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Experimental Study on Fly Ash Concrete Blended With Palm Jaggery

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ABSTRACT: FlyAsh is a waste product generated by coal burning power plants. It has been used for land filling. However in places where regulations preventing atmospheric pollution do not exist, it is billowed into the atmosphere. Fortunately the discovery made several years back that fly ash can be used as a partial replacement for cement in concrete. Fly Ash concrete is a special type of concrete used to increase the workability and to reduce water consumption. Few decades ago, palm jaggery was found to be an additive material. In this experimental investigation, an attempt has been made on fly ash concrete by addition of palm jaggery to modify its properties. In this investigation we take ordinary Portland cement 70% and fly ash 30% as cementitious materials. Palm jaggery was replaced to fly ash by 0%, 5%, 10%, 15% and 20, that means 1.5%, 3.0%, 4.5%, 6.0% of concrete quantity.

KEYWORDS: Fly ash, concrete, Palm jaggery.

I. INTRODUCTION

Environmental pollution is the major problem associated with rapid industrialization, urbanization and rise in living standards of people. Waste reduction and reuse have recently become the preferable methods in various technology. Fly ash is considered as a material of very low value, useful only for landfill. But its usefulness as pozzolonic additive to cement is an important discovery. Continuous research studies by various engineering research laboratories revealed its varied usefulness has on additive for enhancing the various qualities of concrete including its workability, strength and durability if handled and cared properly. Fly Ash is obtained as a waste product after undergoing several industrial processes in thermal power plants. Fly Ash is one of the waste materials which can have a promising future in construction industry. Concrete is one of the oldest manufactured construction materials used in the construction of various structures globally as well as the infrastructural development. Fly Ash concrete is a concrete which is made by coarse aggregate, fine aggregate and cement with medium of water. The increased demand for fly ash is to provide better workability and to reduce quantity of cement. Fly Ash content greater than 35% can be considered as high volume replacement or high blending. Palm jaggery is a natural product which has been used as cementitious material in ancient days. Therefore, in this project Palm jaggery has been added in Fly Ash concrete and thus the behavior and strength is investigated.

II. RELATED WORK

Previous studies reveal that the addition of fly ash in concrete resulted in great benefits such as reduction in heat of hydration, minimization of potential alkali aggregate reaction, significant reduction of steel corrosion, improvement in durability of concrete, reduction in cost etc. In addition, it improves the environment by contributing towards reduction of greenhouse gases. The objective of this investigation is to study the effect of palm jaggery fly ash concrete.

III. MATERIALS AND THEIR PROPORTIONS

CEMENT: The Cement used in the concrete is ordinary Portland cement 53 grade. The company name of the cement is Ultratech.

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Specific gravity of cement for sample 1 is as follows,

Empty weight of Le-Chateliars flask (W1)	=25 gram.
Weight of flask with dry cement (W2)	= 75 gram.
Weight of kerosene and cement with flask (W3)	=113.2 gram.
Weight of kerosene with flask (W4)	=70 gram.
Specific Gravity of Cement G	= $\frac{[(W2-W1)]}{[(W2-W1)-(W3-W4)0.79]}$
Specific gravity of cement	=3.15

Table 1 Initial Setting Time of cement

Sl.No	Penetration	Minutes
1	0	0
2	1	10
3	1	15
4	3	25
5	5	30

Initial Setting Time = 30 Minutes

Final Setting Time = 9.15 hours

FINE AGGREGATE : The fine aggregate which is taken from river is used to manufacture the concrete.

Specific Gravity

Specific Gravity of sample 1 is	
Empty weight of pycnometer (W1)	= 660 Gram
Weight of fineaggregate+pycnometer (W2)	= 1180 Gram
Weight of pycnometer+fineaggregate+water (W3)	= 1760 Gram
Weight of pycnometer+water (W4)	= 1430 Gram
Specific Gravity of Fine Aggregate G	= $\frac{(W2-W1)}{[(W2-W1)-(W3-W4)]}$ = 2.74

Fineness Modulus of Fine Aggregate

Table 2. Fineness Modulus of Fine Aggregate

IS Sieves	Empty weight of sieves	Retained weight of sieves	Retained weight of sand	Cumulative weight retained	Cumulative percentage weight retained	% Finer
4.75	365	395	30	30	3.0	97
2.36	245	265	20	50	5.0	95
1.18	360	505	145	195	19.5	80.5
1.00	360	530	170	365	36.5	63.5
600	300	420	120	485	48.5	57.5
300	320	690	370	855	85.5	14.5
150	310	450	140	995	99.5	0.5
pan	300	305	5	1000	100	0

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Fineness modulus is an index number which represents the mean size of the particles in sand.
It is equal to (Cumulative % sand retained / 100)

$$\begin{aligned} &= 397.5/100 = 3.975 \\ \text{Confirming Zone} &= \text{Zone 1 [As per IS 383-1970]} \end{aligned}$$

COARSE AGGREGATE :The fine aggregate which is taken from river is used to manufacture the concrete.

