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Study & Development of Underwater Construction in Present Scenario

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ABSTRACT - This report has aimed at presenting a brief over view on the development of underwater construction in the current context. An under the water technology of constructing the structures is studied in this report. It was mentioned that the underwater buildings have existed since the year 1960 and yet no one knew about it. Underwater building of such buildings can also help the people and environment as long as the right methodology is entered and people succeed in building such constructions. The following paper is talking about what materials ought to be utilized in the construction of the structure of underground buildings, how to build and unique demands, whether such structures are feasible, what are the merits and demerits of underground buildings on the environment, how would such buildings affect the social life and conveyance. Destiny goal or future foundation is underwater construction so that it can leave an awesome impression on the environment, it shall also result to some of the nuisance caused to the surroundings which shall be experienced as a result of the use of this technology but in case we achieve fulfillment in achieving it will be a grand advantage to the environment which would get congested day after day because of the presence of increasing population. The floor of the earth is roughly 3/4th surrounded with the help of water and water our bodies. To this end the emerging technology, which lies nearer the underwater production technology will be beneficial to the mankind. Underwater buildings are going to be buildings that are constructed beneath the water and every structural construction done has got a motive attached to it in accordance to the kind of building done.

Key Words :- Introduction, Literature Review, Case Studies, Objective, Research Gap, Future Scope, Methodology, Techniques Used, Underwater Concrete Properties, Challenges

1. INTRODUCTION

An underwater construction is a niche of civil engineering and marine engineering where structures designed, planned and built below the water tables are constructed. In the last few decades, this field has changed a lot based on advancement in technology, material science, and techniques of engineering. Construction and creation of underwater tunnels, pipelines, offshore platforms as well as artificial islands and marine research stations are now an important part of current infrastructure projects.

Value of underwater construction is apparent in numerous arenas such as the offshore energy producing business, marine transport, deep sea tourism and coastal defence. As people have become more concerned about having sustainable energy systems and meanwhile, with the changes in climate, the necessity of constructing solid things under the water and ensuring coastal profiles are resilient to changes in climate, the role of underwater construction becomes even more important.

The underwater construction in the current situation is depicting the use of new age materials, and other novel techniques of constructions. The advances have made it possible to complete some of the most sophisticated projects in a hazardous marine setting, including deep-sea oil platforms to underground transportation links between large cities.

Nevertheless, unique problems are also associated with underwater construction, such mining, physical conditions, poor visibility, high pressure and additional safety measures. To address them, a multidisciplinary perspective is necessary as it incorporates the knowledge in civil engineering, oceanography, robotics, and environmental science.

This paper seeks to discuss the recent technologies, materials and processes involved in underwater construction. It shall also emphasize the issues encountered and the remedies that have been found to provide safety, sustainability and efficiency of the underwater construction projects in the current situation**.**

2. LITERATURE REVIEW

• **Hemant Kumar Sain, Mayank Mehandiratta, Vikas Yadav, (2019) :** The underwater construction is purely needed in cases where no transportation and field area is available to have the required living so there should be an underwater construction. In the underwater construction, has to be faced numerous difficulties. We initially need to sight the site of construction either right or wrong and there should be no harm to be aquatic life. It offers improved transportation route or public transportation and that it will eat lesser time or transportation but the drawback is it would eat up more time during construction period. Good materials only are used in this kind of construction in stable life long time.

• **Chiranjit Samanta, Rabi Das, Kousik Sabui (2018) :** The process to construct the concrete mixtures ought to be such that they should be easily cast and even capable of remaining in the resonance situations even in the worst ground of underwater. The properties that must be achieved are concrete can flow, its workability should last a reasonable period, self-compacting, sufficient cohesion to prevent segregation, low heat of hydration, low bleeding, set times controlled, develops adequate compressive strength, high bond strength, low creep and shrinkage, washout by flowing water, abrasion resistant, and few others depending on the environment where the structure is to be constructed. Of all the mixes, the material that performs best as

an anti-washout admixture as well as optimization of the dosage of the said material to specific volume of concrete will be done.

