Effect of Sugarcane Bagasse Ash as Fine Aggregates on the Flexural Strength of Concrete

Ali Aizaz Dayo[1], Aneel Kumar[1], Anees Raja[1], Naraindas Bheel[2], Abdul Wahab Abro[1], Zubair Hussain Shaikh[1]

[1]*Department of Civil Engineering, Mehran UET, Jamshoro, Sindh, Pakistan*
[2]*Department of Civil Engineering, Hyderabad College of Science & Technology Hyderabad, Sindh, Pakistan*

***Abstract*: Concrete is a material widely used in the world. According to global use, it is located in the second position after the water. River sand is costly due to the high cost of transportation from a natural source. In concrete production the most commonly River sand used as fine aggregate, which creates a serious shortage in many areas and continuous use has become a major problem in terms of its availability, cost, and environmental impact. So, the engineer started searching for alternative materials to fine aggregate. The main purpose of this study was to identify alternative sources of high-quality aggregates. Studies are currently underway to know the effects of sugarcane bagasse ash on mechanical characteristics when replacing various percentages of fine aggregates in concrete. A total of 30 concrete samples were made of (1:2:4) mix ratios with 0.50 water-cement ratio blended with a various proportion of 0%, 10%, 20%, 30% and 40% sugarcane bagasse ash in concrete. These concrete specimens (500mm x 100mm x 100mm) were used to determine the flexural strength of concrete on UTM at 7 and 28 days. It was noted that the flexural strength of concrete enhanced by 14.41% by using 10% of SCBA as a fine replacement material in concrete. The flow of fresh concrete decreased with an increase in the content of SCBA.**

***Keywords*: Sugarcane Bagasse Ash, Sand Replacement Materials, Strength of Concrete, Utilization of natural resources.**

I. INTRODUCTION

In subtropical and tropical countries sugarcane is a major food crop. Sugar is main source of its production after juice abstraction from sugarcane; waste is generated that is known as sugarcane bagasse (SCB). After control burning of sugarcane bagasse, sugarcane bagasse ash (SCBA) is obtained. Direct disposal of SCB forms rubbish bundle in open areas creates environmental issues [1]. According to Barroso [2], 280 kg of bagasse waste created by one ton of sugarcane, environmental as well as economic issues generated through this, for proper, disposed off, handling and operation, reliable efforts have been taken by bagasse waste organization. The utilization of waste products in cement concrete is an important condition to overcome the environmental burden, (SCBA) is a discarded product of sugar factory, which has a good capability to use as cement replacement in concrete. Sugarcane is a major harvest and due to high amount crop of south Asia generally known as cash crop.

The sugar factory shows an important role in the country wide economics of Pakistan. Regarding to the specific information of sugar mill union of Pakistan, Pakistan's sugarcane production in the year 2015-16 is 65.45 million tons and also year of 2016-17 the production is calculated 71.371 million tons [3]. Moreover, all over the scholars are focusing on mutually agro and industrial waste as raw material sources for the factory, the proper usage of this waste material would not only be economical benefits but may also outcome in foreign exchange wages and environmental pollution control[4]. Special work for the state is to diminish the harmful effects of waste on environmental as well as on health [5]. The overall usage of sand as fine aggregate (F.A) in the production of concrete is very high and some advanced countries have some pressure on the supply of natural sand in order to meet the growing demand for infrastructure enhancement in current years[6]. Additionally, the construction factory has a high demand for river sand scholars have distinguish some sand substitutes, such as rice husk ash [7-8], millet husk ash, sugarcane bagasse ash [9] silica fume, maize cob ash [10], marble powder, tile powder [11].In promoting countries, environmental management is facing from various problem due to environmental issues inevitably associated to economic and social aspects, which must be undertaken in the promoting any environmental plan or regulation[12]. Especially in more populated areas, there are so many waste problem existed in all over the world [13].

In construction works utilization of solid industrial wastes as sand replacement material not only saves a dump area but also diminishes the need for the extraction of natural raw materials [14]. Hence, the goal of this work is to replace sand with SCBA as in cement concrete.

