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A Review on Partial Replacement of Cement with Cow Dung Ash (CDA) in Concrete

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***Abstract*: This review paper presents the influence of cow dung ash as partial replacement of cement material in production of concrete. In this modern era, many new technologies of construction materials are introduced. Growing population, urbanization and industrialization has increased the requirement of cement. The production of cement leads to environmental issues due to emission of gaseous pollutants. The availability of materials with good quality is less and also economically very high. So we need a material which is cheaper as well as ecofriendly for the environment like cow dung ash. These materials are partially replaced by cement. Many experiments by different researcher were done to study the effect of adding CDA in various percentage (0%, 5%, 10%, 15%, 20%, 25% and 30%) by the weight of cement. The curing period is of 7, 14 and 28 days respectively for the testing of compressive strength. The other mechanical properties like split tensile test, the durability properties like rapid chloride permeability test and water penetration test were to be conducted on M25 grade concrete. Thus the settling time is prolonged by adding the cow dung ash to the cement. The materials like cow dung and fly ash are of good quality, cheaper, ecofriendly and durable.**

***Keywords*: Compressive strength, Workability, Consistency, Cement mortar, Cow dung ash (CDA), Fly ash, cement Concrete, Curing.**

1. Introduction

In current scenario Sustainable development is the alarming issue in the world. It involves the development of community so that everyone can live with comfort without consuming all available resources. Concrete is the heart of the construction of modern infrastructure. The demand of cement has increased as it is main constituent of concrete. Concrete is mixture of cement, sand and aggregate. The purpose of cement is to bind the sand and coarse aggregate into a rigid mass. Strength and durability of the structure depend on the quality of concrete. The production of cement emits large amount of harmful gases (eg.CO2) for the environment. These gases cause depletion of ozone layer and environment pollution thus it leads to greenhouse effect. The cost of cement is also very high. So it is required to find eco-friendly materials which can act as a binding material in concrete and also liberate less amount of energy as compared to that of the production of cement. To reduce CO2 emission from the cement industry one way can be use of the industrial by-products or use of supplementary replaceable cementing material such as kota stone slurry, glass fibers, coconut fiber, fly ash, silica fume and cow dung ash. Whereas river sand is mostly used as fine aggregate for a very long time present days, availability of river sand is matter of concern because of over use of river sand by concrete industry due to restriction increase on mining of river sand.

2. Literature Review

Dhiraj Thakur et.al (2019) [1] presented the effect on concrete by adding cow dung ash to the cement. The cement in concrete is replaced with cow dung ash in different proportion by weight (like 5%, 10% and 15%). The strengths of concrete (compressive & tensile) were tested at different curing periods (7, 14 and 28 days). Tests like determination of bulk density, workability and settling time of cow dung ash for different proportion are conducted on samples. The compressive strength was found maximum at 5% cow dung ash. Compressive load variation decreases when proportion of cow dung is increased from 5% to 10% and 10% to 15% and more. Cow dung ash's specific gravity is 2. The Compressive load variation for the cow dung proportion of 5%, 10% & 15% after 28 days is 793,684,576 respectively.

Duna Samson et.al (2014) [2] reported the investigation into the pozzolanic potentials of cow dung ash. Cow dung was calcined at a temperature range of 400-500, sieving was done through 212µm sieve and characterization was done using chemical and physical methods. CDA proportion used in cement was 0 to 30% (at 5% interval). Different test like soundness Standard consistency and setting time test were conducted on the fresh cement paste, while on the hardened mortar samples compressive strength test was conducted at different curing time of 7, 28, 60 and 90days. The sum of Fe2O3, Al2O3 and SiO2 in CDA exceeds the 70% minimum specified by standard ASTMC 618-12.The test results are prolonged setting time and increased standard consistency after adding CDA to cement paste, while there is decrease in

compressive strength with increase in CDA and increase with curing age. Compressive strength with cow dung ash was predicted with the help of linear regression model and predicted curing age was highly significant. The result reveals that addition of CDA decreased the expansion (change in volume) from 2.0mm (for control sample) to 0.85mm (for 15% CDA) which is within the acceptable limit specified by BS 12(1978). Strength activity index of CDA was calculated to be 77.6% which is higher than the 75% minimum specified by ASTM C 618 standard for pozzolana. The compressive strength for 10% CDA was 10.72 N/mm^2 after curing of 7 days which increases by 34%, 61% and 106% at the end of 28days, 60 days and 90 days respectively and 22.14 N/mm^2 after 90 days which is very close to 25.16N/mm^2 for 0% cow dung ash. There was an increase of 3.2%, 17.7%, 24.20%, 41.9%, 48.4% and 54.8% in water required to achieve standard consistency at 5%, 10%, 15%, 20%, 25 and 30% CDA addition respectively.

