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Optimum Use of Fly Ash (FA) and Glass Powder (GP) as a Partial Replacement for Cement in Concrete

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Abstract: ***To eliminate the environmental impact of cement production, it is important to offer alternative binders for concrete. Consequently, an intensive dive continues during the replacement of cement with various wastes and industrial wastes. Protecting the environment and conserving natural resources are at the heart of any development. In addition, R&D is currently constantly involved in the development of technology and industry in the field of waste management. Since the partial replacement of cement or aggregates, attempts at concrete ash, crushed concrete, glass waste, rice husks, etc. have been conducted in the concrete industry. If less waste is considered practical and economical for concrete production, significant benefits will be obtained in waste management and lower construction costs. During the works, the possibility of using fly ash, glass powder(GP) as a replacement in some percentage part for cement at different percentages is examined. To this end, this procedure is divided into seven mixed lots. The cement content of 25% is replaced by different proportions of fly ash (FA) and glass powder (GP). Then, the compressive strength(CS) and the flexural strength(FS) were tested in the interval of 7-14- 28 days and compared with ordinary concrete. M25 brand cubes and beams in the laboratory.***

Keywords: ***Proportions, Fly Ash(FA), Glass Powder(GP), M25***

I. INTRODUCTION

Today, the development of our country is growing day by day, various materials are used in construction, of which concrete is one of the most used materials. The use of any recycled material helps maintain an ecological environment. Each has a specific meaning in the field of construction. When using cement, heat of hydration is formed and cracks appear. To reduce the crack, the amount of cement will be reduced by Glass powder and fly ash with a certain percentage. Glass sand is made from 100% post-consumer glass and is available in a wide range. The total amount of glass waste in India in 2012 amounted to 12.57 million tons. The amount of glass waste is 2.4 million tons. It has become cheaper due to the source of the elderly. These materials are recycled and used in construction.

Leaving waste directly in the environment can lead to environmental problems. Therefore, the emphasis is placed on the reuse of waste. The useful waste is used to developed the new byproduct as a extra added materials so that natural resources are used more efficiently, flexible and protected from environment . These industrial wastes are dumped on nearby soil and the natural fertility of the soil is damaged. Fly ash is a finely converted into mineral residue produced by burning coal or dust in a thermoelectric power station that generates electricity. Fly ash is a beneficial mineral mix for concrete. It affects many of the properties of fresh and hardened concrete. Furthermore, the use of waste in the cement and concrete industry reduces the environmental problems of power plants and reduces the production costs of electricity. The project involves the use of cement which can be replaced by fly ash and glass dust. In this work, 7 sets of proportions of different connections are prepared and cubes and beams are poured.

II. MATERIAL DECRIPTIONS

A civil Engineering concrete materials consist of basically cement, sand, aggregate & water.

Other than these the two predominant waste materials is used in this project i.e. glass powder and fly ash. Both the product is partials replaced with cement only due to its fine property just like cement.

As per the below fig 1 & fig 2 the basic materials is added with recycled materials in to it. The fly is obtained from the seganji thermal power plant khandwa MP and glass power is collected through different shops of glass in the city of Indore. The both materials are used as combined mix with each mix. Before use the basic fundamental test can be done i.e. initial(IST) and final(FST) setting time of cement, amount of silt content in sand and test of aggregate. Finally mixing is carried with to get the concrete mix.

