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Evaluation of Strength Properties of Mortar Containing Waste Glass

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Abstract: ***In order to make concrete industry sustainable, the use of waste glass in place of natural resources is one of the best alternatives. To solve the environmental problems caused by industrial waste, other materials are being used in the manufacturing of concrete. Utilization of waste glass in concrete production not only provides significant environmental benefits but also enhance performance of concrete when used in optimum amounts. Mortar is a masonry product which is matrix of concrete. It consists of binder and fine aggregates. It is an essential associate in any reinforced structural construction. The strength of mortar is a special concern to the engineer because mortar is responsible to give protection in the outer part of the structure as well as at a bricks joint in masonry wall system. In this paper, investigation was conducted to study the viability of using waste glass as an alternative material applied as partial replacement of fine aggregates in manufacturing of fresh mortar. Fine aggregates were replaced by waste glass aggregates as 10%, 15%, 20%, and 25% by weight of mortar. The proportion used for mortar mix is 1:3. The mortar specimen was casted. The compressive strength test was conducted at 7 days, 14 days and 28 days and the results obtained is compared with control blocks mortar cubes.***
Keywords: mortar, cement, sand, compressive strength, and waste glass replacement.

I. INTRODUCTION

In developing countries such as India, where the rapid urbanization are vigorously embarked upon to improve the standard of living, the major problem is environmental pollution by the increasing generation of domestic and industrial waste. Disposal of wastes has become a major problem in metropolitan areas in India, especially the disposal of waste glass generated from domestic and industry in the country. Quantities of waste glass have been on the rise in recent years due to an increase in industrialization and the rapid improvement in the standard of living. For these reasons, this study has been conducted through basic experimental research in order to analyze the possibilities of crushed waste glass as fine aggregates in mortar. If the large amount of waste materials generated is used instead of natural materials in the construction industry, there would be three benefits: conserving natural resources, disposing of waste materials and freeing up valuable land for uses others uses [Bhandari P, S. et AL 2014]. Glass is a common product that founds in different form of bottles, jars, windows, windshields and bulbs etc. therefore, the civil engineers have been challenged to convert this waste glass to useful building and other construction materials.

II. MATERIALS

The following materials were used in the experimental work are cement (PPC), sand, water, waste glass.

A. Sand

Naturally sand which passing passes through 4.75 mm sieves is used.

B. Waste Glass

The broken window glass was used as waste which has supplied from windows glass market. The size of the fine waste glass is 0 to 1.18 mm is used.

1) Source of waste glass

Glass food and beverages container
Window repair shops
Glass decorative items
Old decorative items
Glass polishing and glass window and door manufacturing shop

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2) Properties of glass

Glass is a uniform amorphous (non-crystalline) solid material.
The most familiar form of glass is the silica-based material
Glass falls in the category of biologically inactive material that can be formed with very smooth and impervious surfaces

C. Cement

Portland Pozzolana Cement (Ultratech) Fly ash based conforming to IS: 1489-1991 (Part. 1). The physical properties of cement were obtained by conducting appropriate test. Fineness-2% retaining on 90 micron sieves.

Table

Ingredient	Percentage (%)	Range
Lime (CaO)	62	62-67
Silica	22	17-25
Alumina	5	3-8
Calcium Sulphate	4	3-4
Iron Oxide	3	3-4
Magnesium (MgO)	2	0.1-3

D. Water

Fresh water available in institute laboratory was used.

