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CASTING OF PAVING BLOCK BY REPLACING FINE AGGREGATE WITH WASTE GLASS TO IMPROVE COMPRESSIVE STRENGTH

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ABSTRACT-Concrete paving blocks are ideal materials on the footpaths and roads for easy laying, better look and finish. In this paper, the issues of environmental and economic concern are addressed by the use of waste glass as partial replacement of fine aggregates in concrete. Fine aggregates were replaced by waste glass as 20%, 40%, 60% by weight for M-35 mix. The waste glass material used was obtained waste collectors. The study indicated that waste glass can effectively be used as fine aggregate replacement (up to 60%) without substantial change in strength. The concrete specimens were tested for compressive strength and water absorption at 7 ,14 and 28 days of age and the results obtained were compared with those of normal Paving block.

INDEX TERMS- Waste glass, compressive strength, water absorption test, fine aggregate, Paving block.

1. INTRODUCTION

Concrete paving blocks has been extensively used in many countries for quite some time as a specialized problem- solving technique for providing pavement in areas where conventional types of construction are less durable due to many operational and environmental constraints. Paving blocks have made a fast inroad into the construction industry, and have almost become the de-facto choice. Most construction firms nowadays prefer paving blocks over slabs, asphalt, stone or clay. Mass production of paving blocks has reduced their price, and made it easily affordable. With the advent of paving block machines, it has become even simpler to complete their laying. Concrete paver blocks were first introduced in Holland in the fifties as replacement of paver bricks which had become scarce due to the post-war building construction boom. These blocks were rectangular in shape and had more or less the same size as the bricks. During the past five decades, the block shape has steadily evolved from non-interlocking to partially interlocking to fully interlocking to multiply interlocking shapes.

In recent years there has been an increasing worldwide demand of concrete paving blocks for the footpaths, roads and airfields which has led to a local depletion of aggregates. In this research, fine aggregates were partially replaced by waste glass as 20%, 40%, and 60% by weight. Concrete specimens were tested for compressive strength, water absorption and light weight nature for different waste glass percentages. The results obtained were compared with results of normal M-35 concrete mix and it was found that maximum increase in compressive strength occurred for the concrete mix containing 40% waste glass as fine aggregate. With increase in waste glass content, water absorption decreased indicating increase in durability. Density of concrete decreased with increase in waste glass content thus making concrete light weight in nature.

II. SHAPES AND CLASSIFICATIONS

There are four generic shapes of paver blocks corresponding to the four types of blocks as below and figure 1 shows the different shapes of paving blocks: [10]

a) Type A: Paver blocks with plain vertical faces, which do not key into each other when paved in any pattern.
b) Type B: Paver blocks with alternating plain and curved/corrugated vertical faces, which key into each other along the curve/corrugated faces, when paved in any pattern.
c) Type C: Paver blocks having all faces curved or corrugated, which key into each other along all the vertical faces when paved in any pattern.
d) Type D: 'L' and 'X' shaped paver blocks which have all faces curved or corrugated and which key into each other along all the vertical faces when paved in any pattern.

Various advantages of paving block

- Capability of being moulded in different sizes, shapes, and colours.
- Good stability and durability, if properly manufactured and installed.
- Easy to produce ,Easy laying
- Good indoor climate (balanced humidity; cool) Various attractive patterns can be formed
- Equipment to produce tiles can be easily made by local workshop

Waste Glass in concrete offer several advantages:

- It is one of the most durable materials known because it has basically zero water absorption.
- The excellent hardness of glass may give the concrete improved abrasion resistance that can be reached only with few natural stone aggregates.
- Glass aggregates may enhance the flow properties of fresh concrete so that very high strengths can be obtained even without the use of admixture (plasticizer' s, superplasticisers etc.
- The aesthetic potential of colour-sorted, post-consumer glass has barely been explored at all and offers numerous novel applications for architectural purposes.
- Very finely ground glass has pozzolanic properties and therefore, can serve both as partial cement replacement and filler.

2. EXPERIMENTAL WORK

Materials used

The following materials were used in the experimental investigations described.

2.1 Cement- In this work, Ordinary Portland cement (OPC) of Birala (53 grade) brand obtained from a single batches was used. The cement satisfies the requirement of IS: 8112-1989. The specific gravity was 3.15 and fineness was 2800 cm2/g.

