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Review on Comparative Study of Conventional Concrete and Floating Concrete

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Abstract- The construction industry everywhere faces the problems and challenges. The present day world is witnessing construction of very challenging and difficult civil engineering structures. Two third of the world surface is covered with water. It is therefore not surprising that there has been much activity with concrete in the sea in recent decades. In this study comparison has been made between normal concrete and floating concrete. Floating concrete structure is a solid body made of lightweight materials nearly 2/3rd weight of normal concrete. This project deals about the preparation of mix design and conducting various tests like compressive strength, tensile strength, slump cone, etc. for comparing both the concretes. Casting of the blocks was done and testing was done on 7th and 28th day. No change was made in proportion of normal concrete whereas for floating concrete the proportions of ingredients were changed. The purpose of this study was to evaluate the density (unit weight), splitting tensile strength, and compressive strength of normal and floating concrete mixtures under different curing conditions to achieve a better understanding of the properties that are essential for long lasting and cost-effective structures. Thus, in deciding between floating and normal weight concrete, careful consideration should be given to their physical characteristics.

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I. INTRODUCTION

There is no denying that concrete and the technology surrounding it has come a long way since its discovery and development. The earliest recordings of concrete structures date back to 6500 BC by the Nabataea traders in regions of Syria and Jordan. They created concrete floors, housing structures, and underground cisterns. During the middle ages, concrete technology crept backward. After the fall of the Roman Empire in 476 AD, the technique for making pozzolana cement was lost until the discovery of manuscripts describing it was found in 1414. This rekindled interest in building with concrete. It wasn't until 1793 that the technology took a big leap forward when John Smeaton discovered a more modern method for producing hydraulic lime for cement. He used limestone containing clay that was fired until it turned into clinker, which was then ground into powder. He used this material in the historic rebuilding of the Eddystone Lighthouse in Cornwall, England. In 1824 Joseph Aspdin invented Portland cement by burning finely ground chalk and clay until the carbon dioxide was removed. Aspdin named the cement after the high-quality building stones quarried in Portland, England. In the 19th Century concrete was used mainly for industrial buildings. The first widespread use of Portland cement in home construction was in England and France between 1850 and 1880 by Francois Coignet, who added steel rods to prevent exterior walls from spreading.

A. Conventional Concrete

In the broadest way concrete is defined as a uniform mixture of cement, sand, aggregate and water in prescribed proportions, which sets, hardens and acquire strength over a period of time. The concreting operation consists of measuring the ingredients, mixing them to obtain a uniform mixture, placing the concrete in the moulds, known as form work, compacting allowing setting and then curing for appropriate period, generally 28 days, by keeping it constantly moist.

B. Floating Concrete

Basically, floating concrete is a type of light weight concrete which is light in weight and the density is also less than the density of water i.e. 1000 Kg/m3. Floating concrete is made by replacing conventional aggregate with light weight aggregates which include pumice stone, vermiculite, thermocole and styro foam as they have low density. Expanded clay, slate, shale or slags are also used. Admixtures like aluminum powder, foaming agent, etc. are essential to make concrete waterproof.

II. OBJECTIVES

1. To identify the materials which reduce the density and weight of concrete

2. To study the effects of buoyant force on floating concrete

3. To compare the test result of floating concrete with conventional concrete

III. NEED

1. To check the stability analysis of floating concrete when immersed in water

2. To check the effects of water on floating concrete and study its behavior under such condition.

3. To check the feasibility of the floating concrete by comparing it with the conventional concrete.

IV. MATERIALS AND METHODOLOGY

A. Materials Used

1. Cement:

Cement can be defined as the bonding material hving cohesive and adhesive properties which make it capable to unite the different construction materials. Portland cement is one of the mostly used types of cement. It has great resistance

258 kg/m3

:1.82:1.83

der = 1323 kg/m3

panded clay Aggregate = to cracking and shrinkage but has less resistance to chemical attacks.

2. Coarse Aggregate:

Aggregates of size between 4.75mm to 20mm were used in concrete. In this study light expanded clay aggregate were been used to reduce the density of concrete. Light expanded clay aggregate or LECA is a form of high temperature burnt clay nodules. These are formed from special „plastic" clay that is fired in kiln. LECA is strong and durable. The dry density of light expanded clay aggregate is 350 kg/m3.

