Strength Parameter of Mortar Incorporated with Agro-Industrial wastes

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Abstract **- Concrete is the most adaptable construction material in the engineering sector, owing to its excellent strength and long-lasting resilience. Typical concrete mix compositions can be improved by integrating industrial and agricultural by-products such as fly ash (FA) and sugarcane bagasse ash (SBA), which fulfill both sustainability and efficiency goals. The physical properties of the materials such as OPC 53 cement, SBA, FA, M-sand & 20mm aggregate were examined. The consistency of the mix is determined and adopted a water cement ratio as 0.5. The mortar cubes of size 70.6 x 70.6mm were prepared by replacing the cement with flyash (0%, 10%, 20%, 30%, and 40%), sugarcane bagasse ash (15%) and combination of SBA and FA were studied. Samples were tested for compressive strength at the ages of 3, 7, 14 & 28 days. SBA 15% and FA 10% reaches the maximum compressive strength when compared to conventional mortar.**

Keywords— Sugarcane bagasse ash, flyash, Combination of mortar cubes

I. INTRODUCTION

A significant amount of energy is used in the cement-making process, which results in the emission of CO_2, a greenhouse gas, into the atmosphere. In order to effectively replace cement in this situation, attention must be directed towards either industrial or agricultural waste as a supply of raw materials. The cement industry may find it cost-effective to use by-products (S. Praveenkumar et al, 2020).

It could also lead to a sensible response to environmental issues. When used as additional cementitious materials, several industrial by-products, such as fly ash and blast furnace slag, have shown to be economical materials. Various agricultural waste products have been identified as pozzolanic materials, such as bagasse ash, sawdust, coconut fibres, rice husk ash, and wheat straw ash (G. Sankarasubramanian et al, 2020).

The combustion by-product of sugar industry boilers is sugarcane bagasse ash (SBA). Bagasse is the fibrous residue of sugarcane that is thrown after the cane is crushed in sugar mills and the juice is extracted by milling. Bagasse is frequently utilized as fuel in boilers for the cogeneration process in sugar mills (B.S. Thomas et. al, 2021).

Bagasse ash is collected in a bag-house filter and disposed of locally after burning in a cogeneration boiler, which poses serious environmental issues. In India, the production of bagasse ash is rising dramatically due to the swift adoption of cogeneration facilities in the sugar industry. Bagasse ash disposal is a significant source of concern for the sugar and food sectors (Bahurudeen A. et.al, 2015). Due to the high-quality quantity of amorphous silica in their chemical makeup, bagasse ash may be employed as an additional cementitious material (S. Praveenkumar, et.al).

When bagasse ash is added to cement, the silica and free lime combine. Products are generated from the hydration of cement and a fresh calcium silicate hydrate. This enhances concrete's mechanical and long-lasting qualities (K. Ganesan, et.al, 2007). Particle size reduction of bagasse ash leads to an improvement in pozzolanic activity. (N. Chusilp, et.al, 2009)

Only 63% of fly ash was consumed in 2009–2010; moreover, fly ash consumption has declined. According to NTPC Noida's projection, fly ash output is anticipated to rise by 225 million tonnes in 2017. Therefore, it would require extra work for us to use this fly ash in concrete (Sasi Rekha, et.al). According to the American Society for Testing and Materials (ASTM) (ASTM, 2008), fly ash (FA) was divided into two main groups: class C and class F.

Class F fly ash is pozzolanic, Class C fly ash is pozzolanic, cementitious, produced from sub-bituminous or lignite coal burning; according to the ASTM, the overall quantity of Fe_2O_3, Al_2O_3, and SiO_2 must be greater than 50% (Seham S. Alterary, et.al). By substituting these industrial goods for the binder in concrete, greenhouse gas emissions into the environment may be considerably reduced. Additionally, waste and pollution issues can be avoided (A.K. Mullick, 2007).

