

Effects of Fly Ash and Other Ingredients to The Strength And Cost Of 'FalgcSD' (Flyash, Lime, Gypsum, Cement, Stone Dust) Bricks

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Abstract— In this region, specially in Jabalpur, there is no commercial brick kiln around 100 km area, and the clay bricks are being made locally by villagers in small quantities by locally burning with wood and cow dung, which are neither properly burnt nor in sufficient quantity and these clay bricks do not fulfill the IS specifications.

As we know, the demand of dwelling unit in India is increasing day by day. The demand for dwelling units is likely to raise to 80 million units by year 2015 for lower middle and low income groups, involving an estimated investment of \$670 billion, according to the Associated chamber of commerce and industry.

However, commercial clay bricks are being used in India conventionally for long time. But good quality of bricks as well as required quantity is not available, especially during the rainy season, supply of clay bricks are very difficult. Therefore, in order to fulfill the requirements, now there is a demand of time, to use bricks of fly ash and other ingredients. There is an ample scope for fly ash brick and block units which will save not only our fertile top soil every year but also help to clean the environment and solve the problem of disposing of fly ash.

In this paper we have made 'FALGCSD' Bricks with the varying combinations of fly ash and other ingredients and named 'FALGCSD' bricks, which's meaning is FLYASH, LIME, GYPSUM, CEMENT, STONE DUST Bricks. These bricks are better in cost and strength in comparison to conventional clay BRICKS. The strength and cost is affected by varying the quantity of fly ash and other ingredient of these bricks.

Index Terms— Cement, Cost, FALGCSD bricks, Fly Ash, Gypsum, Lime, Lignite, Methodology, Properties, Raw Materials, Stone dust.

I. INTRODUCTION

Fly ash is a waste generated from combustion of bituminous coal or lignite in a thermal power plant. Indian coals have on an average 45% ash content. Currently India generates around 95 million tonne of ash per year. It is likely to reach 125 million tonne mark by 2005 and 180 million by 2015.

Fly ash has got inherent characteristics for the manufacture of bricks / hollow and solid blocks / cellular light weight

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concrete, partial replacement of cement, construction of roads and embankments, manufacture of sintered aggregate, wood substitute material and for use in the manufacture of emulsion / paints / buildings distempers, etc. The Fly ash can be consumed in different ways of projects as shown in Fig-1.

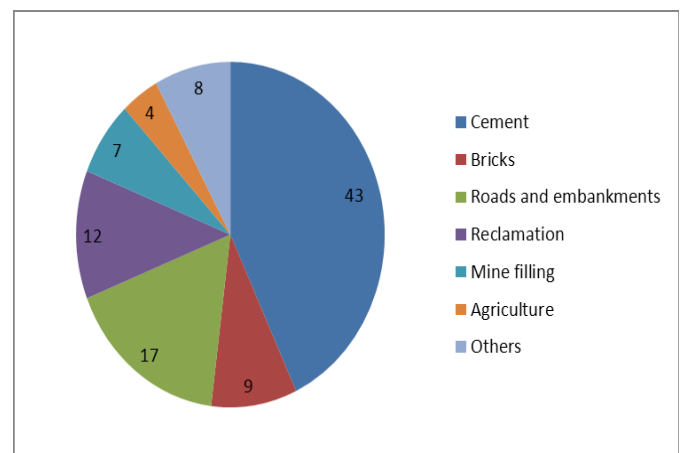


Figure :-1, Mode of fly ash utilization sector-wise for the year 2008 – 09 Source CEA (2009-10)

II. RAW MATERIALS

Fly Ash is the inorganic mineral residue obtained after burning of coal/lignite in the boilers. Fly Ash is that portion of ash which is collected from the hoppers of ESP's and pond ash is collected from the ash ponds. Bottom ash is that portion of ash which can be collected from the bottom portion of the boilers. The characteristics of fly ash depend upon the quality of lignite/coal and the efficiency of boilers.

India depends upon primarily on coal for the requirement of power and her power generation is likely to go up from 60,000MW in the year 2010. While generation of power from bituminous sources is on increase. The generation of fly ash is also likely to increase. The fly ash generation in India Thermal Stations is likely to shoot up to 170 million tones in 2010 from the present level of 100 million tones. The disposal of fly ash in the present method will be a big challenge to environment, especially when the quantum increases from the present level.

