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Role of Lime Stone Powder & Glass Powder Fly Ash Concrete: An Experimental Study

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Abstract - Studies have been made to examine the potential mineralogical and mechanical properties of glass and lime stone aiming to improve the characteristic properties of concrete where glass and limestone has been used in various forms, powder form or fine and coarse aggregate form, taken as part of aggregate or replacement of cement. However, the results presented in these studies were sometimes very different, even contradictory, due to the way in which the glass was used in these experiments, leading to a difficulty in distinguishing between the effect of Glass & limestone with the role of cement. To overcome this confusion the present research aimed to study the effects of glass powder on the properties of concrete by series of test. The aim of the present work was to use glass powder & lime stone powder with fly ash concrete, then study their effect.

To reach the target of this research, the study is extended to add the glass powder and limestone powder by rate of 5% to the batches with the use of admixture to investigate its potential mechanical properties. The slump test and compression test showed modest results in the first campaign but very important results in the second, when the glass powder was added with the plasticizer, which could be promoted to serve the concrete industry, particularly the production of the self compacting concrete where high performance concrete is required.

1. INTRODUCTION

Concrete is most widely used construction materials in the world. Due to global warming, the need to cut down energy consumption has increased. The effect of global warming has impacted everyone on the planet and is a well recognised concept. High levels of energy are needed to produce cement, which releases large amounts of carbon dioxide (CO2) and also contributes to the green house gases. Concrete is a construction material composed of Cement, fine aggregate, coarse aggregate, and water with or without admixtures. The concrete industry is one of the heaviest consumers of natural resources due to which sustainability of concrete industry is under threat. The environmental and economic concern is the greatest challenge the concrete industry is confronting. Cement manufacturing industry is one of the carbon dioxide emitting sources besides deforestation and the combustion of fossil fuels. The production of Portland cement, an essential ingredient of concrete, leads to the release of significant amounts of CO2, a greenhouse gas; one ton of Portland cement clinker production is supposed to produce approximately one ton of CO2 and other greenhouse gases. Decomposition of industrial waste is among big problems every country is facing these days. Use of recycled materials in construction is the most convenient option because of the large quantity and due to widespread sites of construction. Many waste materials like Pulverized Fly Ash (PFA), Ceramic Waste Powder, Ground Granulated Blast Furnace Slag (GGBS), Lime stone powder (LSP), Marble Dust Powder, Glass Powder (GLP) can also used as a binder with the addition of cement. Glass powder and lime stone powder also shows pozzolanic properties as it contains SiO2 and therefore to some extent addition in flyash concrete and contribute for the strength development and also enhances durability characteristics. This study can work as solution in Industrial waste disposal.

2. LITERATURE REVIEW

Bui Le Anh Tuan (May 2019) Researched on high strength concretes (HSC) containing manufactured sand (or maybe called crushed sand) as fine aggregate in the presence of fly ash (FA), silica fume (SF) were made. The HSC mixtures were designed to achieve 28-day compressive strength beyond 55 MPa. Compressive strength, drying shrinkage, watertightness and sulfate attack tests were conducted to evaluate the feasibility on the production of HSC having crushed sand, FA and SF. The test results indicated that the compressive strength of all HSC mixtures exceeded 55 MPa at 28 days. There was an improvement in the compressive strength following the addition of SF in HSC

Sasikumar & Tamilvanam (2016) performed an experiment investigation on properties of glass powder as a partial replacement of cement. Main parameter investigated in this study is M30 grade concrete with partial replacement of cement by glass powder 0%, 5%, 10%, 20%, 25%. The optimum 7 and 28 days compressive strength has been obtained in the 25% glass powder replacement level.

Contrariwise Keryou and Ibrahim (2016) confirmed a reduction of water requirement as the glass powder content increases and an improvement of compressive

strength at the early age followed by a decrease with the age of curing due to the Alkali-Silica Reaction.

Kumar & Dhaka (2016) write a review paper on partial replacement of cement with glass powder and its effect on concrete properties the main parameter investigated in this study M35 concrete with partial replacement of glass powder with varying 0,5,10,15,20,25% by weight of cement. The paper presents a detailed study on compressive strength, flexural strength and split tensile strength for 7 days and 28 days respectively.

Anwar (2016) used the waste glass powder as replacement of cement in the mix proportion; the waste glass powder was varied in fraction from 0 to 50% per increment of 5% by weight of concrete. Concrete was tested on compression, split and flexure strength, and an appreciable increase in strength was observed with the increase in percentage replacement of cement by glass powder from 5 to 15%. The author estimated that the strength increase has taken place after 28 days be- cause of pozzolanic action of glass powder; however, there was no explanation for the considerable decrease of strength from rate 20 to 50%.

