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Comparative Study of Two Sources of Sugarcane Bagasse Ash (SCBA) as partial replacement of Cement

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Abstract: Cement industries give rise of the carbon dioxide in our social environment. The air is not fresh near cement industry and its parts affect the breathing system. To reduce air pollution and carbon dioxide, the alternative materials like cement are needed to find out as admixture or partial replacement. The industrial and agricultural wastages in concrete partly as cement replacement not only reduce the cost of making concrete but also reduce environmental pollution and minimize the waste emissions. In this paper, two sources of sugarcane bagasse ash were used as partial replacement of cement. Sugarcane bagasse ash (SCBA) sample was collected from NwayDay and Oatkan sugar factories. Untreated bagasse ash has been partially replaced in the ratio of 0%, 5%, 10% and 15% by weight of cement in concrete and compared with water cement ratio 0.4, 0.5 and 0.6. Fresh concrete test and hardened concrete test at the age of 7, 14, 28 and 56 days are investigated. And then two sources were compared at 56days compressive strength to get the Grade 40. The result shows that the strength of Oatkan SCBA is better than NwayDay SCBA.

Keywords: carbon dioxide, air pollution, SCBA, alternative material, sources, strength

1. INTRODUCTION

Ordinary Portland Cement (OPC) is used as main components in the construction works. The increase in carbon dioxides emissions in cement industry leads to vast effect in our environment. Therefore alternative material like cement should be used to reduce air pollution and carbon dioxide emissions. Some of the industrial wastes like fly ash, blast furnace slag, silica fume was successful used as admixture and partial replacement of cement. Some of the wastes like maize combs, palm kennel shell, coconut shell and groundnut shell etc. are not easily decomposed and accumulation in the environment. Cementitious materials need little or no direct energy related costs, so it is cheaper than OPC. From the economical point of view, cement is known to be more expansive as its production is highly energy intensive.

Sugarcane mainly grows in tropical and subtropical regions. The most planted areas in Myanmar was Sagaing, HtiChike and Kathar regions. Sugarcane is the products of sugar. After extraction sugar from sugarcane, 30% fibrous residue of bagasse by weight of sugarcane was obtained. It was used as fuel in sugar mills. Sometimes the bagasse was used in making the paper. The combustion yields sugarcane bagasse ash (SCBA) containing silica contents. The burning temperature of sugarcane bagasse varies from 700 to 1200° C. It effects on chemical composition of SCBA. The properties of sugarcane depend on the nature of soil and its species. It also effects chemical composition of SCBA and its reactivity on concrete.

2. OBJECTIVE of THIS STUDY

The goal of this study is to reduce the cost of construction and to find the alternative material for cement as admixture or partial replacement. The main objective is to inspire the use of the wastes as construction materials.

3. MATERIALS AND METHODS

3.1 Cement

The most commonly used material is Ordinary Portland Cement (Type I). Apache Cement brand (Type I) was used in this study. The physical tests of cement were made on High Tech Lab and Technological University (Thanlyin) according to the American Society for Testing and Materials (ASTM), and Indian Standard (IS) procedures. The specific gravity of cement is 3.15.

3.2 Aggregates

The river sand passing through 4.75 mm sieve was used as fine aggregate. The sand is free from debris and organic impurities. The maximum size of crushed aggregate 20mm was used as coarse aggregate. The results of specific gravity, fineness modulus and bulk density of coarse and fine aggregates are shown on Table 1.

Table 1. Physical Properties of Aggregates

Physical Test	Coarse Aggregate	Fine aggregate
Fineness Modulus	3.74	2.2
Specific gravity	2.8	2.7
Bulk density (kg/m^3)	1505	1560

3.3 Water

Tube well water in Tharkayta was used in the concrete works. Water test was carried out on ISO tech laboratory. PH level in water is 7.2, so it is accessible to use in concrete works.

3.4 Sugarcane Bagasse Ash (SCBA)

In the present study two kinds of sugarcane bagasse ash were used. It can be obtained from NwayDay (NA) and OatKan

(OA) sugar factories. NwayDay SCBA (NA) mainly contains silica content, but it is lack in alkali content. But silica content of over 70% is a good pozzolanic material. The total amount of silica, aluminum oxide and ferrous oxide is over 70% in OA. Specific gravity of NwayDay and OatKan SCBA was 1.79 and 1.92. Chemical test was carried out in Chemistry lab by using EDXRF at West Yangon University. Chemical compositions of NA, OA and Ordinary Portland Cement (OPC) were compared and shown in Table 2.

