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Comparison of Fly Ash Bricks and Conventional Burnt Clay Bricks

Rajdeep Singh[1], Sameer Malhotra[2]
[1]*Student, Department of Civil Engineering, GVIET, Banur, India*
[2]*Assistant Professor, Department of Civil Engineering, GVIET, Banur, India*

***Abstract*: In this work, the effects of fly ash on the properties of bricks are studied and the behavior of fly ash bricks is compared with conventional burnt clay bricks. The various properties of fly ash bricks with different materials were tested. The properties studied water absorption, hardness, efflorescence, soundness, shape and size, crushing strength and basic compressive strength of the prism using different mortar mixes normally 1: 3, 1: 4 and 1: 5 cement-sand mortars. In general bricks are made by top fertile agricultural soil but by using fly ash, 28 percent of top fertile agricultural soil is saved. Use of fly ash in brick making also is beneficial in diverse ways. As compared to conventional clay bricks fly ash bricks are stronger, more durable and yet more economical. Also, the process of fly ash brick manufacturing results in lesser pollution. Being less permeable as compared to clay bricks dampness related issues are far lesser in case of fly ash bricks than their clayey counterparts.**

***Keywords*: crushing strength of bricks, conventional Bricks, crushing strength of bricks, fly ash, efflorescence**

1. Introduction

Burnt clay bricks are being utilized widely nearly all through India and are perhaps the most imperative building construction material. Be that as it may, the boundless utilization of clay is hurtful to society as every one of the bricks kilns in India rely upon great quality clay accessible from rural fields and assuming a weight of 3 kg. per brick [1]. The add up to clay taken out from the horticultural fields per day was more than 300 million tons for 10,000 Crore bricks. In addition, clay bricks accessible in specific areas are poor in quality and exorbitant which have constrained designers to search for better material equipped for decreasing the expense of construction. At present, India has creation capacities of more than 10,000 Crore bricks through around 45,000 neighborhood kilns, in the disorderly part [2]. So the utilization of mechanical waste items, for example, fly ash, for making bricks is naturally and financially advantageous since apart from saving precious top agricultural soil, it meets the social objective of disposing industrial waste i.e. fly ash which otherwise is a pollutant and a nuisance. The consistently expanding volume of fly ash amounts on the planet has not been remotely coordinated by its usage. Australia is a country where such usage has been negligible. The most critical and prominent utilization of fly ash in Australia has been in the halfway substitution of portland concrete [3]. The utilization of fly ash in concrete is to the degree of most extreme of 25% substitution of Portland bond. This conservatism can be comprehended with regards to concrete where the ash is blended raw, and the impacts of high volume substitution are as yet subject to look into. It is however not quite justifiable that the brick industry should take similar conservative attitude. Environmental concerns have been raised in some parts of the world where coal is the main power generating resource and where bricks are also the main building material. Such concerns have resulted in legislation to oblige the brick industry to incorporate at least 25% by weight of fly ash and or bottom or pond ash in the brick making mixture if the industry is within 50 km from a coal power generation plant [4]. Some successful ventures have been reported where fly ash was incorporated in the mixture at the rate of 20% to 50%. Nevertheless, there is only little evidence that incorporation of fly ash in the brick mixture has exceeded the 30% by volume, even when the legislation was obeyed. Reasons behind such reluctance are not clear. A most probable reason is the fear of change in many small factories and the ingrained conservatism in the attitude of stake holders of the large producers. Added to this is the fact, that with an existing clay brick factory, the incorporation of fly ash is a potential addition of cost. The possible incompatibility of the ash with the clay and shale during the various processes of production including the crucial one of firing may be a legitimate difficulty. At high temperatures beyond 1000 ºC, the temperature and length of time of firing become very sensitive to the type of ash and of course to the clay and shale if in the same mixture [5]. This would be the case as long as the factory still uses the ash as partial replacement to the main clay and shale ingredients. The situation may become completely different when the ash is the only ingredient of the bricks mixture. Compatibility is no more an issue in such a case. So far, few attempts at manufacturing bricks from more than 80 % fly ash have been made. The engineers now believe that fly ash on its own can be an excellent raw material for brick making. This has now been proven and a patent is taken for the manufacture of bricks from fly ash. The response of the ash to firing temperature at 1000 ºC and beyond can be accurately controlled even in small factories [6]. The potential savings with this approach are many. Savings in production and transportation costs and producing bricks of

superior qualities to those of standard clay bricks are in addition to the environmental solution that such venture may bring about.

