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EXPERIMENTAL INVESTIGATION ON FOAM CONCRETE WITH PARTIAL REPLACEMENT OF CEMENT BY GGBS

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Abstract – *Light-weight concrete is a special type concrete that includes cement, water, preformed foam and fine sand. Light weight concrete is getting popular now a days. It is a versatile material which consist primarily of cement based mortar mixed with at least 20% volume of air. Density of lightweight concrete is generally ranging from 400 to 1800 kg/m³.The aim of this study is to develop structural foamed concrete. An experimental investigation was conducted to study strength characteristics of GGBS incorporated foam concrete. The mechanical properties can be improved by partial replacement of cement by GGBS. The various percentage of GGBS used are 0%,5%,10%,15%,20%. The properties such that compressive strength, splitting tensile strength were tested and result showed that strength has increased.*

Key Words: FOAM CONCRETE, GGBS, COMPRESSIVE STRENGTH TEST, SPLITTING TENSILE STRENGTH, LIGHT-WEIGHT CONCRETE

1. INTRODUCTION

With the increase in demand for structures which are light in weight, researcher's attention in foamed concrete to be used in structural applications is steadily increasing. Foamed concrete, also known as lightweight concrete is a type of concrete which contains cement, fine aggregate, flyash, water and voids ,but no coarse aggregate. Foamed concrete can be produced with dry density of 400 to 1800 kg/m³.

Foamed concrete is a light in weight, cost effective and easy to produce material with good workability and has excellent performance in thermal insulation, acoustic insulation and shock absorption. Conventional foam concrete can achieve only low compressive strength (e.g., between 1 and 10N/mm²).So it is used in void fill, trench reinstatement, and thus material is largerly ignored for using in structural sections. Due to its unique properties and cost effectiveness, foamed concrete has many engineering applications. Foamed concrete minimises the cost of production and transportation of building components compared to normal concrete. It can reduce dead load on structures, provide energy conservation and reduces labour cost during construction. Foamed concrete have so many advantages and applications. Some advantages and applications of foamed concrete include: production of light weight block and precast panels, fire insulation, thermal and acoustic insulation, road sub-base construction and trench reinstatement. It renders high load bearing strength ,high durability, easy handling ,good sound absorption, earthquake resistance and so on. High density foamed concrete has the possibility of being used as a structural material. Stable foamed concrete production depends on : kind of foaming agent, process of preparation of foaming agent to initiate a uniform distribution of air voids and mix design. Compressive strength is the major function of the desirable design density, and as main consideration for this concrete to be finally used to construct structural, non-structural or semi-structural components. Stable foamed concrete production depends on; kind of foaming agent, process of preparation of foaming agent to initiate a uniform distribution of air voids and mix design. Compressive strength is the major function of the desirable design density and as a main consideration for this concrete to be finally used to construct structural, non-structural or semi-structural components.

In this study strength characteristics of foamed concrete incorporated with GGBS are evaluated by compressive strength test and splitting tensile strength test. In this present work GGBS is partially replaced with GGBS in the range of 0%,5%,10%,15%,20%.

1.1 Objective

1. To find out fresh state characteristics of foam concrete
2. To find out optimum percentage of GGBS in foam concrete

3. To find out strength of GGBS incorporated foam concrete in terms of compressive strength and split tensile strength.

2. EXPERIMENTAL METHODOLOGY

1. A detailed literature study was done on the studies of foam concrete.
2. Physical properties of materials were tested and found that all properties are confirming to IS standards.
3. Foamed concrete is prepared by trial mixing in the ratio of 1:2 with a water cement ratio of 0.5.
4. Foaming reagent is added by weight of cement as 1%, 2%, 3%and 4% based on target density.
5. For the optimum proportion of foam found from above samples , cubes and cylinders are casted by varying GGBS in the range of 0 %, 5% ,10%,15%, 20%.
6. Mechanical properties of foamed concrete are determined in terms of compressive strength and splitting tensile strength in cubes and cylinders respectively.

