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Effect of partial replacement of sand by glass powder and steel powder over the properties of M-30 concrete

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ABSTRACT

In the present research, a series of experiments had been performed to compare the use of glass powder and steel powder as partial replacement of sand in different proportions. Concrete mixes are modified by 10%, 15% and 20% and 25% of glass powder and steel powder in replacement. The inclusion of glass powder increases the compressive strength up-to certain proportions. It has also been noted that with the increase in the content of glass powder decreases the slump value or workability. It has also been noted that with the increase in the content of supplementary materials decreases the slump value or workability. Comparatively higher early strength gain (7-days) is obtained with steel powder concrete.

Keywords— *Steel powder, Glass powder, Concrete, Workability, Compressive strength*

1. INTRODUCTION

In the present research, a series of experiments had been performed to compare the use of glass powder and steel powder as partial replacement of sand in different proportions. Concrete mixes are modified by 10%, 15% and 20% and 25% of glass powder and steel powder in replacement.

It is usually believed that concrete structures designed for a service life of more than 60 years would actually last much longer with no maintenance. But by the use of an inappropriate specification or the use of regular and improper materials or construction practice could be the cause of early deterioration.
The utilization of mineral admixtures or so-called supplementary construction materials offers new chances to concrete technology. With the appropriate selection of the blending material and its chemical admixture, it is now possible to make concrete for focused applications, having ultra-high strength, low permeability and high performance in different environments.

2. OBJECTIVES OF STUDY

In the present research, a series of experiments had been performed

- To compare and determine various mechanical properties of concrete mixes prepared by OPC.
- To analysis the change in properties of concrete when ingredients (glass powder and steel powder) are mixed in M-30 proportions. The properties studied are 7 days, 14 days and 28 days compressive strengths and workability.
- To check the effect on properties of concrete mixes which are modified by adding 10%, 15%, 20% and 25% of glass powder and steel powder as partial replacement of sand.

3. METHODOLOGY

Experimental work had been conducted on cement concrete mixes by using a different type of binder mix modified with different percentages of steel powder and glass powder in partial replacement of fine aggregates. Concrete mixes are modified by 10%, 15 %, 20% and 25% of glass powder and steel powder in replacement. For each replacement 9 cubes have been cast for determining the compressive strength and workability.

4. EXPERIMENTAL PROCEDURE

Experiments have been performed for evaluating compressive strength of concrete blocks prepared by replacing sand with glass powder and steel powder in different percentage. Several concrete cubes have been prepared by replacing 10%, 15%, 20% and 25%, sand by weight with these waste materials. For preparing mix the cement, sand, and aggregate have been batched as per the design mix for forming M-30 mix. Cube molds of 150 x 150 x 150 mm have been used for casting cubes.

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Table 1: Design Mix for M-30 concrete for 1 cubic meter concrete

S. no	Particular item	Weight in kg/m3
1	Cement	350
2	Water	140
3	Fine aggregate	723
4	Coarse aggregate - 20mm	726
5	Coarse aggregate - 10mm	475
6	Chemical admixture	3.15
Total		2417.15

In the table given above there is the quantity of each material used for the production of one cubic meter of concrete but in the present study, we have to prepare 100 kg of concrete for without replacement of fine aggregate and at each replacement of fine aggregate that is 10%, 15%, 20%, 25%. We produce 100kg of concrete for each replacement because for each stage we cast 9 cubes (150mm*150mm*150mm) and weight of each cube is around 8 kg to 8.4 kg therefore for the casting of 9 cubes we required 72 kg to 75 kg concrete. For the safer side, we prepare 100 kg of concrete.

For preparing the 100 kg of concrete, the quantity of each ingredients given in above table is calculated as per requirements of 100 kg of concrete and after the calculations, each quantity are listed in the below-given table :

Table 2: Design Mix for M-30 concrete for 100 kg concrete

S. no	Particular item	Weight in kg for 100 kg of concrete
1	Cement	14.48
2	Water	5.79
3	Fine aggregate	29.91
4	Coarse aggregate - 20mm	30.03
5	Coarse aggregate - 10mm	19.65
6	Chemical admixture	0.13
Total		99.99

In the present research, we have to partially replace the sand with the glass powder and steel powder at 10%, 15%, 20%, 25% while quantities of all other materials remains the same.

