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Review On Effects Of Cattle Manure Ash On Properties Of Fresh And Hardened Concrete

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Abstract-The consumption of cement in concrete industries has been increasing day by bay to fulfill the pressing needs of infrastructure due to growing population, industrialization and urbanization. The production of cement poses environmental problems due to emission of gaseous pollutants. Combustion is an attractive method for cattle manure waste disposal since it produces heat and electrical energy and minimizes groundwater and air pollution by consumption of the waste. A major problem arising from the combustion of cattle manure waste is the significant resultant quantity of cattle manure ash (CMA). In this paper, we study the strength, workability and water permeability of concrete when CMA is used as a partial replacement in cement. CMA was replaced by 5%, 10% and 15% by volume of cement in concrete. CMA were tested, which were generated after combustion at 500 °C. The strength of concrete that contained CMA was determined using cubic samples (150 mm edge) at 7, 14 and 28 days. The workability was measured from the slump when the concrete was mixed manually or mechanically. The water permeability, including percentage, velocity and coefficient of water absorption of concrete, was deter- mined at 7 and 28 days using an improved initial surface absorption test.

Key words- concrete, workability, (CMA) cattle manure ash, fresh properties, strength, and water permeability

INTRODUCTION

With the continuous consumption and depletion of fossil fuels, various countries are seeking alternative energy sources. Biomass energy is of great interest and has developed rapidly around the world. In 2014, the world's biofuel production rose 7.4%, and the proportion of renewable energy in global energy consumption reached 3.0%. In India there are more than 283 million, more than anywhere else in the world. In China, there are now more than 200 biomass power plants. Clear support for biomass power by the 13th Five- Year Plan of China is expected to result in 1000 plants by 2020. Cattle manure is a source of biomass energy that is available in large quantities. In 2014, there were 105.78 million cattle in China producing an estimated 500 million metric tons of dry cattle manure every year. This amount of cattle manure would occupy vast frontiers of land and negatively influence environmental quality if not effectively managed. At present in China, the management of cattle manure follows three main methods of recycling: either as an energy source, as feed or as fertilizers Studies have found that there is abundant potential energy in cattle manure. As a result, power generation through burning cattle manure as fuel has become a promising method by which to utilize cattle manure, as has been successfully practiced in many places such as the Imperial Valley in southern California and the Andalusia region in southern Spain.

In India, cattle rising are an attractive industry, which provides abundant products and assists the economy. However, cattle manure causes environmental problems and has a serious negative effect on the industry. Statistics, although incomplete, indicate that there are currently 2.16 billion cattle on farms in India; each beast produces approximately 8.2 tons of collectable manure per year, containing 35% moisture and 65% solids (combustibles + ash) [1,2]; this totals some 17.7 billion tons of cattle manure in a year. In many cases, the production of manure from one or more animal species is more than can be safely applied to farmland in accordance with nutrient management plans, and stockpiled waste is an economic and environmental liability. This bio-waste contributes to surface- or groundwater contamination and air pollution by releasing CH_4(a greenhouse gas), NH_3, H_2S, amides, volatile organic acids, esters, and others compounds. With the gradually increasing number of cattle impacting on feed and energy resource requirements in India, the development of alternative uses for feedlot manure may become more attractive in some cattle feeding areas in the future. Biogases produced by mixing cattle manure with additives have been used for fuel and to generate power; for example, biogas obtained for these purposes from mixtures of cattle manure and straw has been reported.

CMA can be used to replace some of the cement in concreteand to make thermal insulating building blocks. Several authors have investigated the effect of quantity of cement replaced and age on CMA concrete strength. For example, Thomas and Percival deter- mined the optimum cattle manure combustion temperature to produce CMA and how CMA replacement influences concrete strength at different times. Because of combustion conditions, such as temperature, the chemical and physical properties of the biomass ash, its particle size distribution, its loss on ignition (LOI) and unburned carbon content will differ. These proper- ties of the biomass ash affect the concrete properties. In this study, we investigate the effect of the partial replacement of cement with CMA produced combustion temperatures on the compressive strength, workability and water permeability of concrete, with the aim of developing CMA with optimal structural properties for use in concrete.

1. **Comparison between Chemical properties of Fly ash, Concrete and Cattle manure ash**

$3Ca(OH)_2 + 2SiO_2 + H_2O = 3CaO \cdot 2SiO_2 \cdot 4H_2O$

- Proportion of hydrated lime (Ca(OH)2) in CMA is 15.4% compared to 1.58% for FA.

From Eq. (1), therefore, CMA produces more hydrated calcium silicate than FA, inducing greater pozzolanic reactivity.

