TO STUDY THE MECHANICAL PROPERTIES OF COWDUNG ASH MODIFIED CONCRETE

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Abstract— Concrete is the second most used material around the world, the first being water.OPC is mainly used as binder. Manufacturing of OPC holds 5-8% greenhouse gas emission which contributes to global warming. Thus development of sustainable building materials technology has got much importance.Geopolymer concrete was developed on this context.Geopolymer concrete is a type of concrete where OPC is fully or partially replaced using waste materials containing aluminosilicates.Cowdung ash which is obtained by drying and burning of cow excreta has aluminosilicate content.It is bulky and has a large ash content contating a nitrogen rich material,potassium,phosphorus and calcium.In this study cement is partially replaced by cowdung ash(CDA) at 5%,7.5%,10%,15%.Compressive strength twest,flexural strength test and spilt tensile strength test are conducted.M30 mix concrete is used for the study if CDA replaced cement shows sufficient strength we can not only reduce greenhouse gas emission but also the cost of construction to a great extent.

Index Terms—*Binder; Compressive strength;Cowdung ash;geopolymer;Mechanical properties;Flexural strength;Spilt tensile strength*

1 INTRODUCTION

Concrete is the second most used material around the world.OPC is mainly used as binder.Manufacturing of OPC holds 5-8% green house gas emission.ie,Approximately, one ton of CO2 is delivered into the atmosphere for each ton of cement production.Thus development of sustainable building materials technology has got much importance.

Geopolymer concrete was developed on this context. Geopolymer concrete is a type of concrete where OPC is fully or partially replaced using waste materials containing aluminosilicates.It can be synthesised from coal fly ash,BFS, blended ash, lignite bottom ash, gypsum blended ash etc.

Cow Dung Ash which is obtained by drying and burning of cow excreta has aluminosilicatecontent.It is obtained in black colour. It is bulky and has a large ash content containing a Nitrogen rich material, Potassium, Phosphorous and Calcium .Cow dung is basically the rejects of herbivorous matter which is acted upon by symbiotic bacteria residing within the animal's rumen.Cow dung comprises of organic matter including fibrous material that passed through the cow's digestive system, among other liquid digesta that has been left after the fermentation, absorption and filtration, then acidified, then absorbed again.

Physical properties of cow dung:

a) It is bulky
b) It has large ash content
c) It has low volatile content after burning
d) Carbon content is low
e) Burning ratio is low

Exact chemical composition is of mostly carbon, nitrogen, hydrogen, oxygen, phosphorus, etc. with salts, cells sloughed off as the digester went through the digestive tract, some urea, mucus, as well as cellulose, lignin and hemicellulose. CDA contains approximately 60% of silica and other elements.

Here we are studying in detail about the mechanical properties of cowdung ash modified concrete.Cement is replaced by 5%,7.5%,10% and 15% with cowdung ash and compressive strength test,tensile strength test and flexural strength test are conducted.

2 PROCEDURE

2.1 GENERAL

The study is done using M30 mix. 5%,7.5%,10% and 15% of cement is replaced using cow dung ash.15cmX15cmX15cm cubes are casted for these percentage replacements and compressive strength is tested at 7 and 28 days.Cylinders of 15cm dia and 30cm height are casted and tensile strength is tested.The percentage replacement for which best result is obtained is found out.Prisms are casted at the best percentage replacement.

2.2 MATERIALS REQUIRED

- Cement(Grade 43)
- Cow Dung Ash(CDA)
- Fine aggregates(m sand)
- Coarse aggregate(12mm and 20mm)
- Water

2.3 APPARATUS

- 15cmX15cmX15cm cube moulds
- Cylinder moulds of 15 cm diameter and 30 cm depth
- Prisms
- Compression testing machine
- Apparatus for testing bulk density
- Apparatus for testing workability
- Apparatus for testing initial setting time

2.3 TESTING OF PROPERTIES OF MATERIALS:

Various tests has to be conducted to determine the properties of materials used.Various tests included are:

