EFFECT ON COMPRESSIVE STRENGTH AND WORKABILITY OF M-20 CONCRETE MIX AFTER PARTIAL REPLACEMENT OF CEMENT BY FLY ASH AND FINE AGGREGATE BY WASTE MATERIALS (GLASS POWDER AND STEEL POWDER)

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Abstract: In present scenario of modern society the requirements of well-maintained infrastructure is too challenging to meet. Concrete is a conventional material used for construction over the time. Civil structures are designed considering the target compressive strength of the concrete. Although, few other parameters such as workability, water to cement ratio, setting time of cement and surface hardness influence the performance of concrete. The use of waste material in concrete as Supplementary Cementitious Materials helps to consume these waste materials and also improves the properties of concrete in fresh and hydrated states.

The use of waste materials such as GLASS POWDER & STEEL POWDER as partial Replacement of fine aggregate (Sand) in various proportions (i.e. 10%, 15%, 20% and 25%) is being introduce in present study. Also, blended cement concrete mixes are prepared by mixing of Ordinary Portland Cement and fly ash, replacing the content of OPC by 33 % and 50% with fly ash (i.e. 1:0.5 and 1:1). These blended concrete mixes are also modified by 10%, 15 %, 20%, and 25 % of glass powder and steel powder in replacement of fine aggregate (Sand).

Index Terms **-Compressive Strength, Slump Value- Workability, Waste Materials- Glass and Steel Powder, Fly ash cement Blend.**

I. INTRODUCTION

Concrete is a mixture of cement, sand, coarse aggregate and water. Its success lies in its versatility as can be designed to withstand harshest environments while taking on the most inspirational forms. Engineers and scientists are further trying to increase its limits with the help of innovative chemical admixtures and various waste materials.

Utilization of glass powder, steel powder or other desecrate materials in preparing concrete for various civil engineering projects is a subject of high significance. Integration of extra materials in concrete or mortar affects its several characteristics such as strength, workability and other relative performances.

There are various purposes of applying additional materials as substitute to cement and other components in concrete – first is the financial saving obtained by replacing a considerable part of the sand or other ingredients with these materials and second is enhancement in the properties of concrete.

The ecological aspects of cement are now receiving more concern of researchers, as cement developing is liable for about large amount of total worldwide waste emissions from manufacturing sources. The trend of mixing several kinds of additional materials in building engineering is now growing. This has double advantage -

a. To reduce the quantity of deposited waste.
b. To conserve natural resources.

Additives used in the present study-

Sand (Fine Aggregate) is the main material needed for fulfilling the modern infrastructure needs. As an outcome, the construction and concrete industry worldwide is facing growing challenges in conserving material and energy resources. According to the International Energy Agency, the main concern for material producers are the increase in energy efficiency and the use of substitute wastes or other waste materials. Consequently, it is converting into employ the substitute material in cement concrete. By the sieve analysis of sand it has been determined that sand used in the present study falls under the category of Zone II. Specific gravity of sand is 2.65 and water absorption is found to be 0.6 %.

Glass powder is a significant material utilized in the building production. During the last decade, considerable attention has been given to the use of Glass powder as a partial replacement of sand to produce high-strength concrete. Glass powder is added to

improve the properties of concrete, in particular its compressive strength, and other resistance. Glass powder consists of fine particles with size similar to the size of average sand particle size. This material has low density (200-300 Kg/m3) and a large surface area (13000 - 30000 m2/Kg) and having more than 60 % of silica content. The micro silica is considered as a very active pozzolana. Fineness Modulus (FM): 2.65, Bulk specific gravity (SSD): 2.55, Field moisture content: 0.68 and Absorption capacity: 1.66

Steel powder is formed from steel cutting factories during the sawing and finishing of steel parts, and almost 20 - 25% of the processed steel is converted into the powder. Deletion of the steel powder from the steel cutting places is a noteworthy environmental trouble today. Though, waste material from steel industry can be used to enlarge several properties of concrete. It has been analyzed that typically compressive strength increased with accumulation of this powder in place of cement or sand. Therefore, employment of the steel dust in a variety of industrial sectors particularly the civil engineering projects, would aid to defend the surroundings.