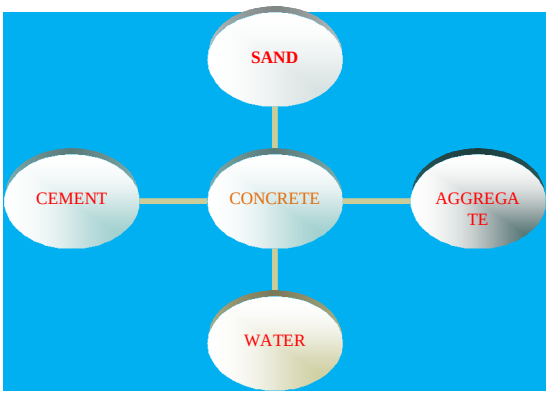


Fig 1: Basic concrete materials

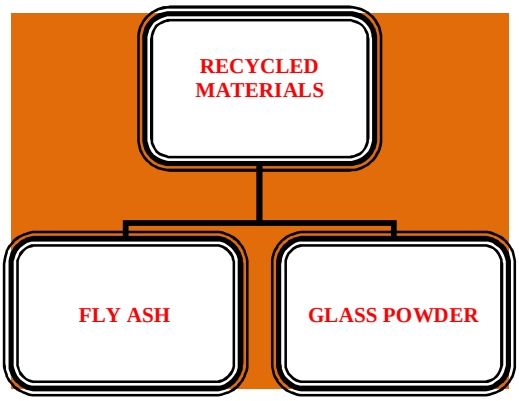


Fig 2: Recycled materials

The result is as follows:

1) *Cement:* For cement the basic test of consistency with initial and final setting time evolution the results get is 0.58 hr (nearly by 0.5 hr as specify in codes) and 9.75 hr (nearly by 10 hr as specify in codes) of OPC cement .
2) *Sand:* The fundamental of silt contents in sand which is obtained as 7.3% (less than 10 % as specify in codes)
3) *Glass Powder:* The power of glass form used in replacement can be tested as a 90 µ sieves (similar to cement size)
4) *Fly Ash :* The power of fly ash form used in replacement can be tested as a 90 µ sieves (similar to cement size)
5) *Aggregates:* The value obtained are impact, Flakiness Index and elongation Index are 15.15, 37.83 and 30.86 respectively

III. MIXING APPROCH OF DIFFERNET BATCHES

The preparation of mix is takes place with taking different 7 mix. The batch mix 1 is standard mix of cement, sand & aggregate and other six mix are taken by replacing cement as a GP and FA. Table 1 shown the mix percentage of different mix.

Table 1: Mix Portions

Mixing Batch	Cement used per mix in %	Fly ash used per mix in %	Glass Powder use per mix in %	Sand used in per mix in %	Aggregate used per mix in %
Batch 1	100	-	-	100	100
Batch 2	75	25	00	100	100
Batch 3	75	20	05	100	100
Batch 4	75	15	10	100	100
Batch 5	75	10	15	100	100
Batch 6	75	05	20	100	100
Batch 7	75	00	25	100	100

IV. WORK STEPS OF PROJECTS

Following steps are to taken for complete the research work.

1) *Step 1: Collections of Recycle Material:* basically the two types of recycle material is used in this project.
a) *Fly ash:* Take it out from Shree Singaji Thermal Power Plant from Khandwa Dist. (M.P.)
b) *Glass Powder:* Waste pieces of broken glass collected from different shops of Indore.
2) *Step 2: Making of Powder Forms:* Selection of other materials: crushed by loss angles machine and pass it 90 micron sieves to convert in powder form.
3) *Step 3: Selection of Basic Engineering Materials*
a) *Aggregate:* In this sieve analysis taken by using 25mm, 20mm, 12.5mm sieves and we get 20mm passing &12.5 retain aggregates
b) *Sand:* Fine sand are taken by using sieve analysis. The sand is which is passed by 4.75 mm sieve i.e. fine sand is used.

4) *Steps 4: Making of Beam Mould:* The availability of cubes moulds are there with size 150 mm x 150 mm x 150 mm. But due to lack of avaibility of beam mould, mould are to be made up by plywood of 12 mm thickness, the inside beam size are taken in mould are 500mm x 100 mm x 100mm.
5) *Step 5: Casting of Cubes and Beams:* The concrete mix is prepared as per different combination of seven batch mix.
6) *Step 6: Testing:* The two fundamental tests are taken on all specimens of seven mix i.e. compressive strength and Flexural Strength test.
7) *Step 7: Results and Conclusions:* On the behalf of testing of specimen the result and conclusion can be taken out.

V. RESULTS AND DISCUSSIONS

In this the compressive strength and Flexural Strength test is perform of batch mix 01 to mix 07 by casted cubes and beams.

