be economical. Caissons are designed as per its size based on load carrying capacity such as large caissons and small caisson. Large caissons are used as foundations for bridge piers, deep-water wharves, and other large underwater superstructures. Small caissons are used usually singly or in groups to carry loads as building columns in structures or act as a building member. Caissons are provided, where the soil cannot bear other simple deep foundation. Caisson foundation is one of the most efficient among all deep foundations used in underwater constructions.

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