

Drying Shrinkage of Ternary Blended Concrete Made with Sugarcane Bagasse Ash and Silica Fume

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ABSTRACT: Experimental investigation had been carried out to evaluate the shrinkage of Ternary Blended Concrete. Ternary Blended Concrete is made by partial replacement of cement by sugarcane bagasse ash and silica fume. The shrinkage of Ternary blended Concrete has been studied using the different percentage replacements of cement by sugarcane bagasse ash and silica fume. From the test results of the above investigation it can be concluded that the shrinkage strain of Ternary Blended Concrete increases with age. The shrinkage strain of concrete with replacement of cement by 5 % to 15% of Sugarcane bagasse ash and 10% Silica fume respectively at various ages are less than the shrinkage strain of concrete 0%, 20% 25% and 30%. The shrinkage strain of Ternary blended Concrete is also compared with that of normal strength concrete. Test results show that the shrinkage strain of ternary blended concrete is less than that of normal strength concrete up to an optimum replacement of up to 15%.

KEYWORDS: Ternary Blended Concrete, Sugarcane Bagasse Ash, Silica Fume, Shrinkage, Shrinkage strain, Superplasticizers.

I. INTRODUCTION

Ordinary Portland cement is the most commonly used building material throughout the world and it will retain its status in the near future also because of demand and expansion of construction industry all over the world. Further the greatest challenge before the concrete construction industry is to serve the two pressing needs of human society, namely the protection of the environment and meeting the infrastructure requirements of our growing population. Structures which are constructed in aggressive environments are liable to be subjected to cracking due to shrinkage. One of such major problems is shrinkage of concrete due to which there will be loss of weight and reduction in strength of concrete, ultimately sacrificing the life of the structure and volume change namely shrinkage of concrete can be seen. Relative humidity and change in temperature are some of the major causes of shrinkage in concrete. The use of blended cements has shown a major effect on shrinkage as the percentage increase in Sugarcane bagasse ash and Silica fume which shows pozzolanic properties is being used as a partial replacement in concrete in regular intervals of 5% up to 30%. The SCBA is being produced from sugar manufacturing units as a waste material which will be ground to the fineness less than cement and 10 % replacement of silica fume for obtaining good bonding between cement and SCBA. This project discusses the exposure of percentage replacement of concrete with SCBA and Silica fume.

II. MATERIALS USED

The influence of pozzolanic materials like Sugarcane bagasse ash and silica fume on concrete is studied, the cement was partially replaced by sugarcane bagasse ash and silica fume. In the present investigation the parameters varied are.

Replacement of cement by 0% to 30% with an interval of 5% of sugarcane bagasse ash and a constant replacement of silica fume of 10% is made i.e. 5% S.C.B.A + 10% S.F, 10% S.C.B.A + 10% S.F, 15% S.C.B.A + 10% S.F, 20% S.C.B.A + 10% S.F, 25% S.C.B.A + 10% S.F, 30% S.C.B.A + 10% S.F,

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A constant water cement ratio is maintained. In order to get required degree of workability superplasticizer was added at a rate of 0.8% by the weight of cement. The physical properties and chemical properties of fine aggregate, coarse aggregate, sugarcane bagasse ash, silica fume and super plasticizer are given in the table 1 to 7 respectively.

Table 1. Physical Properties of Fine Aggregates

S.No	Properties	Value
1	Bulk Density (gm/cc)	1.542
2	Fineness Modulus	2.74
3	Specific Gravity	2.60
4	Water Absorption	
5	Zone	II

Table 2. Physical Properties of Coarse Aggregate

S.No	Properties	Value
1	Bulk Density gm/cc	1.610
2	Specific Gravity (G) (20mm)	2.74
3	Fineness Modulus	7.17
4	Aggregate Impact value (%)	25.21
5	Aggregate Crushing value (%)	25.22

Table 3. Physical Properties of Sugarcane Bagasse Ash

S.No	Properties	Value
1	Density	575 Kg/m ³
2	Specific Gravity	2.2
3	Mean Specific Surface area	0.1-0.2 μm
4	Min. Specific Surface area	2500m ² /kg
5	Particle shape	Spherical

Table 4. Physical Properties of Silica fume

S.No	Properties	Value
1	Specific Gravity	2.2-2.55
2	Specific Surface area	20000 ² /Kg
3	Particle Size	0.1 Micron
4	Bulk loose Density	230 – 300 kg/m ³
5	color	Grey

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Table 5. Chemical Properties of Sugarcane Bagasse Ash

S.No	Constituent Determined	Percent by weight
1	Silica (SiO ₂)	63
2	Alumina (Al ₂ O ₃)	31.5
3	Ferric Oxide (Fe ₂ O ₃)	1.79
4	Manganese Oxide (MnO)	0.004
5	Calcium Oxide (CaO)	0.48
6	Magnesium Oxide (MgO)	0.39
7	Loss on Ignition	0.71

Table 6. Chemical Properties of Silica fume

S.No	Constituent Determined	Percent by weight
1	Silica (SiO ₂)	90-96
2	Iron Oxide (Fe ₂ O ₃)	0.2-0.8
3	Alumina (Al ₂ O ₃)	0.5-0.8
4	Calcium (CaO)	0.1-0.5
5	Magnesium Oxide (MgO)	0.5-1.5
6	Sulphur (SO ₃)	0.1-0.4
7	Carbon (C)	0.5-1.4
8	Pottasium Oxide (K ₂ O)	0.4-1.0
9	Sodium Oxide (Na ₂ O)	0.2-0.7

Table 7. Properties of Superplasticizer

S.No	Properties	Description
1	Specific Gravity	1.220 to 1.225 at 30 ⁰ c
2	Chloride Content	Nil to IS: 456
3	Air Entrainment	Approx. 1% additional air is entrained

III. EXPERIMENTAL PROGRAMME

Shrinkage of concrete is measured by the Volume change apparatus. The instrument should be confined to IS 1199-1959.

