SEYBOLD Report
ISSN: 1533 - 9211
https://seyboldreport.net/

ANALYSIS OF SUGARCANE ASH-BASED GEOPOLYMERCONCRETE

Mr Shailesh Singh Thakur[1], Mr Akshit Lamba[2]
Department of Civil Engineering, Kalinga University, Naya Raipur[1,2]
thakurshaileshsingh@rocketmail.com[1] , akshit.lamba@kalingauniversity.ac.in[2]

Abstract

The preservation of natural resources, the reduction of environmental pollution, and the appropriate utilization of waste materials are the fundamental goals of sustainabledevelopment. These goals can be achieved in concrete construction by partially replacing cement and aggregates with agro waste like rice husk ash, sugarcane bagasse ash, and so on. and industrial waste like steel slag, fly ash, coal bottom ash, and copper slag, among others the idea that sugarcane bagasse ash (SCBA) can be used in place of cement to create high- performance concrete [1,2]. By replacing cement, sugarcane bagasse ash, fly ash, and glass areused as mineral intermixtures in Portland cement to increase the tensile, compressive, and flexural strengths of concrete. As we've seen, every type of construction makes use of Portland cement. As construction grows, so does the availability of Portland cement. As a result, we use natural materials to replace cement. It may also have positive effects on the environment, such as reducing waste emissions and energy consumption as well as emissions of greenhouse gases. These admixtures also help us cut down on carbon dioxide (CO_2) emissions [3,4]. Because of its high silica (SiO_2) content, sugarcane bagasse powder (SCBA) can be utilized as a mineral admixture. We used sugarcane bagasse ash (SCBA) at 0%, 5%, 10%, 15%, 20%, 25%, 30%, and 35% in this experimental study. This indicates that, in comparison to standard concrete, the SCBA possessed significantly higher flexural, compressive, and splittensile strengths. When compared to conventional cement, the results demonstrate that Sugarcane Bagasse improves the workability of concrete. The findings demonstrate that SBA can be substituted for 15 percent of conventional concrete [5,6].

Introduction

Concrete is the world's most consumed construction material because of its excellent mechanical and durability properties. Worldwide, the concrete industry produces over 10 billion tons of concrete annually [Meyer 2006]. At present, concrete industry is cursed with the scarcity of the aggregate sand environment pollution from cement production. The cement industry has a significant contribution in global warming because combustion of fuel in the cement kiln and the electricity used for grinding the clinker, emit large amount of CO_2. Cement industry is responsible for about of 5% of global CO_2 emissions [Worrell*etal* 2001]. Furthermore, the natural resources of aggregates are depleting gradually due to development in infrastructure all around the world. The ban on mining in some areas is further increasing the problem of availability of natural aggregates [7]. Therefore, it becomes very essential and more significant to findout the substitutes for both cement as well natural aggregates. Apart from it, the continuous growth of agro and industrial waste is the principle cause of many environmental concerns and burdens which can be reduced by using these wastes in concrete construction. It is well known that mineral intermixtures are very effectively implement as harmonious materials in Portland cement [8,9]. Rise husk ash, sugarcane bagasseused as mineral intermixtures in Portland cement to improve the, tensile strength, compressive strength, flexural strength of concrete by replacing of cement or sand. Portland cement is being used extensively for almost every construction [10,11].

Project Specific

If we are successfully, replace it by cement the cost of concrete also reduced. It can also cause environmental advantages like minimizing in energy consumption or in greenhouse gas emissions and decrease of waste emissions. We also reduce carbon dioxide [CO2] emissions with these admixtures. Sugarcane bagasse ash [SCBA] can be utilized as mineral admixture because of its high percentage of silica [SiO2]. Cement containing ground bagasse ash includes different tests compressive strength, split tensile strength, flexural strength. Sugarcane bagasse ash [SCBA] is the most extensively material used in place of cement [12]. Brazil is the no.1 country in the world to be known for producing sugarcane at large number of scale, which at 720 million tons grows over 40% of world crop. In India Uttar Pradesh, Maharashtra and Karnataka are three largest states in India. India's 2017-2018 sugar production likely to touch 30 million tons. One ton of burned bagasse ash produce 25 kg of ash. Fineness modulus of bagasse ash is 0.6 to 1.2mm [13,14].