2.1 Aggregate –Aggregate are the important constituents in concrete. They give body to the concrete, reduce shrinkage and affect economy. Aggregate occupy is to assist in producing workability and uniformity in mixture.
2.2.1-**Fine aggregate (Sand)**- In this project we are using (Natural Sand) Fine aggregate. Sand is used to make mortar and concrete and for making moulds in foundries. Size of sand used which passing from 4.75mm. The specific gravity of sand used was 2.51. Specific gravity of sand is found out by the Pycnometer test.

2.2.Coarse Aggregates- Coarse aggregate are the crushed stone used for making concrete. Size of Coarse Aggregates used which passing from 11.98mm and passing through 10mm. The specific gravity of Coarse Aggregates used was 2.92. Specific gravity is found out by the Pycnometer test

2.3**Admixture**- Superplastisizers recommended by IS-9103

2.4 Glass-In this project the non-recyclable glass is used. Basically waste glass material that cannot be reused due to the high cost of manufacturing .It is crushed by using los angles abrasion testing machine up to 2.37 mm passing and 90 micron retaining glass taking for project work. The specific gravity of sand used was 2.85. Specific gravity of sand is found out by the Pycnometer test.

2.5 Water -The water used for mixing and curing of concrete should be free from harmful materials

3. EXPERIMENTAL INVESTIGATIONS

3.1 Mix Proportion -The concrete mix design was proposed by using IS 10262 [10]. The grade of concrete used was M-35 with water to cement ratio of 0.42.

3.2Compressive strength- A standard compression testing machine was used to determine the compressive strength of the specimens at constant a displacement rate of 50 mm/min according to BS EN 12390-3:2000. Figure 1,2,3 shows the average of the compressive strengths of paving block testing recorded for each testing

3.3. Water absorption test- The average dry weight of cube specimens after removing from moulds was measured and the average weight of cube specimens after submerging in water for curing was measured at 28 days of age. The percentage of water absorption was measured for each concrete specimen and it gave indirect measure of durability.

3.4. Light weight character- The average dry weight of concrete cube specimens containing 20%, 40% and 60% waste glass in place of fine aggregates was compared with average dry weight of normal M-35 concrete cube specimens and the percentage decrease in dry weight was measured.

3.5 Specific Gravity test-The specific gravity of a material is defined as the ratio of the mass of a unit volume of a material to the mass density of gas-free distilled water at a stated

temperature. The Pycnometer is used for determination of the specific gravity of soil particles of both fine grained and coarse grained soils.

4. RESULTS AND DISCUSSION

4.1 Mix Proportion - The concrete mix design was proposed by using IS 10262 [10]. This standard provides the: guide line s for proportioning concrete mixes as the requirements using the concrete making materials including ether Supplementary materials identified for th is purpose, The proportioning is carried out to achieve specific characteristics at specified age, work ability of fresh concrete and durability requirements The grade of concrete used was M-35 with water to cement ratio of 0.42. and their proportion is **1 : 1.74 : 3.30** the mixing proportion used in this project are shown in TABLE NO 1

4.2 Compressive strength- The compressive strength tests are presented in TABLE 2. Compressive strength tests were carried out at 7, 14 and 28 days. An increase in compressive strength was observed up to 40% replacement of fine aggregates with waste glass and there after decreasing. The maximum compressive strength measured was 29% more than that of normal paving block at 28 days corresponding to concrete mix containing 40% waste glass in place of fine aggregates. Compressive strength for concrete mix with 40% waste glass content was found to be less than that of normal paving block.

4.3. Water absorption Water absorption test was carried out for all mixtures and percentage water absorption was measured. The percentage water absorption decreased with increase in waste glass content. The lowest value of water absorption was found for concrete mix with 60% waste glass content. TABLE 3 depicts the percentage water absorption for all

4.4 Light weight character Average dry weight of cube specimens of each mixture as compared to reference mix was studied and it was observed that density decreased with increase in waste glass content. The results showed 6.25% reduction in dry weight of concrete cube specimens for concrete mix with 60% waste glass content as compared to reference mix. Thus, waste glass concrete is light weight in nature. TABLE 4 depicts the value of dry density and percentage change in dry weight with respect to reference mix. Waste glass place of fine aggregates was compared with average dry weight of normal M-35 concrete paver block specimens and the percentage decrease in dry weight was measured.

