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Floating Concrete Opportunities for Future Sustainable Development of Floating Buildings Structures

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ABSTRACT- In India, Floating structures are deficient as maximum construction is done on land. But due to high rate of increasing population we need an alternative for our future generations. It has been successfully confirmed that we can built floating structures that can float on water. Many structures have been constructed so far by different countries. Floating structures like docks, floating islands, floating supermarkets, floating terminals, airports etc. have been constructed and are functioning successfully. In India we are lacking the concept of floating structures which can help us to reserve land and use water bodies for the construction. Firstly, we need to adopt floating structures as an alternative for the structures like airports, terminals, as they require more land and then later, we can shift to other types of floating structures. The main objective of our study is to develop such a concrete that can float in water (i.e., low density concrete) and that is possible only when the density of our concrete is less than that of water that is less than 1000kg/m^{3}Along with the lesser density it should fulfill the strength requirements both compressive as well as flexural strength. One of the most important objective of our study is that we are using light weight aggregates like glass beads and pumice stone as an alternative to the coarse aggregate along with sand. We are also using Aluminium powder in order to increase porosity of our concrete along with fly ash as fly ash can be used as a filler to provide enough bulk and surface area to our specimen to float. Secondly we will try to prove that by using glass beads as an alternative to the aggregate the property of concrete in flexure is enhancing as glass beads are less prone to fatigue. Thirdly we will try to show that use of glass beads as an makes it eco-friendly.

KEYWORDS- Light Weight Floating Concrete, Glass Beads, Pumice Stones, Aluminium Powder, Fly ash, Super plasticizer (HRWRA), Sand and Cement.

I. INTRODUCTION

Floating concrete is a composite material consisting of cement, aggregates and admixtures. Floating concrete is prepared by using light weight aggregates and some advanced admixtures which make it lighter than the traditional port land cement concrete. Ordinary port land cement concrete has density about 2400 kg/m^3. The density of floating concrete is between 600 kg/m^3 to 1000 kg/m^3. As the density of floating concrete is between 600 kg/m^3 to 1000 kg/m^3 which is less than that of water i.e., 1000 kg/m^3, the concrete floats in its hardened state. In the present civilization we are witnessing the construction of very challenging, difficult and complicated structures. As a result of which number of attempts are taken to develop low density concrete. Being low in density this floating concrete has a special ability to float, which provides an important engineering structure application. Floating concrete has a density of about ½ as to that of conventional concrete.

Floating concrete has proven to be very useful in making floating structures and thereby reduce the land consumption for building structures. It is also used in building of structures such as bridges, docks, islands, cities, breakwaters, terminals, airports ,etc. The main advantage of light weight floating concrete is due to its cellular structure.

The objectives of the study are as follows:

- In this project, we are dealing with the development of floating concrete (light weight concrete) by using light weight aggregates like Glass Beads and Pumice stone in order to reduce the self-weight of the concrete. Also, we are using fly ash as a filler.
- To show improved Bending/Flexural strength as compare to other available alternatives for light weight aggregates and to prove model block is less prone to fatigue.
- To compare compressive strength and tensile strength of different specimens. Also to check for Sorptivity test.
- To prove it is cost effective and eco-friendly.

II. LITERATURE REVIEW

R. S. Muralitharan and V. Ramasamy [1] investigated the mechanical properties of pumicelightweight mixture concrete. during this investigation, rock ar planned to be used because the coarse mixture. it's attainable to develop light-weight concrete mistreatment pumice stone with a dry density of 1200 kg/m3 up to 1450 kg/m3 [1].At present, the quantity of works has been undertaken to research the mechanical properties of light-weight mixture concrete. (i.e.) Compressive strength, ripping strength, acid resistance, and thermal resistance were investigated for pumice stone light-weight mixture concrete and at varied ages of hardening [1].

the target is to develop light-weight concrete mistreatment Indian pumice stone coarse mixture and to review the behaviour of pumice stone light-weight concrete underneath cyclic loading [1]. At the tip of the investigation, the subsequent conclusions were made: Structural compressive strength of pumice stone nearly reached traditional coarse mixture compressive strength. Reduction in density confirms that light-weight concrete are often used for light-weight structures [1].

A. Suba Hindu deity et al. [2] carried out the study on light-weight concrete by mistreatment pumice stone mixture. exchange rock with coarse mixture is alleged to be structural light-weight concrete solves to scale back the self-weight of building [2]. the most objective is to work out whether or not rock light-weight concrete are often used as structural concrete, to work out the compressive strength and split strength of light-weight concrete having density below 1800kg/m3 and to review the result of assorted varieties replacements (20%, 50%, 80%, 100%) of natural mixture by lightweightaggregate (pumice) and standard concrete on seven, twenty eight days [2]. From the study, it's found that fifty replacement of pumice stone light-weight mixture with typical coarse mixture is that the optimum replacement level and therefore the increasing share of pumice stone mixture decreases the strength of concrete [2].

