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Research Article

EXPERIMENTAL ANALYSIS ON USE OF WASTE GLASS AS A FINE AGGREGATE IN CONCRETE

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A R T I C L E I N F O

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A B S T R A C T

Concrete is utilized as a significant material in construction industries. As the number of inhabitants in world increases quickly, world faces the issue for home and waste result. As the waste is corresponding to the population. However there are limitations for common assets utilized in cement, The construction industry need some attention regarding utilization of some other material with the goal that they can be blend in cement to get the new product whose physical properties are same as the conventional one. Consistently there is a few tons of waste glasses created everywhere throughout the world. India produces 22 (32) million tonnes glass wastes in a year. Glass constitutes about 5% of the municipal solid waste, but only a small percentage of it is recycled. Waste glass can be re-utilized as a fine raw material and it displays a choice to spare regular and non-sustainable materials. The utilization of waste glass powder in concrete can make the construction industry progressively environmental. In this research an attempt has been made to bring into play the waste glass in different extents with the goal that the concrete mixture has the property of solid blend same as the conventional one. Waste glass fine crushed material was replaced with fine aggregate in different percentages varying from 5%, to, and 40% at an interval of 5 %.

INTRODUCTION

The study is to work out the impact of waste glass fine crushed material in cement of grade M-30 when it is substituted for the fresh state and hardened state i.e. for workability and strength of concrete using OPC (Ordinary Portland Cement) (43 grade), as the waste glass fine crushed material have been replaced by fine aggregate which changes from 5% to 40% at interval of 5% by total weight of fine aggregate (Sand). Around 120 concrete specimens of different mix proportions were analyzed in the investigation. The study focuses on the development of compressive strength at 7 and 28 days likewise 28 days flexural strength and 28 days split tensile strength with different scope of replacement of fine aggregate by waste glass fine crushed material in the concrete.

Test outcomes showed that on 25% Replacement of waste glass fine crushed material into fine aggregate for M 30 grade in concrete, the compressive strength observed were greater than the mean compressive strength of ordinary M 30 grade concrete.

Further, on 25 % partial replacement of waste glass fine crushed material into fine aggregate of M 30 grade in concrete, flexural strength were additionally more prominent than the flexural strength of ordinary M30 grade concrete.

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Almost same pattern was observed with splitting tensile strength of concrete. On 25 % replacement of waste glass fine crushed material into fine aggregate with M 30 grade concrete, the split tensile strength was observed to increase to the split tensile strength of ordinary M30 grade concrete.

All mixes of concrete were examined for workability as slump test of fresh concrete. Hardened concrete was tested for compressive strength for 7 days and 28 days, flexural strength for 28 days and for split tensile strength for 28 days.

Literature Review

Experimental study by Adaway M, Wang.Y (2015) (1) sought to identify the effects of implementing waste glass as a partial replacement for fine aggregate in structural grade concrete. He has carried out test at 5%, 10%, 15% and 20% replacement of sand by waste glass for the mix M-40.The workability of concrete followed a decreasing trend, due to the angular nature of the waste glass particles. Despite this trend, the concrete was deemed workable and was within the specified tolerance intervals. The optimum percentage replacement of sand with fine waste glass aggregate was determined to be 30%.

Bharat Nagar and Bhargava V.P (2016)(2): Have studied to evaluate the effect of dry sludge on concrete performance, its physical and mechanical properties. In this research an attempt is made to bring into play the sludge waste in various proportions so that the final product property of concrete mixture is same as the control mix. Waste sludge material was replace with fine and coarse aggregate in various percentages

such as 50%, 45%, 40%, 35%, 30%, 25%, 20%, 15%, 10%, 5%, 4% and 3% for the mix M-20.

Ion Dumitru, Tony Song, et al, 2014, [5]

In their research the effects of waste glass sand replacement and cementations materials replacement with powder waste glass on fresh and hardened concrete properties were assessed The investigation were carried out to assess the potential of the crushed recycled waste glass as natural sand replacement using ratios of 30%, 45% and 60% by weight for mix M-30.