Table No.1 chemical properties of CMA, FA and Cement. [1]

	SiO_2	CaO	Al_2O_3	K_2O	Fe_2O_3	MgO	P_2O_5	SO_3	CL	Na_2O	Loss by ignition
Cement	47.5	9.17	27.0	1.93	4.97	1.08	0.32	1.29	-	0.72	0.75
CDA	52.0	15.4	7.79	4.91	3.20	2.94	2.92	1.54	0.35	0.66	2.5
FA	55.2	1.58	4.04	1.29	3.23	1.73	-	4.45	-	0.51	0.99

2. **Physical properties of cattle manure ash:**

- It is bulky.
- It has large ash content.
- It has low volatile content after burning.
- Carbon content is low. Burning ratio is low. (Elsevier journals)

3. **Particle size distribution of cement, FA and CMA**

- The volume-weighted mean of the CMA is 44.9 um.
- FA 50.792 um.
- Cement 36.16 um.

4. **Concrete workability**

Slump cone test was used to determine the workability of concrete mixed with CMA. The concrete was mixed manually and mechanically for more than 5 min and less than 3 min, respectively. Concrete slumping was tested according to a proprietary standard test for concrete mixtures.

5. **Concrete cube compressive strength**

According to the standard mechanical test for concrete, the mixture was placed in a cubic mould with 150 mm edge and vibrated until the grout was visible on the concrete surface after manual and mechanical mixing. The concrete sample was removed from the mould after 24 h and placed in a curing room (at 20 ± 3 °C and a humidity greater than 95%) to cure to 7, 14 and 28 days.

6. **Percentage water absorption**

The percentage of water absorbed by the CMA-blended concrete samples was measured based on ASTM C 642 2006 after 7,and 28 days of moisture curing.

Literature Review

Ramachandran andVishwakarma (2018) conducted an experiment on detailed studies of cattle manure ash modified concrete exposed in fresh water. Concrete structures in proximity of water environment whether exposed directly or indirectly undergo physical and chemical changes. The water can be seeping into porous concrete and this triggers the need to modify the exposed concrete with suitable add-ons. Cow dung ash is having pozzolanic qualities, which can produce quality concrete structures. This study is focused on M30 grade concrete mix namely normal concrete and concrete modified with cattle manure ash. Concrete modified with CDA was prepared by 15% partial replacement of OPC with CDA. After 28 days of curing, specimen were exposed in fresh water for 56, 90, 180 and 365 days. [1]

Shah et al. (2018) has conducted an experiment on influence on strength characteristic of concrete using cattle manure ash. The consumption of cement in concrete industries has been increasing day by bay to fulfill the pressing needs of infrastructure due to growing population, industrialization and urbanization. The production of cement poses environmental problems due to emission of gaseous pollutants. Huge amount of industrial waste like rice husk ash generation has been causing waste disposal problems. Cow dung is used as fuel for the domestic purpose, which generate solid waste ash. In this study, an attempt was made to replace the cement using rice husk ash and cow dung ash with 10 % of brick aggregate instead of fresh aggregate. Different cube of M25 grade mix is made to check strength criteria. These sets were prepared using different proportion of cement, rice husk and cow dung ash with brick aggregate. These sets were prepared using different proportions of cement, fly ash and cow dung ash. Then the cubes were cured forth period of 7 days, 14 days, 21 days and 28 days. The compressive strengths of all the cubes were determined using a Universal Testing Machine. Compressive strength of different cubes is different as per the percentage vary of replaced material in each cube. The study revealed that fly ash and cow dung ash with brick aggregate could be used as partial replacement of cement and aggregate in concrete. There are some other tests we have done in present study like workability, initial setting and final setting time and consistency. [2]

Divya et al. (2018)has conducted an experiment on concrete with Replacement of Fine Aggregates by Foundry Sand and Cement by Cow dung ash. Concrete is the most important engineering material and the addition of some other material may change the properties of concrete. This research is carried out to produce a low cost and eco-friendly concrete. Studies have been carried out to investigate the possibility of utilization a broad range of material of partial replacement of fine aggregate and cement in production of concrete. Here the partial replacement of fine aggregate by waste foundry sand in the percentage of 5%, 15%, 25% and cement by cow dung ash with constant percentage of 10% is used. The tests were carried out to determine the mechanical properties of concrete. The main aim of this study is to make economical and eco-friendly concrete. [3]

