CONCRETE FOR FLOATING STRUCTURES

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Abstract –*Floating concrete is a type of light-weight concrete (LWC) whose density varies from 300-1850 kg/m3.LWC can be produced by different methods like:*

- *By using porous light weight aggregate of low apparent specific gravity, that is lower than 2.6. This type of concrete is known as light weight aggregate concrete.*
- *By introducing large voids within the concrete or mortar mass; these voids should be clearly distinguished from extremely fine voids produced by air entrainment. This types of concrete is known as aerated, cellular, foamed or gas concrete.*
- *By omitting the fine aggregate from the mix so that a large number of interstitial voids are present; normal weight coarse aggregate is generally used. This concrete is known as no- fines aggregate.*

In order to prepare the mix, the method we adopted in our project is by eliminating the coarse aggregate content with glass beads which is a light weight aggregate. The introduction of alumininum powder into the mix made it cellular structure by creating voids, which in turn reduces the density. Fly ash helped in reducing the density without much significant change in strength. Thus, by using all this, we got a concrete mix which is light weight as well as with definite strength. The procedure we adopted was preparation of mix proportion of floating concrete, materials used & various test results of compressive strength at the age of 7 days for acceptance of this concrete.

Key Words: ***Fly ash, Glass Beads***

1. INTRODUCTION

Today s world is witnessing construction of very challenging and difficult civil engineering structures. Due to this, attempts are made to develop low density or light weight concrete. The density of light weight concrete varies from 300-1850 Kg/m^3.The concrete mix can be prepared by using light weight aggregates like pumice stone, rice husk ash, thermocol beads etc,. Concrete is the most widely used composite material in the construction industry. In the wider definition, concrete is a mixture of Portland cement, aggregate and portable water.

Floating concrete consists of cement, water, aggregate and air voids. The uses of floating concrete structures is to reduce the consumption of land for building and they are inherently base isolated from earthquake. It is also used for making structures like pantoons, break waters, docks, container terminals, storage, airports, islands, cities etc,. The main disadvantage of conventional concrete is its high self weight. Density of normal concrete is in the order 2200-2600 Kg/m^3. The light weight of floating concrete is due to the cellular structure.

2. MATERIALS USED

2.1 Ordinary Portland Cement

Ordinary Portland cement (OPC) of grade 53 was chosen for the mixing of concrete. The chief chemical constituents of OPC are Calcium, Silica, Alumina and iron .They are used in high rise buildings ,all types of RCC works, pre-stressed concrete work like ,silos, railway sleepers, bridges etc., When it comes to different grades of cement, the 53 grade OPC cement gives consistently higher strength compared to others.

2.2 Aggregate

Aggregates are the important constituents in concrete. They give body to the concrete, reduce shrinkage and affect economy. They occupy 70-80% of volume of concrete.

2.2.1 Sand

They are composed of finely divided rock and mineral particles. They should be clean and coarse, should be free from any organic matter and chemically inert. The fine aggregate passing through IS 2.36 mm sieve is used.

2.2.2 Glass beads

The glass beads are our main constituent in our project. We eliminated the coarse aggregate with glass beads. They are made up of glass materials having a specific gravity of 2.3-2.5 and density of 1490 Kg/m^3.By the addition of glass beads, we obtained a light weight concrete mix with required strength.

FIG 2.1 GLASS BEADS

TABLE 2.1 CHEMICAL DESCRIPTION

Compound Element	Chemical Formula	Typical Content
Silicon Dioxide	SiO_2	73.00%
Sodium Oxide	Na_2O	15.00%
Calcium Oxide	CaO	7.00%
Magnesium Oxide	MgO	4.00%
Aluminium Oxide	Al_2O_3	1.00%

TABLE 2.2 PHYSICAL PROPERTIES

Bulk Density	1.50 g/cm3
Shape	Spherical
Colour	Colourless
Specific Gravity	2.55 g/cm3
Hardness	5.0 Mohs

2.3 Aluminium Powder

The aluminium powder is expected to increase the permeability of concrete mix by producing H_2 gas during reaction with water and forming open porosity within the micro structure.

The reaction of Aluminum with fresh concrete →3 parts Calcium Hydroxide + 2 parts Aluminum 3 parts TriCalcium Aluminate + 3 parts Hydrogen.

