OPEN ACCESS
International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-3 Issue-1, October 2013

The Study of Fibre Reinforced Fly Ash Lime Stone Dust Bricks With Glass Powder

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Abstract- In the present study, fly ash was used as a raw material for replacing clay for making Fly ash reinforced bricks. The effect of fly ash with high replacement, and different properties of bricks combination were studied. It was found that the compressive strength of Plain Fly Ash and Treated Fly Ash Bricks (FAB, FALB) increases linearly and maximum with 5% coarse sand and 15% sand combination at 10% cement. This increase of compressive strength continues with the addition of 0.25% Plastic fibre in FAB and FALB. However, in the combination of Fly ash Lime stone dust glass powder Brick (FALSDGPB) with and without Plastic fibre the strength achieved to be maximum at 25% stone dust and 25% sand replacement. At the most, the combination of Fibre reinforced Fly ash Lime stone Dust glass powder Brick (25FRFALSDGPB) found to be highest compressive strength with 25% stone dust and sand combination at 10% cement. The strength achieved was nearly close to Indian First class Brick.

Keywords: Brick, compressive strength, Fly ash, Lime,

I.INTRODUCTION

Most cement plants consume much energy and produce a large amount of undesirable products, which affect the environment. In order to reduce energy consumption and CO_2 emission and increase production, cement manufacturers are blending or intergrinding mineral additions such as slag, natural pozzolana, sand and limestone [1]. From the cement point of view, the mineralogy of fly ash is important. 80-90% of it is glass. It starts out as impurities in coal- mostly clays, shales, limestone & dolomite. They cannot be burned so they turn up as ash. The plasticity index of mixture of fly ash and clay decrease dramatically with increasing of replacing ratio of fly ash was to be determining according to Xu Lingling [2]. Against the destructive action of rain, the incorporation of fly ash in pozzolanic plaster provides a satisfactory resistance to aggressive chemicals such as sulfate, salts and acids by N Degirmenci [3]. It was concluded by Mustafa Sahmaran et al [4] that among the mineral additives used, fly ash and limestone powder significantly increased the workability of Self Compacting Mixtures. The setting time of the mortars, which could, however, is eliminated with ternary mixtures, such as mixing fly ash with limestone powder.

Manuscript published on 30 October 2013.
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On the other hand, especially fly ash significantly increased The two polycarboxyl based Super Plasticizers yield approximately the same workability and the melamine formaldehyde based SP was not as effective as the other two. Through the experimental study by Kae Long Lin [5]. The addition of MSWI slag to the mixture reduced the degree of firing shrinkage. This indicates that MSWI slag is indeed suitable for the partial replacement of clay in bricks.

II.EXPERIMENTAL SET UP AND PROCEDURE

Materials Used Present Fly ash conforming the properties according to I.S. 3812 [6] used in the study was the portion of the ash collected from electrostatic precipitators of Dadri thermal power station, Dadri (U.P.), India. The ordinary Portland Cement (OPC) of 43 grade as per I.S.8112 [7] was used. Locally available Lime was used to augment the cementitious properties of Fly ash. The physical properties of different materials used in the study are given in Table 2, as the coal is supplied from different mines of Bihar the chemical properties also vary a great extent and the results of Chemical analysis of fly ash along with their range for different materials are given in Table 1. The finely ground Calcium Hydroxide, a laboratory reagent, was used to augment the cementitious properties of the Fly ash. Its optimum amount with respect to Optimum Moisture Contents (OMC) and Maximum Dry Density (MDD) was determined. It was done through Standard Proctor's Test.

III.DETERMINATION OF OMC AND MDD

Light compaction test according to IS: 2720-VII is done to get the value of Optimum Moisture Content (OMC) and Maximum Dry Density (MDD). This test conforms to the specifications of SPCT or Standard AASHTO (T-99) Test. The curve shows OMC & MDD in figure 3.

IV.PREPARATION OF SPECIMEN

To determine the compressive strength, prism of 9´´ × 4½´´ × 3´´ size were prepared. The mortar mix was designed to get the compressive strength as close to standard first class brick in Indian conditions. The mix proportion for each test series is given in Table 2(a) to 5(b). Three prism of each combination were prepared for determine compressive Strength. The weighted material was placed on a level platform, Plastic fibre sprinkled gently on it and was mixed using mixer. Care was taken to prevent agglomeration of fibres and to ensure their uniform distribution as far as possible. The fresh mortar was poured into three equal layers in the brick mould also properly placed and compacted.

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Table.1. Chemical properties of Fly ash as per Indian, American and British standards [8].