In this paper investigated the study of mortar cubes by using flyash and bagasse ash.

II. EXPERIMENTAL INVESTIGATION

Materials

Specifically, this study uses regular ordinary Portland Cement (OPC) 53 grade. Flyash and bagasse ash are also used in this investigation. Removed fly ash from a thermal power plant. The sugar industry is the source of the raw bagasse ash. Manufactured sand (also known as M sand), which meets Indian standards for fine aggregates. Indian standards are satisfied by the 20mm aggregate utilised. The materials physical property tests are displayed in Tables 1 and 2.

MIX DESIGN

Mix Proportion for Mortar Cubes

Mortar cubes are a blend of cement, sand, and water. According to IS 4031 part 6, the ratio of mortar cubes is 1:3. The fine aggregate is removed out of the mortar cube using sieves measuring 1 mm, 500 µm, and 90 µm. In terms of water cement ratios, it is determined that the standard consistency is 29% for cement, 38% for SBA, 31% for FA, and a mix of SBA and FA.

Testing of specimen

The investigation involved the preparation of mortar cubes measuring 70.6 x 70.6 mm. Flyash (0%, 10%, 20%, 30%, and 40%), sugarcane bagasse ash (15%), and a combination of SBA and FA (15% and 10%, 20%, 30%, 40%) were substituted for cement in the process. To assess the compressive strength, specimens were cast as mortar cubes at ages 3, 7, 14, and 28 days.

Table 1

Name of The Test	Cement	SBA (15%)	FA (10%)
Specific Gravity	3.14	1.97	2.29
Fineness	6%	35%	27%
Consistency	30%	39%	33%
Initial Setting time	31mins	3hr 1mins	55mins

Table 2

Name of The Test	Fine Aggregate	Coarse Aggregate
Specific Gravity	2.74	2.79
Water Absorption	1.8%	0.3%
Fineness Modulus	2.27	-
Sieve Analysis	Zone II	-

Casting and curing of mortar cubes

Ten different percentages of fly ash and sugarcane bagasse ash were used to cast mortar cubes: 0%, FA10%, FA30%, FA30%, FA40%, SBA15%, S15F10, S15F20, S15F30, and S15F40. In accordance with IS 4031-1996 part 6, the mix was created for mortar cube compressive strengths after 3, 7, 14, and 28 days which is shown in fig 1. Following casting, the specimens were submerged in a curing tank. After 3, 7, 14, and 28 days, the specimens were removed from the curing tank and their compressive strength was assessed and shown in fig 2.

Fig 1. Casting of mortar cubes

Fig 2. Curing of mortar cubes

III. RESULTS AND DISCUSSION

Compressive Strength of Mortar Cube

- ✓ The compressive strength of Conventional Mortar shows in the figure 1. Compressive strength of Conventional Mortar found to be 23.2N/mm^2, 33.4 N/mm^2, 46.1 N/mm^2 and 53.8 N/mm^2 for 3, 7, 14 & 28days respectively.
- ✓ The compressive strength of mortar cubes of CM and SBA shows in the figure 1. SBA 15 mix attains 80.6% of compressive strength of CM at the age of 3days. The increase in compressive strength between 3, 7, 14 & 28 days is 23.6%.
- ✓ Figure 3 which represents the compressive strength of mortar cube in the age of 3days.The compressive strength of FA10, FA20, FA30, and F40 attains 30%, 32.2%, 41.1% and 23% respectively. FA30 mix attains 93.9% compressive strength of CM.