Objective

1. To accomplish that the SCBA had highly strength for flexural, compressive and splittensile as compare to normal concrete.
2. To accomplish that the Sugarcane Bagasse gives increment in the workability of concrete when contrasted with conventional cement.
3. Reduce the cost of concrete [15].

Materials & Methodology

Material Used

Cement

Cement is a binder that binds together the other materials. It has cohesive and adhesive properties in the presence of water. It is obtained by burning the mixture of calcareous and argillaceous materials. This mixture is properly intimated and fused inkiln at about 1450°C and a product called clinker is obtained. The clinker is cooled and the cooled clinker is mixed with a few percent of gypsum, then ground to get cement. Cements used in construction can be characterized as being either hydraulic or non- hydraulic, depending upon the ability of the cement to set in the presence of water. Hydraulic cements such as

OPC set and become adhesive due to a chemical reaction between the dry ingredients and water.

Coarse Aggregates

Aggregates most of which is retained on 4.75-mm BIS Sieve are known as coarse aggregates. The various types of coarse aggregates described as:

i) Uncrushed gravel or stone which results from natural disintegration of rock.

ii) Crushed gravel or stone when it results from crushing of gravel or hard stone.

Partially crushed gravel or stone when it is a product of the blending of above two. The shape of coarse aggregates is an important characteristic since it affects the workability and strength properties of concrete[16,17].

Sugarcane Bagasse Ash

Sugarcane bagasse ash is produced when bagasse is reutilized as a biomass fuel in boilers. When this bagasse is burned under controlled temperature, it results in to ash. The ash obtained from the boiler of a sugar mill was used in this study. Shown in Figure 3.1.Thesugar mill is situated at Kawardha area which falls at a distance of about 100 kms from Raipur [Capital of Chhattisgarh]. The collection of the ash was carried out during the boiler cleaning operation.

Effect of Mineral Admixtures on Properties of Concrete

Incorporation of mineral admixtures, particularly industrial waste by-products such as fly ash, blast furnace slag, and silica fume improves many properties of concrete significantly and favorably. Because of the spherical shape and small size of the glassy particles, the industrial by product admixtures tend to fill the void space between relatively large cement grains which is otherwise occupied by water[18,19]. In the water filled capillaries, the admixtures undergo pozzolanic reaction with Ca[OH], released during cement hydration. As a result, pore refinement occurs as larger size pores are transformed into smaller size pores. There is also a marked decrease in the volume of pores and as a consequence of both the physical and pozzolanic effects of these add mixtures, properties of concrete in both fresh and hardened state are affected. The extent of influence on concrete properties, however, depends on the type and amount of add mixture used, concrete mix proportions, addition of chemical add mixtures such as super plasticizer and air entraining agents, combined use of mineral admixtures, and many other factors[20,21].

Heat of Hydration

Hydration of portland cement is an exothermic reaction accompanied by liberation of heat that results in temperature rise of fresh concrete. In mass concrete, sections thicker than 60 cm or so, depending on the type and amount of cement, thickness and type of formwork, ambient temperature and humidity conditions, the temperature rise at times may amount to 20°C to 50°C within 2 days to 5 days after concrete placement. On cooling a subsequent age, the concrete with initial temperature rise may crack due to thermal stresses induced inhardened concrete. Additions of mineral admixtures such as natural pozzolans, fly ash, blast furnace slag in concrete as replacement of cement, result in reduction of temperature rise due to heat of hydration almost in proportion to the amount of cement replacement. Low calcium bituminous fly ashes tend to reduce the rate of temperature rise more than high calcium sub bituminous ashes as well as blast furnace slag and silica fume.

Methods of Concrete Mix Design

The process of selecting suitable ingredients of concrete and determining their relative amounts with the objective of producing a concrete of the required strength, durability and workability as economical as possible, is termed the concrete mix design. In present study mix design was done by BIS mix design method which is based on BIS: 10262- 2009.In this experiment, we used standard size of cubes with dimension of 150mm×150mm×150mm. From 10262-2009 code, we designed a mix proportion of concrete. We used M40 grade of concrete. Ratio of cement, sand and aggregate is 1:1.56:2.42 with water cement ratio of 0.464. SBA replaces cement with ratio of 0% to 35%. The elements of concrete were completely blended in blender machine till we get uniform consistency of concrete. Machine oil was spread on the inward surfaces of cubes before casting. Concretewas filled with the cube and compacted altogether utilizing table vibrator. The surface was finalize by method of trowel [22]. The cubes were separated after 24 hours and cured submerged for 7 and 28 days.