• **Zaran D. Patel , Dr. Jayeshkumar Pitroda 2017) :** This record examined a current era of the building of the structures below the water. The future establishment has an excellent impact on the environment since it is to be made under the water as building is constructed. Through this document we have revealed what underwater buildings are. It has talked of the effect of the underwater constructions on the environment and the social life.

• **Kiran Dabral, R Selvaraj, Simon J (2016) :** The procedures adopted to lay concrete underwater include pre-packed concrete laying procedure, tremie laying process, as well as concrete pumping laying process. The most popular currently used method of concrete placement under water is the use of the tremie. In an effort to accommodate all the needs of the properties of the underwater concrete, scientists have been putting a lot of effort in the construction material so as to come up with admixtures that can be used in concrete to ensure that the concrete can be poured under water without the component of tremie. Such materials are called anti-washout concrete. In the underwater placement of concrete, the mixture is to prevent washout of cementitious material and also dispersion of the aggregate.

3. CASE STUDIES

• **Kolkata underwater tunnel :-** East West Metro tunnel is a under construction under bulging river tunnel of Kolkata Metro West Bengal. The tunnel was built under Hooghly River. The length of the tunnel is 10.8km and the width 5.5 metres. The tracks will be a 520m tunnel bend under the Hooghly River. The tunnel would have a roof that is approximately 30 metres above the ground. The tunnel will be the underwater river-crossing tunnel in India and is projected to be ready in march 2022. Water tightness, waterproofing, gasket design, were the key issues in case of tunnelling below the river. The tunnel is being built to serve 120 years thus it cannot take any water leakage during its service.

• **Ithaa under sea Construction Restaurant :-** The Ithaa Undersea Restaurant is a spectacular acrylic-made restaurant in the island country Maldives, which is 16 feet below the water line. The restaurant is almost built off transparent acrylic that provides the people who eat there with a 360-degree view of the marines that are around the restaurant. The 500 square feet restaurant is constructed via the float and lower technique. Once constructed in Singapore, Ithaa was carried in a barge, and lowered by use of sandbags onto steel-driven piles, which make its base. The restaurant is supposed to have a life span of 20 years.

• **Dubai Underwater resort :-** This is the one which is under construction. The motel is located at the depth of 33 feet under the water line. One can link the surface one to core project which is located under water through a tunnel which is 515 meters long . It was a 260 hectares facility where they have made 220 bubble shaped suits which have been inbuilt 20 meters below the waterline. It is comprised of series of water proof entrances that can be utilized in any event of rapture. It will equally have its missile defense machine should the extremist attack take place.

• **UNDERSEA - The Poseidon Luxurious Resort :-** This idea belongs to one of the American engineers Bruce Jones. The elevator can be used to access the Poseidon resort as seen in the figure. It is constructed in an area of 11 lakh of rectangular foot. Each room has an area made up of 550 rectangular foot. To develop this project 100 million dollar was spent completely.

• **Atlantis hotel** :- The Atlantis hotel is situated in the human-made island, the Palm in Dubai Island in the form of a palm frond made. Most of the its structure is above ground and the hotel will have several twenty feet below sea level underwater suites. After descending lift up to suites, one is welcomed by huge windows that go down to the ceiling with some views of sea animals in the bed and bath tub. Though little is known about the process of the underwater suites creation, on land the construction was made with the help of modular units, which could have been he applied to the undersea part also.

4. OBJECTIVE

The main aim of the present work is to carry out the in-depth study of the situation in the underwater construction and target the latest technologies, materials, and approaches employed in this area. In particular, the objective of the study will be to :-

• Research on the materials that are employed in under water construction with their properties, advantages and limitation.
• To learn the various ways carried out in underwater construction.
• The various challenges encountered in the underwater construction would be studied.
• To analyse various underwater construction works.
• Determine environmental problems that underwater construction may imply and discuss green ways.
• Assess safety measures and standards that would be used to preserve employees and under-water structures.

• To develop the procedure of Rehabilitation of Damaged Underwater Construction Phase.

5. RESEARCH GAP

• No system to find an appropriate zone of underwater construction depending on geological, ecological factors, and economical aspects.
• Scarcity of information regarding the employ of high-performance concrete, self-compacting concrete, or resonance resistance additives.
• Lack of quantified studies indicating the impact on the environment caused by underwater construction.
• No quantification of cost, technical feasibility, or life-cycle assessment for underwater living systems.
• No structure on safety requirements, legal issues, or human versatility in the underwater conditions.
• Little bit of information about long-term maintenance, underwater structure durability.

