Experimental Investigation on Effect of Glass Powder, Pond Ash & Recycled Aggregate on The Strength of Concrete in Terms of Workability & Flexural Strength

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Abstract- *Cement was replaced by the glass powder in the proportion of 5%, 10%, 15%, 20% and 25% . The flexural strength were conducted for the above replacements. The result showed glass powder improves the mechanical properties. The advantages of this project are that the replacement of glass powder is economically cheap as well as a superior concrete can be made.*

Concrete is the most widely used man made construction material in the world. The popularity of concrete is due to the fact that from the common ingredients the properties of concrete are tailored to meet the demand of any particular application and then most widely used in all types of civil engineering works including infrastructures, low and high rise buildings, defense developments.

The project explores a theme on the need for recycled aggregates and highlights its potential use as aggregate in new concrete construction. Research comprises of studies on offer of replacement of cement, sand & aggregate by glass powder, pond ash and recycled aggregate in concrete by some percentage for 28 days flexural strength of concrete. A result show that the flexural strength of modified concrete gives higher result with combination of 5% glass powder with 20% (pond ash and recycled aggregate), 10% glass powder with 10% (pond ash and recycled aggregate),10% glass powder with 15%(pond ash and recycled aggregate),20% glass powder with 10% (pond ash and recycled aggregate).

I. INTRODUCTION

The concrete is the most important construction material which is manufactured at the site, it is a composite product obtained by mixing cement, water and an inert matrix of sand and gravel or crushed stone, it undergoes a number of operations such as transportation, placing, compacting and curing. The distinguishing property of the concrete is its ability to harden under water. The ingredients of the concrete can be classified into two groups namely active and inactive. The active group consists of cement and water whereas inactive group comprises of fine and coarse aggregates, the inactive group is sometimes called as inert matrix. Good concrete, whether plain, reinforced or pre-stressed, should be strong enough to carry superimposed loads during its anticipated life and should have all other essential properties include durability, impermeability, minimum amount of shrinkage and cracking.

Use of recycled waste glass in Portland cement and concrete has attracted a lot of interest in worldwide due to the increased disposal costs and environmental concerns. Glass used for containers, jars and bottles is soda lime silica counts for 80% of the recycled glass. The glass being mainly a silica-based material in amorphous form can be used in cement-based applications.

Ground glass is considered a pozzolanic material due to its silica content and as such an exhibit properties similar to other pozzolanic materials such as fly ash, met kaolin, slags and wheat husk ash.

Work carried out on Glass concrete by Anderson, J. E. (2007), suggest that for every ton of cement clinker produced, 579 kg of CO_2 gas is emitted solely from chemical reaction, regardless of the process used or the fuel efficiency. By replacing Portland cement with glass powder in concrete would considerably reduce carbon dioxide emissions.

Workability: Workability is the property of freshly mixed concrete that determines the ease with which it can be properly mixed, placed, consolidated and finished without segregation. The workability of fresh concrete was measured by means of the conventional slump test as per IS; 1199(1989). Before the fresh concrete was cast into moulds, the slump value of the fresh concrete was measured using slump cone. In this project work, the slump value of fresh concrete was maintained in the range of 25mm to 50mm.

Flexural strength of concrete: Flexural strength is one measure of the tensile strength of concrete. It is a measure of a concrete beam or slab to resist failure in bending. The flexural strength is expressed as Modulus of Rupture (MR) in measured psi (MPa).

Flexural strength is checked after 7 and 28 days curing. Beams of size 700 x 150 X 150 mm are casted for both controlled concrete as well as for modified concrete from reference mixes. The specimens are tested in universal testing machine with 2 ton load capacity cell as per IS: 516-1959 (2004).

$$F_f = \frac{w * l}{b * d^2}$$

Where,
W= load,
l= length of beam ,
b= breath of beam, and
d= depth of beam

II. PROPOSED METHODOLOGY

In this experimental study consist of collection of different materials to be used for investigation, In this study an attempt is made to find out the hardened properties of concrete such as Flexural Strength of M40 grade concrete containing waste glass powder as pozzolanic, pond ash as sand and recycled aggregate as aggregate.

