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A Comparative Study on Cow-dung Ash and Bagasse Ash Concrete with Partial Replacement of Cement by Egg Shell Powder

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Abstract - *This work aims at utilizing the agricultural and poultry waste in the production of concrete there by reducing the use of cement which results in the welfare of environment. From previous research works it is found that cow-dung ash and sugarcane bagasse ash are rich source of silica and they possess pozzolanic activity in cement concrete when used in certain proportion. Cow-dung is a byproduct of dairy farming industry it is commonly used as manure in agricultural fields. Sugarcane bagasse ash is a waste product of sugar industry and it is thrown as waste or used as fuel, the resulting ash will be dumped into landfills causing environmental pollution. Egg shell is a rich source of calcium as it is made up of 95% $CaCo_3$ compounds, so it contains around 50% of CaO which is a main ingredient of ordinary portland cement. This work involves the use of cow-dung ash, sugarcane bagasse ash and egg shell powder as partial replacement of cement in concrete production and also determination of properties of concrete like workability, compressive strength, split tensile strength, and flexural strength. Cow-dung ash and sugarcane bagasse ash mixture is varied up to 30% (0%, 5%, 10%, 15%, 20%, 25%,and 30%) and egg shell powder is added to the optimum cow-dung ash and sugarcane bagasse ash content cement concrete from 0 to 12.5% (0%, 2.5%, 5%, 7.5%, 10% and 12.5%).*

***Key Words*: Cow-dung Ash (CDA), Sugarcane Bagasse Ash (SCBA), Egg Shell Powder (ESP), Compressive Strength, Split Tensile Strength, Flexural Strength**

1. INTRODUCTION

Cement is a material which contains various constituents in it, mainly Calcium oxide and Silica. Many research scholars have discovered the Calcium and Silica containing materials and efforts are made to experimentally investigate the behavior of concrete with partial replacement of cement by those materials. Surprisingly, the strength characteristics of concrete were increased with the partial replacement of cement in concrete as compared to the conventional concrete. There are many advantages by the use of cement replacement materials in concrete, the major one is reduction in the usage of cement quantity required for the concrete production. Decreased cement requirement in the production results in the less release of main green house gas i.e. carbon-di-oxide into the atmosphere which is very hazardous to the environment, it increases the atmospheric temperature contributing to so called global warming. Use of alternative materials for cement may reduce the amount of CO_2 release to the environment due to decreased cement production, this is possible when the cement replacement materials in concrete are used in wide range. It is the emerging trend to use the cement replacement materials in combination with one another, this enables the use of waste materials in relatively larger quantities. In this work the category of waste materials used are Agricultural and Poultry waste namely Cow-dung Ash, Bagasse Ash and Egg Shell Powder. Among these wastes except cow-dung ash, other two wastes causes nuisance in the environment when they are not properly disposed off, and pollutes the landfill sites.

1.1 Cow dung ash

Cow-dung is cattle excreta which can be used as manure for agricultural fields, recent research works have found that ash obtained from cow-dung is rich source of Silicon dioxide. Experimental investigation on cow-dung ash mixed cement mortar and concrete has been carried out to determine the behavior of fresh and hardened concrete. The result shows that cow-dung ash can be effectively used as a partial replacement of cement.

Fig -1: Cow dung ash

1.2 Sugar cane bagasse ash

Sugarcane is the major commercial crop widely grown in many countries in the world. In India sugarcane production is over 300 million tons per year. Sugar producing industries generates million tons of waste as bagasse. After processing the sugarcane to extract sugarcane juice it generates around 26% bagasse by weight of sugarcane. Bagasse thus generated is often used as fuel for sugar mills, and other small scale industries to produce heat energy for their processing units. After burning bagasse the ash obtained as residue mainly contains Silicon dioxide (SiO_2). The ash thus resulted, if it is improperly disposed off, it can pose a serious threat to the environment and eco-system.

