Use of Kadappa Waste as a Resource Material for Building Construction

V.G. Kalpana, Aravind B, P. Eswaramoorthi

Abstract: The burnt clay brick is a longstanding building material for house construction. The raw material for the production of burnt clay is top soil which is removed from agricultural land and natural landscapes. This process paves way for the depletion of the soil nutrient content and moisture content as well as destabilizes the soil. Also the emission of greenhouse gases during burning of bricks affects the environment. To evade these problems, researchers attempted to establish an alternative green material named Fly ash bricks which utilizes the waste from thermal plants for its production. In addition to the innovation of fly ash bricks, an attempt has been made to utilize the kadappa stone waste as an ingredient in fly ash bricks for construction works. This study focuses on the effect on utilization of kadappa waste as an ingredient for manufacturing a building material. Experimental work is carried out on kadappa fly-ash bricks comprised of different proportions of kadappa stone waste, fly-ash and lime and the comparative study is made to fine the optimum mix proportion.

Keywords: Kadappa waste; Fly Ash; Lime; Kadappa Fly - ash bricks.

I. INTRODUCTION

It is well known that in India the most common and economical building material for housing is burnt clay bricks. The manufacturing process of burnt clay bricks involves many issues right from raw material to production in terms of land and air pollution. Digging out of top soil from land affects the soil fertility and burning of bricks releases the harmful gases into the atmosphere. In recent years, there are several technologies meant for research and to study the utilization of waste materials will result in the reduction of environmental load and waste management. Through the study (Nitin S. Naik, et.al[1] & O.kayali[2].), they found that the bricks manufactured by fly ash can be an alternative material to conventional clay bricks. But, these fly ash bricks are having disadvantages like environmental pollution i.e. cement is used as an ingredient, in construction sector. The successful utilization of these materials such as fly ash, lime cement and quarry dust for the brick manufacturing which on production emits carbon-di-oxide,

which is a greenhouse gases. Materials like kadappa wastes, granite wastes and marble wastes (Dhanapandian.S et al.[3].) have recently gained attention to be used in construction industry. In addition to the innovation of fly-ash bricks efforts in this area have been focused in identifying and optimizing the benefits of adding other waste materials like kadappa stone wastes as an ingredient for manufacturing fly-ash bricks.The Anatapur, Kurnool and Kadappa district areas of Andhra Pradesh identified as much potential for kadappa by exploring from the quarry and making into finished goods stones (natural black stone). More than 1300 industries are running in those areas. Kadappa stones are manufactured for flooring, tabletop, shelves and racks. During this stage of converting into finished goods the waste is generating and these are dumped in and around the stone industry and road side, which causes inconvenience to the people who are residing near the industry and beside the road. These kadappa wastes have been used in minimum amount for some activities like manufacture of pavers. The present study attempts to investigate the influence of addition of kadappa waste into fly ash bricks and is named as Kadappa Fly Ash Bricks (KFB) which is manufactured in different proportions. The various tests such as compressive strength test, water absorption, and dimension test are conducted and compared with conventional fly-ash bricks. A detailed study on management has also been carried out.

II. LITERATURE REVIEW

N. Gamage et.al.[4], studied how fly ash is being incorporated with other materials. Fly ash is produced, in massive amount, as a waste material of burning fossil fuel. Currently about 900 million tons of fly ash produced, worldwide, annually and about 30-40% of this residue is being utilized for various purposes including in cement and concrete production. They recommend using around 25% of fly ash as replacement of cement in order to obtain effective resultant end product. N.Venkata Ramana, et.al.[5], studied a technical feasibility approach to utilize the stone waste for construction works. Utilization of the black stone powder waste as partial replacement of cement and fine aggregate so as to keep the environment green. The disposal problem can be eradicated up to some extent. Properties of black stone wastes are tested and results were found. C. Nataraja et.al [6], studied the strength properties of paver blocks such as compressive strength, split tensile strength, bending strength and water absorption by replacing coarse aggregate wih crushed granite, kadappa and broken paver. The coarse aggregates used in this study are crushed granite, kadappa and old paver block aggregate whose specific gravity are

2.58, 2.44 and 2.60 respectively. As a result, water absorption of paver blocks by using 100% of kadappa stone is 5.01, Compressive strength - 37.73 N/mm2, Splitting strength - 2.38 N/mm2, Bending strength - 7.25 N/mm2. They concluded that kadappa aggregates are better than granite aggregate in terms of water absorption limit and are most suitable as it gives better strength like natural aggregate.