A. Characteristics of Fly ash

It possess pozzolanic properties. And is as per IS 3812(Part-I):2003.

The physical and chemical properties of Fly Ash are as under

(i) Physical Properties

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Specific Gravity 2.54 to 2.65 gm/cc
 Bulk Density 1.12 gm/cc
 Fineness 350 to 450 M2/Kg

(ii) Chemical Properties

Silica 35-59 %
 Alumina 23-33%
 Calcium Oxide 10-16%
 Loss on ignition 1-2%
 Sulphur 0.5- 1.5%
 Iron 0.5- 2.0 %

It may be seen that lignite fly ash is characterized primarily by the presence of silica, alumina, calcium etc. Presence of silica in fine form makes it excellent pozzolanic material. Its abundant availability at practically nil cost gives a very good opportunity for the construction agencies.

Characteristics of Lignite and Coal Fly ash:

Table : 1

CONTENTS	LIGNITE FLY ASH (%)	COAL FLY ASH (%)
L.O.I	1.0 TO 2.0	3-15
SiO ₂	45.59	40-64
Al ₂ O ₃	23-33	15-29
Fe ₂ O ₃	06-4.0	2-11
CaO	5.0-16.0	0.1-1.0
MgO	1.5-5.0	0.2-4.0
So ₃	0-5.0	0.1-1.7

About 20 to 30% (by weight) fly ash has been used for the production.

B. Gypsum:



Figure:- 2, Fibrous gypsum selenite showing its translucent property



Figure :-3, Veins of gypsum in Caprock Canyons State Park,

Texas.

Hydrated calcium sulphate are called gypsum. (CaSO₄·2H₂O). Gypsum should have minimum 35% purity and has used 0.5% by weight.

C. Lime :



Figure :-4, Limestone quarry in Brønnøy, Norway

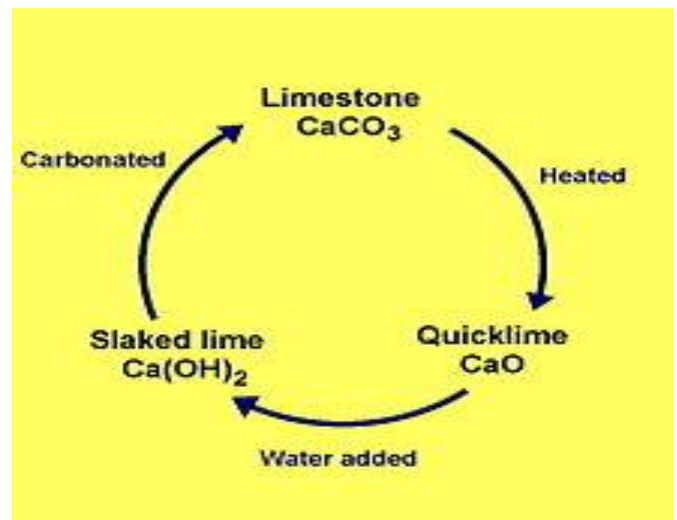


Figure :-5, The lime cycle.

are indigenous and readily available from the manufacture or traders. Quick Lime or hydrated lime or both can be mixed in the composition. Lime should have minimum 40% CaO content and it has been used 2-5% by weight.

D. Stone dust/quarry stone dust Sand

Stone dust from crushers/ quarry stone dust has coarse sand properties, clean & coarse dust has been used about 44.5 to 67.5% by weight. It fulfills the requirements of IS 383:1970.

E. Cement

Ordinary Portland cement grade 43 (IS 8112 :1989) has used about 10-20% by weight.

All the raw materials are indigenous and readily available from the manufacture or traders.

III. METHODOLOGY OF 'FALGCSD' BRICKS:-

The manufacturing process of bricks can be broadly classified in three operations viz. mixing the ingredients, pressing the mix in the machine and curing the bricks for a stipulated period. Selection of machinery depends on the demand of bricks. For manufacturing 'FALGCSD' bricks, the best suited machinery is a fully mechanized Vibro-compaction machine, which is an indigenous low cost machine and can be run by ordinary semiskilled worker. Its production capacity of bricks can be increased as per requirements by increased shifts of working for production of bricks. The maintenance cost of machine is so low that it can be ignored.