Table No.1 Physical Properties of Sugarcane Ash

Material	Sugarcane bagasse Ash
Specific gravity	1.85
Bulk Density [g/cm^2]	0.61
Specific Surface[m^2/kg]	958
Mean grain size[um]	5.58

The basic steps involved in the concrete mix design can be summarized as follows:

1. Based on the level of quality control the target mean strength is estimated from thespecified characteristic strength.

2. The water cement ratio is selected for the mean target strength and checked for therequirements of durability. [23]

3. The water content for the required workability is determined.

4. The cement content can be determined from the water cement ratio and water content obtained in step [i] and [ii] respectively and is checked for the water requirements.

5. The relative proportion of fine and coarse aggregates is selected from the characteristic of coarse and fine aggregates.

6. The trial mix proportions are determined.

7. The trial mixes are tested for verifying the compressive strength and suitable adjustments are made to arrive at the final mix composition.

Sieve Analysis for Coarse and Fine Aggregates as per BIS: 2386 [Part1] -1963

1. The sample was dried on a hotplate or in an oven temperature of 110ºC [230ºF].

2. The air dry sample was weighed and sieved successfully on the appropriate sieves starting with the large.

3. Each sieve was shaken separately over a clean tray until not more than atracepasses, but in any case for a period of not less than two minutes. The shaking was done with a varied motion, left to right, backward and forward, circular clockwise and anti- clockwise, and with frequent jarring, so that the material is kept moving over the sievesurface in frequently changing directions.

Compressive Strength of Concrete as per BIS: 516-1959

The quantities of cement, coarse aggregates [20 mm and 10 mm], fine aggregates, bagasse ash, coal bottom ash and water for each batch were weighed separately. Firstly, the cement and bagasse ash were mixed dry then after fine aggregates and coal bottom ash were mixed uniformly in dry form. The coarse aggregates were mixed to get uniform distribution throughout the batch. Water was added to the mix and then mixed thoroughly for 3 to 4 minutes in mechanical mixer.

Figure 1: Casting of Cube Specimens

Results and Discussion

The present chapter deals with the results of tests conducted on materials used in research work. The performance of various mixes containing different percentage of SCBA. All the tests were conducted in accordance with the methods described in ChapterIII.

1. It indicates that SCBA provided highly flexural strength, compressive strength andsplit tensile strength as compare to normal concrete.

2. The outcomes demonstrate that Sugarcane Bagasse gives increment in the workabilityof concrete when contrasted with conventional cement.

3. The outcomes show that SBA can be utilized 15% substitution as compared to normal concrete.

Test Results for Compressive Strength Compressive

Table 2: Compressive Strength for 7 days using Sugarcane Ash [SBA]

% ReplacementBy SBA	Casting I[Mpa]	Casting II[Mpa]	Casting III [Mpa]	Average[Mpa]
0%	34	35.80	30.50	33.43
5%	43.12	40.90	42.70	42.24
10%	42.56	44.66	45.00	44.07
15%	44.80	43.33	46.85	44.99
20%	42.95	40.18	40.73	41.28
25%	39.17	39.51	40.34	39.67
30%	40.55	39.41	38.15	39.37
35%	38.15	38.97	38.84	38.65

In table 2, it shows the compressive strength for 7 days and we successfully replace it by cement by 15% of sugarcane bagasse ash [SBA]. Expansion in compressive strength up to 15% concrete substitution of bagasse ash might be credited due to silica content, the strength abatements to a lesser incentive than that of normal concrete. In this manner, 15% bagasse ash-mixed cement is by all accounts as far as possible.