3. Fine Aggregate:

Fine aggregate plays a very important role in concrete. It manages to fill the voids between the coarse aggregate. In floating concrete pumice powder has been used as fine aggregates. The size, shape and texture of aggregate controls the workability and drying shrinkage parameters. Pumice stone of igneous origin was disintegrated into size less than

4.75 mm and is used as fine aggregate. It varies in density according to thickness of solid material between the bubbles. Pumice has an average porosity of 90%. It is used to make low density cinder blocks and lightweight concrete

4. Foaming Agents

Foaming agent is a material which facilitates formation of foam such as surfactant or blowing agent. In this floating concrete, Sodium Laurel Ether Sulphate (SLES) used as a foaming agent. Sodium Dodecyl Sulphate (SDS), synonymously Sodium Laurel Sulphate (SLS), is a synthetic organic compound with the formula CH3(CH2)11SO4Na. Sodium Laurel Ether Sulphate (SLES) is an anionic detergent and surfactant found in many personal care products (shampoo, soap, toothpaste, etc.) SLES is an inexpensive and very effective foaming agent.

5. Water:

Water is the key ingredient, when mixed with cement, forms a paste that binds the aggregate together. The water causes hardening of concrete through a process called hydration. The role of water is important because the water to cement ratio is the most critical factor in production of perfect concrete.

B. Methodology

1. Mix Design:

The conventional concrete mix design was arrived as per IS 10262-2009 whereas for floating concrete it was taken with reference from the mix proportion by replacement of coarse and fine aggregates and adding foaming agent. The mix design for M30 grade concrete was achieved.

a. Grade of concrete = M30
b. Water cement ratio = 0.45
c. Size of aggregate = 10mm
d. Slump value = 100mm
e. Mix proportion achieved = 1:1.82:1.83
f. Bulk density of pumice powder = 1323 kg/m^3
g. Bulk density of Light Expanded clay Aggregate= 258 kg/m^3

Table 1. Quantity of Materials Used

Sr. No	Material	Quantity
1.	Cement	10.21 Kg
2.	Pumice Powder	17.08 Kg
3.	Light Expanded Clay	3.35 Kg

2. Combinations Used:

The specimens were designed by replacing the coarse aggregates by expanded clay aggregates, fine aggregates by pumice powder and foaming agent in different percentages of 10%, 20% and 30% to that of water content to be used respectively.

3. Experimental Procedure:

a. Material Testing:

The materials such as cement, conventional coarse aggregate and fine aggregate, lightweight aggregate which were used by the authors in the concrete mix is tested. The tests taken were:

Table 2. Test to be Performed on Materials

Sr. No.	Material	Test Performed
1.	Cement	i. Std. Consistency ii. Initial setting time iii. Final setting time iv. Fineness modulus v. Specific gravity
2.	Pumice Powder	i. Fineness modulus ii. Specific gravity
3.	Light Expanded Clay Aggregate	i. Water absorption ii. Specific gravity

a. Casting of Specimen:

After calculating the mix proportion, the concrete is prepared using the material cement, coarse aggregate, fine aggregate and the foaming agent with the required water content (determined from the water cement ratio). The mould is prepared and properly fabricated. Initially the foaming agent is added with the water and mixed to achieve the required foam. Then the cement, sand and foam are mixed followed by the addition of coarse aggregate. The specimens with different foaming agent proportions were achieved. The specimens were then allowed to cure for 7 days and 28 days.

b. Testing of Specimen

The tests for concrete are classified in two types:

1. Fresh concrete test- Slump cone test

2. Hardened concrete test- Compressive strength test, Split tensile test and Density test.

The tests on hardened concrete were taken on 7th day and 28th day after curing respectively.

V. EFFECT OF BUOYANT FORCE ON FLOATING CONCRETE

When an object is kept in a fluid, the fluid exerts a force in the upward direction called buoyant force. The buoyant force is due to pressure exerted by the fluid on the object. As the pressure increases with increase in depth, the pressure on the bottom surface of an object is always greater than the force at the top surface, which results in a net upward force called buoyant force. The buoyant force exists based on the object's condition whether it floats or sinks. Now consider a floating cube, but we can analyze the same for an object that is submerged.

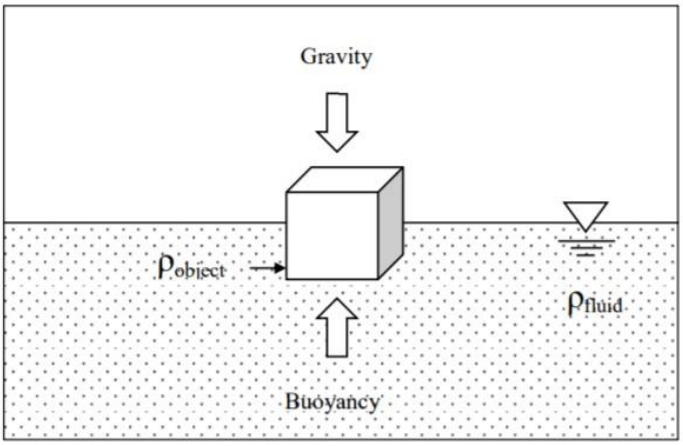

Figure 1. Buoyant Force Acting on Floating Concrete Cube Immersed in Water

In a cube, although a similar analysis results the same for

complicated objects, the object experiences forces on all of its six sides. On each side, force is obtained by multiplying pressure with area of the side and its direction is normal to the same side and acts towards inside of the object. The force on the left side is tricky to calculate because the pressure is different at different levels. Luckily we need not calculate it because this force is equal and-opposite to the force on the right side. Similarly, the forces on the front and back cancel. The force varies vertically and it is function of depth. As the depth increases force also increases proportionately. Hence we get a larger force at the bottom surface than the upper surface. As we go deeper into water, the pressure due to water increases by the equation-

