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Effect of Corn Husk Ash on Compressive Strength of Concrete

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ABSTRACT

Concrete usage has increased rapidly over the past few decades. It is no longer made of only aggregates, cement and water. Admixtures are added to the concrete to increase the workability, durability, strength and various other properties as required. Natural organic materials can replace the existing admixtures of concrete keeping in view the environmental aspects. The objective of this paper is to analyse the effect of Corn Husk Ash which is a natural organic material on the compressive strength of M30 grade concrete.

Key words: Corn husk, Cement, Concrete.

1. INTRODUCTION

Concrete has posed challenges to architects, engineers, researchers and constructors all throughout the years. Replacement of Ordinary Portland Cement by Pozzolana Portland Cement is more efficient in terms in mass construction. Replacement of Pozzolana Portland Cement by mineral admixtures (slag, silica fume) shows more efficiency in terms of both economy & strength. Industrialization in developing countries has resulted in an increase in agricultural output and consequent accumulation of unmanageable agro wastes. Pollution arising from wastes is a cause of concern. Using Corn Husk Ash in its natural form may lead to a cheaper concrete. This results in the decrease in cost of construction. Corn husk can be burnt into ash that fulfils the physical characteristics and chemical composition of mineral admixtures. Suitable incinerator/furnace as well as grinding method is required for burning and grinding rice husk in order to obtain good quality ash. The effect of partial replacement of cement with different percentages of ground Corn Husk Ash on the compressive strength and durability of concrete is examined.

2. MATERIALS

Materials used in this experiment are cement, fine aggregate, coarse aggregate, admixture (corn husk ash), and water. The cement used in this research work is Ordinary Portland Cement of 53 Grade. Cement was tested for its suitability according to IS 12269:1999. The various properties of the cement are shown in Table 1.

Sand used in this research work is M-Sand(Manufactured Sand). Advantages of M-sand are as below:

- We can create large amounts of sand to a specific quality as suitable for construction.
- It doesn't contain impurities such as silt and clay and therefore it is stronger than sand from riverbed.
- It helps the environment (we do not have to scrape the natural landscapes)
- It does not contain organic compounds.

The sieve analysis of Fine Aggregate is shown in Table 2. The sand used in this experiment falls in Grading zone 2, as per IS: 83:1970.

3. OBSERVATIONS

Table 1 Properties of Cement

Test Parameter	Value	Permissible range as per IS12269-1999
Specific gravity	3.15	3.10-3.15
Blaine Fineness(m2/kg)	307	225

Normal consistrncy(%)	32	30-35
Initial Setting Time(min)	62	30
Final Setting Time(min)	260	600
Soundness of Cement (Le Chatlier expansion value in mm)	2	10
Compressive Strength (Mpa)		
7 days	37	
28 days	58	53

Table 2 Sieve analysis of fine aggregate and zones as per IS383-1970

Sieve size (mm)	Passing (%)	(%) Passing Zones As per IS: 383:1970		
		1	2	3
10	100	100	100	100
4.75	98.5	90-100	90-100	90-100
2.36	95.5	60-95	75-100	85-100
1.18	87.5	30-70	55-90	75-100
0.600	54	15-34	35-59	60-79
0.300	8	5-20	8-30	12-40

The properties of Fine Aggregate are shown in Tables 3.

Table 3 Properties of fine aggregate

Properties	Values
Fineness Modulus	2.5
Specific Gravity	2.66
Bulk Density	1614

The sieve analysis and properties of Coarse Aggregate are shown in Table 4 and Table 5 respectively.

Table 4 Sieve analysis of coarse aggregate

Sieve Size (mm)	Percentage Passing (20mm and down)
20	100
12.5	95
10	86
6.3	70
4.75	18
2.36	4.5

Table 5 Properties of coarse aggregate

Properties	Values
Fineness Modulus	6.7
Specific Gravity	2.68
Water Absorption (%)	0.4
Bulk Density (kg/m3)	1810

The properties of Corn Husk Ash are tabulated and shown in Table 6 below:

Table 6 Properties of Corn Husk Ash

Properties	Values
Silicon Dioxide(SiO2)	96%
Aluminium Oxide(Al2O3)	0.17%
Ferric Oxide(Fe2O3)	0.18%

Calcium Oxide(CaO)	0.60%
Magnesium Oxide(MgO)	0.39%
Sulphur Trioxide(SO3)	0.26%
Carbon (C)	6.5%

The mix design proportions of concrete of grades M30 and M35 are shown in Table 7 and Table 8 respectively:

