Floating Concrete by using Light Weight Aggregates (Pumice Stones) and Air Entraining Agent

MALIK MEHRAN MANZOOR[1], ABHISHEK GUPTA[2], RUKHSANA GANI[3], [4]ANKUSH TANTA

[1,3]Postgraduate student, Structural Engineering, [2]Assistant Professor of Department of civil Engineering, [4]HOD
Baddi university of Emerging Sciences and Technology, Baddi, Distt.Solan (HP), India.

***ABSTRACT*: This Project deals with the development of Floating type of concrete by using lightweight aggregate (Pumice stone) and Aluminium powder as an air entraining agent. There are many types of lightweight concrete which can be produced either by using lightweight aggregate or by using an air entraining agent. In this study we have worked on combination of above mentioned types. This concrete is a non-structural concrete. In this study, comparison has be made between plain cement concrete and lightweight concrete having different proportion of Aggregate size and fix quantity of Aluminum content (i.e. 2%) by the weight of cement has been taken into account. It helps to increase volume of concrete and hence reduce the weight.**

***Keywords*: Floating concrete, Pumice stone, Aluminium powder, Density, Compressive strength.**

1. INTRODUCTION

The present day world is witnessing construction of very challenging and difficult civil engineering structures. Researchers all over the world are attempting to develop low density or lightweight concrete by using different admixtures in concrete up to certain proportions. This study deals with the development of Floating concrete by using light weight aggregate (Pumice stone) and Aluminum powder as an air entraining agent. Floating concrete is made by introducing air or gas into concrete slurry, so that when the mix sets and hardens, uniform cellular structure is formed. Thus it is a mixture of water, cement and finely crushed sand. We mix fine powder of Aluminum to the slurry and it reacts with the calcium hydroxide present in it thus producing hydrogen gas. This hydrogen gas when contained in the slurry mix gives the cellular structure and thus makes the concrete lighter than the conventional concrete. Pumice stone is a lightweight aggregate of low specific gravity. It is a highly porous material with a high water absorption percentage. In this we do not use the conventional aggregate and replace it by the pumicestone.Pumice is the specimen of highly Porous rocks having density approximately 500-600 Kg/m^3. Pumice is produced when super-heated, highly pressurized rock is violently ejected from volcano.

2. Materials and Properties

The materials used for the preparation of floating concrete are Cement, sand, water, pumice stone These materials and their properties are discussed below

A. Cement:- Cement is the material that has cohesive and adhesive properties in the presence of water. Such cements are called hydraulic cements. These consist primarily of silicates and aluminates of lime obtained from limestone and clay. Ordinary/Normal Portland cement is one of the most widely used type of Portland Cement.

B. Aggregate

Aggregate properties greatly influence the behaviorofconcrete since they occupy 80% of the total volume of concrete. The aggregates are classified as Fine Aggregate & Coarse Aggregate

Those particles passing the 9.5 mm sieve, almost entirely passing 4.75 mm (No.4) sieve, and predominantly retained on the 75 µm (No. 200) sieve are called fine aggregate. Those particles that are predominantly retained on the 4.75 mm (No. 4) sieve, are called coarse aggregate. But in our study we have replaced the coarse aggregate with pumice stone to get the required floating density.

C .Water

Water is the key ingredient, which when mixed with cement, forms a paste that binds the aggregate together.

D Pumice Stone

Pumice is a type of volcanic rock formed when lava with extremely high levels of water and gases is violently ejected from a volcano. As explained by the Mineral Information Institute, when the gases escape, the rock become "frothy." Once the rock hardens, the result is a very light, buoyant material. The main use of pumice is for making lightweight construction materials such as concrete. Pumice has a chemical composition similar to that of obsidian, or volcanic glass. It has very thin, translucent bubble walls of extrusive igneous rock

3. Research Objective

The main research objective was to develop light weight concrete using Pumice stone to reduce the self weight of the structures. The focus was on to develop the floating concrete with good strength, less porous, less capillarity so that the concrete that will floatshould be durable.This study deals with the development of floating concrete by using pumice stones separately.

This is a convenient place to summarize again the advantages of floating concrete structures

- Durability and low maintenance.
- Excellent high resistance to compressive forces.
- Excellent behavior in cold weather and at low temperatures.
- Good thermal insulating properties
- High fire resistance,
- Utilization of mainly local materials,
- Economy.

