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AN APPROACH FOR ALTERNATIVE SOLUTION IN BRICK MANUFACTURING

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Abstract: An effort for an alternate approach in the manufacturing of brick was accomplished by using industrial byproducts like class F fly ash, granite dust and sludge lime as key ingredients. In India thermal power plants and granite industries are generating fly ash and granite dust in large quantities. Industrial waste are hazardous in nature, their disposal is of major concern. Recycling such wastes by utilizing them into building materials is a moderate solution for the pollution issues. Much of an emphasis is laid on energy saving and economy. In this paper an attempt is made for such an alternate approach.
Keywords: Class F Fly ash, Granite dust, Recycling, Energy saving, Cost feasibility.

1. INTRODUCTION

Housing is a basic need. Owning a house is a problem for majority of the people in India due to expensive cost of construction. 60-70% of the families come under the low income group and housing becomes an acute problem to them. This results in reducing the cost of housing and to make affordable housing for India's increasing population. It has been necessitated to increase the use of alternate materials from the industrial activities because of their abundance. Clay bricks available in some regions have poor quality, low compressive strength, higher water absorption, uneven surfaces and so on, which have been compelled to come up with better materials capable of countering these issues as well as reducing the cost of construction.

Fly ash is a finely divided residue resulting from the combustion of powdered coal and collected by electronic precipitators in thermal power plants. Presently in India, approximately 160 million tons of fly ash is produced by thermal power plants every year.

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The estimate for generation of fly ash during the year 2031-32 would be expected to be around 900 million tons [1].

Granite cutting industry produces solid waste in large amount and across large areas, which are expected to increase as the construction industry grows, owing that the overall production of granite industry has been increasing rapidly in recent years. It is a non-biodegradable waste that can be easily inhaled by humans and animals and is also harmful to the environment. It is estimated that nearly 175 million tones of granite dust are produced every year and about 250-400 million tons of granite dust is generated at site [2].

Sludge lime being another construction waste is obtained as a residue after the hydration of lime.

These wastes have been incorporated effectively into the construction industry in the form of an alternative. The usage of fly ash and granite dust for making bricks is ecologically advantageous as it helps in saving top agricultural soil as well as meets the objective of disposing these wastes which otherwise are pollutants.

The chemical and physical properties of various materials are studied and the bricks are tested for Compression, Water absorption and Durability. All the properties of these bricks have been assessed in comparison with IS 12894:2002.

2. EXPERIMENTAL MATERIALS

2.1 Fly ash (Class 'F'):

Class ' F ' category Fly ash is a powderous by-product of coal incineration in thermal power plants . It is also known as Flue-ash. This is a uniformly graded compound of silica, alumina and unburnt carbon. This Fly ash is pozzolanic in nature containing less than 10% lime.

Table 1: Chemical Composition Of Class 'F' Fly ash

Sl. No.	Chemical compound	%
1	Sio_2	57
2	Al_2 O_3	29
3	Fe_2 O_3	6.34
4	Cao & k_2O	3.7
5	MgO	0.7

(**Source:** Raichur Thermal Power Station)

Fig. 1: Fly ash

2.2 Granite Dust:

The ornamental granite stone processing industries produce tones of fine powder waste during sawing and polishing. Granite mass is lost by 30% in the form of dust during cutting .

Table 2: Chemical Composition Of Granite Dust

Sl. No.	Chemical composition	%
1	Sio_2	74
2	$Al_2 O_3$	12
3	$Fe_2 O_3$	2.5
4	Cao & k_2O	4
5	MgO	1

(**Source:** Thandya Industrial Estate, Nanjangud)

Fig. 2: Granite Dust

2.3 Sludge Lime:

The naturally occuring limestone on calcination gives lime and lime sludge. This lime sludge is a residue of lime stone during the hydration process.

