Experimental Study of Concrete with Glazed Hollow Beads as a Replacement of Fine Aggregate

R. Urmila, Anantha Krishnan. R, Adarsh. S, Rahul. J

Abstract- In the field of construction concrete inevitable substance. The weight which the concrete possess is a greater demerit as greater weight increases the structural load the building has on the foundation. The glazed hollow beads are glass microspheres produced of soda-lime borosilicate a replacement material for the fine aggregates. Fine aggregates are natural elements present and for the concrete preparation they are being largely consumed which causes a depletion in these natural elements. Studies are being carried to determine fine aggregate replaced concrete which has the same properties of a normal concrete. Glazed hollow beads have a significant effect on compressive strength the load bearing capacity and the split tensile strength of the concrete. There are 8 concrete cubes and 4 concrete cylinders that were casted for the testing of properties of the concrete. The concrete cube specimens were casted for 7 days, 14 days, 21 days and 28 days. The replacement of fine aggregate by glazed hollow beads added to concrete is varied at 0.5% and 1% to obtain the optimum compressive strength. The comparison of the specimen result defines the concrete produced is very light in weight in comparison to conventional concrete.

Index Terms- Fine aggregate, partial replacement, Glazed Hollow beads, Compressive strength, Split tensile strength, 28 days curing, and light weight concrete

1 INTRODUCTION

Concrete a widely and commonly used material in the field of construction, the research on concrete is carried out to produce a more beneficial and environmentally efficient concrete. The modern world research is based on creating a concrete composite that has preeminent qualities and economical efficacy [6]. The research topics are based on the increasing global warming causing the residences to warm up and create concrete composites that have high thermal resistance [1]. Modifying materials are used in the concrete at different proportions and the advancements in the concrete are studied [5]. The need for the thermal insulation material is necessary for the offshore pipelines as they have to resist high temperature [8]. The light weight high strength concrete is one the most widely researched concrete composite due to the reduced weight and the increased strength of the concrete [7]. The reduction in the use of fine aggregates help to reduce the environmental damage and the weight of the concrete is also significantly reduced. The extrusion method are used in these research to produce a concrete composite that requires lesser water and the concrete is more light weighted. The reduction in the weight of the concrete helps not only to reduce the structural weight of the concrete but also the mechanisms needed for the placement and also for the removal of the concrete. Light weight concrete is most desirable due to the easy flowing property which helps the concrete to be placed faster than placing of normal concrete.

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2 MATERIALS AND METHODS

2.1 Cement

The concrete composite is designed of ordinary portland cement (43 Grade). The properties and tests were conducted on the basis of IS 4031. The cement used should not be tampered and free from any impurities.

2.2 Fine aggregate

Fine aggregates are of the size less than 4.75mm. The fine aggregates generally used for the construction are of the size 20mm. The fine aggregates used for the research

work should be unfettered of inorganic or organic substances. The tests on the fine aggregates were conducted on the basis of IS 2386.

2.3 Coarse aggregate

Coarse aggregates have a size greater than 4.75mm. Coarse aggregates used for the concrete specimen are tested using the IS 2386.

2.4 Glazed Hollow Bead

Fine aggregates usage in the recent years have been increasing due to the increase in the usage of concrete that leads for necessity of an artificial material that can used in place of the fine aggregate. Glazed hollow beads are artificially produced microspheres. The glazed hollow beads are produced from soda-lime borosilicate. The soda-lime borosilicate glass is used for the production of laboratory funnel and test tube making. This glass is melted then produced into small spherical shaped glass microspheres. These materials have very small size which helps it to be free floating and helps easily bind with the concrete [9]. The material has a high thermal resistivity because of its usage in the laboratory. The usage of glass microspheres increases the thermal resistivity of the whole concrete sample which in turn has greater benefits such as reduction in heat loss of the residences [6]. Glazed hollow beads have low density which reduces the total weight of the concrete but can resist extremely high compressive loads [5].

TABLE 1

PROPERTIES OF GLAZED HOLLOW BEADS

S.NO	Properties	Values
1	Colour	White
2	Form	Powder
3	Size	35 – 119 μm
4	Density	0.35 – 0.40 (g/cm^3)
5	Thermal conductivity	0.0521(W. m^{-1}. K^{-1})

Fig. 1. Glazed hollow beads

2.5 Specific gravity test

Cement and fine aggregate were tested for specific gravity test. The cement was tested using Le-Chatelier's apparatus. The fine aggregates were tested using the pycnometer apparatus.

