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An Experimental Study on Floating Concrete

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Abstract - *The project is titled as "AN EXPERIMENTAL STUDY ON FLOATING CONCRETE", followed by Archimedes Principle (Law of Buoyancy) to support the structure at a moderate and convenient depth. Floating concrete structure is a solid body made of lightweight materials. This project deals about the preparation of mix design and various tests namely compressive strength, tensile strength, slump test, flow properties of concrete etc., because of its low density and moderate range of compressive strength , it can be used in non-structural application .In this study, floating concrete was developed for different proportions using the ingredients with less specific gravity than the conventional concrete. Casting is done and the testing is made for 7th day and 28th day.*

Key Words: **Floating Concrete, Lightweight Aggregates**

1. INTRODUCTION

The present world is witnessing very challenging in the field of civil engineering structures. Two-third of the world surface is covered with water. Researchers all over the world are attempting to develop low density or lightweight concrete by using different admixtures in concrete up to certain proportions. Floating concrete structures are used to construct a large array of structures, such as highways and streets, bridges, large buildings, airport runways, irrigation structures, break waters, piers and pavements, silos and farm buildings and homes. The Floating concrete structure is a solid body made of lightweight materials composed of cement, water, aggregates and admixtures. The density of concrete ranges from 600 kg/ m3 to1000 kg/m3. Since its density is less than that of water, the concrete floats on water either by usage of light weight aggregate or air entering agent. Thus, floating concrete is a special type of concrete whose density is about 1/3rd compared to the conventional concrete. This study deals with the development of floating concrete by using foaming agent (SLES), dew foam, expanded clay and pumice powder. The advantage of using lightweight materials is to reduce mass improved thermal and sound insulation properties while maintaining adequate strength. The aim of this report is to achieve mix design for floating concrete with density lesser than 1000 kg/m3 and performing experimental approach by making the concrete as a Floating concrete.

2. METHODOLOGY AND MATERIALS

2.1 MATERIALS USED AND ITS PROPERTIES

2.1.1 Cement:

Ordinary Portland cement

Cement can be defined as the bonding material having cohesive & adhesive properties which makes it capable to unite the different construction materials Portland cement is one of the most widely used type of Portland Cement. It has great resistance to cracking and shrinkage but has less resistance to chemical attacks.

Table -1: Properties of Ordinary Portland cement

S.NO	PROPERTIES	RESULT
1	Standard consistency	27%
2	Initial setting time	40s
3	Final setting time	605s
4	Fineness modulus	1.8gm
5	Specific gravity	3.1

2.1.2 Water

Water is the key ingredient, when mixed with cement , forms a paste that binds the aggregate together. The water causes the 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 a production of perfect concrete. The ratio refers to the ratio of water to cement plus pozzolan ratio, w/(c+p).

2.1.3 Coarse Aggregate:

The coarse aggregate constitute the bulk of concrete mixture and gives the dimensional stability to concrete. Generally aggregates of size between 4.75mm to 20mm are used in concrete. In this experimental study, light expanded clay aggregate has been used to reduce the density of concrete. Light expanded clay aggregate, also called lightweight expanded clay aggregate, or LECA, is a form of high-temperature burnt clay nodules. LECA is used for a very wide range of purposes, many of them in Agricultural and hydroponic systems. These are formed from special "plastic"

clay that is fired in kiln. Light expanded clay aggregate is strong, durable, and is an excellent solution. The dry density of lightweight expanded clay aggregate is approximately 350 kg/m^3.

Fig -2: Light expanded clay aggregate

Table -2: Properties of Conventional Coarse Aggregate

S.NO	PROPERTIES	RESULT
1	Water absorption	0.91
2	Specific gravity	2.77

Table -3: Properties of Light expanded clay aggregate

S.NO	PROPERTIES	RESULT
1	Water absorption	0.9
2	Specific gravity	0.4

2.1.4 Fine Aggregate

Fine aggregates play a very important role in concrete. It manages to fill the voids between the coarse aggregates. In Floating concrete, pumice powder has been used as fine aggregates. The size, shape and texture of aggregates control the workability cement content and drying shrinkage parameters .Pumice stone of igneous origin is disintegrated into size less than 4.75 mm and is used as fine aggregate. Here in this investigation study pumice powder has been used as fine aggregate. It varies in density according to the thickness of solid material between the bubbles. Pumice has an average porosity of 90 % .It is used to make lightweight concrete or insulative low density cinder block.