A. *Compressive Strength Results*

Nine cubes are cast in each batch mixture to determine compressive strength. Tests were performed in older than 7 days, 14 days and 28 days of experience. Samples are placed in the test machine according to IS: 516-1959, section 5.5.1 page no. 11, is also downloaded on trial and similar IS code. Since there are three tests for each batch mix, the average part of the three values is taken. Table 2 gives the tabulated result of compressive strength obtained by testing of cubes of different mix proportions.

Table 2: Compressive Strength Result

S.N.	Combination	Compressive Strength (N/mm^2)		
		7 Days	7 Days	7 Days
Mix-01	C+S+NCA	18.17	20.63	24.13
Mix-02	75%C+S+NCA+ 25%FA+0%GP	23.20	26.40	30.61
Mix-03	75%C+S+NCA+ 20%FA+5%GP	21.74	24.72	28.67
Mix-04	75%C+S+NCA+ 15%FA+10%GP	21.08	24.03	27.36
Mix-05	75%C+S+NCA+ 10%FA+15%GP	18.91	21.75	25.16
Mix-06	75%C+S+NCA+ 5%FA+20%GP	17.23	19.87	22.86
Mix-07	75%C+S+NCA+ 0%FA+25%GP	15.36	17.71	20.32

B. *Flexural Strength Results*

Beams of size 100mm × 100mm × 500mm are prepared to determine flexural strength. Testing on beams are carried out with in 7, 14 & 28 days of test of specimen. Placement of specimen in machine is done as per IS: 516- 1959 in the clause no 8.3.1 page no 17. Load is applied at increasing rate of 1.8KN/min. Load is applied until specimen fails and load at which specimen fails is recorded. As specified in the IS code flexural strength is calculated and tabulated below table 3:-

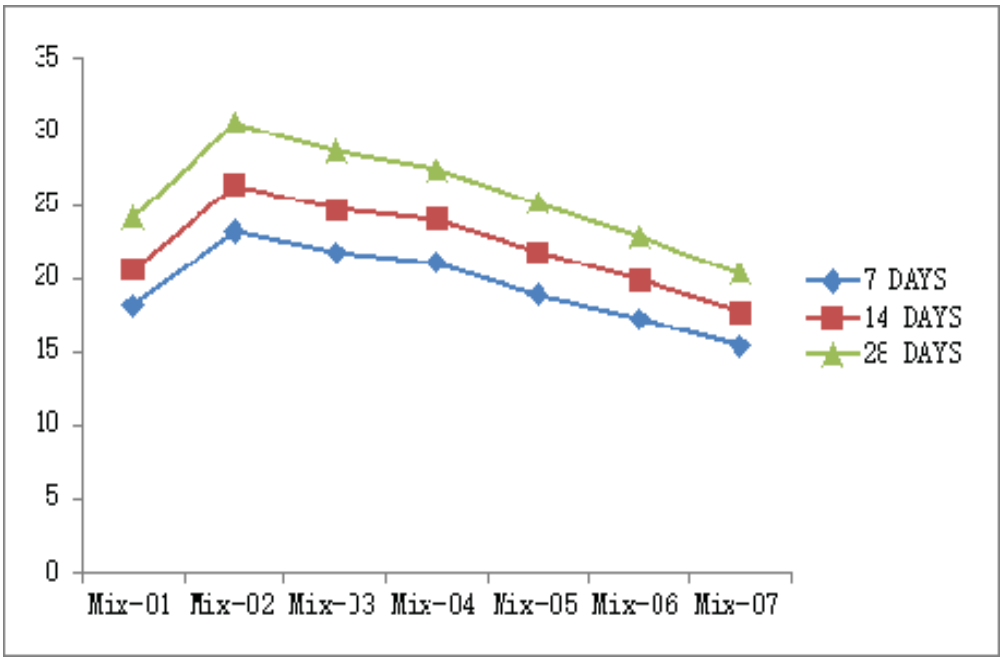
Table 3: Flexural Strength Result

S.N.	Combination	Flexural Strength (N/mm2)		
		7 Days	7 Days	7 Days
Mix-01	C+S+NCA	3.88	4.45	5.14
Mix-02	75%C+S+NCA+ 25%FA+0%GP	4.85	5.58	6.46
Mix-03	75%C+S+NCA+ 20%FA+5%GP	4.53	5.34	6.02
Mix-04	75%C+S+NCA+ 15%FA+10%GP	4.46	5.19	5.98
Mix-05	75%C+S+NCA+ 10%FA+15%GP	4.21	4.89	5.57
Mix-06	75%C+S+NCA+ 5%FA+20%GP	3.88	4.41	5.13
Mix-07	75%C+S+NCA+ 0%FA+25%GP	3.62	4.23	4.75

