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Combine effect of rice husk ash and silica fume with glass powder on concrete production by cement replacement

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ABSTRACT

Concrete is major civil engineering construction material because the ingredients of concrete are locally available materials. In ordinary concrete, the cement is used as the major binding material. The usage of cement in concrete causes a lot of environmental pollution due to the emission of greenhouse gases. So that it is necessary to reduce usage of cement by introducing new supplementary cementitious materials which are the by-products of industries to reduce debris. The rice husk ash is one of the by-products which is released from paddy. The usage of rice husk ash in concrete leads to the development of high strength concrete and also reduces the self-weight of the structure. In this study, partial replacement (by weight) of cement with RHA and silica fume with glass powder in paver blocks is used for determining the change in the compressive strength, water absorption of paver blocks. Partial replacement of cement in different percentage as like 10%, 20%, 30% and 40 % has been done. The compressive strength has been determined at the end of 7, 14 and 28 days, water absorption test has been determined at 28 days.

Keywords: *Compressive strength, Concrete, Ordinary Portland cement, Silica fume, Glass powder, Rice Husk Ash (RHA)*

1. GENERAL

Pavers are the modern day solution for less cost outdoor application. Paver block is used in various places like in street road and other construction places. Interlocking concrete Pavement has been largely used in a number of countries for quite something 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. Concrete block pavements have become an attractive engineering and economical alternative to both flexible and rigid pavements. The strength, durability and pleasing surfaces have made paver blocks attractive for many commercial, municipal and industrial places such as parking areas, pedestrian walks, traffic intersections, container yards and roads. Interlocking paver blocks are installed over a compacted stone sub-base and leveling bed of sand. Concrete paver blocks are made with concrete basically consisting of cement, fine aggregates, coarse aggregates (10 mm and below), water, chemical agents etc.

2. WASTE MATERIALS

Definition of waste: "Wastes materials are substance or objects, which are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of national law"

Solid waste is the unwanted or useless solid materials generated from combined residential, industrial and commercial activities in a given area. It may be categorized according to its origin (domestic, industrial, commercial, construction or institutional); according to its contents (organic material, glass, metal, plastic paper etc. or according to hazard potential (toxic, non-toxic, flammable, radioactive, infections etc.

Waste is any substance which is discarded after primary use, or it is worthless, defective and of no use. If a large number of waste materials generated were used instead of natural materials in the construction industry there would be three benefits:

- Conserving natural resources
- Disposing of waste materials (which are often unsightly)
- Freeing up valuable land for other uses

3. MATERIALS USED

3.1 CEMENT

Ordinary Portland Cement (OPC) of 43 Grade is used for this experimental work. The cement was available in the local market of Bhopal and kept in a dry location.

Fig. 1: Cement

3.2 Coarse aggregate

Coarse aggregate is those, retained on the No. 4 (4.75 mm) sieve. Sieve analysis helps to find out the size of aggregate and to determine the particle size distribution of coarse aggregates. The aggregates were tested as per IS: 383-1970.

Fig. 2: Coarse Aggregate

3.3 Fine aggregate

Fine aggregate (sand) are those that pass through No.4 (4.75 mm) sieve and are retained on the No. 200 (75 µm) sieve. The fine aggregates were tested as per IS: 383-1970. Washed sand from local crusher was used.

Fig. 3: Fine aggregate

3.4 Silica fume

Silica Fume is available in dry powder form and procured from Nakoda Enterprises, Indore. It is usually grey color powder; Silica fume under the product name ―Grade 92 D is available in 25kg bags. Silica Fume used was confirming to ASTM C (1240-2000). Silica Fume is used as partial replacement of cement.

Fig. 4: Silica Fume

3.5 Water

Clean potable water is used for mixing concrete. Tap water was used in this experiment. The properties are assumed to be same as that of normal water. Specific gravity is taken as 1.00.

3.6 Glass powder

Waste glass locally available and it has been collected and made into glass powder. Before adding glass powder in the concrete it has to be powdered to the required size. In this experiments, glass powder (GLP) having a particle size of fewer than 90 microns was used.