Fig -3: Pumice Powder

Table -4: Properties of Conventional Fine Aggregate

S.NO	PROPERTIES	RESULT
1	Fineness modulus	2.44
2	Specific gravity	2.44

Table -5: Properties of Pumice Powder

S.NO	PROPERTIES	RESULT
1	Fineness Modulus	2.44
2	Specific gravity	2.46

2.1.5 Foaming Agent

A foaming agent is a material that facilitates formation of foam such as a surfactant or a blowing agent. In this floating concrete, Sodium Lauryl Ether Sulphate (SLES) used as a foaming agent. Sodium dodecyl sulphate (SDS), synonymously sodium lauryl sulfate (SLS), or sodium laurel sulfate, is a synthetic organic compound with the formula CH3(CH2)11SO4 Na.Sodium Lauryl Ether Sulphate (SLES)is an anionic detergent and surfactant found in many personal care products (soaps , shampoos, toothpaste etc.). SLES is an inexpensive and very effective foaming agent.

Fig -4: Foaming Agent

2.2 MIX DESIGN

The conventional concrete Mix design was arrived as per IS 10262-2009. The floating concrete was taken with reference

from this Mix proportion by the replacement of coarse and fine aggregates and addition foaming agent. The mix design for M30 concrete was achieved.

Grade of concrete = M_{30}
Water Cement Ratio = 0.45
Size of Aggregates Used = 10mm
Slump value = 100mm
Mix Proportion achieved = 1: 1.82: 1.83
Bulk Density of Pumice Powder = 1323 kg/m^3
Bulk Density of Light Expanded Clay Aggregates = 258 kg/m^3

Table -6: Quantity of materials used

S.NO	MATERIALS	QUANTITY
1	Cement	10.21kg
2	Pumice Powder	17.08kg
3	Light Expanded Clay Aggregate	3.35kg

2.3 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 percentage of 10%, 20%, 30% to that of water content to be used respectively.

2.4 EXPERIMENT PROCEDURE

2.4.1 Material Testing

The material such as cement, conventional coarse aggregate and fine aggregate, lightweight aggregate which is used in the concrete mix is tested.
The test taken:

1. For Cement: Standard Consistency Test, Setting Time of Cement, Fineness Modulus Test and Specific Gravity
2. For Coarse Aggregate: Specific Gravity and Water Absorption Test
3. Specific Gravity and Water Absorption Test

2.4.2 Casting of Specimen

After calculating the mix proportion, the concrete is prepared using the material cement, coarse aggregate, fine aggregate and foaming agent with the required water content (determined from 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 the foam is mixed followed by the addition of coarse aggregate. The specimens with different foaming agent proportions are achieved. The specimen is then allowed for curing of 7 days and 28 days.

2.4.3 Testing of Specimens

The test for concrete is classified as two types:

1. Fresh Concrete Test
2. Hardened Concrete Test

For Fresh Concrete: Slump Cone Test
For Hardened concrete: 1. Compressive Strength Test, Split Tensile Test and Density Test
This hardened Concrete Test this taken for 7 days and 28 days curing respectively.

3. RESULT AND DISCUSSION

3.1 COMPRESSIVE STRENGTH TEST

Compressive strength is used to determine the specimen behavior under compressive load. It provides data on helping manufactures ensure that their finished concrete are fit for purpose which follows the necessary requirements. The specimens after 7^{th} day curing and 28^{th} 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 the specimen is aligned carefully with the centre 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.

$$\text{Compressive strength} = \frac{\text{Compressive load (N)}}{\text{Cross sectional Area (mm}^2\text{)}}$$

Table -7: Compressive Strength Test of conventional concrete

S.NO	SPECIMEN TRIAL	7 DAYS STRENGTH (N/mm^2)	28 DAYS STRENGTH (N/mm^2)
1	Average	22.04	30.83

Table -8: Compressive Strength Test of floating concrete

S.NO	% OF FOAMING AGENT ADDED	7 DAYS STRENGTH (N/mm²)	28 DAYS STRENGTH (N/mm²)
1	10%	13.92	21.45
2	20%	8.46	17.89
3	30%	8.38	14.72