1. Specific gravity
2. Initial setting time
3. Bulk density

2.4 TESTS

Three major tests are conducted to determine the mechanical properties of cowdung ash modified concrete.They are,

I. Compressive strength test
II. Split tensile strength test
III. Flexural strength test

2.4.1.Compressive strength test:

Steel mould of cast iron of dimension 150mm x 150mm x 150mm is used. The mould and its base are rigidly clamped together so as to reduce leakage during casting. The sides of cube are thinly oiled before casting so as to prevent the development of bond between the concrete and the mould . The cubes should be filled in three layer is compacted by 25 strokes of 25mm square inches steel. The ramming is done efficiently to ensure full compaction. The cubes are cleaned of excess concrete by passing an iron in a sawing motion over the top of the cubes. The free surface is finish using hand trowel.Themould is stripped off after 24 hours and the cubes are to be stored in water for curing in a curing tank. At the end of the test the cubes are crushed with the crushed faces in contact with the platens of the testing machine. States that the load on the cubes can be applied at the rate of 15N/mm2/min. The rate of increase in strain is progressively increased as failure is approached. This is due to the non-linearity of the stress-strain relationship for the concrete at high stress. The strength at failure is reported to the nearest 0.5N/mm.

2.4.2.Split tensile strength test:

Cylinders of diameter 15 cm and depth 30 cm are casted. Verify that the samples do not have any significant defects that may affect the quality of the test results. Use a straight-edge and square to draw a line parallel to the sample axis on the circumferential face of the sample. Install bearing blocks and other test fixtures as necessary to successfully complete splitting tensile testing of the samples. Turn on the testing machine. Wipe the concrete sample as necessary to remove any surface moisture. Place the sample in the compression-testing machine. First center the sample along the length of the upper bearing block and then ensure that the projections of diametral lines are centered on the upper and lower bearing plates. Zero the force readout of the compression-testing machine and ensure that the peak recording function is enabled. Apply load continuously at a rate of movement corresponding to a splitting tensile stress rate on the sample of 150 per minute. Continue to apply load until the force indicator shows that the load is decreasing steadily and the sample displays a well-defined fracture pattern. Record the maximum load carried by the sample during the test and note the observed fracture pattern.

2.4.3.Flexural strength test:

Prepare the test specimen by filling the concrete into the mould in 3 layers of approximately equal thickness. Tamp each layer 35 times using the tamping bar as specified above. Tamping should be distributed uniformly over the entire crossection of the beam mould and throughout the depth of each layer. Clean the bearing surfaces of the supporting and loading rollers, and remove any loose sand or other material from the surfaces of the specimen where they are to make contact with the rollers. Circular rollers manufactured out of steel having cross section with diameter 38 mm will be used for providing support and loading points to the specimens. The length of the rollers shall be at least 10 mm more than the width of the test specimen. A total of four rollers shall be used, three out of which shall be capable of rotating along their own axes. The distance between the outer rollers (i.e. span) shall be 3d and the distance between the inner rollers shall be d. The inner rollers shall be equally spaced between the outer rollers, such that the entire system is systematic. The specimen stored in water shall be tested immediately on removal from water; whilst they are still wet. The test specimen shall be placed in the machine correctly centered with the longitudinal axis of the specimen at right angles to the rollers. For moulded specimens, the mould filling direction shall be normal to the direction of loading.

The load shall be applied at a rate of loading of 400 kg/min for the 15.0 cm specimens and at a rate of 180 kg/min for the 10.0 cm specimens.

2.5 Details of mix per m3 of concrete (M30)

	Water	Cement	Total binder	FA	CA
Normal concrete	160.6 kg	365 kg	365 kg	794.97kg	1136.54kg

2.6 TOTAL **QUANTITY REQUIRED**

PARTICULAR	QUANTITY REQD.
Water	84 kg
CDA	15 kg
Cement	175 kg

FA	410 kg
CA	600 kg

3. RESULTS AND DISCUSSION

3.1. TESTS ON PROPERTIES

- Bulk density of compacted CA =1.6kg/l
- Bulk density of loosely packed CA =1.52kg/l
- Bulk density of compacted FA =1.83kg/l
- Bulk density of loosely packed FA=1.43kg/l
- Specific gravity of FA =2.13
- Specific gravity of cement =2.75
- Specific gravity of CDA=2.39
- Initial setting time of cement=40 mins

Certain tests were conducted to determine the properties of materials and the results are shown above.

