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Experimental Study on Effect of Bioash on Mechanical Properties of Concrete

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ABSTRACT:
This project work is to study the effect on concrete with partial replacement of cement with bio-ash (cow dung ash). Cement is partially replaced in concrete with bio ash which as high pozzolanic activity compared with other bio ashes and the compressive and splitting tensile strength of concrete were found at different curing periods (7, 14 and 28 days). In this study, it was found that cow dung ash (CDA) has high pozzolanic activity. So cement was partially replaced with cow dung ash in incremental proportions of 5%, 10%, 15%, 20% by weight of cement on M20 grade mix and compressive strength and splitting tensile strength of concrete was determined for 7, 14 and 28 days of curing. Various tests are conducted on samples like compressive strength and splitting tensile strength and acid resistance of cow dung ash based concrete in different proportion. Cow dung ash (CDA) based concrete was found to be economical in terms of cost and also this concrete reducing the environmental risk by maintaining the ecological balance.
Keywords: Cow Dung Ash, Pozzolanic, Strength, Durability.

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I. Introduction:

Concrete is the most widely used man made construction material in civil engineering. As the demand for concrete as a construction material has increased, the world production of cement has also increased since 1990. Approximately, one ton of CO_2, a greenhouse gas is delivered into the atmosphere for each ton of cement production. Worldwide, the cement industry is responsible for about 1.4 billion tons of CO_2 in 1995, which caused the emission of as much CO_2 gas as 300 million automobiles statistically for almost 7% of the total world production of CO_2. Hence environmental pollution and global warming is increasing continuously and natural resources and energies are being reduced day by day. Since global warming has become as the most crucial environmental issue at present time and sustainability is becoming an important issue of economic and political debates, use of alternative materials can lead to sustainable development. Global warming is caused by the emission of greenhouse gases such as CO_2 to the atmosphere by human activities. This gas is also responsible for depletion of the ozone layer. In addition, the rising cost of cement in developing countries has made it difficult for majority of the population who have low income. Several attempts have been made to reduce the rising cost of cement production in developing countries with very little success. There is the need to seek alternative to conventional cement and to seriously consider the utilization of industrial and agricultural by-products such as feedstock for the cement industry to produce blended cement. Utilization of some of these by-products as partial replacement of cement will help in improving the properties of concrete and also generating income and employment. The problem of disposal of these by-products can be solved and the amount of green gases released into the atmosphere through cement production processes is also greatly reduced. Therefore, there is a need to search for supplementary cementitious materials for utilization as partial substitute for cement. Several researchers have used different materials like sawdust ash, cow dung ash, wood ash, fly ash, granulated blast furnace slag, as partial replacement of cement in concrete. The pozzolanic activity of bio ashes were determined and else cow dung ash (CDA) has the high pozzolanic activity compared with other bio ash. So cement was partially replaced with cow dung ash these efforts can help in reducing the amount of CO_2 emissions emitted during cement

production and also to maintain the durability, strength and stability of concrete structure while also reducing the cost of production. The cow dung is mostly used as manure in the farmland and source of fuel in some cases when dried. The ash from combustion of the cow dung is referred to as cow dung ash (CDA) and is mostly dumped as waste resulting in environmental pollution. Therefore, the aim of this study is to examine the effect of cement replacement with cow dung ash on strength and durability.

Material characterization

Materials: In this study materials like ordinary portland cement, cow dung ash and natural aggregates were used in the preparation of concrete. Detailed properties of individual materials were studied.

Cement : In this work Ultratech cement of 53 grade was used for all concrete mixes. The cement was of uniform in colour i.e., grey with a light greenish shade and was free from any hard lumps.

Coarse aggregates : Locally available coarse aggregates having the maximum size of 20 mm were used in the present work. Testing on coarse aggregates was done as per IS: 383–1970. They were then washed to remove dust and dirt and were dried to surface dry condition.

Fine aggregates : The sand used for the experimental program was locally procured and conformed to grading zone II as per IS: 383-1970. The sand was first sieved through 4.75 mm sieve to remove any particles greater than 4.75 mm and then was washed to remove the dust.

Cow dung ash (CDA): Cow are one of the numerous species of cattle family commonly available in all the part on the world they are employed field operations like ploughing, harrowing, sowing and inter-cultivation etc., while some may looks at cow as source of meat and dairy products. Surprisingly when sterilized CDA, it is entirely odorless and offers some wonderful characteristics for the production of variety of fiberboard building materials. The manure essentially replaces the role of sawdust in the production of particle boards, which would cut down wood usage as well as posing a creative solution of huge. The cow dung is said to have strong antibacterial properties it works as a good disinfectant by keeping house cool in summer and warm in winter cow dung's used as construction material for house encourages utilization of material resources and minimizes wastages. In this project work, CDA was obtained from rural housing the cow dung is collected and dried for an period of 12 days and it is burned to form an ash which is added to cement by partially replacing from 5% to 20% the cow dung is an good. Cow dung ash that has been obtained from villages are dried under sunlight, burnt at a temperature of 450 to 500°C and cooled. After cooling it was crushed to powder form, sieved under 300 micron sieve was stored in an air tight container preventing moisture ingress. The cow dung is exposed to sunlight to dry in order to have dung cakes which is then subjected to burning after it is dried to have the cow dung ash which is obtained in black colour.