Fly ash, which is mainly made up of silicon dioxide and calcium oxide, can be used as a alternate for Portland cement, or as an add-on to it. The materials which build up fly ash are pozzolanic, hence, they can be used to bind cement materials together.

Coarse Aggregates – By the sieve analysis of coarse aggregate it has been determined that aggregate used in the present study falls under the category of Zone III. Specific gravity of sand is 2.74 and water absorption is found to be 0.9 %.

II. OBJECTIVES OF PRESENT WORK

In the present research a series of experiments had been performed to compare and determine various mechanical properties of concrete mixes prepared by-

a. Ordinary Portland Cement Concrete mix by partial replacement of Fine Aggregate (Sand) with 10%, 15% and 20% and 25% of glass powder and steel powder.
b. Fly ash cement blend 1:0.5 (33% Cement Replaced by Fly ash) by partial replacement of Fine Aggregate (Sand) with 10%, 15% and 20% and 25% of glass powder and steel powder.
c. Fly ash cement blend 1:1 (50% Cement Replaced by Fly ash) by partial replacement of Fine Aggregate (Sand) with 10%, 15% and 20% and 25% of glass powder and steel powder.

III. METHODOLOGY AND MIX DESIGN

Experiments and tests had been performed on cement concrete mixes by using different type of modified mix design of Concrete with different percentages of steel powder and glass powder in partial replacement of fine aggregates.

Three types of Ordinary Portland Cement concrete mixes were prepared, first category plane OPC concrete mix, Blended cement has been prepared by mixing Portland cement with Fly ash in 1:0.5 in Second category and 1:1 proportion in third category has been used for this study. All these three Concrete mixes are modified by 10%, 15% and 20% and 25% of glass powder and steel powder in replacement. For each Concrete mix several cubes have been casted for determining the compressive strength and workability.

Type of Concrete mixes are following on witch Experimental work performed-

Table 1 Mix Details

Percentage of Replacement	Mix for Replacement Waste - Glass Powder			Mix for Replacement Waste - Steel Powder		
	OPC	Fly ash Cement Blend 1:0.5	Fly ash Cement Blend 1:1	OPC	Fly ash Cement Blend 1:0.5	Fly ash Cement Blend 1:1
0 %	Mix- 1	Mix- 2	Mix- 3	Mix- 16	Mix- 17	Mix- 18
10%	Mix- 4	Mix- 5	Mix- 6	Mix- 19	Mix- 20	Mix- 21
15%	Mix- 7	Mix- 8	Mix- 9	Mix- 22	Mix- 23	Mix- 24
20%	Mix- 10	Mix- 11	Mix- 12	Mix- 25	Mix- 26	Mix- 27
25%	Mix- 13	Mix- 14	Mix- 15	Mix- 28	Mix- 29	Mix- 30

According to IS 10262:2009, Mix calculations per unit volume of concrete is as follows: For M-20 grade-
FLYASH 0%, 33% and 50% Grade Designation = M20 Type of Cement = OPC-43
Type of Concrete = PCC Degree of Supervision = Good
Method of Concrete Placing = Pumping Maximum Nominal Size of Aggregates = 20 mm
Exposure Condition = Severe (Min. Conc. Grade M-20 as per Table 5 IS: 456)

IV. RESULTS AND DISCUSSION

4.1 Compressive Strength Results

Table 2 Comparison of Compressive Strength Results

Type of cement	Percent of Replacement	3 days		14 days		28 days	
		Glass Powder	Steel Powder	Glass Powder	Steel Powder	Glass Powder	Steel Powder
Ordinary Portland concrete	0%	9.54	9.54	23.37	23.37	32.46	32.46
	10%	9.75	9.78	23.62	23.94	33.18	33.27

	15%	9.96	10.02	24.15	24.46	33.89	34.10
	20%	10.16	10.27	24.61	25.12	34.57	34.96
	25%	10.37	10.53	25.10	25.62	35.25	35.83