3. OBJECTIVES

The main objectives of this research paper are as follows:

1. To enhance the properties of concrete by the addition of Glass Powder and Lime Stone powder in fly concrete.

2. World faces a serious problem of disposal of large quantities of industrial waste like Fly ash, glass powder, lime stone powder, Silica fumes etc. The disposal of these wastes without proper attention creates hazardous impact on environmental health. As the landfills are increasing due to tonnes of industrial waste disposal. So Glass powder is used in this project, as the addition with cement in concrete it helps to reduce the quantity of industrial waste.

4. METHODOLOGY

To study the effects of glass powder along with the fly ash on the properties of concrete, series of test were done the amount of cement was maintained constant and the glass powder was taken in addition in increment order. This approach aimed to distinguish between the role of the cement and that of the glass powder.

Batches were made with increment in the quantity of glass powder (5%, 10%, 15% and 20%) To calibrate the effect of the glass powder and to develop a wide perception about this fine particles on the concrete behaviour at early and advanced age, the concrete mixture with glass powder was tested, analysed and compared with that of "control mixture" free of glass powder. The procedures of mixing is done by hand mixing was used for the preparation and mixing of all concrete mixtures a homogeneous mixture is prepared to obtained a desired quantity of all materials cement, coarse aggregate, fine aggregate, water, Glass power and Fly ash to form a homogenous mass. Both, coarse aggregate as well as fine aggregate, were in dry conditions. So, necessary water corrections were applied before the mixing operation. In the end, water was added very carefully, so as to prevent any loss of water during the mixing operations.

Table 4.2 Mix Designs of concrete with GP

Mix Designation	Glass Powder% (additional)	Fly Ash	Cement
T3/M2	5%	30%	70%
T3/M3	10%	30%	70%
T3/M4	15%	30%	70%
T3/M5	20%	30%	70%

Table 4.3 Mix Designs of concrete with LSP

Mix Designation	Lime Powder% (additional)	Fly Ash	Cement
T3/M2	5%	30%	70%
T3/M3	10%	30%	70%
T3/M4	15%	30%	70%
T3/M5	20%	30%	70%

5. RESULTS AND DISCUSSIONS

In this section, results of the various experimental investigations are reported and discussed. The results of physical testing of cement, coarse aggregate, natural sand and Glass Powder are satisfactory. For cement, physical testing included determination of fineness, standard consistency, soundness, initial and final setting time, specific gravity and compressive strength of cement mortar cubes. For coarse aggregates, sieve analysis, bulk density, specific gravity and water absorption of both 20mm and 10mm nominal size of aggregate were determined. For fine aggregate, different tests conducted were sieve analysis, silt content, bulk density, specific gravity and water absorption. For glass powder satisfactory results were found.

The rate at which glass powder is added i.e. 5%, 10% 15% and 20% in Flyash concrete and various tests conducted to evaluate the effect of glass powder in concrete on workability, density, compressive strength, splitting tensile strength, water absorption. The comparison between these properties of different mixes are also presented and discussed. The compressive strength after the addition of cement with glass powder by various rate i.e. 5% 10% 15% 20% is also compared with Lime stone powder samples.

5.1 Workability: Workability test are also perform to check there property to slump cone test of workability is adopted and their test result are in tabulated form in table and showing the variation of workability of graph of different mixes of glass powder.

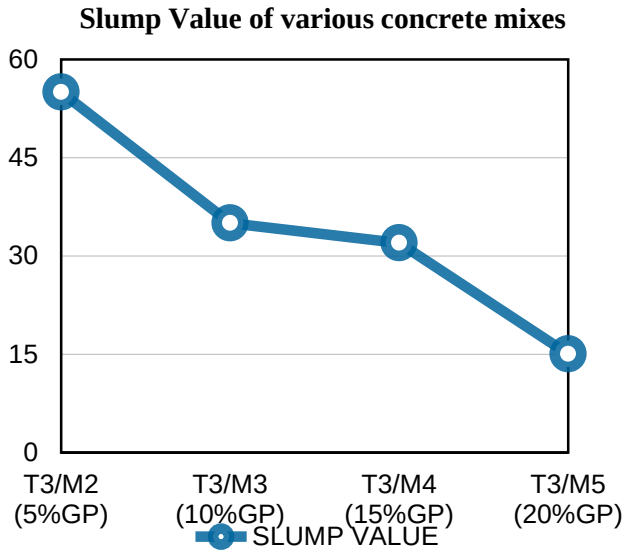

Table 5.1. Workability of concrete of different Glass Power content by slump cone test

Mix	Glass Powder Content	Slump Value in (in mm)
T3/M2	5%	55
T3/M3	10%	35
T3/M4	15%	32
T3/M5	20%	15

5.2. Compressive Strength

The average compressive strength is calculated in this test program. Compressive strength of cube of size is calculated 150 ⍰ 150 ⍰ 150 mm is tested for 7 days and 28 days, also show the test data with the help of table and bar chart.

