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Studies on High Performance Concrete using Mineral Admixtures

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Abstract— This paper presents the results of a laboratory study on high performance concrete prepared with sugar cane bagasse ash and silica fume. The parameters studied included compressive strength, flexural strength, and physical properties of sugar cane bagasse ash / cement concrete and corresponding pastes. The experimental results showed that the average compressive strength of concrete occurs 59.11 N/mm2 after 28 days replacement of cement with 20/10% bagasse ash and silica fume with a water-cement (w/c) ratio of 0.45 and average flexural strength occurs 5.37 N/mm2 after 28 days replacement of cement with 20/10% bagasse ash and silica fume.

Key words: Sugar cane bagasse ash, OPC-43, silica fume, flexural strength, Compressive strength

I. INTRODUCTION

Low calcium fly ash (ASTM Class F) has been widely used as a replacement of cement in normal and high strength concrete. In normal strength concrete, the replacement level can be more than 50% [3,4], while in high strength concrete, the replacement level is usually limited to 15± 25% .The main objectives of using fly ash in high strength concrete are to reduce heat generation and to obtain better durability properties. However, in concrete mixes prepared at a low water-to-binder (w/b) ratio, a 20% fly ash content may not be sufficient to suppress the excessive heat of hydration. In a laboratory investigation carried out at the Madan Mohan Malaviya University of Technology Gorakhpur U.P India.

University the temperature increase due to cement hydration of large concrete blocks (1000 _ 1000 _ 1000 mm) was measured. It was found that for 50 MPa concrete, a 25% fly ash replacement It is known that fly ashes generally have negative effects on the concrete strength, particularly at early ages Using large quantities of this material in concrete seem to be in contradiction to the original aims of preparing high strength concrete. However, as observed by many researchers fly ash concrete may have better strength performance when they are prepared at lower w/ b ratios. Lam et al. demonstrated that at a w/b = 0.5, a 45% fly ash replacement resulted in about 30% reductions in 28-day compressive strength, but at a w/b = 0.3, the strength reduction was reduced to 17%. Also, the advances of concrete admixture technology allow concrete mixtures to be prepared with lower w/b ratios. It is therefore believed that high strength concrete can be obtained with large volumes of fly ash. The present study was based on our previous studies on fly ash concrete with a w/b ratio of >0.3 and aimed to produce high strength concrete with a high fly ash content. The concrete mixtures were prepared at the w/b ratios of 0.24 and 0.19. Low-calcium fly ash was used in the proportions of 0%, 25%, and 45% of the total mass of cementitious materials. The parameters studied included compressive strength, heat of hydration, chloride diffusivity, degree of hydration, and pore structures of fly ash/cement concrete and the corresponding pastes.

II. EXPERIMENTAL PROGRAM

Property	**Results**
Fineness (90-µm sieve)	8.3
Specific surface (m^2/kg)	281
Normal consistency (%)	28
Vicat setting time (min)	
Initial	145
Final	260
Specific gravity	3.15

Table 3.1: Properties of OPC-43 as per IS 8112 (1989).

Property	Silica fume	Bagasse ash
SiO_2 Content	90	42
Surface Area (m^2/kg)	20,000	500
Specific gravity	2.20	2.72
Fineness	5.1	1.2

Table 3.2: Properties of mineral admixtures conforming to IS 15388(2003)

S.No.	**Observation**	**Weight in gram**
1	Weight of picnometer (W_1 gm)	590
2	Weight of picnometer + weight of dry Bagasse ash(W_2 g)	890
3	Weight of picnometer + weight of dry Bagasse ash +weight of distilled water (W_3 g)	1580
4	Weight of picnometer + weight of distilled water (W_4 g)	1468

Table 3.5: Specific Gravity of Bagasse Ash

M_1 = Mass of Empty Bottle = 590 gram
M_2 =Mass of Bottle+ Mass of Bagasse Ash= 890 gram
M_3 = Mass of Bottle+ Mass of Bagasse Ash+ Mass of water= 1580 gram
M_4 = Mass of Bottle + Mass of Water = 1468 gram
Specific Gravity,

$$G_s = \frac{\text{Density of Water at 270C}}{\text{Weight of water of equal volume}} = \frac{W2-W1}{(W4-W1)-(W3-W2)}$$