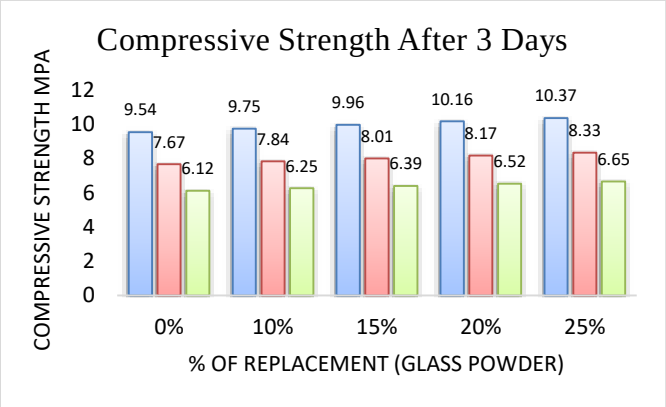
Table 3 Comparison of Compressive Strength Results For Fly Ash Cement Blend (1:0.5)

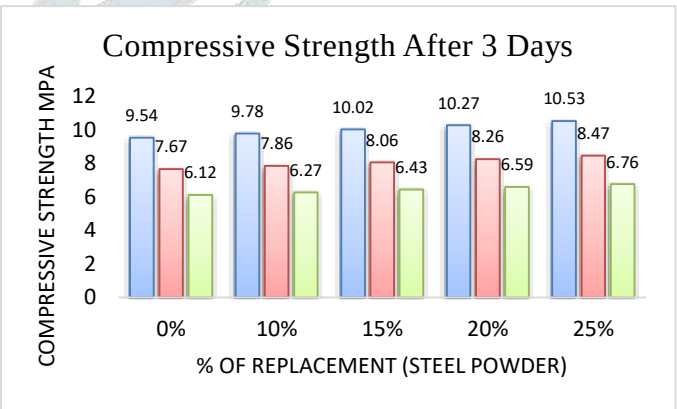
Type of cement	Percent of Replacement	3 days		14 days		28 days	
		Glass Powder	**Steel Powder**	**Glass Powder**	**Steel Powder**	**Glass Powder**	**Steel Powder**
Fly ash cement blend (1:0.5)	0%	7.67	7.67	20.00	20.00	28.57	28.57
	10%	7.84	7.86	20.40	20.50	29.20	29.28
	15%	8.01	8.06	20.86	20.98	29.84	30.02
	20%	8.17	8.26	21.28	21.48	30.44	30.77
	25%	8.33	8.47	21.75	22.06	31.05	31.54

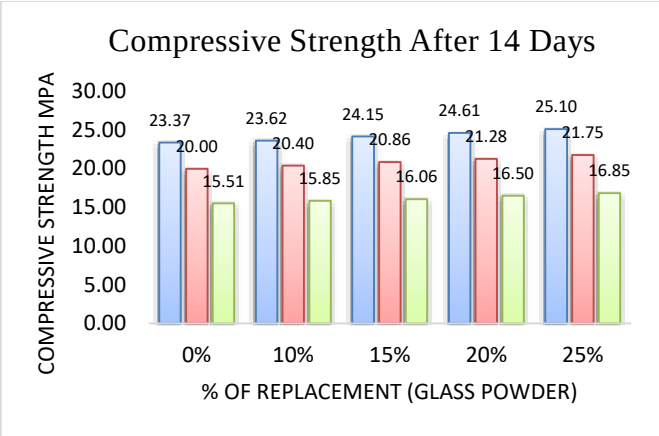
Table 4 Comparison of Compressive Strength Results For Fly Ash Cement Blend (1:1)

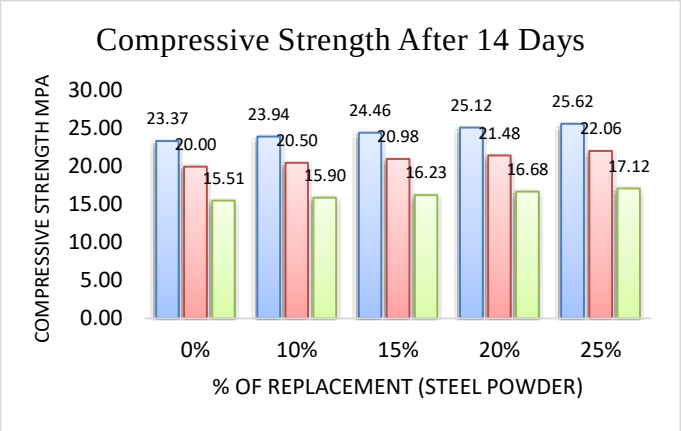
Type of cement	**Percent of Replacement**	**3 days**		**14 days**		**28 days**	
		Glass Powder	**Steel Powder**	**Glass Powder**	**Steel Powder**	**Glass Powder**	**Steel Powder**
Fly ash cement blend (1:1)	0%	6.12	6.12	15.51	15.51	22.16	22.16
	10%	6.25	6.27	15.85	15.90	22.60	22.60
	15%	6.39	6.43	16.06	16.23	23.10	23.24
	20%	6.52	6.59	16.50	16.68	23.46	23.75
	25%	6.65	6.76	16.85	17.12	23.96	24.34