In this work, the effects of fly ash on the properties of bricks are studied and the behavior of fly ash bricks is compared with conventional burnt clay bricks. The various properties of fly ash bricks with different materials were tested.

2. Scope and utmost goal of demonstrated work

The utmost and major goal of this research work is to study the effect of fly ash bricks on the performance and the properties of bricks with the view to study the comparison between clay bricks and a fly ash brick because fly ash is enriched with silica, is the main constituent for conventional building material. From the experiment, it is further desired to compare the strength of fly ash brick by that of the conventional clay brick. The salient properties of bricks like crushing strength, water absorption, shape and size, soundness, hardness and efflorescence are to be determined. Bricks will always be the necessity of building materials and in future soil for the making of bricks would not be available in plenty as the use of land is rapidly increasing, at that time fly ash will fulfil the necessity of clay bricks as these bricks are made by the industrial wastes. Moreover the building structures are getting heavier with time, the use of fly ash bricks would be more efficient as its strength is more than that of clay bricks.

3. Experimental demonstration

In this research work, following tests are performed on fly ash bricks to find out its suitability for the construction work:

A. Absorption test

This test is carried out to determine the amount of water absorbed by the brick. When immersed in water for a period of 24 hours it should not, in any case, exceed 20% of weight of dry brick. This test is carried out for all the samples of fly ash bricks and clay bricks. Table 1 represents the properties of normal bricks and Table 2 shows properties of fly ash bricks.

Table 1
Properties of normal bricks (tested)

S. No.	Dry weight (kg)	Wet weight (kg)	Water absorption (gm)
1	3.13	3.5	10.57
2	3.21	3.64	11.81
3	2.78	3.21	13.4
Average			11.93

Table 2
Properties of fly ash bricks (tested)

S. No.	Dry weight (kg)	Wet weight (kg)	Water absorption (gm)
1	3.17	3.47	8.64
2	2.98	3.30	9.70
3	3.00	3.37	10.97
Average			9.77

B. Hardness test

This test is carried out to see that the brick is sufficiently hard or not. We can judge hardness of the brick by making impression on the surface of the brick with the help of a finger nail. This test is carried out for all samples of fly ash bricks and clay bricks.

Table 3
Checking of impressions on bricks when scratched with nail

Normal Bricks	Fly Ash Bricks
No impression after scratching with the help of a finger nail.	No impression after scratching with the help of a finger nail.

C. Efflorescence test

This test is conducted for finding out the presence of soluble salts in a brick when it is immersed in water for 24 hours and taken out and allowed to dry in shade. Absence of grey or white deposits on its surface indicates absence of soluble salts. If the white deposits cover about 10%surface, the efflorescence is said to be slight and it is considered as moderate, when the white deposits cover about 50% of surface. If grey or white deposits are found on more than 50% of surface, the efflorescence becomes heavy and it is treated as serious, when such deposits are converted into powdery mass. This test is carried out forth fly ash bricks and clay bricks. Table 4 shows the efflorescent test results.

Table 4
Efflorescent test

Normal Bricks	Fly Ash Bricks
Slight to moderate	The grey deposit is less than 10 %.

D. Soundness test

This sound is carried out to find out that a clear ringing sound is produced or not when the two bricks are struck with each other without breaking any of the two bricks. If the two bricks are not broken after striking with each other and a clear ringing sound is produced then it means that the bricks are sufficiently sound. The procedure of this test is self-explanatory.

Table 5
Sound test

Normal Bricks	Fly Ash Bricks
Good	A clear ringing sound produced.

E. Shape and size test

This test is done to examine the structure of the brick when the brick is broken. It is seen that the structure of the brick is homogeneous, compact and free from any defects such as holes, lumps etc. or not. Mainly the defects such as holes, lumps should not be there.

F. Shape and size test

This is the main test conducted to test the suitability of the brick for construction work. This test is executed with the help of compression testing machine. A brick is placed in a compression testing machine.

It is pressed till it breaks. Then the compression strength of the brick is recorded from meter of the compression testing machine. A brick after undergoing compression test, this test is carried out for both fly ash bricks and clay bricks.