C. Compressive Strength

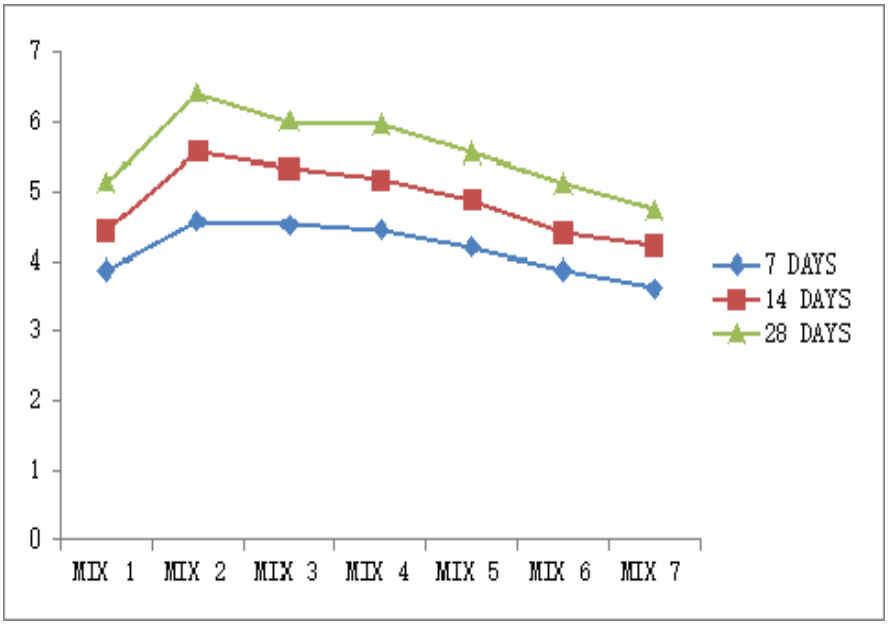
Graph 1 shows compressive strength of cubes for 7, 14 & 28 days curing period. It shows, compressive strength of Mix-02 when 25% cement is replaced by FA, a maximum value is achieved at all the three ages of concrete i.e. for 7, 14 & 28 days. An increment of about 27% was found when compared with conventional concrete. On further replacement of cement by increasing percentage of GP and decreasing FA, a decreased strength was

Graph 1: Compressive Strength in N/mm^2 at different age (Days)



D. Flexural Strength

In graph 2 flexural Strength of beam is shown for at all three curing ages i.e. 7, 14 & 28 days. In this when cement is 25% replaced by FA, a maximum flexural strength was achieved for mix-02. The increment that was observed was 25% as compared to conventional concrete mix. For flexural too, on increasing percentage of GP by decreasing FA, a decreased strength was observed.



Graph 2 : Flexural Strength in N/mm^2 at different age (Days)

VI. CONCLUSIONS

Based on the discussion and from graph 1 & graph 2, this research work can be concluded as:
The replacement of cement at an optimum percentage by FA (25%), improved compressive and flexural strengths as compared to conventional concrete.

A. On decreasing percentage replacement of FA (25% to 0%) by increasing percentage replacement of GP (0% to 25%),decreased strength is determined, i.e. When GP is used as a replacement of cement, the strength of concrete gets reduced.
B. The increase in flexural strength is more when compared with compressive strength with replacement of conventional materials.
C. It was also observed that up to 10 % and 15 % replacement of cement by FA and GP respectively, investigated strengths were more than strengths of conventional concrete, hence depending upon availability of FA and GP, up to 10 % FA and 15 % GP can be used in place of cement without compromising strength.
D. It can be concluded from this research work that FA is predominant used as partial replacement of cement Reduce the material cost in construction by using recycle materials.
E. Experimental Investigation for Feasibility of the Material.
F. Developed the model to recycle by Glass Powder and Fly ash.
G. Decrease in pollution.
H. Reducing Cracks developed due to cement by replacing it recycle materials.