Table 2. Chemical Composition of NA, OA and OPC

Oxide Composition	NA	OA	OPC
Silica	85.1	87.2	21.47
Aluminum Oxide	-	5.3	4.61
Ferric Oxide	2.2	1.4	3.32
Calcium Oxide	4.6	2.9	64.61
Potassium Oxide	5.1	2.1	-
Phosphorous Oxide	0.7	1.6	-
Sulphide Oxide	1.2	0.5	-

4. EXPERIMENTAL WORKS

In the experimental works, total of 48 mortar cubes 50mm×50mm×50mm were prepared for 0%, 5%, 10% and 15% at the age of 3, 7 and 28 days. NA and OA was summarized for NwayDay and OatKan SCBA. N0 and AO were denoted as control mix that is no added SCBA, N5 and A5 as 5% of cement replacement with NA and OA, N10 and A10 as 10% of cement replacement with NA and OA, and N15 and A15 as 15% cement replacement with NA and OA.

The water/cement ratio was 0.4, 0.5 and 0.6 to attain the Grade 40 at 56 days curing. Mix design was based on ACI and high tech procedure. Total of 288 no's of cubes mould 150mm×150mm×150mm were casted with w/c 0.4, 0.5 and 0.6 for compressive strength test after 7, 14, 28 and 56 days curing. Two samples are compared in compressive strength at 56 days curing and their workability.

5. TEST RESULTS AND DISCUSSIONS

5.1 Consistency and Setting Time

The results of consistency and setting time of NA and OA were shown in Table 3 and 4. The test for consistency and setting time was carried out according to ACI. The water requirement of NA replacement increased with the additional percent level of SCBA. It means more water needs for proper consistency in NA. But the water requirement decreased in 5%, 10% and 15% replacement of OA in cement when comparing the control mix. Water requirement in OA is less than control mix (0%). As ashes are hygroscopic in nature, it needs more water for proper consistency.

Increasing the NA and OA level considerably increased the initial and final setting time. Therefore addition of SCBA retarded the setting time. But the results of OA and NA replacement are within the permissible limits. It means that bagasse ash paste was slow the hydration of cement.

Table 3. Consistency and Setting time of NA replacement

% Replacement of Cement with NA	Consistency (%)	Initial Setting Time (min)	Final Setting Time (min)
N0	28	145	240
N5	30	150	260
N10	33	177	290
N15	35	183	313

Table 4. Consistency and Setting Time of OA replacement

% Replacement of Cement with OA	Consistency (%)	Initial Setting Time (min)	Final Setting Time (min)
A0	28	145	240
A5	26	155	270
A10	27	165	275
A15	27.5	147	265

5.2 Compressive Strength test for Mortars

According to ASTM C 109, cubes were casted with w/c 0.485. Comparison of the data for 3, 7 and 28 days of curing time shows that compressive strength increases with OA up to 5% replacement. The strength depends on the surface area and fineness of SCBA. The results are shown in figure 1 and 2.