III. EXPERIMENTAL WORK

In this research, mortar mix 1:3 according to the IS 2250:1981 of masonry mortar was used. Total 45 cube specimens of 1:3 mortar mix with five different volume percentages cubes(0%, 10%, 15%, 20% and 25%) were casted. The control mixtures contained the same materials mix ratio, with 0% replacement. In this remaining four, mortar mixtures, sand was replacement as 10%, 15%, 20% and 25% by waste glass respectively, and the water-cement ratio remaining constant. The fresh mixes were fed into the steel moulds with internal dimensions of 7x7x7cm. The steel moulds were filled with material to about half height and the layer compacted by tamping it with the tamping rod in a uniform manner over the mortar surface in such a way to produce full compaction of the mortar with neither segregation nor excessive laitance. The moulds were then be completely filled and the upper layer of the mortar compacted in a similar manner, after which the mould were kept on the vibrating table. Then, the surface of the mortar struck off plane and leveled the top of the mould using a trowel. The specimen was marked for later identifications. Mortar cube then removed from the mould after 24 hrs and stored in clean water until the time of test. The temperature of the storage water was 27 ± 2°C. The specimen was tested at an interval 7, 14 and 28 days.

IV. RESULTS AND DISCUSSION

In this research, the effect of mortar with partial replacement of waste glass was studied. The results of the experimental study are shown in fig. the compressive strength shown on at 7 days, 14 days and 28 days, this study concluded that the compressive strength of mortar is increased when waste glass is replaced by fine aggregates and maximum strength at 15% and then strength get decreased. The results at 7 days, 14 days and 28 days compressive strength are as shown below.

A. Compressive strength of mortar cube at 7 days

Table 1 Compressive strength on 7 days

.

MIX PROPORTION	STRENGTH(N/mm^2)
0%	14.98
10%	15.14
15%	18.04
20%	14.97
25%	13.96

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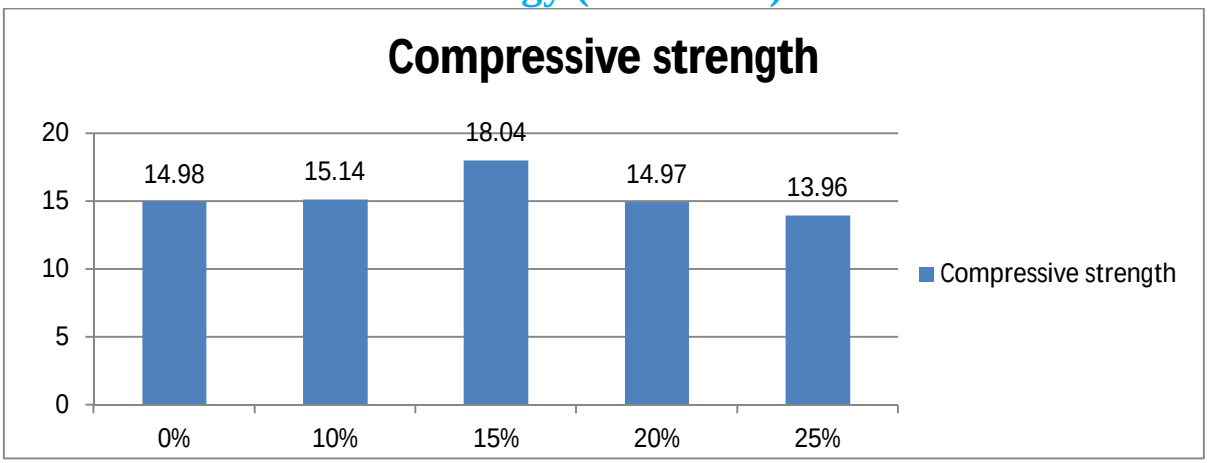
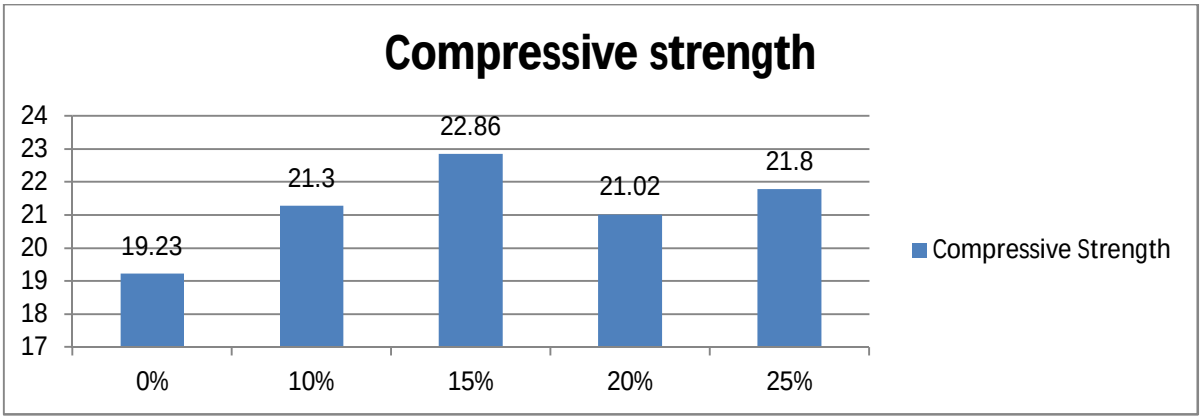