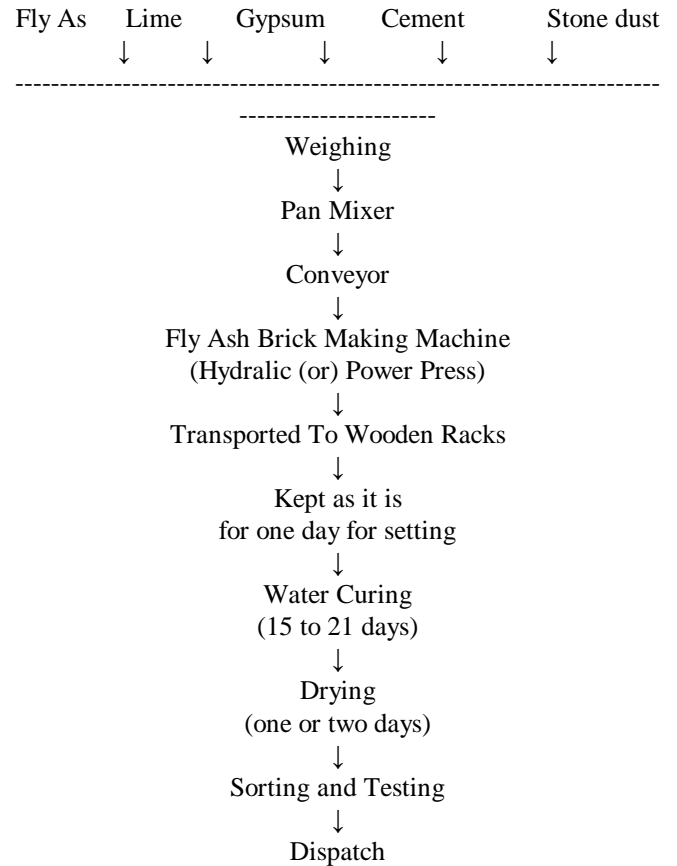
The stone dust/quarry and fly ash is mixed dry in mechanical pan mixer which is electrically operated. After mixing of these ingredients, water is added and further mixing is done then lime and gypsum is added and thorough mixing is done until homogeneous paste/mix is made. The ingredients are mixed with in the required proportions by weight to have uniform quality. The mixed and ground material is conveyed to on the belt conveyor to brick making machine from where the hydraulically compressed (about 35-40 tonnes force) bricks are continuously produced and kept on wooden pallets for one day and taken to curing site on pallets trucks/conveyors, where bricks are cured by water spray or steam cured for early strength for 21 days.

The bricks are casted of modular size bricks as 230mm x 100mm x 75mm (with +,- 2mm tolerance limit).The specifications and size of bricks were followed similar to IS-13757-1993.The flow chart is as under:



Figure 6 : Double acting hydraulic brick press developed to ensure production of high quality fly ash bricks with application of pressure on both sides and commercialization of C - brick press for production of fly ash bricks have been facilitated.

IV. FLOW SHEET DIAGRAM



V. EXPERIMENT ON STRENGTH OF 'FALGCSD' BRICKS :-

A. Compressive Strength

The Test is conducted as per IS-3495, Part-1, 1992. The frog of the brick is filled flush with 1:3 cement mortars and the specimen are stored in damp jute bag for 24 hours and then immersed in clean water for 24 hours. The specimen is placed in compression testing machine with 6 mm plywood on top and bottom of it to get uniform load on the specimen. Then load is applied axially at a uniform rate of 15 N/mm². The crushing load is noted. Then the crushing strength is the ratio of crushing load to the area of brick loaded by formula,

Compressive strength of 'FALGCSD' bricks = (Crushing load in N / area of specimen brick ie 230X100 mm).