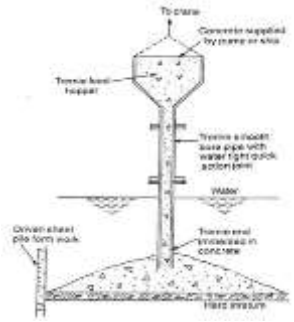
6. FUTURE SCOPE

• Renewable Energy in Construction Operation :- Operation of renewable energy Powering The use of renewable energy sources such as Tidal and wave energy converters Ocean thermal energy conversion Tidal turbine foundations, wave wind and solar Energy resilience and Hybrid Energy System in the construction operation.
• Rehabilitation of Damaged Underwater Construction Phase:- Preparation of underwater compatible material that could offer fast setting, high bond material to be used in repairing of underwater structures and hydrostatic containment ability to seal leaking structures. Application of underwater grouting and polymer wraps reinforced with fiber.
• Smart materials self-healing materials or corrosion-sensing materials:- There is a lack of effective innovation on long-lasting smart coating or sensor that can resist harsh environments underwater. Concrete with low permeability and anti-washout properties to use in replaced underwater circumstances.

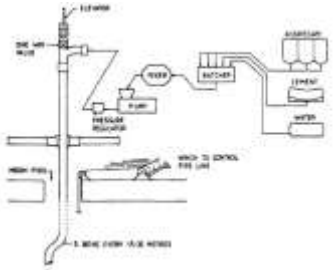
7. METHODOLOGY

These are the means by which underwater concreting are undertaken :-

• **Tremie method :-** One of the most prevalent ways which is being employed in the concreting beneath the water is known as tremie method. In this technology the long steel pipe (tremie as it is called) of diameter15 to 30 cm is pushed vertically downwards up the water. The pipe is supposed to be long enough so that it goes down to the bottom of the body of water and leaves one end of the pipe out of the body of the water. A hopper which is used to pour concrete into the pipe is then attached to the upper end of the tremie. The tremie pipe should be inserted in the water at the bottom end of the pipe using a check valve. Then new mixed concrete is poured using the assistance of hopper. As pouring of the concrete is made the air and water in the pipe displaces and eventually reaches the bed.

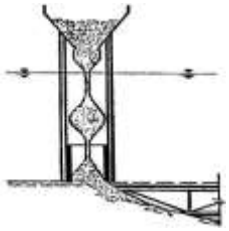


• **Pump method :-** Tremie pipe is a kind of underwater concreting by use of pumping technique and it is a mature form of concreting in the under-pier area which takes time. The benefits of pumping include a number of advantages which Tremie pipe does not have such as pouring concrete directly through mixer into form works, removing blockage in the pipe since concreting is via pumping instead of relying on the force of gravity, and there is a reduction of the dangers of segregation occurring.



• **Toggle bags method :-** Toggle Bags method can be applied where small quantity of concrete is needed. A canvas bag in which they can be filled with concrete and a chain holding things over the top is used which is held by a hook to be lowered into the location which has been decided upon then after opening the bottom at the canvas bag ends the concrete would pour out. Applied in repair works. It is also among the most basic and ancient methods of underwater concrete placements. The bags are plastic-like such that they can interlock each other easily. The bags should be put down, and then spiked together with the reinforcement bars that should be small in size.
• **Bag work technique: -** Bag work concrete, renew the ballast or seal of holes. The bags are made of relatively tough fabric having 10-20 liter capacity that is taken to the desired place by divers. The maximum size of an aggregate that can be used is 40mm and the concrete slump is 19- 50 mm. The process of installing the bags resembles bricks so as to make bonds.

• **Hydro Valve Technique :-** This is the method of underwater concreting which Dutch invent during the year 1969. The concrete is poured by using the hydrostatically compressed hose which is flexible. As soon as concrete is poured to the top of the pipe then the friction in the pipe will be conquered by the weight of concrete and the hydrostatic pressure. The consequence of this is that move concrete drags slowly in the pipe without segregating. A stiff tube is inserted in the hose at the other end where it is sealed. It is not a very costly and a very easy way to do such an approach.