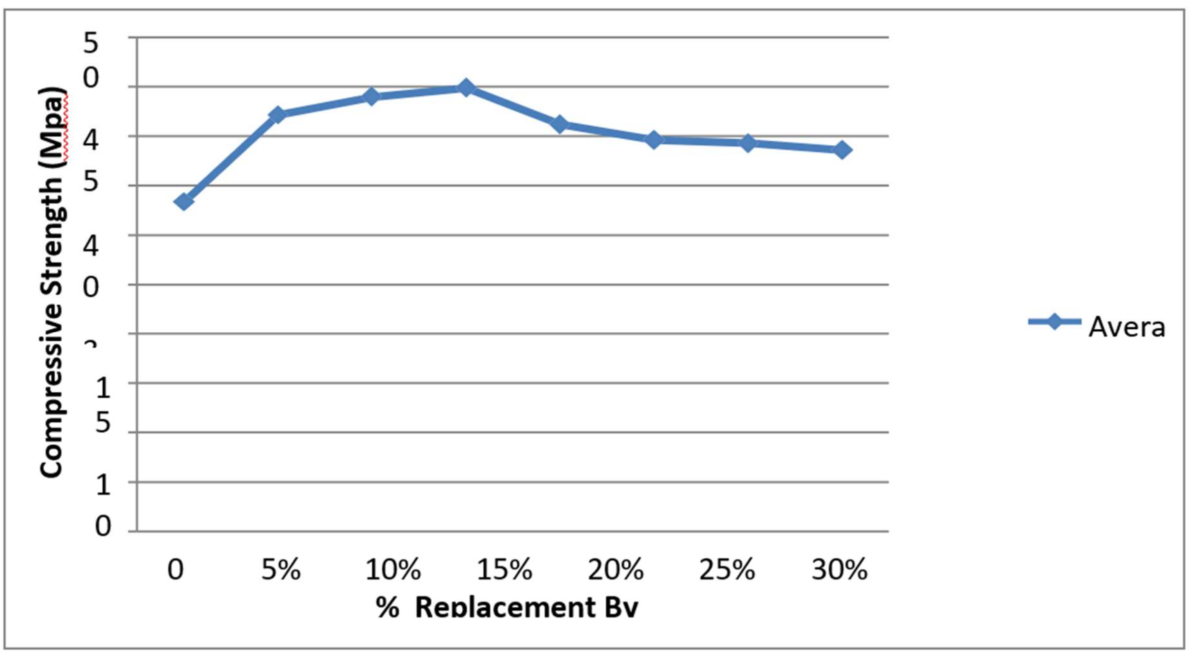

Figure 2: Average Compressive Strength for 7 days using Sugarcane Ash [SBA]

Conclusion

1. In Figure 2 graph shows the Comparison of Average Compressive Strength Results for 7 days and 28 days using Sugarcane Ash [SBA].

2. In Figure graph shows the Comparison of Average flexural Strength Results for 7 days and 28 days using Sugarcane Ash [SBA].

3. Reduce the cost of concrete.

4. SBA reduces the CO2 emissions from the environment.

5. SBA used as a admixture in different countries to reduce cement production and its usage in concrete.

As geo-polymer concrete technology is a new one, there is lot of scope to work in this topic. In the present study we used sugarcane baggase ash as a binder. We recommended extending this topic by using byproducts like rice husk ash, GGBS, pulverized fuel ash etc .And also**, i**nvestigation of Long term properties like durability, creep, drying shrinkage may also gives the suitability of geo-polymer concrete in the field. To implementing such a method the durability can be increased and strength of the material can also be increased.

References

1. **Aggarwal P, Aggarwal Y and Gupta S M** "*Effect of bottom ash as replacement of fine aggregates in concrete*". Asian J Civil Eng 8(1):49-62, 2007.

2. **Amin N**. *"Use of Bagasse Ash in Concrete and its impact on the strength and Chloride resistivity"* American Society of Civil Engineers, 23:717-720,2011.

3. **Andrade L Rocha J C and Cheriaf M** "*Influence of coal bottom* **B,** *ash as fine aggregate on fresh properties of concrete"*, Constr Build Mater 23:609–14, 2009.

4. **Bajare D, Bumanis G and Upeniece L** , *"Coal Combustion Bottom Ash as Microfiller with Pozzolanic Properties for Traditional Concrete"* ,Procedia Eng 57:149 –58, 2013.

