

Effect of Partial Replacement of Cement by SCBA on Workability of Concrete

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Abstract: All over the world various researches are being carried out by focusing on consumption of industrial or Agricultural waste as a replacement of cement in concrete. However utilization of these waste proves to be economical, and also result in foreign exchange earnings as well as environmental pollution is reduced to some extent. Various wastes from industries, like blast furnace slag, fly ash and silica fume are now days commonly used as cement replacement materials. In the present study and work the sugarcane bagasse ash (SCBA) is used as alternate binding material. This has resulted in saving in cement consumption almost equivalent to the alternative binding material (SCBA) used in concrete. The bagasse ash used for this work is obtained from Sant Tukaram factory (Pune) which is grinded and sieved through sieve of size 150 micron and passing out fraction is used in concrete as a partial replacement of cement in the ratio of 0 %, 5%, 10%, 15%, 20% and 25% by weight of the cement. OPC 53 grade cement is used in the study. The effect of replacement of cement by bagasse ash on properties like workability for fresh concrete is determined. It is observed that by reducing w/c ratio by approx. 0.01 for every 5 % additional replacement of cement by SCBA the desired value i.e.75 mm slump value (average) is obtained. During research work 0.5% super plasticizer, Fosroc complast SP500 (a high range water reducer, based on sulphonated naphthalene polymer) by the weight of cement is also used.

Keywords: Sugar-cane bagasse ash (SCBA), cement replacement, workability, w/c ratio and durability

1. Introduction

The most exploited and the reliable construction material used in the world is concrete. Of which the main constituent is cement. This has made the constituent materials (cement) to be of high demand. The uninterrupted utilization of some of these constituent materials like cement is responsible for the serious environmental concerns, such as release of carbon dioxide (CO₂) (one of the green house gases) to the surroundings, causing global ecological warming, during its manufacture of ordinary Portland cement. To prevent the surroundings from these harmful gases, costly equipment will be required adding escalation of price. However increase in demand and scarcities of resources are the other reasons demanding for the supplementary cementitious material which shall be ecofriendly. The selection of the new cementitious materials should only be made after a complete review of its long-term performance, durability in the structure and environment compatibility. On the other hand industrial wastes are being disposed off in low lying areas forming refuse heaps causing environmental nuisance. The byproduct of sugarcane factories, bagasse ash (SCBA) which is found after burning bagasse, which itself is found after the extraction of all the economical sugar from sugarcane. On burning of bagasse under controlled conditions, ash having amorphous silica between 70% to 80% and alumina 7-10 % is generally obtained. Escalation of price of cement and disposal of this material is causing environmental nuisance has led researchers think to make use of the waste bagasse ash in construction activities as a partial replacement of cement. Moreover bagasse ash when grinded and sieved through 150 micron sieve was found to be as pozzolana and was capable to fill the voids between concrete ingredients and compact matrix is formed. Therefore various attempts have been made to replace cement by bagasse ash (SCBA), the left out from sugar

industries to enhance quality as well reduction in cost is also seen.

2. Materials and Methods

2.1 Cement

In this experimental work Ordinary Portland cement (Grade 53) conforming to IS 12269-1987 is used in all trial mixes. The physical properties of the cement used in conducting appropriate tests which are conforming to process laid down in IS: 269/4831 has been performed. The results are mentioned in Table 1 shown below

Table 1: Physical properties of cement (OPC 53) (Birla cement)

S. No	Property of cement	Test value
1	Fineness of cement(m ² /kg)	320
2	Specific gravity of cement	3.15
3	Grade of cement(OPC)	53 grade 0pc
4	Standard consistency of cement	35%
5	Initial setting time	90 mins
6	Final setting time	265 mins
7	Compressive strength (MPA)(28 days)	61.00

2.2 Aggregate

In this study stone dust passing through 4.75 mm sieve conforming to Zone II as per IS: 383-1970 is used as fine aggregate. The fine aggregate is free from clay, silt and organic impurities. Crushed angular/cubical coarse aggregates of locally available rock are used in the study. Coarse aggregates of 20 mm and 10 mm (MSA) is sieved and their gradation is done. To satisfy the gradation combined of Coarse aggregates as per IS 383-1970, it is proposed that the proportion of 53:47 of 20 mm & 10 mm aggregates produces the best gradation as per IS: 383.