Fig. 5: Glass powder

3.7 Rice husk ash

Rice Husk Ash is a Pozzolanic material. It is having different physical & chemical properties. In this experimental work, rice husk ash is collected from Lavya Industries Pvt. Ltd, Bhopal,

Fig. 6: RHA

3.8 Preparation of material for development of test specimen

The test performed for testing the compressive strength and flexural strength of paver block using RHA, silica fume and glass powder. Various paver blocks of I-shape are made with a variable percentage of RHA, silica fume and glass powder by weight of cement, tested and then analyzed for finding the effect of RHA with silica fume and glass powder. Fifteen concrete paver blocks specimens for the test are made for each M40 mix.

3.8.1 Casting of paver blocks

1) The molds are used for making of concrete paver block as per IS: 15658-2006 methods of tests for strength of concrete.
2) Paver block of I- shape mold of 17 ×16 ×6 cm size.
3) Firstly decide the number of samples to be taken during concreting.
4) Before casting of materials shuttering oils should be used inside the mold properly.
5) Collect the all material in the pan before the mixing properly.
6) Mix the all material in the pan
7) Vibrating table is used for compacting the concrete mix in the molds of desired sizes and shapes.

3.8.2 Curing process of paver blocks

Curing is the process by which the concrete is protected against moisture loss and remains within a reasonable temperature range. This process results in concrete with increased strength and reduced permeability. After curing, the blocks are dried in natural atmosphere and sent for use. The concrete paving blocks gain good strength during the first 3 days of curing and maximum gains in strengths are secured in the first 10 to 15 days of curing.

Fig. 7: Specimen ready for test after curing

4. TESTS CONDUCTED

4.1 Workability test

Workability is the property of freshly mixed concrete that determines the ease with which it can be properly mixed, placed, consolidated and finished without segregation. The workability of fresh concrete was measured by means of the conventional slump test as per IS; 1199(1989). Before the fresh concrete was cast into molds, the slump value of the fresh concrete was measured using slump cone.

Fig. 8: Workability test conducted in the lab

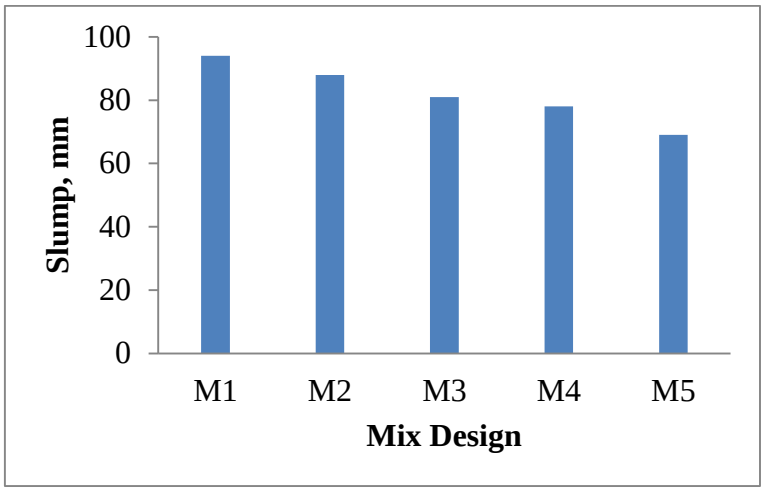

Fig. 9: Slump value for different mix

4.2 Water absorption test

One of the most important properties of good quality concrete is low permeability, especially one that is resistant to freezing and thawing. A concrete with a low permeability is resistant to water ingress and is not so susceptible to freezing and thawing. Water comes in the cement paste and even in the aggregate in pores. For concrete pavers, the test procedure involves drying a sample to a constant weight, weighing it, immersing it in water for a specified period of time and recalculating. The increase in weight as a percentage of the original weight is expressed as the absorption (in percent).

Formula used is Water absorption = [(A – B)/B] x 100%.

Where the A= weight of saturated surface dried sample in gms

B=weight of oven dried sample in gms.

