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STUDY ON CORN COB ASH REPLACED CEMENT IN CONCRETE BY ACCELERATED CURING

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Abstract - *Leaving the waste materials to the environment directly can cause environmental problem. Hence the reuse of waste material has been emphasized. Waste can be used to produce or can be used as admixtures more efficiently and the environment is protected from waste deposits. Normally the waste corncob is burned in open space and these industrial wastes are dumped in nearby land and the natural fertility of the soil is spoiled. In turns pollutes the environment. In this study corn cob ash is to be used as partial replacement of cement. The main objective of this study is to characterize the optimum percentage of corn cob ash involving replacement of cement in the ratio of 0% to 10% by normal water curing and accelerated curing. Extensive literature survey has been done for corn cob ash and accelerated curing in this work, using accelerated curing, concrete strength increased with desirable amount and also higher than target strength of concrete with cement and cement replacing material at early ages, thereby reducing the strengthening cycle time, resulting in cost-saving benefits. One method of accelerated curing i.e., boiling water curing at 100°C has been used to accelerate the strength gain of concrete. This project work deals with mechanical and durability characteristics of CCA replaced concrete. The micro analysis tests Energy dispersive x-ray spectroscopy analysis (EDAX) were also conducted. From the results, it was inferred that the CCA replaced concrete yielded considerable increase in both strength and durability properties when compared to control concrete. It was found that replacement of cement by CCA at 8% gives the optimum strength under accelerated curing than normal water curing.*

Key words:- Corn cob ash, Accelerated curing.

1.Introduction:-

Cement is a powdered material which develops strong adhesive qualities when combined with water. Cement is the second most consumed commodity in the world after water. Increasing demand for cement is expected to be met by partial cement replacement. Finding new alternative affordable and sustainable products is a trend already well-established among the research community worldwide. People are also much more concerned about reusing, recycling and saving environmental issues The present world economic crisis also requires contention and new affordable and sustainable products are desirable. On the other hand, the quality of these products also has to be guaranteed. Affordability, sustainability and quality are therefore the three main vectors which should dictate the design of such product.Using organic materials and low technological processes are a good option to achieve the above requirements.

1.1CORN COB ASH

Corn cob is the hard thick cylindrical central core of maize and it is anagricultural waste product obtained from maize or corn. The maize production in India has shown impressive growth over the years. As per government data, India produced 22.25 million tonnes of maize in 2013-2014 and the output kept increasing with the country producing 23.49 million tonnes in 2014-2015 and 24.56 million tonnes in 2015-2016. The maize production for 2017 was 25.00 million tonnes. The waste products which possess pozzolanic properties and which have been studied for use in blended of corn cob ash. In an attempt to convert waste product into useful material for the construction industry, this research

Figure - 1.1 Corn cob

considered the use of corn cob ash (CCA) as a pozzolana in cement production and was undertaken to determine the optimum replacement of OPC with CCA. Using waste by- products in the manufacture of construction materials has two-fold benefits. The cost of the material is reduced and the burden of the disposal of the waste is decreased. The ready availability of corn cobs and local technology developed for CCA production make it an attractive solution for solving the high cost problem of building and construction materials. Corn cob ash (CCA) is a suitable material for use as a pozzolana, since it satisfies the requirement for such a material by having combined SiO_2 and Al_2O_3 of more than 70%. The CCA-blended cement satisfied BS 12:1991, ASTM C 150:1994 and NIS 439:2000 requirements especially at lower level of CCA substitution.