Average of five specimens is taken as the Compressive strength of 'FALGCSD' bricks as shown in Table-3. and found Average Compressive Strength = 105.00 Kgf/cm². Which is similar strength to sub class "A" bricks



Figure 4: Setup of Compression strength testing machine

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Table-2 : Compressive strength at varying ingredients for 'FALGCSD' bricks

S No	Fly ash in % by weight	Lime in % by weight	Gypsum in % by weight	Stone dust in % by weight	Cement in % by weight	Compressive strength of 'FALGCSD' bricks (Kgf / cm2)
1	20	2.0	0.5	67.50	10	74.50
2	22	2.6	0.5	62.5	12	85.0
3	24	3.2	0.5	58.30	14	95.0
4	26	3.8	0.5	53.70	16	98.50
5	28	4.4	0.5	49.10	18	105.00
6	30	5.0	0.5	44.50	20	103.50

Table- 2(a) : Cost at varying ingredients for 'FALGCSD' bricks (1000 Nos)

S No		Fly ash in % by weight	Lime in % by weight	Gypsum in % by weight	Stone dust in % by weight	Cement in % by weight	Cost of 1000 Nos 'FALGCSD' Bricks
1	% of ingredients of total Vol of material for 1000 Nos bricks	20	2.0	0.5	67.50	10	
2	Quantity	0.345 Cum	29.29 Kg (Density = 849 Kg/Cum)	13.78 Kg (Density = 1602 Kg/Cum)	1.1644 Cum	259.78 Kg (Density = 1506 Kg/Cum)	
3	Rate	Rs 100.00 per Cum	Rs 125.00 per 25 Kg	Rs 175.00 per 25 Kg Bag	Rs 450.00 per Cum	Rs 260.00 per 50 Kg Bag	
4	Amount (Rs)	Rs 34.50	Rs 146.45	Rs 96.46	Rs 523.98	Rs 1350.86	Rs 2152.25
					Total	Rs	2152.25
	Misc (Labor =13%, Transport =5%, Profit =15% , T&P =2%, OH Charges =4% , Total = 37%)					Rs	796.33
	G Total					Rs	2948.58

Table- 2(b) : Cost at varying ingredients for 'FALGCSD' bricks (1000 Nos)

S No		Fly ash in % by weight	Lime in % by weight	Gypsum in % by weight	Stone dust in % by weight	Cement in % by weight	Cost of 1000 Nos 'FALGCSD' Bricks
1	% of ingredients of total Vol of material for 1000 Nos bricks	22	2.6	0.5	62.5	12	
2	Quantity	0.379Cum	38.08 Kg (Density = 849 Kg/Cum)	13.78 Kg (Density = 1602 Kg/Cum)	1.0781 Cum	311.74 Kg (Density = 1506 Kg/Cum)	
3	Rate	Rs 100.00 per Cum	Rs 125.00 per 25 Kg	Rs 175.00 per 25 Kg Bag	Rs 450.00 per Cum	Rs 260.00 per 50 Kg Bag	
4	Amount (Rs)	Rs 37.90	Rs 190.40	Rs 96.46	485.15	Rs 1621.05	Rs 2430.96
					Total	Rs	2431.06
	Misc (Labor =13%, Transport =5%, Profit =15% , T&P =2%, OH Charges =4% , Total = 37%)					Rs	899.46
	G Total					Rs	3330.42

Table- 2(c) : Cost at varying ingredients for 'FALGCSD' bricks (1000 Nos)

S No		Fly ash in % by weight	Lime in % by weight	Gypsum in % by weight	Stone dust in % by weight	Cement in % by weight	Cost of 1000 Nos 'FALGCSD' Bricks
1	% of ingredients of total Vol of material for 1000 Nos bricks	24	3.2	0.5	58.30	14	
2	Quantity	0.414 Cum	46.87 Kg (Density = 849 Kg/Cum)	13.78 Kg (Density = 1602 Kg/Cum)	1.0057 Cum	363.70 Kg (Density = 1506 Kg/Cum)	
3	Rate	Rs 100.00 per Cum	Rs 125.00 per 25 Kg	Rs 175.00 per 25 Kg Bag	Rs 450.00 per Cum	Rs 260.00 per 50 Kg Bag	
4	Amount (Rs)	Rs 41.40	Rs 234.35	Rs 96.46	Rs 452.56	Rs 1891.24	Rs 2716.01
					Total	Rs	2716.01
	Misc (Labor =13%, Transport =5%, Profit =15% , T&P =2%, OH Charges =4% , Total = 37%)					Rs	1004.92
	G Total					Rs	3720.93