Figure 5.3:Compressive strength test result on 7 days testing

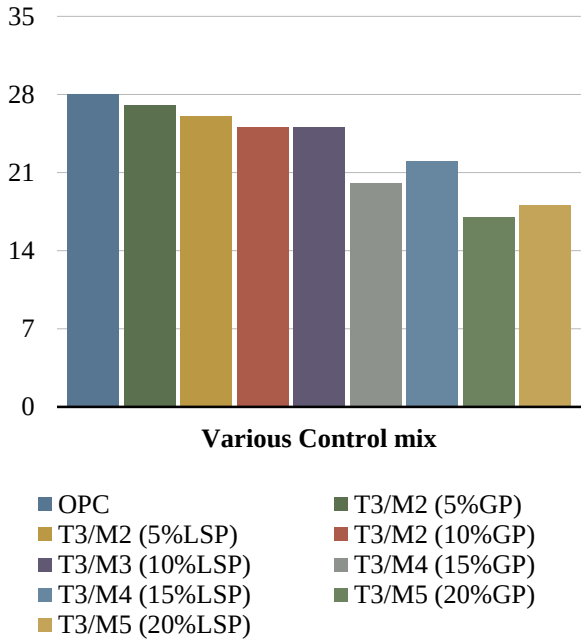

Table 5.3: Compressive strength result on 7 days testing

Mix Design	Control Mix (GP+OPC +FA)	Control Mix (LP+ OPC + FA)	With 100%OPC
T3/M2	27	26	28
T3/M3	25	25	28
T3/M4	20	22	28
T3/M5	17	18	28

Figure 5.4 : Compressive strength test result on 28 days testing

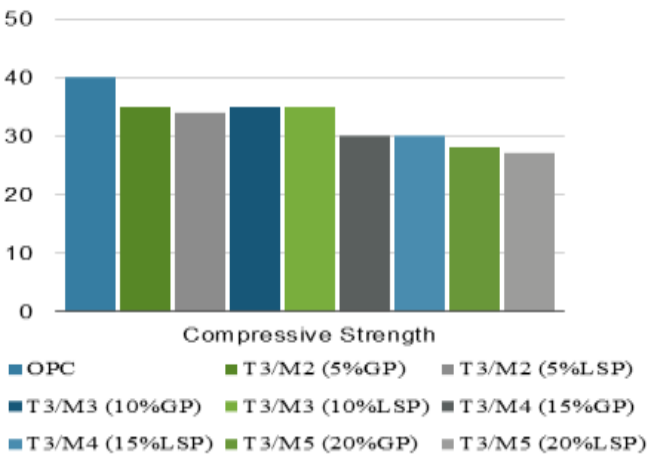

Table 5.4: Compressive strength result on 28 days testing

Mix Design	Control Mix (GP+OPC +FA)	Control Mix (LP+ OPC + FA)	With 100%OPC
T3/M2	35	34	40
T3/M3	35	35	40
T3/M4	30	30	40
T3/M5	28	27	40

Compressive strength of testing of 28days and its clear that the compressive strength of concrete with the addition of Glass powder and Lime stone powder are almost similar. The 5% addition of glass powder are higher. But, on comparing both mixes with the results of 0% of addition i.e. mix with ordinary Portland cement they found to be less.

6. CONCLUSIONS

The investigation in the study of addition of glass powder in concrete different types of mixes are prepared with the variable content of glass powder. In this study our main aim to determine the optimum content of glass powder to satisfied all parameter of concrete composite like fresh, harden property of concrete.

For this study concrete mix is prepared in various mix designation is T3/M2, T3/M3, T3/M4 and T3/M5 are prepared. w/c ratio is varies between 0.4 to 0.5 and determined to physical property and workability, compressive strength and split tensile strength. Here are the following conclusion found in this study

6.1.1. Workability (slump value)

Slump decreases with increasing glass powder in concrete with respect to reference mix. Maximum slump value is 55mm was recorded for mix T3/M2 having 5% glass powder. There is continuous decrement in the value of slump by the addition of glass powder. Whereas in addition of lime stone in concrete it is found that there is continuous increment in the workability of concrete.

6.1.2. Compressive strength

1. It is seen that at 5% & 10% addition of glass powder i.e. T3/M2 & T3/M3 respectively the compressive strength of concrete mix is maximum. After further more addition of glass powder value start decreasing

2. When sample mixes of glass powder was compared with the compressive strength of lime stone powder in concrete, their values were found to be nearly similar. But if we compare them on economical basis so glass powder mixes found more economical then lime stone powder mixes.

3. The Compressive strength values are lesser as compare to concrete mix with no addition in concrete i.e. of pure OPC. The 5% addition of glass powder shows more satisfactory results. But if we compare the concrete on the economical basis glass powder which is a industrial waste turns out to be more economical. Along with that it also helps to reduce environmental waste and also reduces overall cost of concrete.

4. Reduction in value of compressive strength if we increase the glass powder content

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