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III. MATERIALS AND METHODS

A. Fly Ash

Fly ash (FA) obtained from Thermal power plant, Mettur Salem district, Tamilnadu state, India confirming to IS: 3812-1981 used in this study. Its specific gravity is 2.00 – 2.05. The chemical and physical properties are shown in Table 1 and 2.

S.No.	Properties	Values in Percentage (%)
1	Silicon di Oxide (SiO_2) + Aluminium Oxide (Al_2O_3) + iron Oxide (Fe_2O_3), % by Mass, Min	88.60
2	Silicon di Oxide (SiO_2), % by mass, Min	54.92
3	Reactive Silica in %, by mass, Min	28.6
4	Magnesium Oxide (MgO), % by Mass, Max	2.82
5	Total sulphur as sulphur trioxide (SO_3), % by mass, max	3.16
6	Available alkalis as sodium oxide (Na_2O) % By mass, Max	0.97
7	Total Chlorides in % by Mass, Max	0.010
8	Loss on ignition, % by mass, max	1.19

Table – 1: Chemical Properties of Fly Ash

S.No.	Properties	Values
1	Normal Consistency	30
2	Initial Setting Time	230
3	Final Setting Time	355
4	Soundness (by Le- chatlier Method)	0.6 mm
5	Compressive Strength at 28 days, percent, (min)	87 N/mm²
6	Residue on 45 micron (%), percent, (max)	19.42

Table – 2: Physical properties of Fly ash

B. Lime

Lime is calcium containing inorganic materials. Strictly speaking, lime is calcium oxide or calcium hydroxide. It is also the name of the natural mineral (native lime) of the CaO composition which occurs as a product of coal seam fires and in altered limestone xenoliths in volcanic eject .The word "lime" originates with its earliest use as building mortar and has the sense of "sticking or adhering".

C. Kadappa Waste

Kadappa wastes used in this study are of small aggregate form. It is obtained after sieving i.e. wastes which passes through 10 mm IS sieve and retained on 4.75 mm IS sieve. Physically, kadappa wastes are quite impervious, hard rock of sedimentary nature. The properties of kadappa waste are shown in Table 3 as per Industry technical data. The various compositions of kadappa stone and its wastes are shown in table 4. Fig. 1 shows the crushed kadappa waste.

S.No.	Properties	Values
1	Hardness	3 to 4 on Moh's scale
2	Density	2.5 to 2.65 Kg/m^3
3	Compressive strength	1800 to 2100 kg/cm^3
4	Water Absorption	Less than 1 %

Table – 3: Physical properties of kadappa waste

S.No.	*Composition*	*Values in Percentage %*
1	Lime (CaO)	38 – 42
2	Silica (SiO_2)	20 – 25
3	Alumina (Al_2O_3)	2 – 4
4	Other oxides like Na, Mg	1.5 – 2.5
5	Loss of ignition	30 – 32

Table – 4: Composition of Kadappa waste

Fig. 1 Crushed kadappa Waste

D. Water

Water is an important ingredient of bricks as it actively participates in chemical reactions with bricks.

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IV. MIX PROPORTIONS

In general the Fly ash bricks are manufactured by mixing fly ash, lime, cement and quarry dust with the mix proportion as given in Table 5.

Ingredients	Proportions
Fly ash	32
Quarry dust	54
Lime	8
Cement	6

Table – 5: Ingredients of Fly - ash bricks

A. Kadappa Fly Ash Bricks

KFB are manufactured with different proportions fly ash, Lime and kadappa waste. Manufactured KFB is shown in Fig. 2. The proportions are in percentage by weight and are given in Table 6.

