A CASE STUDY ON UNDERWATER CONSTRUCTION

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Abstract— **Underwater construction works as observed by the engineers and designers are considered as the most difficult work. Caissons are sunk through water 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 substructure. In this paper, a brief description of the open caisson is done which is constructed using under water techniques. tremie method for concrete placement is discussed. The general description of open caisson in detail, its technical aspects, improvement in new techniques and also its advantages and disadvantages are discussed. The aim of this paper is to focus on small aspects included in under water construction through caisson which are highly cost consuming structures, to give a better and stable foundation for carrying heavy and dynamic load.**

Keywords:- ***Under water construction, Construction techniques , Analysis & Methodology***

I. INTRODUCTION

Underwater construction is a critical component of the entire project works of construction. It is technically demanding to take on the effective and viable methods as it involves complex construction logistics. Therefore, its significance in the project far beyond the concreting operations themselves, in essence, underwater concrete can be constructed with the same degree of reliability as above-water construction. Underwater construction works as observed by the engineers and designers are considered as the most difficult work. But if it is not carried out properly, with the proper concrete mixture and placement procedure, underwater concrete construction can result in a major cost and schedule overrun. This is the area where sound design and competent construction planning can achieve a meaningful reduction in risk and cost.

II. LITERATURE REVIEW

Useful references on underwater construction technology were identified from journals and government reports. Report subjects included methods of excavation, tunneling, underwater structure lining, waterproofing practices, security, survivabiiity, and cost and energy considerations. Much of the literature presented application of different construction methods to specific structures, such as civil' defense shelters, subways, tunnels, schools, and libraries. The papers surveyed discuss underwater construction methods used in the United States and 11 other countries. Table I lists the reports that discuss underwater construction in foreign countries. Each article is designated by country and reference number. This reference number corresponds to the complete list of references found in the appendix. The literature collected provides an overview of the most current developments.The distribution of reports by year published. Clearly, it shows that the majority of reports have been published since 1977. The appendix: provides a more detailed discussion of the literature review, including databases searched, keywords used, and journals referenced.

III. CASES STUDY

- The project required that a large volume of tremie concrete be placed upto 57 m below the water surface.
- All the tremie concrete was produced on a floating batch plant.
- Each tremie placement was carried out continuosly day and night for 3 days.
- Each tremie pipe covered covered a 100-m2 area.
- The total of 50,000 m3 of concrete was placed in the steel cassion.

IV. FIGURE ANALYSIS OF UNDERWATER CONSTRUCTION

FIG (I) : POWER GENERATION

FIG (II) : UNDERWATER TUNNEL

FIG (III) : BRIDGES

V. CONSTRUCTION TECHNIQUES

- **COFFER DAM:**

A cofferdam is an enclosure within a water environment constructed to allow water to be displaced by air for the purpose of creating a dry work environment commonly used for oil rig construction and repair, bridge and dam work. The cofferdam is usually a temporary welded steel structure, typically dismantled after work is completed. Its components consist of sheet piles, Wales, and cross braces.

FIG:- COFFERDAM

- **CASSION:**

The term caisson is derived from Latin, which means box or case. Caissons are hollow inside and usually constructed at site and sunk in place into a hard bearing stratum. It's a prefabricated hollow box or cylinder. It is sunk into the water to some desired depth and then filled with concrete thus forming a foundation. Most often used in the construction of bridge piers and other structures that require foundation beneath rivers & other bodies of water. This is because caissons can be floated to the job site and sunk into place. Basically it is similar in form to pile foundation but installed using different way Used when soil of adequate bearing strength is found below surface layers of weak materials such as fill or peat.