Table 3: Chemical Composition Of Sludge Lime

Sl. No.	Chemical composition	%
1	Sio_2	28.22
2	$Al_2\,O_3$	0.14
3	$Fe_2\,O_3$	3.8
4	Cao & k_2O	37.7
5	MgO	1.8

Fig. 3: Sludge lime

2.4 : Sand

Sand is a naturally occuring granular material , composed of finely divided rock and mineral particles. The major composition of sand is silica. The composition of sand is variable depending on the local rock sources and conditions.

Table 4: Physical properties of materials

Sl. No.	Properties	F.A	G.D	S.L	S.A
1	Specific gravity	2.01	2.8	2.4	2.65
2	Density (kg/m^3)	900	2700	2700	1600
3	Particle size	Finer than 75 Microns	60% finer than 75microns	30% finer than 75microns	Zone II
4	Appearance	Spherical (under microscope)	Irregular	Granular	Angular

F.A = Fly ash , G.D = Granite Dust , S.L = Sludge Lime , S.A = Sand

3. DESIGN MIX

Design mix is as follows;

Table 5: Design mix

Sample	Fly Ash Class 'F' percentage	Granite Dust percentage	Sludge Lime percentage	Sand percentage	Total Percentage
S0	80	0	10	10	100
S1	60	20	10	10	100
S2	55	25	10	10	100
S3	50	30	10	10	100
S4	45	35	10	10	100
S5	40	40	10	10	100
S6	35	45	10	10	100

4. EXPERIMENTAL METHODLOGY

In this paper , three industrial by-products namely, Fly ash Granite dust and Sludge lime comprise as the major ingredients alongside with sand. Ordinary Portland Cement was utilized as a binder material. With the control brick, i.e. 20%, 25%, 30%, 35%, 40%, 45% of the flyash is replaced with the granite dust. Six proportions were considered and the materials were weighed according to the proportion. All the materials were manually mixed in dry state and approximate water was added.The mould used was of size 200mm X 100mm X 100mm.The bricks were hand moulded and the mould was of column box type fitted with screws on either sides. The prepared mix was filled in the mould in the form of layers and compacted. Three to four layers of mix was filled upto the brim of the mould. The brick is then given a neat surface finishing. The casted bricks after drying for 24 hours are cured by two methods – Partial curing , Immersed curing.

4.1 Compressive Strength:

The bricks were tested for their compressive strength after 7,14,21 and 28 days of curing. The bricks were tested in the testing machine by providing two of 6mm thick iron plates, one below and one above the brick to allow uniform distribution of load on the brick.

Table 6 : Compressive strength of bricks

BRICK SAMPLES	PARTIAL CURING			
	7 DAYS (N/mm^2)	14 DAYS (N/mm^2)	21 DAYS (N/mm^2)	28 DAYS (N/mm^2)
S0	3.7	4.1	4.9	6.3
S1	4.67	4.99	5.85	10.2
S2	4.83	7.2	7.49	12.15
S3	5.5	5.63	7.1	9.3
S4	5.15	6.5	6.75	8.58
S5	4.75	5.43	7.0	8.5
S6	6.53	7.1	8.25	8.75

Table 7: Compressive strength of bricks

BRICK SAMPLES	IMMERSED CURING			
	7 DAYS (N/mm^2)	14DAYS (N/mm^2)	21 DAYS (N/mm^2)	28 DAYS (N/mm^2)
S0	3.95	4.65	5.43	7.29
S1	4.9	5.2	8.13	8.93
S2	4.8	7.63	11.8	12.4