3.2.TEST RESULTS

0% CDA replacement:-

COMPRESSIVE STRENGTH				
	SAMPLE 1	SAMPLE 2	SAMPLE3	AVER-AGE
7 DAYS	21.09	21.3	21.25	21.2
28 DAYS	44.6	44.5	43.95	44.35
SPLIT TENSILE STRENGTH				
7 DAYS	1.75	1.69	1.73	1.72
28 DAYS	3.66	3.76	3.48	3.63

5% CDA replacement:-

COMPRESSIVE STRENGTH				
	SAMPLE 1	SAMPLE 2	SAMPLE 3	AVER-AGE
7 DAYS	21.02	20.91	20.85	20.9
28 DAYS	43.29	43.1	42.19	42.86
SPLIT TENSILE STRENGTH				
7 DAYS	1.75	1.68	1.78	1.73
28 DAYS	3.23	3.04	3.102	3.12

7.5% CDA replacement:-

COMPRESSIVE STRENGTH				
	SAMPLE 1	SAMPLE 2	SAMPLE 3	AVERAGE
7 DAYS	20.89	20.86	20.75	20.83
28 DAYS	41.72	41.02	40.5	41.07
SPLIT TENSILE STRENGTH				
7 DAYS	2.049	2.12	2.069	2.079
28 DAYS	3.11	3.26	3.1	3.15

10% CDA replacement:-

COMPRESSIVE STRENGTH				
	SAMPLE 1	SAMPLE 2	SAMPLE 3	AVERAGE
7 DAYS	20.11	20.2	19.98	20.09
28 DAYS	37.84	37.5	37.7	37.68
SPLIT TENSILE STRENGTH				
7 DAYS	1.758	1.64	1.78	1.727
28 DAYS	3.044	2.846	3.003	2.96

15% CDA replacement:-

COMPRESSIVE STRENGTH				
	SAMPLE 1	SAMPLE 2	SAMPLE 3	AVERAGE
7 DAYS	14.36	13.78	14.1	14.08
28 DAYS	25.6	23	23.6	24.06
SPLIT TENSILE STRENGTH				
7 DAYS	1.81	1.77	1.73	1.77
28 DAYS	2.81	2.96	2.77	2.84