Bagasse is essential by-product of the sugar factory that utilized as an energy fuel for sugar production in the same factory [15]. 25-30 % bagasse obtained from sugarcane, while factory processed sugar makes up about 10 %. Bagasse is utilized as raw source for paper production due to its fibrous appearance and can give output about 0.3 tons of paper from one ton of bagasse [16]. Around 70 sugar factories produce 14 million tons of bagasse annually also used as energy sources. No other uses than landfills, as burning bagasse leaves 3% ash [17-18]. Production of additional calcium silicate hydrate (CSH) due to result of silica content in pozzolana reacts with free lime released during cement hydration [19], which enhances the hardened characteristics of concrete. The ash obtained during burning process of agricultural waste at a controlled temperature of less than 700 ^{0}c for 1 hour converting the silica content in the ashes to the amorphous phase [20], particular surface area of the bagasse ash is linearly associated with the reaction of amorphous silica.

II. MATERIALS & METHODS

A. Cement

The OPC was used locally available in the market under the trademark name "Lucky cement".

Table 02: Tests of Cement

S.No	Tests	Results
01	Normal consistency	32%
02	Initial setting time	48 min
03	Final setting time	230 min

B. Fine Aggregates

Locally available near the river bed and free of debris sand was utilized as finer aggregate which passed through #4 sieves. The various physical characteristics of fine aggregates are mention in a given table 01.

C. Coarse Aggregates

The crushed aggregates were used of 20 mm in size which is locally available in the region of Jamshoro. The preliminary tests were performed on coarse aggregates as tabulated in Table 01.

Table 03: Tests of Aggregates (Fine and Course)

S.No	Properties	Fine Aggregates	Coarse Aggregates
01	Fineness Modulus	2.21	---
02	Water Absorption	1.60%	1.0%
03	Specific Gravity	2.64	2.61
04	Bulk Density	118 lb/ft^3	96 lb/ft^3

D. Sugarcane Bagasse Ash

From Matiari Sugar factory sugarcane bagasse ash was collected. It contains various un-burnt matters, which was sieved through 350-micron sieve to obtain desirable ash that was used as fine aggregates in the production of concrete.

E. Water

The clean and drinkable water was used in this experimental work.

F. Research Methodology

The research study was conducted on the fresh and mechanical characteristic of concrete by using 0%, 10%, 20%, 30% and 40% of SCBA as fine aggregates in concrete. A total of 30 concrete beams (500 mm x 100 mm x 100 mm) were prepared with a 1:2:4 ratio with 0.50 water-cement ratio and cured at 7 and 28 days. Three concrete specimens were cast for each proportion and finally, the average value of the three beams was taken as the final result. This research work was completed in the laboratory of concrete, Department of Civil Engineering, Mehran UET, Jamshoro, Sindh, Pakistan [22].

Table 01: Mix Proportion of Concrete

S. No.	Mix Ratio	Water-cement Ratio (%)	Cement (%)	Coarse Aggregates (%)	Sugarcane Bagasse Ash (%)	Fine Aggregates (%)
01	1:2:4	0.50	100	100	0	100
02	1:2:4	0.50	100	100	10	90
03	1:2:4	0.50	100	100	20	80
04	1:2:4	0.50	100	100	30	70
05	1:2:4	0.50	100	100	40	60

III. RESULTS AND DISCUSSIONS

A. Workability of Fresh Concrete

The fresh property of concrete i-e workability was conducted by slump cone. The maximum value of slump concrete was measured by 52 mm while using 0% SCBA and the minimum value of slump was recorded by 16 mm at 40% of SCBA as fine aggregate replacement in concrete. It was advocated that the flow of concrete was reduced with increases in the amount of SCBA as shown in fig.01.