TABLE 2

SPECIFIC GRAVITY OF ALL MATERIALS

S. NO	Material	Specific gravity
1	Cement	2.7
2	Fine aggregate	2.6

2.6 MIX PROPORTIONS

The mix proportion used for the production of the concrete is given in the table.

TABLE 3

MIX PROPORTIONS / M3 FOR GLAZED HOLLOW BEAD FOR concrete cubes

Specimen	Cement (kg)	Fine Aggregate (kg)	Coarse Aggregate (kg)	Glazed hollow beads (kg)	Water (kg)
Mix Ratio 1	1.87	0.935	3.74	0.935	1.122
Mix Ratio 2	1.87	nil	3.74	1.87	1.122

TABLE 4

MIX PROPORTIONS / M3 FOR GLAZED HOLLOW BEAD FOR CONCRETE CYLINDER

Specimen	Cement (kg)	Fine Aggregate (kg)	Coarse Aggregate (kg)	Glazed hollow beads	Water
Mix Ratio 1	2.7	1.35	5.4	1.35	1.620

3 RESULTS AND DISCUSSION

3.1 Casting of Concrete

The casting of the concrete was done with partial and complete replacement of fine aggregate with glazed hollow beads. The casting was cured for 7 days, 14days, 21 days and 28 days. The casting specimen are casted using cubes of the dimension 150 mm x 150mm x 150mm and the cylinders are of the dimension 100mm x 100mm x 500mm. The concrete after the 48 hours of dry curing, the concrete specimen is placed in water tank.

Fig 2: Cube specimens

3.2 Testing Specimens

3.2.1 Compressive test

Compressive test is carried out in the concrete cube samples to determine the compressive strength of the concrete sample. The compressive testing is done with the help of universal testing machine. The compressive test was conducted for two different ratios. The load in the compressive strength test is gradually increased by a rate at 140 kg/sq.cm/min.

Fig 3: Compressive strength test

3.2.2 Split tensile test

Split tensile strength test is conducted on the concrete samples of cylindrical shape. The concrete sample is compressed in the vertical diameter of the cylinder. The concrete cylinders consists of partial replacement of fine aggregates by glazed hollow beads. The load in the split tensile strength test is gradually increased by varying the load at a rate of 1.2 N/mm² to 2.4 N/mm².

Fig 4: Split tensile strength test

3.3 Compressive Strength

The final values arrived after the testing of the concrete samples are listed.

TABLE 5
COMPRESSIVE STRENGTH VALUES FOR PARTIAL REPLACEMENT

Compressive strength	7 days (N/mm²)	14 days (N/mm²)	21 days (N/mm²)	28 days (N/mm²)
Partial replacement	18.8	23.82	26.6	27.72

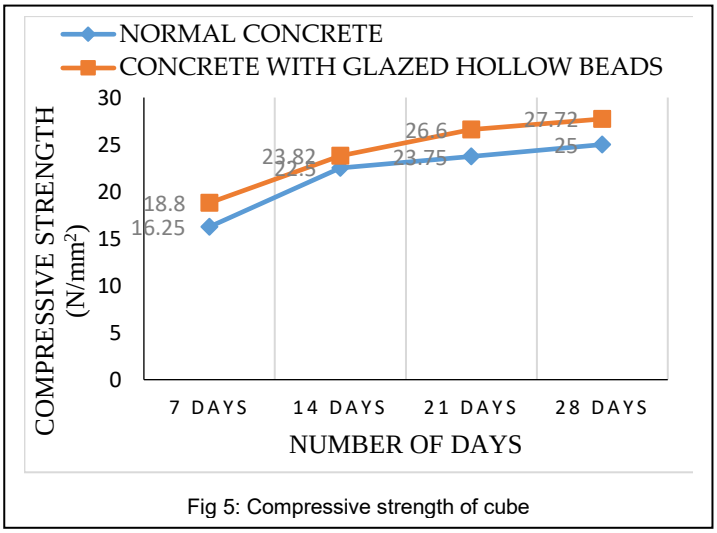

Fig 5: Compressive strength of cube

3.4 Split Tensile Strength

TABLE 6
SPLIT TENSILE STRENGTH TEST VALUES FOR PARTIAL REPLACEMENT

Split tensile strength	7 days (N/mm²)	14 days (N/mm²)	21 days (N/mm²)	28 days (N/mm²)
Partial replacement	0.950	1.426	1.502	1.567