Leopold Mbereyaho et.al (2020) [3] concludes the performance of cow dung mixed with cohesive soil mortar and establish recommended mix content for work of plastering. Twelve samples of soil mortar were prepared with cow dung (10%, 20%, 30% and 40%), and dried for 28 days before performing tests for water absorption, shrinkage, specific gravity, weathering resistance and Atterberg limit tests. The mix ratio of cow dung and soil used was 1:5 that resulted in minimum water absorption of ***19.82***. Durability test resulted that the proposed mortar of cohesive soil mixed with cow dung was suitable referencing to ASTM C270 Standard Specification for Mortar for Unit Masonry. The shrinkage test resulted that the shrinkage of the cohesive soil mortar mixed with cow dung content from 10% to 20% showed an increase from 24.7 % to 25.3%; and then it decreased to 24.2% and 22.9% respectively at replacement of 30% and 40%. The avg. specific gravity of cohesive soil sample measured was 2.603 which follows standards ASTM D 854-92. The addition of 20% of cow dung shows better properties and increased durability.

Aman Kumar (2018) [4] represent that the partial replacement of cement by 10% fly ash and 5% CDA, there is an increase in compressive strength of concrete after that the compressive strength gets lowered. The compressive strength for M25 grade concrete was 40.2N/mm2 which was maximum after 28 days of curing, for replacement of cement by 10% fly ash and 5% cow dung ash and this value is better than the compressive strength of 36.8N/mm2 at 0% mixing. It is found that the workability of concrete gets decreased as the percentage of fly ash and cow dung ash increases. The calculated slump value for concrete having (10% fly ash + 5% cow dung ash) defines it in the low workability category. So this concrete can use in concrete road construction and mass concreting. The standard consistency increases with the increase in amount of fly ash and cow dung ash. Hence, it requires more quantity of water. The byproducts uses reduces the cost of a concrete.

Jitender kumar Dhaka et.al (2015) [5] presented Utilization of fly ash and cow dung ash in concrete. Two sets of M20 grade cubes were prepared separately for the rock and brick as coarse aggregate, using different proportions of cement, cow dung ash and fly ash. 4 proportions of mix design (cement: fly ash: cow dung ash) such as (100:0:0), (80:10:10), (60:20:20), (40:30:30) were considered. The curing period was of 7 days, 14 days, 21 days and 28 days. Universal Testing Machine was used to test the compressive strength. The compressive strength of cubes was the highest at 28 days of curing. They found no significant differences in the strength of concrete prepared only by the cement and by 10% of fly ash plus 10% of cow dung ash at each calculated day of curing. It indicates that replacing cement by cow dung ash up to 10% is suitable.

V.S.R. Pawan kumar et.al (2012) [6] reported the effect of incorporation of cow dung ash on mortar and concrete. Cow dung ash (CDA) was added in various proportion by weight (5 % to 30 %) of cement and curing period for testing of the compressive strength was of 7, 14, 28 days. The cube's compressive strength is calculated as per standard IS: 456-2000. Result reveals that there is decrease in strength of concrete after increasing the ash percentage and good result was up to 10% of CDA mixing. The average compressive strength for 10% of adding cow dung ash, is 23.1 N/mm^2,17.44N/mm^2, and 15.25N/mm^2 after curing of 28 days, 14 days,7 days respectively. Similarly by adding 20% of cow dung ash to cement the maximum average strength 11.3N/mm^2 after 28 days curing. Finally by adding 30% of cow dung ash to cement the maximum average strength is 5.81 N/ mm^2 after 28 days of curing. As the percentage of cow dung ash is increased from 10% to 30% consistency limit also increases from 0.42 to 0.80, which signifies that water requirement increases with ash content increment. Workability is calculated 50 mm for 10% of cow dung ash replacement. Percentage of water requirement increases by increasing the cow dung ash percentages. This paper emphasizes on manufacturing of sustainable concrete with the uses of waste material for construction industry.

Vasu.K (2019) [7] performed experiment on partial replacement of cement with cow dung ash. Cubes of M20 grade is prepared by adding CDA in the range of 5%, 10%, 15% and 20% by weight of cement. Compressive strength is tested at interval of 7, 14 and 28 days. The maximum average compressive strength is 24.56N/mm^2 at 10% replacement of cement by cow dung ash, which is higher than the compressive strength of 22.07N/mm^2 for fresh concrete (or 0% mixing) after curing period of 28 days. So compressive strength is found to be improved. Specific gravity of cement is calculated as 2.65 and standard consistency test provides 32% value. It is concluded that an addition of 10% CDA makes concrete stronger and more durable.

P.Thej kumar et.al (2015) [8] presents the possibility of utilizing Cow dung ash (CDA) as a substitute of cement in cement mortar and concrete. Four proportion (5%, 10%, 15%, and 16%) of cow dung ash by weight was used for partial replacement of cement. Consistency limits was determined for ordinary Portland cement (OPC), cow dung ash and OPC mixed with cow dung ash. The compressive strengths of the specimens were tested at 7, 14 and 28 days curing respectively. Test results indicate that consistency limit shows Gaussian normal curve like behavior with the increase in amount of CDA in cement. Consistency limit goes from 29 to 42 as mixing of CDA increases from 0% to 16% of cement and comes to 35 at 17%. Initial settling time increases from 60 minute to 148 minute with the increase in content of CDA from 0% to 16% of cement. Final settling time also increases from 182 minute to 317minute with the increase in content of CDA from 0% to 16%. The workability of the concrete for different proportion of cow dung ash in cement is tested which changes from 0.914 to 0.762 as CDA increases from 0% to 16%. Strength activity index was 78.21% which makes CDA a suitable element for cement. The compressive strength of cubes is found to be in accordance to standard IS: 456-2000. The compressive strength is resulted 44.29N/mm^2 when the CDA is 5% in cement after 28 days of curing. Initially compressive strength is raised when the CDA is 5% for all the curing days considered in the present investigation and when the CDA content is increased then there is a reduction in the

strength of the cement is observed. As observed in mortar, 5% of cow dung may be used as a partial replacement to cement in concrete.