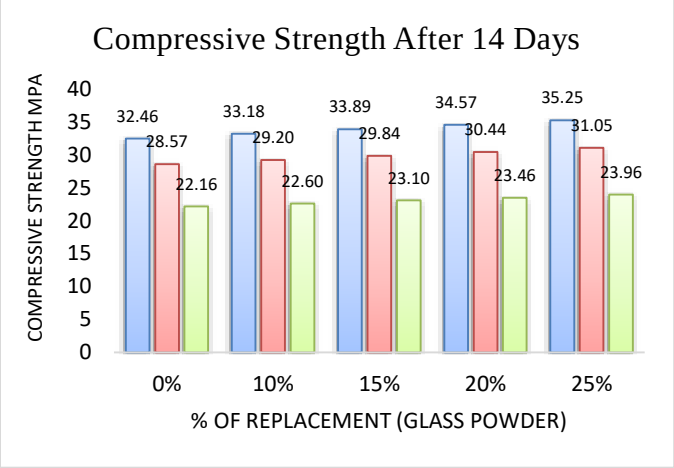
- Compressive strength of Ordinary Portland Cement concrete is higher then fly ash cement blend (1:0.5) and Fly ash cement blend (1:0.5) concrete compressive strength is higher than Fly Ash Cement Blend (1:1) concrete.
- In all these three type concrete- ordinary portland concrete, Fly ash cement blend (1:0.5) and Fly ash cement blend (1:1) with the increase in percent of replacement waste material (Steel Powder and Glass Powder) Compressive strength at 3 days, 14 days and 28 days increases.
- Steel powder as replacement waste material gives higher compressive strength with compare to Glass powder.