4. Experimental Work:-

To study the floating property of the Light weight concrete:

4.1. Materials used.

Cement – Portland Pozzolona cement

The Ordinary Port Cement (OPC) was classified into three grades namely 33 grade, 43 grade and 53 grade depending upon the strength of cement at 28 days when tested as per IS 4031-1988. If the 28 days strength is not less than 33 N/mm^2, it is called 33 grade cement, If the 28 days strength is not less than 43 N/mm^2, it is called 43 grade cement, If the 28 days strength is not less than 53 N/mm^2, it is called 53 grade cement.

The chemical compositions of different properties are given below:-

Specific Gravity	2.57
Water absorption	0.57%
Fineness Modulus	2.39

Properties of Pumice Stone

Specific Gravity	3.14
Initial setting time(min)	30
Final setting time(min)	262

Properties of OPC

Aggregate:-Pumice Stone (size 10mm-20mm)

Specific Gravity	1.13
Desnity (g/cm^3)	0.25
Size (mm)	10-20

Fine Aggregate

In this study we used the sand of zone -II, known from the sieve analysis using different sieve sizes (10mm, 4.75mm, 2.36mm,1.18mm, 600µ,300 µ,150 µ) adopting IS 383: 2016.

Properties of Sand

Aluminum Powder

Water – Tap water

Mixed Procedure – Mixer mixing

Compaction – Table Vibration

Curing practice - Moist curing by pounding

Cube size – 150 mm× 150mm× 150 mm

4.2 Experimental Procedure

We have casted two types of samples cylinder and cube

1 The purpose of casting cube is to find the compressive strength

2 The purpose of casting cylinder is to find the split tensile strength

4.3 Test Specimen

Cube (150 mm x 150 mm x 150 mm)
Cylinder (150 mm x 300 mm)
Testing of materials: Cement
Standard Consistency test:- The standard consistency of a cement paste is defined as that consistency which will permit the vicat plunger to penetrate to a point 5 to 7mm from the bottom of the vicat mould.
Weight of cement = 300g
Amount of water = 102g.
It is given as weight of (water/weight of cement) x 100 and it came out as 34%.
Fineness Test:-
Data:-
Weight of cement taken (A) =100 gm
Weight of cement retained on 90µ I.S. Sieve (B) = 05 gm
Calculation:-
Fineness = (B/A) × 100 = 05%
Fineness should be less than 10% as per IS code.
Fineness value is less than 10%.
Hence it could be be used in this study.
Setting Time:-
Weight of cement = 300 gm.
Water content = 0.85 P. Where P = Standard Consistency = 0.85 × 34% = 28.9% of cement = (28.9÷100) ×300gm = 86.7 gm = 86.7 ml.

Initial Setting Time:-
Initial setting time = 40 minutes
It should be more than 30 (as per I.S 4031-1968)
Final Setting time:- When the test block has attend such hardness that the needle does not pierce through the block more than 0.5 mm, that time is known as final setting time. I.S. requirement = less than 600 minutes (as per I.S. 40311968).
Tests on a light weight aggregates (Pumice Stone):- For this study, we got pumice stone as big as 55 mm size. So we crushed it to the size of 20 mm & less. The mix design for the first sample is decided based on the studies, and then further samples were made by changing some proportions in previous ones.

5.Observations and Calculation for Pumic Stone samples:-

Sample1: 3 cubes for each sample
Cement: 8 kg
Crushed sand: 12 kg
Pumice stone (< 20 mm):24kg
Water: 4.8 kg
W/C=0.6

TABLE5.1 RESULTS: After 3 days of cubetesting.