$3\ Ca(OH)_2 + 2\ Al\ 3Ca_3Al_2O_6 + 3\ H_2$ (2.1)
$3Ca + 6OH^- + 2\ Al\ 3\ Ca_3Al_2O_6 + 3\ H_2$ (2.2)

FIG 2.2. CONCRETE MIX AFTER ADDITION OF Al POWDER

2.4 Admixtures

They are materials other than cement, water and aggregates, that is used as ingredient of concrete. They are add to achieve high quality in terms of properties and performance of the concrete.

2.4.1 Super plasticizers(high range water reducers)

They are chemically different from normal plasticizers. Use of super plasticizer permits the reduction of water to the extent up to 30% without reducing the workability. The use of super plasticizers is practiced for production of flowing, self leveling, and self compacting and the production of high strength and high performance concrete. Here, we used super plasticizer, Glenium -32.

2.4.2 Fly ash

Fly ash is a residue obtained from the compression of powdered coal and transported by flue gas. It act as filler for achieving uniform distribution of air voids. It is observed that replacement of sand with fly ash helping reducing density with an increased strength.

3. METHODOLOGY

Keeping in mind the general objectives of the project a detailed methodology for undertaking the project is proposed which consist of a set of task as given below:

i. Collection of materials such as cement, glass beads, Aluminium powder, fly ash and super plasticizers.
ii. Performance of laboratory test on glass beads.
iii. Mixing and Casting of mortar cubes of size 75mm.
iv. Performance of laboratory test on the prepared sample and sample mixed with varying percentage of fly ash, glass beads and aluminium powder
v. Comparison of results.

4. PROPERTIES OF CONCRETE

The tests conducted in our specimen are:

4.1 Solubility of glass beads

Immersed certain amount of glass beads in water for 24 hrs. It was seen that glass beads are insoluble.

4.2 Density of glass beads

Determine the weight of the glass beads by pouring it in to a 250 ml of measuring cylinder

$$\text{Density} = \frac{\text{Mass}}{\text{volume}}$$

4.3 Mini slump cone test

This is carried out to find out the early stiffness of mortar mix there by its workability. The prepared mix is poured in the mini slump cone and raised after certain time. Workability is measured in terms of the spread obtained.

FIG 4.1. MINI SLUMP CONE TEST

4.4 Compressive strength test

It is carried out to find the compressive strength of the casted cube specimen .It is done as same as any ordinary compressive strength test using a compression testing machine.

5. EXPERIMENTAL WORKS

We started with the standard concrete mix which showed the density of about 1780 Kg/m^3.Our aim was to achieve a mix design of low density with sufficient compressive strength.In order to achieve this we replace the coarse aggregate content with glass beads.Due to the addition of light weight aggregates a significant reduction of workability was observed. In order to make the mix workable and to reduce the chances of bleeding and segregation we added super plasticizer –sikament SIKA-170-1 later on we change this by Glenium-32.It permits the reduction of water to the extend of 30% without reducing the workability .

Initially we started with two variations of M20 concrete mix without any super plasticizers .It was observed that the density was reduced to 1650 Kg/m^3.Then we had done different mixes with different proportions of glass beads ,sand and fly ash. When we used 2.25 % of Al powder for a cement: sand ratio 1:2, we get a density of 1800 Kg/m^3.As the density has increased we change the materials for the mix.

Then we incorporated glass beads with 0.05% of super plasticizers, the density was observed as1750 Kg/m^3 .Then we have done different mixes with different proportions of glass beads, super plasticizers ,Al powder, the density was decreased to 1660 Kg/m^3 and strength 4.3 N/mm^2.

Then we tried a mix of 100 gm glass beads and 2.5 % Al powder, we got an average density of 1546 Kg/m^3 with a 7 day average compressive strength of 2.55 N/mm^2.Finally ,we got a mix of density 1350 Kg/m^3 and strength of 3.5 N/mm^2.