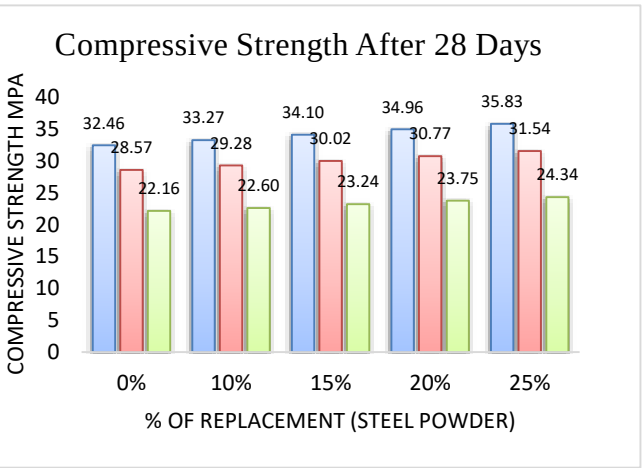










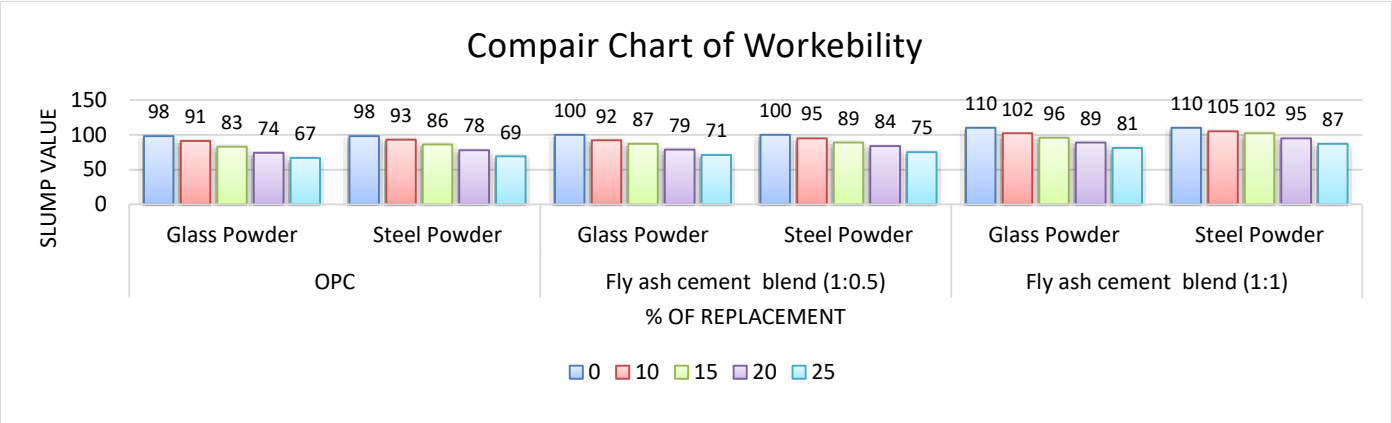


4.2 Result for Slump Value- workability

Table 5 Comparison of Workability (Slump Value) Results

MIX	% Replacement	Slump Value for Sand Replaced By Glass Powder	Slump Value for Sand Replaced By Steel Powder
Ordinary Portland concrete	0	98	98
	10	91	93
	15	83	86
	20	74	78
	25	67	69
Fly ash cement blend (1:0.5)	0	100	100
	10	92	95
	15	87	89
	20	79	84
	25	71	75
Fly ash cement blend (1:1)	0	110	110
	10	102	105
	15	96	102
	20	89	95
	25	81	87

- Workability of Ordinary Portland Cement concrete is lesser then fly ash cement blend (1:0.5) and Fly ash cement blend (1:0.5) concrete compressive strength is lesser than Fly Ash Cement Blend (1:1) concrete.
- In all these three type concrete- ordinary portland concrete, Fly ash cement blend (1:0.5) and Fly ash cement blend (1:1) with the increase in percent of replacement waste material (Steel Powder and Glass Powder) Workability increases.
- Steel powder as replacement waste material gives higher workability with compare to Glass powder.



V. CONCLUSION

Experiments have been done in order to examine Steel Powder and Glass powder as replacement of sand in concrete. Various Concrete mixes were prepared by replacing sand with these materials for determining compressive strength and slump values.

The following conclusions are derived from the experimental programme:

5.1 Replacing of Sand by Glass Powder with following-

Ordinary Portland Cement in early stage (3 days) while changing the proportion of glass powder by 0% to 25% in OPC the increment is 8.70 %. At, 14 days the increment is 7.40 % and at 28 days the increment of 8.59% has been noted.

Fly Ash Cement Blend 1:0.5 (By replacing the 33% of OPC content with fly ash) at early stage (3 days) while changing the proportion of glass powder by 0% to 25% the increment is 13.95%. At, 14 days the increment is 8.75 % and at 28 days the increment of 8.68 % has been noted.

Fly Ash Cement Blend 1:1 (By replacing the 50% of OPC content with fly ash) at early stage (3 days) while changing the proportion of glass powder by 0% to 25% the increment is 10.46%, At 14 days the increment of 6.38 % and at 28 days the increment of 5.87 % has been noted.

5.2 Replacing of Sand by Steel Powder with following-

Ordinary Portland Cement in early stage (3 days) while changing the proportion of steel powder by 0% to 25% in OPC the increment is 10.37 %. At, 14 days the increment is 9.63 % and at 28 days the increment of 10.38% has been noted.

Fly Ash Cement Blend 1:0.5 (By replacing the 33% of OPC content with fly ash) at early stage (3 days) while changing the proportion of glass powder by 0% to 25% the increment is 10.43%. At, 14 days the increment is 10.30 % and at 28 days the increment of 10.29 % has been noted.

Fly Ash Cement Blend 1:1 (By replacing the 50% of OPC content with fly ash) at early stage (3 days) while changing the proportion of glass powder by 0% to 25% the increment is 10.45%, At 14 days the increment of 10.38 % and at 28 days the increment of 9.84 % has been noted.

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