Table 7 Mix Proportions for M30 grade concrete

Mix designation	AC	BR1	BR2	BR3	BR4
Corn Husk Ash(%)	0	5.5	11	16.5	22
w/c ratio	0.47	0.47	0.47	0.47	0.47
Cement(kg/m3)	462	48.9	415.8	392.7	369.6
Corn Husk Ash(kg/m2)	0	23.1	46.2	69.3	92.4
M-sand(kg/m2)	683.76	640.39	597.16	553.94	510.71
Coarse Aggregate(kg/m2)	1219.68	1219.68	1219.68	1219.68	1219.68
Water(lit/m3)	198.66	198.66	198.66	198.66	198.66

Table 8 Mix Proportions for M35 grade concrete

Mix designation	CC	DR1	DR2	DR3	DR4
Corn Husk Ash(%)	0	6.3	12.65	18.97	25.3
w/c ratio	0.54	0.54	0.54	0.54	0.54
Cement(kg/m3)	531.3	504.3	478.17	451.60	425.04
Corn Husk Ash(kg/m2)	0	26.5	53.13	79.6	13.86
M-sand(kg/m2)	785017	736.44	686.73	637.03	587.31
Coarse Aggregate(kg/m2)	1042.63	1042.63	1042.63	1042.63	1042.63

Water(lit/m3)	228.45	228.45	228.45	228.45	228.45

The total numbers of specimens used for the experiment are 110. The distribution of these specimens as cube's, cylinders and beam's are stated below:

Table 9 Number of Specimens

Specimen Type	Number
Cubes 150*150*150mm	60
Cylinders 150*300mm	30
Beams 150*150*500mm	20

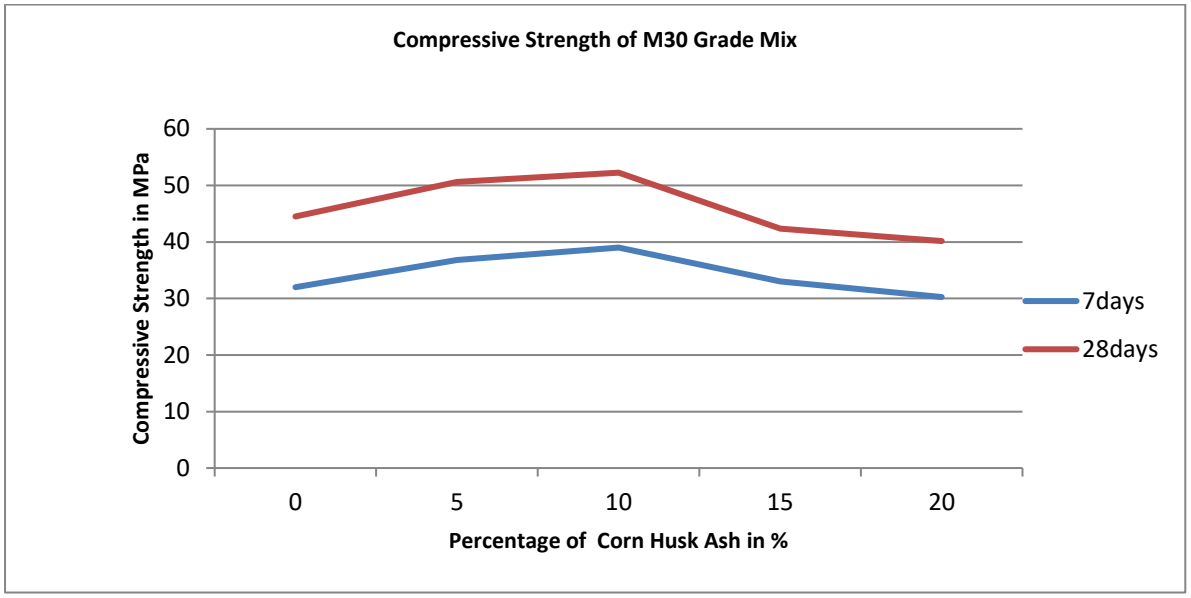
4. RESULTS AND DISCUSSIONS

This results of various test conducted on both fresh as well as hardened concrete. Relationship developed between percentage of Corn Husk Ash added, compressive strength of different mixes. The tests for compressive strength of concrete were conducted for different concrete mixes i.e. M30 and M35 grade with different rice hush ash content i.e. 0%, 5%, 10%, 15%and 20% at the selected age i.e. 7 days and 28days. The results are complied in the Table 10 and Table 11 given below.

Table 10 Compressive Strength of M30 Grade Corn Hus Ash Concrete

Mix Designation	Percentage of Corn Husk Ash (%)	Compressive Strength in MPa for	
		7days	28days
AC	0	32	44.5
BR1	5	36.8	50.6
BR2	10	39	52.25
BR3	15	31	42.35
BR4	20	30.25	40.15

Representation in the form of a Graph gives a clear picture of the increase or decrease in Compressive strength. Graphs were plotted between percentage of Corn Husk Ash added (i.e. 0%, 5%, 10%, 15% and 20%) and Compressive Strength for ages of 7 days and 28 days.

