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RESEARCH ARTICLE

Experimental Investigation on the Effect of Bagasse Ash and Rubber tyre waste in Concrete.

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Abstract

The utilization of industrial and agricultural waste produced by industrial process has been the focus on waste reduction research for economical, environmental and technical reasons. SCBA is a fibrous waste product of the sugar refining industry, along with ethanol vapor. Bagasse ash mainly contains aluminum ion and silica. The use of SCBA as a pozzolonic material for producing high strength concrete. OPC is partially replaced with finely SCBA. At present the disposal of waste tyre is becoming a major waste management problem in the world. In this project, the bagasse ash has been chemically and physically characterized and partially replaced in the ratio of 0%, 5%, 15% and 25% by weight of cement in concrete. The mix proportion for M30 grade concrete was derived. Rubber tyre waste has been used as coarse aggregate with replacement of conventional coarse aggregate and it is taken as constant of 10%.

Introduction:-

Ordinary Portland cement is the most extensively used construction material in the world. Portland cement is the conventional building material that actually is responsible for about 5%-8% of global CO_2 emissions. This environmental problem will most likely be increased due to exponential demand of Portland cement. Today we are focusing on ways of utilizing either industrial or agricultural waste, as a source of raw materials for industry. This waste, utilization would not only be economical, but may also result in foreign exchange earnings and environmental pollution control. Several researchers and even the Portland cement industry are investigating alternatives to produce green building materials. Industrial wastes, such as blast furnace slag, fly ash and silica fume are being used as supplementary cement replacement materials. Agro wastes such as rice husk ash, wheat straw ash, hazel nutshell and sugarcane bagasse ash are used as pozzolanic materials for the development of concrete. Currently, there has been an attempt to utilize the large amount of bagasse ash, the residue from an in-line sugar industry and the bagasse-biomass fuel in electric generation industry. When this waste is burned under controlled conditions, it also gives ash having amorphous silica, which has pozzolanic properties. Solid waste is concerned with waste tyres, has become a problem of interest because of its non-biodegradable nature. Tyre rubber wastes represent a major environmental problem of increasing significance. Most of the waste tyre rubbers are used as a fuel in many of the industries such as thermal power plant, cement kilns and brick kilns etc. this material can also be used for non load-bearing purposes such as noise reduction barriers. Investigations about rubber waste concrete show that concrete performance is very dependent on the waste aggregates. Further investigations are needed to clarify for instance which are the characteristics that maximize concrete performance.

Bagasse ash:-

Sugarcane is major crop grown in over 110 countries and its total production is over 1500 million tons. Sugarcane production in India is over 300 million tonnes per year. The processing of it in sugar-mill generates about 10 million tonnes of SCBA as a waste material. 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 dominates by silicon dioxide. After the extraction of all economical sugar from sugarcane, about 40-45% fibrous residue was obtained, which is reused in the same industry as fuel in boilers for heat generation leaving behind 8 -10 % ash as waste, known as sugarcane bagasse ash (SCBA). The SCBA contains high amounts of un-burnt matter, silicon, aluminum and calcium oxides 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.

About the Project:-

In this project 0%, 5%, 15%, and 25% of bagase ash used in M30 grade of concrete. Cube specimens of size 150mm*150mm*150mm, cylinder specimens of 150mm diameter and 300mm height and prism specimens of size 100mm*100mm*500mm were casted for different proportions with bagase ash. The tests performed on hardened concrete after 7and 28 days of curing were compression test, split tensile strength test and flexural strength test. The collected bagase ash and rubber are shown in fig.1 and Fig.2

Fig.1 Bagase ash

Fig.2 Rubber Tyre

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Mix design:-

The mix design of M30 grade concrete is calculated using IS 456-2000 and IS 10262-2009. The material required as per design are given in Table:1

TABLE 1:MATERIALS REQUIRED AS PER IS METHOD OF DESIGN

W/c ratio	**Quantity of Materials (kg/m^3)**		
	Cement	***Fine aggregate***	***Coarse aggregate***
0.43	380	658	1199

