

A Research Paper on Use of Silica Fume and Plastic Waste in Concrete

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Abstract: For the most part, for making the common structure conventional Portland concrete is utilized around the world. Utilization of plastic waste and silica fume in concrete is a fractional answer for natural issues caused because of concrete. We used M30 grade of concrete and then substituted cement by silica fume in 6%, 9%, & 12% and coarse aggregate by plastic waste in 10%, 20% and then we combine replace cement by silica fume 12% and replacing coarse aggregate by plastic waste with 20%. We found that 6% cement replaced by silica fume give 10% increase in compressive strength as compare to other. We conclude that replacement of cement by silica fume increase in strength by upto 10% and plastic waste replace by coarse aggregate does not yield satisfactory result.

Index Term: Silica Fume Plastic waste, Compressive Strength, Concrete Replacement, etc.

1. INTRODUCTION

Cement is becoming a scarce resource all over the world because of its increasing demands day by day. The construction activities have increased in almost all the developing countries of the world. There always has been great effort in improving the quality and standards of the properties of concrete as a construction material. Traditionally plastic waste and silica fume or the combination of both is added to concrete as a pozzolana material to enhance the properties of concrete. According to Central Pollution Control Board of India, Total plastic waste which is collected and recycled in the country is estimated to be 9,205 tonnes per day (approximately 60% of total plastic waste) and 6,137 tonnes remain uncollected and littered. This is a major environmental issue. Stray animals sometimes eat the waste plastic and die causing further aesthetic and environmental issues. The use of silica fume as a pozzolana material has increased in recent years because when mixed in certain proportions it enhances the properties of both fresh and hard concrete like durability, strength, permeability and compressive strength. Silica fume consists of the fine particles with specific surface about six times of cement because its particles are very finer than cement particles. In this project work we have cast various combinations of concrete. In this study we replacing cement by silica fume in 6%, 9% & 12% and replacing coarse aggregate by plastic waste with a percentage 10% & 20%. Then we combined replace cement by silica fume in 12% and replacing coarse aggregate by plastic waste with 20%. The details of results obtained along discussed in this report along with some suggestion.

II. LITERATURE REVIEW

Sr. No.	Name of Paper and author	Method	Observation	Result & Conclusion
1.	Utilization of waste plastic as a partial replacement of coarse aggregate in concrete blocks - S. Vanita, V. Natrajan & M. Praba	Waste plastic is replaced by aggregate. Aggregate such as 0%, 2%, 4%, 6%, 8%, & 10% added in percentages, in order to replace the same amount of aggregate.	Compressive strength value of the concrete mix decreased with the addition of waste plastics more than 4% of waste plastics.	I. The plastic can be used in the cement concrete mix. II. The cost of construction will reduce.
2.	Use of Plastic in a concrete to improve its properties -Raghatate Atul M.	Compressive strength test and Split tensile strength test carried out on M20 grade of concrete with W/C ratio 0.45 as per IS14858:2000	I. Compressive strength goes on reducing with increase in % of plastic pieces but the rate of reducing compressive strength is very low. II. Improvement of tensile strength	III. Use of plastic can be possible to improve the properties of concrete. IV. The plastic use can increase the tensile strength of concrete.

3.	Influence of silica fume on concrete - Prof. Vishal S. Ghutke , Prof. Rankita S. Bhandari	1) Mix proportioning: M20 grade of concrete & two water cementitious ratios are used(w/cm 0.5, w/cm 0.6) 2) Workability of concrete conducted by slump cone test	3) With the increase in w/cm ratio strength of concrete decreases 4) The optimum value of compressive strength can be achieved in 10% replacement of silica fume	5) Silica fume is better replacement of cement 6) Rate of strength gain in silica fume concrete is high.
4.	Study of partial replacement of cement by silica fume -Lakhbir Singh, Arjun Kumar, Anil Singh	1) Compressive strength & split tensile strength is carried out. 2) Batching, mixing & curing 3) Mix design (M30)	With the increasing % of silica fume , compressive strength increases from 5% to 10% respectively. After 10% it starts decreasing.	The strength & durability characteristics of concrete mixture have been computed in the present work by replacing 5%. 10% & 15% silica fume with the cement.
5.	Re-use of polyethylene Plastic Waste in concrete -Prof. M. Mahesh, Prof. B. Venkat Narsimha Rao, Prof.CH. Satya Sri	Waste plastic added in 0%, 2%, 4%, 6% with replacement of aggregate.	Compressive strength reduced with increase in % of plastic pieces but at low reducing rate	I. Waste plastic can be effectively reused without affecting mechanical properties. II. Specific gravity of waste plastic is less than that of fine aggregate ,thus self wt. of concrete reduces.