Fig -2: Sugar cane bagasse ash

1.3 Egg shell powder

India's poultry industry stands at fifth position in producing chicken eggs which in turn generates about 2 million tons of egg shells as waste material annually. The improper dumping of these egg shells creates serious unhygienic condition. The egg shell is mainly made up of compounds of calcium mainly calcium carbonate which is the major raw material (lime stone) used for the cement production.

Fig -3: Egg shell powder

1.4 Cow-dung Ash+Sugarcane Bagasse Ash

An approach had been made in this study to reduce usage of cement by replacing cement partially by CDA+SCBA and egg shell powder (ESP). Use of alternative materials for cement may reduce the amount of CO_2 release to the environment due to decreased cement production, this can be achieved more effectively when the cement replacement materials in concrete are used in large quantity. It is the emerging trend to use the cement replacement materials in combination with one another, this enables the use of waste materials in relatively larger quantities. In this work the category of waste materials used are Agricultural and Poultry waste namely Cow-dung Ash, Bagasse Ash and Egg Shell Powder.

Fig -4: Cow dung and sugar cane bagasse ash mixture

2. OBJECTIVES

The objectives of this work is

1) To determine optimum percentage of CDA and SCBA mixture to replace the cement in concrete and achieve good strength properties of cement.

2) To examine the exact percentage of CDA+SCBA mixture and ESP variation to improve hardened properties of concrete.

3) To determine the compressive, split tensile and flexural behavior of CDA+SCBA and ESP concrete and optimum content CDA+SCBA and ESP concrete and to compare the same with conventional concrete.

3. EXPERIMENTAL PROGRAM

3.1 Materials used

Ordinary Portland Cement of 43 grade conforming to 8112-1989 is used. Fine aggregates used in this work are natural river sand conforming to zone II of IS 383-1970. Coarse aggregates used in this work are crushed stones of 20mm downsize. Cow dung obtained from local dairy farms, sundried and burned to get ash. The ash thus obtained is sieved through 90 microns size sieve and grounded to a fine powder. Sugarcane bagasse ash is obtained from local sugar cane based sweet producing small scale industries where bagasse is used as fuel. The Egg Shells are obtained from local hotels and washed thoroughly. Washed shells were sundried and grounded to get a fine powder.

Table -1: Physical properties of cement

Sl.No	Properties	Results
1	Specific Gravity	3.14
2	Fineness Modulus	3.2%
3	Initial Setting Time	34 min
4	Final Setting Time	349 min

Table -2: Physical properties of fine and coarse aggregates

Sl.No	Properties	Fine Aggregates	Coarse Aggregates
1	Specific	2.62	2.68
2	Water	1.25%	0.38%
3	Fineness	2.369	6

Table -3: Physical properties of agricultural and poultry waste

Sl.No	Properties	Cow-dung Ash	Sugarcane Ash	Egg Shell Powder
1	Specific	2.59	2.63	1.92
2	Fineness	2.35%	2.23%	5.75%

3.2 Concrete mix design

M20 concrete conforming to IS 456-2000 the proportion used is 1:1.5:3. Weigh bathing and hand mixing is being carried out.

3.2.1 Workability of mixes

Concrete specimens were casted by varying the percentage of Cow-dung Ash+Bagasse ash mixture and for optimum CDA+SCBA content concrete Egg Shell Powder was added at various percentage replacement levels. For each mix slump test was conducted to determine Workability. Table shows the results of Slump Test for various mixes. It was observed that workability of concrete is decreased as percentage replacement levels increased.

Table -4: Slump test results

Mixes	CDA+SBCA	ESP	Workability
M	0%	-	110
M1	5%	-	130
M2	10%	-	100
M3	15%	-	85
M4	20%	-	35
M5	25%	-	10
M6	30%	-	0
M7		2.5%	30
M8		5%	27
M9		7.5%	21
M10	20%	10%	10
M11		12.5%	5