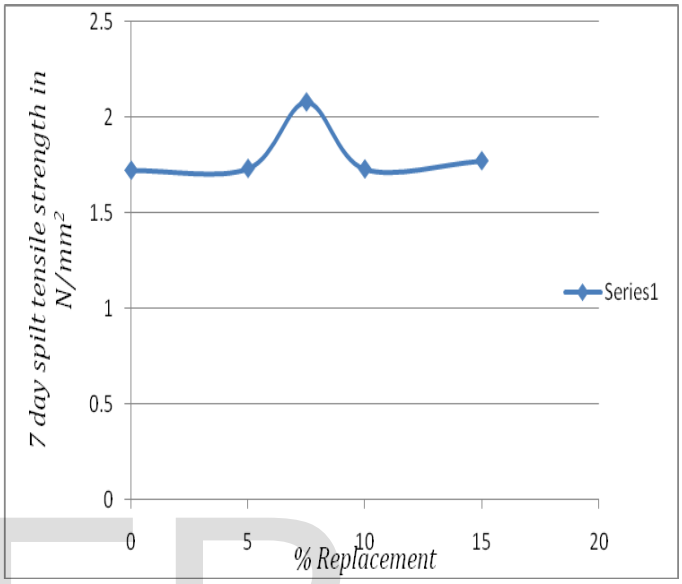

Fig: 7 days Split tensile strength V/S % replacement of CDA

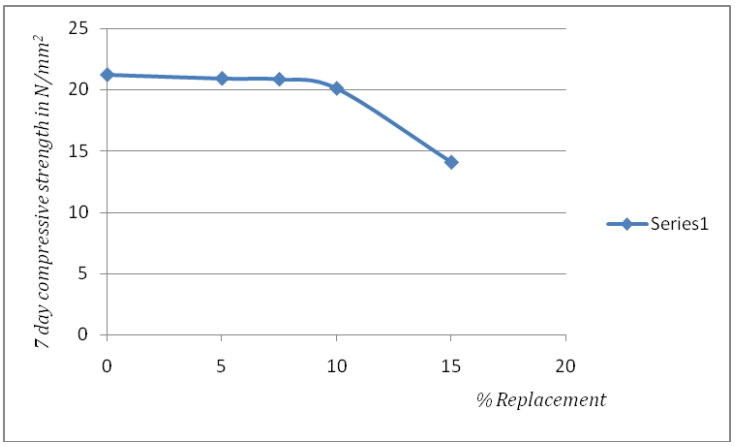

Fig: 7 days Compressive strength V/S % replacement of CDA

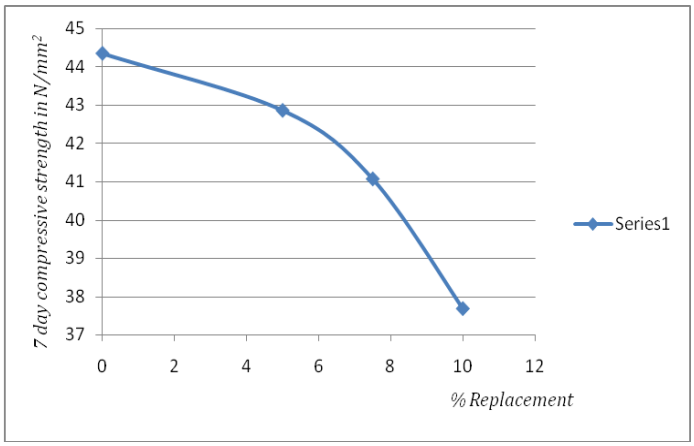

Fig 28 day compressive strength V/S percentage Replacement

FLEXURAL STRENGTH TEST RESULTS

FLEXURAL STRENGTH				
	SAMPLE 1	SAMPLE 2	SAMPLE 3	AVERAGE
0% CDA replacement	3.95	3.89	3.82	3.88
10% CDA replacement	3.79	3.69	3.8	3.76

The results of compressive strength test and split tensile strength test of test specimens with different percentages of CDA replacements are given. The 7 day compressive test results of 0%,5%,7.5%,10% and 15% are 21.2,20.9,20.83,20.09,14.08 (in N/mm^2)respectively and 28 days test result of 0%,5%,7.5% and 10% are 44.35,42.86,41.07,37.68(in N/mm^2) .From the results, it is found that compressive strength decreases with increase in ash content .However up to 10% replacement the compressive strength does not decrease much. The CDA replaced specimens up to 10% satisfies the characteristic compressive strength. From the results it is seen that the strength decreases below minimum strength when cement is replaced at a rate greater than 10%.ie, 15% CDA replaced concrete shows drastic decrease in compressive strength.

The 7 day split tensile strength for 0%,5%,7.5%,10% and 15% are 1.72,1.73,2.079,1.72,and 1.77(in N/mm^2) respectively and 28 days compressive strength are 3.63,3.12,3.15,2.96 respectively. The variation is random.

4. CONCLUSION

Following are the conclusions drawn from the study,

- Strength of concrete decreases slightly as percentage of CDA increases but it satisfies characteristic compressive strength up to 10% replacement.
- Replacement of CDA doesnot vary split tensile strength to greater extent. However the variation is random.
- Cement can be replaced with CDA upto 10%.The reduction of cement has got much significance from economical as well as environmental point of view.
- CDA replaced concrete can be used for small scale constructions.
- Future studies can be conducted on this context. It may help in greener and low cost construction.

5. ACKNOWLEDGMENT

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