

# Study of Engineering Properties of Fly Ash Bricks for Construction

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**ABSTRACT:** The coal fired thermal power station generate large volumes of fly ash every year. In this study an attempt has been made to prepare bricks from fly ash with other ingredients with study of engineering properties. Combinations used were (i) Flyash, clay, sand (ii) Flyash, cement, stone dust (iii) Flyash, Lime, sand and Gypsum. Maximum compressive strength found 93.25 Kg/cm<sup>2</sup> for mix 30:40:30, 105 Kg/cm<sup>2</sup> for mix 35:07:58 and 174 Kg/cm<sup>2</sup> for mix of 40:30:20:10 respectively.

**KEYWORDS:** Engineering properties, Fly ash Bricks, Compressive Strength, Volumetric Shrinkage, Density.

## I. INTRODUCTION

The coal fired thermal power station generate large volumes of fly ash in view of the high ash content of Indian coals. Presently, fly ash to the tune of more than 100 million tones are generated every year. The utilization rate is only about 10-15% and most of the fly ash still gets disposed off as a wet slurry to the ash pond thereby, resulting in vast agricultural lands being used up for this purpose and also creating environmental problem in terms of air and water pollution.

Our country needs about more than 60 billion bricks every year and thus exhaust about  $1600 \times 10^6$  KN of clay from agricultural land. It will thus make barren about 3000 ha of fertile land. The extent of damage is increasing as the demand of bricks is raising continuously for housing. Thus it will also load to the erosion of fertile land, degradation of soil and disturbance in ecology. One of the alternatives to overcome this problem is to use the flyash as a mix in building material.

## II. MATERIALS AND METHODS

The fly ash was collected from the Thermal Power Plant, Parli Vaijnath Dist. Beed . Bricks are prepared from various mix of fly ash, clay and sand. Its properties such water absorption, weight per unit volume, compressive strength were measured.

Secondly for fly ash bricks were prepared by using cement and stone powder in varying proportions. Also, the bricks were prepared from flyash, lime, sand and gypsum. The bricks were prepared by using different proportions of fly ash, lime, sand and gypsum.

Initially the lime was slaked with water and made it soft. The flyash was thoroughly mixed with fly ash shows cementious property. The sand was used as an adulterant and gave the strength to the bricks. The gypsum was used in the mixture to increase the speed of hardening. The admixture was tempered by adding required quantity of water.

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The bricks are prepared by moulding it in 10 x 10 cm size mould. The clay in the mould was compacted by using compaction machine. The blocks were kept in shade for drying and curing for 7-10 days.

### Test conducted in laboratory

**Shrinkage test :** Volumetric shrinkage is the measure which decide the final size of mould which was to be used in the brick preparation.

$$1) \quad \text{Volumetric shrinkage} = \frac{W_1 - W_2}{W_2} \times 100$$

$W_1$  - Volume of moulded bricks (cm<sup>3</sup>)  
 $W_2$  - Actual volume of moulded bricks after drying (cm<sup>3</sup>).

$$2) \quad \text{Density} = \frac{M}{W} \times 100$$

$M$  - Mass of dry block in gm  
 $W$  - Volume of dry blocks (cc)

3) Percent water absorption : The dried brick was immersed in water for 24 hours.

$$W_3 = \frac{W_2 - W_1}{W_1} \times 100$$

$W_1$  - Weight of dry brick in kg.  
 $W_2$  - Weight of brick after 24 hrs immersion in water  
 $W_3$  - Percent water absorption.

4) Compression test : Universal Testing Machine was used to determine compressive strength of the brick.

$$5) \quad \text{Compressive strength} = \frac{\text{Crushing load (kg)}}{\text{Surface area in contact}} \times 100$$

Others test for bricks were carried out such as hardness, presence of soluble salt, soundness and structure.