R.B. Karthika et al. [3] investigated the pumice stone mixture, pumice stone mixture is employed due to its tenuity than typical coarse mixture, and it's simply obtainable. light-weight concrete is ready by part exchange the coarse mixture with pumice stone mixture by five hundredth, 80% & 100%. the standard concrete and pumice stone light-weight mixture concrete is created by mistreatment combine M30 with Conplast SP430 admixture. The mechan ical and sturdiness properties of typical concrete and pumice stone light-weight mixture concrete ar compared by conducting varied damaging and non-destructive tests and favorable replacement is found.

Mohsin Mushtaq Khan[4] gift the study to check typical concrete with the light-weight concrete that is created by part exchange cement with ash and coarse mixture with rock and adding Thermocol beads mistreatment M25 grade of concrete. light-weight concrete has been created by partial replacement of Coarse mixture by rock variable within the magnitude relation of 100 percent V-J Day and 2 hundredth and Thermocol beads by zero.2%, 0.4% and 0.6%.Also cement is replaced by ash within the variable ratios of 2 hundredth half-hour and four-hundredth by weight of cement. **Mukesh D Ghade and Vaibhav D Kamble [5]** study the comparison has been created between PCC and LWC having totally different proportions of mixture size and fix amount of metal cement (i.e., 2%) by the burden of cement has been taken under consideration. it's supported the actual fact of mistreatment LWC and Air Entraining Agent. during this explicit analysis following materials ar used: 1)Binding material(Cement) 2)Coarse mixture (Pumice stone) 3)Fine mixture (Pumice Powder) 4)Admixture- metal Powder 5)Water From their take a look at results he need to apprehend several parameters of floating LWC like Compressive Strength take a look at results, strength take a look at results, Water Absorption take a look at results etc.

Jay Bankim Shah et al.[6] complete that the prices, compressive strength and strength bit by bit decrease with the rise of BPA in concrete blocks. Adding plastic balls to concrete blocks with EPS will increase compressive strength, however it conjointly bit by bit will increase prices. the utilization of EPS and plastic beads in applicable amounts ends up in smart compression strength and rising prices don't seem to be necessary. this could be a good variety of eliminating and mistreatment EPS Plastic beads that ar waste from several industries.

Hemant k. Sarje et al.[7] studied the technique of growing light-weight concrete. His study focuses on demonstration on compression, water absorption. Low thermal physical phenomenon and tenuity ar the most benefits of lightness. Concrete, that minimizes the permanent load and therefore the construction prices by combining ash and air entraining agents such Protein-based Kemelit foaming agent.

One more study managed by **Habibi et al.[8]** associated with the environmental and energy connected issues and solutions for future development of buildings conjointly cover the big info regarding floating concrete.

III. METHODS AND METHODOLOGY

The various materials used in the experimental works are:

- Cement
- Fine aggregate (Sand)
- Coarse aggregate (Glass Beads And Pumice Stone)
- Water
- Fly Ash
- Admixture (Aluminum Powder)
- Super Plasticize (HRWR)

A. Methodology

Methodology for undertaking the project is listed below in few points:

- Collecting the materials such as cement, glass beads, Aluminium powder, fly ash and super plasticizers.
- Performing the laboratory test on glass beads.
- Mixing and Casting of concrete cubes of size 15mm x 15mm x for compressive strength test 15mm and 15mm x 15mm x 75 mm for flexural strength test.
- Performing the lab tests on the prepared sample with varying percentage of fly ash, glass beads and aluminium powder specially compression strength test and bending/flexural strength test along with sorptivity test.
- Comparison of results.

IV. MIX DESIGN PROCEDURE

- The process of selecting the suitable ingredients and to determine the relative
- Proportions of these ingredients in order to produce concrete of certain workability, strength and durability is called Mix design. As there is not any mix design procedure defined so far for floating concrete so, we have considered own design mix. Our procedure is based on the volume concept. Let us consider the total concrete volume as one unit, hence by deducing the volume of

voids and the volume of paste from the unit volume we can calculate the total volume of aggregates. The volume of fine aggregates is chosen between the range of 10% to 20% keeping both the strength and permeability parameter requirements in mind. We have adopted 1:1:2 (M 25) as our mix proportion that is also the standard mix. We have adopted the mixing by conventional method of hand mixing. Known quantities of the materials were mixed with calculated amount of water by keeping in a measuring portable jar. Dry mix which is containing aggregate both fine and coarse and cement is prepared and is mixed thoroughly for about 2 minutes. Then it is put in the moulds and kept on vibrating machine for about 1 to 2 minutes. Placing the moulds on the vibrating table, we pour the fresh wet concrete inside the mould. Now vibrate the concrete by table vibrator and by hand compaction both using tamping rod. Vibration should be limited else segregation of aggregates will occur. After moulds are filled, we level the surface and hence de-mould it after 24 hours.