S3	6.3	8.67	10.8	11.7
S4	5.05	6.75	8.25	12.1
S5	7.7	8.4	8.8	10.25
S6	6.93	7.25	8.5	9.75

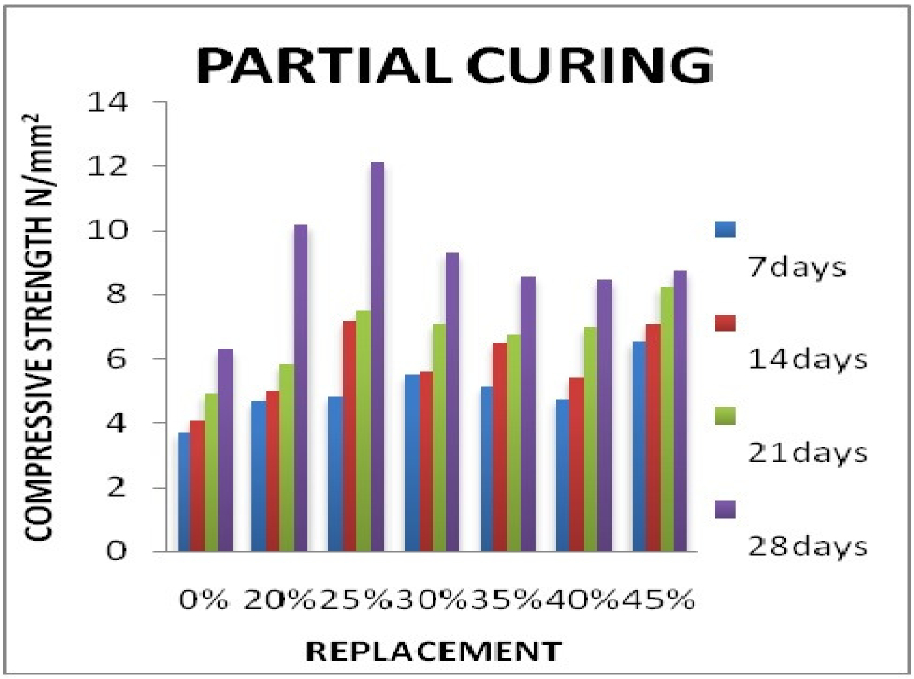

Fig. 4: Percentage Replacement v/s Compressive Strength of Bricks

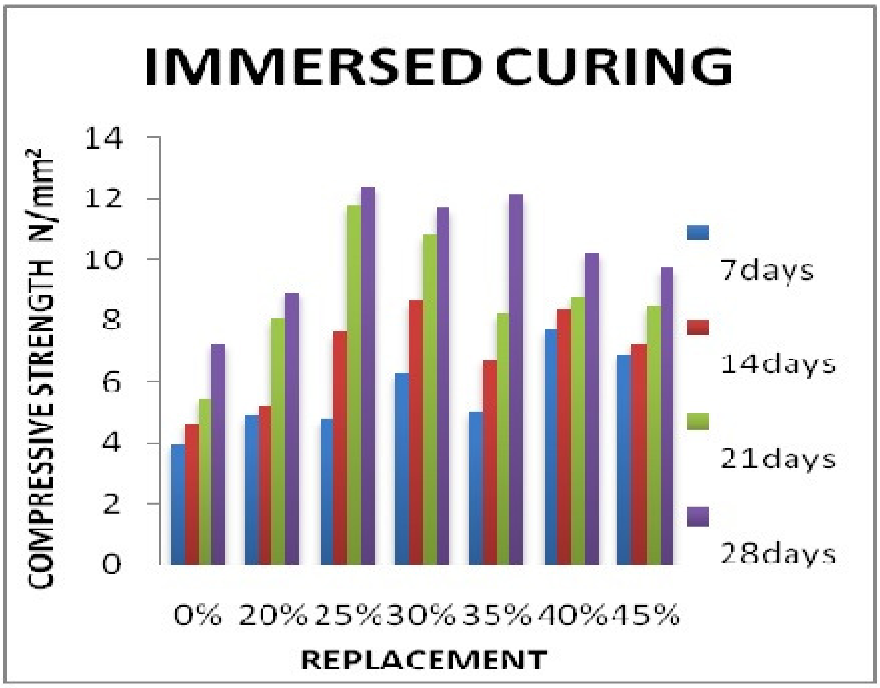

Fig. 5: Percentage Replacement v/s Compressive Strength of Bricks

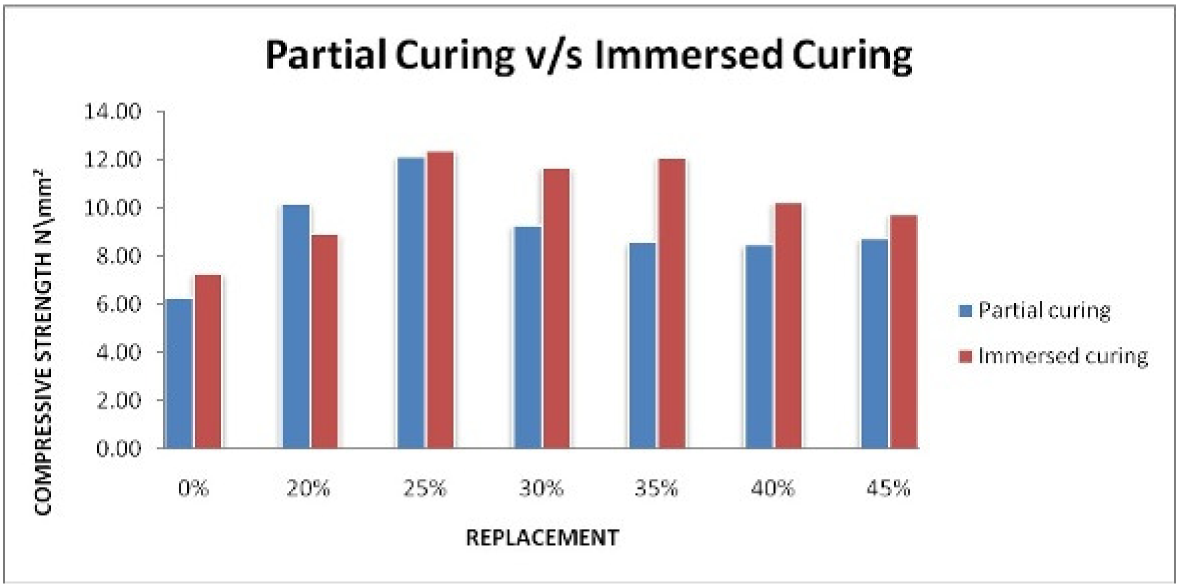

Fig. 6: Partial Curing v/s immersed curing

5. COST FEASIBILITY

Table 8: Cost of materials

Sl. No.	Materials	Rate (Rs/kg)
1.	Flyash (Class F)	0.40
2.	Granite Dust	0.30
3.	Sludge Lime	0.25
4.	Sand	1.4

Table 9: Total Cost Of Materials

Types of bricks	Fly ash	Granite dust	Sludge lime	Sand	Cement	Total Cost of Materials
S0	1.15	0	0.10	0.5	1.1	2.85
S1	0.87	0.22	0.10	0.5	1.1	2.79
S2	0.79	0.27	0.10	0.5	1.1	2.76
S3	0.72	0.32	0.10	0.5	1.1	2.74
S4	0.65	0.37	0.10	0.5	1.1	2.72
S5	0.58	0.42	0.10	0.5	1.1	2.70
S6	0.51	0.47	0.10	0.5	1.1	2.68

Table 10: Comparison of Fly ash-Granite dust bricks with conventional Clay bricks

Sr. No.	Description	Clay Bricks	Flyash-Granite dust Bricks
1.	Size, (mm)	190X90X75	200X100X100
2.	Volume, (cm3)	1282.5	2000
3.	Compressive strength, (Kg/cm2)	30-40	80-120
4.	Water absorption(%)	12-20	6-8

6. RESULTS AND CONCLUSION

1. Maximum Compressive Strength was attained when the percentage of Flyash and Granite dust were 55 and 25 respectively for both methods of curing i.e., partial curing and immersed curing.
2. Completely immersed brick samples project a higher Compressive Strength trend when compared to partial cured brick sample.
3.Water Absorption Capcity of these Bricks are relatively lower when compared to the Clay Bricks.
4.Flyash-Granite Dust Bricks prove to be Energy efficient, lower in cost and aim towards a " Greener Eco-friendly Bricks for Construction".
5.Hazardous effects and disposal problems of waste materials can be reduced through this study.

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