Studies were carried out at 2% 4% 6% 8% replacement by crushed waste glass for the mix M-20 by Mohd Syahrul Hisyam Mohd Sani, Ahmad Rasidi Osman, and Fadhluhartini Muftah (2015)

It was evident that the concrete mix with 4 % crushed waste glass was given a high compressive strength in early and mature age. More than 4 % crushed waste glass added in concrete were affected the compressive strength due to alkali silica reaction and also some deleterious chemical effect. The workability test of the concrete mixes was reported the height of slump decreased with increasing of the percentage of crushed waste glass. The increment in compressive strength found at 2%, 4%, 6% and 8% replacement is 35.85%, 37.27%, 17.78% and 13.34% respectively.

Naga Niranjan Kumar.B, Ashok Kumar.M (April, 2016) (10);They carried out the test at 5% 10% 15% and 20% replacement of sand by crushed waste glass for the mix M-25.The waste glass as natural sand replacement in concrete trials was a crushed product with a size distribution between 3mm-0.3mm.

Critical Observations

The past examinations demonstrated that a lot of endeavors have been accomplished for exploring the impact of utilizing waste glass materials as a fine aggregate in concrete mix, yet every one of them were attempting to acclimate the situation and the applicable determinations in their local areas. This research aims to implement a similar task but with applying the available locally used materials by replacing sand from 40% to 50% at an interval of 5% for a M-30 concrete.

Objective of Research Work

The primary goal of this research work is to use waste glass material by partially replacing fine aggregate in concrete mixture, research the impact of waste glass in concrete and adjust the percentage of waste glass material to be used in concrete moulds and note down various results.

To analyze the results of density, workability, compressive strength, flexural strength and splitting tensile strength for M 30 grade of concrete by using waste glass material.

To reduce up to some natural river sand utilization and increasing the use of waste material as mineral admixture in concrete industries.

To compare the engineering properties of so improved concrete for M30 samples with conventional concrete (M 30 as per mix design) with water/cement ratio of 0.40. This research centers on considering the impact of waste glass on the properties of concrete mixtures as partial replacement of fine aggregates to compare the engineering properties of so improved concrete for M30.

Experimental Set Up

Using IS code (IS: 10262-2009-25) Total 120 concrete mixes were prepared, including the reference mix. For each mix, cubes were casted to find compressive strength, cylinders for split tensile strength and beams for flexural strength.

The size of cube was 150 mm(length) x 150 mm(width) x 150 mm(depth), the size of cylinder was 150 mm diameter and 300mm height and the size of beam 100 mm x 100 mm x 500 mm. Mixing of concrete was carried out in a mixer. The concrete was casted in all the molds by compacting with tamping rods. After that, it was kept on vibrating table to remove all the air voids. The specimens were remolded after 24 hours and cured for 7 days to check the strength in 7 days and some of them are cured for 28 days.

After 28 days of curing, the specimens were taken out of the curing tanks and then were tested. Different tests like compressive strength, split tensile strength, flexural strength and density have been carried out and the results were tabulated, for M 30 grade concrete.

Concrete Mixing Procedure

Concrete was blended on a water sealed platform to avoid seggregation and also the mix platform was non-absorvent. Mixing of concrete was done by hand mixing method as per IS516:1959.

Waste glass fine crushed material was replaced with fine aggregate in different percentages for example 5%, 10%, 15%, 20%, 25%, 30%, 35%, and 40%. Reference concrete mix is also made for comparative reasons.

Around 120 concrete specimens of different mix proportions were analyzed in this investigation. This study focuses on the development of compressive strength at 7 and 28 days likewise 28 days flexural strength and 28 days split tensile strength.

Various Expeperiments Conducted

The various experimental studies carried are described below.

Workability

All mixes of concrete were examined for workability as slump test of fresh concrete. Hardened concrete was studied for compressive strength for 7 days and 28 days, flexural strength for 28 days and for split tensile strength for 28 days respectively. The results are depicted in Table 4.1

Density tests

To determine density of specimen's first external surface of the specimen was cleaned with the help of cotton cloth. Average weight of Cube, Cylinder and Beam were 8.50 Kg (for 7 days) & 8.51 Kg (for 28 days), 12.79 Kg (for 28 days) and 38.95 Kg (for 28 days) respectively. The results are illustrated in Table II

Effect of Waste Glass Material on Density of Hardened Concrete (M30) on Replacement of fine aggregate is illustrated in Figure I

Compressive Strength

The compressive strength of all the mixes was determined with cubical specimens of size 150 mm(length) x 150 mm(width) x 150 mm (depth). The specimens were tested after curing

period for both 7 days and 28 days (fully submerged in water) as per IS 516:1959 for the method of tests for strength of concrete. Results are indicated in Fig. II

Flexural Strength

To determine the flexural strength of all the concrete mixes, beam specimen of size (700mm x 150mm x 150mm) were used. The beam specimens were tested after curing period of 28 days fully submerged in water as per IS 516:1959. The central point loading/single point loading method was used for this test.