1.2ACCELERATED CURING

Curing is the process of controlling the rate and extent of moisture loss from concrete during cement hydration. In order to obtain good quality of concrete, the standard strength tests, which are based on keeping the concrete immersed in water at room temperature for 28 days, have been carried out. The weak point of this method is the necessity of delaying the determination of test results for 28 days. This period is too long in today's concreting technology and therefore, more rapid methods of determining the potential strength of concrete have been investigated. In maturity concept of concrete, both the duration time and temperature of curing are important factors, and for this reason, increasing the temperature of concrete gives the opportunity of determining the strength at early ages, which is the basic approach of accelerated curing methods. In this method of curing the temperature of water is increased, which results in increase in concrete temperature and rate of development of strength accelerates which will be more comparing to normal moist curing. It predicts that 28 days compressive strength within 28 hours. IS- 9013 evolved a standard method of determining compressive strength

2. MATERIALS USED:-

2.1CEMENT

Ordinary Portland cement of 53 grade is used.

2.2FINE AGGREGATE

Manufactured sand (M-Sand) has been used as fine aggregate in this study.

2.3COARSE AGGREGATE

The local availability of quarry stones or granite stones are used as coarse aggregate in this study.

2.4WATER

Portable water conforming to the requirements of water for concreting and curing as per IS: 456-2000.

2.5CORN COB ASH

The corn cobs were collected from nearby villages. They were burnt in open air. The burning was continuous, with the temperature increasing to 650°C.

3. MATERIALS TEST FOR CONCRETE

Material	Cement	M-Sand	Coarse Aggregate	Corn cob Ash
Specific Gravity	3.15	2.63	2.55	2.35

4. MIX DESIGN

The mix proportion for M30 grade concrete is 1:1.39:2.52 at 0.45 W/C ratio have been used.

5. STRENGTH TEST

5.1COMPRESSIVE STRENGH

Compressive strength tests for mortar cubes and concrete cubes by normal water curing and by accelerated curing were carried out for conventional concrete and cube specimens prepared with replacement of cement by corn cob ash in various proportions. Test results were experimented at 28 days curing period for normal water curing and 3.30 hours curing period for accelerated curing. Replacement proportion varies from 2%, 4%, 6%, 7%, 8%, 9% and 10% for mortar cubes. Compressive strength tests for concrete cubes were conducted for optimum replacement proportion of cement by corn cob ash respectively. Table 5.1.1 and 5.1.2 show the compressive strength of mortar and concrete cubes for 28 days of normal water curing and 3.30hours of accelerated curing.

Specimen details	Compressive Strength N/mm²	
	Normal water Curing	Accelerated curing
CCA0	53.29	54.16
CCA2	53.46	54.32
CCA4	53.91	54.76
CCA6	54.58	55.33
CCA7	54.83	55.91
CCA8	55.27	56.74
CCA9	54.25	55.41
CCA10	53.05	54.10

Table 5.1.1 Compressive Strength of Mortar Cubes

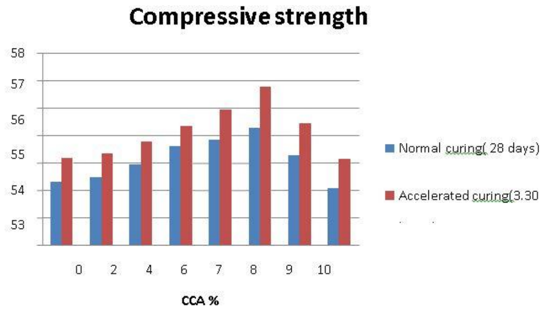

Figure 5.1.1 Compressive strength of mortar cubes

Specimen details	Compressive strength (N/mm²)	
	Normal water curing	Accelerated curing
CCA0	35.16	36.25
CCA8	36.84	37.98

Table 5.1.2 Compressive strength of concrete cubes

From table 5.1.1 and figure 5.1.1 it is found that, for CCA replaced mortar cube maximum strength of 56.74N/mm² is achieved in the mix CCA8 under accelerated curing.