Specific gravity of Sugar Cane Bagasse Ash at 27^0C = 2.542

Synod.	**Observation**	**Weight in gram**
1	Weight of picnometer (W_1 g)	590
2	Weight of picnometer + Weight of Silica Fume (W_2 g)	790
3	Weight of picnometer + Weight of Silica fume +weight of distilled water (W_3 g)	1578
4	Weight of picnometer + Weight of distilled water (W_4 g)	1468

Table 3.6 Specifics Gravity test for Silica Fume

Sample=200gm
Specific Gravity,

$$G_s = \frac{\text{Density of Water at } 27^0\text{C}}{\text{Weight of water of equal volume}} = \frac{W2-W1}{(W4-W1)-(W3-W2)}$$

A. Result:

Specific gravity of Silica Fume at 27^0C = 2.22

Property	**Fine aggregate**	**Coarse aggregate**
Specific gravity	2.46	2.75
Specific gravity (SSD)	2.50	2.78
Apparent relative density	2.56	2.83
Los Angeles abrasion	-	20.50
Absorption (%)	1.62	1.05
Fineness modulus	4.60	6.00
Voids (%)	36.70	38.10
Unit weight (kg/m^3)	1705	1617

IS Sieve size	Wt. retained (gm.)	Cumulative Wt. retained (gm.)	Cumulative % Wt. retained (gm.)	Cumulative % Wt. passing (gm.)
40mm	0	0	0	100
20mm	0.428	0.428	8.44	91.55
16mm	1.393	1.821	35.91	64.08
12.55mm	2.19	4.011	79.09	20.90
10mm	0.997	5.008	98.75	1.24
4.75mm	0.063	5.071	100	0
2.36mm	………	0	100	0
1.18mm			100	0
600			100	0
300			100	0
150			100	0
Lower than150				
TOTAL	5.071		822.204	

Table 3.7: Physical properties of aggregates conforming to IS 383 (1970)

The sample taken should be not less than 1.5kg.
The sample is separated into different sizes by sieve
Fineness modulus of coarse aggregate =822.204/100=8.22

S.No.	**Observation**	**Weight in gram**
1	Weight of picnometer (W_1 gm)	590
2	Weight of picnometer + Weight of Sand (W_2 g)	890
3	Weight of picnometer + Weight of Sand +weight of distilled water (W_3 g)	1652
4	Weight of picnometer + Weight of distilled water (W_4 g)	1468

Table 3.9: Specific Gravity of Sand

Sample taken=300 gram
Specific Gravity,

$$G_s = \frac{\text{Density of Water at 270C}}{\text{Weight of water of equal volume}} = \frac{W2-W1}{(W4-W1)-(W3-W2)}$$

B. Result:

Specific gravity of Sand at 27^0C = 2.60

III. EXPERIMENTAL RESULTS

A. Compressive Strength of Concrete

The compression test of the concrete mixtures was performed on the 150-mm cubes at the ages of 7, 14 and 28 days. The results are given in Table 4. At the w/c of 0.45, the mix with 20% sugar cane bagasse ash showed slightly lower compressive strength at the ages of 3 and 7 days, but higher compressive strength at the ages of 28 days. The mix with 20% sugar cane bagasse ash showed a 28-day compressive strength of 59.33 MPa, which was 8% lower than that of the reference mix. The negative effect of using fly ash on concrete strength appeared to be insignificant. However, lowering the w/b ratio to 0.19 did not further improve the concrete strength.

Percentage of SGBA and SF	Compressive Strengtin N/^{2} after 7 Days
0	55.55
02/5	55.11
20/10	54.00
20/15	53.77
20/20	53.11
20/25	52.88

Table 5.1: Compressive Strength after 7 Days

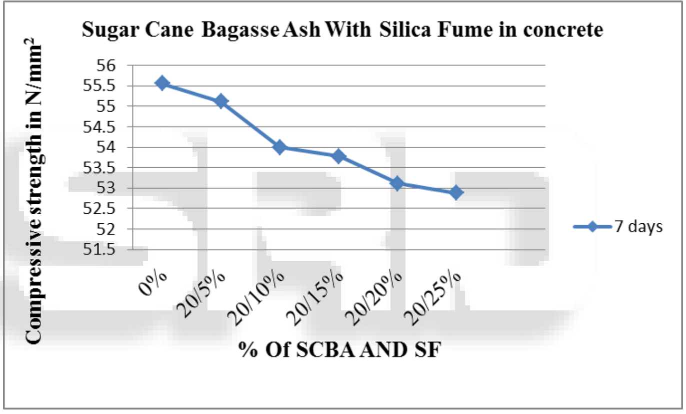

Fig. 5.1: Variation of Compressive Strength with Bagasse Ash and Silica Fume after 7 days.