S. No.	Component/ Characteristics	Unit	British Standard BS:3892	American Standard ASTM :C618	Indian Standard: 3812 (Part 1) : 2003 Fly Ash		Indian Standard: 3812 (Par 2): 2003 Fly Ash	
					SPFA	CPFA	SPFA	CPFA
Chemical Requirements								
1.	$SiO_2 + Al_2O_3 + Fe_2O_3$	%	-	70	70	50	70	50
2.	Sio_2 Min	%	-	-	35	25	35	25
3.	Reactive SiO_2 Min (Optional)	%	-	-	20	20	-	-
4.	CaO, Max	%	-	-	-	-	-	-
5.	MgO, Max	%	4	-	5	5	5	5
6.	Total S as SO_3, Max	%	2.5	5	3	5	5	5
7.	Alkali as Na_2O, Max	%	-	1.5	1.5	1.5	1.5	1.5
8.	Total CI, Max	%	-	-	0.05	0.05	0.05	0.05
9.	Loss on Ignition, Max	%	7	12	5	5	5	5
10.	Moisture content, Max	%	1.5	3	2	-	-	-

Table.2.The physical properties of materials

S. No.	Materials	Physical Properties	Value
1.	Plain Fly ash	Specific Gravity	1.86 at 28 ^{0}C
		Optimum Moisture Content (Standard Proctor Test)	18.0%
		Maximum Dry Density	1.28*g/cc*
		Coefficient of uniformity, C_u	2.0
		Coefficient of Curvature, C_c	1.13
		Cohesion	0.0
		Angle of shear resistance	27^o
2.	Cement (43Grade) UltraTech	Initial Setting time Final setting time Normal consistency Compressive Strength (1:3 cement sand mortar) Tensile Strength (1:3 cement sand mortar)	32 *min* 389 *min* 28% 19.2 *MPa* (3 days) 28.5 *MPa* (7 days) 1.90 *MPa* (3 days) 2.45 *MPa* (7 days)
3.	Sand	Specific Gravity Water Absorption (30 *min*) Fineness Modulus Silt Content	2.60 0.42% 2.88 2.49%
4.	Stone Dust	Specific Gravity Water Absorption (30 *min*) Fineness Modulus Silt Content	2.68 0.38% 2.89 2.3%
5.	Plastic Fibre	Diameter Cross Section Elongation Length Melting point Softening point Specific Gravity Tensile Strength	30-40Micron Circular >100% 12mm 240-260 ^{0} C 220 ^{0} C 1.4 4000-6000 Kg/cm^2

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Table.2 (a) Mix proportions of FAB

Designation	Cement (%age)	Mix Proportion			Stress (Kg/cm²)
		Plain Fly ash (%age)	Stone Dust (%age)	Sand (%age)	
SFCB	-	-	-	-	105.50
00FAB	10	80	00.0	20.0	36.80
05FAB	10	80	05.0	15.0	39.40
10FAB	10	80	10.0	10.0	46.50
15FAB	10	80	15.0	05.0	59.50
20FAB	10	80	20.0	00.0	46.25

*FAB – Fly ash Brick *SFCB – Standard First Class Brick

Table.2 (b) Mix proportions of FRFAB

Designation	Cement (%age)	Mix Proportion				Stress (Kg/cm²)
		Plain Fly ash (%age)	Stone Dust (%age)	Sand (%age)	Plastic Fibre Content (%age)	
00FRFAB	10	80	00.0	20.0	0.25	39.80
05FRFAB	10	80	05.0	15.0	0.25	41.40
10FRFAB	10	80	10.0	10.0	0.25	50.40
15FRFAB	10	80	15.0	05.0	0.25	66.25
20FFRAB	10	80	20.0	00.0	0.25	51.50

*FRFAB – Fibre reinforced Fly ash Brick

Table.3 (a) Mix proportions of FALB

Designation	Cement (%age)	Mix Proportion			Stress (Kg/cm²)
		Treated Fly ash (%age)	Stone Dust (%age)	Sand (%age)	
00FALB	10	80	00.0	20.0	39.80
05FALB	10	80	05.0	15.0	44.55
10FALB	10	80	10.0	10.0	52.50
15FALB	10	80	15.0	05.0	68.90
20FALB	10	80	20.0	00.0	48.50

* FALB - Fly Ash Lime Brick

Table.3 (b) Mix proportions of FRFALB

Designation	Cement (%age)	Mix Proportion				Stress (Kg/cm²)
		Treated Fly ash (%age)	Stone Dust (%age)	Sand (%age)	Plastic fibre Contents (%age)	
00FRFALB	10	80	00.0	20.0	0.25	45.55
05FRFALB	10	80	05.0	15.0	0.25	48.50
10FRFALB	10	80	10.0	10.0	0.25	62.80
15FRFALB	10	80	15.0	05.0	0.25	81.90
20FRFALB	10	80	20.0	00.0	0.25	58.40

