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Comparative study of concrete strength by partially replacing cement with sugarcane bagasse ash and Fly Ash

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Abstract: Sugar-cane bagasse is a waste-product of the sugar industry. This Sugar-cane Bagasse ash is already causing serious environmental pollution, which lead to need of urgent ways of handling the waste.
Bagasse ash contains aluminum ion and silica. In this paper, Bagasse ash has been partially replaced in the ratio of 0%,10%, 15%,20% and 25% by weight of cement in concrete. Fresh concrete tests similar to compaction factor test and slump cone test were undertaken was well as hardened concrete tests like compressive strength test, , flexural strength and at the age of seven ,14and 28 days were noted. The result shows that strength of concrete increased as percentage of bagasse ash replacement increased.

Key Terms: bagasse ash, concrete

Introduction

Ordinary Portland[1] cement is recognized as a major construction material around the world. Researchers all over the world today are focusing on ways of utilizing either industrial or agro waste, as the supply source of raw materials[2] for industry. This waste, utilization would not only be economical, but may also result in external exchange income and environmental pollution control..Industrial[3] wastes, such as fly ash and bagasse ash are being used as supplementary cement replacement materials. Currently,[4] there has been an attempt to utilize the huge amount of bagasse , the residue from the sugar industry . When this[5] waste is burned under controlled conditions, it gives ash with amorphous silica, which has pozzolanic properties. A few studies have been carried out on the ashes taken directly from the industries to study pozzolanic activity and their suitability as binders, partially replacing cement. so it is possible to use sugarcane bagasse ash (SCBA) as cement replacement material to improve quality and reduce the cost of construction materials .

The present study was carried out on SCBA obtained by controlled combustion of sugarcane bagasse, which was procured from the gorakhpur in India. Sugarcane generation in India is over 300 million ton per year making about 10 million tons of as unused and, hence, waste material. This paper analyzes the effect of SCBA to concrete by partial replacement of cement in the ratio of 0%,, 10%, 15%,20% and 25% by weight. The experimental analysis gives the compressive strength, split tensile strength, flexural strength.. The main constituents consist of ordinary portland cement, SCBA, river sand, coarse aggregate and water. After mixing, concrete samples were casted and then all test specimens were cured in water at seven,fourteen and 28 days.

Materials and methods

The materials used in this investigation are:

Cement: The most common cement is used is ordinary Portland cement. Out of the total production, ordinary Portland cement accounts 90% percent. Many tests were conducted on cement some of them are consistency tests, setting tests, soundness tests, etc.

Fine Aggregate: Locally available nearly riverbed sand is used as fine aggregate. The sand particles should be properly packed to give minimum void ratio because higher voids content leads to requirement of more mixing water. In the[6] present study the sand conforms to zone II as per the Indian standards.. The specific gravity of sand is 2.67. Those fractions from 4.75 mm to 150 micron are termed as fine aggregate, and the bulk density of fine aggregate (loose state) is 1392.16kg/m3 and rodded state is 1605.84kg/m^3.

Coarse Aggregates: The crushed aggregates used were 20mm nominal[7] maximum size and are tested as per Indian standards and results are within the permissible limit. The specific gravity of[8] coarse aggregate is 2.82. The bulk density of coarse aggregate (loose state) is 1693.31kg/m3 and rodded state is 1941.17kg/m3.

Water: Water available[9] in the college campus conforming to the requirements of water for concreting and curing as per IS: 456-20009

. *Sugarcane Bagasse Ash :* The sugarcane bagasse consists of approximately 51% of cellulose, 25% of hemicellulose and 24.5% of lignin. Each ton of sugarcane generates approximately[10] 27% of bagasse (at a moisture content of 50%) and 0.61% of residual ash. The residue after combustion presents a chemical composition dominated by silicon dioxide (SiO2). In this sugarcane bagasse ash was collected during the cleaning operation of a boiler operating in the khorabar mini sugar mill, located in the city of Gorakhpur ,uttar Pradesh.