V. EXPERIMENTAL WORK

We prepared the standard concrete mix, which showed the density of about 1680 Kg/m3.Our aim is to adopt a mix design with lower density but having sufficient Compressive and bending strength .For this to achieve we replace the coarse aggregate content with glass beads and pumice stones. As a result of addition of light weight aggregate, it is observed that workability reduces significantly. order to make concrete more workable and to minimize the chances of bleeding and segregation we added super plasticizer Glenium-32. It helps in the reduction of water up to 30% without lowering the workability of concrete. We prepared different mixes with different proportions of glass beads, fly ash, sand etc. when 2.25% of Alumunium powder is used in the mix we observe that density is changing drastically. Now we introduced glass beads with 0.06% of HRW the density is observed decreasing. We tired the mix of glass beads 100gm, Al-powder 2.5%, we get the density of 1330 kg/m3. It indicates that by introducing glass beads as aggregates tend to Reduce the density of concrete.
Now, we changed the proportions of glass beads, fly ash, Al-powder, in order to attain our desired specimen having low density, so that it can float with maximum possible strength both compressive as well as flexural/bending.

Figure 1: Concrete block floating

In Figure 1, it is shown that after complete hardening of the specimen how our block floats in the water.

VI. RESULTS AND DISCUSSION

Table 1 is showing the results in 28 Day Compressive Strength, we can observe that with increasing the content of glass beads and by increasing the percentage of aluminium powder the density of the specimen is decreasing while the compressive strength is also decreasing.

Table 1: Test Results of the Trial Mixes For Compessive Strength

MIX 1:1:2 (M 25)	AVG. Density Kg/m^3	28 Day Compressive Strength N/mm^2
AL 1.75%	1680	24.971
AL 2% GB-100gm	1510	22.879
AL 2.25% GB -150gm FA - 90gm	1330	20.481
AL -2.5 % GB -200gm FA -125gm	1109	19.017
AL –2.75% GB -250gm FA- 150gm	921	17.75

In table 2, we can observe that with increasing the content of glass beads and aluminium powder the density and flexural strength decreasing are both decreasing, but the rate of decrease in flexural strength is lower as compared to compressive strength.

Table 2: Test Results of the Trial Mixes for Flexural Strength

MIX 1:1:2 (M 25)	AVG. Density Kg/m^3	28 Day Flexural Strength N/mm^2
AL 1.75%	1680	3.745
AL 2% GB-100gm	1510	3.238
AL 2.25% GB 150gm FA -90gm	1330	3.875
AL -2.5 % GB -200gm FA -125gm	1109	2.851
AL 2.75% GB -250gm FA-150gm	921	2.6625

A. Variation of Density with Glass Beads

When a graph is plotted between the density vs glass beads, we can observe that without any glass beads the density is about 1680kg/m3 at the aluminium content of 1.75%. Now by increasing the glass beads content from 100gm to 250gm we can observe that density decreases from 1510kg/m3 to 921 kg/m3 at varying aluminium powder percentage (Figure 2).

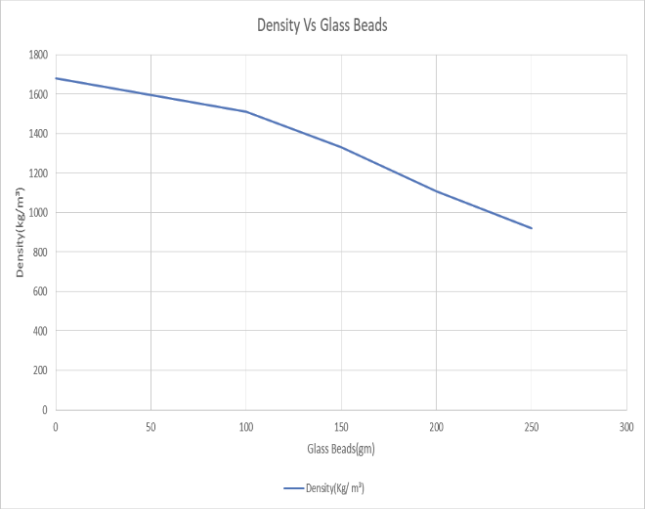

Figure 2: Density Vs Glass Beads

B. Variation of Compressive Strength with Glass Beads

On plotting graph between compressive strength and glass beads we can observe that with increasing the content of glass beads compressive strength is changing drastically. Compressive strength of the test specimen is decreasing from 22.879 N/mm2 at 100gm content of glass beads to the 17.75 N/mm2 at 250gm content of the glass beads. It shows the decrease with a very fast rate. (Figure 3)

