Comparative study of compressive strength of concrete by partial replacement of cement with Fly ash and Bagasse ash

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Abstract: We are aware that a lot of damage is done to environment in the manufacture of cement. It involves lot of carbon emission associated with other chemicals. Research has shown that every one ton of manufacturing of cement releases half ton of carbon dioxide. So there is immediate need to control usage of cement. On the other hand, sugarcane bagasse ash is a byproduct of the sugar factories found after burning sugarcane bagasse which itself is found after the extraction of all economic sugar from sugarcane and Fly ash is a byproduct of burning pulverized coal in an electric generating station.

Initially samples were collected from the respective factories. OPC was replaced by SBA and Fly ash. Five different samples of concrete mix with the bagasse ash and result from different review paper is noted for fly ash . The results have shown that up to 10% replacement of OPC by bagasse ash achieved a higher compressive strength as compared to fly ash at the test age i. e. 7 and 28 days , whereas 15% replacement of cement by bagasse ash have shown slightly low compressive strength whereas fly ash is useful in lower grade of cement such as M30. It can be stated that 25% replacement of fly ash there is considerable increase in strength properties.

Keywords —Fly ash , Bagasse ash , partial replacement , cement , comparative study , compressive strength

INTRODUCTION

1.1 Concrete of Mix design M30 is to be tested by partial replacement of cement with bagasse ash and Fly ash respectively.

Now a days, bagasse is also being used in the manufacturing of pulp and paper products. Previous researches have shown that for each 10 tons of sugarcane crushed; a sugar factory produces nearly 3 tons of wet bagasse which is a waste product of the sugar cane industry. It is the cellular and fibrous waste product after the extraction of the sugar juice from sugarcane. Bagasse ash is a residue obtained from the burning of bagasse in sugar producing factories. A good solution to the problem of recycling of sugarcane residues would be by burning them in a controlled environment and use the ashes (waste) for more noble means (Ghavami et al., 1999). SCBA constitutes an environmental nuisance as they form refuse heaps in areas when they are disposed off in low lying areas. Comparative Study Of Fly ash and Bagasse ash is done for the better understanding of their effects and properties.

1.2 Ordinary Portland Cement

OPC is a controlled blend of calcium silicates, aluminates and ferrate, which is ground to a fine powder with gypsum and other materials. After 1987 OPC was divided into 3 types based on the strength obtained at 28 days

1. OPC 33 grade:-strength not less than 33N/mm2 at 28 days

 DOI : 10.35291/2454-9150.2021.0477

2. OPC 43 grade:-strength not less than 43N/mm2 at 28 days
3. OPC 53 grade:-strength not less than 53N/mm2 at 28 days

Portland cement gets its strength from chemical reactions between the cement and water. The process is known as hydration. This is a complex process that is best understood by first understanding the chemical composition of cement.

1.3 Introduction to Cement Concrete

An artificially built up stone resulting from hardening of a mixture of a cement, aggregates and water with or without a suitable admixture, is generally known as concrete. Cement concrete is a mixture of aggregates and cement water paste. The cement water paste has its role to bind the aggregates to forma strong rock like mass after hardening has a consequence of the chemical reaction between cement and water. Aggregates are classified into fine aggregate and coarse aggregate. Fine aggregate consist of sand whose particular size does not exceed 4.75mm coarse aggregate consist of gravel, crush stone etc. of practical size more than 4.75mm. When the materials are mixed together so has to form a workable concrete, it can be moulded into beams, slabs etc. A few hours after mixing the material undergo a chemical combination and have a consequence the mixture solidifies and hardness, attaining 9 greater strength with age. Concrete possess a high compressive strength and has a poor tensile strength. It also develops shrinkage stresses.