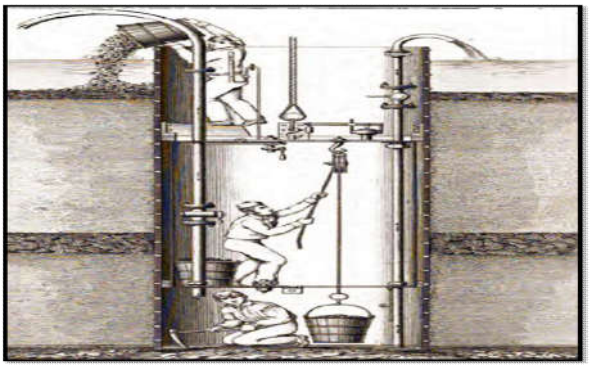


FIG: CASSION

VI. MATERIAL USED IN CONSTRUCTION TECHNIQUES :

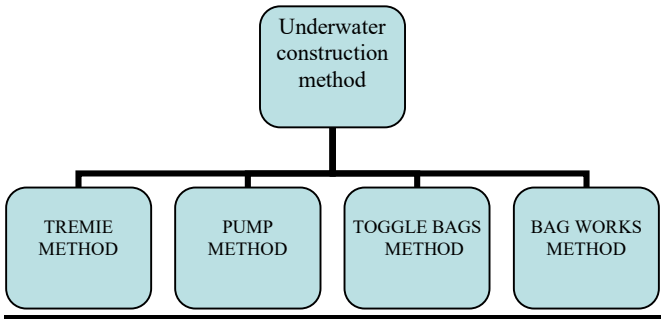
The common materials which are usually employed for the construction of under water techniques are as follows,

- Cast-iron
- Reinforced cement concrete
- Steel
- Timber

- **Cast-iron** :- The cast-iron is suitable for caissons of open-well type. New segments of cast-iron are bolted as the caisson sinks. This material is unsuitable for pneumatic caissons as there is risk of failure due to tension developed by the compressed air. The cost also works out to be more in relation to the steel or R.C.C.
- **Reinforced cement concrete**:- The reinforced cement concrete is suitable for caisson shoes. This material has more weight and therefore 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 filling.
- **Steel** :-The steel is found to be the most suitable material for the construction of a 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 used as a material for the construction of a caisson in the early stages of development of a caisson. But this material is now practically not adopted mainly because of its bulk and risk of fire.

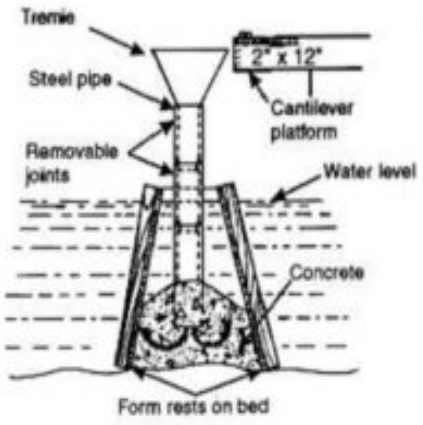
VII.METHODOLOGY

Following are the methods described the underwater construction:-



TREMIE METHOD

Tremie method is one of the most common methods that is used for concreting under water. In this method, a long steel pipe (named as tremie) having a diameter of 15 to 30 cm is inserted vertically into the water. The pipe should be long enough that it reaches to the bed of water keeping its one end above the water level. The tremie is then fitted with a hopper at the upper end for pouring concrete inside the pipe. The lower end of the tremie pipe must be closed with a check valve before inserting it into the water. After that, freshly mixed concrete is poured with the help of hopper. When the concrete is poured, it displaces the air and water present in the pipe and finally reaches to the bed.



The principle of this method is that concrete is poured down a pipe or tube from above the surface and is forced into the mass of concrete already in place by the weight of concrete in the tube. The tube is surmounted by a hopper and the whole is suspended from a staging or frame, mounted so that it can be moved vertically when held by a crane. As the pour rises, sections of the tube can be removed to facilitate working. A convenient diameter for the tube is 8 to 16 times the maximum

aggregate size and 250 mm is a common diameter. A diagrammatic representation of a tremin. Before starting the pour, a plug is inserted into the tube to stop the concrete and water intermixing. This plug can be purpose-made (similar to a bath plug), a sponge rubber ballor exfoliated vermiculite, which is the most common method in the UK.

At start-up the bottom of the tube should be on or very close to the sea or river bed,sufficient to allow the water in the tube to escape and to force the first load of concrete to spread out horizontally into a mound shape. The concrete pouring should be continuous with the bottom of the tube always inside previously placed concrete. If this immersion depth, normally at least 0.5 m, is not sufficient, a breakthrough will occur and the poor will have to be abandoned for the day.The concrete flow pattern is dependent upon the consistency of the concrete mixture and the placement rate. In addition, the flow pattern is also affected by the thickness of the concrete placement and the tremie embedment depth of concrete.