Specific Gravity

Specific Gravity of sample 1 is

$$\begin{aligned} \text{Empty weight of pyconometer (W1)} &= 660 \text{ Gram} \\ \text{Weight of coarse aggregate+pyconometer (W2)} &= 1330 \text{ Gram} \\ \text{Weight of pyconometer+coarse aggregate+water (W3)} &= 1850 \text{ Gram} \\ \text{Weight of pyconometer+water (W4)} &= 1430 \text{ Gram} \\ \text{Specific Gravity of Fine Aggregate G} &= \{(W2-W1)/[(W2-W1)-(W3-W4)]\} = 2.68 \end{aligned}$$

Water Absorption

$$\begin{aligned} \text{Weight of saturated surface dry sample (A)} &= 1009 \text{ g} \\ \text{Weight of oven dry sample (B)} &= 1005 \text{ g} \\ \text{Water absorption of Coarse Aggregate} &= \{[A-B]/B\} \times 100 \\ &= \{[1009-1005]/1005\} \times 100 \\ &= 0.49\% \end{aligned}$$

FLY ASH

Specific Gravity

$$\begin{aligned} \text{Weight of Flask, W1} &= 25 \text{ gms} \\ \text{Weight of Flask+Sample, W2} &= 75 \text{ gms} \\ \text{Weight of Flask+Sample+Kerosene, W3} &= 95 \text{ gms} \\ \text{Weight of Flask+Kerosene, W4} &= 70 \text{ gms} \\ \text{Specific Gravity, G} &= (W2-W1)/[(W2-W1)-(W3-W4)] \\ &= (75-25)/[(75-25)-(95-70)] = 0.79 \\ &= 1.650 \end{aligned}$$

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Chemical properties

Table 3 chemical properties of fly ash

SL.NO	Constituents	Percentage
1	SiO ₂ +Al ₂ O ₃ +Fe ₂ O ₃	94.25
2	Sulphur trioxide as SO	3 0.71
3	Sodium oxide as Na ₂ O	0.26
4	Loss On Ignition	0.38
5	Silica as SiO ₂	59.90
6	Alumina as Al ₂ O ₃	30.81
7	Iron as Fe ₂ O ₃	3.83
8	Reactive SiO ₂	30.01
9	Calcium oxide as CaO	1.94
10	Free CaO	Nil
11	Reactive CaO ₂	1.44
12	Chloride as Cl	0.009
13	Magnesium oxide as MgO	0.36
14	Manganese dioxide as MnO ₂ (mg/Kg)	12.38
15	Potassium oxide as K ₂ O (mg/Kg)	0.031

PALM JAGGERY

It is black and brown in colour
It is obtained from palm tree.
It provides more strength when added to mortar.

Specific Gravity

$$\begin{aligned}
 \text{Weight of Pycnometer, } W_1 &= 655 \text{ gms} \\
 \text{Weight of Pycnometer+Sample, } W_2 &= 920 \text{ gms} \\
 \text{Weight of Pycnometer+Sample, } W_3 &= 1590 \text{ gms} \\
 \text{Weight of Pycnometer+Water, } W_4 &= 1480 \text{ gms} \\
 \text{Specific Gravity, } G &= \frac{(W_2 - W_1)}{(W_2 - W_1) - (W_3 - W_4)} \\
 &= \frac{(920 - 655)}{(920 - 655) - (1590 - 1480)} \\
 &= 1.709
 \end{aligned}$$