Chemical analysis of OPC 53 grade cement and Cow dung ash

Chemical Compounds	**OPC 53 grade cement (%)**	**Cow dung ash (%)**
Silica (SiO_2)	18.78	79.22
Alumina (Al_2O_3)	2.87	5.62
Ferric oxide (Fe_2O_3)	4.03	2.98
Calcium oxide (CaO)	54.66	13.71
Magnesium oxide (MgO)	3.46	1.88
Sulphuric anhydride (SO_3)	1.13	0.19
Insoluble residue (IR)	9.69	1.65
Loss of ignition (L.O.I)	4.83	4.25

Cow dung ash preparation

Physical properties of cow dung ash:
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

Objective of the study
1) The objective of the present study is to utilize the supplementary material (CDA) in place of cement in incremental proportions of 5%, 10%, 15%, 20% by weight of cement .
2) To determine the mechanical properties of CDA concrete

Mechanical properties were investigated by the following tests
1. Compressive strength
2. Split tensile strength
3. Acid resistance test

Methodology
Preparation of concrete cubes: Concrete cubes of size 150×150×150 mm was casted in standard moulds at three intervals using various percentages of cow dung ash. At each interval, concrete was compacted giving 25 blows by a compaction rod. At the end of the third interval, cubes were vibrated for 1-2 minutes on a vibrating machine and then the top surface of the cube was finished using a trowel. After that, the moulds were left for drying for 24 hours. At the end of 24 hours, the cubes were removed from the moulds and were submerged in water tanks for curing.

Casting

Curing of concrete cubes: The cubes prepared with aggregates using different proportions of cement, cow dung ash based concrete specimens were cured for the periods of 7 days, 14 days, and 28 days.
Testing of concrete cubes: The samples cured for the periods of 7 days, 14 days, and 28 days were tested for the compressive strength using universal testing machine.

Compressive strength test:
Compressive strength of concrete is a measure of its ability to resist static load. 7, 14 and 28 day compressive strength test were conducted on three specimens having size 150x150 mm and the average strength was taken as the cube compressive strength of concrete. The tests were conducted by using compression testing machine. From the results of

the compression tests, the optimum percentage of CDA to be added is determined as the one which renders the maximum compressive strength. The cube specimen was taken out from the curing tank after specified curing time and were allowed for dry and the weight of each specimen as well as measure the dimension of the specimen were noted. The specimens were placed in the machine such that load shall be applied to the opposite sides of the specimen, and the specimens were aligned centrally on the base plate of the machine. The movable portion was rotated gently by hand so that it touches the top surface of the specimen. The load was applied gradually till the specimens failed and the maximum load at failure of specimen were recorded. Load was applied at the rate of 140 kN/m^2 . The compressive strength of the specimen was calculated by dividing the failure load by the cross-sectional area of the specimen.

Testing of concrete by compressive testing machine

Split tensile strength test:

Cylindrical specimens of 150 mm diameter and 300 mm length at different replacement levels of cow dung ash 0%, 5%, 10%, 15%, 20% were casted. These specimens were left undisturbed for 24 hours after casting. Then it is demoulded and cured for 7 and 28 days and dried for 30 minutes. These specimens were crushed each at 7 and 28 days after casting at different replacement levels of cow dung ash using the split tensile testing machine in the concrete laboratory of Sethu Institute of Technology, Kariapatti.

Split tensile strength test

Acid resistance:

The concrete cube specimens of various concrete mixtures of size 100mm x100mm x100mm were cast and after 28 days of water curing, the specimens were removed from the curing tank and allowed to dry for one day. The weights of concrete cube specimen were taken. The acid attack test on concrete cube was conducted by immersing the cubes in the acid water for 28 days. Concrete cubes were stored in solution of 5% sulphuric acid (H_2SO_4) solution. After 28 days of immersion, the concrete cubes were taken out of acid water. Then the specimens were tested for compressive strength. The resistance of concrete to acid attack was found by the percentage loss of weight of specimen and the percentage loss of compressive strength on immersing concrete cubes in acid water. The cube specimens immersed in 5% H_2SO_4 solution.