Percentage of SGBA and SF	Compressive Strength in N/mm^2 after 14 Days
0	57.33
02/5	57.11
20/10	57.55
20/15	56.88
20/20	56.22
20/25	55.77

Table 5.2: Compressive Strength after 14 Days

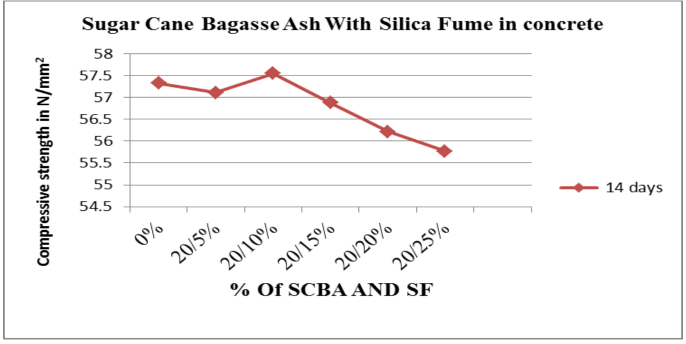

Fig 5.2: Variation of Compressive Strength with Bagasse Ash and Silica Fume after 14 days.

Fig 5.3: Compressive strength test procedure and loading condition

Percentage of SGBA and SF	Compressive Strength in N/mm^2 after 28 Days
0	59.33
02/5	58.88
20/10	59.11
20/15	58.22
20/20	57.55
20/25	57.11

Table 5.3: Compressive Strength after 28 Days

Percentage of SGBA and SF	Compressive Strength in N/mm^2 after 7 Days	Compressive Strength in N/mm^2 after 14 Days	Compressive Strength in N/mm^2 after 28 Days
0	55.55	57.33	59.33
02/5	55.11	57.11	58.88
20/10	54.00	57.55	59.11
20/15	53.77	56.88	58.22
20/20	53.11	56.22	57.55
20/25	52.88	55.77	57.11

Table 5.4: Variation of Compressive Strength with Bagasse Ash and Silica Fume after 28 days

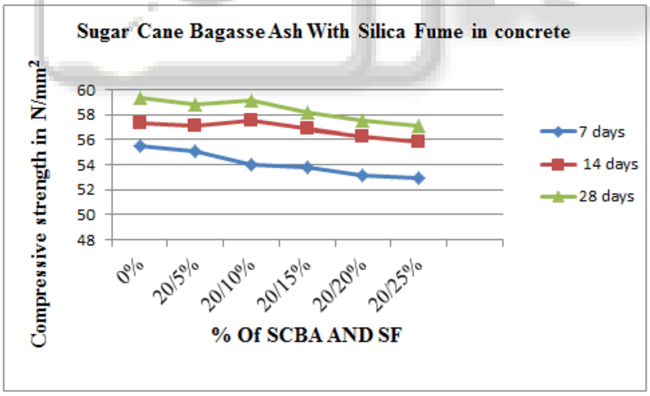

Fig. 5.5: Comparatively Variation of Compressive Strength with Bagasse Ash and Silica Fume.

Fig. 5.6: Flexural Strength Test of prism unloading condition

Percentage of SGBA and SF	Flexural Strength in N/mm^2 after 7 Days
0	5.21
20/5	5.19
20/10	5.14
20/15	5.13
20/20	5.1
20/25	5.08

Table 5.5: Flexural Strength after 7 Days

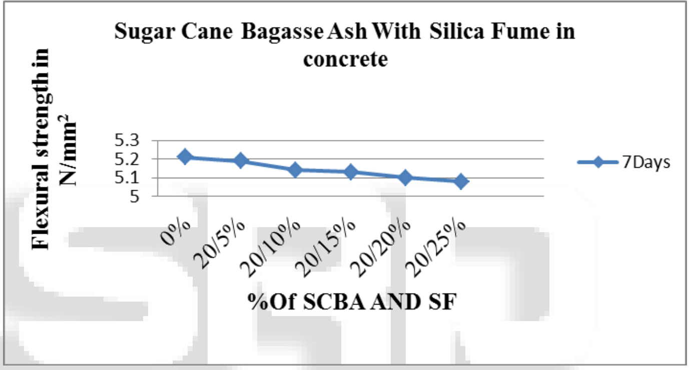

Fig 5.7: Variation of Flexural Strength with Bagasse Ash and Silica Fume after 7 days