Component	Mass (%)
Sio_2	78.33
Al_2	8.56
Fe2o	3.62
Cao	2.14
Na2o	0.12
Mno	0.13
K2o	3.47
Tio2	0.50
Bao	Less than 0.16
P2o5	1.07
Ignition loss	0.41

Experimental work

In this experimental work, a total of 15 numbers of concrete specimens were casted. The specimens choosen in this research consisted of 15 number of 150mm side cubes. The mix design of concrete was done according to Indian Standard guidelines of IS 10262;2009 for M35 grade for the granite stone aggregates and the water cement ratio is 0.48. Based upon the quantities of ingredient of the mixes, the quantities of SCBA for 0, ,10, 15, 20 and 25% replacement by weight were taken. The ingredients of concrete were completely mixed in mixer machine[11] till uniform complete consistency was achieved. Before casting, machine oil was spread on the inner surfaces of the cast iron mould. Concrete was poured into the mould and compacted completely using table vibrator. The top surface was finished by means of trowel. The samples were removed from the mould after 24h and then cured .. The[12] specimens were taken out from the cube curing tank just prior to test. The test for compressive strength were conducted using a 2000kN compression testing machine, the modulus of elasticity in the test calculated using a compression testing machine and compressometer . These tests were conducted as per the relevant Indian Standard specifications.

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Experimental results

Workability-

A high-quality concrete is one which has acceptable workability (around 6.51 cm slump height) in the fresh condition and develops enough strength. Basically, higher the measured height of slump, better the workability will be, which indicates that the concrete flows easily but at the same time is free from segregation. Maximum strength of concrete depends upon workability and can only be obtained if the concrete has adequate degree of workability because of its ability of self compacting.. .

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Sample name	% of SCBA	Workability	
		Slump (mm)	Compaction factor
1	0	61	0.95
2	10	200	0.96
3	15	222	0.97
4	20	226	0.97
5	25	232	0.97

STRENGTH RESULT OF SCBA CONCRETE AT SEVEN DAYS

Sample name	% of scba	Compressive strength(mpa)
1	0	35
2	10	39.4
3	15	35.4
4	20	31.62
5	25	32.83

STRENGTH RESULT OF SCBA CONCRETE AT FOURTEEN DAYS

Sample name	% of scba	Compressive strength(mpa)
1	0	40
2	10	44.6
3	15	46.6
4	20	40.5
5	25	38.26

STENGTH RESULT OF SCBA AT 28 DAYS

Sample name	% of scba %	Compressive strength(mpa)
1	0	44
2	10	48.27
3	15	52.2
4	20	44.82
5	25	43.64

RESULTS AND DISCUSSION

1. SCBA concrete performed better when compared to ordinary concrete up to 10% replacement of sugar cane bagasse ash.

2. Increase of strength is mainly to presence of high amount of Silica in sugarcane bagasse ash.

3. Compressive strength is increased for 7, 14 and 28 days when cured in normal water.

4.Utilization of the waste material Sugar Cane Bagasse ash can be advantageously used as a replacement of cement in the preparation of concrete.

FLY-ASH

Fly ash is one of the by products generated from combustion, and consists of fine particles that rise with gases. Ash that do not rise is called as bottom ash. In industrial terminology fly ash usually refers to ash produced by combustion of coal. Fly ash is generally captured by precipitators or other particle filtering equipment before gases reach the chimneys of coal-fired power plants. . Depending upon the source and makeup of the coal being burned, the components of fly ash varies but all fly ash includes major amounts of silicon dioxide (both amorphous and crystalline) and calcium oxide (CaO), both being major components of many coal-bearing rock strata.

In some cases, such as the burning of solid waste to create electricity , the fly ash may contain higher amount of contaminants than the bottom ash and mixing the fly and bottom ash together brings the proportional levels of contaminants within the range to qualify as non hazardous waste in a given state, whereas, unmixed, the fly ash would be within the range to qualify as hazardous waste.

Chemical Composition

Fly ash material goes in solid state while in suspension in the exhaust gases and is collected by[13] electrostatic precipitators or filter bags. fly ash particles are generally spherical in shape and range in size from 0.5μm to 300 μ because they solidify rapidly. The main consequence of the rapid cooling is that only few minerals will have time to get crystallize and that mainly amorphous, quenched glass remains.some refractory phases in the pulverized coal will not melt completly and remain crystalline. fly ash is a heterogeneous material. SiO_2, Al_2O_3, Fe_2O_3 and occasionally CaO are the main chemical constituents present in the fly ash. Fly ash has very diverse mineralogy. The major phases encountered are glass phase, quartz, mullite, iron oxides hematite, magnetite .