The properties of materials used are

- Specific gravity of cement = 3.15
- Specific gravity of fine aggregate = 2.5
- Specific gravity of coarse aggregate = 2.79

Casting:-

The required materials like Rubber tyre and Bagase ash have been mixed as per the ratio in table 4.1. These materials are mixed together, and then they are conveyed to cube mould of size 150 mm* 150 mm* 150mm, cylinder mould of size 150mm*300mm. After casting, the specimens were kept for 24 hours and then demoulded. They were cured at water for 28 days.

Casting of cubes, cylinders and prism are shown in fig.3 (a), fig .3(b), and fig.3(c).


Fig.3(a) casting of cubes


Fig.3(b) Casting of cylinders


Fig.3(c) Casting of prism

Experimental Procedure:-

Tests on specimens:-

The specimens were taken for testing such as compression test, split tensile test and flexure test. Three numbers of specimens in each were tested and the average value is calculated. The results were compared and analyzed with that of control mix. The test set up for Compression test, Split tensile test and Flexural strength test are shown in fig.4(a), fig.4(b), fig.4(c) respectively.


Fig. 4(a) compression test set up


Fig.4 (b) split tensile set up


Fig.4 (c) Flexure test set up

Compressive strength test:-

The compressive strength of the cube specimen is calculated using the following formula

Compressive strength $F_{c} = P/A$ N/mm^2

Where P = Load at failure in N

A = Area subjected to compression in mm^2

Compressive strength test results of concrete cubes in Table III

TABLE II COMPRESSIVE STRENGTH FOR 28 DAYS

Sl.No	***Mix***	***Avg.Compressive strength @28 days (N/mm^2)***
1	P0	36.53
2	P1	38.21
3	P2	40.89
4	P3	35.31

The graph shown in figure 5 illustrates the variation of the compression strength of specimens with different percentage of bagase ash.

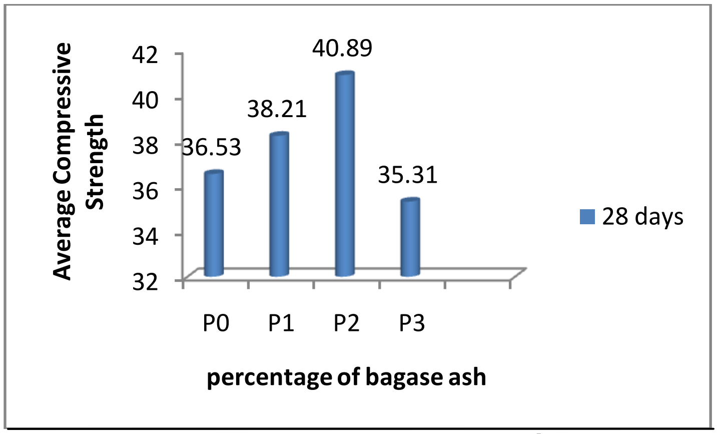

Fig.5 Average compressive strength

From the Table III and fig.5 it is clear that concrete specimen with 15% has given better results when compared to the control specimen. This shows that bagase ash increase the strength of concrete. Among all concrete cubes, 15% bagase ash concrete shows the best result. In 25% the compressive strength value reduces since bagase ash imparts brittle characteristics to concrete.

Split tensile strength test:-

The split tensile strength of the cylinder specimen is calculated using the following formula

Split Tensile Strength, $f_{sp} = 2P/ \prod Ld$ N/mm^2

Where, P = Load at failure in N

L = Length of the Specimen in mm

D = Diameter of the Specimen in mm

The Split Tensile Strength test results are in the Table III

TABLE III SPLIT TENSILE STRENGTH @ 28 DAYS

Sl.No	***Mix***	***Avg.Split Tensile strength @28 days (N/mm^2)***
1	P0	2.64
2	P1	2.56
3	P2	2.83
4	P3	2.35

The graph shown in figure 6 illustrates the variation of the split tensile strength of specimens with different percentage of bagase ash.