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Figure.1 Shrinkage measuring apparatus along with reference rod



Figure.2 Casting of prismatic moulds

A prismatic concrete specimen of cross section 75mm x 75mm having a gauge length of 285mm were casted with different replacements of cement with sugarcane bagasse ash and constant replacement of silica fume. Gage studs are used on either side of the specimen in order to hold the specimen in the volume change apparatus. Gage studs are placed in such a way that it should coincide with the principle axis of the specimen. 7-days water curing should be done immediately after demoulding and it should be noted as initial reading with help of a digital dial gauge attached to the apparatus. Then the specimens are dried for 60 days. The dial gauge readings are constantly monitored daily up to the specified age of 60 days. The dial gauge readings of 3, 7, 14, 21, 28 and 60 days are taken as final readings. The change in length to the same are calculated. The change in length is the difference between the initial reading and final reading and shrinkage strain to that were calculated.

IV. EXPERIMENTAL PROCEDURE

In the present study SCBA and SF are replaced with cement at different replacements

Mix proportion:

A total of 7 series of 75x75x250mm specimens is casted. One with conventional concrete and the other 6 with different percentage replacements.

Table 8: Mix proportion of ternary blended concrete

53 Grade OPC (Kgs)	SCBA (Kgs)	Water (Lit)	Sand (Kgs)	20mm Agg (kgs)
340	-	163	736.2	1231.2

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The slump measured is 50-75mm of fresh concrete.

Series	SCBA Replacement for OPC	SF Replacement for OPC
A	Plain cement concrete (0%)	
B	5%	10%
C	10%	10%
D	15%	10%
E	20%	10%
F	25%	10%
G	30%	10%

For each series 3 prismatic specimens were casted.

Casting of Specimens:

The materials such as SCBA and SF are mixed for half an hour in order to get a homogeneous mixture. Preparation of specimens are carried out and they are kept for 7 days water curing for initial reading. After taking out specimens from curing they are kept in racks in drying state so that the specimen while shrinkage upon age to the remaining dry readings.



Figure. 3 Prismatic specimens kept for 7 days curing



Figure. 4 Prismatic specimens kept for drying



Figure.5 Test result from the apparatus



Figure. 6 Obtaining test results from the apparatus

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V. EXPERIMENTAL RESULTS

Drying shrinkage results:

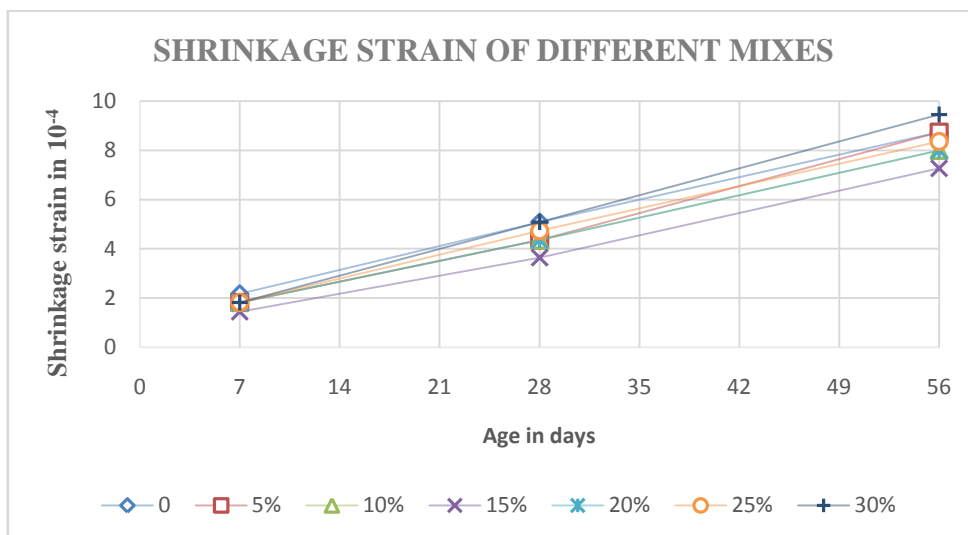
Table9: Experimental results of shrinkage of ternary concrete made of different mixes

S.No	Series	Age of the specimen			Shrinkage Strain (DL/L X 10 ⁻⁴)		
		7	28	56	7	28	56
1	A	0.06	0.14	0.24	2.18	5.09	8.73
2	B	0.05	0.12	0.24	1.82	4.36	8.73
3	C	0.05	0.12	0.22	1.82	4.36	8.00
4	D	0.04	0.10	0.20	1.45	3.64	7.27
5	E	0.05	0.12	0.22	1.82	4.36	8.00
6	F	0.05	0.13	0.23	1.82	4.73	8.36
7	G	0.05	0.14	0.26	1.82	5.09	9.45

Observations change in the length of the specimen:

1. From the above table it is observed that length change in the specimens are due to drying conditions.
2. Humidity is also one of the pervading factor for the concrete to shrink.
3. The shrinkage of the concrete reduced with increase in the content of pozzolanic materials Sugarcane bagasse and Silica fume.
4. With increase in the time shrinkage strain also increased.

The resulting graph shows the shrinkage strain results



IV. CONCLUSION

1. From the present study, it is noticed that 15% SCBA & 10% SF ternary concrete replacement of OPC has shown Better performance at all ages.
2. Usage of superplasticizer has no significant on the shrinkage of ternary blended concrete made with SCBA and SF.

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3. The shrinkage strain of the concrete increases with age.

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