Table 6
Crushing strength test (normal bricks)

S. No.	Length mm	Breadth mm	Depth mm	Load KN	Crushing Strength (N/mm^2)
1	228	110	72	220	8.7
2	221	110	70	160	6.58
3	220	105	69	160	6.93
4	218	104	70	220	9.7
5	227	104	74	200	8.47
6	226	103	71	190	8.47

Table 7
Crushing strength test (fly ash bricks)

S. No.	Length mm	Breadth mm	Depth mm	Load KN	Crushing Strength (N/mm^2)
1	228	114	75	387	14.89
2	227	114	76	522	21.33
3	228	113	74	390	15.13
4	217	114	74	613	23.68
5	227	114	74	453	17.50
6	226	113	73	520	20.36

Table 8
Crushing strength test (normal bricks)

Mortar type	Prism size mm (lLxBxH)	h/t	correction factor	Failure Load KN	Stress of fly Ash bricks MPa	A Bricks as per IS:1905-1987 MPa
1	600×230×685	3	0.86	290	1.8	1.31
2	600×230×610	2.65	0.82	264	1.56	1.19
3	600×230×610	2.65	0.82	240	1.42	1.13

G. Prism test

Fig. 1. Prism test on fly ash bricks

4. Results and discussion

The average absorbed moisture content of clay bricks is found to be 11.93% and for fly ash bricks are found to be 9.77%. Thus there is net 18.10% decrease in moisture absorbed for fly ash bricks as a part to clay bricks.

A. Absorption test

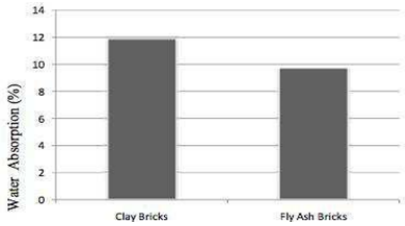

Fig. 2. Absorption of water (percent)

B. Hardness test

The hardness test for clay bricks and fly ash bricks was conducted, test brick was taken and scratch was made on bricks surface with the help of finger nail and found no impression after scratching in both the cases.

C. Efflorescence test

The Efflorescence test for clay bricks and fly ash bricks was conducted and the results were compared in which Grey or white deposits are slight to moderate in normal bricks and less than 10% on the surface area in fly ash bricks.

D. Soundness test

The Soundness test for clay bricks and fly ash bricks was conducted and the results were compared in which two bricks are struck with each other. It was found that a normal brick shows good results when struck with each other but fly ash bricks show clear ringing sound.

E. Shape and size test

The Shape and Size test is done for clay and fly ash bricks to examine the structure of a brick when the brick is broken and it was found both types of bricks are free from any defects such as holes, lumps etc. but fly ash bricks are compact and homogeneous.

Table 9
Results of crushing strength test

Type of Bricks	Average Crushing Strength (N/mm)^2	% Increase Average Crushing Strength
Class A Clay Bricks	8.14	---
Fly Ash Bricks	18.81	56.72

F. Crushing strength test

Crushing strength test for clay bricks and fly ash bricks was conducted and the result are compared. The crushing strength of clay bricks is found to be 8.14 N/mm^2 and for fly ash bricks is found to be 18.81 N/mm^2. Thus there is net 56.72% increase is crushing strength for fly ash bricks as a part to clay bricks.

G. Prism test

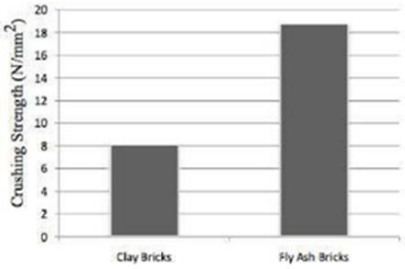

Fig. 3. Crushing strength (N/mm^2)

H. Load

In prism testing of 1:5 cement sand mortar maximum width of crack appeared to be 3.5 mm and average width of crack was 1 mm on applying load of 60 KN. On again applying load crack were measured with the maximum width of 6 mm and average crack width of 2 mm by applying load of 180 KN. In prism testing of 1:4 cement sand mortar maximum width of crack appeared to be 1.5 mm and average width of crack was 1 mm on applying load of 140 KN. On again applying load crack were measured with the maximum width of 2.5 mm and average crack width of 1.5 mm by applying load of 190 KN. Prism of 1:4 cement sand mortar failed on applying load of 264 KN.