PUMP METHOD

Underwater concreting using pumping technique is a developed version of Tremie pipe and it is quicker method for concreting in areas that is difficult to access such as under piers.Pumping provide several advantages that Tremie pipe is lacking for example, pouring concrete from mixer to formworks directly, solve blockages in the pipe because concreting is through pumping instead of using gravitational force, and risk of segregation is decreased.

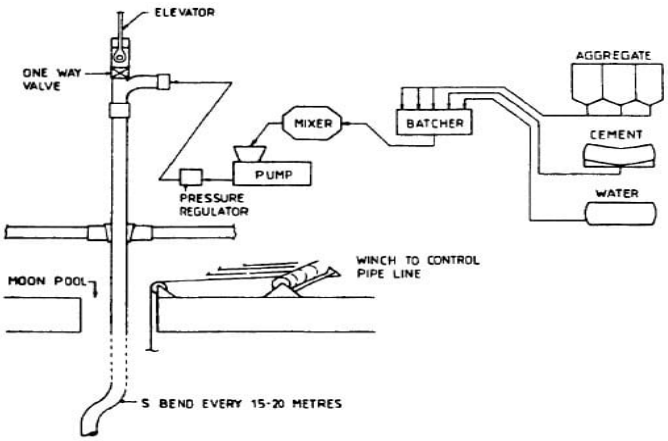


FIG : PUMP METHOD

TOGGLE BAGS METHOD

Toggle Bags method is useful when small amount of concrete is required. A reusable canvas bag is sealed at the top with chain and secured with toggles is filled with concrete and dropped carefully into the determined location then through opening at the bottom of the bag the concrete is discharged.

FIG: TOGGLE BAG METHOD

BAG WORK METHOD

Bag work concrete method used for renew ballast or to seal holes temporarily. The bags are produced from considerably strong fabric with capacity of 10 -20 liters and it carried by divers to the selected position.The concrete slump is between 19- 50 mm and 40 mm is the maximum aggregate size that can be used. The installation of the bags is similar to bricks in order to create bonds.

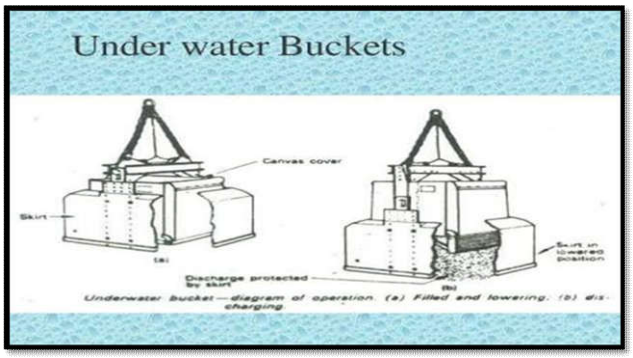


FIG: BAG WORK METHOD

VIII. ANALYSIS & PROJECT REPORT

- Project Site : Hasdo river over bridge (korba)
- Length of bridge: 500m
- Estimate cost: 500cr. Approx
- Company tying with govt.: Dilip buildcon (MP)
- Depth of water from surface : 35m
- Foundation type: Pile foundation
- Diameter of pier: lower-1500mm, Upper-2200mm
- Material used: Coarse aggregrate, sand ,cement, reinforcement,soil, timber, metal plate, sheet piel ,wire etc.
- Machine used : Drilling machine, bucket, floating boat, breaking machine, seizer, fantam.

IX. ACKNOWLEDGMENT

This research paper is made possible through the help and support from our teachers and friends. Especially, we are thankful to our project guide **Prof. Bhumika Das** (Head of civil department). We would also like to thank for her valuable guidance.

X.CONCLUSION

These are the following conclusion carried out from the literature review and case studies:
1) Caissons are permanent structures and become economical in cases where the plan area of foundation is small, large depth of water and for loose soils.
2) At present, the tremie placement method is the standard way of placing high-quality concrete underwater. The other placement method are not able to reliably place high-quality underwater concrete for major structures, although they may find application in special cases.
3) High quality concrete can be placed underwater in drilled shafts. However, proper concrete mix and proper placement techniques are essential as well as performing effective non-destructive testing to confirm sound concrete
4) Open caissons are small cofferdam that are placed and then pumped dry and filled with concrete. These are generally used in the formation of a pier.

XII. REFERENCE

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