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# Experimental Studies on High Performance Concrete by Waste Glass and Marble Powder

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***Abstract: Glass is used in many forms in day-to-day life. It has limited life span and after use it is either stock piled or sent to landfills. Since glass is non-biodegradable, landfills do not provide an environment friendly solution. Hence, there is strong need to utilize glass wastes. Many efforts have been made to use glass waste in concrete industry as a replacement of coarse aggregate, fine aggregate and cement. The aim of the present work was to use glass powder as a replacement of cement to assess the strength characteristics of fine glass powder in concrete and compare its performance with normal conventional concrete. A series of tests were conducted to study the effect of 10%, 20%, 30%, 40% & 50% replacement of cement by waste glass powder on compressive strength and flexural strength. Another aim of our present study is to replace the fine aggregate with marble powder. A series of tests were conducted to study the effect of 10%, 20%, 30%, 40% & 50% replacement of fine aggregate by marble powder along with the above mentioned replacement of cement with glass powder. Results showed that replacement of both the materials gave the desired strength. The various comparison of test results were illustrated graphically.***

***Key words: High Performance Concrete, Glass Waste, Marble Powder, Viscosity Modifying Admixture***.

## I. INTRODUCTION

HIGH performance concrete is a concrete mixture, which possess high durability and high strength when compared to conventional concrete. This concrete contains one or more of cementitious materials such as fly ash, Silica fume or ground granulated blast furnace slag and usually a super plasticizer. The term ‘high performance’ is somewhat pretentious because the essential feature of this concrete is that it’s ingredients and proportions are specifically chosen so as to have particularly appropriate properties for the expected use of the structure such as high strength and low permeability. Hence High performance concrete is not a special type of concrete. It comprises of the same materials as that of the conventional cement concrete.A glass is defined as an inorganic product of fusion which has been cooled to a rigid condition without crystallization. According to this definition, a glass is a non-crystalline material obtained by melt quenching process.In 2005, approximately 12.8 million tons of waste glass was generated in the United States, and only about 20% of it was recycled. Due to dwindling landfills and increasing cost of land-filling, recycling and reusing glass has become imperative.During the last decades it has been recognized that Sheet Glass waste is of large volume and is increasing year by year in the Shops, construction areas and factories. Using waste glass in the concrete construction sector is advantageous, as the production cost of concrete will go down. Waste glasses are used to replace with cement for concrete. In Tamil Nadu, there is a place called Chidambaram where most of the colored sheet glasses from windows are packed as a waste and sent to landfill. The plain sheet glasses can be recycled, but it is costly to remove the color of colored glasses and recycle again. Estimated cost for housing is more and some construction materials like natural sand are also becoming rare.Glass is cheaper to store than to recycle, as conditioners require expenses for the recycling process. There are several alternatives for the reuse of composite-glass. According to previous studies, all these applications, which require pre-conditioning and crushing, are more or less limited and unable to absorb all the quantities of waste glass available. In order to provide a sustainable solution to glass storage, a potential and incentive way would be to reuse this type of glass in concretes.Depending on the size of the glass particles used in concrete, two antagonistic behaviors can be observed: alkali silica reaction, which involves negative effects, and pozzolanic reaction, improving the properties of concrete.Marble as a building material especially in palaces and monuments has been in use for ages. However the use is limited as stone bricks in wall or arches or as lining slabs in walls, roofs or floors, leaving its wastage at quarry or at the sizing industry generally unattended for use in the building industry itself as filler or plasticizer in mortar or concrete. The result is that the mass which is 40% of total marble quarried has reached as high as millions of tonnes.

This huge unattended mass of marble waste consisting of very fine particles is today one of the environmental problems around the world. One of the logical means for reduction of the waste marble masses calls for utilizing them in building industry itself. Some attempts have been made to find and assess the possibilities of using waste marble powder in mortars and concretes and results about strength and workability were compared with control samples of conventional cement-sand mortar/concrete.

## II. MATERIAL USED

Following are the materials used for the present investigation of using waste glass powder and marble powder in concrete.

### *A. Cement*

The cement used for this study is ordinary Portland cement (OPC) of 53-grade "Penna Brand"

### *B. Sand*

The sand is of river sand screened and washed to remove all the organic and inorganic compounds that are likely to present in it. Sand has been sieve in 4.75mm (passed)

### *C. Glass powder*

The glass powder is of white color. The size of particles is same as that of cement. The chemical properties of glass powder are as follows.