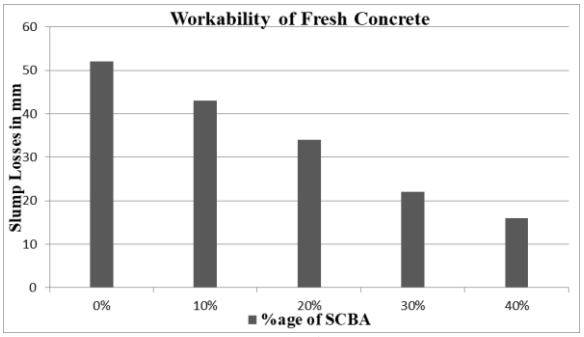

Fig .1 : Workability of Fresh Concrete

B. Flexural Strength of concrete

Flexural strength test was investigated on beam samples (500mm x100 mm x 100 mm) by using the various proportion of SCBA. Proportion of replacement was 0%, 10%, 20%, 30% and 40% by the weight of sand particles. In this research study three samples were cast for each replaced level and taken mean of three samples for each curing days. The maximum flexural strength was observed by 13.63% and 14.40% at 10% SCBA as a sand replacement material in concrete after 7 and 28 days respectively. Similarly the minimum value of flexural strength obtained 22.13% and 15.73% at 40% SCBA level in concrete at 7 and 28 days of curing period.

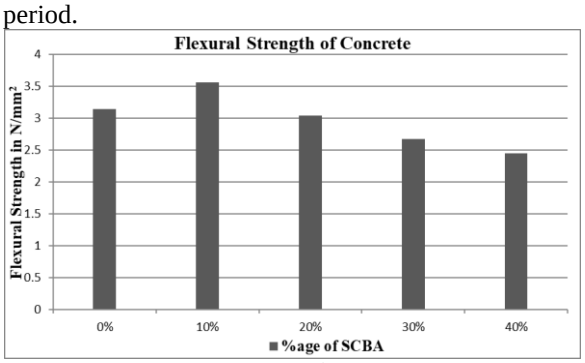

Fig.2 : Flexural Strength of Concrete @ 7 days

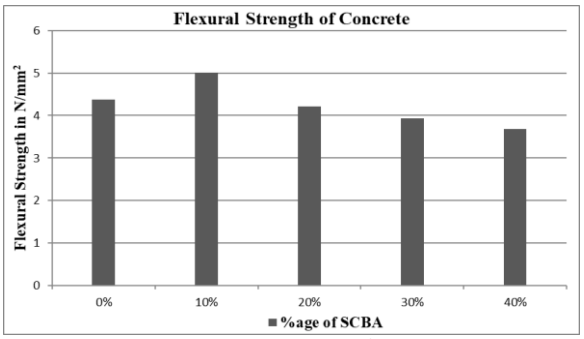

Fig 4.7: Flexural Strength of Concrete

IV. CONCLUSIONS

- The maximum workability was obtained 52mm in concrete by using 0% of SCBA and the minimum value of the flow of fresh concrete was measured 16mm at 40% of SCBA by using the dry weight of fine aggregate. The flow of fresh concrete is decreased with the increase in percentages of SCBA content in concrete.
- The higher value of flexural strength 3.56 MPA and 5.01 MPA are obtained at 10% replacement with fine aggregate with sugarcane bagasse ash, which is 13.63% and 14.4% more than of control mix at 7 and 28 days.

REFERENC

[1] Abdulkadir T S, Oyejobi D O and Lawal A A 2014 Evaluation of Sugarcane Bagasse Ash as a replacement for Cement in Concrete Works Acta Tehnica Corviniensis – Bulletin of Engineering (Ilorin: University of Ilorin) pp 71–76
[2] Barroso J, Barreras F, Amaveda H and Lozano A 2003 On the optimization of boiler efficient using bagasse as fuel, Fuel 82 1451–63
[3] Iskander M K 2016 Annual review status by Pakistan Sugar Mills Association Centre, Retrieved on October 20,2016 from http://www.psmacentre.com/aboutus.php?id=6&type=annual_ review&status=1
[4] Idris M K, Eldin K and Yassin E 2015 Determination of the effects of bagasse ash on the properties of portland cement, Journal of Appl. and Industr. Sci. 3 6–11
[5] Eddine, BT, Salah, MM: Solid waste as renewable source of energy: current and future possibility in Algeria. Int. J. Energy Environ. Eng. 3, 17 (2012).
[6] Joel, M: Use of crushed granite fine as replacement to river sand in concrete production. Leonardo Electronic Journal of Practices and Technologies 17, 85–96 (2010).