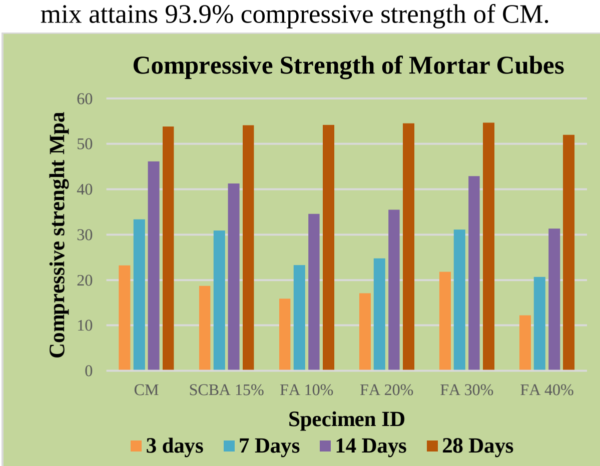

Fig.3 Compressive strength of mortar cubes.

- ✓ The compressive strength of a mortar cube after seven days is shown in Figure 4. CM, SBA, FA10, FA20, FA30, and F40 achieve compressive strengths of 43.9%, 46.7%, 58.6%, and 39, respectively. The FA30 blend achieves a compressive strength of CM of 93.1%.
- ✓ For 14 days, the compressive strength of FA10, FA20, FA30, and F40 attains 65.3%, 67%, 80.9% and 59.1% respectively. FA30 mix attains 93.2% compressive strength of CM.
- ✓ The compressive strength of mortar cubes in the age of 28 days for FA10, FA20, FA30, and F40 attains 36.1%, 34.8%, 21.5% and 39.8% respectively.
- ✓ Figure 4 which represents the compressive strength of combined effect of mortar cube in the age of 3days. The compressive strength of S15F10, S15F20, S15F30 and S15F40 attains 40.8%, 35.7%, 33.2% and 29.2% respectively. As compared to other mixes, S15F10 shows the higher compressive strength of combined effect of mortar cube at the age of 3 days. The mix S15F20, S15F30 and S15F40 shows the decrement in compressive strength of 12.5%, 18.5% and 28.2% respectively.

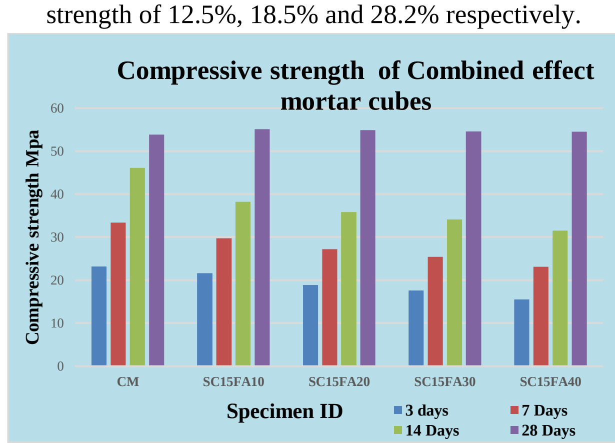

Fig.4 Compressive strength of combination of mortar cubes

- ✓ The compressive strength of the combined action of the mortar cube after seven days is shown in Figure 2. S15F10, S15F20, S15F30, and S15F40 achieve compressive strengths of 56%, 51.3%, 47.9%, and 43.6%, in that order. At 7 days, S15F10 has a greater compressive strength of the combined action of mortar cube when compared to other mixtures. Compressive strength degradation is observed in the mixes S15F20, S15F30, and S15F40, with percentages of 8.4%, 14.4%, and 22.2%, respectively.
- ✓ S15F10, S15F20, S15F30, and S15F40 achieve compressive strengths of 72.1%, 67.5%, 64.3%,

and 59.4%, in that order. At 14 days, S15F10 has a greater compressive strength of the combined action of mortar cube when compared to other mixtures. Compressive strength degradation is observed in the mixes S15F20, S15F30, and S15F40, with percentages of 6.3%, 10.7%, and 17.5%, respectively.

- ✓ The compressive strength for S15F10, S15F20, S15F30, and S15F40 at the age of 28 days attains 30.6%, 34.7%, 37.5% and 42.2%.