Fig. 1 Glass Powder

| COMPOSITION | PERCENTAGE |
|---|---|
| SiO2 | 72.20 |
| Al2O3 | 1.54 |
| Fe2O3 | 0.48 |
| CaO | 11.42 |
| MgO | 0.79 |
| $Na_2O$ | 12.85 |
| $K_2O$ | 0.43 |
| $SO_3$ | 0.09 |
| Fineness % passing 45 micron | 80 |
| Density ($kg/m^3$) | 2480 |

Table 1 Chemical properties of Glass Powder

*D. Marble Powder*

Marble powder was collected from the dressing and processing unit. It is of Greyish color.

Fig. 2 Marble Powder

| OXIDE COMPOUNDS | MARBLE DUST (MASS %) |
|---|---|
| SiO2 | 28.35 |
| $Al_2O_3$ | 0.42 |
| Fe2O3 | 9.70 |
| CaO | 40.45 |
| MgO | 16.25 |
| Density,(g/cm$^3$) | 2.80 |

Table 2 Chemical Properties of Marble Powder

*E. Viscosity Modifying Admixture*

GLENIUM-II is a High range water reducer which is also used as a VMA. This makes the water content as gel and resists the corrosion

in the concrete. Normally the dosage is limited to 1.1% by weight of cement used.


Fig. 3 Viscosity Modifying Admixture

## III. MATERIAL TEST REPORT

*A. Cement*

Fineness of cement = 4%

Specific gravity of cement = 3.1

Initial setting time = 95min Final setting time = 540min

*1) Fine Aggregate*

Specific gravity = 2.4

Fineness modulus = 2.34 Water absorption = 17%

*2) Coarse Aggregate*

Specific gravity =2.7

Crushing value = 48.84%

Impact value = 17.9%

Water absorption = 0.5%

*3) Glass Powder*

Specific gravity = 2.66 E) Marble Powder

Specific gravity = 2.75

The following table shows the trial mixes for analysis.

| Mix | Cement | GP | FA | MP | CA |
|---|---|---|---|---|---|
| C | 1 | - | 0.97 | - | 1.5 |
| M1 | 0.9 | 0.1 | 0.87 | 0.1 | 1.5 |
| M2 | 0.9 | 0.1 | 0.77 | 0.2 | 1.5 |
| M3 | 0.9 | 0.1 | 0.67 | 0.3 | 1.5 |
| M4 | 0.9 | 0.1 | 0.57 | 0.4 | 1.5 |
| M5 | 0.9 | 0.1 | 0.47 | 0.5 | 1.5 |
| M6 | 0.8 | 0.2 | 0.87 | 0.1 | 1.5 |
| M7 | 0.8 | 0.2 | 0.77 | 0.2 | 1.5 |
| M8 | 0.8 | 0.2 | 0.67 | 0.3 | 1.5 |
| M9 | 0.8 | 0.2 | 0.57 | 0.4 | 1.5 |
| M10 | 0.8 | 0.2 | 0.47 | 0.5 | 1.5 |
| M11 | 0.7 | 0.3 | 0.87 | 0.1 | 1.5 |
| M12 | 0.7 | 0.3 | 0.77 | 0.2 | 1.5 |
| M13 | 0.7 | 0.3 | 0.67 | 0.3 | 1.5 |
| M14 | 0.7 | 0.3 | 0.57 | 0.4 | 1.5 |
| M15 | 0.7 | 0.3 | 0.47 | 0.5 | 1.5 |

| | | | | | |
|---|---|---|---|---|---|
| M16 | 0.6 | 0.4 | 0.87 | 0.1 | 1.5 |
| M17 | 0.6 | 0.4 | 0.77 | 0.2 | 1.5 |
| M18 | 0.6 | 0.4 | 0.67 | 0.3 | 1.5 |
| M19 | 0.6 | 0.4 | 0.57 | 0.4 | 1.5 |
| M20 | 0.6 | 0.4 | 0.47 | 0.5 | 1.5 |
| M21 | 0.5 | 0.5 | 0.87 | 0.1 | 1.5 |
| M22 | 0.5 | 0.5 | 0.77 | 0.2 | 1.5 |
| M23 | 0.5 | 0.5 | 0.67 | 0.3 | 1.5 |
| M24 | 0.5 | 0.5 | 0.57 | 0.4 | 1.5 |
| M25 | 0.5 | 0.5 | 0.47 | 0.5 | 1.5 |

Table 3 Trial Mixes

## IV. RESULTS AND DISCUSSIONS

The experimental investigations carried out in the laboratory to determine the strength properties of the high performance concrete with the additional mixture of waste glass powder and marble powder were discussed.

