IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Study of Mechanical Properties of Concrete by Partially Replacing Cement with Sugarcane Bagasse Ash and Coconut Husk Ash

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Abstract:

With increasing demand and consumption of cement, researchers and scientist are in search of developing alternate binders that are eco-friendly and contribute towards waste management. The utilization of industrial and agricultural waste produced by industrial processes has been the focus of waste reduction research for economical use. Cement industry creating environmental problem by emission of CO2 during manufacturing of cement. Sugarcane bagasse and coconut husk is a fibrous waste-product. This waste product (Sugar-cane Bagasse ash, Coconut husk ash) is already causing serious environmental pollution, which calls for urgent ways of handling the waste. Bagasse and coconut husk mainly contains aluminums ion and silica. This experimental and analytical study investigates the strength performance of concrete using Ordinary Portland cement and Sugarcane Bagasse Ash as well as Coconut Husk Ash. India produces some 24- 25MEGATON of sugar these days and also same is approximately the estimated sugar cane bagasse ash (SCBA), where as unwanted hairy coconut shells are burnt or thrown in water bodies which creates about 17MEGATON of (CHA) waste every year. Therefore it is essential that a useful method of utilization of this sugar factory waste and coconut husk waste should be found and used. As the demand and consumption of cement raising, researchers and scientist are in search of developing binders that are eco-friendly and contribute waste management. The utilization of industrial and agricultural waste has been focus of waste reduction research for economic and environmental reasons. This waste product is already causing serious environmental pollution, which calls for urgent ways of handling the waste. It has limited life span and after use its either stock piled or sent to landfills. In these project sugarcane bagasse ash and coconut husk ash has been chemically and physically characterized and partially replaced in the ratio of 0%, 5%, 10%, 15% and 20% and coconut husk ash is partially replaced in the similar ratios throughout the project i.e., 5% by weight of cement, after the hardening of M25 grade concrete the test for compressive strength is conducted at the age of 7 and 28 days and the strength was obtained.

Keywords: Sugarcane bagasse ash, coconut husk ash, compressive strength, concrete block

1. Introduction:

A concrete block is primarily used as a building material in the construction of walls. It is sometimes called a concrete masonry unit (CMU). A concrete block is one of several precast concrete products used in construction. The term precast refers to the fact that the blocks are formed and hardened before they are brought to the job site. Most concrete blocks have one or more hollow cavities, and their sides may be cast smooth or with a design. In use, concrete blocks are stacked one at a time and held together with fresh concrete mortar to form the desired length and height of the wall. These early blocks were usually cast by hand, and the average output was about 10 blocks per person per hour. Today, concrete block manufacturing is a highly automated process that can produce up to 2,000

blocks per hour. Concretes are mostly divided into types of grades i.e., M20, M25, M30, Etc.

Ingredients	Percentage in Concrete block
Cement	10-15%
Coarse Aggregate and Pebbles	50-65%
Fine Aggregate	25-30%
Water	15-20%

Table: 1 Ingredients of Concrete block.

The main aim of the project is to adopt a material which improves the properties of concrete and it should be somehow environmental friendly. To get the desired properties for a M25 grade concrete sample we are up to this replacement process. The replacement even results in the costs reduction which can be highly used for low cost constructions, as well as utilization of waste bagasse and husk in higher quantities leads in the reduction of pollutants over the land. Based on these objectives this project was undertaken.

2. Literature Survey

DAMRE SHRADDHA1, FIRAKE HITALI1 (2014)

In this paper we studied that among the useful agricultural waste materials the family of palm shells namely palm shell and coconut shell are highly available in torrid zones of the world. According to research coconut shell aggregates are in ratio of 1:5 used in normal concrete when compared with the compressive strength results that are obtained.

SELWYN BABU J AND MAHENDRAN N (2014)

This paper studied that light weight aggregate place the major role in sustainable concrete. By mixing synthetic light weight aggregates with concrete mixture the light weight concrete is prepared. In the 28th day of concrete mix is less than 2000kg per meter cube. The satisfied requirements for coconut shell aggregate are ASTM C 330. The authors showed the strength of flexural behavior workability density of concrete containing ¼, ½, ¾ and 4/5 of metallic element replaced to traditional coarse mixture by volume.