a. Batching and mixing

The batching plant/concrete mixer shall be capable of proportioning the materials by weight, each type of material being weighted separately. The mixing of all concrete ingredients should be uniform to make homogeneous mix. This can be achieved during the mixing phase, preferably the dry quantity of cement, sand, glass powder, pond ash, recycled aggregate, aggregate are mixed and then water & admixture is added to the mixture.

b. Placing

After mixing of concrete, it is placed and filled in the concrete mould and care should be taken to see that no segregation of material is occurred.

c. Compaction

The controlled concrete, and modified concrete (concretes in which Glass Powder, Pond Ash and Recycled Aggregate are added are called 'modified concrete') compacted immediately in the vibration machine just after the material is filled in the cubes and beams with necessary surcharge (extra loose material).

d. Finishing

Finishing of concrete specimen is done with the help of trowel by doing levelled surface of beams. It should be ensured that, the surface should be plain to carry equal load at every point on surface.

e. Curing

After 24 hours of casting, the specimen are removed from the mould and immediately submerged in clean fresh water and kept there until taken out just prior to test. The water in which the specimens are submerged, are renewed every seven days. The specimens are not to be allowed to become dry at any time until they have been tested.

III. RESULTS

A. Fineness of Cement and Glass Powder

The degree of fineness of cement/Glass Power is a measure of the mean size of the grains in the cement/Glass Powder. The rate of hydration and hydrolysis, and subsequent development of strength depends upon the fineness of cement. It can be calculated from the particle size distribution or determined from one of the air permeability methods. For ordinary Portland cement, the residue by mass in 90 micron sieve should not exceed 10 percent. The standard cement should comply with the following conditions of fineness as given by IS: 460-1978 & IS: 269-1976.

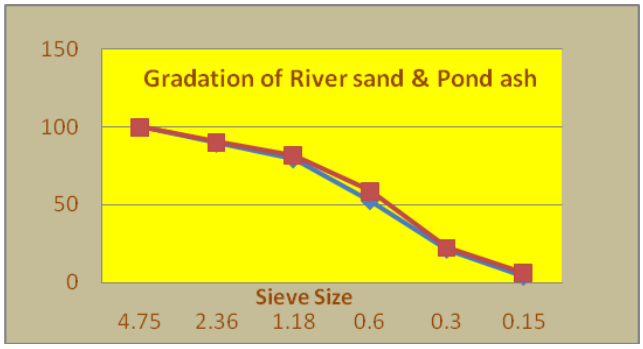

FIGURE - GRADATION OF NATURAL SAND & POND ASH

B. WORKABILITY OF VARIOUS CONCRETE MIX

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Type of mix	% addition of admixture (by weight of cement)	Slump value (mm)
G10PA05RA05	0.8%	39mm
G10PA10RA10	0.8%	37mm
G10PA15RA15	0.8%	32mm
G10PA20RA20	0.8%	35mm
G10PA25RA25	0.8%	34mm
G15PA05RA05	0.8%	38mm
G15PA10RA10	0.8%	35mm
G15PA15RA15	0.8%	33mm
G15PA20RA20	0.8%	32mm
G15PA25RA25	0.8%	30mm
G20PA05RA05	0.8%	37mm
G20PA10RA10	0.8%	35mm
G20PA15RA15	0.8%	32mm
G20PA20RA20	0.80%	30mm
G20PA25RA25	0.80%	28mm
G25PA05RA05	0.80%	32mm
G25PA10RA10	0.80%	30mm
G25PA15RA15	0.80%	29mm
G25PA20RA20	0.80%	28mm
G25PA25RA25	0.80%	26mm

Figure: BEAM CASTING SIZE 700X150X150

C. FLEXURAL STRENGTH OF CONCRETE MIXES

Type of mix	Flexural strength(N/mm²)	
	7 days	28 days
G10PA05RA05	5.506	5.668
G10PA10RA10	4.911	6.989
G10PA15RA15	4.739	6.705
G10PA20RA20	4.989	6.182
G10PA25RA25	4.915	5.928
G15PA05RA05	4.495	6.106
G15PA10RA10	4.506	6.386
G15PA15RA15	4.503	6.132
G15PA20RA20	4.354	5.808
G15PA25RA25	3.812	5.336
G20PA05RA05	4.425	5.786
G20PA10RA10	4.47	6.68
G20PA15RA15	4.319	5.354
G20PA20RA20	3.722	5.199
G20PA25RA25	3.508	4.077
G25PA05RA05	3.997	4.798
G25PA10RA10	3.714	4.497
G25PA15RA15	3.300	3.956
G25PA20RA20	2.883	3.363
G25PA25RA25	2.470	2.532