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Table- 2(d) : Cost at varying ingredients for 'FALGCSD' bricks (1000 Nos)

S No		Fly ash in % by weight	Lime in % by weight	Gypsum in % by weight	Stone dust in % by weight	Cement in % by weight	Cost of 1000 Nos 'FALGCSD' Bricks
1	% of ingredients of total Vol of material for 1000 Nos bricks	26	3.8	0.5	53.70	16	
2	Quantity	0.4485 Cum	55.70 Kg (Density = 849 Kg/Cum)	13.78 Kg (Density = 1602 Kg/Cum)	0.9263 Cum	415.66 Kg (Density = 1506 Kg/Cum)	
3	Rate	Rs 100.00 per Cum	Rs 125.00 per 25 Kg	Rs 175.00 per 25 Kg Bag	Rs 450.00 per Cum	Rs 260.00 per 50 Kg Bag	
4	Amount (Rs)	Rs 44.85	Rs 178.50	Rs 96.46	Rs 416.84	Rs 2161.43	Rs 2898.08
					Total	Rs	2898.08
	Misc (Labor =13%, Transport =5%, Profit =15% , T&P =2%, OH Charges =4% , Total = 37%)					Rs	1072.29
	G Total					Rs	3970.37

Table- 2(e) : Cost at varying ingredients for 'FALGCSD' bricks (1000 Nos)

S No		Fly ash in % by weight	Lime in % by weight	Gypsum in % by weight	Stone dust in % by weight	Cement in % by weight	Cost of 1000 Nos 'FALGCSD' Bricks
1	% of ingredients of total Vol of material for 1000 Nos bricks	28	4.4	0.5	49.10	18	
2	Quantity	0.483 Cum	64.44 Kg (Density = 849 Kg/Cum)	13.78 Kg (Density = 1602 Kg/Cum)	0.847 Cum	467.61 Kg (Density = 1506 Kg/Cum)	
3	Rate	Rs 100.00 per Cum	Rs 125.00 per 25 Kg	Rs 175.00 per 25 Kg Bag	Rs 450.00 per Cum	Rs 260.00 per 50 Kg Bag	
4	Amount (Rs)	Rs 48.30	Rs 322.20	Rs 96.46	Rs 381.15	Rs 2431.57	Rs 3279.68
					Total	Rs	3279.68
	Misc (Labor =13%, Transport =5%, Profit =15% , T&P =2%, OH Charges =4% , Total = 37%)					Rs	1213.48
	G Total					Rs	4493.16

Table- 2(f) : Cost at varying ingredients for 'FALGCSD' bricks (1000 Nos)

S No		Fly ash in % by weight	Lime in % by weight	Gypsum in % by weight	Stone dust in % by weight	Cement in % by weight	Cost of 1000 Nos 'FALGCSD' Bricks
1	% of ingredients of total Vol of material for 1000 Nos bricks	30	5.0	0.5	44.50	20	
2	Quantity	0.5175 Cum	73.27 Kg (Density = 849 Kg/Cum)	13.78 Kg (Density = 1602 Kg/Cum)	0.7676 Cum	519.57 Kg (Density = 1506 Kg/Cum)	
3	Rate	Rs 100.00 per Cum	Rs 125.00 per 25 Kg	Rs 175.00 per 25 Kg Bag	Rs 450.00 per Cum	Rs 260.00 per 50 Kg Bag	
4	Amount (Rs)	Rs 51.75	Rs 366.35	Rs 96.46	Rs 345.42	Rs 2701.76	Rs 3561.74
					Total	Rs	3561.74
	Misc (Labor =13%, Transport =5%, Profit =15% , T&P =2%, OH Charges =4% , Total = 37%)					Rs	1317.84
	G Total					Rs	4879.58

A. Water Absorption :-

The brick specimen is wiped but by clean cotton cloth and weight is taken and noted. The brick specimens are immersed in water for 24 hours. After taking out specimen bricks from water, it is again cleaned by dry cotton cloth and weight is taken again. We got average water absorption for all samples = 12 %.

By formula, Water absorption=(weight of wet brick-Weight of dry bricks)/weight of dry bricks)*100

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VI. CONCLUSION :-

The different percentage of ingredients in the 'FALGCSD' bricks affects the Strength and Cost of the bricks.

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