The weight of sand, steel powder & glass powder is mentioned in the below-given table:

Table 3:The weight of sand, steel/glass powder for 100 kg concrete

S. no	% Replacement	The weight of materials in Kg	
		Sand	Steel Powder / Glass powder
1	0	29.91	0
2	10	26.919	2.991
3	15	25.424	4.486
4	20	23.928	5.982
5	25	22.434	7.476

5. RESULTS

5.1 Replacement by Glass Powder

By replacing sand with glass powder in different percentages the following results have been obtained
From the below-given table, it has been found that:

1. From the experiment, it has been observed that the strength of concrete after replacement with glass powder is increased up to a certain proportion after that it starts decreasing.
2. Early or 7 days strength increases rapidly with increase in the percentage of replacement by glass Powder up to a certain percentage.
3. When we replace sand with glass powder at 25% the strength of concrete is less than the strength of concrete at 20% replacement.

Table 4: Results of the compressive test

Type of cement	% of sand replaced by Glass powder	7 days	14 days	28 days
OPC	0	23.54	28.48	33.91
	10	24.95	29.91	35.19
	15	26.48	31.17	36.85
	20	28.12	33.45	38.72
	25	27.05	31.78	37.47

The compressive strength of concrete at 7, 14 & 28 days at different percentage of glass powder has been presented in the form of bar graphs in the following figure:

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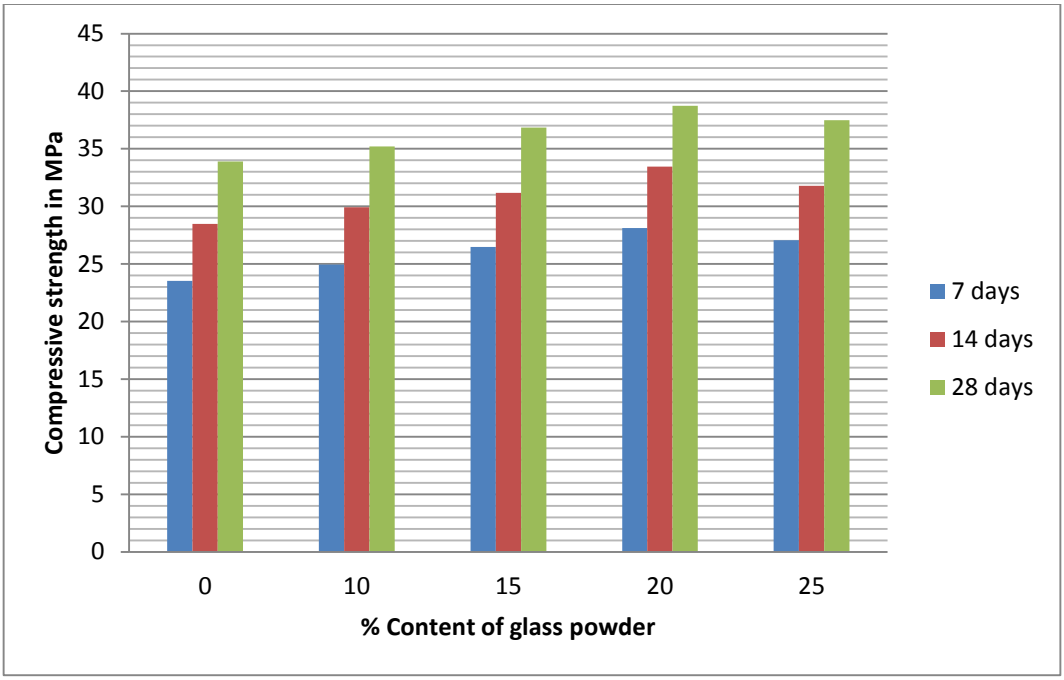

Fig. 1: The compressive strength of OPC concrete

5.2 Replacement by steel Powder

By replacing sand with steel powder in different percentages following results have been obtained:-

From the below-given table, it has been found that –

1. From the experiment it has been observed that the strength of concrete after replacement with steel powder is increased up to a certain proportion after that it becomes nearly constant and after further replacement, it starts decreasing.
2. Early or 7 days strength increases rapidly at 10 % replacement by steel Powder.
3. When we replace sand with steel powder at 20% the strength of concrete is almost similar to the strength of concrete at 15% replacement.
4. When we replace sand with steel powder at 25% the strength of concrete is lesser than the strength of concrete at 20% replacement.