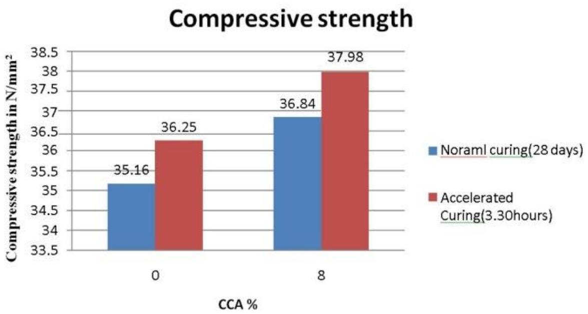

Figure 5.1.2 Compressive strength of concrete cubes

At accelerated curing, strength attainment of CCA replaced mortar cube is more than that of control mortar cube. i.e., 4.76% of increase in strength is observed in the mix CCA From the table 5.1.2 and figure 5.1.2 it is found that, the CCA replaced concrete cubes under accelerated curing at 100°C has yielded maximum compressive strength than normal water curing. At accelerated curing, increase in compressive strength of 5.07% is achieved for mix CCA8 when compared to conventional concrete. At normal water curing, increase in compressive strength of 4.77% is achieved when compared to conventional concrete.

5.2 FLEXURAL STRENGTH OF BEAM

The 28 days flexural strength test of the concrete were carried out for control concrete beam and beam prepared with 8% CCA replaced concrete.

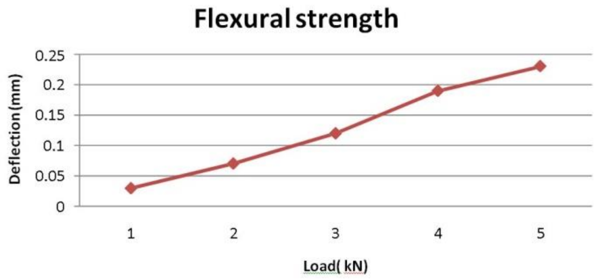

Figure 5.2.1 Load Vs Deflection for control

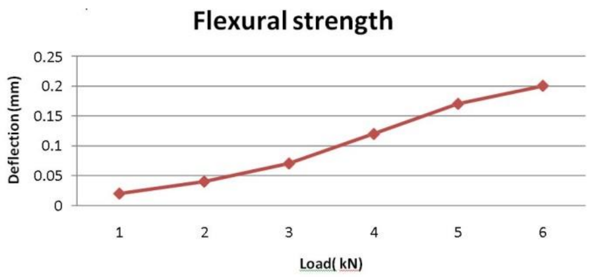

Figure 5.2.2 Load Vs Deflection for 8% of CCA

From figure 5.2.1 and 5.2.2, it is found that the flexural strength of control concrete and 8% CCA replaced concrete is obtained as 3.75 N/mm^2 and 4.5 N/mm^2.The CCA replaced concrete shows higher flexural strength than control concrete.

6. DURABILITY TEST

6.1WATER ABSORPTION TEST

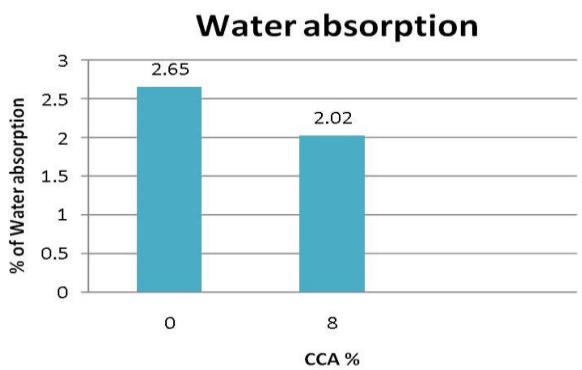

Figure 6.1.1 CCA % replacement Vs % of water absorption

From figure 6.1.1, it has been found that lower water absorption occur at 8% CCA replacement when compared to control concrete.

6.2SORPTIVITY TEST

From figure 6.2.1, it has been found that lower sorptivity occur at 8% CCA replacement when compared to control concrete.