5. **Behnood A and Ghandehari M** , *"Comparison of compressive and splitting tensile strength of high-strength concrete with and without polypropylene fibers heated to high temperatures*", Fire Saf J 44:1015-22, 2009.

6. Lamba, A. (2020). A Study On Geo Polymer Concrete Using Sugarcane Bagasse Ash. *Solid State Technology*, *63*(6), 13127-13134.

7. Lamba, A. (2022). FORMATIVE DESIGN OF HIGH-RISE SYSTEM IN STEEL STRUCTURE. *Harbin Gongye Daxue Xuebao/Journal of Harbin Institute of Technology*, *54*(6), 49-56.

8. Lamba, M. A. (2022). In-Structure Response Spectra Considering Nonlinearity Of RCC Structures: Experiments And Analysis. *Yantu Gongcheng Xuebao/Chinese Journal of Geotechnical Engineering*, *44*(5), 97-103.

9. Lamba, M. A., Tamrakar, M. G., & Gaur, M. H. (2022). A comparative analysis on CI turbine act and emissions resorting to a novel antioxidant preservative. *Telematique*, 523-535.

10. Sahu, M. K., Padhy, M. A. P., & Lamba, M. A. (2022). Preliminary Study on Interpretation Motion Traits of Moored Well-proportioned Wheeled vehicle for hauling-substitute in Common Waves. *Telematique*, 497-511.

11. Padhy, M. A. P., Lamba, M. A., & Tamrakar, M. G. (2022). Impact of Process Limits on Cable and Curve Additive Production Process. *Telematique*, 512-522.

12. Mahant, M. V., Agrawal, M. S., & Lamba, M. A. (2021). Experimental Study on Dolomite Bricks with Positive Permanent Linear Change.

13. Pathak, A., Singh, V., Darjee, M. A., & Agrawal, M. S. (2017). A Seismic Behavior of Building in Earthquake Zone in Nepal.

14. Agrawal, M. S. (2022). IMPACT OF HEAVY METAL ACCUMULATION IN GROUND WATER DUE TO LEACHATE & ASSESSMENT OF RHEOLOGICAL PROPERTIES. *Journal of East China University of Science and Technology*, *65*(2), 318-326.

15. Agrawal, M. S. (2022). A STUDY ON SEWAGE TREATMENT & GROUND WATER CONTAMINATION IN RAIPUR CITY. *Harbin Gongye Daxue Xuebao/Journal of Harbin Institute of Technology*, *54*(5), 187-191.

16. Agrawal, M. S., Vanarotti, M. B., & Yashwant, K. M. (2022). Research on Emotion in Artificial Life and Artificial Intelligence: Dealing with Issues. *Telematique*, 860-864.

17. Sarangi, M. S., Agrawal, M. S., & Vanarotti, M. B. (2022). Design and development of a suspension system to generate automatic electric power. *Telematique*, 2244-2253.

18. Mishra, C., & Das, M. P. Study and Design of Bridge Substructure and Foundation. Journal homepage: www. ijrpr. com ISSN, 2582, 7421.

19. Prasad, M. S., Das, M. P., & Lamba, M. A. STUDY ON CONSTRUCTION AND QUALITY CONTROL OF PQC PAVEMENT OF NH-216.

20. Rathore, M. M., Dhapekar, M. N., & Das, M. P. (2022). The Essential Design of Averting a Sudden Accident by Using a Safety Rebound Device in an Automobile. Telematique, 2355-2366.

21. Das, M. P. (2022). A REVOLUTIONARY APPROACH OF MODEL NGGB IN RURAL AREAS OF CHHATTISGARH. Harbin Gongye Daxue Xuebao/Journal of Harbin Institute of Technology, 54(6), 378-383.

22. Manas Rathore. (2022). Effect of admixtures on strength of concrete with the substitution of Aggregates. *Yantu Gongcheng Xuebao/Chinese Journal of Geotechnical Engineering*, *44*(5), 133–141.

23. Mr. Manas Rathore. (2022). Sustainable Design & Construction of Civil Infra-Structure. *Yantu Gongcheng Xuebao/Chinese Journal of Geotechnical Engineering*, *44*(5), 104–109.