Experimental Investigation of Properties of Concrete on Replacing Cement Partially With Waste Glass Powder and Fly Ash: A Review

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Abstract— The present review is based on high strength concrete with mix grade of M40. In this work the workability, compression strength, split tensile strength and flexural strength of the specimen will be tested and will be presented in the form of a graph comparing the properties with conventional concrete. The replacement of cement will be done using waste glass powder, fly ash and the mixture of the both in the percentage of 0, 10, 20 and 30.The beam, cube and cylinder size are (500x100x100) mm, (150x150x150) mm and (300x150) mm respectively. The curing period for the specimen will be 3 days, 7 days and 28 days.

Keywords: Glass Powder, Fly Ash, M40, Compressive Strength, Flexural Strength, Split Tensile Strength

I. INTRODUCTION

Concrete can be characterized as a structure material that can be made by blending rock or broken stone, sand, cement, and water. The blend can be filled any shape, size of form, which on solidifying gives a strong stone like mass, the quality of solidified strong mass can be expanded by including admixtures. The principle point of the admixtures is to improve the properties to some reach out of the ideal strong mass. In like manner man language concrete can be characterized as blend of glue and totals. In this exploration work we have supplanted the cement substance with different materials i.e waste glass powder, fly ash and mixture of both. The research work has been completed on high quality concrete of M-40 Grade. High quality concrete are such kind of solid which have high quality and high toughness when contrasted it and the ordinary regular concrete. The development of high quality concrete is now and again bloated in view of the way that the blend of the fixings is to taken so that the ideal quality of strong mass is gotten subsequent to solidifying. At end of the twentieth century, there has been development in the utilization of admixtures in getting ready of high strength concrete, an enormous number of item has been utilized for the fractional swap of cement for making solid cost proficient.

A. Waste Glass

Glass is an inert material which could be recycled and used many times without changing its chemical property. Glass is amorphous material with high silica content, thus making it potentially Pozzolanic when particle size is less than 75µm. Studies have shown that finely ground glass does not contribute to alkali – silica reaction. In the recent, various attempts and research have been made to use ground glass as a replacement in conventional ingredients in concrete production as a part of greenhouse management. A major concern regarding the use of glass in concrete is the chemical reaction that takes place between the silica – rich glass particle and the alkali in pore solution of concrete, which is called Alkali – Silicate reaction and can be very detrimental to the stability of concrete, unless appropriate precautions are taken to minimize its effects. ASR can be prevented or reduced by adding mineral admixtures in the concrete mixture, common mineral admixtures used to minimize ASR are pulverized fuel ash (PFA), silica fume. Several studies have proven the suppressing ability of these materials on ASR. The fact that glass has high silica content has led to laboratory studies on its feasibility as a raw material in cement manufacture.

B. Flyash

Fly ash is a naturally-cementitious coal combustion by-product. It is extracted by the precipitators in the smokestacks of coal-burning power plants to reduce pollution. About 120 coal based thermal power stations in India are producing about 112 million tonne fly ash per year. With the increasing demand of power and coal being the major source of energy, more and more thermal power stations are expected to be commissioned/augment their capacities in near future. Fly ash has been considered as a "Pollution Industrial Waste" till about a decade back and was being disposed of in ash ponds. Indian coal has high ash content (35%-45%) and low calorific value (3500 kcal/kg – 4000 kcal/kg) because of which huge quantity of fly ash is generated. It is expected to increase to about 200 MT per year by the year 2012. This would require about 4000 ha of land for the construction of ash ponds. Generally, one acre of land is required per megawatt of power generation. Continuous studies have been carried out in India towards management of fly ash (FA), disposal and utilization. Large number of innovative alternate building materials and low cost construction techniques developed through intensive research efforts during last three to four decades satisfies functional as well as specification requirements of conventional materials/ techniques and provide an avenue for bringing down the construction cost. fly ash, an industrial by-product from Thermal Power Plants (TPPs), with current annual generation of approximately 112 million tons and its proven suitability for variety of applications as admixture in cement/concrete/mortar, lime pozzolana mixture (bricks/blocks) etc. Cement and Concrete Industry accounts for 50% fly ash utilization, the total utilization of which at present stands at 30MT (28%). The other areas of application are Low lying area fill (17%), Roads & Embankments (15%), Dyke Raising (4%), Brick manufacturing (2%) and other new areas for safe disposal of fly ash is in paint industry, agriculture etc. Table 1.6: Fly ash generation and utilization in different countries (J.Alam and M.N Akhtar 2011)

II. LITERATURE REVIEW

(Dali J.S. and Tande S.N. 2012) studied the properties of concrete containing mineral admixtures, when it is subjected to alternative wetting and drying and high temperature and

resulted that the compressive strength increment is up to 25% replacement of cement by waste glass powder, but the peak % increment is at 20% replacement in both the cases, i.e. concrete without subjecting to alternate wetting and drying, and concrete subjected to alternate wetting and drying.