1.3.1 Properties of Concrete

1. Strength
2. Durability
3. Elasticity.
4. Shrinkage

1.4 Sugarcane Bagasse Ash

Bagasse is a by-product from sugar industries which is burnt to generate power required for different activities in the factory. For each 10 tonnes of sugarcane crushed, a sugar factory produces nearly 3 tonnes of wet bagasse. Since bagasse is a by-product of the cane sugar industry, the quantity of production in each country is in line with the quantity of sugarcane produced. The burning of bagasse leaves bagasse ash as a waste, which has a pozzolanic property that would potentially be used as a cement replacement material. It has been known that the worldwide total production of sugarcane is over 1500 million tons. Sugarcane consists about 30% bagasse whereas the sugar recovered is about 10%, and the bagasse leaves about 8% bagasse ash (this figure depend on the quality and type of the boiler, modern boiler release lower amount of bagasse ash) as a waste, this disposal of bagasse ash will be of serious concern. Sugarcane bagasse ash has recently been tested in some parts of the world for its use as a cement replacement material. The bagasse ash was found to improve some properties of the paste, mortar and concrete including compressive strength and water tightness in certain replacement percentages and fineness. The higher silica content in the bagasse ash was suggested to be the main cause for these improvements. Although the silicate content may vary from ash to ash depending on the burning conditions and other properties of the raw materials including the soil on which the sugarcane is grown, it has been reported that the silicate undergoes a pozzolanic reaction with the hydration products of the cement i.e. calcium hydroxide and results in a reduction of the free lime in the concrete.

1.5 FLY ASH

Pozzolans are materials which have little or no inherent cementitious properties, but which develop cementitious properties in the presence of calcium hydroxide (lime) and water. Such materials usually derived from natural deposits. Many modern pozzolans still derive from natural deposits, but the bulk of pozzolana derive from the combustion of powdered coal during electric power generation. This product is commonly called fly ash. There are currently three classes of pozzolana defined by the ASTM: Class N, Class C, and Class F. Class N are natural pozzolans: calcined shale, calcined volcanic ash, etc. Class F is fly ash nominally produced from anthracite, bituminous, and some sub- bituminous coals. Class C is nominally produced from fly ash derived from combustion of lignite and some sub-bituminous coals. The vital environmental problems related with cement production is releasing of CO_2, one of the major greenhouse gas which causes Global Warming. Keeping this ill effect of cement, various replacements include fly ash, ground granulated blast furnace slag, rice husk and silica fume is used. Fly ash is a much cheaper material than Portland cement, so that large replacements can result in significant economic savings.

CALCULATION

2.1 Mix Proportion

To achieve target strength mix design of concrete is required. In this work concrete of grade M30 prepared by replacing the cement with fly ash. M30 mix design prepared using the following guidelines.

2.2 Concrete mix Design data required

I. Data required for concrete

a. Characteristic compressive strength at 28-day grade designation: M30
b. Nominal aggregate size (maximum) used: 20 mm
c. Shape of coarse aggregate used: Circular
d. Workability requirement (slump): 40-70 mm
e. Quality control checking : as per IS:456
f. Type of exposure: Mild (as per IS: 456)

 DOI : 10.35291/2454-9150.2021.0477

g. Type of cement: OPC grade 43

h. Method of concrete placing: by hand

II. Concrete ingredient data

a. Specific gravity of cement used: 3.10

b. Specific gravity of fine aggregate (FA): 2.52

c. Specific gravity of coarse aggregate (CA): 2.71

2.3 Target Strength determination

F target = f ck + 1.65 x S= 30 + 1.65 x 4.0= 36.6 N/mm2

Where,

S = standard deviation in N/mm2 = 4 (From IS 10262-2009 Table no. 1)

fck = Characteristic Compression Strength at 28 days.

2.4 Water/cement ratio selection

Water Cement Ratio 1200/2000 = 0.6 is mix concrete design as per Indian Standards

From IS 456 Table no. 5

Maximum water-cement ratio used= 0.55 Adopting water-cement ratio as 0.5

RESULTS

% Ash	7 Days		28 Days	
	Bagasse ash	Fly Ash	Bagasse ash	Fly Ash
0 %	24.43	24.43	36.60	36.60
5%	23.59	22.1	35.38	34.87
10%	23.75	17.22	35.61	28.42
15%	20.74	17.5	31.11	28.89
20%	19.50	16.5	29.25	28.01

Table 2. Effect on Compressive Strength of concrete in (N/mm^2) after partial replacement of cement with ash as mentioned above

CONCLUSION

- The results showed that, the concrete with 10% Bagasse Ash (BA) replacement after 28 days of curing, showed maximum strength when compared to concrete with other percentage replacement mixes.
- In the economic point of view, the cement replaced by BA saves money.
- Since bagasse ash is a by-product material, its use as a cement replacing material reduces the levels of CO2 emission by the cement industry. In addition its use resolves the disposal problems associated with it in the sugar industries and thus keeping the environment free from pollution.
- Also result show that Bagasse Ash is more effective than Fly ash.

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DOI : 10.35291/2454-9150.2021.0477