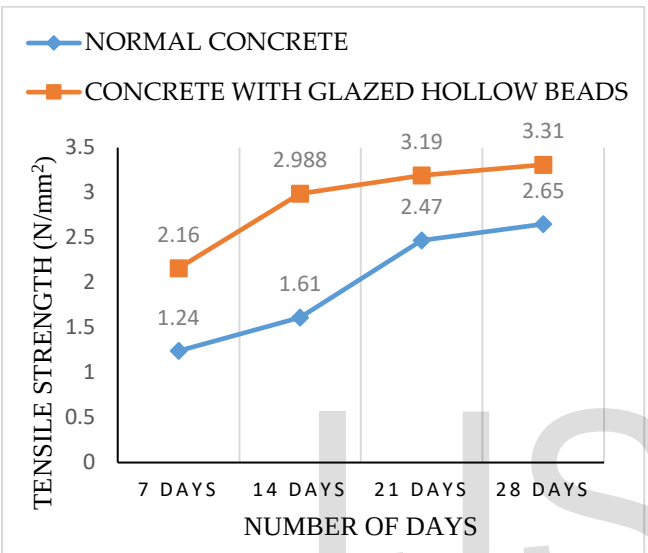

Fig 6: Split tensile strength test of cylinder

3.5 Comparison of compressive strength

The compressive strength of the concrete samples of two different ratios was obtained. The mix ratio 2 is the complete replacement of fine aggregates with glazed hollow beads. The compressive strength of the concrete samples are measured to determine the capacity of glazed hollow bead used as an artificial fine aggregate.

TABLE 7
COMPRESSIVE STRENGTH VALUES FOR COMPLETE REPLACEMENT

Compressive strength	7 days (N/mm²)	14 days (N/mm²)	21 days (N/mm²)	28 days (N/mm²)
Complete replacement	24.79	29.42	31.07	32.72

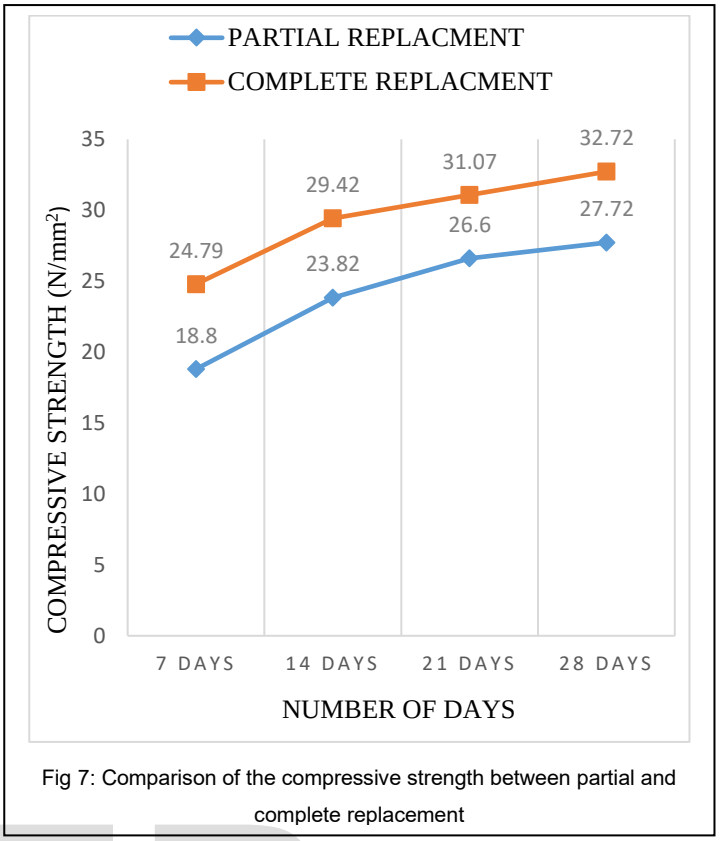

Fig 7: Comparison of the compressive strength between partial and complete replacement

4 CONCLUSION

According to the values obtained after the testing of the concrete samples the conclusion is that the compressive strength of the concrete increases [6]. There is high split tensile strength in the concrete samples [10] and when compared to concrete the usage of water is very less. The thermal resistivity of the concrete also increases by the addition of glazed hollow beads [12].

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