Percentage of SCBA and SF	Flexural Strength in N/mm^2 after 14 Days
0	5.29
02/5	5.28
20/10	5.3
20/15	5.27
20/20	5.24
20/25	5.22

Table 5.6: Flexural Strength after 14 Days

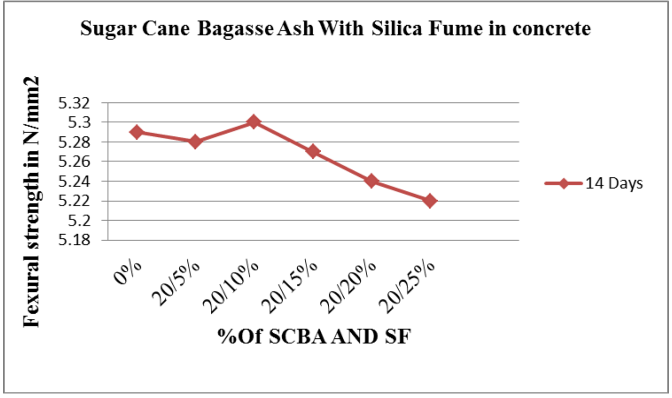

Fig 5.8: Variation of Flexural Strength with Bagasse Ash and Silica Fume after 14 days

Percentage of SGBA and SF	Flexural Strength in N/mm^2 after 28 Days
0	5.39
02/5	5.37
20/10	5.37
20/15	5.34
20/20	5.3
20/25	5.28

Table 5.7: Flexural Strength after 28 Days

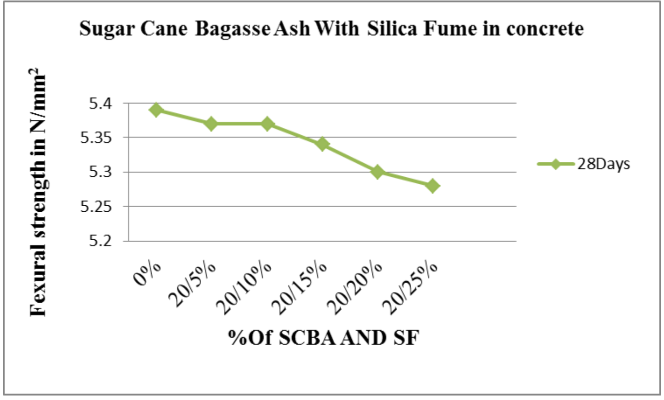

Fig 5.9: Variation of Flexural Strength with Bagasse Ash and Silica Fume after 28 days

Result: The average flexural strength occurs 5.37 N/mm2 after 28 days replacement of cement with 20/10% bagasse ash and silica fume.

Percentage of SGBA and SF	**Flexural Strength in N/mm^2 after 7 Days**	**Flexural Strength in N/mm^2 after 14 Days**	**Flexural Strength in N/mm^2 after 28 Days**
0	35.21	35.77	36.38
02/5	35.07	35.70	36.25
20/10	34.71	35.84	36.31
20/15	34.64	35.63	35.05
20/20	34.43	35.42	35.84
20/25	34.35	35.28	35.70

Table 5.8: Flexural Strength after 7, 14 and 28 Days

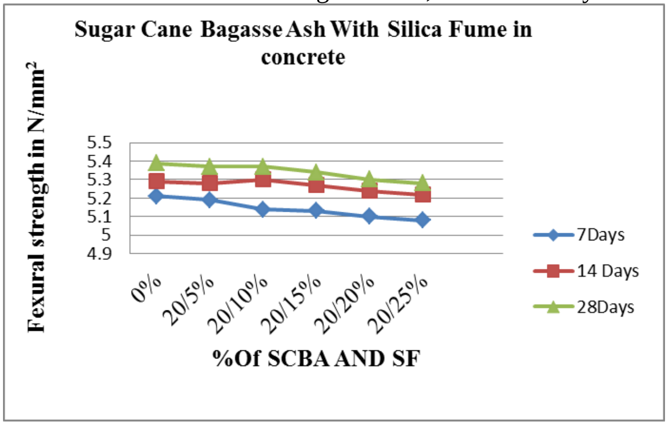

Fig 5.10: Comparatively Variation of Flexural Strength with Bagasse Ash and Silica Fume

IV. CONCLUSIONS

Based on the experimental studies conducted following conclusions are drawn on the sugar cane bagasse ash high performance concrete (M50).