(Patel Dhirendra et. al 2012) Investigated the strength characteristics of pre-cast blocks incorporating waste glass powder and studied that the moderate level decrease in the compressive strength at 28 days occurs. Many works have been done to explore the benefits of using waste glass powder in making and enhancing the properties of concrete.

(Vasudevan Gunalaan and Kanapathy pillay Seri Ganis 2013) investigated the test results at 7, 14, 28 days of curing of specimens containing waste glass powder as partial replacement of cement and his results showed that the 20% glass powder mix amount shows a positive value of compressive strength at 28 days compare to other ratio which 10% and 15% is not achievable even though have slight increment from 14 days' results.

(Nwaubani Sunny O. and Poutos Konstantinos I. 2013) concluded that increasing the amount of glass in mortar causes a general decrease of compressive strength, but the decrease becomes less evident with prolonged curing time. The particle size distribution of waste glass used was the key factor influencing the strength development.

(Dr. G.Vijayakumar, Ms. Vishaliny, Dr. D. Govindarajulu 2017) Investigated the test results at 28 days of curing of specimens containing waste glass powder as partial replacement of cement and his results showed that Conventional concrete shows at 28 days compressive strength as 31.1 N/mm2, split tensile strength of 2.27N/mm2 and flexural strength of 3.25N/mm2

1) Replacement of glass powder in cement by 20%, 30% and 40% increases the compressive strength by 19.6%, 25.3% and 33.7% respectively.
2) Replacement of glass powder in cement by 40% increases the split tensile strength by 4.4% respectively
3) 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, Dr. Keshav K. Sangle 2018) investigated the test results at 28 days curing of specimen containing waste glass powder as partial replacement of cement and his results showed that on addition of GLP initial the rate of gain of strength is low but at 28th day it meets required design strength.

- Addition of GLP increases the strength of concrete.
- 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..

(Abdullah Anwar et al 2015) Their studies tell that Fly ash is rich in cementitious industrial wastes and has great potential to replace Portland cement. Their studies tell that 28 day compressive strength of Mix can be achieved with a replacement of 30% of fly ash with the cement. When the percentage of replacement is increased the water/ binder ratio gets reduced, thereby, increasing the compressive strength.

(Vinit Kumar Singh et al) their study tells that Fly ash can be added in concrete as partial replacement of up to 20% without compromising compressive strength of PPC concrete. Workability is decreased with increase in replacement level. At 20% replacement level strength is substantially decreased at all ages.

III. METHODOLOGY

A. Objectives to Study:

- The primary objective of this study is to investigate the practicality, versatility and feasibility of utilizing fly ash and recycled glass as a partial replacement to cement.
- To Study the influence of waste glass powder on hardened properties of concrete mixes such as: compressive strength, flexural and splitting resistance.
- To Study the influence of fly ash on hardened properties of concrete mixes such as: compressive strength, flexural and splitting resistance.
- To study the effect of addition of different percentages of Fly ash i.e. 10%,20%, & 30% on strength properties such as compressive strength, flexural strength and split tensile strength of geo-polymer concrete.
- To study the effect of addition of different percentages of Waste glass powder i.e. 10%, 20%, & 30% on strength properties such as compressive strength, flexural strength and split tensile strength of geo-polymer concrete.
- Determine the optimum fly ash powder to be added as a partial replacement of cement.
- Determine the optimum waste glass powder to be added as a partial replacement of cement.
- To compare the results and to study the effects of different percentages of fly ash glass powder on the strength properties of concrete.