Table 5: Results of the compressive test

Type of cement	% of sand replaced by steel powder	7 days	14 days	28 days
OPC	0	23.54	28.48	33.91
	10	26.45	30.29	34.94
	15	27.98	31.87	35.78
	20	27.95	31.80	35.75
	25	27.15	30.95	35.18

The compressive strength of concrete at 7, 14 & 28 days at different percentage of steel powder has been presented in the form of bar graphs in the following figures.

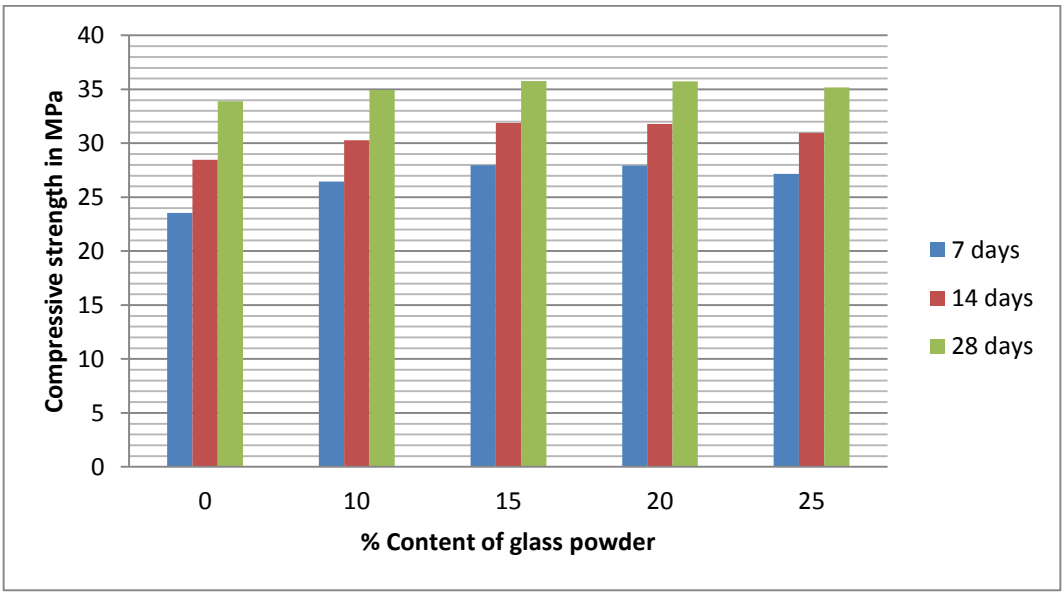

Fig. 2: The compressive strength of OPC concrete

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5.3 Replacement of sand with glass powder

Along with compressive strength workability of concrete is major parameter required for testing the quality of the concrete mix, again by mixing glass powder in cement concrete in different proportions such as in 10, 15, 20 and 25% following results were obtained.

It has been observed from below given table that slump value reduces with the increase in values of percentage replacement following changes are presented in the following figures. However, it has been observed that workability of concrete increases with the use of steel powder.