AJAY LONE, ANIKET DESHMUKH (2016)

The coarse aggregate are the main materials of concrete. In authors of this paper discussed about replacing coconut shell for coarse aggregate. 25% and 50% of coarse aggregate replacement prepared by binding constantly along with water in the ratio of 0.45 per all mixes, density, workability and water adsorption. One week, two weeks and four weeks were determined compressive strength, tensile strength and flexural strength.

PARAG S. KAMBLI, SANDHYA R. MATHAPATI (2014)

The goal of the above paper was to use eco waste in construction materials which reduces the cost for housing. And it also purposes of encouraging house developers and investing these materials in house construction. They used three variants of concrete mixes in three different grades known as M20, M35 and M50 grades with various proportions of natural material. 0%, 10%, 20%, 30% and 40% will be replaced and 7 and 28 days tests will conducted. International Journal of Pure and Applied Mathematics Special Issue 20.

TOMAS U. GANIRON JR (2013)

The author's experimental research covered a wide series of property tests like mechanical property and sieve analysis tests along with the content of specific moisture gravity Test were undertaken in accordance with the ASTM Outcomes showed that by replacing certain amount of coconut shell can satisfy the concrete work mix. When differentiated the normal concrete mixture's strength with the coconut shell included concrete's strength is more.

3. Methodology:

The materials that are required for making the sugarcane bagasse ash and coconut husk ash based concrete, coarse aggregates, sand and the sugarcane bagasse ash and coconut husk ash coarse. This presents the details of development of the process of making sugarcane bagasse ash and coconut husk ash based concrete, aggregate as per design of mix proportion M25 are clearly mentioned in a tabular format as per IS 10262-2009.

Preparation; Casting and Curing of sugarcane bagasse ash and coconut husk ash based Concrete

3.1.1 MIX PROPORTIONING

The batching of all the ingredients was performed by weight. The sand was air dried in the laboratory before mixing. First the surface was damped with water then all the aggregates (Natural Coarse Aggregate, Fine Aggregate and sugarcane bagasse ash and coconut husk ash course Aggregate) were spread on the surface area till the aggregates. After thorough mixing of

aggregates cement was introduced on the ground surface and water were added slowly as per W/C ratio. The concrete was mixed for approximately three minutes after the water was added.

3.1.2 MIX CASTING

It is found that the sugarcane bagasse ash and coconut husk ash based Concrete is dark in color and is cohesive. The amount of water in the mixture plays an important role on the behavior of fresh concrete. When the mixing time is long, mixtures with high water content bled and segregation of aggregates and the paste occurred. This phenomenon is usually followed by low compressive strength of hardened concrete. From the preliminary work, it was decided to observe the following standard process of mixing in all further studies,

- Take the suitable proportion of the ingredients of the concrete.
- Spread the fine aggregate on the ground,
- After that put the coarse aggregate as well as sugarcane bagasse ash and coconut husk ash.
- After that add the water in suitable quantity.
- And continue the wet mixing for another four minutes. Then the fresh prepared mix wascasted standard cube moulds cylinders and beams.

3.1.3 CURING

All the moulds were cured by immersing in a curing tank in the lab. The specimens were brought out from water approximately 24 hours before testing and kept at room temperature till testing.

3.2 MATERIALS USED

There are various studies that have been conducted on concrete diversifying the sources of materials. Furthermore ,there are various types of aggregates that has been set consist of industrial waste ,construction waste such as crush brick, brick waste, concrete side, and more.

- Cement.
- Coarse aggregate.
- Fine aggregate.
- Sugarcane bagasse ash.
- Coconut husk ash.
- Water.