TABLE NO 1- Mixture Proportion

Waste glass%	w/c ratio	Water kg	Cement kg	Fine aggregate Kg	Waste glass kg	Coarse aggregate kg
0	0.42	0.438	0.740	1.287	00	2.438
20	0.42	0.438	0.740	1.03	0.260	2.438

40	0.42	0.438	0.740	0.767	0.520	2.438
60	0.42	0.438	0.740	0.521	0.770	2.438

TABLE NO 2- Compressive strength result

Waste glass%	Compressive strength of concrete paving block		
	7day	14day	28day
0	33.33	39.56	41.72
20	35.83	41.88	49.79
40	39.56	45.68	53.79
60	37.86	42.73	50.03

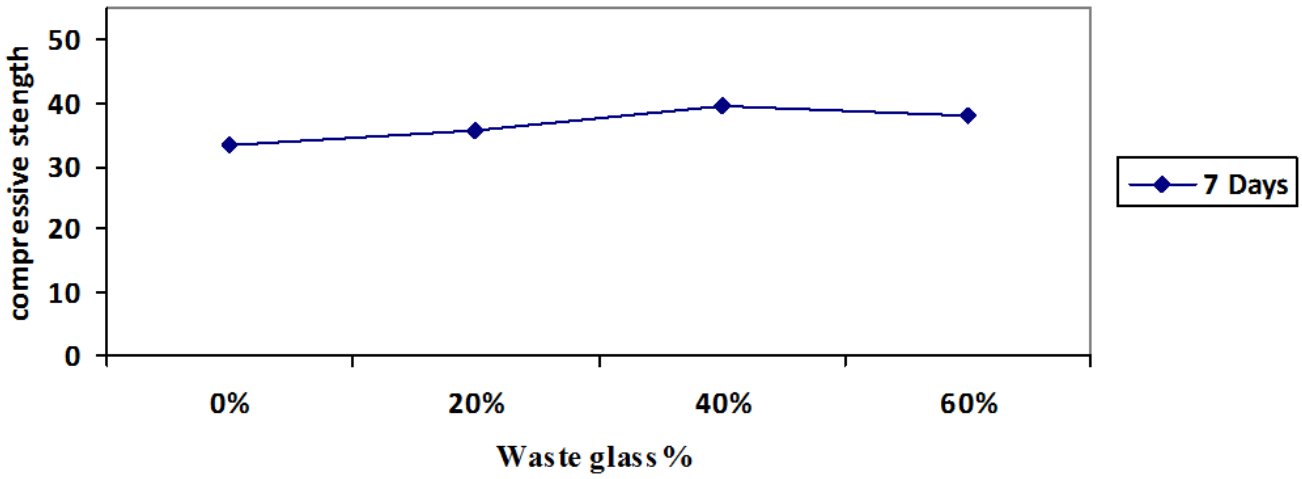

Fig.1 Compressive Strength of paving block at 7days

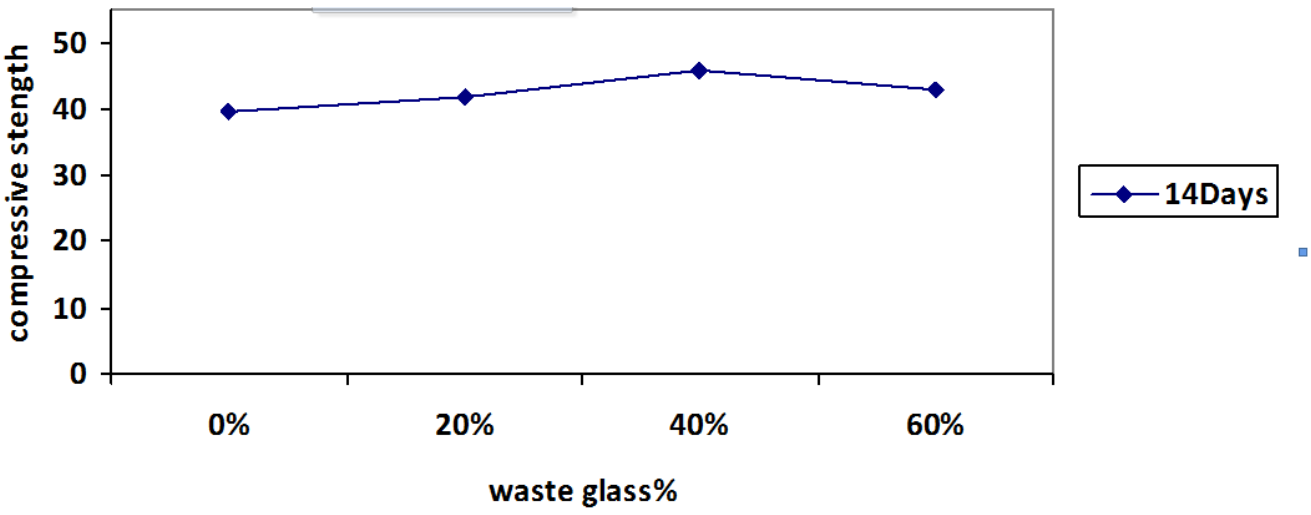

Fig.2 Compressive Strength of paving block at 14 days

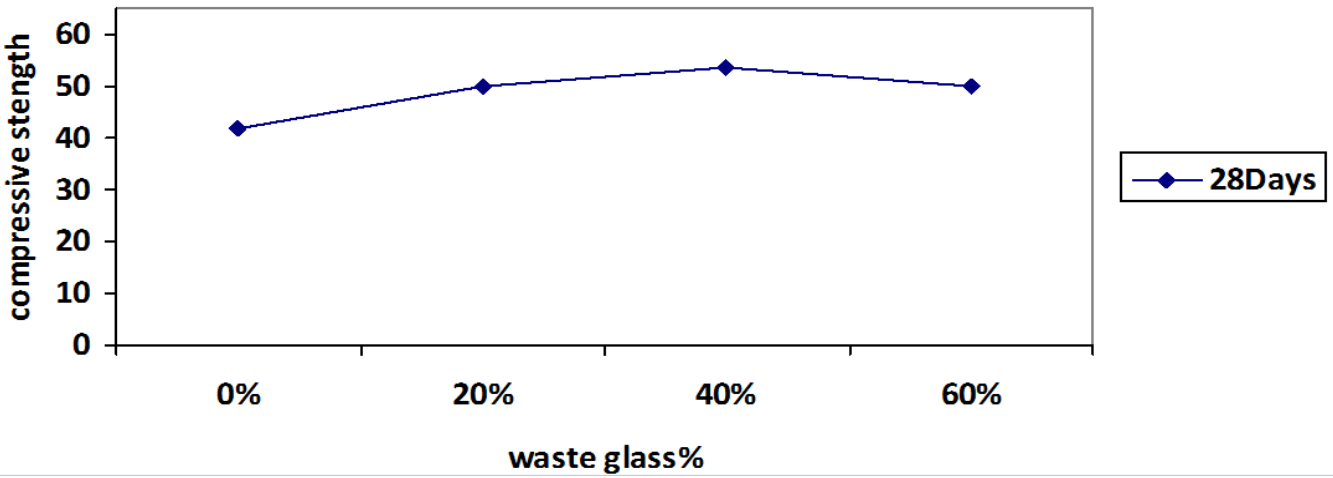

Fig.3 Compressive Strength of paving block at 28days

TABLE NO 3 -Water absorption test result for paving block (2440mm x 120mm x 60mm)

Waste glass contain	Average dry weight in oven	Average wet weight after 24 hours curing	Water absorbed (gm)	Percentage water absorption %
0	4360	4460	102	2.29
20	4304	4390	86	1.99
40	4153	4222	69	1.66
60	3954	4006	52	1.33

TABLE NO 4 -Light weight test result for paving block (2440mm x 120mm x 60mm)

Waste glass contain	Average dry weight of paving block	Percentage change in weight with normal paving block
0	4360	0
20	4304	1.301
40	4153	4.98
60	3954	10.25

5. CONCLUSION

The feasibility of concrete paver blocks with the Fine waste Glass was shown technically in the present study. Based on the experimental investigation with using of I.S. Code, the following conclusions are drawn-

- When increase the waste glass content then density of concrete is decreased thus making concrete light weight in nature.
- The use of waste glass in paver block decreases the unit weight of concrete.
- 20% replacement of fine aggregates by waste glass showed 8% increase in compressive strength at 7 days and 20% increase in compressive strength at 28 days.
- 40% replacement of fine aggregates by waste glass showed 19% increase in compressive strength at 7 days and 29% increase in compressive strength at 28 days.
- With increase in waste glass content, average weight decreases by 6.25% for mixture with 60% waste glass content thus making waste glass concrete light weight.
- Water absorption is less by adding waste glass as fine aggregate as compare with normal block
- Compressive strength increases with increasing the glass percentage from 20% to 40% replacement of glass and after 60% waste glass replacement onwards the strength is decreases. Strength reduce because of internal voids of waste glass increases.
- Use of waste glass in concrete will secured natural resources particularly river sand.
- Use of waste glass as fine aggregate will completely destroy the disposal problem of waste glass & prove to be eco-friendly
- Workability of concrete is increases with addition of waste glass content.
- Cost of paving blocks is decreases with increase in glass content as fine aggregate.

6. REFRENCE

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