3.2 Casting and testing of specimens

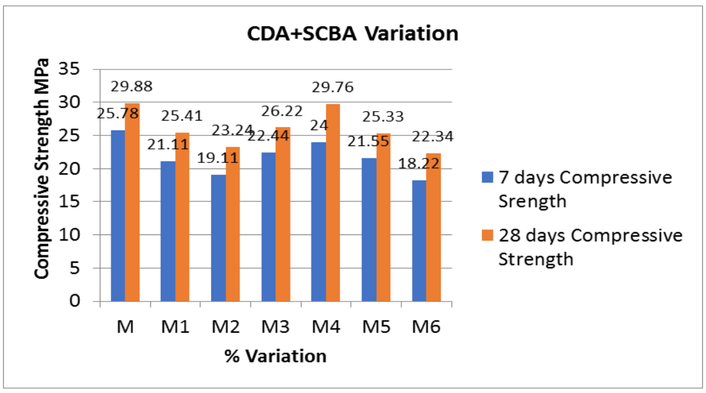
Cubes of size 150mm*150mm*150mm size, Cylinders of size 100mm dia and 200mm length and beams of size 100mm*100mm*500mm were casted. Specimens were demoulded after 24 hours and cured in water tank. Compressive strength of cubes, split tensile strength of cylinders, flexural strength of beams after 28 days of curing were determined.

Fig -5: Demoulded and cured specimens at 28 days

3.2 RESULTS AND DISCUSSIONS

The 7 days and 28 days compressive strength of concrete with partial replacement of cement by cow-dung ash and bagasse ash mixture is graphically represented (refer with fig. 6). It can be observed in the graph that at 20% replacement level there is no significant change in compressive strength of concrete after 28 days of curing period. At 7 days curing age the compressive strength at all replacement levels is observed less than the conventional concrete. Split tensile strength and flexural strength at optimum replacement level of CDA+SCBA mix are greater than conventional concrete (Refer with fig. 7, Fig. 8). Split tensile strength and flexural strength are maximum at 20% replacement of CDA+SCBA mixture at 28 days. Flexural strength increased up to 25% replacement level, and decreased afterwards.

Chart-1: 7 & 28 days Compressive Strength of CDA+SCBA



variation

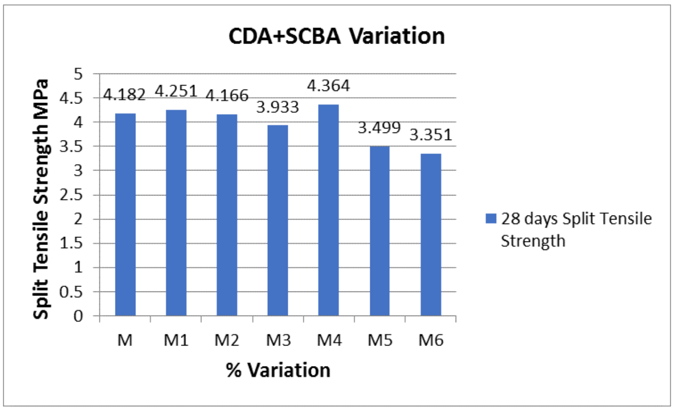


Chart-2: 28 days Split Tensile Strength of CDA+SCBA variation

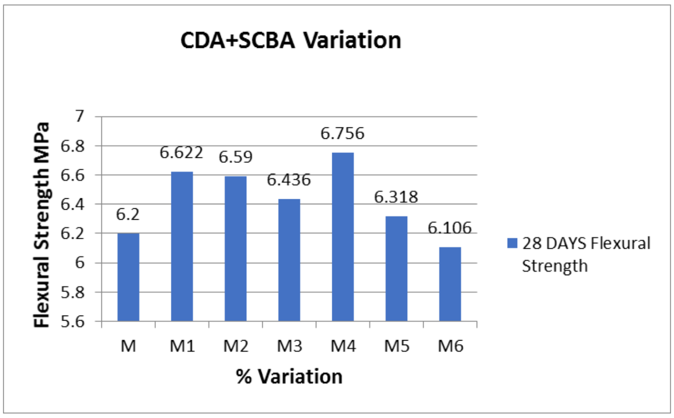


Chart-3: 28 days Flexural Strength of CDA+SCBA variation

After knowing the optimum replacement level that is 20% CDA+SCBA mix, ESP was varied. The maximum compressive strength was achieved at 7.5% replacement level of ESP after 28 days curing period (refer with chart.1). The split tensile strength was more than the conventional concrete up to 7.5% of ESP variation to optimum CDA+SCBA concrete and then it was gradually decreased (refer with chart.2). Flexural strength is greater than conventional concrete for all replacement levels (refer with chart.3).