8. TECHNIQUES USED

• **Cofferdam :-** A coffer (also a cofferdam) is a compartment constructed in, or matched pairs in a water body to permit the contents to be pumped out. The pumping makes the working environment dry in order to ensure that the work is done safely. Muflow coffers Enclosed coffers are usually applied to the construction or maintenance of permanent dams, oil platforms, bridge piers, etc. constructed in or over water. Such cofferdams are normally welded steel structures, having components made of sheet piles, Wales, and cross braces. These frameworks become dismantled once the building job is done.

• **Caisson :-** Caisson A caisson is a retaining structure that is watertight, employed e.g. to repair a ship or construct a concrete dam, or to work on the foundations of a bridge pier. Caissons are built such that the water would be pumped out maintaining a dry working atmosphere.

9. UNDERWATER CONCRETE PROPERTIES

• **Thermal behaviour :-** Heat of hydration heat is one of the most crucial issues of mass concrete due to thermal stress. What is particularly severe about in-the wet construction of the navigation structures is that due to the mass concrete thermal expansion, the unacceptable cracks may appear in the precast concrete form. The situation is even worsened by the fact that, in most cases involving the underwater concrete setting, the construction should almost always be performed without construction joints and the opportunity to lose the heat is limited.

• **Laitance, haemorrhages and separation :-** Laitance is layer of weak and nondurable Material that consists of cement and fined aggregates deposited on the top of over wet concrete by bleeding water. Laitance chiefly occurs in underwater concrete as a consequence of washing of cementitious substances by water together with Bleeding and segregation of concrete.

• **Form pressure :-** Tremie seal of Cofferdams where lateral form pressure is not a grave issue has been in the past done with underwater concrete. There are only few underwater construction works which needed to consider the hydrostatic pressure of fresh concrete on formwork some years back. In In-the-wet construction of navigation structures it is paramount to properly consider the form Pressure.

10. CHALLENGES

• **Budget :-** Construction under water is a quite expensive process due to consumption of weighty equipment, gadgets and skilled laborers. Construction under water also comprises certain elements of Welfare and it wants to have a big price range.

• **Erosion :-** Weathering and transport of Solids by the process of Erosion involves bringing the Solids in the natural environment or the location where they are formed and depositing in another place. It usually occurs due to Transport of resource of wind, water or ice and thus Engineers should select right material to build under water.

• **The fuss of hotness of the water** :- The temperature moderates sufficiently over the surface of Water, it is warmed by the ground of the underneath by the employment of daylight hours, however, the maximum of the Water may well be very cold.

• **The issue of pressure :-** Stress plays a significant role in convincing the Guidelines about the constructing further people as he/she runs into problems one way or another within the Development system or within the protection Process.

• **Building elements related to environment :-** There is no denying of the fact that the main issue which is to be present in our mind is the issue of Aeration. it should have a source of renewable air that Assists in breathing and evacuation of undesired gases. The air flow hassle got a treatment, in the form of permits, that has been adopted during the construction of the underwater Holland tunnel.

11. CONCLUSIONS

Finally, research and design of underwater construction are key topics in establishment of long lasting, tolerant and sustainable sea structures. Research and development of the process of underwater construction is an important and even an interesting topic in the developed world. The tenet that a piece of this article is writing resources and contextual analyses. After reflecting about writings associated with Underwater construction development, we are able to understand that Underwater construction development is an expensive and muddled affair. This report examined a current generation of the construction of buildings below the water. The next building that is bound to cause an excellent impact on environment is construction under water. This document has revealed what underwater buildings present. It has referred to the effect of the underwater constructions on environment and social Existence. It has experimented on the materials, that may be used in underwater constructing. It has also outlined the Challenges which are experienced when coming up with constructions below the water. The present situation with the study and development of underwater construction demonstrates great progress of this field provoked by the technological innovations and the broadening

need in the offshore infrastructure. Further study and work of engineers and scientists is indispensable to reveal all possibilities of underwater building and maintain the underwater environment.

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