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RESEARCH ARTICLE

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A STUDY ON THE BEHAVIOUR OF CEMENT CONCRETE WITH PARTIAL REPLACEMENT OF CEMENT WITH BAGASSE ASH

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ABSTRACT

This project presents the behavior of cement concrete with partial replacement of cement by bagasse ash. Bagasse ash is a by-product of sugar/ethanol agro-industry abundantly available in some regions of the world and has cementitious properties indicating that it can be used together with cement. Totally five cube specimens were tested. Two specimens were tested with 25% and 30% of fly ash, two specimens were tested with 25% and 30% of bagasse ash and the results are compared with control specimen.

INTRODUCTION

Concrete is an artificial material obtained by cementing together fine and coarse aggregate using binding material .cement is used as a binding material in cement concrete .Cement and water react chemically and bind the fine and coarse together. In addition to the above material steel is used as reinforcement in reinforced cement concrete.

Concrete mixes are designed by grades based on their characteristic compressive strength as M20, M25, and M30 etc. Grade M20 concrete means the characteristic strength of 150mm size cubes cast out of concrete is 20N/mm^2 at 28 days curing.

FLY ASH

Fly ash, also known as "pulverised fuel ash" is one of the coal combustion products, composed of the fine particles that are driven out of the boiler with the flue gases. Ash that falls in the bottom of the boiler is called bottom ash. In modern coal-fired power plants, fly ash is generally captured by electrostatic precipitators or other particle filtration equipment before the flue gases reach the chimneys. Together with bottom ash removed from the bottom of the boiler, it is known as coal ash. Depending upon the source and makeup of the coal being burned, the components of fly ash vary considerably, but all fly ash includes substantial amounts of silicon dioxide (SiO_2) (both amorphous and crystalline), aluminiumoxide (Al_2O_3) and calcium oxide (CaO), the main mineral compounds in coal-bearing rock strata.

Bagasse ash

Researchers all over the world today are focusing on ways of utilizing either industrial or agricultural wastes as a source of raw materials for the industry. These wastes utilization would not only be economical, but may also result to foreign exchange earnings and environmental pollution control. Currently, many countries are using pozzolanic materials in concrete structures for improving compressive strength and reducing the cost of concrete .many pozzolanic materials such as fly ash, silica fume, rice husk, palm oil fuel ash, etc., have been improved and used to replace cement in concrete .There is the additional bonus that these materials are waste products to begin with which would otherwise incur a disposal or environmental cost. By incorporating pozzolanic materials into concrete is also adding value to these products.

Bagasse is the matted cellulose fiber residue from sugar cane that has been processed in a sugar mill. Previously, bagasse was burnt as a means of solid waste disposal. However, as the cost of fuel oil, natural gas, and electricity has increased, bagasse has come to be regarded as a fuel rather than refuse in the sugar mills. Environment reports states that 1 ton of sugarcane generates 280 Kg of bagasse , and that based on economics as well as environmental related issues i.e. utilization , storage and disposal. Different avenues of bagasse utilization are more or less known but none of them have so far proved to be economically viable or commercially feasible. Hence, the objective of this present work is to characterize the bagasse in order to explore it use in the metallurgical and materials industry and make it commercially feasible.

REVIEW

Sugarcane bagasse ash is a byproduct of sugar factories found after burning sugarcane bagasse which itself is found after the extraction of all economical sugar from sugarcane. The disposal of this material is already causing environmental problems around the sugar factories. The bagasse ash was then ground until the particles passing the 63 μm sieve size reach about 85% and the specific surface area about 4716 cm^2/gm. Ordinary Portland cement and Portland Pozzolana cement were replaced by ground bagasse ash at different percentage ratios .Normal consistency and setting time of the pastes containing Ordinary Portland cement and bagasse ash from 25 and 30% replacement were investigated. Different concrete mixes with bagasse ash replacements of 25% and 30% of the Ordinary Portland cement were prepared with water to cement ratio of 0.45 and cement content of 370kg/m3 for the control mix. The test results indicated that upto 10% replacement of cement by bagasse ash results in better or similar concrete properties and further environmental and economical advantages can also be exploited by using bagasse ash as a partial cement replacement material

CONCRETE MIX DESIGN

a) Design stipulations

Characteristic compressive strength
Required in the field at 28 days = 30 N/mm^2
Maximum size of aggregate = 20 mm
Degree of workability = 100-150mm (slump)
Degree of quality control = Good
Type of exposure= Mild

b) Test data for materials

Cement used –Ordinary Portland cement(53 grade)
Specific gravity of cement =3.15
Specific gravity of fine aggregate =2.65
Specific gravity of coarse aggregate =2.71
Specific gravity of bagasse ash =2.2

c) Target strength

$F'_{ck}=f_{ck} +1.65\ s$

Where,

f_{ck}= Target average compressive strength at 28 days
f_{ck}= Characteristic compressive strength at 28 days
s=standard deviation
From table 1 standard deviation

s=5N/mm^2

f_{ck} =30+1.65*5

=38.25N/mm^2

d) Selection of water cement ratio

From table 5 of IS 456-2000

Maximum water cement ratio=0.55

Based on experience adopt water cement ratio as 0.45 as the cement is 53 grade

0.45< or =0.55

Hence ok.