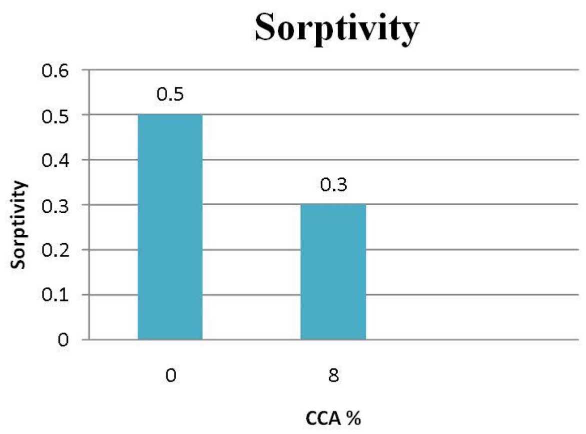

Figure 6.2.1 CCA % replacement Vs Sorptivity

6.3ACID ATTACK TEST

After normal curing the cubes were air dried for 24 hours and their initial weight was taken. Afterwards, the cubes were immersed in curing tanks containing 5% concentrated sulphuric acid. The cubes are kept in these tanks for 30days after which the cubes were taken out again air dried for 24 hours and weighed for final weight. Table 6.7 show the results of the reaction of CCA blended mortar specimens with H2SO4 acid water.

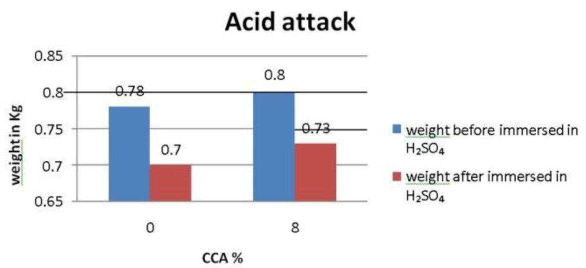

Fig 6.3.1 Acid attack test

From Figure 6.3.1 shows that the Percentage losses due to deterioration of H_2SO_4 is less in 8% CCA replaced concrete compared to the controlconcrete.

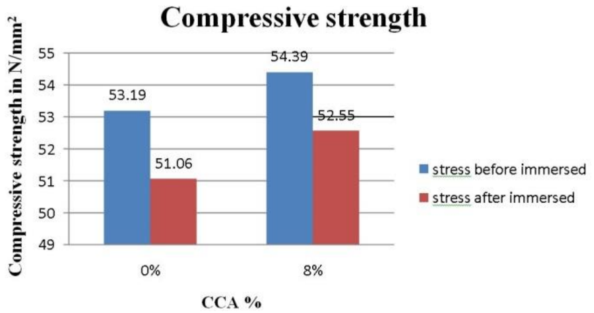

Figure 6.3.2 Compressive strength of cubes

From figure 6.3.2, it is found that the compressive strength of 8% CCA replaced concrete and control concrete shows decreased compressive strengths after immersion in H_2SO_4. The difference in strength before and after immersion in H_2SO_4 solution for control concrete is 2.13 N/mm^2 and it was 1.84 N/mm^2 for CC8 concrete. The difference is not so significant in all the cases and even after immersion in H_2SO_4 solution CCA replaced concrete shows higher compressive strength than control concrete.

7. ENERGY DISPERSIVE X-RAY SPECTROSCOPY ANALYSIS

Energy-dispersive X-ray spectroscopy is an analytical technique used for the elemental analysis or chemical characterization of a sample. The chemical characterization of sample was given below.

