

EXPERIMENTAL INVESTIGATION OF THE EFFECT OF GLASS POWDER AND MANUFACTURED SAND IN HIGH STRENGTH CONCRETE

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ABSTRACT

Concrete is one of the most widely used construction material in the world. With growing need for multi-storeyed buildings, High Strength Concrete has become more important. The cement, an essential constituent of concrete, during its production leads to the release of carbon di oxide gas. This greenhouse effect producing gas contributes to around 65 percentage of global warming. The other ingredients of concrete, the river sand obtained through mining from river bed have created ecological imbalances in the country. With increasing need for concrete, there arises need for replacing a portion of cement and river sand with alternate materials to save the environment. Many researches have shown that some of the industrial waste like fly ash, silica fume, blast furnace slag can be effectively used in concrete production. Waste glass, when ground to very fine powder shows some pozzolanic properties because of silica content. Similarly, Manufactured sand or msand which is a by-product during production of coarse aggregate can be used as substitute material for river sand in concrete to reduce the impact on nature. The purpose of this study is to experimentally investigate the effect of Msand and Glass powder by partially replacing river sand and cement respectively.

KEYWORDS: High Strength Concrete- Manufactured Sand, Glass Powder.

Concrete is by far the most widely used construction material today. The versatility and mouldability of this material, its high compressive strength, and the discovery of the reinforcing and pre-stressing techniques which helped to make up for its low tensile strength have contributed largely to its widespread use. We can rightly say that we are in the age of concrete.

Manufactured Sand

Manufactured sand which is called as Msand is a by-product during production of coarse aggregate. It can be used as substitute material for fine aggregate in production of concrete to reduce the impact on nature. With the intense construction activity results in growing shortage and price increase of the natural sand in the country. Therefore, looking for a viable alternative for natural sand is a must. One alternative used as replacement is the use of msand. When rock is crushed and sized in quarry the main aim has generally been to produce coarse aggregate and road construction materials. msand is defined as a purpose made crushed fine aggregate produced from suitable source materials. Manufactured sand has been produced by variety of crushing equipment including cone crushers, impact crushers, roll crushers, road rollers etc., The raw material for msand production is the parent mass of rock. It is based on the parent rock that the chemical, mineral properties, texture, composition of sand would change.

Glass Powder

Glass powder is obtained by crushing waste broken glass. Now powdered glass powder are available in market.

LITERATURE SURVEY

Glass Powder in Concrete

Dr. G.Vijayakumar, Ms H. Vishaliny and Dr. D. Govindarajulu have given a technical report for "Studies on Glass Powder as Partial Replacement of Cement in Concrete Production", on examination of the glass powder concrete and normal concrete compressive and flexure strength. It is found that replacement of glass powder in cement by 20%, 30% and 40% increases the compressive strength by 19.6%, 25.3% and 33.7% respectively. Replacement of glass powder in cement by 40% increases the split tensile strength by 4.4% respectively. Replacement of glass powder in cement by 20%, 30% and 40% increases the flexural strength by 83.07%, 99.07% and 100% respectively.

Dhanaraj Mohan Patil and Dr. Keshav K. Sangle carried out research work in "Experimental Investigation of Waste Glass Powder as Partial Replacement of Cement in Concrete", their conclusion is that at the level of 20% replacement of cement by glass powder meets maximum strength as compare to that of normal concrete and other percentage of replacement of cement. As the size of GLP particle decreases in concrete the strength of concrete increases. From results it is conclude that particle size less than 90

micron get higher strength than that of particle size ranges from 90 to 150 micron.

Hongjian Du and Kiang Hwee Tan have published paper on "Waste Glass Powder as Cement Replacement in Concrete". In this paper, it is revealed that the concrete compressive strength was not decreased by cement substitution after 28 days because of the pozzolanic reaction between glass powders and cement hydration products, if the replacement is below 30%. Also the resistance to chloride ion and water penetration continuously increases with increasing glass powder content up to 60% cement replacement.

Manufactured Sand in Concrete

M. Adams Joe, A. Maria Rajesh, P. Brightson, M. Prem Anand in the journal "Experimental Investigation on The Effect Of M-Sand In High Performance Concrete", have found that, replacement of 50% of fine aggregate by M-Sand induced higher compressive strength, higher split tensile strength, higher flexural strength.

SIGNIFICANCE OF INVESTIGATION

The production of cement, an essential constituent of concrete, leads to the release of carbon dioxide. This greenhouse effect producing gas contributes to around 65 percentage of global warming. Identifying a suitable substitute will help in reducing release of carbon dioxide to the environment.

The other ingredients of concrete, the river sand obtained through mining have created ecological imbalances in the country. Also these days natural sand are very coarse and contain very high percentage of silt and clay. Silt and clay absorb water and reduce strength of concrete. Whereas msand which is a by product during production of coarse aggregate can be used as substitute material in production of concrete to reduce the impact on nature. It has no impurities as they are well graded, sieved and washed. The particles are more rounded and granular and do not have sharp edges compared to natural river sand. Manufactured Sand has better quality consistency with significant savings. Manufactured Sand can overcome the defects such as honeycombing, segregation, void, capillary, etc., occurring in concrete. The purpose of this study is to experimentally investigate the effect of Msand and Glass powder by partially replacing river sand and cement respectively.

METHODOLOGY

The experimental investigation was routed through following steps.

Step 1: Physical properties of the ingredients to were determined in laboratory.

Step 2: Base Control concrete cube to was casted with cement as binder.