Table 2 (A): Properties of coarse aggregate

Physical test	Coarse aggregate (20 mm)	Coarse aggregate (10mm)	Fine aggregate
Specific gravity	2.62	2.62	2.59
Fineness modulus	2.96	3.82	2.36
Bulk density(kg/m ³)	1.8	1.67	1.58

2.3 Water: Fresh potable drinking water of pH value (6.5-7.2) free from organic impurities is being used which is available in college campus (testing laboratory).

2.4 Superplasticizer: Water reducing admixture brand complast SP 500 from Fosroc with a dose of 0.5 % by weight of Cement is used.

2.5 Bagasse: Bagasse was obtained from Shri Sant Tukaram factory in the near vicinity. Physical and chemical properties of the bagasse ash are mentioned in Table 2B and 2C.

Table 2 (B): Chemical properties of bagasse ash

Chemical Components	% Weight
SiO ₂	80.12
Al ₂ O ₃	8.51
Fe ₂ O ₃	3.61
CaO	2.06
Na ₂ O	0.14
K ₂ O	3.37
MgO	0.11
TiO ₂	0.50
BaO	0.16
P ₂ O ₅	1.00
LOSS OF IGNITION	0.42

Table 2(C): Physical properties of bagasse ash

Properties	Bagasse ash
Specific gravity	2.06
Fineness modulus	2.12
Bulk modulus	1408kg/m ³

3. Experimental Work

3.1 Effect of SCBA on workability

Workability of concrete is a composite property which depends on many parameters of the components of the concrete. Workability for the fresh concrete was tested by slump cone test method. The following are the results of fresh concrete using slump cone test for various percentages of replacement of cement by SCBA. Since the controlled concrete (M 35) is designed for 75 mm average value of slump value. Therefore a deviation of ±10 % in Slump value is allowed while fixing the slump value in individual samples accordingly i.e. slump value lies between 68-83mm. However to obtain 75 mm (average) slump value changes were made in w/c ratio for concrete mixes with specified cement replacements. In this experiment water/cement ratio was reduced by 0.01% for each iteration of replacement and respective slump values were recorded. For each replacement of additional 5 % cement replacement by SCBA w/c ratio was varied from 0.43 to 0.37 to obtain the optimum average slump value i.e. 75 mm. For each replacement by SCBA test were conducted on three trials and average of three readings are mentioned in tables shown below and also corresponding graphs are drawn for each test.

Table 3: Slump values for control concrete

S. No	w/c ratio	Slump value as observed in mm	Average value
1	0.43	72,75,78	75
2	0.42	69,72,78	73
3	0.41	65,69,70	68
4	0.40	64,68,69	67
5	0.39	63,65,67	65
6	0.38	60,61,65	62
7	0.37	57,61,62	60

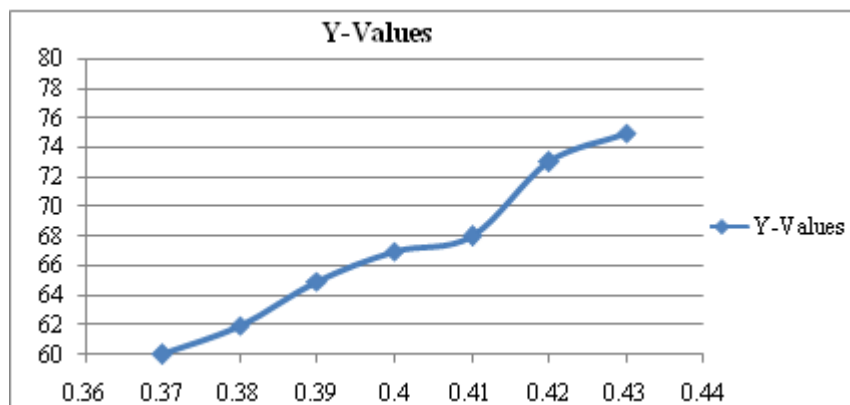
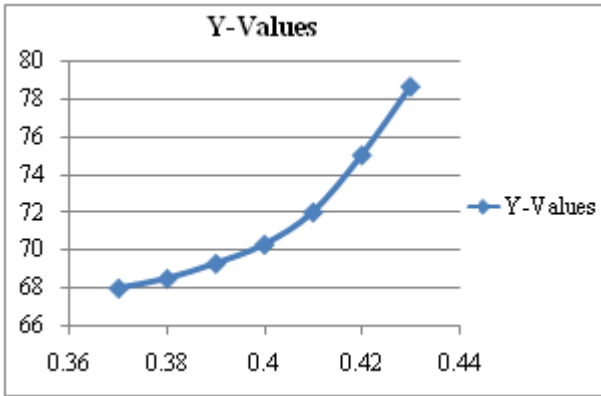