$$P=\rho*g*h$$

So according to Boyle's law, as pressure increases volume decreases, which is stated as PV=constant.

VI. RESULTS

A. Compressive Test:

Compressive strength is used to determine the specimen behavior under compressive load. It provides data on helping manufacturers that their finished concretes are fit for purpose which follows necessary requirements. The specimens after 7th day curing and 28th day curing are removed from water in the specified days and dried for few hours. Then the dry specimens are placed at the compressive strength testing machine so that the axis of specimen is aligned carefully with the center of the spherically seated plates and uniform load is applied to the specimen. The load is increased until the resistance of the specimen fails and it breaks down. The maximum load applied at which the specimen fails is note down and the compressive strength is calculated with the formula provided. Table 3 and figure 2 shows the results for compressive strength obtained from the test carried out by experts.

$$\text{Compressive Strength} = \frac{\text{Compressive Load (N)}}{\text{Cross-sectional Area (mm}^2\text{)}}$$

Table 3. Comparison of Compressive Strength on 28th day of Conventional Concrete and Floating Concrete

Sr. No.	Conventional Concrete (N/mm^2)	Floating Concrete (N/mm^2)
1	30.83	21.45 (10% foaming agent added)
2	30.83	17.89 (20% foaming agent added)
3	30.83	14.72 (30% foaming agent added)

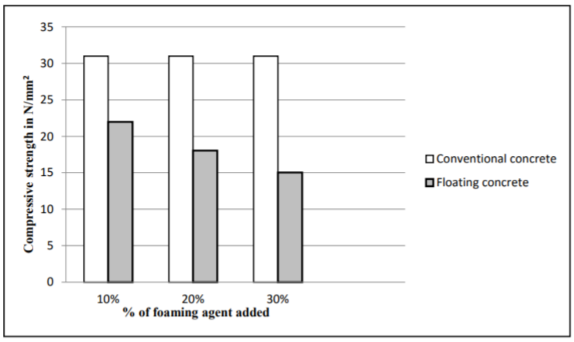

Figure 2. Comparison of 28th day Compressive Strength of Conventional and Floating Concrete

B. Density Test:

The density of concrete is necessary to be known in order to achieve the floating property of concrete. It is also necessary for the concrete to possess a density less than that of water which is 1000 kg/m3. The concrete was casted in the specimens and the density of the concrete was calculated using the following formula –

$$\text{Density of Specimen} = \frac{\text{Weight of the Specimen (Kg)}}{\text{Volume of the Specimen (m}^3\text{)}}$$

Table 4. Comparison of Density Test on Conventional Concrete and Floating Concrete

Sr. No.	Conventional Concrete (Kg/m^3)	Floating Concrete (Kg/m^3)
1	2400	1081.48 (10% foaming agent added)
2	2400	1007.40 (20% foaming agent added)
3	2400	992.59 (30% foaming agent added)

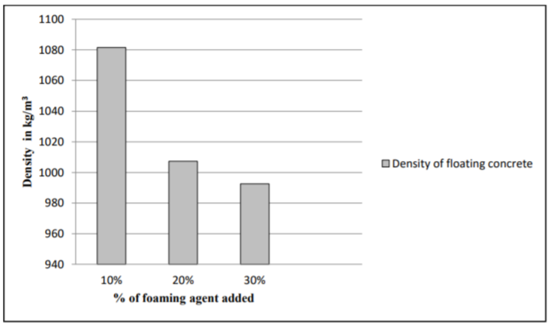

Figure 3. Results of Density Test on Floating Concrete

VII. ADVANTAGES OF FLOATING CONCRETE

1. Rapid and relatively simple construction.
2. Used as an acoustic medium.
3. Low thermal conductivity. Constructions on water bodies.
4. Reduce the self-weight of the structure. Economical in terms of transportation as well as reduction in manpower.

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5. Significant reduction of overall weight results in saving structural frames, footing or piles.
6. Most of lightweight concrete have better nailing and sawing properties than heavier and stronger conventional concrete.