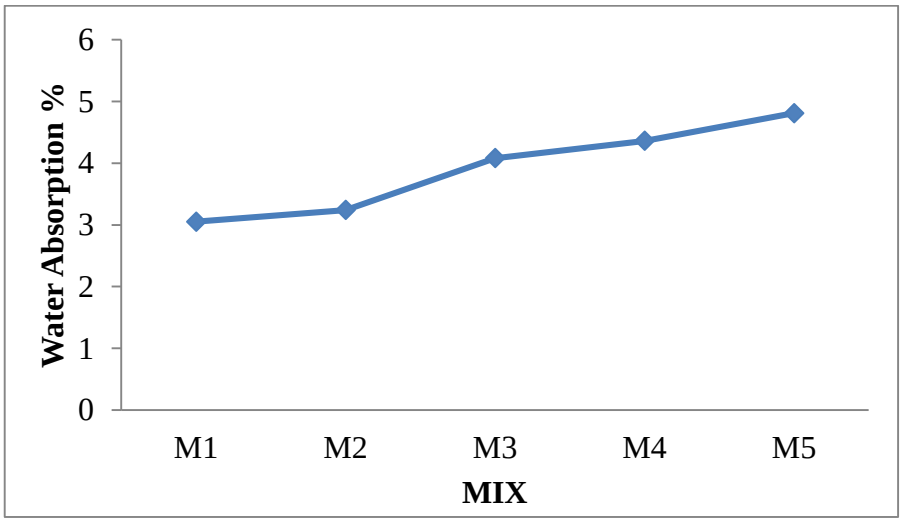

Fig. 10: Water absorption for different samples

4.3 Compressive strength test

The compressive strength test was carried out conforming to IS 15658:2006 to obtain compressive strength for paver blocks for M33, M43 and M53 grade of concrete. Compression testing machine was used for the testing of paving blocks.

Fig. 11: Compressive strength test

The compressive strength is taken as maximum compressive load resisted by per unit area. The failure load was noted. In each category, cubes were tested and their value is reported. The compressive strength was calculated as follows,
Compressive strength (MPa) = Failure load / cross-sectional area.

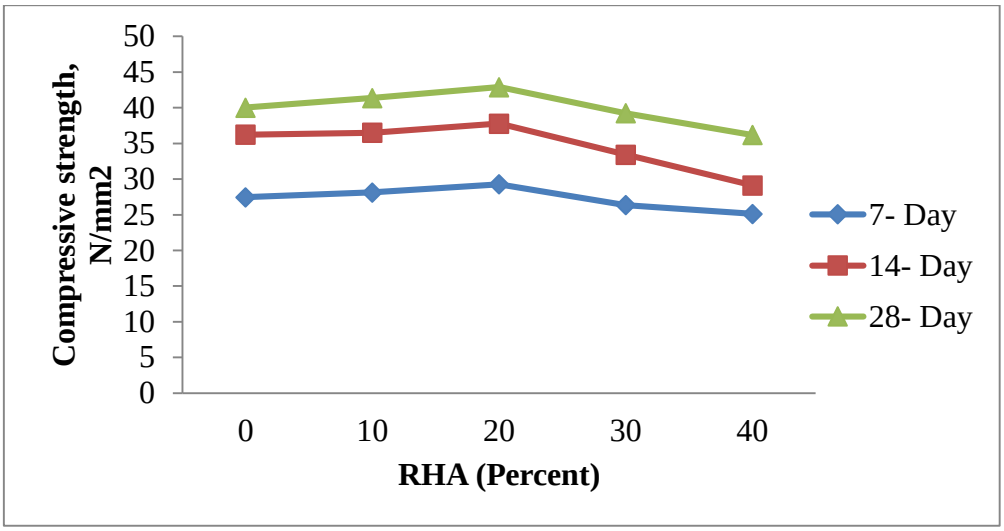

Fig. 12: Compressive Strength versus RHA Percentage

4.4 FLEXURAL STRENGTH TEST

Flexural strength test was conducted on specimens under two-point loading as per IS 15658:2006. The average ultimate flexural tensile stress was determined from the failure flexural loads. For flexural strength test beam specimens of were cast. The samples were tested after 28 days of curing. The load is normally increased and the failure load is noted when the sample is cracked.