e) **Selection of water content** Maximum water content=186 liters

Estimated water content =197 liters

Based on the trails with super plasticizer (0.8% BWC) water content reduction of 30% has been achieved. Hence, the arrived water content =197 x 0.85 =167 liters

f) **Calculation of cement content**

Water content ratio=0.45

Cement content=167/0.45

=370Kg/m^3

From table 5 of IS 456 minimum cement content for moderate exposure condition is = 300kg/m^3

Hence ok.

g) **Proportion of volume of coarse aggregate and fine aggregate content**

From table 3 volume of coarse aggregate corresponding to 20mm size aggregate and fine aggregate(zone 1) for water cement ratio of 0.50=0.60

Modify this as W/C is 0.45

The new value is 0.61 volume of fine aggregate is 0.39

h) **Mix calculations**

1) Volume of concrete=1m^3

2) Volume of cement=mass of cement/specific gravity of cement*1/1000

= (370/3.15)*1/1000

=0.118 m3

Volume of water= (167/1)*(1/1000)

=0.167m^3

Volume of super plasticizer = (2.96/1.14)*(1/1000)

=0.003m^3

Volume of air-entrapped = 0.002m^3

Volume of all in aggregate

=1-(0.118+0.167+0.003+0.002)

=0.710m^3

Volume of coarse aggregate=e*volume of CA*specific gravity of CA

=0.710*0.61*2.71*1000

=1174 kg

Volume of fine aggregate =e*volume of FA*specific gravity of FA

=0.710*0.39*2.65*1000

=735 kg

Mix proportion of trial number:

Cement=370kg/m^3

Water=167kg/m^3

Fine aggregate=735kg/m^3

Coarse aggregate=1174kg/m^3

Super plasticizer =2.96kg/m^3

Mix Ratio

Water	Cement	Fine Aggregate	Coarse Aggregate
0.45	1	1.98	3.17

Comparison of plain concrete and (fly / baggase ash) concrete

Sl.No	ID	Water (lit)	Cement (kgs)	F.A (kg)	Coarse aggregate (kg)	Admixture (0.8% BWC)	Fly ash (kg)	Baggase ash (kg)
1	TM-1	167	370	735	1174	2.96		
2	TM-2	167	310	715	1142	3.3	100	
3	TM-3	167	285	713	1140	3.3	125	
4	TM-4	167	310	705	1130	3.3		100
5	TM-5	167	285	700	1125	3.3		125

EXPERIMENTAL WORK

It was proposed to investigate the behavior of concrete as partial replacement of cement with fly ash in concrete and baggase ash replaced cement in concrete it is compared with the conventional concrete mix

Characteristics of cement

S.NO	Characteristics	Values obtained	Standard values
1	Normal consistency	29.5% (34mm)	33 to 35 mm
2	Initial setting time	210min	Not be less than 30mins
3	Final setting time	295min	Not be greater than 600min
4	Specific gravity	3.15	3.12 to 3.19

Characteristics of Sand

S.NO	CHARACTERISTICS	VALUE
1	Specific gravity	2.65
2	Fineness modulus	3.16
3	Bulk density	1709.7 kg/cum

Characteristics of coarse aggregates

S.NO	CHARACTERISTICS	VALUE
1	Specific gravity	2.71
2	Bulk density	1487.64 kg/cum

Chemical properties of Baggage ash

Compound	Bagasse ash	Ordinary Portland cement
SiO_2	78.34	20.85
Al_2O_3	8.55	4.23
Fe_2O_3	3.61	5.25
CaO	2.15	63.49
Na_2O	0.12	0.16
K_2O	3.46	0.4
P_2O_5	1.07	-
Loss on ignition	0.42	1.05

Workability test on concrete

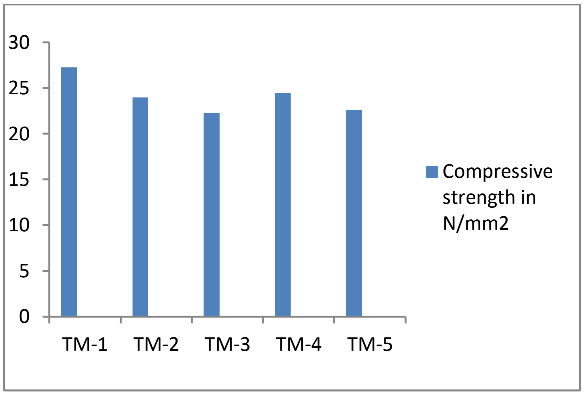
Result obtains from slump test show that the workability of concrete is 110mm