VIII. DISADVANTAGES OF FLOATING CONCRETE

1. Very sensitive with water content in the mixtures.
2. Mixing time is longer than conventional concrete to assure proper mixing.
3. Difficult to place and finish because of the porosity and angularity of the aggregate.
4. In some mixes the cement mortar may separate the aggregate and float towards the surface.

IX. CONCLUSION

Based on result analysis and graphs it could be concluded that:

1. The density of floating concrete can be achieved less than that of water i.e. 1000 kg/m3. Hence it can be used in the water body construction. Further experiment may be carried out to find the usage of light weight concrete over sea for the structural construction.
2. The compressive strength test results show that the maximum average compressive strength is in 10% foaming agent added in floating concrete of compressive strength 21.45 N/mm2.
3. The split tensile strength test results show that the maximum average tensile strength is in 10% foaming agent added in floating concrete of tensile strength 1.22 N/mm2.
4. The density is reduced due to the increment of voids throughout the sample caused by the foam and hence the decrease in the compressive strength of the concrete. Foam concrete requires no vibration or compaction and it fills all cavities, voids and seams
1. over a long distance. It offers fast and settlement free construction with good heat insulation and air content. It has good thermal insulation, good freeze/thawing properties and has excellent fire resistance properties.
5. The initial findings have shown that the floating concrete has a desirable strength to be an alternative construction material for the industrialized building system. The strength of foam concrete is low for lower density mixture. Significant reduction of overall weight results in saving structural frames, footing or piles and rapid and relatively simple construction.

X. FUTURE SCOPE

Following are the points which can be considered for future scope of floating concrete:

1. Attempts can be made to develop floating concrete of larger dimensions.

2. Further experiment may be carried out to find the usage of light weight concrete over sea for the structural construction.

REFERENCES

1. Dhirendra Singhal, Sanjiv Kumar Aggarwal, Jaspreet Singh Brar, “Concrete Mix Design IS: 10262-2009 Vs IS: 10262-1982”, Conference: Innovations in Concrete Constructions, Volume: 01, March 2013
2. Aginam C. H., Umenwaliri S. N. and Nwakire C., “Influence of Mix Design Methods on the Compressive Strength of Concrete”, Journal of Engineering and Applied Sciences, ARPN, Volume: 08, Issue: 06, PP 438-444, June 2013.
3. Maheshkumar H. Thakrele, “Experimental Study on Foam Concrete”, International Journal of Civil, Structural, Environmental and Infrastructure Engineering Research and Development (IJCSEIERD), Volume: 04, Issue: 01, PP 145-158, Feb 2014.
4. R. M. Manoj Kumar, J.Amit Binglesh, “Economical Design of Floating Bridges”, International Journal of Emerging Technology in Computer Science & Electronics (IJETCSE), Volume: 12, Issue: 02, PP 112-115, January 2015.
5. Aswathy .M, “Experimental Study on Light Weight Foamed Concrete”, International Journal of Civil Engineering and Technology (IJCIET), Volume: 08, Issue: 08, PP 1404-1412, August 2017.
6. Rayees Ahmad Ganie, ‘Floating Concrete By Using Pumice Stone and Foaming Chemical (Thermocole)’, International Journal of Civil Engineering (IJCE), Volume: 04, Issue: 02, PP 24-28, 2017.
7. Dr. Sergi O. Kroviakov,Dr. Eng. Andrey V. Mishutin, “Production Technology of Modified Expanded Clay Lightweight Concrete for Floating Structures”, The Scientific Journal of Cihan University-Sulaimanyia, Volume: 01, Issue: 04, PP 2-10, August 2017.
8. Dr. Elson John, “Concrete for Floating Structures”, International Research Journal of Engineering and Technology (IRJET), Volume: 05, Issue: 04, PP 2346-2349, April 2018.
9. J. Esmeili, M. Ghaffarinia, J. Kasaei, M. Nourizadeh, A. Ebrahimi Emanieh, “Investigation on Energy Absorption Capacity of Lightweight

Fiber Reinforced Concrete", 11th International Congress on Civil Engineering, May 2018 .

10. Thousif Khan, Ibrahim Killedar, Sharu Malik H N, Muhathasheem R F, Jagannatha G M, Dr. Shivakumara B,, "An Experimental Study on Floating Concrete Using Light Weight Materials", International Research Journal of Engineering and Technology (IRJET), Volume: 05, Issue: 05, PP 2325-2331, May 2018.
11. Ukarde Uday Kumar, "A Study On Floating Concrete By Using Light Weight Material", International Journal of Research in Engineering, Science and Management (IJRE), March 2019, Volume: 02, Issue: 03, PP 381-383
12. M. S. Dinesh Kumar, Amrutha .S, Gayatri .M, Geetha .L, "An Experimental Study on Floating Concrete", International Research Journal of Engineering and Technology (IRJET), Volume: 06, Issue: 03, PP 7681-7685, March 2019