Fig. 13: Flexural strength test

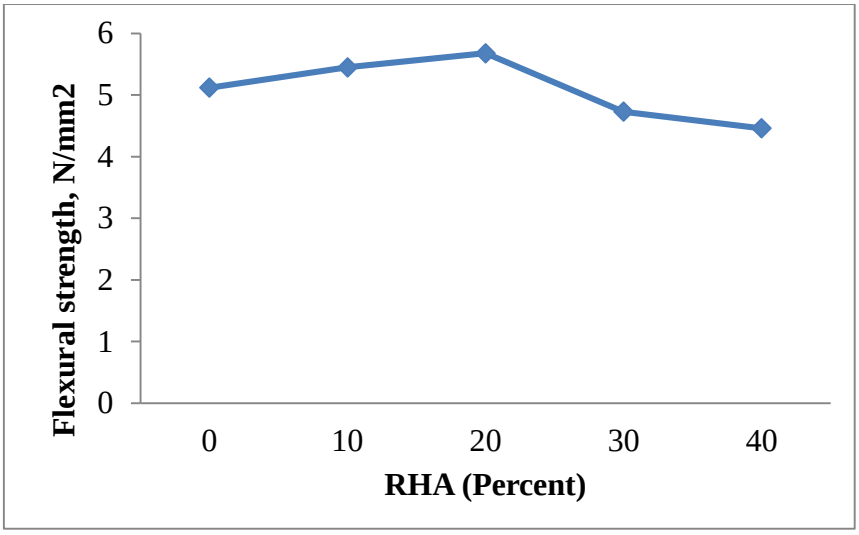

Fig. 14: Flexural Strength versus RHA Percentage

5. CONCLUSION

This research was completed with the aim to determine the possibility of using RHA with silica fume and glass powder to replace cement in concrete. To achieve this scope, intensive research was needed into the main components of this thesis and into the effects on the mechanical properties of concrete as a result of the incorporation of RHA with silica fumes and glass powder into a concrete mix. As part of the research, concrete mixes with different contents of RHA with silica fume and glass powder were replaced by cement and poured into concrete pavement blocks and then cured in water. A compression test and flexural test was carried out to test the compressive strength and flexural strength of the concrete mixes immediately after the mixing of the ingredients was completed.

Experimental results show the following outcomes:

1. In this compressive Strength analysis of Paver Block with 0%, 10%, 20%, 30% and 40% RHA with silica fume and glass powder are tested and the graph showed that at 20% RHA with silica fume and glass powder is partially replaced by cement give higher strength as compared to conventional mix.
2. Also, the graph illustrates that compressive strength at 7, 14 and 28 days increase with the inclusion of RHA till 20 % inclusion and later it decreases. There was an increase of 7.17 % in compressive strength at 20 % RHA inclusion compared to normal paver block at 28 days. At 20% of RHA maximum compressive strength of paver block at 7, 41 and 28 days are 29.27, 37.78 and 42.89 N/mm^2.
3. The Flexural Strength of concrete is tested at the interval of 28 days and it seems that Flexural Strength goes on decreasing with the increase in RHA as a cementitious material. At 20 % RHA in sample shows the high flexural strength of concrete mix at 28 days i.e. 5.68 N/mm^2.
4. From the test results, it can be seen that the water absorption values for all the specimens of mix ratios were lower than 7% as per IS: 15658-2006 specifications. It was also found that for specimens without RHA with silica fume and glass powder, the water absorption values are comparatively lower as compared to that of specimens containing no admixtures.
5. The result shows that as the RHA with silica fume and glass powder content increases (i.e. cement content decreased) workability decreases. Because there is a decrease in fineness modulus of the cementitious material, quantity of cement paste available is less for providing lubricating effect per unit surface area of aggregate. Therefore, there is a confine on the mobility.

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