Fig. 2 Manufactured KFB

Mix ID	Fly ash (%)	Lime (%)	Kadappa Waste (%)
M 1	40	30	30
M 2	40	25	35
M 3	40	20	40
M 4	30	25	45
M 5	30	20	50
M 6	30	15	55
M 7	20	25	55
M 8	20	20	60
M 9	20	15	65

Table – 6: Ingredients of Kadappa Fly - ash bricks

V. METHODOLOGY

In this study, the quarry dust and cement in Fly ash bricks is fully replaced by kadappa waste and Kadappa Fly ash Bricks are manufactured. The materials fly ash, lime and kadappa wastes are well mixed in a pan mixer. The mixed material is ported in conveyer belt to brick manufacturing machine. It is compressed at 28 Mpa and KFB is manufactured.

VI. EXPERIMENTAL STUDY

Properties of KFB such as compressive strength and water absorption were experimented in this study.

Mechanical Property.The compressive strength of Kadappa Fly ash Bricks specimens was obtained as per IS: 4139:1989 & 12894:1990. Fig. 3 shows the loading setup of KFB and Fig. 4 shows the failure of KFB. The 28 day compressive strength of fly ash bricks is shown in Table 7. The comparison of compressive strength of red bricks, Fly ash bricks and KFB are shown in Fig.5.

Fig. 3 Load setup of KFB

Fig. 4 Failure of KFB

Fig.5 Comparison of compressive strength of KFB with Red Bricks and Fly ash Bricks

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Mix ID	Kadappa Fly ash Bricks (N/mm^2)	Red Bricks (N/mm^2)	Fly ash Bricks (N/mm^2)
M 1	11.1		
M 2	13.52	7.75	9.45
M 3	14.23		
M 4	14.42		
M 5	14.49		
M 6	14.56		
M 7	14.92		
M 8	14.78		
M 9	14.51		

Table – 7: Compressive strength test

The compressive strength of KFB M7 is greater than all other KFB's. The Fly ash bricks and Red bricks are 1.92 and 1.5 times lesser in compressive strength when compared to KFB M7.

A. Water Absorption Test

The external causes may be physical, chemical or mechanical and attack by natural or industrial aggressive liquids and gases. Water curing is done for 28 days. After that the dry weight is noted. Then the brick is dumped in water for 1 day and the wet weight 'Ws' is noted. Water absorption values in percentages are given in Table 8.

$$\text{Water absorption} = (W_s - W_d) / W_d$$

Where,

W_s- Wet weight of the specimen

W_d – Dry weight of the specimen.

	Kadappa Fly ash Bricks (%)	Red Bricks (%)	Fly ash Bricks (%)
M1	8.13		
M2	8.2		
M3	7.59		
M4	7.43		
M5	7.02	17.75	13.2
M6	6.8		
M7	6.61		
M8	6.43		
M9	6.39		

Table 8: Water Absorption test

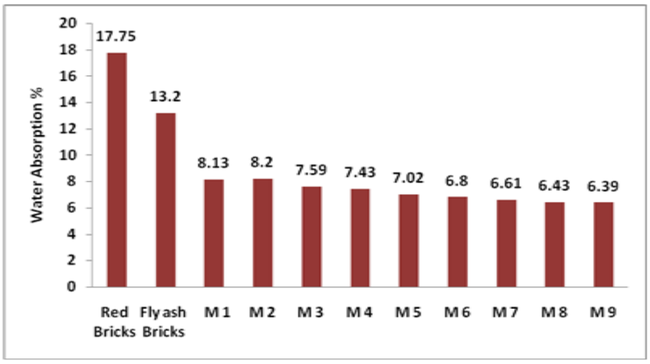

Fig. 6 Comparison of the percentage of water absorption of KFB with Red Bricks and Fly ash Bricks

The Water absorption of KFC M1 absorbs more water than all other KFB's. The Fly ash bricks and Red bricks absorb 1.99 and 2.68 times greater water when compared to KFB M7.

VII. COST FEASIBILITY

The cost of brick which is manufactured will be derived in this chapter. It is done based on the ingredients cost for one kilogram. The cost of ingredients is discussed in Table 9.