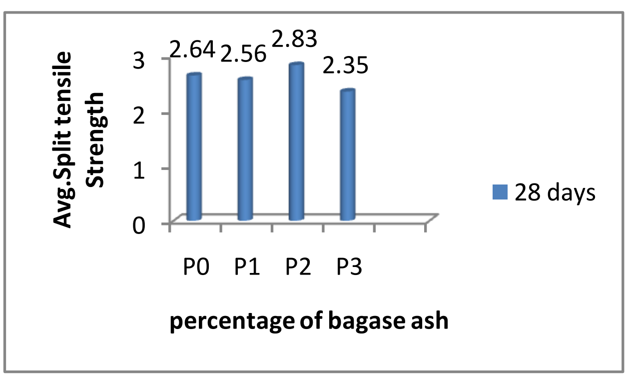

Fig 6 Average Split tensile strength

The Split tensile strength of the cylinder is seen to be increasing till the 15% of the bagase ash and then decrease slightly with increase in percentage of bagase ash. The percentage of the bagase ash with 15% is found to be reasonable with high split tensile strength compared to the other percentages.

Flexural strength test:-
The flexural strength of the specimen is calculated using the following formula

The flexural strength $f_b = PL/ bd^2$ N/mm^2
The Flexural strength results are in the Table IV

TABLE IV FLEXURAL STRENGTH FOR 28 DAYS

Mix	***Flexural strength @ 28 days (N/mm^2)***
P0	4.67
P1	5.17
P2	6.33
P3	4.58

The graph shown in figure 7 illustrates the variation of the flexural strength of specimens with different percentage of bagase ash.

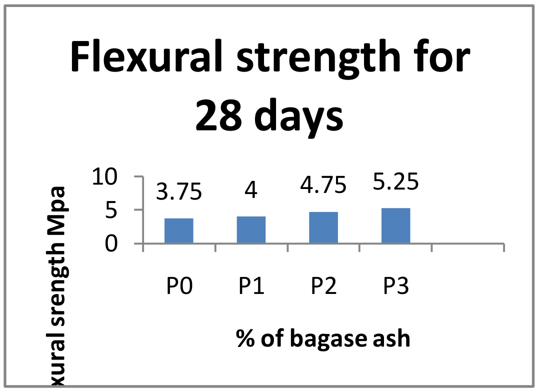

Fig.7 Flexural strength

The flexural strength of the specimens will increased gradually with increase in the percentage of bagase ash. The percentages of the bagase ash with 15% will be reasonable than other percentages.

Conclusion:-

1. Partial replacement of cement by SCBA increases workability of fresh concrete.
2. The SCBA concrete gives higher compressive strength than that control concrete.
3. The split tensile strength is increased with decreased percentage of scrap tyre rubber.
4. Compressive strength of 40.89N/mm^2, split tensile strength of 2.83N/mm^2, and flexural strength of 6.33N/mm^2 at 28days is achieved for M30.
5. Comparison of control concrete and various percentage of SCBA with 5%, 15% will be increased 3%, 10% of compressive strength. In SCBA 25%, the compressive strength will be decreased 3 %.
6. Comparison of control concrete and various percentage of SCBA with 5%, 15% will be increased 3%, 6% of Split tensile strength. In SCBA 25%, the Split tensile strength will be decreased 12 %.
7. Comparison of control concrete and various percentage of SCBA with 5%, 15% will be increased 9%, 26% of Flexural strength. In SCBA 25%, the Flexural strength will be decreased 2 %.
8. The compressive strength, split tensile strength and flexure increases with SCBA up to 15% replacement and decreases, the results of 25% replacement.
9. It is clearly seen that the 20% cost of cement can be save with better strength than control concrete.
10. The test result indicate that the strength of concrete increase up to 15% SCBA replacement with cement.

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