Table 6: Results of workability test

Mix	% Replacement	Slump Value
OPC	0	94
	10	90
	15	88
	20	85
	25	70

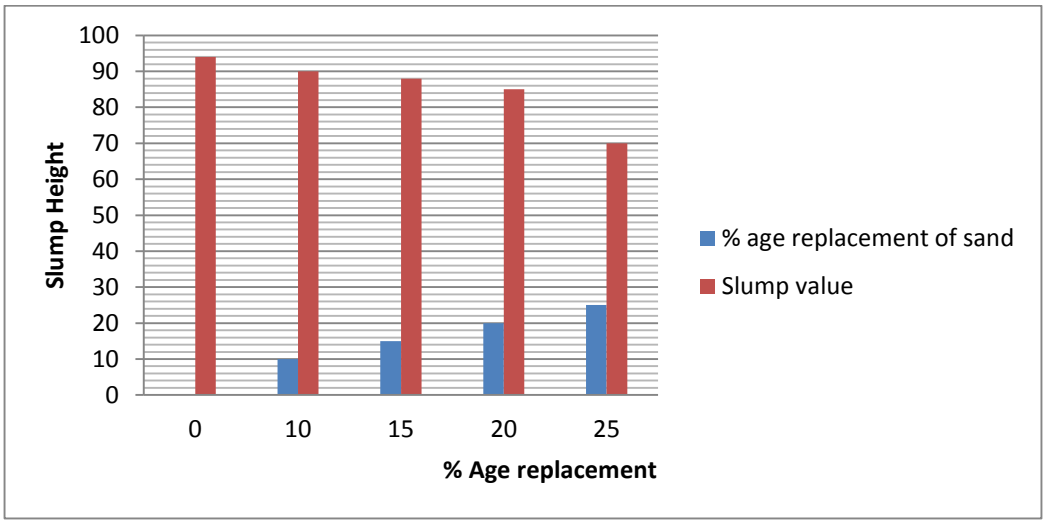

Fig. 3: Slump height for OPC

5.4 Replacement of sand with steel powder

Along with compressive strength workability of concrete is major parameter required for testing the quality of the concrete mix, again by mixing glass powder in cement concrete in different proportions such as in 10, 15, 20 and 25% following results were obtained.

Table 7: Results of workability test

Mix	% Replacement	Slump Value
OPC	0	94
	10	94
	15	92
	20	85
	25	75

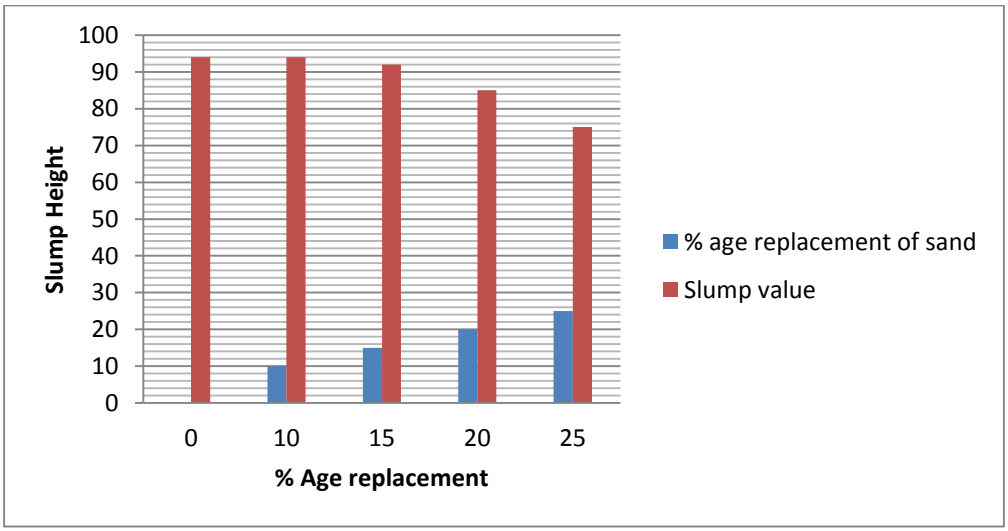

Fig. 4: Slump height for OPC

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6. CONCLUSION

The main conclusions drawn are that inclusion of glass powder increases the compressive strength up-to certain proportions. It has also been noted that with the increase in the content of glass powder decreases the slump value or workability. It has also been noted that with the increase in the content of supplementary materials decreases the slump value or workability. Comparatively higher early strength gain (7-days) is obtained with steel powder concrete.

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