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EFFECT OF BI-BLEND SILICEOUS MATERIAL ON STRENGTH PROPERTIES OF BI-BLEND SILICEOUS CONCRETE (BBSC)

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ABSTRACT

Now-a-days, the pollution is beyond tolerable limits. The rate at which pollution increasing is worrying scientist all over the world. Many sectors are culprits behind this situation, of which manufacturing of cement is also a main and active participant. This work emphasizes to reduce using of pollution producing agent cement in production of concrete, with siliceous materials without varying its mechanical properties of concrete. Siliceous materials, which also help not only to improve C-H-S gel but also improve packing factor leading to increase in strength of concrete. Siliceous materials chosen were Fly ash and silica flour basing on their specific usability and their existing standing in world. Generally, production of cement evolves a lot of carbon discharge associated with other harmful chemicals. As per research done for every one ton of cement made it discharges half-ton of carbon dioxide, so there is an immediate need to control the usage of cement. Material wastes such as Fly Ash and Silica Flour are problematic in nature to dispose of. Uncontrolled dispose leads to environmental menace.

This work mainly focus on production of concrete of M50 grade with the replacement of cement with siliceous materials, controlled bi-blend of Silica Flour and Fly Ash (six parts of silica flour and four parts fly-ash) and studying mechanical properties of Bi-Blend Siliceous Concrete (BBSC). The concrete mixes considered by replacing cement with proportions of bi-blend siliceous material of 0%, 5%, 10%, 15%, 20%, 25% and 30% are designated as C0,C1,C2,C3,C4,C5 and C6 studied at ages of 7 days, 28 days.

Comparing with ordinary concrete of M50 grade BBSC reached acceptable strength without losing much workability. Mixes C1 to C3 achieved targeted compressive strength at 7 and 28 days, strength increased steadily. Mixes C4 and C5 have attained highest compressive strength at 7th and 28th day respectively, But are harsh mixes. C6 mix did not achieved designated strength. All mixes except C6 gave acceptable results in split tensile strength and flexural strength.

Key words: Bi-Blend Siliceous Concrete (BBSC), Compressive Strength, Flexural Strength, Split Tensile Strength, Silica Flour.

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1. INTRODUCTION

Ordinary Portland cement, the most commonly used building material throughout the world. It will retain its status in near future also since of demand and expansion of construction industry all over the world. Further the greatest challenge before the concrete construction industry, to serve the two pressing fundamentals of human society, namely the protection of environment and meeting the infrastructure necessities of our growing population.

In manufacturing of conventional cement nearly for every one ton of cement produced, approximately half ton of CO_2 has been released in to the atmosphere.

It has been a great deal for engineers to come across the ever rising demand on one hand and on other conservation the environment.

The use of blended cements have performed significantly well. Research have concluded that fly ash and silica flour which shows pozzolonic properties can be used as a partial replacement in concrete. It has been documented that strength of concrete may vary depending on content of Pozzolonic material in concrete. Strength increased when pozzolonic material used was less than 30 percent of weight of cement used. Since pozzolonic material were inert in nature and weren't involving in C-H-S gel formation. Rather fine nature of pozzolonic material strengthen mix in other way around by filling the voids. Making concrete a densely packed, substantively increasing strength. Here in this study regular interval of five percent has been considered up to thirty percent pozzolonic material replacing cement by weight. Fly ash, being produced from thermal power units' waste material which will be grinded to the fine less than cement for obtaining good bonding between cement and fly ash

2. MATERIALS

In this present experimental investigation Silica flour and fly ash has been used as partial replacement by weight of cement in concrete mixes.

2.1. Concrete

Materials used in this work were locally available. Ordinary Portland cement of 53 grade from a single batch was used for entire work. Airtight containers were used to prevent it from being affected by the atmospheric effects and moisture. The cement procured was tested for in accordance with IS 12269-2013 and for chemical analysis in accordance with IS: 4032-1977 R 2014. Preliminary test have been conducted on Cement and mortars were casted to verify quality of batch before work. Results were acceptable, hence batch was accepted. Locally available natural river sand of zone II was used fine aggregate confirming to IS 383.Fine aggregate was free from clay, silt and other organic impurities. Throughout the investigation crushed even angular stone aggregate passing through 16 mm sieve and retained on 12 mm sieve was used as coarse aggregate confirming to IS 383. Material was procured from local crushing plant. Portable Water fit for drinking, free from oil and organic impurities was used for mixing and curing.

2.2. Mix proportions

Indian Conventional mix Design procedure has been adopted for designing mix. It was taken into account all parameters for while designing a mix such as degree of workability, w/c ratio, minimum cement etc. Following portion was derived and were maintained throughout project.

Table 1 Mix Proportions for Control Mix C0

Mix Proportion	Ratio of materials			
	Water	Cement	Fine Aggregate (Sand)	Coarse Aggregate
C0	0.32	1	1.23	2.1

2.3. Mix Proportions of Bi-Blend Siliceous Concrete (BBSC):

Based upon the quantities of ingredient of the mixes, the quantities of silica flour was varied from 3, 6, 9, 12, 15, and 18% and fly ash was varied 2, 4, 6, 8, 10, and 12% for replacement by weight.