The results show that the SCBA in blended concrete gives higher compressive strength, tensile strength, and flexural strength as compared to that of the concrete without SCBA. It is found that the cement could be advantageously replaced with SCBA up to maximum limit of 10%. Although, the optimal level of SCBA content was achieved with 1.0% replacement. Partial replacement of cement by SCBA increases workability of fresh concrete; therefore[14] use of super plasticizer is not substantial. The density of concrete decreases with increase in SCBA content,

low weight concrete produced in the society with waste materials (SCBA).

CHEMICAL PROPERTIES OF FLY ASH

Chemical compound	Class F fly ash	Class C fly ash
Silicon dioxide	54.90	39.90
Aluminium oxide	25.80	16.70
Iron oxide	6.90	5.80
Calcium oxide	8.70	24.30
Magnesium oxide	1.80	4.60
Sulphur trioxide	0.60	3.30
Sodium oxide and potassium oxide	0.60	1.30

PHYSICAL PROPERTIES OF FLYASH

Properties	Values
Specific gravity	2.3
Moisture content	19.75%
Fineness	0.001-0.6mm
Maximum dry density	1.53 g/cm3
Permeability	0.000000487cm/s
Angle of internal friction	23-41 degrees

Cohesion	3-34 kpa
Compression of index	0.15
Cofficient of consolidation	0.1-0.5 sq.m per year

Types Of Fly-Ash

- **Class F fly ash**

The burning of harder, older anthracite and bituminous coal produces Class F fly ash. This fly ash is pozzolanic in nature, and contains less than 20% lime (CaO) having pozzolanic properties, the glassy silica and alumina of Class F fly ash requires cementing agent, such as Portland cement, quicklime, or hydrated lime, with the presence of water to react and produce cementations compounds. Alternatively, the addition of a chemical activator such as sodium (water glass) to a Class F ash leads to the formation of geopolymer.

- **Class C fly ash**

Fly ash produced from the burning of younger lignite or sub bituminous coal, in addition to having pozzolanic properties, also has some self-cementing properties. In the presence of water, Class C fly ash will harden and gain strength over time. Class C fly ash generally contains more than 20% lime (CaO). Unlike Class F, self-cementing Class C fly ash does not require an activator. Alkali and sulfate (SO4) contents are generally higher in Class C fly ashes.

Methodology VIII.1. Experimental Setup

. A slump of 200mm +mm was maintained in all the mixes to ensure that mixes could be pumped and placed even in the most unfavorable areas. . To achieve the uniform workability, the admixture dosage was adjusted without changing the unit water content .This ensured the identical w/cm ratio for a particular cementitious content
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VIII.2 Ingredients Cement

The ordinary Portland cement conforming to IS: 8112 was used. The specific surface of cement used in this study was 280 m2/kg .

Coarse Aggregate The coarse aggregate from crushed basalt rock, conforming to IS: 383 were used. The flakiness and elongation index were maintained well below 15%.

Fine Aggregate The river sand and crushed sand was used in combination as fine aggregate conforming to the requirements of IS: 383. The river sand was washed and screened, to eliminate deleterious material and over size particle.

Admixture The high range water reducing and retarding super plasticizer conforming to ASTM C-494, Type G was used. The base of admixture used in this study was sulphonated naphthalene formaldehyde and water reduction of admixture was around 20%.

Procedure

- First of all the mould of cast iron, is used to prepare the specimen of size 150*150*150mm.

- Then these moulds are placed on the vibrating table[15] and are compacted until the specified condition is achieved.

The test specimens are stored in place free from vibration, in moist air of at least 90% relative humidity and at a temperature of 27degree +_2degree C for 24 hrs .

- After this period, thespecimen was marked and put in water and kept there until taken out just prior to test. The water in which the specimens are submerged , is renewed after every 7 days .The specimens are not to be allowed to become dry at any time until they have been tested.

The cube is then taken out of the curing tank and placed in the UTM machine so to find the maximum load at which the concrete fails by compression

RESULTS

1. **7 days strength-**

Sample name	% of FA	Compressive strength(mpa)
1	0	37
2	10	40
3	15	38.4
4	20	34.62
5	25	36.65

2. *14 days strength-*

Sample name	% of FA	Compressive strength(mpa)
1	0	42
2	10	46.6
3	15	48.6
4	20	42.5
5	25	40.26

3. 28 days strength-

Sample name	% of FA	Compressive strength(mpa)
1	0	44.6
2	10	48
3	15	49.5
4	20	47.65
5	25	48.50

Comparison of the results from the 7, and 28 days samples shows that the compressive strength, tensile strength and also flexure increases with SCBA up to 1.0% replacement and then it decreases.