Graph 1 Variation in compressive strength of cement mortar at 7 days

B. Compressive strength of mortar cube at 14 day

Table 2 compressive strength on 14 days

MIX PROPORTION	STRENGTH (N/mm^2)
0%	19.23
10%	21.30
15%	22.86
20%	21.02
25%	21.80



Graph 2 Variation in compressive strength on cement mortar at 14 days

C. Compressive strength of mortar cube at 28 days.

Table3 compressive strength on 28 days.

MIX PROPORTION	STRENGTH(N/mm^2)
0%	19.72
10%	22.71
15%	24.48
20%	23.12
25%	22.08

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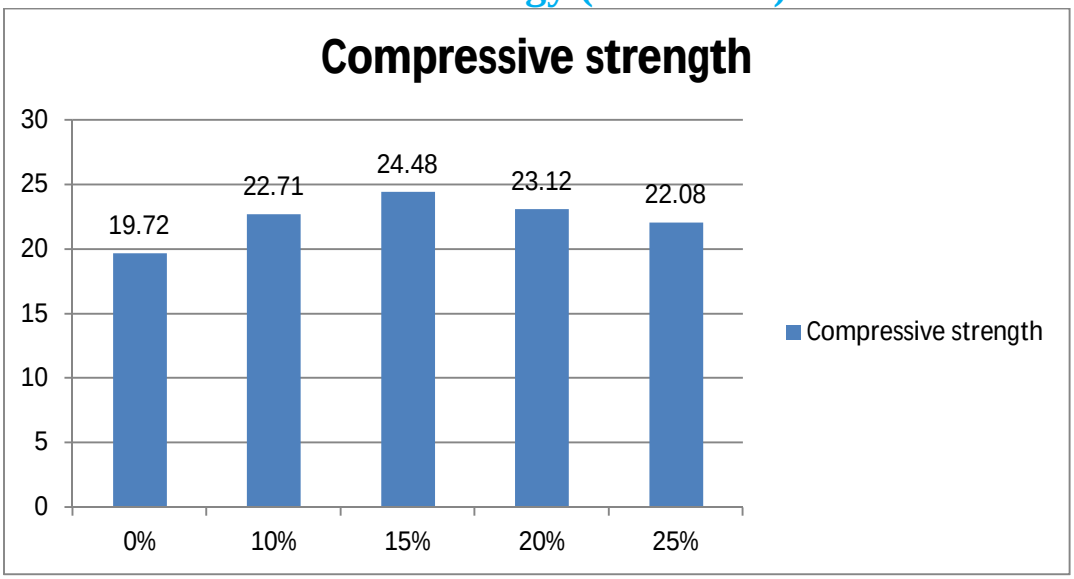

Graph 3 variations in compressive strength on cement mortar at days

V. CONCLUSION

A. According to the analysis of the whole study on the comparison between Control mortar and modified mortar.

B. On the addition of waste as fine aggregates, the rate of gain of strength is low at early age but it meet nearly required design strength at 28 days.

C. The strength of modified mortar containing 15% waste glass is higher than control mortar.

D. Addition of 20% and 25% waste glass decreases the strength of mortar.

E. Waste glass is quite appropriate to be selected as the substitution of fine aggregates.

F. Waste glass has a potential to provide alternative to the fine aggregates minimizing waste product. Thus waste glass can be used as a functional construction material.