III. MATERIALS USED

- Cement:** It is very fine powder with adhesive properties and acts as binder material in the concrete matrix. Ordinary Portland cement of 43 grade cement was used in this study. The basic tests were carried out in accordance with relevant IS codes. Pozzolana Portland cement of Ambuja brand of 53 grade confirming IS 12269-1987.
- Coarse Aggregate:** Crushed aggregate confirming to IS: 383-1987 was used. Aggregates of size 20 mm of specific gravity 2.71 kg/m³
- Fine Aggregate:** Natural sand as per IS: 383-1970 was used. Locally available Bhandara River sand having specific gravity 2.63kg/m³.
- Water:** Water confirming to as IS 456-2000 for mixing as well as curing concrete specimens.
- Micro silica:** Micro silica procured from the steel wire industries, Nagpur. It contains 85.5 percent silicon dioxide. Bulk density varies from 550 to 650Kg/m³. Following are the property of micro silica:-

TABLE NO.1: Property of Micro Silica

ANALYSIS	RESULT` A85
SiO ₂ (%)	85.50
Fe ₂ O ₃ (%)	0.85
Al ₂ O ₃ (%)	0.36
CaO (%)	0.60
Na ₂ O +K ₂ O	0.45
Moisture	2.25
Loss On Ignition	2.92
PAI at 7 days	100%
Bulk Density (kg/m ³)	550-650

- 6) *Plastic Waste*: Plastic waste is in crushed form having particle size below 10mm. Specific gravity 1.3 gm/cc.



- 7) *Plasticizer*: ADDAGA PLAST AP 251 Plasticizer having specific gravity 1.121 gm/cc, PH value is 7 and Chloride contain is less than 0.05%
- Reduces water up to 15% without affecting the workability.
 - Increase workability at a given W/C ratio easy compaction, eliminates honeycombing.
 - Provides highly cohesive concrete mix and reduce the chance of bleeding and segregation.
 - Applied for positive negative sides of water proofing.
 - No- Chloride suitable for RCC.

IV. EXPERIMENTAL PROCEDURE

A. Mix Design of Concrete

Concrete mix design is the process of finding the proportions of concrete mix in terms of ratio of cement, sand and coarse aggregates.

According to IS10262:2009, the prepared mix design the quantities for 1m^3 and the ratio obtained are as follows:

- CEMENT : 380.56 kg/m^3
- WATER : 167.45 kg/m^3
- FINE AGGREGATE : 800.87 kg/m^3
- COARSE AGGREGSATE : 1088.57 kg/m^3
- ADMIXTURE : 2.1 L/m^3
- W/C RATIO : 0.44
- MIXING RATIO : 1:2.1:2.86

B. Preparation Of Speciman

For this study, M30 grade of concrete and 0.44 as W/C ratio, after calculating the quantities seven types of concrete mix were prepared.

- Conventional concrete
- Concrete (6% Silica Fume)
- Concrete (9% Silica Fume)
- Concrete (12% Silica Fume)
- Concrete (10% Plastic Waste)
- Concrete (20% Plastic Waste)
- Concrete (12% Silica Fume & 20% Plastic Waste).

Total 63 cubes were casted for compressive strength test.

C. Measurement of Ingredients

The measurement of materials used for preparing concrete paste is done using weight batching. The following quantity of materials was used for preparing concrete.

1) *Quantity of Material:* Volume of concrete for each type is 0.05m³.

TABLE NO.2: Quantity of material

Concrete Mix	Cement (kg)	Silica Fume (kg)	Plastic Waste (kg)	Fine Agg. (kg)	Coarse Agg. (kg)	Water (kg)	Admixture (L)
Type 1	19.03	0	0	40.03	54.43	8.37	0.105
Type 2	17.93	0.9	0	40.03	54.43	8.37	0.105
Type 3	17.36	1.33	0	40.03	54.43	8.37	0.105
Type 4	16.79	1.79	0	40.03	54.43	8.37	0.105
Type 5	19.03	0	1.97	36.03	54.43	8.37	0.105
Type 6	19.03	0	3.94	32.02	54.43	8.37	0.105
Type 7	16.79	1.79	3.94	32.02	54.43	8.37	0.105

- a) *Mixing of Concrete:* The mixing of ingredients of concrete was done using electric concrete mixer machine. As per the guidelines of the IS Code 15388:2003, silica fume and plastic waste concrete is prepared.
- b) *Workability of Concrete:* Workability is defined as the properties of freshly mixed concrete or mortar which determines the homogeneity with which it can be mixed, placed, consolidated and finished. In the investigation, we observed that the slump of the concrete reduces with constant W/C ratio.