Step 3: The compressive strength of base control concrete cube was checked with our required design compressive strength of concrete.

Step 4: Cement was be replaced by Glass powder at various percentage from 5% at increment of 5 %. The effect of replacement was studied. The optimal replacement percentage of glass powder giving compressive strength or best result was determined through concrete cube casting and testing in UTM machine.

Step 5: Similarly river sand was replaced with manufactured Sand at various percentage from 10% at increment of 10% with determined optimal percentage proportion of glass powder. The effect of replacement of manufactured sand was studied.

EXPERIMENTAL INVESTIGATION

Mix design was done for High Strength concrete M70 as per ACI 211 4R - Guide for Selecting Proportions for High-Strength Concrete with Portland Cement and Fly Ash. Initially control concrete was casted with the obtained mix design without glass powder and Msand. The control concrete cubes were checked after 7 days for strength. Initially control concrete was casted with the obtained mix design without glass powder and Msand. The control concrete cubes were checked after 7 days for strength. Then cement was replaced with Glass powder gradually starting from 5% to 35%. After testing after 7 days optimum replacement percentage was finalised. River sand was replaced with 10% and 20% and the strength was compared with the control concrete. Further, it is planned to be check the effect of Msand by replacing river sand by 30% to 100%.

Material Used

53 grade Ultra Tech Ordinary Portland Cement, 12mm aggregate and river sand from Tanjavur, msand from Karur, glass powder sourced from Madurai and Polycarboxylate ether super plasticizer Tec Mix 650 were used in this investigation.

Fineness modulus of Coarse Aggregate and river sand was found to be 3.212 and 4.415 respectively. The other properties of aggregates are table 1, 2 and 3.

Table 1. Properties of River Sand

| Sl. No. | Property | Value |
|---------|------------------------|-------------------------|
| 1 | Specific Gravity | 2.91 |
| 2 | Water absorption | 0.83% |
| 3 | Dry rodded unit weight | 1.605 g/cm ³ |
| 4 | Fineness modulus | 4.415 |
| 5 | Surface texture | Smooth |

Table 2. Properties of Msand

| Sl. No. | Property | Value |
|---------|------------------|--------|
| 1 | Specific Gravity | 3.136 |
| 2 | Water absorption | 1.739% |
| 3 | Surface texture | Smooth |

Table 3. Properties of Coarse Aggregate

| Sl. No. | Property | Value |
|---------|-------------------|-------------------------|
| 1 | Specific Gravity | 3.064 |
| 2 | Water absorption | 1.05% |
| 3 | Dry rodded weight | 1.569 g/cm ³ |
| 4 | Fineness modulus | 3.217 |
| 5 | Surface texture | Angular |

Mix Proportion Used

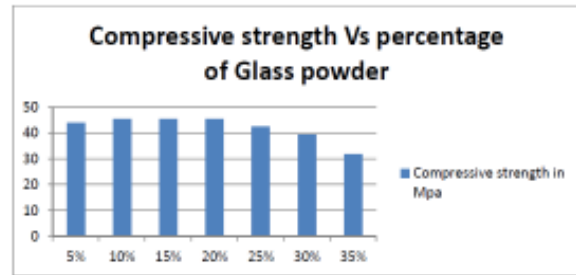
Mix proportion of 1:1.45:1.8 with w/c ratio of 0.26 and super plasticizer at the rate of 1.5% weight of cement was used in this study for making base control concrete.

RESULTS AND DISCUSSION

Compression Test

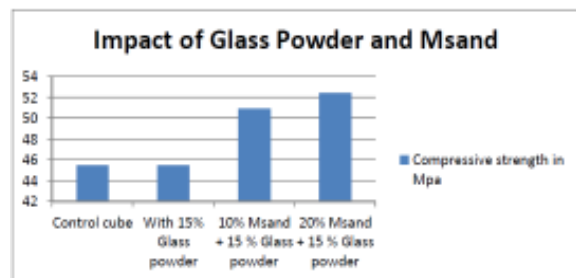
The control concrete cubes were tested after 7 days. It is observed from laboratory investigation that the design mix proportion obtained by ACI method for M 70 Grade have yielded 65 % strength (45.5 Mpa) in 7 days. It indicates that M70 can be obtained at 28 days. This arrived mix proportion was kept as base proportion for further investigation using glass powder and manufactured sand. After testing, the optimal percentage of Glass powder was finalised as 15%. Concrete was tested with 10 and 20 % replacement of river sand with Msand. It is found that the strength increased by 12 and 15% respectively.

The graph showing the variation of compressive strength with various proportion of glass powder is shown in Figure 1. The impact of Glass powder and Msand with respect to control mix is shown in Figure 2 at 7days of testing.

**Figure 1: Compressive strength Vs Glass powder (7 Days)**

FUTURE SCOPE

In further investigation, optimal percentage of msand can be determined by replacing river sand with msand.

**Figure 2: Impact of Glass powder and Msand (7 Days)**

The long term effect of ingredient can be studied in comparison with normal base control concrete. Relationship of grain size distribution of fine aggregate and strength of concrete can be analysed through sieve analysis.

CONCLUSION

From the results it is concluded that the glass powder can be used as partial replacement for cement without affecting the strength of concrete. It is found that 15% replacement of cement by glass powder will be optimum. Msand when replaced by 10 and 20% reveal that the strength has increased by 12 and 15% respectively. Thus, with use of msand and glass powder in production of High Strength Concrete, harmful environmental effects of release of carbon di oxide into atmosphere during production of cement and depletion of natural river bed through mining of river bed can be avoided.

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