* FRFALB – Fibre reinforced Fly Ash Lime Brick

Table.4 (a) Mix proportion of FASDGPB

Designation	Cement (%age)	Mix Proportion				Stress (Kg/cm²)
		Fly ash (%age)	Stone Dust (%age)	Sand (%age)	Glass Powder (%age)	
00FASDGPB	10	80	00.0	20.0	00.1	36.660
05FASDGPB	10	80	05.0	15.0	00.2	42.350
10FASDGPB	10	80	10.0	10.0	00.3	70.560
15FASDGPB	10	80	15.0	05.0	00.4	65.690
20FASDGPB	10	80	20.0	00.0	00.5	47.906

* FASDGPB - Fly ash Stone Dust Glass Powder Brick

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Table.4 (b) Mix proportion of FRFASDGPB

Designation	Cement (%age)	Mix Proportion					Stress (Kg/cm^2)
		Fly ash (%age)	Stone Dust (%age)	Sand (%age)	Glass Powder (%age)	Plastic fibre Contents (%age)	
00FRFASDGPB	10	80	00.0	20.0	00.1	0.25	36.660
05FRFASDGPB	10	80	05.0	15.0	00.2	0.25	42.350
10FRFASDGPB	10	80	10.0	10.0	00.3	0.25	80.600
15FRFASDGPB	10	80	15.0	05.0	00.4	0.25	65.690
20FRFASDGPB	10	80	20.0	00.0	00.5	0.25	47.906

*FRFASDGPB – Fibre reinforced fly ash Stone Dust Glass Powder Brick

Table.5 (a) Mix proportion of FALSDGPB

Designation	Cement (%age)	Mix Proportion			Glass Powder (%age)	Stress (Kg/cm^2)
		Treated Fly ash (%age)	Stone Dust (%age)	Sand (%age)		
10FALSDGPB	10	80	10.0	10.0	00.1	81.60
15FALSDGPB	10	70	15.0	15.0	00.2	83.30
20FALSDGPB	10	60	20.0	20.0	00.3	85.20
25FALSDGPB	10	50	25.0	25.0	00.4	86.95
30FALSDGPB	10	40	30.0	30.0	00.5	74.80

* FALSDGPB - Fly ash Lime Stone Dust Glass Powder Brick

Table.5 (b) Mix proportion of FRFALSDGPB

Designation	Cement (%age)	Mix Proportion				Plastic fibre Contents (%age)	Stress (Kg/cm^2)
		Treated Fly ash (%age)	Stone Dust (%age)	Sand (%age)	Glass Powder (%age)		
10FRFALSDB	10	80	10.0	10.0	00.1	0.25	83.15
15FRFALSDB	10	70	15.0	15.0	00.2	0.25	85.45
20FRFALSDB	10	60	20.0	20.0	00.3	0.25	86.25
25FRFALSDB	10	50	25.0	25.0	00.4	0.25	90.50
30FRFALSDB	10	40	30.0	30.0	00.5	0.25	77.55

*FRFALSDGPB' – Fibre reinforced Fly ash Lime Stone Dust Glass Powder Brick

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IV. COMPRESSION TESTING OF BRICKS

The bricks were tested in compression after proper curing for a period of 28 days as per I.S specification. The specimen under test is shown in fig 1. The stress-strain curves of different test series of FAB, FRFAB, FALB, FRFALB, FALSDB and FRFALSDB have been plotted and shown if fig 5. Each stress-strain curve is the average of the three bricks pair. The compressive strength of FAB, FRFAB, FALB, FRFALB, FALSDB and FRFALSDB increases almost linearly with 0.25% Pastic fibre (Fig 6). The compressive strength of FRFAB and FRFALB increases 10.18% and 15.87% respectively at 0.25% Pastic fibre with respect to FAB and FALB. Further, the compressive strength of 25FRFALSDGPB is increases 22%, 9.8% and 4% with respect to 10FASDGPB, 10FRFASDGPB and 25FALSDGPB respectively. This increase of compressive strength continues and achieved maximum value with the combination of 25FRFALSDGPB, which is nearly close to SFCB.