TABLE NO.3: Slump Reduction of Concrete

Types of concrete mix	% replacement of cement by SF	% replacement of sand by PW	Slump for W/C ratio (0.44)
Type 1	0	0	80
Type 2	6	0	82
Type 3	9	0	75
Type 4	12	0	70
Type 5	0	10	50
Type 6	0	20	40
Type 7	12	20	40

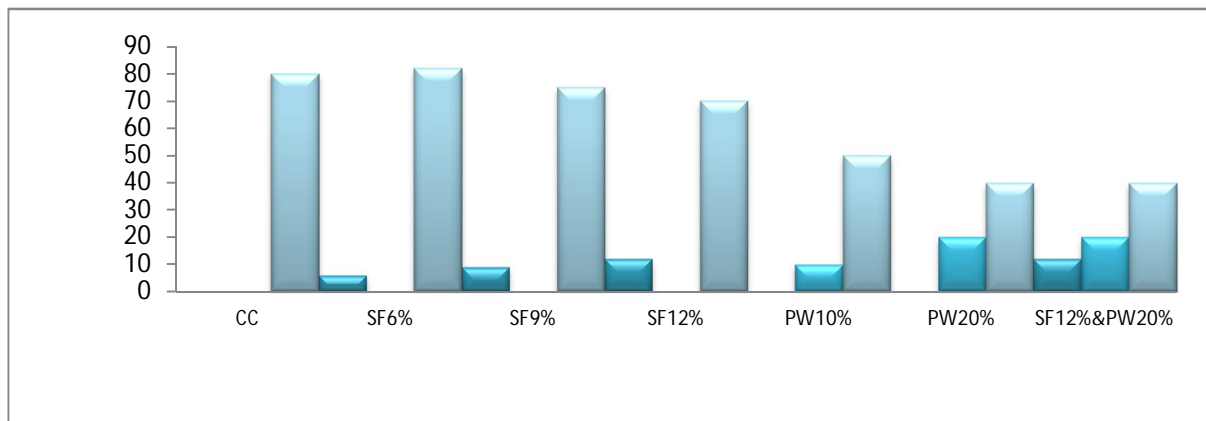


Fig. (a) Slump Reduction of Concrete

- c) *Placing Of Concrete And Compaction:* Standard cube of size (150 mm x 150 mm x 150 mm) was used as specimens for determination of compressive strength of concrete. Three specimens were tested for 7, 14 & 28 days. The concrete was filled 3 layers and each layer is compacted 25 times.
- d) *DE-Moulding and Curing of Speciman:* After 24hours, the specimens were removed from the mould and cured in clean water for 7, 14, & 28 days and then cube were tested for compressive strength as per Indian Standard Guidelines. The temperature of water used for mixing and curing was 27±2°C.

V. PERFORMANCE ANALYSIS

A. Compressive Strength Of Cubes

After the curing of concrete cube for respective days i.e. 7 day, 14days, 24 days, the cube was tested in the compressive testing machine. The following formula was used to derive the compressive strength of respective day of the cube from the readings. The details are given in table:

Formulated as,

$$\text{Compressive strength of cube} = \frac{P}{A} \text{ N/mm}^2$$

Where,

P= Load applied by CTM in N

A= Cross section area of cube in mm²

Table No: 4 Result Of Compressive Strength

Concrete Mix	7 days	14 days	28 days
TYPE 1	18.98	25.72	36.44
TYPE 2	23.33	34.62	40.44
TYPE 3	20.45	27.8	38.5
TYPE 4	19.47	27.87	37.2
TYPE 5	11.78	12.8	24.09
TYPE 6	3.07	9.51	14.62
TYPE 7	8.21	14.62	18.58