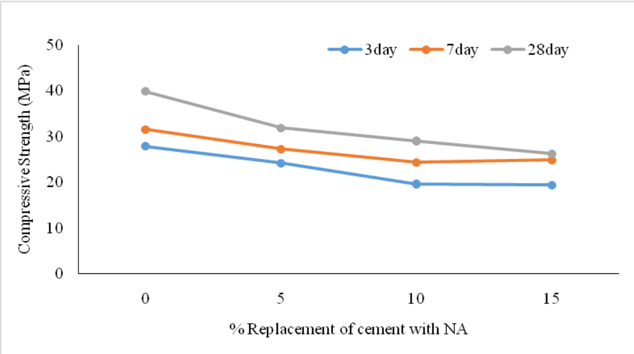

Figure 1. Compressive Strength of OPC-NA mortars

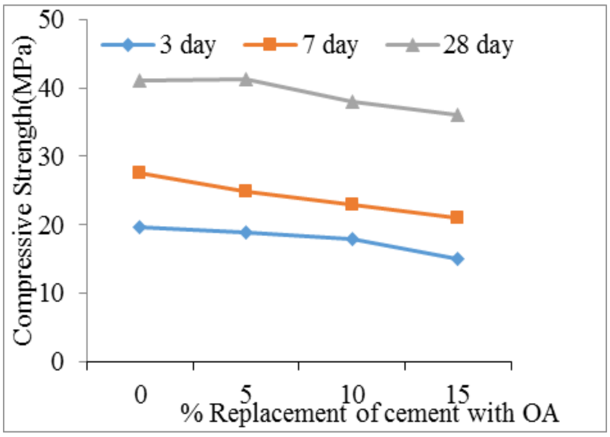

Figure 2. Compressive Strength of OPC-OA mortars

5.3 Effect of SCBA on Workability

The results with water cement ratio 0.4, 0.5 and 0.6 for all mixes are shown in Table 5 to 7. With w/c 0.4, slump values decreased in the partial replacement of NA when the percentage of SCBA increased. However slump values in 10% partial replacement of OA increased. Water cement ratio, temperature and times affect the workability. In general SCBA absorbs more water than cement. But slump values in OA replacement has not significantly changed.

Table 5. Workability of Fresh Concrete with w/c 0.4

% Replacement of cement with SCBA	Slump of NA (mm)	Slump of OA (mm)
0%	215	190
5%	195	180
10%	160	190
15%	60	175

Table 6. Workability of Fresh Concrete with w/c 0.5

% Replacement of cement with SCBA	Slump of NA (mm)	Slump of OA (mm)
0%	235	190
5%	235	190
10%	230	180
15%	190	160

Table 7. Workability of Fresh Concrete with w/c 0.6

% Replacement of cement with SCBA	Slump of NA (mm)	Slump of OA (mm)
0%	180	190
5%	200	190
10%	160	180
15%	115	160

5.4 Compressive Strength of SCBA replacement on Concrete

Cubes mould were casted with w/c 0.4, 0.5 and 0.6 at the partial replacement of NA and OA for the period of 7, 14, 28 and 56 days curing. When comparing two sources of SCBA in compressive strength, OA replacement got the strength of 56.6MPa in 5% replacement at 56 days curing. NA replacement got the required strength at water cement ratio 0.4 at 56 days. 5 to 15% replacement of OA on concrete with w/c 0.4 got the required strength. The silica and aluminum content in OA supported to increase the strength. The strength values are shown in Table 8to 13. Fig. 5 to 7 shows the comparison of NA and OA replacement with varying w/c on compressive strength.

Table 8. Compressive Strength of NA replacement with w/c 0.4

Age (days)	Compressive Strength (MPa)			
	N0	N5	N10	N15
7	35.15	27	26.9	26.4
14	39.4	30.3	30.5	29.1
28	50.7	40.5	39.2	37.2
56	61.5	50.5	49.8	43.9

Table 9. Compressive Strength of NA replacement with w/c 0.5

Age (days)	Compressive Strength (MPa)			
	N0	N5	N10	N15
7	23.6	18	16.4	13.8
14	32.2	24.4	19.6	17.6
28	37.2	29.6	24.4	21.1
56	44.6	36	30.9	27.9

Table 10. Compressive Strength of NA replacement with w/c 0.6

Age (days)	Compressive Strength (MPa)			
	N0	N5	N10	N15
7	21.9	14.5	14.7	14.5
14	25.6	19.2	18.3	18.1
28	30.7	21.6	20.7	20.1
56	34.1	25.8	24	23.1

Table 11. Compressive Strength of OA replacement with w/c 0.4

Age (days)	Compressive Strength (MPa)			
	A0	A5	A10	A15
7	36.7	33.1	29.6	28.7
14	48.7	43.1	41.2	36.8
28	57.4	49.7	47.5	45
56	60.5	56.6	51.3	48.5

Table 12. Compressive Strength of OA replacement with w/c 0.5

Age (days)	Compressive Strength (MPa)			
	A0	A5	A10	A15
7	29.6	25.8	23.2	21.5
14	36.7	32.1	29.8	26.5
28	41	36	32.9	30.7
56	43.2	41.35	36.1	32.6

Table 13. Compressive Strength of OA replacement with w/c 0.6

Age (days)	Compressive Strength (MPa)			
	A0	A5	A10	A15
7	25	22.5	19.8	17.8
14	27.4	25.4	21.6	18.9
28	32.6	29.2	25	22.4
56	38.8	35	31.3	26.5