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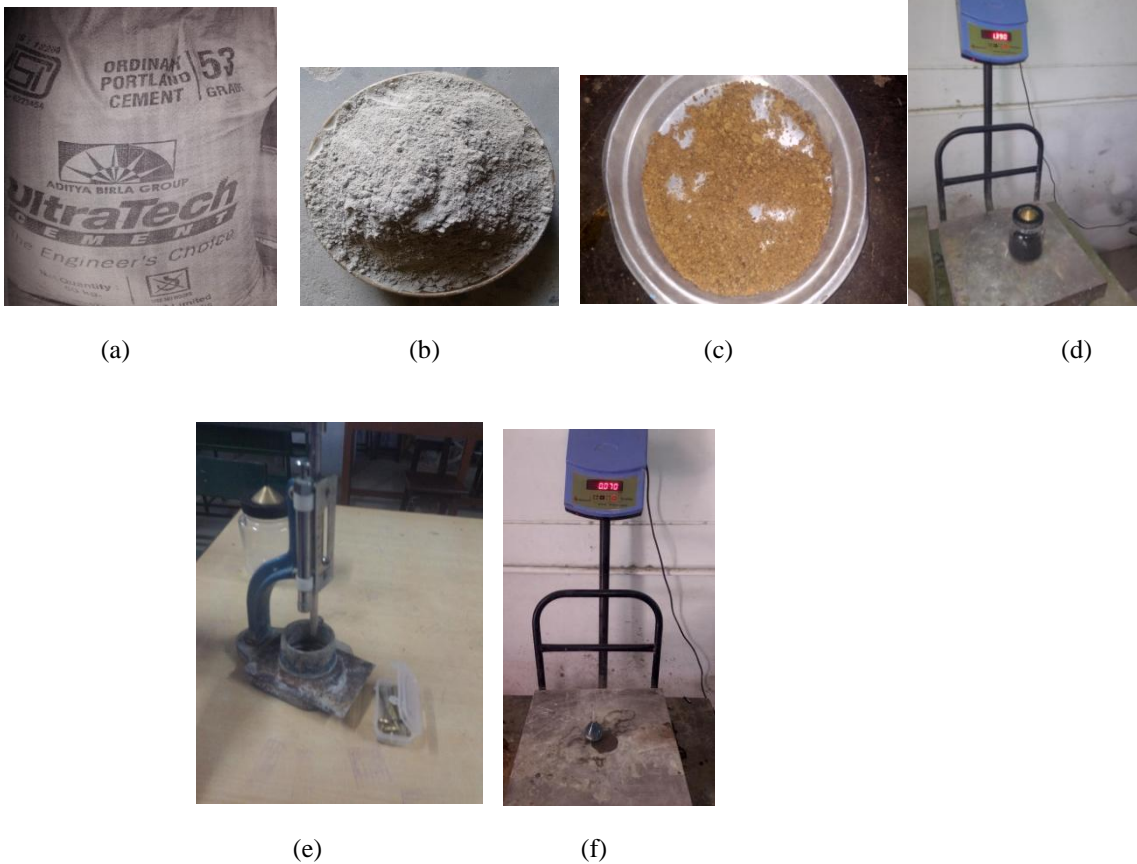


Fig.1 Materials and properties (a) cement (b) Fly ash (c) Palm jaggery (d) Pycnometer (e)Vicat Apparatus
(f) Le Chateliars Flask

IV. EXPERIMENTAL RESULTS

MIX PROPORTION

Mix design for M30 as per IS 10262(2009)	
Cement	= 275.8 kg/m ³
Fly Ash	=118.2 kg/m ³
Water	= 190 kg/m ³
Fine Aggregate	= 742.87 kg/m ³
Coarse Aggregate	= 1089.90 kg/m ³
Water cement ratio	= 0.5
Mix Proportions	= 1 : 1.88 : 2.76

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Table 4 Mix proportion Table

MIX ID	Cement in kg/m ³	Fly ash in kg/m ³	Palm Jaggery in kg/m ³	Fine aggregate in kg/m ³	Coarse aggregate in kg/m ³	Water l/m ³
Mix 1	275.8	118.2	0.00	742.87	1089.90	137.9
Mix 2	275.8	112.29	5.91	742.87	1089.90	137.9
Mix 3	275.8	100.47	11.82	742.87	1089.90	137.9
Mix 4	275.8	82.74	17.73	742.87	1089.90	137.9
Mix 5	275.8	59.10	23.64	742.87	1089.90	137.9

Mixing

Mixing of concrete is initially done with dry ingredients. Cement, fly ash, sand and coarse aggregate were mixed in a dry state for 3 to 5 minutes in the concrete mixer. After dry mixing the required amount of water is added to the mix and allowed to the mix for another 5 minutes.

Preparation of Test Specimens

Compressive strength was found out using cubes of standard size 150 mm x 150 mm x 150 mm. Totally 15 cubes were cast with 6 cubes for each mix ratio. Out of 30 cubes were used to find the compressive strength. After casting process, the specimens were kept for 24 hours and then demoulded. They were cured at curing tank for 28 days.