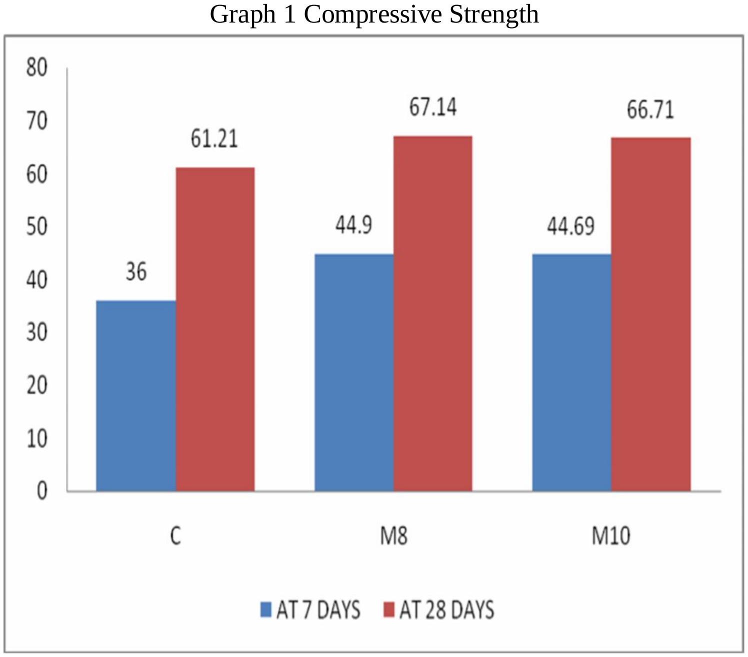
Hardened Concrete Properties

### A. *Compressive strength*

The tested compressive strength for various mixes at the age of 7, 28 days are given in the graph.

1) As far as the compressive strength results are concerned, it is clear that all the mixes that uses glass powder and as well as the marble powder showed higher compressive strength when compared to the control concrete, and it is quite inevitable that one or two mixes showed relatively less strength when compared to the control concrete.
2) In all the 25 different mixes, two best mixes (M8 & M10) are selected and those mixes are casted again for further analysis. They are subjected to split tensile strength and flexural strength analysis

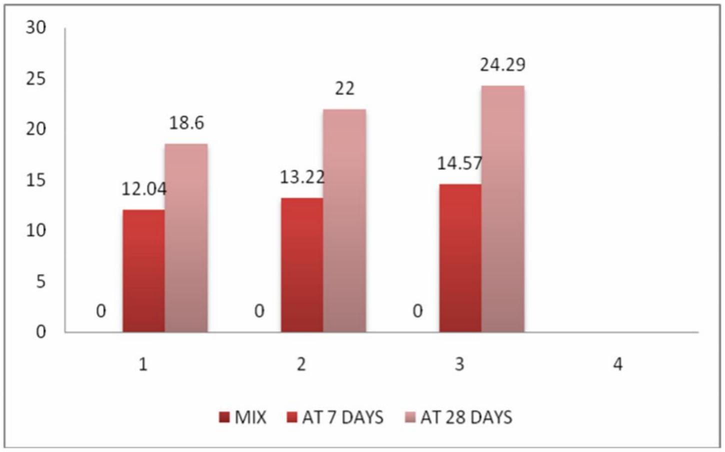
Graph 1 Compressive Strength




### B. *Splitting tensile strength*

For control concrete one cylinder is cast. The best mix is selected from the compression tests and using the corresponding mix ratio 12.

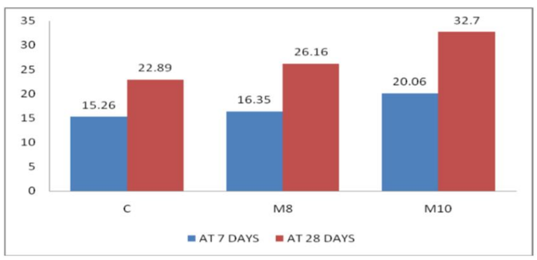
Graph 2 Splitting Tensile Strength



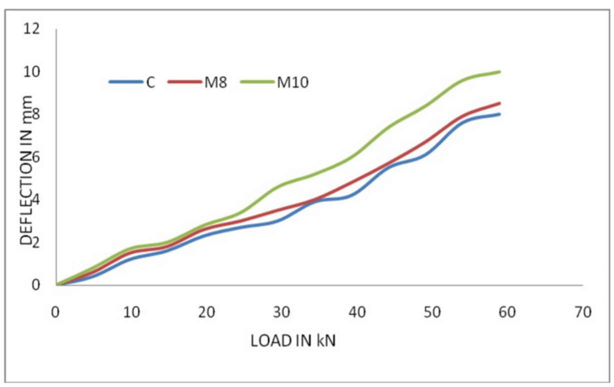

### *C. Flexural strength*

For testing the flexural strength of the selected mix, six beams of size 150x150x750mm are cast.

Graph 3 Flexural Strength of Concrete




Graph 4 Deflection of beam




The M10 mix undergoes greater deflection than M8. This increases the flexural strength of the mix M10.