IV. CONCLUSION

The mortar cubes were made for conventional mortar, sugarcane bagasse ash of 15% and flyash of 10%, 20%, 30% and 40% and combined effect of SBA and FA were replaced in cement mortar for replacement of cement and tested for compressive strength.

- ➢ The cement mortar that was mixed with water and sand achieved a compressive strength of 52.6N/mm^2.
- ➢ SBA 15 mix shows 8.5% decrement when compared to CM at the age of 3days. The age of 7 days the decrement value exhibits as 4.7% which is half of the value of decrement in 3days. Hence, it clearly shows that SBA attains the later strength.
- ➢ At the latter age, SBA 15 shows greater strength when compared to conventional mortar.
- ➢ FA30 mix attains 93.9% compressive strength of CM which is nearer to the conventional mortar at the age of 7days.
- ➢ Due to the pozzolanic properties of flyash the compressive strength of FA30 attains nearer strength of the CM and are expected to be higher strength in later ages.
- ➢ The combined effect of SBA and FA gives a considerable compressive strength and are expected to be higher strength in later ages.
- ➢ At the age 28 days, SBA 15% and FA 10% attains the maximum compressive strength when compared to conventional mortar due to pozzolanic nature of the material.

REFERENCE

[1] Herve Kouamo Tchakoutea, Claus Henning Rüscherb, Malte Hinsch Jean, Noel Yankwa Djoboc, Elie Kamseuc, Cristina Leonelli, Utilization of sodium waterglass from sugarcane bagasse ash as a new alternative hardener for producing metakaolin-based geopolymer cement, *Chemie der Erde*, 2017

[2] Tayyeb Akram, Shazim Ali Memon, Humayun Obaid, Production of low cost self-compacting concrete using bagasse ash, *Construction and Building Materials* 2009, 23,703–712

[3] Jayminkumar A. Patel & Dr. D. B. Raijiwala, Use of Sugar Cane Bagasse Ash as Partial Replacement of Cement in Concrete, *Global Journal of Researches in Engineering*, 2015, 15(5)

[4] A. Bahurudeen, Deepak Kanraj, V. Gokul Dev, Manu Santhanam, Performance evaluation of sugarcane bagasse ash blended cement in Concrete, *Cement & Concrete Composites*, 2015, 59, 77–88

[5] Juliana P. Moretti, Almir Sales, Fernando C.R. Almeida, Mariana A.M. Rezende, Pedro P. Gromboni, Joint use of construction waste (CW) and sugarcane bagasse ash sand (SBAS) in concrete, *Construction and Building Materials* 2016, 113, 317–323

[6] A. Bahurudeen, Manu Santhanam, Influence of different processing methods on the pozzolanic performance of sugarcane bagasse ash, *Cement & Concrete Composites,* 2015, 56, 32–45

[7] Eduardo M.R. Fairbairn, Branca B. Americano, Guilherme C. Cordeiro, Thiago P. Paula, Romildo D. Toledo Filho, Marcos M. Silvoso, Cement replacement by sugar cane bagasse ash: CO2 emissions reduction and potential for carbon credits, *Journal of Environmental Management*, 2010, 91, 1864-1871

[8] Parisa Setayesh Gar, Narayana Suresh, Vivek Bindiganavile, Sugar cane bagasse ash as a pozzolanic admixture in concrete for resistance to sustained elevated temperatures, *Construction and Building Materials*, 2017, 153, 929–936

[9] Moises Frias , Ernesto Villar, Holmer Savastano, Brazilian sugar cane bagasse ashes from the cogeneration industry as active pozzolans for cement manufacture, *Cement & Concrete Composites* 2011, 33, 490–496

[10] Elisabeth Arif , Malcolm W. Clark , Neal Lake, Sugar cane bagasse ash from a high-efficiency co-generation boiler as filler in concrete, *Construction and Building Materials* 2017, 151, 692–703

[11] IS 456 2000, Plain and reinforced concrete: Code

of practice, New Delhi, Bureau of Indian Standards, India.