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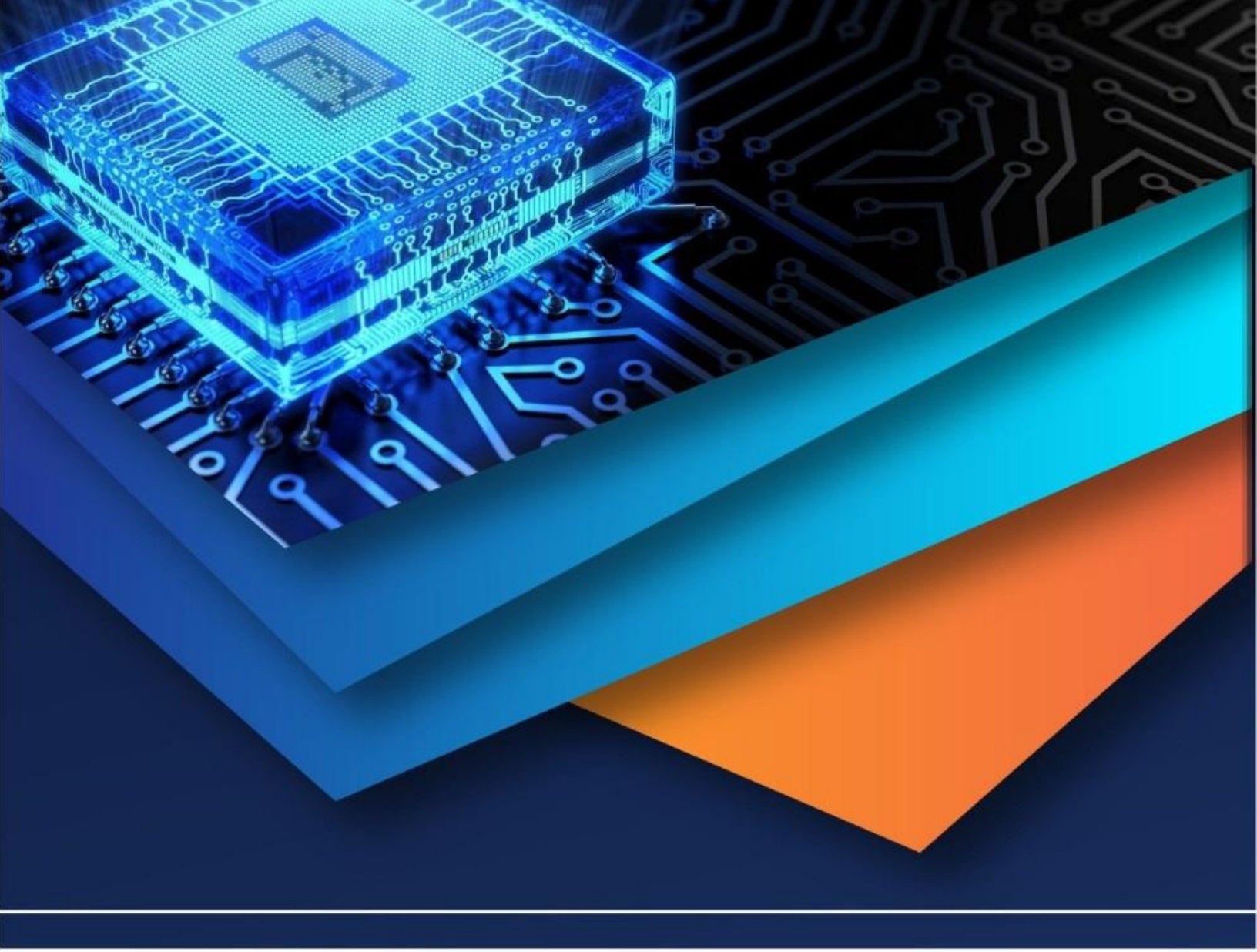

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