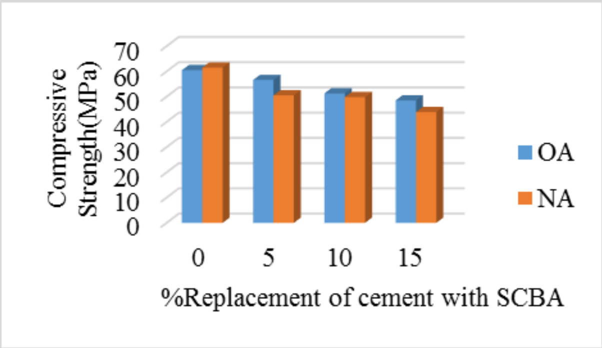

Figure 3. Compressive Strength of NA and OA replacement with w/c 0.4 at 56 days curing

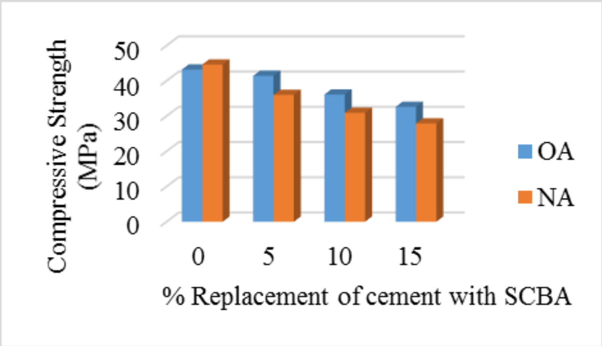

Figure 4. Compressive Strength of NA and OA replacement with w/c 0.5 at 56 days curing

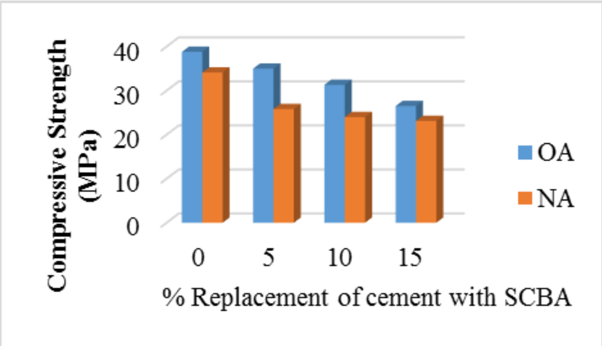

Figure 5. Compressive Strength of NA and OA replacement with w/c 0.6 at 56 days curing

6. CONCLUSIONS

From the above results, the following conclusion can be drawn. OatKan bagasse ash is better than NA. Up to 5 to 15% replacement of OA with w/c 0.4 reached the required strength at 56 days curing. In the NA replacement, 5 to 15% replacement with w/c 0.4 got the required strength. But when w/c ratios were changed, the strength decrease in NA replacement. In the mortar test results, 5% replacement of OA increase the compressive strength when comparing to control mix (0%). When compared two sources in compressive strength, the strength of 5% to 15% replacement of OA relatively more increased than that of NA replacement. With w/c 0.5, only 5% replacement in OA got the required strength, but NA replacement does not attain the required strength. Although it can't compared the control mix, OatKan SCBA can be replaced on concrete without chemicals to get higher strength. Wet concretes are more workable than dry concretes therefore OA gets the good slump values. And also the application of SCBA reduce the environmental problem and use of cement.

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8. REFERENCES

[1] A.M Neville, J.J Brooks, *Concrete Technology*, 2nd ed., 2010.
[2] Johy F.Ryan., *Story of Portland Cement*, Journal of chemical education, 1929, vol. 6 Issue 11.
[3] Shilpa Raju, "Effect of Using Glass Powder in Concrete" vol.3, Issue 5, July. 2014
[4] Maung Hein Min Htet, "Feasibility study on application of sawdust ash for cement replacement in structural concrete" 2017 International Conference
[5] R.Srinivasan Senior Lecturer, Department of Civil Engineering "*Experimental Study on Bagasse Ash in Concrete*" International Journal for Service Learning in Engineering Vol. 5, No. 2
[6] [2014] Research Gate website [online]. Available: http://www.researchgate.net
[7] [2013] MAST home page [online]. Available: https//matsel.matse.illinois.edu/home.html
[8] John Newman, Ban Seng Choo , , "*Advanced Concrete Technology*" 1st Edition 2003
[9] A.M Neville "Properties of Concrete" 5th edition 2011