Admixture	Wt (Kg)	Density (kg/m^3)	Load (KN)	Strength (N/mm^2)
5g	5.95	1798.94	290	12.89
6g	5.90	1783.82	270	12.005
7g	5.85	1768.70	249	11.07

Sample2: 3 cubes
Cement: 5 kg
Crushed sand: 7.5 kg
Pumice stone (< 20 mm):15kg
Water: 2.5kg
W/C=0.5

TABLE 5.2 RESULTS: After 7 days of cube testing

Admixture	Wt (Kg)	Density (kg/m^3)	Load (KN)	Strength (N/mm^2)
5g	4.95	1496.59	290	12.88
6g	4.90	1481.48	265	11.77
7g	4.85	1466.36	235	10.44

Sample3: 3 cubes

Cement: 4kg
Crushed sand: 6 kg
Pumice stone (< 20 mm):12 kg
Water:1.6 kg
W/C=0.4

TABLE5.3 RESULTS: After 21 days of cube testing

Admixture	Wt (Kg)	Densit (kg/m^3)	Load (KN)	Strength (N/mm^2)
5g	4.30	1300.07	200	8.88
6g	4.20	1269.84	190	8.44
7g	4.10	1239.60	170	7.55

Sample4: 3 cubes3 cubes for each sample
Cement:6 kg
Crushed sand:4.5kg
Pumice stone (< 20 mm): 9 kg
Water:1kg
W/C=0.3

TABLE5.4 RESULTS: After 28 days of cubetesting

Admixture	Wt (Kg)	Densit (kg/m^3)	Load (KN)	Strength (N/mm^2)
5g	3.27	988.66	74	3.228
6g	3.12	943.31	71	3.155
7g	2.98	900.98	68	3.022

number of Cylinders Samples for tensile Proportions are 1:1.5:3 (M20)

Cement: 24 kg
Crushed sand: 36 kg
Pumice stone (<20 mm): 72kg
Water: 9.6kg W/C = 0.4
Admixture: Aluminum powder 2%

TABLE 6.1 Results:7 days Tensile Strength

S.No	Weight (kg)	Tensile Strength (N/mm^2)	Avg Tensile Strength (N/mm^2)
1.	9.81	5.73	5.56
2.	9.79	5.50	
3.	9.75	5.45	

TABLE 6.2 Results:14 days Tensile Strength

S.No	Weight (kg)	Tensile Strength (N/mm^2)	Avg Tensile Strength (N/mm^2)
1.	8.80	4.95	4.83
2.	8.75	4.80	
3.	8.50	4.75	

TABLE 6.3 Results:28 days Tensile Strength

S.No	Weight (kg)	Tensile Strength (N/mm^2)	Avg Tensile Strength (N/mm^2)
1.	7.95	4.10	3.94
2.	7.90	3.90	
3.	7.89	3.80	

7. Results and Discussions

Sample 1 gives average compressive strength 11.98 N/mm^2, which is good for lightweight concrete. Also it gives average density 1783.82 kg/m^3, but we have to reduce the density of concrete to nearly equals to density of water, so it is to be required that reduce the quantity of crush sand and that's why we reduced the quantity of crushed sand and also replaced it with pumice sand passing through IS sieve of size 4.75 mm. in next sample. Also we used two fractions of Aggregate i.e. M1 (10mm to 20 mm) and M2 (4.75 mm to10 mm).

Sample 2 gives the improved results having average density 1481.47 kg/m^3 and average compressive strength 11.69 N/mm^2, but average density of concrete is not nearly equals to the density of water. Also the quantity of cement is high, so we discussed this situation with our guide. He told us that if you reduce the quantity of cement it will help us to reduce the density as well as to achieve economy. Therefore in next sample we reduced the cement quantity and increased the pumice sand.

Sample 3 gives the improved results having average density 1269.83kg/m^3 and average compressive strength 8.29 N/mm^2. We reduced the quantity of cement in this sample, but average density of concrete is still not nearly equals to the density of water. Therefore in next sample we again reduced the cement quantity and increased the pumice sand.

Sample 4 gives lightweight concrete having average compressive strength 3..155 $N/mm^2$and average density 944.31 kg/m^3, which is nearly equal to the density of water hence the concrete may be float on the water. It was light as desired but its finishing was not good.