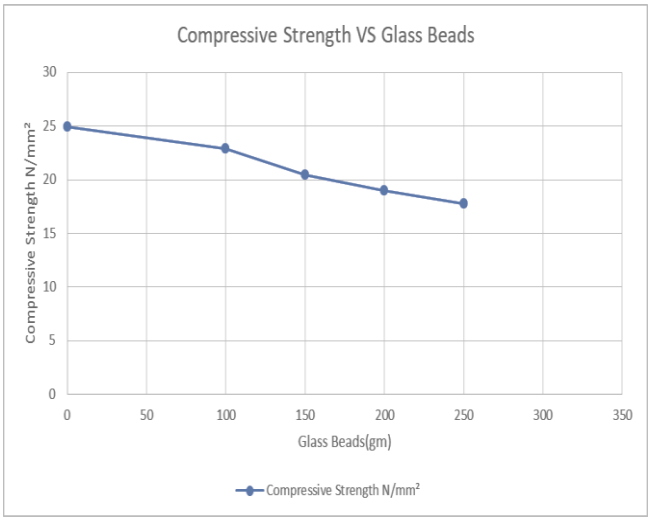

Figure 3: Compressive Strength Vs Glass Beads

C. Variation of Flexural Strength with Glass Beads

On plotting the graph between glass beads content we can observe that flexural strength of the test specimen is also decreasing from **3.238 N/mm^2 at 100gm** content of glass beads up to the **2.6625 N/mm^2 at 250gm** content of glass beads. But here we can observe rate of decrease is slow as compare to that in compressive strength. Hence we can say it enhances the property of the concrete in flexure.(Figure 4)

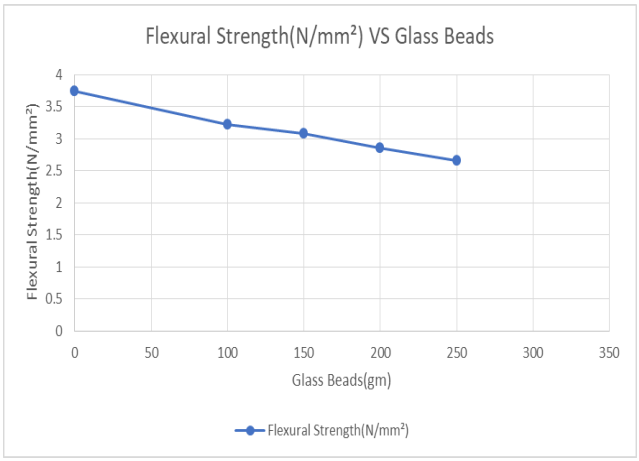

Figure 4: Flexure Strength Vs Glass Beads

VII. CONCLUSION

The main objective of our research work was to prepare such a concrete mix, which is light in weight, so that it can float at the same time concrete mix should possess a definite strength in order to resist the external loads. In order to obtain the required concrete mix, we eliminated the coarse aggregate fraction by using glass beads and pumice stone instead. With the use of glass beads and pumice stone as an alternative to the coarse aggregate We concluded that the density can be decreased so that concrete can float. Further in order to make our concrete light in weight we used Aluminium powder along with super plasticizers and fly ash. We adopted different mixes by varying proportions of glass beads, aluminium powder, fly ash with same sand and pumice stone content. We observed that by increasing the percentage of aluminium powder density and strength both are decreased. We prepared five specimen of grade M 25 with varying proportions of glass beads, aluminium powder and fly ash.

In our experiment, we observed that by increasing the content of aluminium powder from 1.75% to 2.75% density of concrete decreases drastically. Further with the use of glass beads in varying proportions along with the pumice stone and fly ash as a filler we observed that with increasing the glass beads content along with aluminium powder and fly ash density is decreasing but compressive strength is also reducing .We can observe that the 28 day compressive strength decreases from 24.971 N/mm2 to17.75N/mm2. It indicates that with increasing the content of both aluminium powder and glass beads along with fly ash strength is reducing with density. From the flexural test results, we can observe that the flexural strength is also decreasing but at lower rates as compare to the compressive strength which indicates that flexural strength is not as much affected as compressive strength or in other words, we can say it enhances the concrete in fatigue.

Glass beads when used as aggregates provides alternative use of glass waste obtained from glass industries hence proved to be eco-friendly. As glass cannot be decomposed under normal conditions, it requires ideal conditions with high temperature and pressure for the decomposition which are

not possible under normal conditions. So, we can conclude that that use of glass breads as an alternative to aggregate helps to preserve our nature resources of aggregates and is cost effective, economical and easily available in the industrial areas. The reduction of permeability depth in the sorptivity test indicates that the durability of concrete has been enhanced by using glass beads and pumice stone as an aggregate in the concrete.

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