S.NO	Materials	Rate (Rs/Kg)
1	Fly ash	0.98
2	Lime	1.50
3	Kadappa Wastes	0.80
4	Labour,Electricity, Maintenance and Others (Wastages)	0.65

Table 9: Cost of Materials

Total cost of KFB The total cost of every individual KFB are given in Table

Mix	Fly ash (in Rs.)	Lime (in Rs.)	Kadappa waste (in Rs.)	Labour, Electricity and others (in Rs.)	Total Cost of a KFB (in Rs.)
M 1	1.18	1.35	0.72	0.65	3.9
M 2	1.18	1.13	0.84	0.65	3.79
M 3	1.18	0.9	0.96	0.65	3.69
M 4	0.88	1.13	1.08	0.65	3.74
M 5	0.88	0.9	1.2	0.65	3.63
M 6	0.88	0.68	1.32	0.65	3.53
M 7	0.59	1.13	1.32	0.65	3.68
M 8	0.59	0.9	1.44	0.65	3.58
M 9	0.59	0.98	1.56	0.65	3.77

TABLE 10: cost of KFB

VIII. UTILIZATION OF WASTES (WASTE MANAGEMENT)

Tadpatri is a town in Anatapur (Dist.), which is having about 1310 stone polishing industries and 300 granite industries. From these industries around 40,000 peoples are benefited directly and indirectly. It is well known place for producing kadappa stone and granite polishing in Anantapur (Dist.).The lime stone reserves are extending from Tadipatri (Anantapur(Dist.) to Kamalapuram , Kadappa(Dist.) and yerraguntla to Bethamcherla in Kurnool district. The following statistical data of waste generation are collected from polishing industries. (This was obtained from the owners of industries).

S.No	Description	value
1.	One tractor carrying capacity to bring rough stone for polishing	1150 Sq.ft.
2.	Damage during transportation	50 Sq.ft.
3.	Finished product from 6 polishing machines	1100 to 1500 Sq.ft.
4.	Waste generation during finishing of lime stone slab	170 to 210 Sq.ft.
5.	Total number of factories	1310

TABLE 11

From the above data, the total quantity of waste generation from the factories per day is calculated as:

Waste generation (if 170Sq.ft consider)
=1310X170
=222700 Sq.ft
Waste generation (if 210 Sq.ft consider)
=1310X210
=275100 Sq.ft

From the above data is observed that daily around 175 to 220 tractors are disposing the waste in and around the town. The quantity of waste being disposed in tons,

Waste being disposed (if 200 tractors considered)
=200X2.5
=500 tons/day

Utilizing these disposed Kadappa wastes as a component in bricks. Say for manufacturing KFB of one lakh numbers, the waste utilized in those bricks can be calculated

KFB M7 (1,00,000 Nos. considered)
=100000X1.65
=1,65,000 kgs

Here 1.65 is the amount of kadappa waste for M7 in Kgs. So the amount of utilization of kadappa waste per day will be 165 tons. Thus, the kadappa wastes being disposed can be utilized to some extent.

IX. CONCLUSION

In the present work the experimental study was done on testing of KFB manufactured with kadappa waste. Based on limited experimental investigations concerning the compressive strength of bricks, the following results were observed regarding the replacement of cement and quarry dust by kadappa waste. Kadappa waste is waste material obtain from sizing and polishing units which is available in

ample quantity. Kadappa waste is economical material as compare to other material use for manufacturing of brick. Kadappa waste has high impact value. Kadappa waste reduces the quantity of fly ash use in brick and it also gives high compressive strength. Compressive strength increases through 0.3% when the amount of fly ash decreases by rate of 10%. Compressive strength increases through 0.27% by increase in lime content at the rate of 5%. Water absorption decreases through 0.11% by decrease in fly ash at the amount of 10%. Water absorption decreases by 0.5% when lime content increases at the rate of 5%. Based on the result, it is clear that compressive strength increases and water absorption decreases by increase in lime and decrease in fly ash. from the compression test and water absorption test results it is concluded that bricks made of kadappa waste can be a replacement for conventional burnt clay bricks and fly ash bricks.

Management studies were done on testing of KFB manufactured with kadappa waste. As per the study result, the utilization of kadappa waste and its application are used for the development of the construction industry. In KFB, incorporation of kadappa waste is increased and the quantity of those wastes that are being dumped can be decreased to some extent. The cost of KFB is low when compared to conventional brick and fly ash brick, so finally the total project cost will be reduced.

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