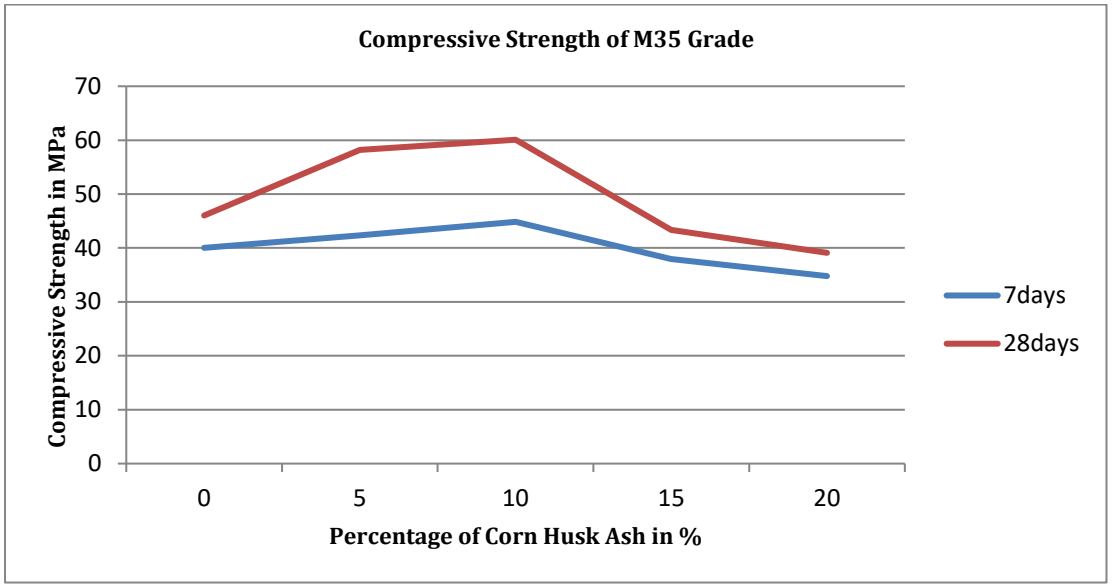


X-Axis represents: % of Corn Husk Ash; Y-Axis represents: Compressive Strength of Concrete

Table 11 Compressive Strength of M35 Grade Corn Husk Ash Concrete

Mix Designation	Percentage of Corn Husk Ash (%)	Compressive Strength in MPa for	
		7days	28days
CC	0	40	46
DR1	5	42.32	58.19
DR2	10	44.85	60.08
DR3	15	37.95	43.33
DR4	20	34.78	39.1

Representation in the form of a Graph gives a clear picture of the increase or decrease in Compressive strength. Graphs were plotted between percentage of Corn Husk Ash added (i.e. 0%, 5%, 10%, 15% and 20%) and Compressive Strength for ages of 7 days and 28 days.



X-Axis represents: % of Corn Husk Ash; Y-Axis represents: Compressive Strength of Concrete

5. CONCLUSIONS

Effect of corn husk ash on compressive strength:

Replacement of cement by corn husk ash in M30 and M35 grade concrete compressive strength showed varied results for both M30 and M35 Grade concretes.

For M30 Grade Concrete:

1. For 5% of Corn Husk Ash added the compressive strength at 7days increased by 15%, while compressive strength for 28 days increased by 13.7%.
2. For 10% of Corn Husk Ash added the compressive strength at 7 days increased by 21.8%, while for 28 days the compressive strength has increased by 17.4%.
3. For 15% of Corn Husk Ash added the compressive strength at 7days decreased by 3.1%, while compressive strength for 28 days decreased by 4.8%.
4. For 20% of Corn Husk Ash added the compressive strength at 7 days decreased by 5.4%, while for 28 days the compressive strength has decreased by 9.7%.

For M35 Grade Concrete:

1. For 5% of Corn Husk Ash added the compressive strength at 7days increased by 5.8%, while compressive strength for 28 days increased by 26.5%.
2. For 10% of Corn Husk Ash added the compressive strength at 7 days increased by 12.1%, while for 28 days the compressive strength has increased by 30.6%.
3. For 15% of Corn Husk Ash added the compressive strength at 7days decreased by 5.1%, while compressive strength for 28 days increased by 5.8%.
4. For 20% of Corn Husk Ash added the compressive strength at 7 days decreased by 13.05%, while for 28 days the compressive strength has increased by 15%.

FUTURE ISSUES

An extended research is required to establish the long-term durability of concrete containing mineral admixtures. The microstructure properties of concrete are needed to be further researched. New levels of replacement of cement can be researched. Tests relating to durability aspect such as water permeability, resistance to chloride, corrosion of reinforcement, resistance to sulphate attack, durability in marine environment etc. need further investigations.

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