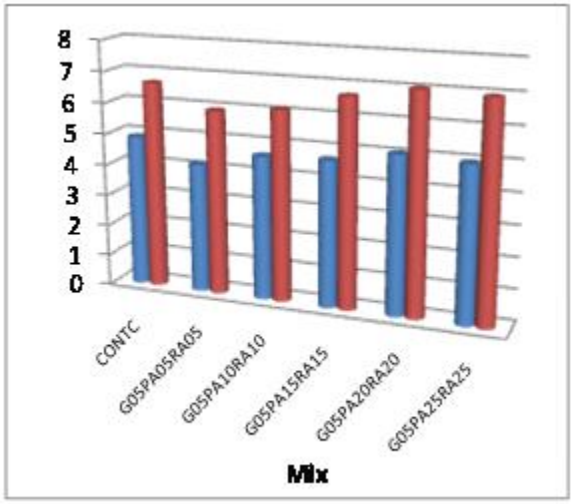

Figure: - 7 days (Blue) & 28 days (Brown) Flexural Strength at 5% constant percentage of Glass Powder

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Table - Flexural strength of concrete of 5% cement replaced by the Glass powder and with varying percentage of Pond Ash & Recycled Aggregate.

Type of mix	7-Days (N/mm^2)	28-Days (N/mm^2)
CONTC	4.89	6.67
G05PA05RA05	4.174	5.935
G05PA10RA10	4.626	6.126
G05PA15RA15	4.694	6.691
G05PA20RA20	5.067	7.043
G05PA25RA25	4.981	6.955

Table - Flexural strength of concrete of 10% cement replaced by the Glass powder and with varying percentage of Pond Ash & Recycled Aggregate

Type of mix	7-Days (N/mm^2)	28-Days (N/mm^2)
CONC	4.89	6.67
G10PA05RA05	5.506	5.668
G10PA10RA10	4.911	6.989
G10PA15RA15	4.739	6.705
G10PA20RA20	4.989	6.182
G10PA25RA25	4.915	5.928

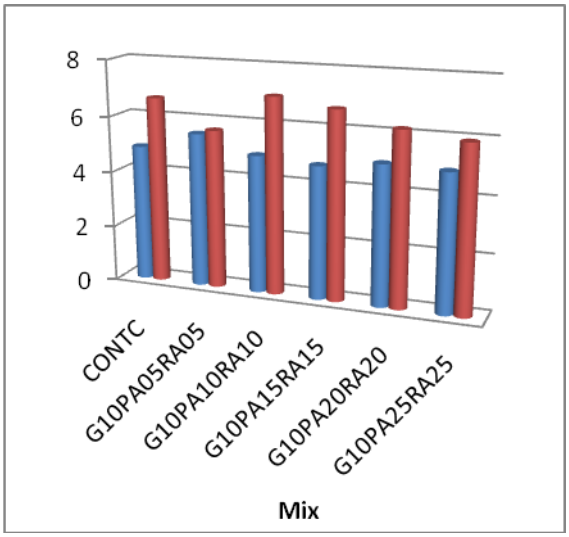

Figure: - 7 days & 28 days Flexural Strength at 10% constant percentage of Glass Powder

Table: Flexural strength of concrete of 15% cement replaced by the Glass powder and with varying percentage of Pond Ash & Recycled Aggregate.