Fig -5: Compressive strength test

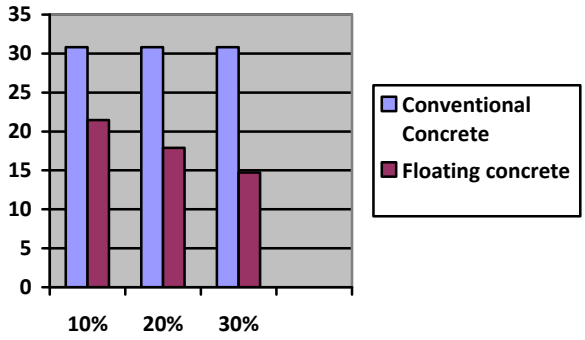

Chart -1: Comparison of 28th day compressive strengths

3.2 SPLIT TENSILE STRENGTH TEST

Concrete does not usually resist direct tension because of its low tensile strength and brittle nature. Thus it is necessary to determine the load at which the concrete members may crack due to tension failure. The specimen is placed in the testing machine and load is applied uniformly and increased continuously at a nominal rate until failure. The maximum load applied was recorded and any unusual type of failure is observed.

$$\text{Split Tensile Strength} = \frac{\text{Tensile load (N)}}{\text{Cross sectional Area (mm}^2\text{)}}$$

Fig -5: Split tensile strength test

Table -9: Split Tensile Strength Test of conventional concrete

S.NO	SPECIMEN TRIAL	7 DAYS STRENGTH (N/mm²)	28 DAYS STRENGTH (N/mm²)
1	Average	1.15	1.69

Table -10: Split Tensile Strength Test

S.NO	% OF FOAMING AGENT ADDED	7 DAYS STRENGTH (N/mm²)	28 DAYS STRENGTH (N/mm²)
1	10%	0.93	1.22
2	20%	0.78	1.06
3	30%	0.82	0.94

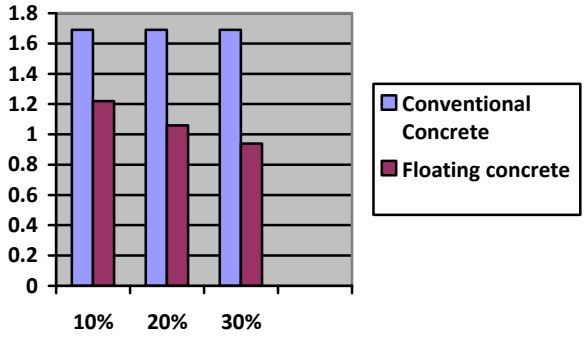

Chart -2: Comparison of 28th day Split Tensile strengths

3.3 DENSITY TEST

The density of the concrete is necessary to be known in order to achieve the floating property of the concrete. It is also necessary for the concrete to possess a density less than or merely equal to the density of water which is 1000 Kg/m^3. The concrete was casted into three trial specimens and the weights of the concrete specimens were noted and the densities of the concrete specimens were calculated using the following formula:

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

Table -9: Density Test of floating concrete

S.NO	WEIGHT OF THE CUBE (Kg)	VOLUME OF THE CUBE (m^3)	DENSITY OF THE CUBE (Kg/m^3)	AVERAGE DENSITY (Kg/m^3)
1	3.65	0.003375	1081.48	
2	3.40	0.003375	1007.40	1027.15
3	3.35	0.003375	992.59	

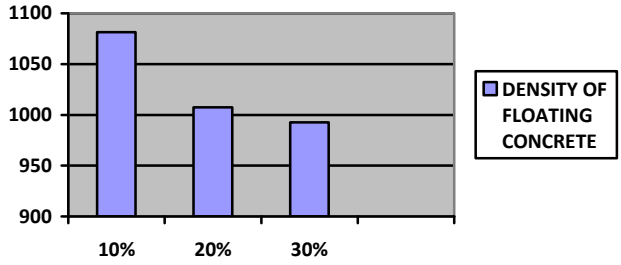

Chart -3: Results of Density Test

4. CONCLUSIONS

[1] The density of the experimental floating concrete achieved is less than 1000kg/m^3 which is less than the density of water.

[2] Floating concrete can be achieved by using Light Expanded Clay Aggregates (LECA) as coarse aggregates, Pumice Powder as fine aggregates and addition of Sodium Lauryl Ether Sulphate as foaming agent.

[3] The density of the floating concrete can be achieved less than that of water.

[4] The compressive strength test results show that the maximum average compressive strength achieved is in 10% foaming agent added floating concrete of compressive strength 21.45 N/mm^2.

[5] The split tensile strength test results show that the maximum average tensile strength achieved is in 10% foaming agent added floating concrete of tensile strength 1.22 N/mm^2.

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