Sharmila et al. (2018**)**have done an Experimental Investigation on Partial Replacement of Cement with Cow dung Ash and Marble Chips with Fine Aggregate in Concrete. Concrete is most widely used in construction material in the world, with about two billions tons of utilization worldwide during each year. Concrete is widely used in all types of infrastructural application because it offers considerable strength .The study focuses on the compressive strength, split tensile strength and flexural strength performance of the blended concrete containing different percentage of cow dung ash and marble powder as a partial replacement of cement and fine aggregate. The fine aggregate in concrete is replaced accordingly with the percentage of 20%, 30%, 40 %, by weight of F.A and 5%, 10%, 15% is added by weight of cement. Sand is a prime material used for preparation of mortar and concrete and which plays a major role in mix design. Now days erosion of rivers and considering environmental issues, there is the scarcity of river sand will affect the construction industry. The production of cement posses many environmental problems due to emission of gaseous pollutants. Cow dung is used as a fuel for the domestic purpose, which generates solid waste as ash. This work examines the possibility of using cow dung ash and marble powder as partial replacement of cement and fine aggregate for new concrete. Concrete are made for m-40 grade mix and tested for its compressive strength up to 7, 14 28 days of age and compared with conventional concrete. [4]

Magudeaswaran&Hilal (2018)has conducted an experiment on Development of Eco Brick and Concrete with the partially replacement of cow dung. Cow dung is the undigested residue of plant matter, which has passed through the gut of goat. It is rich in minerals like Potassium, Magnesium, Sodium and Manganese and is comprised of organic matters. Cow dung has been used in India for thousands of years in the fields of agriculture or farming. The method of producing traditional bricks from kiln is costly and causes pollution. Cow dung can be used to manufacture bricks, which are eco-friendly and much cheaper. Drying Cow dung under sun and then burning it obtain cow dung ash. We used 10%, 20% and 30% of Cow dung brick and 10%, 20% and 30% of Cow dung ash in concrete, and obtained maximum strength at 10 % replacement. Approximately, one ton of CO2, a greenhouse gas, is delivered into the atmosphere for each ton of cement production. Studies were done in the manufacture of brick and concrete using cow dung. In this project we are trying to study the properties of brick by introducing goat dung and Cow dung ash as a supplementary cementing material in concrete. [5]

Sruthyet al. (2017)has conducted An Experimental Study on Strength Properties of Concrete on Addition of Cow Dung Ash and Glass Fiber. In this present experimental work an attempt is made to replace cement by Cow dung ash (CDA) to overcome these problems. The cement has been replaced by CDA in the range of 6%, 8%, 10%, 12% and14% by weight of cement for M25 grade mix. It was tested for compressive strength and split tensile strength at the age of 7, 14 and 28 days and compared with those of conventional concrete. Results showed that 8% replacement of cement by cow dung ash makes a considerable increase in compressive strength and split tensile strength. The present investigation has shown that an addition of 0.5% glass fiber to concrete makes it stronger and more durable. [6]

Ramachandran et al. (2017)has conducted an experiment on Studies of Strength, Durability and Microstructural Properties of Cow Dung Ash Modified Concrete. This study is done by partially replacing cow dung ash (CDA) instead of ordinary Portland cement (OPC) in the production of concrete. Five sets of concrete mixes of M40 grade had CDA replaced with OPC in the ratio of 5.0, 7.5, 10.0, 12.5 and 15.0% CDA by weight of cement. It was compared with normal concrete (NC). Energy dispersive X-Ray diffraction (XRD) study confirmed presences of Nano-silica in CDA. After 7d of curing, there was not much appreciable increase in compressive strength of CDA aided mixes. But after 28d both compressive and split tensile strength was increased in the 15% modified CDA. Superplasticizer requirement was increased with increase in CDA percentage for achieving similar workability. Rapid chloride Penetration Test (RCPT) results confirmed, CDAmodified concretes are low in permeability as well as surface and internal pH study confirmed that alkalinity is also well maintained. The chemical composition and microstructure properties were analyzed by X-ray diffraction (XRD), Field Emission Scanning Electron Microscopy (FESEM) and Thermogravimetry/ /Differential thermal analysis (TG/DTA). [7]

Feng et al. (2016)has conducted an experiment onEffect of cattle manure ash on workability and mechanical properties of magnesium phosphate cement. Cattle manure ash (CMA) is an industrial waste produced from the combustion of cattle manure. This research examined the effect of added CMA produced at combustion temperatures of 500 °C, 650 °C and 800 °C on the workability and mechanical properties of magnesium phosphate cement (MPC). The obtained data indicates that CMA decreases workability and mechanical properties of MPC to which it is added. However, relatively higher combustion temperature in CMA preparation can diminish the adverse effect that CMA exerted on mechanical properties and workability of MPC. CMA promotes the formation of struvite in the hydration reaction of MPC. [8]