Combinations of SCBA/SF used as partial replacement of cement at different levels produced concrete with high strength and acceptable microstructure. Curing conditions adopted in this research produced significant changes in the properties of concretes especially those containing high replacement levels.

1) Sugar cane bagasse ash concrete is economical as compare with controlled concrete. This has been proved that sugar cane bagasse ash can be used in making concrete strong, durable, Eco-friendly and economical.
2) Use Industrial Waste in concrete, so helps in reducing the environment pollution.
3) The 20% of replacement of bagasse ash and 10% replacement of SF gives average compressive strength at 28 days is 59.11 Mpa and flexural strength is 5.36Mpa.
4) If the bagasse is burnt again at controlled temp fineness of cement is increased hence it will improve the fresh and hardened properties of concrete.
5) Flexural strength of different concrete mixes as influenced by curing conditions was found to be reasonably well correlated with compressive strength.

V. FUTURE SCOPE

This research was carried out to obtain a high performance durable concrete with a practical range of combinations of cement replacement materials. The study of mechanical properties under different curing regimes has identified several areas where further research is needed. The following recommendations for further research are suggested:

1) Throughout this investigation specimens were cured in the laboratory environment at 27°C. It is of interest to study the performance of these SCBA/SF blended mixes under aggressive environments such as deep water and hot/dry regimes.
2) Satisfactory oxygen permeability values are obtained in this investigation; however, a further study on permeability of SCBA/SF concretes to water as well as chloride under practical curing conditions requires an in-depth examination to accumulate enough data in order to give a clear understanding of the degree of influence in the permeability of concrete brought by the combination of these cement replacement materials.
3) The pore structure and oxygen permeability in this study are conducted on concrete specimens cast especially for this purpose. It would have been preferable and more practical for the researchers in this field to execute experiments on concrete samples rather than cement or mortar specimens cast, and the results are more likely to be representative of that in concrete.

REFERENCES

[1] Muhannad Ismeik, Effect of mineral admixtures on Mechanical Properties of High Strength Concrete made with locally available materials,Jordan Journal of Civil Engineering Volume3,No.1,2009.
[2] Swamy, R. N., Fly ash concrete - potential without misuse, RILEM Material and Structures, Vol. 23,1990, pp. 397-411.
[3] ACI Committee 226, Fly ash in concrete, ACI Materials Journal, Sept-Oct. 1987, pp. 381-409.

[4] ACI Committee 226, Ground granulated blast-furnace slag as a cementitious constituent in concrete, ACI Materials Journal, July-Aug. 1987, pp. 327-342.
[5] Sellevoid, E., and Nilson, T., Condensed silica fume in concrete", FIP state of art report, Thomas Telford, London, 1988,32pp.
[6] Mehta, P. K., Concrete: Structure, Properties, and Materials, Prentice-Hall, Inc., 1986, 450pp.
[7] Neville, A. M. and Brooks, J. J., Concrete Technology, Longman group, UK, 1990.
[8] Gower, M. R. and Calder, A. J., Monitoring and evaluating reinforcement corrosion using, "contest", P International conference on, deterioration and repair of reinforced concrete in the Arabian Gulf, Bahrain, October 1989, Vol 1, PP. 381- 400.
[9] Al-tayyib, A. J., Kahn, M. S., Concrete deterioration problems in the Arabian Gulf, Durability of Building Materials, No 4, 1987, pp. 287-298.
[10] Harrison, T. A. and Spooner, D. C., The Properties and use of concretes made with composite cements, Cement and Concrete Association, Interm technical note 10, November 1986,28pp.
[11] Swamy, R. N. and Bouikni, A., Some engineering properties of slag concrete as influenced by mix proportioning and curing , ACI Materials Journal, Vol. 87, No. 3, May June 1190, pp. 210-220.
[12] Price, W. H., Factors influencing concrete strength, ACI Journal, Vol. 47, Feb 1951, pp. 421-423.
[13] Long, B. G. and Kurtz, H. J., Effects of curing methods upon the durability of concrete, proceedings- American Society for Tooling and Materials, Vol. 43,1943, pp. 1051-1065.
[14] Mangat, P. S. and El-Khatib, J. M., Influence of initial curing on pore structure and porosity of blended cement concretes, ACI Special Publication SP-1 14, May 1992, pp. 813 833.
[15] Shetty M.S., “concrete technology theory and practice”, 2005.