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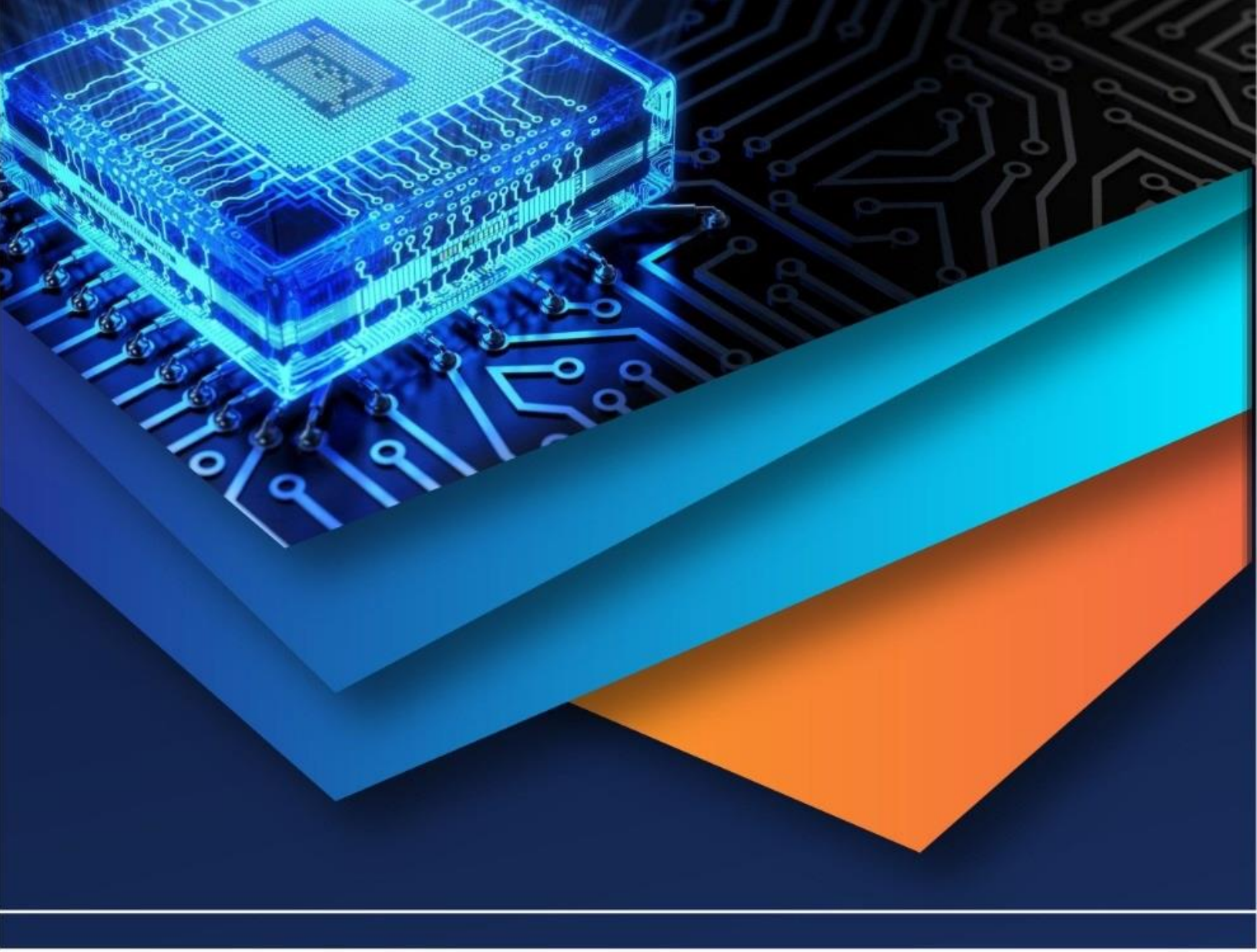

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