O. Y. Ojedokun et.al (2016) [9], presented effects of adding Cow Dung Ash (CDA) in various percentages by weight (10%, 20% and 30%) of cement and testing for the Compressive strengths after curing for the periods of 7, 14, 21 and 28, days respectively. Testing is done for Setting time, Bulk Density, and Workability of Cow Dung Ash after mixing with Portland cement. The Compressive strength test results are 21.33 N/mm^2, 21.11 N/mm^2, 11.11 N/mm^2 and 6.00 N/mm^2 for 0%, 10%, 20% and 30% replacement of cement with CDA respectively at 28days. The results gives 40mm, 48mm, 80mm and 100mm value for workability respectively for 0%, 10%, 20% and 30% replacement. Consistency limit is improved from 0.34 to 0.78 as CDA percentage is increased from 0 to 30. The setting time (initial and final) is prolonged as the percentage of Cow Dung Ash is added. CDA provide lightness of weight and low thermal conductivity. They finds that it can be made to perform well in the certain floor and wall application when a 10% only it is added. The water requirement is more as the% of CDA is increases.

C. Venkatasubramanian et.al (2017) [10] published a paper on Experimental studies on effect of cow dung ash (Pozzolanic binder) and C. Venkatasubramanian et.al (2017) [10] studies the effect of using cow dung ash and coconut fiber on strength of concrete. The research study focuses on addition of waste materials to reduce emission of greenhouse gases and low energy consumption. The cow dung ash replace cement by about 2.5, 3 & 3.5 % by weight and 1% of coconut fiber is added. The strengths of concrete were found at different curing periods (7, 14 & 28 days). It is concluded that there is a reasonable strength improvement in concrete properties about 55-70%. The value of tensile strength is 2.92MPa when 3.5 % CDA was added. The Concrete's compressive strength improved by about 77.2% and 75.5% for 2.5% and 3.5% replacement of cement using CDA and CF. The Tensile strength is improved by 46% for 3.5% replacement of cement using CDA and CFA. So both the Compressive and Tensile strength of concrete are increased for 3.5% replacement of Cement using cow dung ash and coconut fiber. The replacement by CDA, CF is economical and lowers the environmental risk and keeping the ecological balance. These are applicable in compound walls, sill slabs, non-load bearing partition walls, lightly loaded precast members-shelf slabs, cut lintels and sunshades, kerb walls and medians of road.

3. Properties of COW DUNG ASH

In this study cement % is reduced by adding cow dung ash. CDA has good binding properties and it reduces voids in concrete. 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
f) Low thermal conductivity
g) Eco-friendly material
h) Economical
i) Easily available

The constituents of CDA are similar to OPC. In PC main oxides of CaO, Al2O3, and Fe2O3 are more than in CDA. The combined alkali (Na2O+K2O) is 3.5% in CDA, which is less. It reduces the chances of disintegration of concrete by AAR. The SO3 of 1.36% present is below the 4% maximum specified by ASTM C 618-12. so CDA when used in mortar and concrete can improve durability and prevent unsoundness.

4. Methodology

4.1 Preparation of concrete cubes

Concrete cubes of size 150×150×150 mm were casted in standard moulds at three intervals using varying 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 machine vibrator and then trowel is used to finish the top surface of the cube. After that, 24 hours drying of mould is done. The cubes were removed from the moulds after 24 hours and were immersed in water tanks for curing.

4.2 Curing of concrete cube

The cubes with CDA were cured for the periods of 7 days to 28 days.

4.3 Testing of concrete cubes

Universal Testing Machine is used for testing compressive strength for the cubes prepared.

5. Conclusion

- The Cow Dung ash makes the concrete light weight.
- The Concrete with cow dung ash is economical.
- The compressive strength of concrete with Cow Dung Ash is good with the limit of 10% of replacement.
- There is reduction in workability of concrete with increase in the cow dung ash quantity.
- Initial and Final settling time increases with increase in quantity of CDA.
- Water requirement increases with the increase in CDA to achieve the standard consistency which poses a limit to be used in less water region.
- The mixture of other material glass fiber or coconut fiber with CDA provides high strength to concrete comparatively to alone CDA.
- Compressive strength after 28 days of curing was increased.
- For structure requiring high strength Concrete with CDA is unsuitable..

- Good for sustainable development and green technology.
- It provides good utilization of Byproducts.
- CDA remains concrete cannot be used in water stored region.

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