B. Methodology Charts:

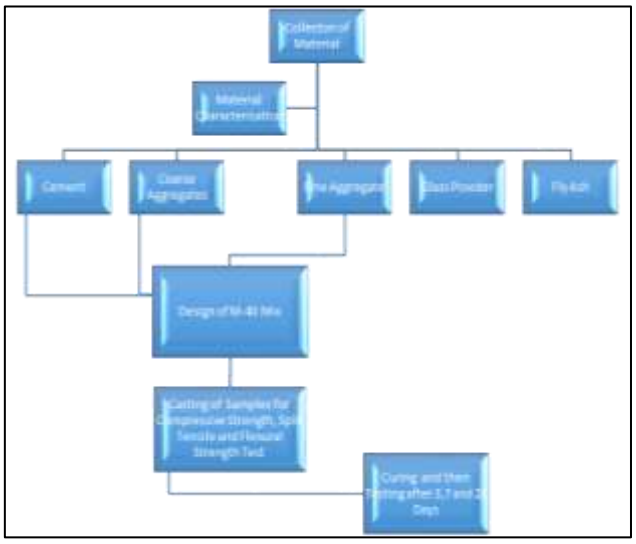

Fig. 1: Methodology Showing Mix Design of M-40 and Testing

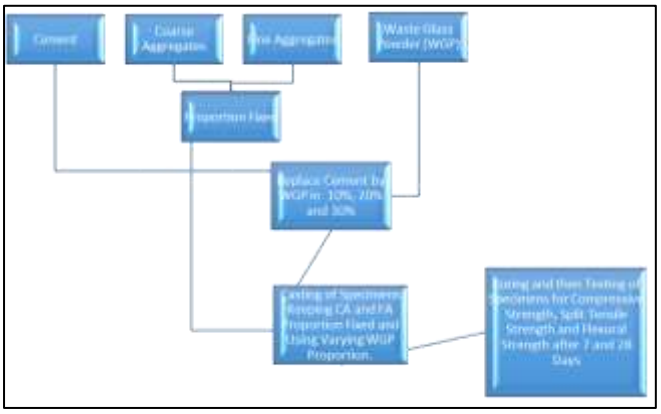

Fig. 2: Methodology Showing Incorporation of Waste Glass Powder in Concrete Mix

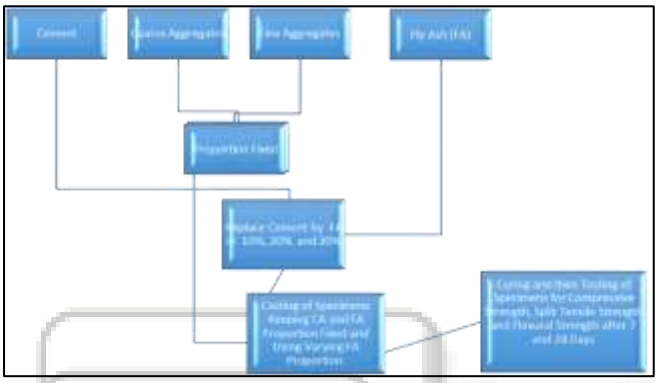

Fig. 3: Methodology Showing Incorporation of fly ash in Concrete Mix

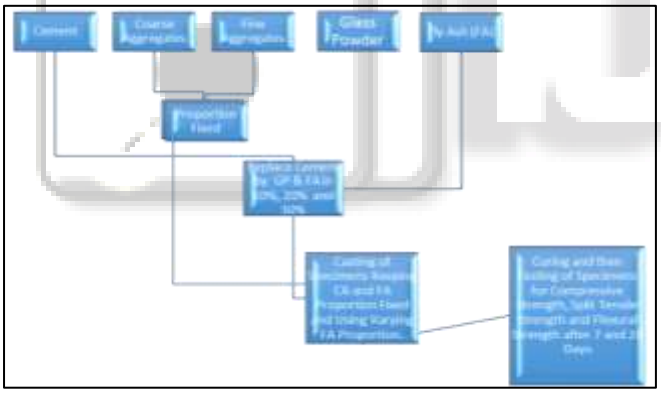

Fig. 4: Methodology Showing Incorporation of glass powder and fly ash in Concrete Mix

Replacement %	Cubes with Glass Powder	Cubes with Fly Ash	Cubes with Glass Powder and Fly Ash
0	9	9	9
10	9	9	9
20	9	9	9
30	9	9	9

Table 1: No. of cubes to be casted.

Replacement %	Beams with Glass Powder	Beams with Fly Ash	Beams with Glass Powder and Fly Ash
0	9	9	9
10	9	9	9
20	9	9	9
30	9	9	9

Table 2: No. of beams to be casted.

Replacement %	Cylinders with Glass Powder	Cylinders with Fly Ash	Cylinders with Glass Powder and Fly Ash
0	6	6	6
10	6	6	6
20	6	6	6
30	6	6	6

Table 3: No. of cylinders to be casted.

IV. CONCLUSIONS

In this paper I had discussed about the high strength concrete mix grade M40. The specimen will be tested and results will be compared with the conventional concrete. The replacement of cement will be done using glass powder, fly ash and the mixture of the both in the percentage of 0, 10, 20 and 30.The curing period for the specimen are 3,7 and 28 days respectively. This paper has been developed to satisfy all proposed requirements.

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