Cubes immersed in acid solution

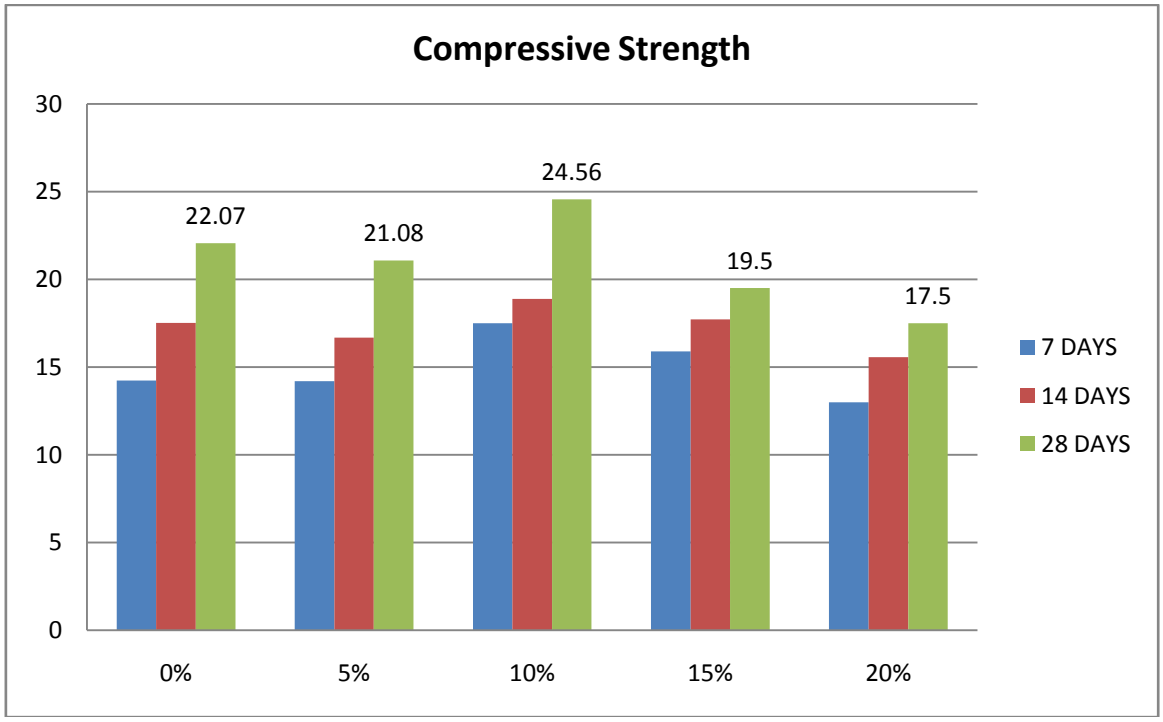
II. Results and discussion:

Compression strength test:

Compressive strength test is performed by using CTM having capacity of 2000 kN. The compressive strength of concrete of cubes 150x150x150 mm size were used for the test. The compressive strength of cubes is calculated as per IS: 456-2000. At first the compressive strength of conventional concrete of M20 grade was calculated by taking average value of three cubes. This is kept as reference. Then compressive strength values of concrete made by replacing the cement with 5%, 10%, 15% and 20% of CDA were found.

Compressive strength test result

S no.	CDA Mix (%)	Average compressive strength (N/mm^2)		
		7 days	14 days	28 days
1.	*0*	*14.24*	*17.52*	*22.07*
2.	*5*	*14.20*	*16.68*	*21.08*
3.	*10*	*17.50*	*18.88*	*24.56*
4.	*15*	*15.89*	*17.72*	*19.5*
5.	*20*	*13*	*15.56*	*17.50*