Effect of waste glass material on concrete of M30 grade by partial replacement to fine aggregate into waste glass for 28 days (Flexural Strength of Beam) is illustrated in Figure III and Photo I illustrates the testing machine.

Splitting Tensile Strength

Cylindrical specimen of size 300 mm (length) x 150 mm (diameter) was used to determine splitting tensile strength of all the mixes. The specimens were cured for 28 days fully immersed in water tank as per IS 5816:1999 for method of test of splitting tensile strength of concrete.
Results are is illustrated in Figure IV.

ANALYSIS OF RESULTS

Workability

In sieve analysis it was found that the waste glass composite aggregate would have a denser gradation than just the fine aggregate. A denser gradation means that more of the air voids would be filled with aggregate and it resulted that there may be a reduction in void in the waste glass concrete mix made in the primary tests. (Photo II)

The workability of concrete shows lump of the concrete mix constant up to 25%, replacement 107 mm as compared to the slump 100 mm of control mix in M30 grade of concrete respectively

With increase in waste glass content, percentage water absorption decreases.

For getting the proper workable concrete a super plasticizer was used up to 1.26%of cement percentage by weight of cement, resulting in increasing the workability significantly.

Compressive Strength

Compressive Strength for 7 days

Compressive strength was found to increase. There is an increase in strength with 25% replacement of waste glass fine crushed material in M30 grade as 29.82 N/mm^2 as compared to control mix of M30 which was 25.98N/mm^2. Higher strength percentage variation achieved as 14.78% .After increasing the waste glass fine crushed material in concrete, the compressive strength goes decreasing because density reduces and water absorption decreases.

Strength after 28 days

Compressive strength of concrete was found to increase with the replacement of waste glass crushed fine material in fine aggregate, there is an increase in strength with 25% replacement of waste glass crushed fine material in M 30 grade as 43.34 N/mm^2 as compared to control mix of M30 which was 38.89N/mm^2. Higher strength percentage variation of 11.44% is achieved for M 30 grade by replacement of waste glass crushed fine material with fine aggregate in concrete.

But further after increasing the waste glass crushed fine material in concrete, the compressive strength goes to decreasing because the density reduces and water absorption decreases of replaced material.

Results of Density Test

The density test of 28 days of control mix and waste glass shows that there is a change in density as the density of concrete mix with waste glass crushed material is decreasing with increase in replacement values.

When we compared the density of control mix M30 (23888.21 N/m^3) and waste glass replacement mix, we found that there is no major effect of density on strength of concrete with value of replacement as 25% in M30 grade (223483.98 N/m^3). But after increasing the replacement percentages of waste glass more than above discussed values the density starts decreasing (shown in table 4.2, figure B9 and figure B10)

Increasing percentage of waste glass in concrete beyond 25% at M30 grade level causes a continuous decrease in compressive strength of concrete. This decrease may be due to an increase in the silica content present in waste glass causing developments of cracks in the concrete. These cracks are due to ASR (Alkali-Silica reaction).

CONCLUSIONS

Waste glass can be replaced by fine aggregate (sand) without compromising the strength.

There is an increase in compressive, split and flexural strength of M30 concrete up to 25 % replacement of fine aggregate (sand) by waste crushed glass after which decrease in trend was observed. The decrease in density was recorded beyond 25 % replacement.