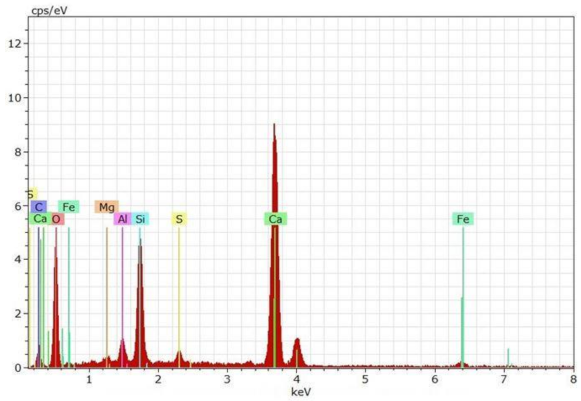

Figure 7.1 Sum spectrum of control concrete

Element	Weight %	Atomic %
O K	51.68	64.94
Ca K	29.50	14.80
C K	7.56	12.65
Si K	6.96	4.98
Al K	1.18	0.85

Table 7.1 Elements found in EDS Analysis of control concrete

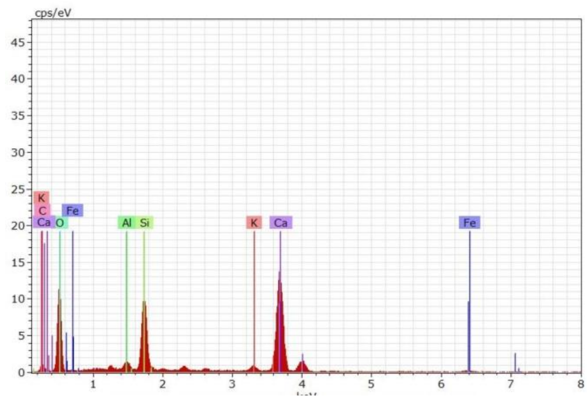

Figure 7.2 Sum spectrum of CCA replaced concrete

Element	Weight %	Atomic %
O K	60.27	73.76
Ca K	24.42	11.93
C K	4.33	7.07
Si K	8.07	5.63
Al K	1.62	1.21

Table 7.2 Elements found in EDS Analysis of CCA replaced concrete

Concrete replaced with 8% CCA contains lower calcium content and higher silica and alumina contents. Lower calcium content indicates the conversion of calcium hydroxide to hydrated calcium silicate. They create better packing between the particles and reduce the porosity. Because of this, the strength and durability characteristics are improved.

8. Conclusions

- Test results indicated that, higher strength was obtained from accelerated curingwhen compared with specimens subjected to normal curing.
- The optimum level of CCA replaced cement from structural load view point is 8%.
- At accelerated curing, increase in compressive strength of 5.07% is achieved when compared to conventional concrete. At normal water curing, increase in compressive strength of 4.77% is achieved when compared to conventional concrete.
- The percentage decrease in water absorption is found to be 2.65% for CCA0 and 2.02% for CCA8 and sorptivity is found to be 0.5 $mm/min^{0.5}$ for CCA0 and 0.3 $mm/min^{0.5}$ for CCA8.
- The maximum percentage reduction in weight obtained for control mortar cube is 11% and for CCA replaced mortar cube is 9.5%.
- The maximum percentage of reduction in strength obtained for control mortar cube is 4% and for CCA replaced mortar cube is 3.5%
- The resistance of the mortar cubes to chemical attack was improved for CCA replaced cube when compared to control cubes, caused a decrease in permeability and reduction in weight loss due to reaction of the specimens with H_2SO_4 acid water.
- It has been observed that there is an increase in flexural strength of 8% CCA replaced concrete as compared to normal concrete.
- From EDAX test, it can be concluded that CCA replaced concrete shows lower calcium content which indicates the conversion of calcium hydroxide to hydrated calcium silicate. They create better packing between the particles and reduce the porosity. Because of this, the strength and durability characteristics are improved.

9. SCOPE OF FUTURE WORK

- Further studies can be done on 0 – 50% replacement of cement with corn cobash
- Concrete with CCA as partial replacement for cement can be allowed to cure for 120 days, by which pozzolanic activity of ashes would have been concluded.
- Corrosion studies in Corn cob ash replaced concrete have been planned.

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