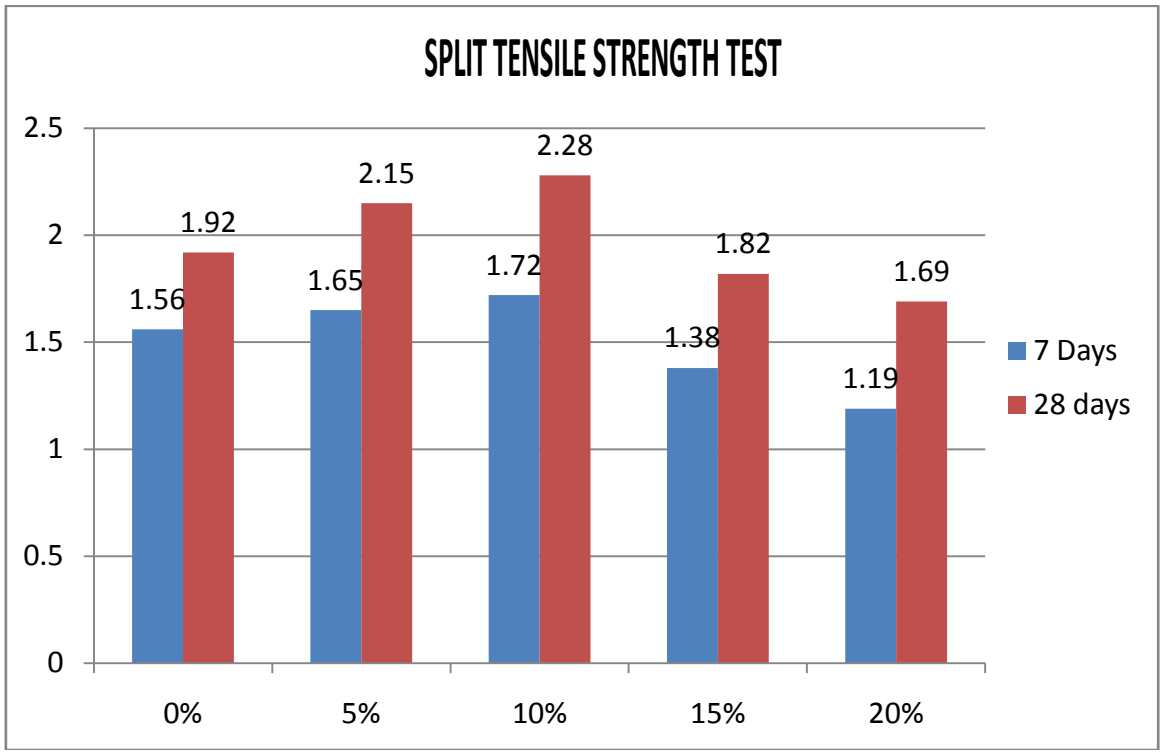


Split tensile strength test:

Cylindrical specimens of 150 mm diameter and 300 mm length made up by partial replacement of cement by cow dung ash is tested in split tensile testing machine. The test results are plotted in a form of graph as shown below. From the graph it was found that the tensile strength of concrete with partial replacement of cow dung ash attains an optimum value upto 10% with tensile strength of 1.72 N/mm^2 for 7 days and 2.28 N/mm^2 for 28 days respectively. After 10%, the splitting tensile strength of the concrete tends to decrease.

Average split tensile strength data and curing age

Test	Curing time taken (days)	% of replacement with CDA				
		0%	5%	10%	15%	20%
Average split tensile strength N/mm^2	*7*	*1.56*	*1.65*	*1.72*	*1.38*	*1.19*
	28	*1.92*	*2.15*	*2.28*	*1.82*	*1.69*



Acid resistance:

The below table shows percentage mass loss of concrete due to acid attack. The loss in mass of 10% CDA concrete specimen was 16.2% after 28 days of acid attack. In the case of the OPC concrete specimens, the loss in mass was about 20.2% after 28 days of immersion. The loss in compressive strength of the 10% CDA concrete specimens soaked in the H_2SO_4 solution was 26.5% after 28 days of immersion. In the case of the OPC concrete specimens, the loss in compressive strength was about 32.3% after 28 days of immersion.

Acid attack test

CDA Mix (%)	Acid attack		% of weight loss	Compressive strength in N/mm^2		% of strength loss
	Weight before exposure (kg)	Weight after exposure (kg)		Strength before exposure	Strength after exposure	
0%	*7.62*	*6.08*	*20.2*	*22.07*	*14.94*	*32.3*
5%	*7.58*	*6.17*	*18.6*	*21.08*	*15.16*	*28.1*
10%	*7.59*	*6.36*	*16.2*	*24.56*	*18.05*	*26.5*
15%	*7.61*	*6.25*	*17.9*	*19.5*	*13.83*	*29.1*
20%	*7.6*	*6.15*	*19.1*	*17.50*	*12.22*	*30.2*

III. CONCLUSION

a) Experimental investigations were carried out to study the cow dung ash on the strength of concrete. Cement was partially replaced with four percentages (5%, 10%, 15%, and 20%) of cow dung ash by weight.

b) The compressive strength and splitting tensile strenght of the concrete specimens were determined at 7, 14 and 28 days.

c) Test results indicated that the mechanical properties was increased up to an optimum content of 10% CDA and decreased further with the increase in the % of CDA in cement.

d) The compressive strength and splitting tensile strength was increased when the cement was replaced by 10% of CDA and decreased with increase in the cow dung ash content. Hence, it is concluded that the 10% cement can be replaced with CDA in concrete.

e) The replacement level of 10% of CDA in concrete mix yields the maximum compressive strength of 24.56 N/mm^2 and maximum tensile strength of 2.28 N/mm^2.
f) Based on test results, we conclude that the partial replacement of cement with 10% of cow dung ash increase the compressive strength and splitting tensile strength of the concrete than that of conventional concrete. So, this ecofriendly CDA based concrete can be easily adopted in construction of all structures.

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