Type of mix	7-Days (N/mm^2)	28-Days (N/mm^2)
CONC	4.89	6.67
G15PA05RA05	4.495	6.106
G15PA10RA10	4.506	6.386
G15PA15RA15	4.503	6.132
G15PA20RA20	4.354	5.808
G15PA25RA25	3.812	5.336

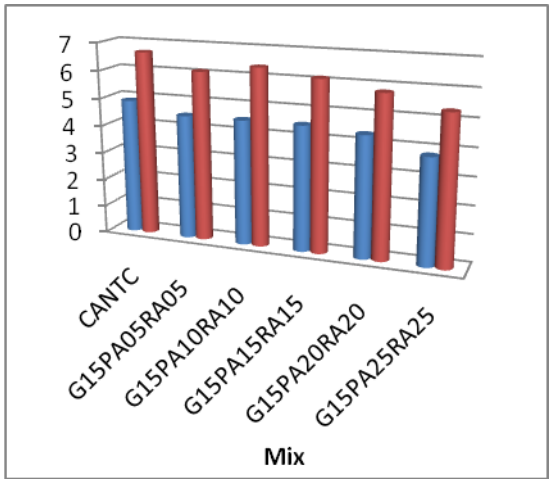

Figure: - 7 days & 28 days Flexural Strength at 15% constant percentage of Glass Powder

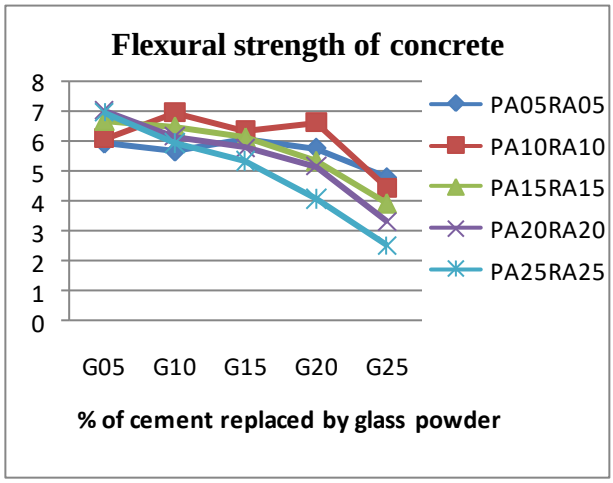

Fig: Flexural strength of concrete in 28-days at 5%, 10%, 15%, 20% and 25% constant of glass powder

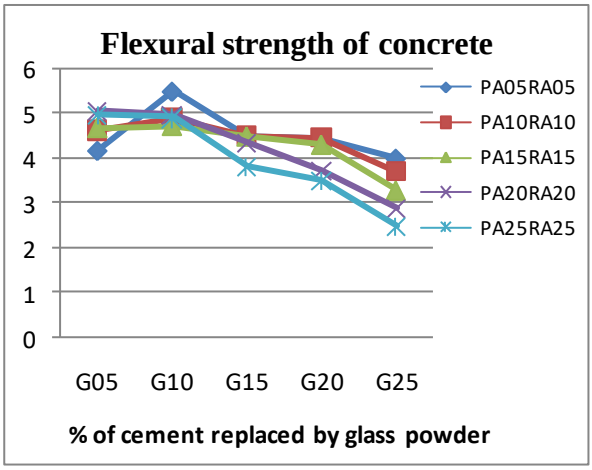

Figure :- Flexural strength of concrete in 7-days at 5%, 10%, 15%, 20% and 25% constant of glass powder

IV. CONCLUSION

The strength of concrete is also improved with addition of pond ash. One of the main reasons of this fact that may be attributed to the formation of more C-S-H gel and less portlandite in concrete due to the reaction occurring between the silica – rich pond ash and the alkali in pore solution of concrete. But it is seen that at the later age, secondary reaction starts between Pond ash and calcium hydroxide and forms additional cementitious material for modified concrete. Pond ash initially acts as pore filler. Only later, .i.e., after 7 days, finer particles of pond ash react with calcium hydroxide from cement and formed additional cementitious material and the larger particles of pond ash acts as filler material. Pond ash is porous in nature, needs more water in concrete compare to OPC concrete.

Glass Powder, Pond Ash & Recycled Aggregate withstand under any aggressive environment and climatic conditions because of balanced combined physical and chemical properties. In this project flexural strength of modified concrete and controlled concrete is compared. Workability of concrete is decreases with increase the percentage of glass powder, Pond Ash and Recycled aggregate because materials absorb more quantity of water.

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