TABLE 5.1 TEST RESULTS OF THE TRIAL MIXES FOR FINALISING MIX

Mix	Date of Casting	Avg Density Kg/m^3	Load (Tonnes)	Avg Compressive Strength (N/mm^2)
C : S 1 : 2 Al 1.75%	29/01/18	1866	5.7	11.17
C : S 1 : 2 Al 2%	29/01/18	1829	4	7.84
C : S 1 : 2 Al 2.25%	29/10/18	1806	4.5	8.82
C : S 1 : 2 Al 2.5%	05/02/18	1855	5.5	10.78
GB 250g Al 2%	05/02/18	2086	9	17.64
GB 250g Al 2.25%	05/02/18	1974	10	19.6
GB 200g ,F 90g Al 2.75%	14/02/18	1660	2.2	4.3
C 250g, S 212g,F 188g, GB 100gAl 2.75%	14/02/18	1546	1.3	2.55
C 625g, F 125g Al 2.5%	15/02/18	821	0.39	0.78
GB 100g, F 150g, Al 2.5%	19/02/18	1284	0.61	1.2
GB 375g, F 125g Al 2.5%	19/02/18	1655	3.97	7.8
GB 200g, F 150g, Al 2.5%	19/02/18	1364	1.78	3.5
GB 250g, F 100g, Al 2.5%	19/02/18	1327	1.00	1.96

** C- Cement
GB-Glass beads
S- Sand
Al – Aluminium powder
F- Fly ash
Water cement ratio – 0.45

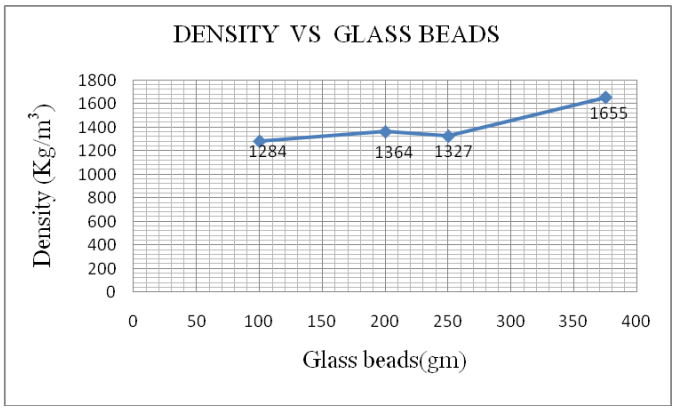

CHART 5.1. DENSITY VS GLASS BEADS

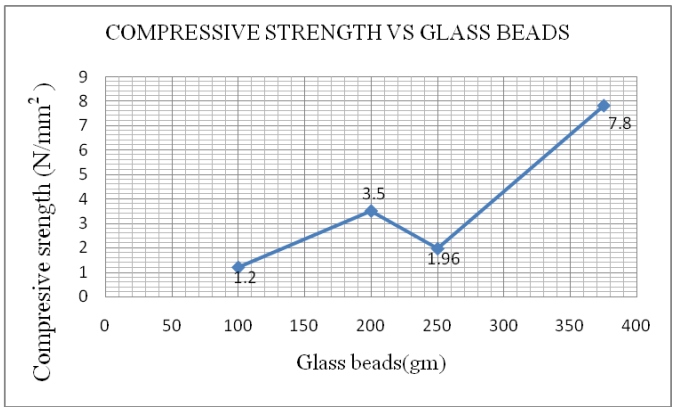

CHART 5.2. COMPRESSIVE STRENGTH VS GLASS BEADS

6. CONCLUSIONS

The main aim of our project was to prepare a concrete mix which is lightweight, at the same time which is having a definite strength so as to resist the external loads. For obtaining this mix, the methodology we adopted was by eliminating the coarse aggregate content and incorporating glass beads as aggregate. By using glass beads we come to the conclusion that the density can be decreased without much reduction in strength. Along with glass beads when we introduced fly ash, density has decreased significantly with less drastic change in the strength.

We prepared different mixes by varying the proportions. Then we come to know that by increasing the percentage of aluminium powder content both density and strength have been decreased. By preparing many mixes, we optimized the value of aluminium powder as 2.5%. Another conclusion we made was, when the amount of glass beads was less than half the total aggregate used, the density has decreased and strength remains in the nominal margin. By trial and error method, we adopted a mix of density 1360 Kg/m3 and a strength of 3.5 N/mm2.

7. REFERENCES

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