## V. CONCLUSIONS

The compressive strength of mix M8 and M10 are increased by 19.82% and 19.44 as compared to Control concrete at 7 days respectively. When compared to control concrete the compressive strength of mix M8 and M10 are increased by 8.8% and 8.24% at 28 days respectively.

The split tensile strength of mix M8 and M10 are greater than that of control concrete by 8.93% and 17.36% at 7 days and when compared to control concrete the tensile strength of mix M8 and M10 are increased by 15.45% and 23.43% at 28 days respectively.

The flexural strength of mix M8 and M10 are increased by 6.7% and 23.93% when compared to control concrete at 7 days and the28

days flexural strength of mix M8 and M10 are increased by 12.5% and 30% as compared to control concrete at 28 days respectively. The compressive strength of M10 is slightly lower than the compressive strength of M8 (i.e. 0.6%).

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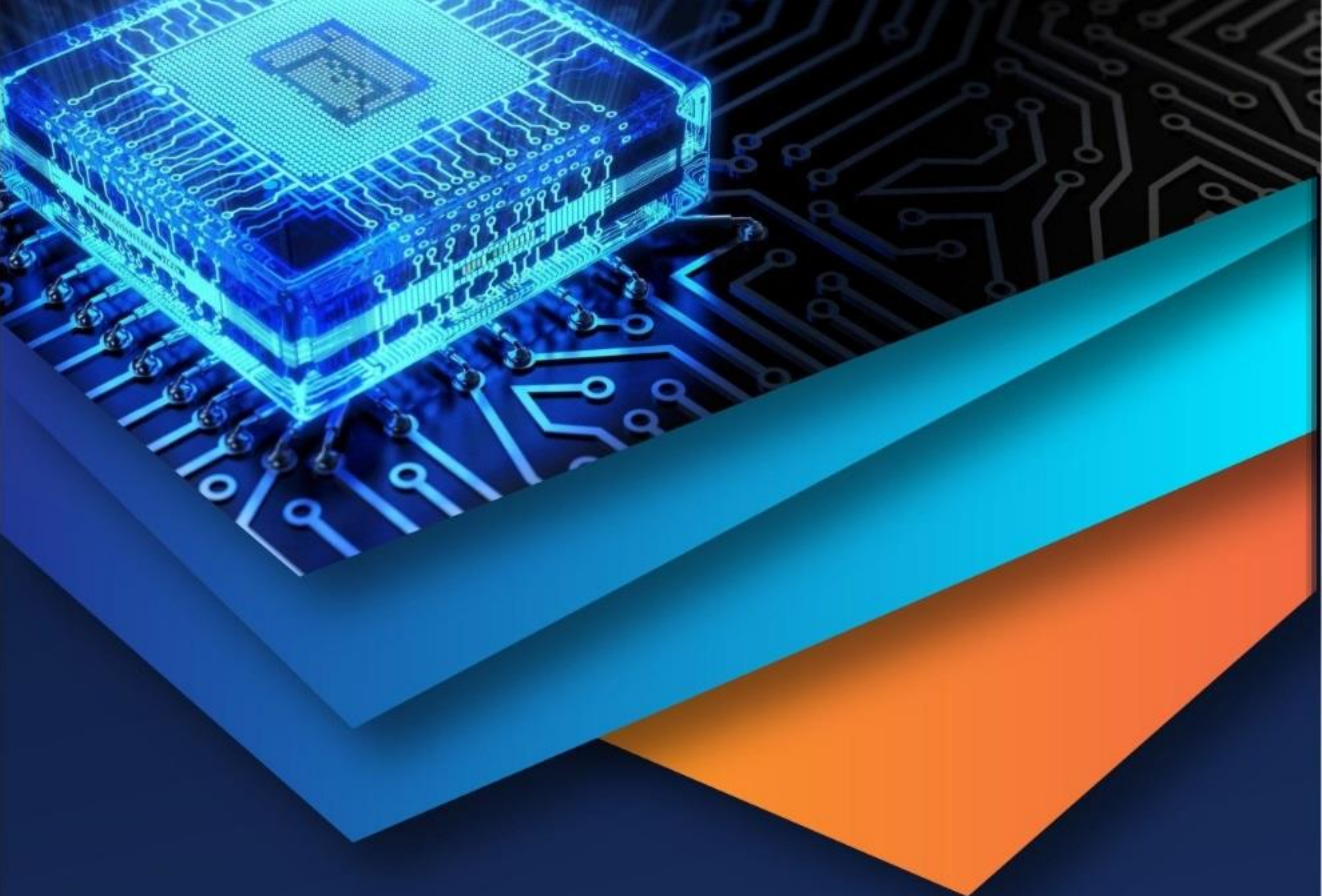


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