[7] N., Bheel, S.L., Meghwar, S.A., Abbasi, L.C., Marwari, J.A., Mugeri, and R.A., Abbasi, "Effect of rice husk ash and water-cement ratio on strength of concrete", Civil Engineering Journal, vol. 4, no. 10, pp.2373-2382, 2018.
[8] N. Bheel, A.W. Abro, I. A. Shar, A. A. Dayo, S. Shaikh, and Z. H. Shaikh, "Use of Rice Husk Ash as Cementitious Material in Concrete," Engineering, Technology & Applied Science Research, vol. 9, no. 3, p. 4209, 2019.
[9] N.D., Bheela, F.A., Memonb, S.L., Meghwar, A.W., Abroa, and I.A., Shara, "Millet Husk Ash as Environmental Friendly Material in Cement Concrete", In Proceedings of the 5th International Conference on Energy, Environment and Sustainable Development, Mehran UET Jamshoro, Sindh, Pakistan: Energy and Environment Engineering Research Group, vol. 1, November 14-16, 2018, pp. 153-158.
[10] Z.H., Shaikh, A., Kumar, M.A., Kerio, N., Bheel, A.A., Dayo and A.W., Abro, "Investigation On Selected Properties Of Concrete Blended With Maize Cob Ash", In proceeding of 10Th International Civil Engineering Conference, NED UET Karachi, 23-24, February, 2019, pp. 23-28.
[11] N., Bheel, R.A., Abbasi, S. Sohu, S.A. Abbasi, A.W. Abro, & Z.H. Shaikh, "Effect of Tile Powder Used as a Cementitious Material on the Mechanical Properties of Concrete", Engineering, Technology & Applied Science Research, Volume 9, No. 5, pp: 4596-4599, 2019.
[12] N. Bheel, S.L. Meghwar, S., Sohu, A.R., Khoso, A. Kumar, and Z.H., Shaikh, "Experimental Study on Recycled Concrete Aggregates with Rice Husk Ash as Partial Cement Replacement", Civil Engineering Journal, vol.4, no. 10, pp.2305-2314, 2018.
[13] Silva, MAR, Mater, L, Souza-Sierra, MM, Corrˆea, AXR, Sperb, R, Radetski, CM: Small hazardous waste generators in developing countries: use of stabilization/solidification process as an economic tool for metal wastewater treatment and appropriate sludge disposal. J Hazard Mater. 147, 986–990 (2007).
[14] Batayneh, M, Marie, I, Asi, I: Use of selected waste materials in concrete mixes Waste Manag. 27, 1870–1876 (2007).
[15] Ismail, ZZ, AL-Hashmi, EA: Reuse of waste iron as a partial replacement of sand in concrete. Waste Manag. 28, 2048–2053 (2008).
[16] Xie, Z., and Xi, Y. (2001). "Hardening mechanisms of an alkaline-activated class F fly ash," Cem. Concr. Res., 31(9), 1245–1249.
[17] Amin, N.U., 2010. Use of bagasse ash in concrete and its impact on the strength and chloride resistivity. Journal of materials in civil engineering, 23(5), pp.717-720.
[18] Ramesh, S.T., Gandhimathi, R., Nidheesh, P.V., Rajakumar, S. and Prateepkumar, S., 2013. Use of furnace slag and welding slag as replacement for sand in concrete. International Journal of Energy and Environmental Engineering, 4(1), p.3.
[19] Mangi, S.A., Jamaluddin, N., Ibrahim, M.H., Halid Abdullah, A., Awal, A.S.M., Sohu, S. and Ali, N., 2017, November. Utilization of sugarcane bagasse ash in concrete as partial replacement of cement. In Materials Science and Engineering Conference Series (Vol. 271, No. 1, p. 012001).
[20] Hernandez, J. M., Rodriguez, B. S., and Middendorf, B. (2001). "Pozzolanic properties of residues of sugar industries (second part)", Mater. Construcc., 51(261), 67–72.
[21] Amin, N., Shah, M. T., and Ali, K. (2009), "Raw mix designing and clinkerization high strength portland cement from the raw material of Darukhula Nizampur, District Nowshera, N.W.F.P., Pakistan." Mag. Concr. Res., 61(10), 779–785.
[22] N.D., Bheel, S.A., Abbasi, S.L., Meghwar, and F.A., Shaikh, "Effect of Human Hair as Fibers in Cement Concrete", International Conference on Sustainable Development in Civil Engineering, 23th -25th, November 2017, vol. 01, pp.67-72.