### III. EXPERIMENTAL RESULTS

Results obtained for Fly-ash, Clay and Sand Bricks are shown in following TableNo.1

Table 1 : Properties of Fly-ash, Clay and Sand Bricks

Sr. No.	Mix FA:CL:S	Water absorption (%)	Weight per unit volume kg/cm <sup>3</sup>	Compressive strength (kg/cm <sup>2</sup> )
1.	0:80:20 (A)	15.41	1827	62.47
2.	10:70:20 (B)	18.50	1491	70.40
3.	20:60:20 (C)	19.49	1379	80.10
4.	30:40:30 (D)	19.80	1372	93.25
5.	40:30:30 (E)	21.80	1320	88.20

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From above table, it is observed that, the water absorption ranges from 15.41% to 21.80%. Mix S.No.4 with 30 per cent fly ash and sand gave maximum strength of 93.25 kg/cm<sup>2</sup>. The mix without fly ash for S. No.1 having 20% sand results compressive strength of 62.47 kg/cm<sup>2</sup>. It is observed that flyash more than 30% shows decreasing strength.

Table 2 : Properties of fly ash, cement and stone dust bricks.

Sr. No.	Composition	Flyash(%)	Cement (%)	Stone Dust (%)	Water absorption (%)	Compressive strength (kg/cm <sup>2</sup> )
1.	A	35	7	58	8.2	105.0
2.	B	40	7	53	9.0	98.0
3.	C	45	7	48	9.5	85.0
4.	D	35	5	60	10.0	74.0
5.	E	40	5	55	10.5	70.0
6.	F	45	5	50	10.5	50.0

From Table No.2, the fly ash bricks manufactured from fly ash, cement, and stone dust are used for brick manufacturing. The brick compositions with fly ash content up to 45% shows excellent strength and minimum compressive strength of 50 kg/cm<sup>2</sup> for 45% of flyash and 50% stone dust. Water absorption not exceeding 10% by mass up to 35% of flyash .

Table 3 : Properties of fly ash- Lime – Gypsum bricks.

Sr. No.	Proportion (FA:L:S:G)	Average density (gm/cm <sup>3</sup> )	Water absorption (%)	Compressive strength (kg/cm <sup>2</sup> )	Volumetric shrinkage (%)
1.	40:30:20:10 (A)	1.24	14.0	174	9.50
2.	50:25:15:10 (B)	1.20	13.2	168	5.20
3.	60:20:10:10 (C)	1.14	12.5	124	6.24
4.	70:15:05:10 (D)	1.11	12.0	78	6.0
5.	80:10:00:10 (E)	1.10	11.0	64	5.00

From Table No.3, it was observed that fewer cracks were developed in the proportions of mix A & B. However, negligible cracks were seen in sample C, D & E. The development of fewer cracks is due to the use of more lime. The volumetric shrinkage decreased with the increase of fly ash and lime. The volumetric shrinkage was found in the range of 5-9.5% .

The density of bricks decreased with the increase in flyash, lime, sand and gypsum proportion. It is related with the volumetric shrinkage and was found in the range of 1.10 to 1.24 gm/cm<sup>3</sup>. The water absorption of the blocks were found in the range of 11-14%. As per IS - code percent water absorption in 24 hours should be less than 20 per cent. Compressive strength is the main property which determines the ultimate crushing strength of the bricks. The compressive strength determined by using Universal Testing Machine. Mix A, B,C,D,E, were found to be 174, 168, 124, 78 & 64 kg/cm<sup>2</sup> respectively. Thus, the maximum compressive strength was observed in the proportion A & B satisfies the requirement of class-A bricks.

Other tests for bricks reveals that no scratch was observed by using nails on the surface of the brick. There was no efflorescence seen on the surface of the brick. Clear ringing sound was heard after striking two bricks with each other. The structure after breaking of the brick was found dense and homogenous.

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## IV. CONCLUSION

Combinations used were (i) fly ash, clay, sand and (ii) fly ash, cement, stone dust and (iii) fly ash, Lime, sand and Gypsum. Maximum compressive strength found 93.25 Kg/cm<sup>2</sup> for mix 30:40:30, 105 Kg/cm<sup>2</sup> for mix 35:07:58 and 174 Kg/cm<sup>2</sup> for mix of 40:30:20:10 respectively.

It seems that the fly ash added building bricks show reasonably good properties and may become competitive with the conventional building bricks. Use of fly ash as a raw material for the production of building bricks is not only viable alternative to clay but also a solution to a difficult and expensive waste disposal problem. Flyash-lime gypsum bricks are very good products giving the highest strength among various bricks.

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