Fig.7.1: Cube showing rough surface

Fig7.2: Cube showing smooth surface

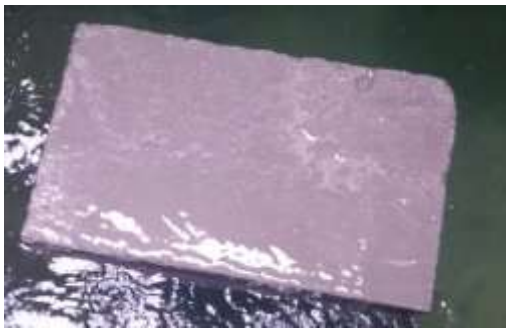
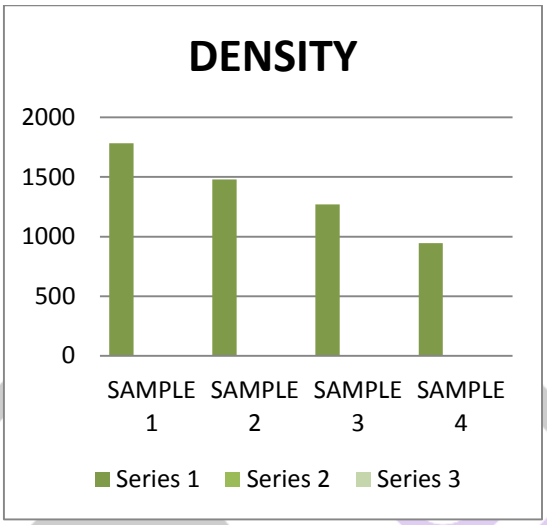


Fig7.3 cube floating on water



8. Conclusion

In this study, the influences of aggregate types and the amount on the compressive strength of concrete were investigated. Using different aggregate proportions (pumice) and five different lightweight concrete mixtures were produced with a satisfied strength. The result of the investigation showed that aggregate size and proportion influenced the unit weight and compressive strength of concrete. Moreover, the result showed that it is possible to produce a Floating and satisfied strength concrete by using pumice as aggregate. It was also seen that, using light weight aggregate in the concrete mixture can reduce the dead load but decreases the concrete strength. However for the sample 6 it is Reverse, because this proportion gives compressive strength 8.61 N/mm^2, which is good for the light weight concrete having density 1102.66 kg/m^3. From cost analysis it is proved that the cost of our project is less than that of brick masonry. The study showed that using pumice aggregate as a commixture enable to produce different strength grade lightweight concrete with different unit weight. These concrete does not satisfies the strength requirements for load bearing structural elements. In this study only strength and unit weight were considered, other properties including carbonation and drying shrinkage, thermal conductivity and sound insulation properties can be investigated as a further study.

References

[1] Dhawal Desai, (2014), "Development of Light Weight Concrete", Civil EngineeringPortal.
[2] T. Parhizkar, M. Najimi and A.R. Pourkhorshidi, (2012) "(Application of Pumice aggregate in structural lightweight concrete", Asian journal of civil engineering (building and housing) VOL. 13, NO. 1 pp43-54.
[3] N. SivalingaRao, Y.RadhaRatnaKumari, V. Bhaskar Desai, B.L.P. Swami,(2013)"Fibre Reinforced Light Weight Aggregate (Natural PumiceStone) Concrete ",International Journal of Scientific & Engineering Research, Vol 4,(5),pp 2229-5518.
[4] Lakshmi Kumar Minapu1, M K M V Ratnam, Dr. U Rangaraju,"(Experimental Study on Light Weight Aggregate Concrete with Pumice Stone, Silica Fume and Fly Ash as a Partial Replacement of Coarse Aggregate)", International Journal of Innovative Research in Science, Engineering and Technology,3(12).
[5] Kılıç1, C. D. Atis, A. Teymen, O. Karahan and Kamuran Arı (2009), The effects of scoria and pumice aggregates on the strengths and unit weights of lightweight concrete , Scientific Research and Essay,4 (10), pp961-965. Anon:Structural lightweight aggregate concrete in India. Indian Concrete Journal, Vol. 60, No. 9, sep. 1986, pp219-220.
[7] IS 456-2000: Code of practice for plain and reinforced concrete. Bureau of Indian Standards, New Delhi, 2000.
[8] Mix Design by Indian Standard Recommended Guidelines as per IS: 10262 :2009.
[9] Mix Design by Indian Standard Recommended Guidelines as per IS: 10262 :1982
[10]. IS: 516- 1959: Methods of tests for strength of concrete. Bureau of Indian Standards, New Delhi, 1999.
[11] IS: 5816-1999 Method of test for split tensile strength of concrete cylinders.