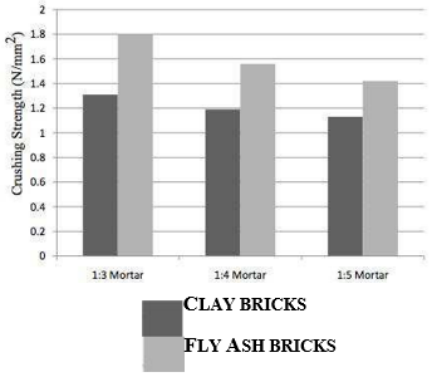

Fig. 4. Crushing strength by prisms (N/mm^2)

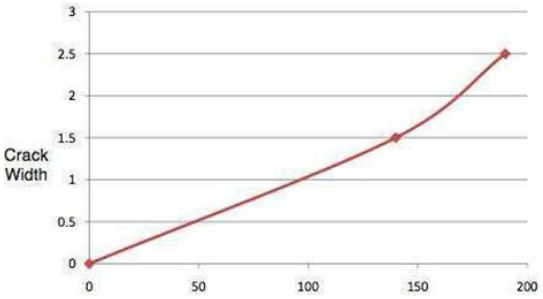

Fig. 5. Cracks in 1:4 cement sand mortar prism

In prism testing of 1:3 cement sand mortar maximum width of crack appeared to be 3.5 mm and average width of crack was 1.5 mm on applying load of 180 KN. On again applying load crack were measured with the maximum width of 6 mm and average crack width of 2 mm by applying load of 210 KN. Prism of 1:3 cement sand mortar failed on applying load of 290 KN.

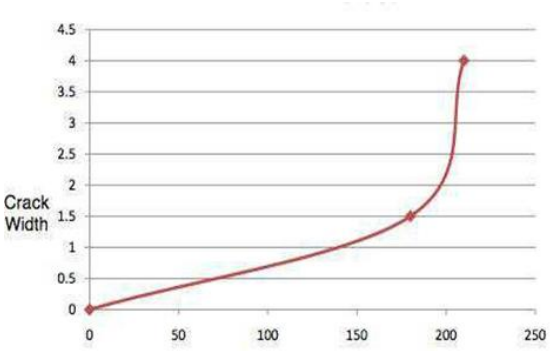

Fig. 6. Cracks in 1:3 cement sand mortar prism

5. Conclusion

Fly Ash Bricks were observed to be adequately hard as scratching by the finger nail at first glance left no impact on it when contrasted with typical bricks. The Efflorescence of all bricks tried were observed to be slight as white or dark stores were under 10% on surface of the bricks which is relatively same as that in the typical bricks. A ringing sound in the Fly ash Bricks was seen to be obviously better than that in ordinary bricks. Structure of the bricks was observed to be minimal, homogeneous and free from any imperfections like holes, lumps and so on when contrasted with ordinary bricks. The normal ingested dampness substance of clay bricks is observed to be 11.93% and for fly ash bricks are observed to be 9.77%. In this way there is net 18.10% diminishing in dampness consumed for fly ash bricks as a section to clay bricks. The crushing quality of clay bricks is observed to be 8.14 N/mm^2 and for fly ash bricks is observed to be 18.81 N/mm^2. Consequently there is net 56.72% expansion is crushing quality for fly ash bricks as a section to clay bricks. The crushing strength by prism of clay bricks is found to be 1.31 N/mm^2 and for fly ash bricks is found to be 1.8 N/mm^2. Thus there is net 27.22% increase is crushing strength by prism for fly ash bricks as compared to clay bricks. The crushing strength by prism of clay bricks is found to be 1.19 N/mm^2 and for fly ash bricks is found to be 1.56 N/mm^2. Thus there is net 23.71% increase is crushing strength by prism for fly ash bricks as compared to clay bricks. The crushing strength by prism of clay bricks is found to be 1.21 N/mm^2 and for fly ash bricks is found to be 1.59 N/mm^2. Thus there is net 23.90% increase is crushing strength by prism for fly ash bricks as compared to clay bricks.

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