Table 2 Mix Proportions for BBSC

Mix Proportion	Ratio of materials					
	Cementious material proportion in concrete including cement	Silica flour in % weight of cement	Fly-Ash in % weight of cement	Total siliceous material in % weight of cement	Fine Aggregate (Sand)	Coarse Aggregate
C0	1	0	0	0	1.23	2.1
C1	1	3	2	5	1.23	2.1
C2	1	6	4	10	1.23	2.1
C3	1	9	6	15	1.23	2.1
C4	1	12	8	20	1.23	2.1
C5	1	15	10	25	1.23	2.1
C6	1	18	12	30	1.23	2.1

3. EXPERIMENTAL PROGRAM

3.1. Test specimens

In this experimental work, a total of 7 numbers of concrete mixes were derived. Each mix was designated from C0 to C6. Mechanical properties such as average compressive strength, average split tensile strength and average flexural strength were paralleled for 7 and 28 days. The standard size of 150mm×150mm×150mm was used to prepare cubes for testing of compressive strength. Cylindrical mould with standard specification of 150mm diameter and 300mm was used to cast cylindrical specimen. Plain Concrete Beams of dimensions 150 mm×150 mm ×150 mm were casted to evaluation flexural strength. Each mix was tested at 7^{th} day and 28^{th} day. The mix design of concrete was done according to IS 10262:2009 for M50 grade.

3.2. Preparation of Test Specimen

Mixing:

Mixing of ingredients was done using pan mixer. The cementitious materials are thoroughly blended separately (outside pan mixer) and then the added to aggregate followed by gradual

addition of water, to avoid lumps formation. Mixing is done until a uniform colour is attained and uniformity are achieved. Mix which is considered ready for casting workability was found by compaction factor test.

Preparation of specimens:

The cast iron moulds were cleaned of dust particles and applied with mineral oil on all sides before concrete is poured in it. Moulds are placed on a level platform, then transferred on to vibration table. Excess concrete was removed with trowel and top surface is finished level and smooth as per IS 516-1969

Curing of the specimens

The specimens were left in the moulds intact at room temperature for roughly 24 hours after cast. The samples were then removed from moulds and immediately transferred to the curing environment tubs i.e. cubes were allowed to cure in fresh water.

Testing of specimens

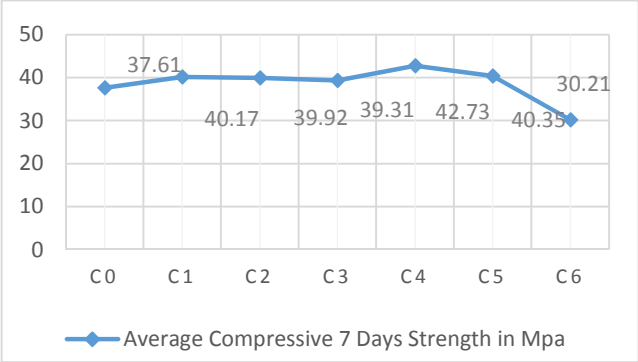
A time schedule for testing of samples was maintained to ensure their proper testing on the due date and time. The cast samples are tested as per standard techniques, as per IS 516-1959.

4. RESULTS AND DISCUSSION

4.1. Average Compressive strength of BBSC

Table 3 Average Compressive strength of BBSC at the end of 7 and 28 days

Sample Designation	% Replacement of Silica Flour	% Replacement of fly ash	Compressive Strength at the End of 7 days(MPa)	Compressive Strength at the End of 28 days(MPa)
C-C0	0	0	37.61	62.99
C-C1	3	2	40.17	63.89
C-C2	6	4	39.92	65.07
C-C3	9	6	39.31	67.40
C-C4	12	8	42.73	70.84
C-C5	15	10	40.35	72.60
C-C6	18	12	30.21	56.02



Graph 1 Average Compressive Strength at 7 days

4.2. Average Split Tensile strength of BBSC

Table 4 Mix Proportions for Control Mix C0

Sample Designation	% Replacement of Silica Flour	% Replacement of fly ash	Split Tensile Strength at the End of 7 days(MPa)	Split Tensile Strength at the End of 28 days(MPa)
S-C0	0	0	2.60	7.43
S-C1	3	2	2.61	7.45
S-C2	6	4	2.79	7.97
S-C3	9	6	2.77	7.91
S-C4	12	8	2.90	8.29
S-C5	15	10	2.96	8.44
S-C6	18	12	2.73	7.81

4.3. Average Flexural Strength of BBSC

Sample Designation	% Replacement of Silica Flour	% Replacement of fly ash	Flexural Strength at the End of 7 days(MPa)	Flexural Strength at the End of 28 days(MPa)
F-C0	0	0	11.05	17
F-C1	3	2	11.895	18.3
F-C2	6	4	12.155	18.7
F-C3	9	6	12.285	18.9
F-C4	12	8	12.48	19.2
F-C5	15	10	12.09	18.6
F-C6	18	12	11.76	18.1

5. CONCLUSION

The following conclusions can be drawn based on the limited experimental investigation concerning compressive strength and split tensile strength with silica flour and fly ash as a combined partial replacement of cement:

- Increase in compressive strength of concrete is observed by the use of silica flour and fly ash up to 25% replacement of cement. There is a gradual increase in compressive strength, beyond it starts to decrease. The maximum 28 days Compressive strength was obtained with combination of 15% Silica flour and 10% Fly ash (C5 mix proportion).
- Because of high pozzolonic nature of silica fume to form more densely packed C-S-H gel, the compressive strength of concrete mainly depends on the percentage of silica fume.
- Increase in split tensile strength of concrete is observed by the use of silica flour and fly ash up to 25% replacement of cement. There is a gradual increase in split tensile strength till 25% replacement and sharp fall after it. The maximum 28 days split tensile strength was obtained with combination of 15% Silica flour and 10% Fly ash (C5 mix proportion).
- Increase in split tensile strength is mainly due to improvement in packing factor, i.e., action of siliceous compound as a filler material.
- Increase in flexural strength of concrete is observed by the use of silica flour and fly ash up to 20% replacement of cement. There is a gradual increase in flexural strength from 0% and sudden drop after 20% replacement. The maximum 28 days flexural strength was obtained with combination of 12% silica flour and 8% fly ash (C5 mix proportion).

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