Table 3 (A): showing variation in slump value with change in w/c ratio for 5% cement replacement

S. No	w/c ratio	Slump value as observed in mm	Average value
1	0.43	79,73.8,83	78.6
2	0.42	69,74,82	75
3	0.41	70,69.5,76.5	72
4	0.40	70.9,68,72	70.3
5	0.39	69,70,68.9	69.3
6	0.38	68,69,68.5	68.5
7	0.37	68,68,68	68



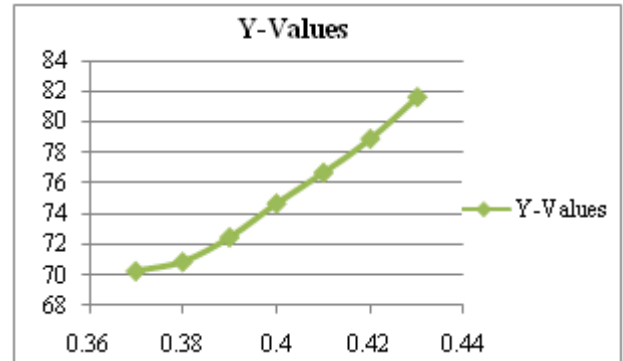
Graph showing relation between w/c ratio and workability for 5 % replacement of cement by SCBA (M 35)

Table 3 (B): showing variation in slump value with change in w/c ratio for 10 % cement replacement by SCBA

S. No	w/c ratio	Slump value as observed in mm	Average value
1	0.43	78,78,81	79.9
2	0.42	72, 79.5,81	77.5
3	0.41	68,72.8,83	74.6
4	0.40	68,73,75	72
5	0.39	68 ,70,73.8	70.6
6	0.38	68, 69, 71.8	69.6
7	0.37	68, 69.2,69.5	68.9

Table 3 (C): showing variation in slump value with change in w/c ratio for 15% cement replacement by SCBA

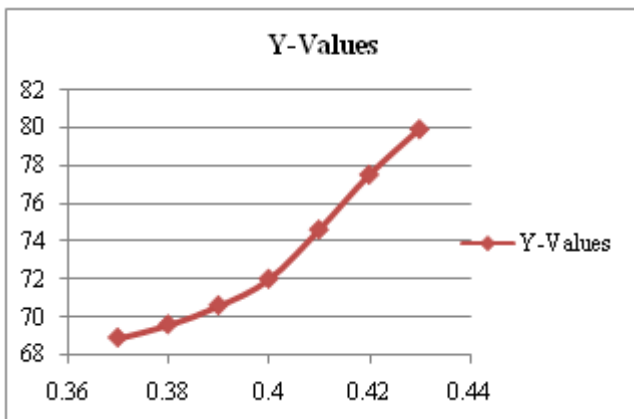
S. No	w/c ratio	Slump value as observed in mm	Average value
1	0.43	80 ,81.8,83	81.6
2	0.42	76.7,79,81	78.9
3	0.41	71.1,79, 80	76.7
4	0.40	68,73.1,83	74.7
5	0.39	68,72.5,77	72.5
6	0.38	69.7,71,72	70.9
7	0.37	69.9,70,71	70.3