Compressive Strength Test

The compressive strength is the ratio of the maximum load to the surface area of the cube. Three cubes were tested for each mix ratio and the average of three specimens is taken as the compressive strength it was tested by compression testing machine of capacity 2000 kN. The concrete were tested for compressive strength at the age of 7 day and 28 day.

Density test

Density is an important parameter to determine the self weight of concrete. This parameter considered at designing process of any concrete structures. This test done by weighing concrete cube after releasing the cube from mold.

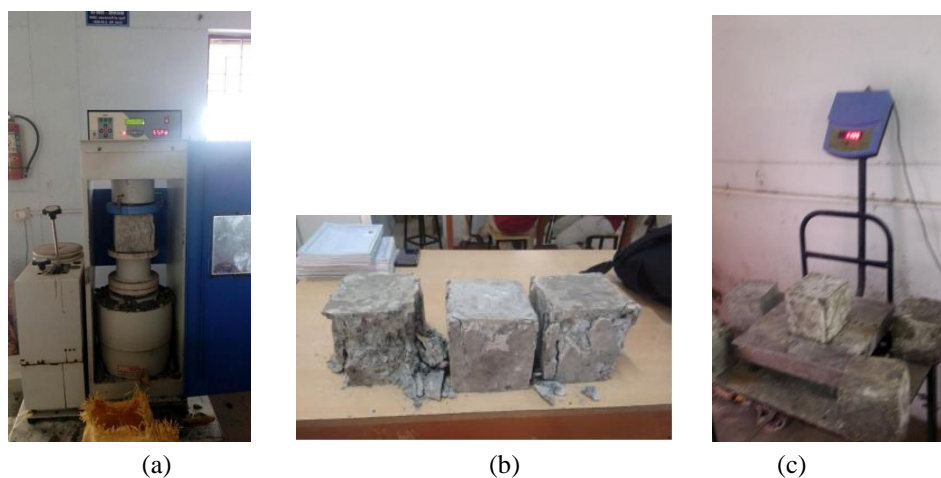


Fig.2 Testing concrete cubes (a) Cubes During Test (b) Cubes After Test (c) Cubes measuring for density

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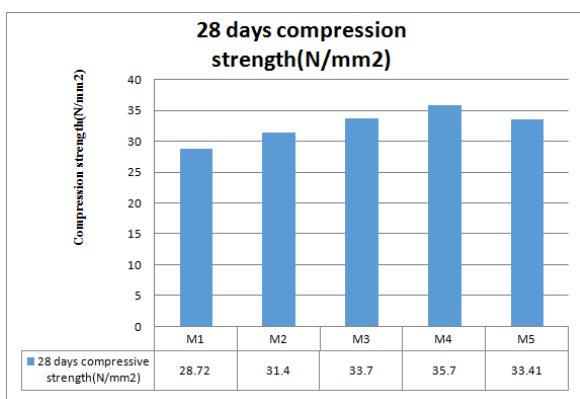
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Table 5 Compressive strength of the cube was tested at 28 days

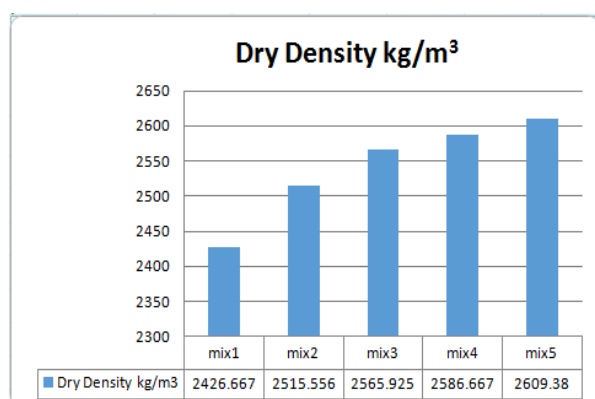
Mix ID	28 days average compression strength in N/mm ²
Mix1	28.72
Mix2	31.4
Mix3	33.7
Mix4	35.7
Mix5	33.41

Table 6 Density for various mix proportions

MIX ID	Density in kg/m ³
Mix 1	2426.67
Mix 2	2515.6
Mix 3	2565.93
Mix 4	2586.67
Mix 5	2609.38



(a)



(b)

Fig.2 Experimental Results (a) compression Test (b) Density Test

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V. CONCLUSION

1. The strength of flyash concrete increase with replacing in quantity of palm jaggery upto 4.5%.
2. Palm jaggery acts as a accelerator and the non-chemical additive for concrete.
3. Increasing palm jaggery contents increases the density of concrete.

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