3.2.1 CEMENT:

Cement is a material that has a cohesive and adhesion properties that enable binding chunks of rock into one cohesive body. There are dissimilar cases of cement made at factory for specific purposes and to conform to the specific demands. When the void between the aggregates is minimized, then the need for cement to fill the empty space can be reduced to maintain the workability and the strength of concrete. And so, the optimal mixing ratio of aggregates will produce a concrete with minimal quantity of cement contain. Therefore, the lower water and cement quantity of water and cement ratio (w/c) constant, would result a more durable concrete.

Fig:Cement

S.NO	PHYSICAL PROPERTIES OF CEMENT	TEST RESULT
1	Specific Gravity	3.17
2	Fineness Modulus	8%
3	Initial and Final Setting Time	30 MIN

Table**:** physically properties of Cement.

3.2.2 COURSE AGGREGATE

Coarse aggregate can be defined as inert granular materials such as gravel, crushed stone and sand. Coarse aggregate is one of the essential ingredients apart of water and cement in concrete production. It consists about 60 to 75 percent of total concrete production Coarse aggregate comes from particles greater than 4.75mm but commonly in a range between 9.5mm to 37.5mm.

Fig: Coarse Aggregate

S.NO	PHYSICAL PROPERTIES OF COARSE AGGREGATE	TEST RESULT
1	Specific Gravity	2.68
2	Nominal size of Coarse Aggregate	20 mm
3	Porosity (or) Water Absorption	0.5%

Table: physical properties of Coarse Aggregate.

3.2.3 FINE AGGREGATE

Locally available river sand conforming to Grading zone IV of IS: 383 –1970. Clean and dry river sand available locally will be used. Sand passing through IS 4.75mm Sieve will be used for casting all the specimens

Fig: Fine Aggregate.

S.NO	PHYSICAL PROPERTIES OF FINE AGGREGATE	TEST RESULTS
1	Specific Gravity	2.67
2	Size of Aggregate equal to or less than	< 4.75 mm
3	Water Absorption	0.6 per unit weight

Table: physical properties of Fine aggregate.

3.2.4 SUGARCANE BAGASSE ASH

The sugarcane bagasse consists of approximately 50% of cellulose, 25% of hemicellulose and 25% of lignin. Each ton of sugarcane generates approximately 26% of bagasse (at a moisture content of 50%) and 0.62% of residual ash. The residue after combustion presents a chemical composition dominates by silicon dioxide (SiO2). In spite of being a material of hard degradation and that presents few nutrients, the ash is used on the farms as a fertilizer in the sugarcane harvests.

Fig: Process to obtain Ash from Sugar Bagasse.

3.2.5 COCONUT HUSK ASH

To address the increasing amount of municipal and urban wastes brought about by tough and heavy biodegradable wastes from popular consumption of coconut water and meat in municipal and urban centers in the country, a study is conducted to utilize these waste materials into ash to substitute cement for concrete production. Wasted coconut husks or coconut fiber, is a natural fiber extracted from the outer husk of coconut and used in products such as floor mats, doormats, brushes and mattresses. Coir is the fibrous material found between the hard, internal shell and the outer coat of a coconut. Other uses of brown coir (made from ripe coconut) are in upholstery padding, sacking and horticulture.

Fig: Process to obtain Ash from Coconut Husk.

4 EXPERIMENTAL AND ANALYTICAL PROCEDURE:

We have prepared sugarcane bagasse and coconut husk ashes based concrete of M25 grade. With the help of code books **IS: 10262-2009 & IS: 456-2000**. By doing mix design we get the value of the proportions of each aggregate. By replacing the cement with sugarcane bagasse and coconut husk ashes as follows, SCBA in the ratio of 0%, 5%, 10%, 15% and 20% and CHA is partially replaced in similar ratios throughout the project i.e., 5%.

Fig:Proportion ing and mixing

Fig: Moulding

Fig: Casting of Concrete Blocks

fig: Demoulding and curing

4.1TESTING OF CONCRETE BLOCKS

After the curing time of concrete blocks i.e. 7 days and 28 days are completed, and then the concrete blocks are moved from the curing tank and kept at room temperature for drying at least 24 hours (or) one day before testing.