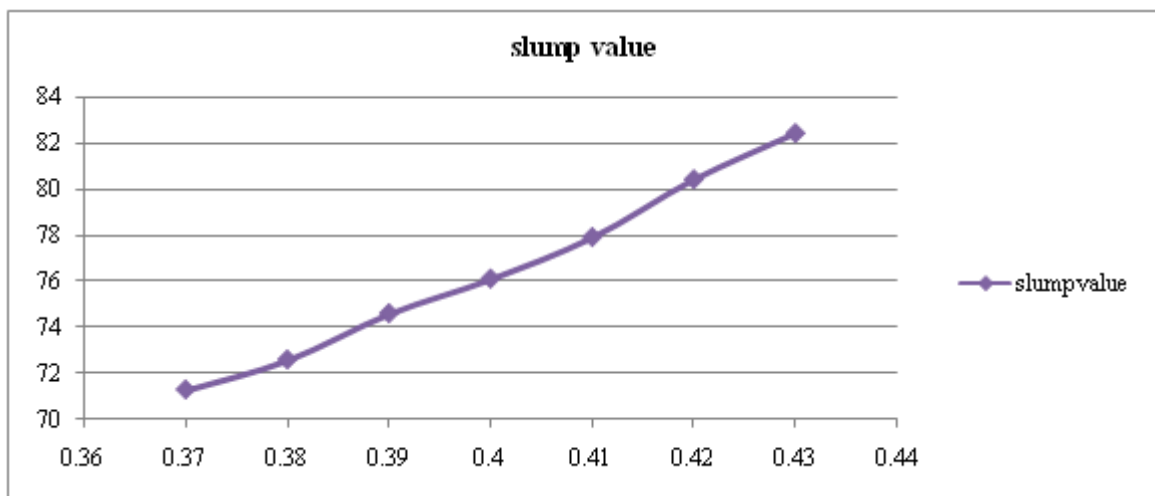
Graph showing relation between w/c ratio and workability for 15 % replacement of cement by SCBA (M 35)

Table 3 (D): showing variation in slump value with change in w/c ratio for 20% cement replacement by SCBA (M 35)

S. No	w/c ratio	Slump value as observed in mm	Average value
1	0.43	82,82.2,83	82.4
2	0.42	79,80.2,82	80.4
3	0.41	74.7, 79,80	77.9
4	0.40	71,75,82.3	76.1
5	0.39	69,72.8,82	74.6
6	0.38	70,71.8,76	72.6
7	0.37	70.,71,72.9	71.3



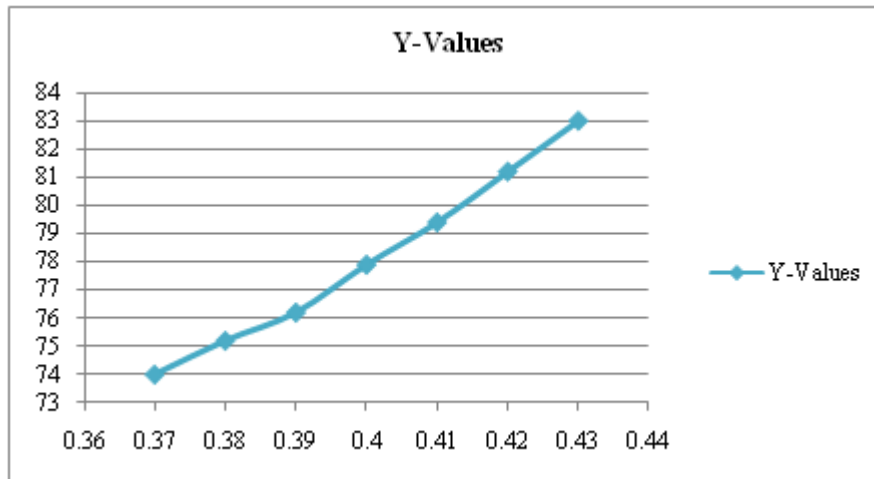
Graph showing relation between w/c ratio and workability for 10 % replacement of cement by SCBA (M 35)



Graph showing relation between w/c ratio and workability for 20 % replacement of cement by SCBA (M 35)

Table 3 (E): showing variation in slump value with change in w/c ratio for 25% cement replacement by SCBA

S. No	w/c ratio	Slump value as observed in mm	Average value
1	0.43	83,83,83	83
2	0.42	78.6,82,83	81.2
3	0.41	78,79.2,81	79.4
4	0.40	76,78,79.7	77.9
5	0.39	73.6,77,78	76.2
6	0.38	69.6,74,82	75.2
7	0.37	68,71,74	74