Fig.1 Test under Progress

Fig.2 Test under Progress

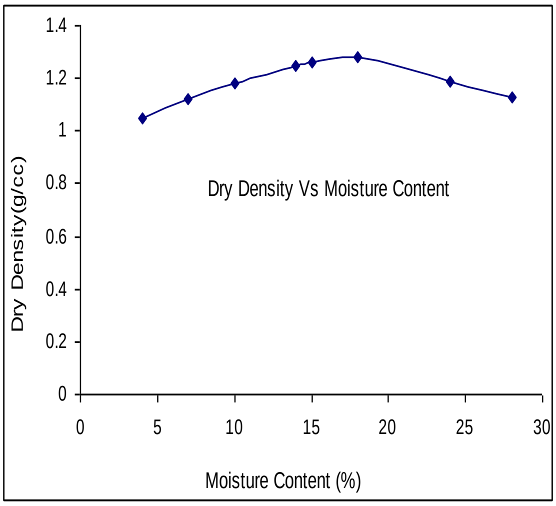

Fig.3 Dry Density vs. Moisture Content for

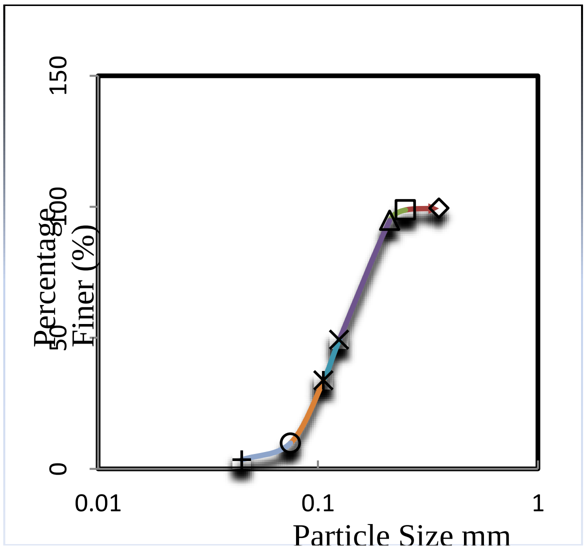

Fig.4 Particle Size Distribution Curve of Plain Fly ash

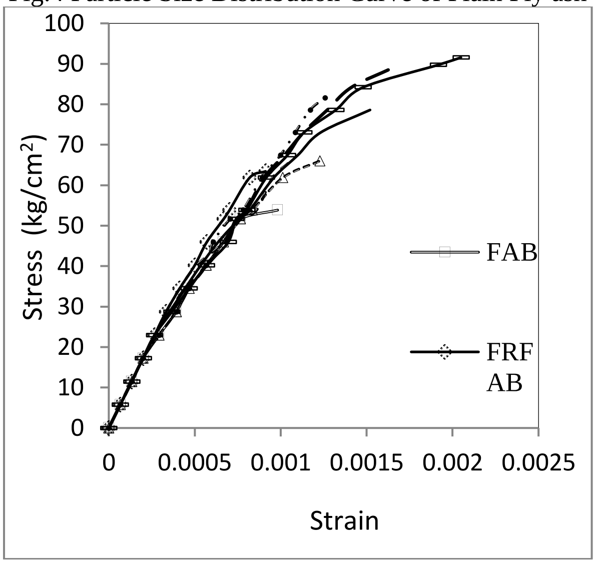

Fig.5 Stress vs. Strain Variation

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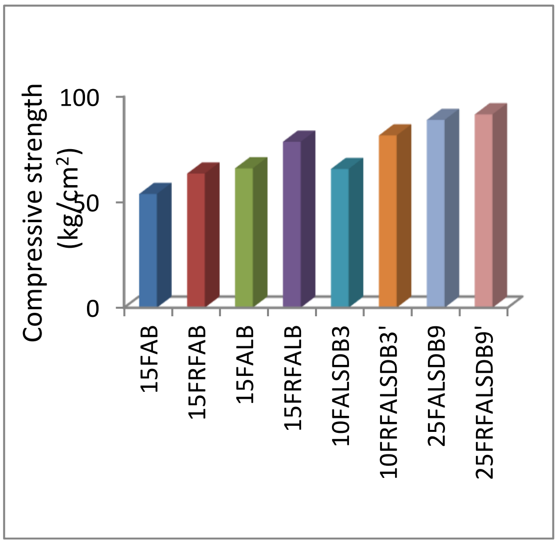

Fig.6 Compressive strength variation

V.CONCLUSIONS

1. The addition of lime to the fly ash increases the cementitious properties of Fly ash and it was found that at 1.5% of lime, the OMC is minimum and dry density is maximum.
2. The compressive strength of Plain Fly Ash Brick and Treated Fly Ash Brick is increases linearly and maximum with 5% coarse sand and 15% sand combination at 10% cement.
3. The compressive strength of Treated Fly Ash Stone Dust glass powder Brick (FALSDGPB) is maximum with 25% stone dust and sand combination.
4. Fibre reinforced Fly ash Lime Stone Dust Glass Powder Brick (FRFALSDGPB) achieved highest compressive strength with 25% stone dust and sand combination at 10 % cement.
5. Fly ash is not only to enhance the mechanical properties of brick but the addition of fibre, lime and glass powder correlate their gape of strength and their use in helping to reduce environmental pollution and save energy.

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