COMPRESSIVE STRENGTH OF CONCRETE TEST

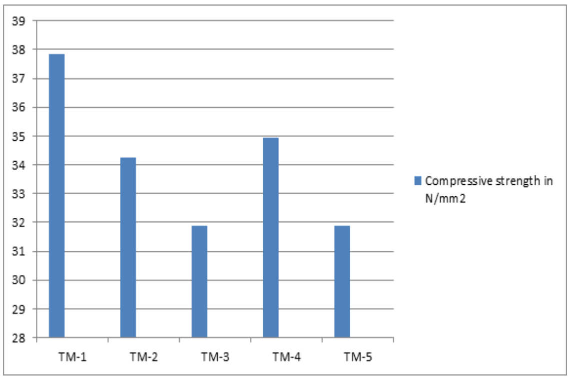
These results are obtained by testing the total 5 specimens for 7 days, and 28 days and by considering the average of the test results and that are tabulated in table

Compressive strength of fly ash, baggase ash concrete cubes

Compression Test For Cubes			
ID	Description	Compressive strength in N/mm^2	
		7 Day	28 Days
TM-1	Fly ash 0%,Bagasse ash 0%	27.25	37.85
TM-2	Fly ash 25%,bagasse ash 0%	23.97	34.25
TM-3	Fly ash 30%,bagassea ash 0%	22.3	31.87
TM-4	Fly ash 0%,bagassea ash 25%	24.46	34.95
TM-5	Fly ash 0%,bagassea ash 30%	22.61	32.3



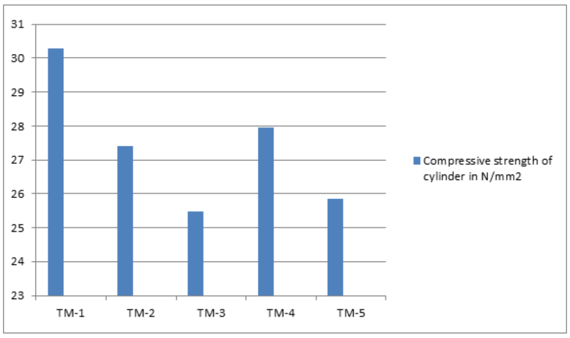
Compressive Strength of Cube Specimen at 7 Days



Compressive Strength of Cube Specimen at 28 Days

Compressive strength of concrete cylinders

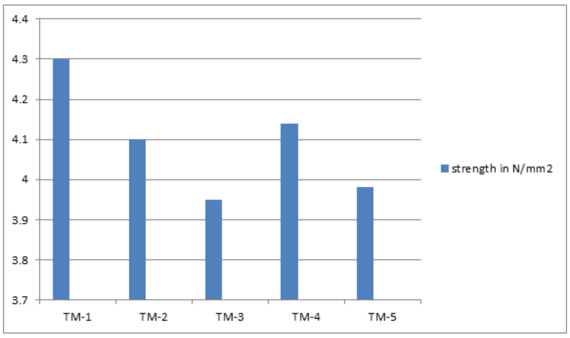
Compression Test For Cylinder		
Mix ID	Description	Compressive strength in N/mm² 28th Day
1	TM-1	30.28
2	TM-2	27.4
3	TM-3	25.49
4	TM-4	27.96
5	TM-5	25.84



Compressive Strength of Cylinder Specimen at 28 Days

Flexure test For Beams		
Sl.No	Mix ID	strength in N/mm² 28th Day
1	TM-1	4.3
2	TM-2	4.1
3	TM-3	3.95
4	TM-4	4.14
5	TM-5	3.98

Flexural Strength



Flexural Strength of beam Specimen at 28 days

CONCLUSION

- The specimen which was replaced cement with bagasse ash for 25% has the same and equal load carrying capacity when compared to cement with fly ash and it can be used in the construction industries.
- Here we can observe that the specimens which was replaced cement with 25% and 30% of bagasse ash has the same and equal load carrying capacity when compared with the specimens replaced with 25%and 30% of fly ash.
- By using bagasse ash the emission of CO2 is reduced.
- By comparing the results baggase ash replaced by cement get better results than fly ash replaced by cement
- By using ash products the volume of Fly Ash produced from coal-based thermal power plants may bring several problems from environmental point of view. Fly Ash particles ranging in size from 0.5 to 300 micron in equivalent diameter, being light weight, have potential to get airborne easily and pollute the environment. If not managed properly Fly Ash disposal in sea/rivers/ponds can cause damage to aquatic life also. Slurry disposal lagoons/ settling tanks can become breeding grounds for mosquitoes and bacteria. It can also contaminate the under-ground water resources with traces of toxic metals present in Fly Ash. Huge investments/ expenditures are made just to get Fly Ash out from the thermal power plants and dump it in the ponds can be reduced

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