When combinedly both FA and SCBA are used together-

7 days strength-

Sample name	% of FA+SCBA	Compressive strength(mpa)
1	0	32
2	10	38
3	15	33
4	20	31
5	25	30.9

14 days strength-

Sample name	% of FA	Compressive strength(mpa)
1	0	38
2	10	42.6
3	15	44.6
4	20	38.5
5	25	36.26

28 Days strength-

Sample name	% of FA	Compressive strength(mpa)
1	0	42
2	10	46
3	15	50
4	20	41
5	25	42

Conclusions

The results show that the SCBA in blended concrete gives higher compressive strength as compared to that of the concrete without SCBA. It is found that the cement could be advantageously replaced with SCBA up to maximum limit of 10%. Although, the optimal level of SCBA content was achieved with 1.0% replacement. Partial replacement of cement by SCBA increases workability of fresh concrete; therefore use of super plasticizer is not substantial.

low weight concrete produced in the society with waste materials (SCBA).

The results of compression test are in the form of the maximum load the cube can carry before it ultimately fails .The compressive stress can be found by dividing the maximum load by the area normal to it. The results of compression test and the corresponding compressive stress is shown in table

India has a vast resource of fly ash across the country. This material if collected and used properly can solve the major problem of fly ash disposal and will reduce the use of cement, which consumes lot of energy and natural resources and finance. in India many organizations are putting their efforts to promote the awareness of fly ash concrete and its advantages. Based on the studies conducted by authors following conclusion are drawn on the fly ash concrete.

1. Use of fly ash improves the workability of concrete.

2. Normally use of fly ash slightly retards the setting time of concrete, but it is compensated by reduction in the admixture dosage to maintain the same workability.

3. Bleeding in fly ash concrete is reduced and other properties like cohesiveness, pumping characteristics and surface finish are improved.

4. As we increase fly ash content there is reduction in the strength of concrete. This reduction is more at earlier ages as compared to later ages.

5. Modulus of elasticity of fly ash concrete reduces with increase in fly ash percentage for a given W/Cm. Reduction in E value is less as compared to compressive strength.

6. Fly ash concrete is more durable as compare to OPC concrete but it is less permeable as compared to opc.

References Journal Papers Arpn Journal Of Engineering And Applied Sciences, Recycled Aggregate Concrete Exposed To Elevated Temperature [3] Featured at the proceedings FIB-symposium "Conc**:** [1] Vol. 3, No. 1, February 2008, Arpn Journal Of Engineering And Applied Sciences, Effect Of Concentration Of Alkaline Liquid And Curing Time On Strength And Water Absorption Of Geopolymer Concrete. [2] Vol. 7, No. 1, January 2012, rete and environment" in Berlin, October 2001, Environmentally "Green" Concrete Structures. **Books:** [4] Rangan, B. V., Hardjto, D. 2005. Development and properties of low calcium fly ash based geopolymer concrete. Research report GC-1, Faculty of Engineering, Curtins University of Technology, and Perth, Australia. [5] Van Jaarsveld, J. G. S., Van Deventer, J. S. J., Lorenzen, L. Factors affecting the immobilization of metals in Geopolymerized fly ash. Metallurgical and Material Transactions. B 29B (1): 283-291. [6] M.L., Concrete Technology [7] M.S. Shetty, Concrete Technology [8] R.S. Khurmi [9] IS Code 456:2000. [10] Neville A.M. (1995), Properties of Concrete, Essex: Longman **Chapters in Books:** [11] Recommended guidelines for concrete mix design, IS 10262: 1982.Bureau of Indian Standards, New Delhi, India. [12] ACI Committee 201. 1989. Guide to durable concrete. American Concrete Institute. [13] Specification for fly ash for use as pozzolona and admixture IS 3812: 1981.Bureau of Indian Standards, New Delhi, India. [14] Specification for Coarse & Fine Aggregates from Natural Sources for Concrete (2nd Revision). IS:383: 1970, BIS, New Delhi. [15] Specification for 53 grade ordinary Portland cement, IS 12269:1987, Bureau of Indian Standards, New Delhi, India.