Fig: weighing the Block & Compressive strength testing (2000KN)

The concrete blocks of 7 days and 28 days of curing were tested in the laboratory under the supervision of the project guide and the lab in charge and the results were obtained.

5. ACKNOWLEDGEMENT

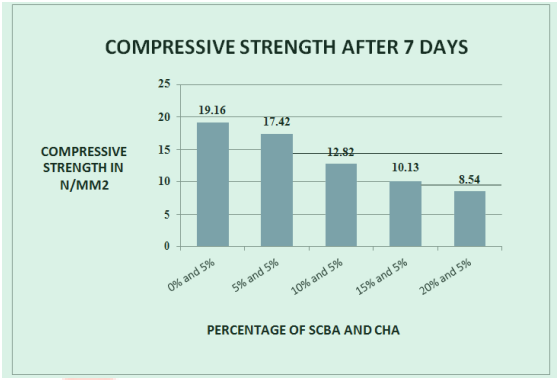
We would like to thank all the authors of different research papers referred during writing this paper. It was very knowledge gaining and helpful for the further research to be done in future.

6. RESULTS:

Strength Concrete after 7 days of curing

Sample No:	Percentage of Ashes		Load trials (KN)			Average load (KN)	Compressive strength (N/mm2)
	% of SCBA	% of CHA	Trial 1	Trial 2	Trial 3		
1	0%	5%	431	424	439	431.3	19.16
2	5%	5%	397	379	480	392	17.42
3	10%	5%	290	297	279	288.67	12.82
4	15%	5%	232	216	236	228	10.13
5	20%	5%	195	189	193	192.3	8.54

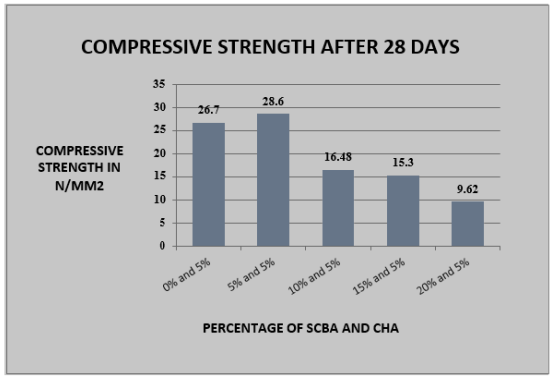
Table: Strength Concrete after 7 Days of Curing.



Strength Concrete after 28 days of curing

Sample No:	Percentage of Ashes		Load trials (KN)			Average load (KN)	Compressive strength (N/mm2)
	% of SCBA	% of CHA	Trial 1	Trial 2	Trial 3		
1	0%	5%	679	522	602	601	26.7
2	5%	5%	716	602	613	643.6	28.6
3	10%	5%	481	327	305	371	16.48
4	15%	5%	291	470	276	345	15.3
5	20%	5%	193	240	217	216.66	9.62

Table: Strength Concrete after 28 Days of Curing.



7. CONCLUSION:

The results from above tests show that Sugarcane Bagasse Ash can be utilized for partial replacement of cement up to 15% by weight of cement without any major loss of strength. The results showed that the concrete with 5% of SCBA after 28 days of curing had higher strength when compared to concrete with other replacement percentages. Greenhouse gasses emissions can be reduced by replacement

of cement with OPC. Mechanical properties of concrete are developed in later ages due to slow pozzolanic reactions. From the results obtained, CSA/OPC mix showed some promise for use in reinforce concrete as well as mass concrete structures in building construction. The compressive strength of the cubes at 28 days curing indicates that 10% and 15% replacement levels meet the requirement of BS EN 206-1: 2000 for class C25/30 and C20/25 respectively for heavy weight concreting and LC25/28 and LC20/22 respectively for light weight concreting. In conclusion, the study reveals that 10 to 15% partial replacement of OPC with CSA using W/C ratio of 0.5 are suitable for production of both heavy weight and light weight concrete.

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