2.1. Materials Used

a) Ordinary Portland cement (OPC) which is grey in colour. OPC of 53 grades is used in this experiment.
b) Sand is naturally available granular material composed of finely divided rock and mineral particles.
c) Water which is used for drinking is satisfactory for usage in concrete
d) Foaming reagent used in this work is sodium lauryil ether sulphate. It is an anionic detergent and surfactant widely used in foamed concrete production which is inexpensive and effective
e) Ground granulated blast furnace slag (GGBS) is a by-product of steel manufacturing. The chemical composition of blast furnace slag consists of essentially silicates and alumina-silicates of calcium. It has a specific gravity of 2.63.

3. EXPERIMENTAL INVESTIGATION

The experimental investigations such as compressive strength test, splitting tensile strength are done on foamed concrete using foam concrete incorporated GGBS.

A. Mix Design

There are no standard guidelines for mix proportioning of foam concrete and the mix design producer is based on trial mixes.Based on the results obtained from the trial mixes, a better mixproportion was choosen.When foamed concrete is considered not only the strength but also the density is an important factor.Since the compressive strength of foamed concrete is a function of its density,strength can be altered by changing its density.Mixproportion was obtained based on trial and error.

B. Mix proportion

The present experiments to make lightweight foamed concrete without coarsed aggregate.For that a mixproportion of 1:2 by weight of cement and sand and water cement ratio of 0.5 was used.Four variations of foam (1%,2%,3%,4%) were added and cement was partially replaced with GGBS.

C. Test Procedure

The mix proportion of foamed concrete was obtained by trial and error method based on target density. The appropriate quantity of foam required was created and added instantly to the mix and mixed for a minimum time until there was no foam on the surface and all the foam was homogeneously spread sand incorporated into the mix. Fig 1 shows foam generation. Optimum percentage of foam obtained after conducting strength tests.Mould of size 150 mm x 150mm x 150mm were used to prepare the cube specimen and moulds of size 150 mmx300 mm were used to prepare a cylinder specimen for determining .Cubes and cylinders were casted by partially replacing cement with GGBS.Testing of specimen for compressive strength and splitting tensile strength on 7 th day and 28 th day and determining optimum percentage of GGBS from results.

Fig -1: Foam preparation and mixing of it by pre-foaming method

Fig-2: Casting of specimen

Fig -3: Curing of specimen

4. RESULT AND DISCUSSION

4.1. Fresh state characteristics

Fresh state characteristics of foamed concrete are determined by using flow table test. The fresh foamed concrete produced was first poured into an inverted slump flow cone without any compaction and vibration is then given. The flowability of foamed concrete mixes was measured by the diameter of the slump. As foam content increases flow value of foamed concrete also increases.

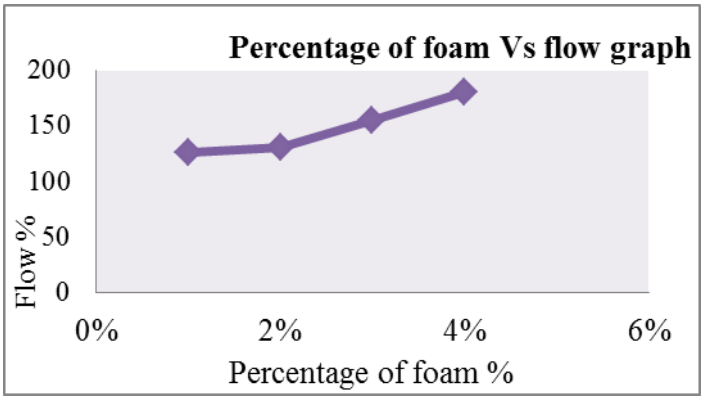

Fig -4 : Percentage of GGBS vs flow percentage graph

4.2. Compressive Strength

By foam addition foam concrete shows decrease in compressive strength.2% is considered as optimum quantity in terms of density and compressive strength Fig 4 shows compressive strength test of foam concrete. Compressive strength test results of foam concrete incorporated GGBS are given in table I. Fig 5 shows variation of compressive strength of foamed concrete with different mixes of GGBS.