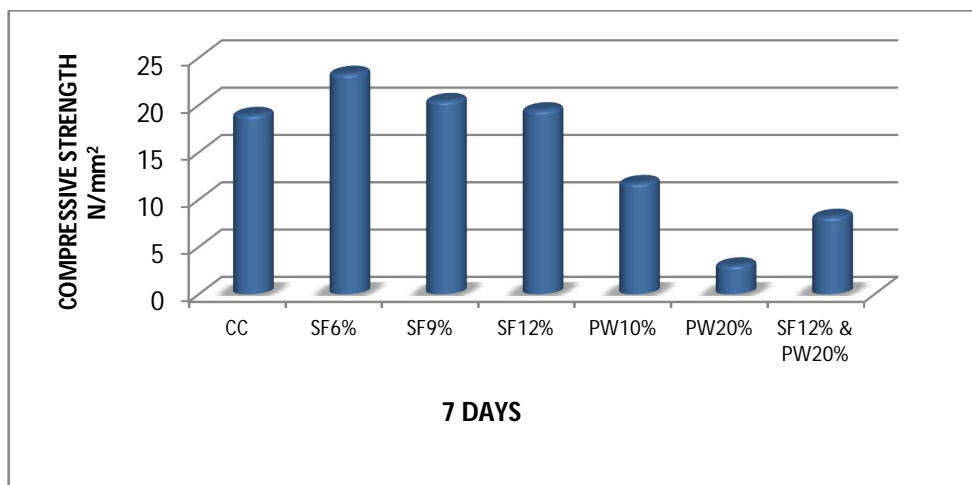


Fig. (b) Compressive Strength Test 7 Days

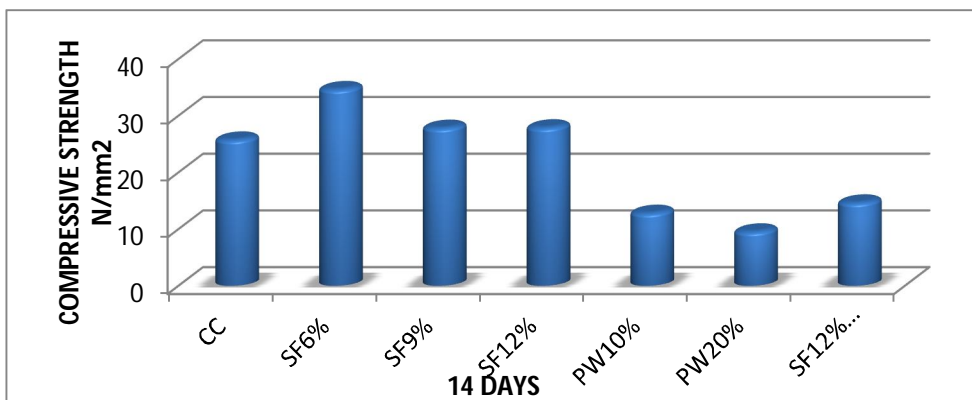


Fig. (c) Compressive Strength Test 14 Days

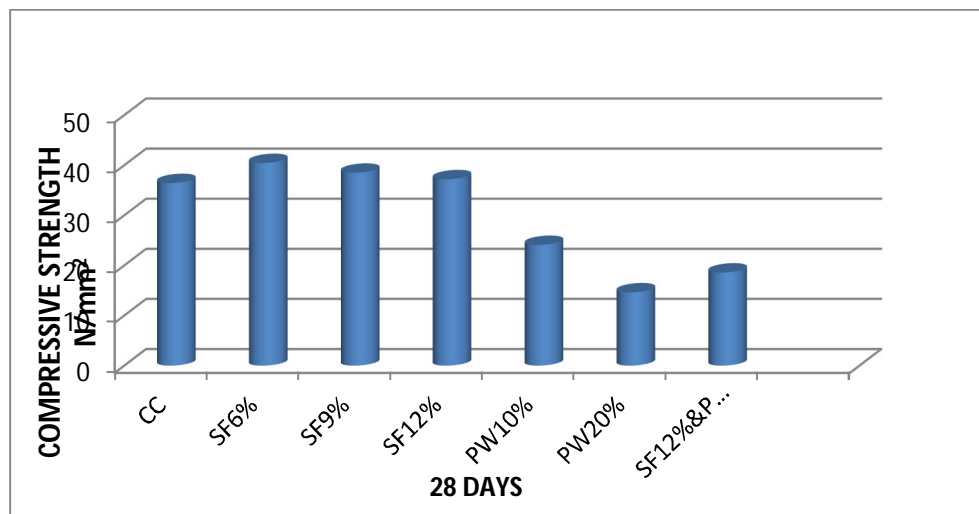


Fig. (d) Compressive Strength Test 28 Days

VI. CONCLUSION

On the basis of experimental investigation about the replacement of cement using silica fume and coarse aggregate using plastic waste the following conclusion are found out:

- A. With increase in replacement of cement by silica fume the compressive strength of the concrete increased up to 9% replacement.
- B. It is observed that the compressive strength of the concrete containing silica fume is higher than the concrete containing plastic waste.
- C. It was observed that workability of concrete was increased in silica fume concrete as compared to the plastic waste concrete.
- D. The compressive strength was increased by 10.4% in type 2 concrete, 2% in type 3 concrete and decreased by 5% in type 4 concrete.
- E. It is observed that plastic waste concrete does not yield sufficient compressive strength rather it decreased.

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