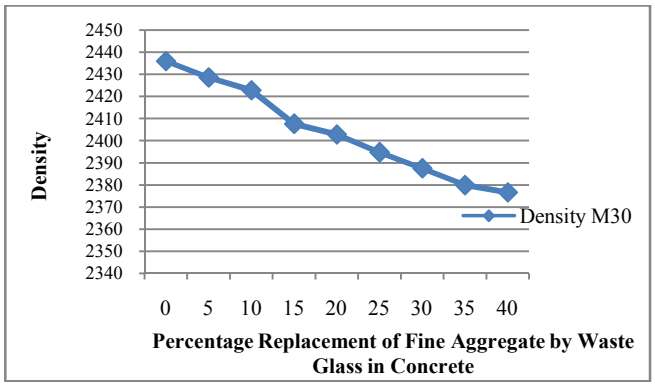

Figure I Effect of Waste Glass Material on Density (N/mm2)

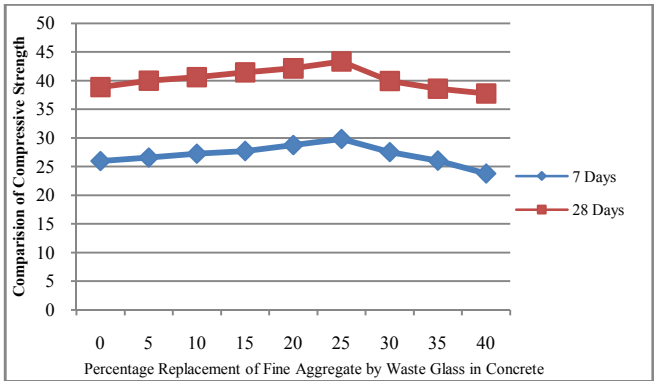

Figure II Effect of Waste Glass in Concrete for 7 days and 28 days compressive strength.

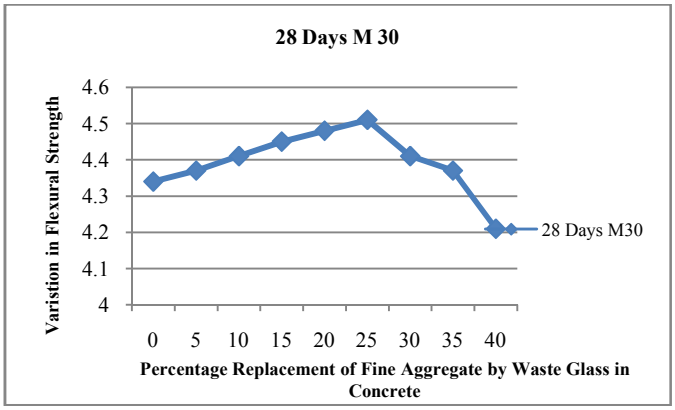

Figure III Effect of Waste Glass Material on Concrete of M 30 Flexural Strength of Beam

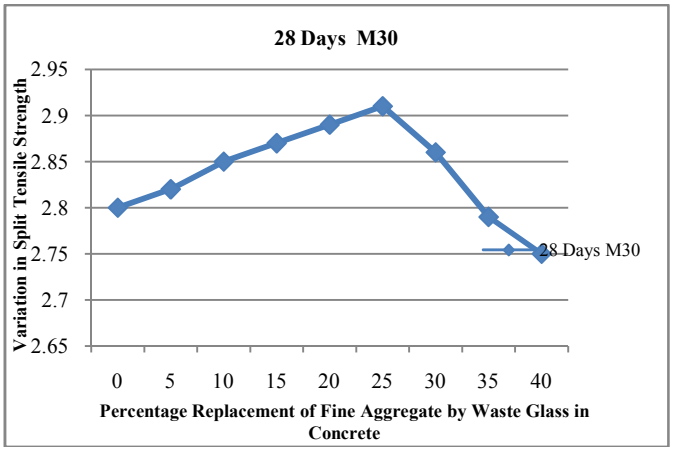

Figure IV Splitting Tensile Strength Of Cylinder.

Table I Results of Slump Tests

Mix (Percentage of Waste Glass)	Initial Height (mm)	Slump (mm)
0	300	100
5	300	103
10	300	105
15	300	107
20	300	107
25	300	105
30	300	100
35	300	95
40	300	90

Table II Density of Concrete

S. No.	Percentage of Waste Glass Material into Fine Aggregate	Density of Hardened Concrete (N/m^3)
1	0	23888.21
2	5	23815.84
3	10	23759.06
4	15	23610.39
5	20	23562.92
6	25	23483.98
7	30	23412.88
8	35	23338.15
9	40	23306.09

Photo I Flexural Strength Test of Beam Specimen

Photo II Waste glass crushed fine material

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