Fig -5: Compressive strength test

Table -1: Compressive strength test on varying GGBS

Specimen (by varying percentage of GGBS)	7th day strength (N/mm^2)	14th day strength (N/mm^2)	28th day strength (N/mm^2)
0%	12.59	16.4	18.22
5%	12.88	16.6	18.44
10%	**13.33**	**16.8**	**19.11**
15%	12.22	15.5	17.11
20%	8.88	11.3	12.22

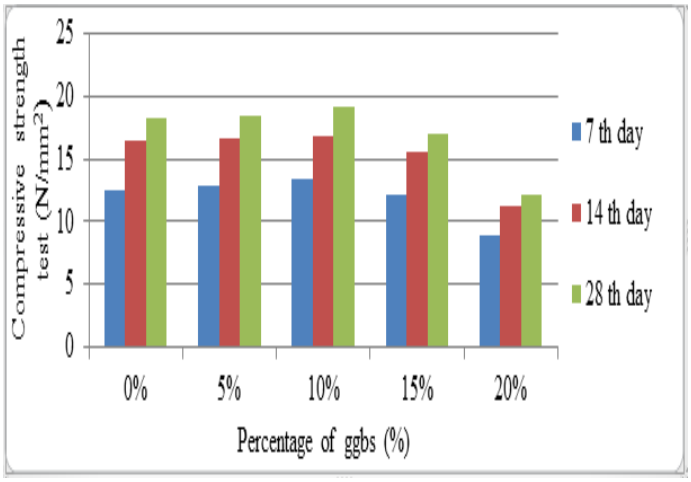

Fig-6: Compressive strength of GGBS incorporated foam concrete after 7 days, 14 days ,28 days of curing

4.3. Splitting tensile strength

By foam addition foam concrete shows decrease in compressive strength. 2% is considered as optimum quantity in terms of density and splitting tensile strength.Fig 6 shows splitting tensile strength test of foam concrete .Splitting tensile strength test results of foam concrete incorporated GGBS are given in table II. Fig 6 shows variation of splitting tensile strength of foamed concrete with different mixes of GGBS.

Fig-7: Splitting tensile strength test

Table -2: Compressive strength test on varying GGBS

Specimen (by varying percentage of GGBS)	7th day strength (N/mm^2)	14th day strength (N/mm^2)	28th day strength (N/mm^2)
0%	1.48	1.69	1.83
5%	1.55	1.55	1.69
10%	**1.62**	**1.65**	**1.90**
15%	1.41	1.43	1.50
20%	1.27	1.34	1.48

Fig-8: Splitting tensile strength of GGBS incorporated foam concrete after 7 days, 14 days ,28 days of curing

5. CONCLUSIONS

Effect of GGBS on both fresh state characteristics and mechanical properties of foamed concrete are studied. The following conclusions are drawn from this study:

- Compared to other foam concrete mixes, the concrete mix with 2% foaming agent gave rise to desired density.
- GGBS is a waste product and readily available can be used to make foam concrete cost-effective and ecofriendly.
- Effect of GGBS increase compressive strength of foam concrete. The largest increase acquired is 19.11MPa at 28 days by adding foaming agent 2 % by weight of cement , and by replacement of cement by with 10% GGBS.
- Effect of GGBS increase splitting tensile strength of foam concrete. The largest increase acquired is 1.90 MPa at 28 days by adding foaming agent 2 % by weight of cement , and by replacement of cement by with 10 % GGBS.

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REFERENCES

[1] N. K. Amudhavalli et al (2012) "effect of silica fume on strength and durability parameters of concrete", International Journal of Engineering Sciences & Emerging Technologies,ISSN: 2231 – 6604 Volume 3, Issue 1, pp: 28-35

[2] Y.H. Mugahed Amran et al(2015) "Properties and applications of foamed concrete; a review", Construction and Building Materials, elsevier,pp 990–1005.

[3] MD Jalal et al (2017)"Foam Concrete ", International Journal of Civil Engineering Research , Volume 8 , Issue 2, February ISSN 2278-3652 , pp. 1-14 .

[4] E. K Kunhanandan Nambiar et al (2008)"Fresh state characteristics of foam", Journal of Materials in Civil Engineering, ASCE, Volume 20, Issue 2, February pp.111-117.

[5] Iman Kattoof Harith et al(2018) "Study on polyurethane foamed concrete for use in structural applications", Case Studies in Construction Materials, elsevier,pp 79–86.