[12] IS 650 1991, Standard sand for testing cement-specification, India.

[13] IS 383 2016, Coarse and fine aggregate for concrete: Specifications, Bureau of Indian Standards, New Delhi, India.

[14] IS 10262 2019, Concrete mix proportioning: Guidelines, Bureau of Indian Standards, New Delhi, India.

[15] IS 2386 2021, Methods of Tests for Aggregates for Concrete, Bureau of Indian Standards, New Delhi, India. 39

[16] IS 4031 2021, Methods of Physical Tests for Hydraulic Cement, Bureau of Indian Standards, New Delhi, India.

[17] IS 516 1959, Methods of Tests for Strength of Concrete, Bureau of Indian Standards, New Delhi, India.

[18] IS 5816 1999, Splitting Tensile Strength of Concrete - Method of Test, Bureau of Indian Standards, New Delhi, India.

[19] Pitthaya Jamsawang, Hatairat Poorahong, Naphol Yoobanpot, Smith Songpiriyakij, Pornkasem Jongpradist, Improvement of soft clay with cement and bagasse ash waste, *Construction and Building Materials*,2017, 154, 61–71

[20] Alireza Joshaghani, Mohammad Amin Moeini, Evaluating the effects of sugar cane bagasse ash (SBA) and nanosilica on the mechanical and durability properties of mortar, *Construction and Building Materials* 2017, 152, 818–831

[21] G. C. Cordeiro, R. D. Toledo Filho, E. M. R. Fairbairn, Ultrafine sugar cane bagasse ash: high potential pozzolanic material for tropical countries, *IBRACON*, 2010, 3(1), 50 - 67 Sumrerng Rukzon, Prinya Chindaprasirt Utilization of bagasse ash in high-strength concrete, *Materials and Design*, 2012, 34, 45–50

[22] V.G. Jimenez-Quero, F.M. Leon-Martinez, P. Montes-Garcia, C. Gaona-Tiburcio, J.G.Chacon-Nava, Influence of sugar-cane bagasse ash and fly ash on the rheological behavior of cement pastes and mortars, *Construction and Building Materials*, 2013, 40, 691–701

[23] Nidhi Relan, Dr. A K Saxena, Experimental Study of Replacement of Cement by SBA in Concrete, *IJSR* 2319-7064

[24] A. Bahurudeen, A.V. Marckson, Arun Kishore, Manu Santhanam, Development of sugarcane bagasse ash based Portland pozzolana cement

[25] Chintan.M. Patel, Prof. N.N. Chinwala, An experimental study on bagasse ash in high strength concrete, *IJAREST* e-ISSN: 2393-9877, p-ISSN: 2016, 3(5), 2394-2444

[26] K. Lakshmi Priya, R. Ragupathy, Effect Of Sugarcane Bagasse Ash On Strength Properties Of Concrete, *IJRET*, 2016, 5(4), eISSN: 2319-1163, pISSN: 2321-7308

[27] Elisabeth Arif, Malcolm W. Clark, Neal Lake, Sugar cane bagasse ash from a high efficiency co-generation boiler: Applications in cement and mortar production, *Construction and Building Materials*, 2016, 128, 287–297 and evaluation of compatibility with superplasticizers,

[28] K. Ganesan, K. Rajagopal, K. Thangavel, Evaluation of bagasse ash as supplementary cementitious material, *Cement & Concrete Composites*, 2007,29, 515–524

[29] Goñi S, Frias M, Vegas I, García R, Vigil de la Villa R, Quantitative correlations among textural characteristics of C–S–H gel and mechanical properties: Case of ternary Portland cements containing activated paper sludge and fly ash, Cement & Concrete Composites. 34 (2012) 911–916.

[30] Khan MI, Lynsdale CJ, Waldron P, Porosity and strength of PFA/SF/OPC ternary blended paste, Cement and Concrete Research. 30 (2000) 1225-1229.