Vishwakarma andRamachandran (2016)have conducted an experiment on Microbial deterioration effect of cow dung ash modified concrete in freshwater environments.This paper explains the microbial deterioration of normal concrete (NC) and concrete modified with cow dung ash (CDA) in freshwater environments. Five different concrete mixes of M30 grade were prepared by replacing ordinary Portland cement (OPC) with 2.5, 5.0, 7.5, 10.0, 12.5 and 15.0% CDA by weight of cement and were compared with NC (0% CDA). First the antimicrobial properties of CDA powder were evaluated. All the specimens were cured for 28 days and then exposed in fresh water for 45 days to identify the best mix of concrete. pH degradation studies on the exposed samples were evaluated. Total viable bacterial counts (TVC) studies revealed that microbial growth was less in CDA modified concrete as compared to NC. Total dissolved solids (TDS) and Total suspended solids (TSS) were done to know the inorganic and organic content in the biofilm sample. Epifluorescence microscopic observation showed less number of fluorescing cells indicated the inhibition of biofilm formation on CDA modified concrete. XRD analysis was done to find the changes in the crystalline phases within the modified concrete microstructures and its antibacterial activity. [9]

Zhou et al. (2012) has conducted an experiment on Pozzolanic activity of feedlot biomass (cattle manure) ash. The pozzolanic activity of cattle manure ash (CMA) was determined and compared with fly ash (FA) in this study. X-ray diffraction (XRD) and energy-dispersive analysis (EDA) were used to determine the chemical composition of the CMA and FA. Scanning electron microscope (SEM) images indicated that the microstructure of the CMA is mainly in the shape of floccules. Mortar prism and concrete cube specimens were tested to determine the reactivity of CMA; the compressive strength of CMA mortar was found to be greater than that of FA mortar. The same result was obtained for concrete cube compressive strengths at 7, 28 and 56 days. Tests of electric flux to assess chloride anion penetration resistance of the concrete gave the CMA concrete the highest results for the four materials after 28 days, and least after 180 days. These results indicate that the pozzolanic activity index of CMA exceeds that of FA, indicating that CMA is a suitable replacement for cement in the preparation of concrete. Such a result can assist the cattle raising industry to drastically reduce waste disposal problems. [10]

Zhou et al. (2015) has conducted an experiment on Effect of cattle manure ash on strength, workability and water permeability of concrete. Combustion is an attractive method for cattle manure waste disposal since it produces heat and electrical energy and minimizes groundwater and air pollution by consumption of the waste. A major problem arising from the combustion of cattle manure waste is the significant resultant quantity of cattle manure ash (CMA).

In this paper, we study the strength, workability and water permeability of concrete when CMA is used as a partial replacement in cement. Three types of CMA were tested, namely CMA, CMA-M and CMA- U, which were generated after combustion at 200 °C, 500 °C and 800 °C. The strength of concrete that contained CMA was determined using cubic samples (100 mm edge) at 7, 28 and 56 days. The workability was measured from the slump when the concrete was mixed manually or mechanically. The water permeability, including percentage, velocity and coefficient of water absorption of concrete, was deter- mined at 7, 28 and 90 days using an improved initial surface absorption test. The workability increased from CMA to CMA-M to CMA-U. The compressive strength increased with increasing particle size from CMA to CMA-M but decreased from CMA-M to CMA-U. The water permeability, including percentage, velocity and coefficient, increased from CMA to CMA-M to CMA-U at 7 and 28 days. At 90 days, the water permeability, including percentage, velocity and coefficient of water absorption of CMA-M concrete, were the lowest in the three CMA concretes. CMA-M was the best material in terms of its overall workability, strength and water permeability. Mechanical concrete mixing and vibration was the optimal preparation procedure. CMA can therefore be blended with cement for concrete production depending on the ultimate use. [11]

Conclusion

At present, the process of manufacturing of cement involves a larger emission of harmful gases, which poses a threat to environment in many ways. Many research works are being carried out to replace either partially or wholly, the fine aggregate, coarse aggregate and cement in concrete. In this project, an attempt has been made to use cattle manure ash as a replacement material of cement. The addition of these materials marginally improved the structural properties of concrete. It also leads to reduction of environmental impact caused by land filling or dumping of these materials. Replacement using these materials can bring down the original cost of production of concrete and it also lead to reuse of waste materials. The above tested methods for production of concrete can be applied in the construction of compound walls, non-load bearing partition walls, lightly loaded precast members-shelf slabs, sill slabs, cut lintels and sunshades, kerb walls and medians of road.

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