Graph showing relation between w/c ratio and workability for 25 % replacement of cement by SCBA (M 35)

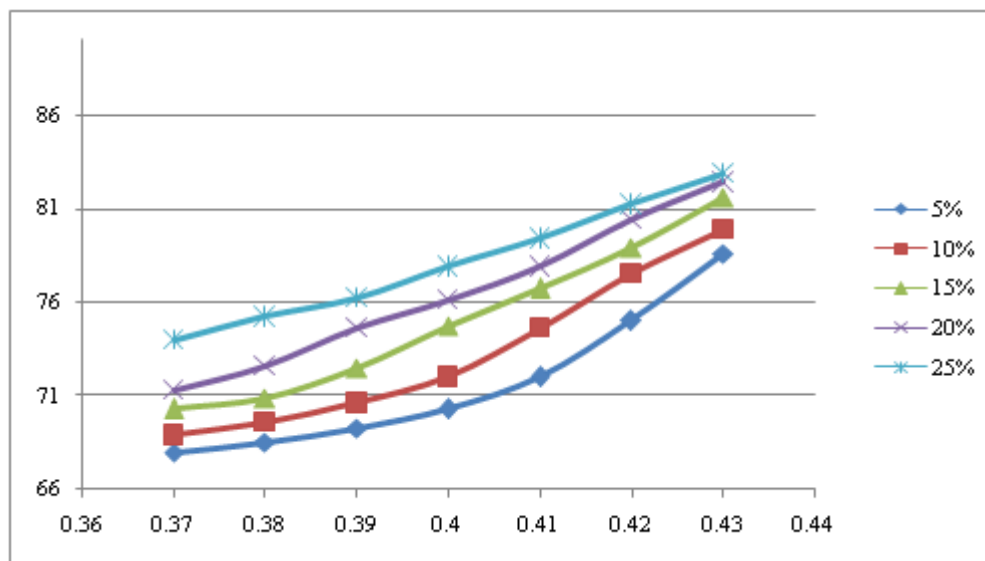
The workability of the freshly mixed concrete was determined using slump test that was performed according to BS 1881: Part 102 (1983). Trials were conducted on various w/c ratio varying from 0.43-0.37 in successive 0.01 decrement in value, so that the effect of SCBA on workability of concrete can be clearly understood. It is clear from the table shown below that replacement of SCBA with cement content reduces the water demand in concrete for achieving a desired workability, which may be beneficial for high performance concrete.

cement by SCBA can be worked for getting desired slump values which is mentioned in below mentioned tables

Table 3(F): Showing adjustment of w/c ratio for getting 75 mm slump value

S.NO	%SCBA	Water/Cement Ratio	Slump Value
1.	5%	0.42	69-82 mm
2.	10%	0.41	68-83 mm
3.	15%	0.40	70-82 mm
4.	20%	0.39	71-83 mm
5.	25%	0.38	74-83 mm

According to the tests conducted, the appropriate value of corresponding w/c ratio for various % replacement of



Final graph showing relation between w/c ratio and workability for all replacement of cement by SCBA (M 35)

4. Conclusions

Above data clearly reveals that the addition of bagasse ash in concrete produces higher slump value which implies that by increasing the percentage of bagasse ash workability also increases. Therefore to keep same workability, water cement ratio needs to be reduced by 0.01. The magnitude reduction in w/c ratio depends on the value of replacement of cement by SCBA. The possible reason for this may be the availability of finely divided particle of bagasse ash present in concrete.

From the study conducted, it is concluded that:

- Workability of concrete increases by increasing the percentage of replacement of SCBA in concrete.
- Finely grounded SCBA can be successfully replaced by cement and is responsible for higher compressive strengths than normal concrete (keeping quantity of cement constant).
- To keep same workability water cement ratio needs to be reduced for each replacement of cement by SCBA.
- Water cement ratio (w/c) also depends on the particle sizes. The finer the particle size more will be the workability for given w/c ratio.
- For same workability and same cement + SCBA content the strength of concrete is likely to increase due to reduction in water content in concrete.

References

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