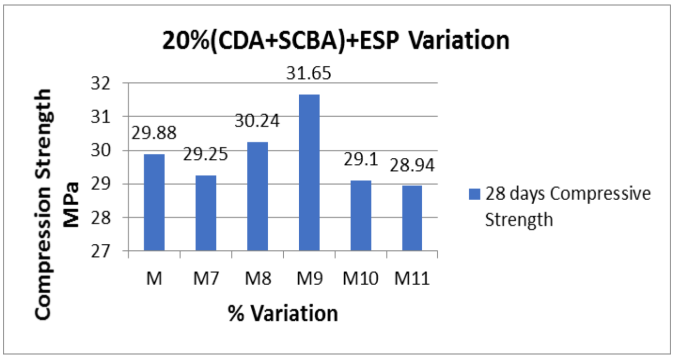


Chart-4: 28 days Compressive Strength of 20%(CDA+SCBA)+ESP variation

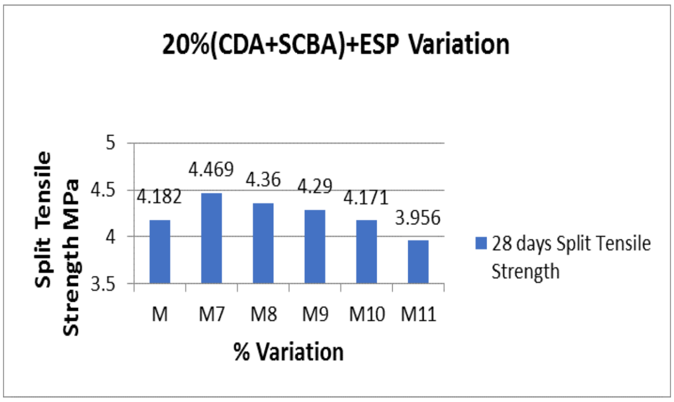


Chart-5: 28 days Split Tensile Strength of 20%(CDA+SCBA)+ESP variation

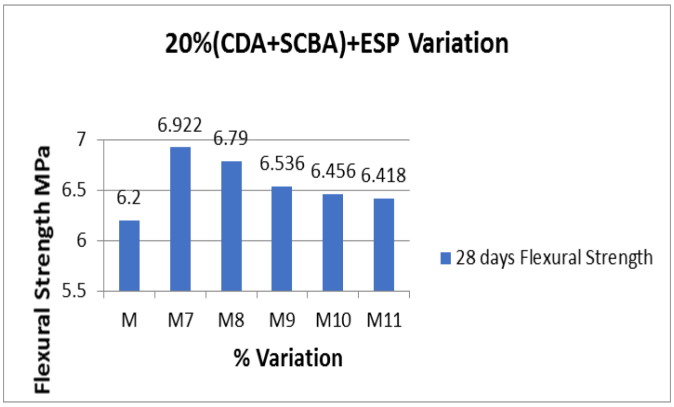


Chart-6: 28 days Flexural Strength of 20%(CDA+SCBA)+ESP variation

4. CONCLUSIONS

1. Compressive strength of (CDA+SCBA)+ESP concrete at 7 days curing age was less than the normal concrete and almost similar at 28 days curing age.

2. The (CDA+SCBA)+ESP concrete's split tensile strength was almost similar and flexural strength was greater than the normal concrete.

3. The addition of ESP to the optimum CDA+SCBA content concrete improved the compressive strength, split tensile strength and flexural strength.

4. Further increase of ESP beyond 7.5% reduced compression strength of concrete, beyond 10% reduced split tensile strength but flexural strength was more than the normal concrete at all replacement levels.

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