COMPARITIVE STUDY OF THE PROPERTIES OF FLY ASH CLAY BRICKS AND CLAY BRICKS

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Abstract: Brick is one of the most widely used construction materials throughout the world since ancient time. Fly ash clay bricks are one of the best alternatives to the conventional burnt clay bricks. This dissertation gives the results of an experimental investigation in which the compressive strength, water absorption, density and durability of Fly ash-clay bricks are investigated by using varying quantities of fly ash with partial replacement of clay. The properties of Fly ash clay bricks are compared with those of the ordinary burnt clay bricks. The results indicate that these bricks are lighter in weight, durable in aggressive environments and have sufficient strength for their use in building construction.

Keywords: Fly ash; Brick; Clay; Sand; Compressive Strength.

1. GENERAL- .Fly Ash from the NTPC TANDA (U.P.) plant produces 6-800 tons of fly ash per day, over 20 MT a year, in the form of dry Bottom Ash. Gorakhpur is situated only 111 km away from the NTPC Tanda, Ambedkar Nagar (U.P.). Energy requirements for the countries for electricity get energy from coal. Thermal power stations use pulverized coal as fuel generates large quantities of fly ash as by-product. The disposal of the thermal waste is called fly ash. Fly ash is a powdery substance collected by the electrostatic precipitators in the thermal power plants. There are about 125 thermal power plants in India, which form the major source of fly ash in the country (Kumar and Singh, 2006).

In India, construction industry shares a part about 9 % of the Gross Domestic Product (GDP), and annual growth of about 10%. Clay bricks are the main building material for the construction industry and housing. In developing countries in the world, India is one of the largest with the economic growth rate averaging 9% for the last 5 years plan so that this growth rate will also effect on the construction work and GDP. The brick technology in India varies from region to region and depends generally on scale of production, soil and fuel available, demand, market conditions and also on the enforcement of law for shifting from one technology to the other

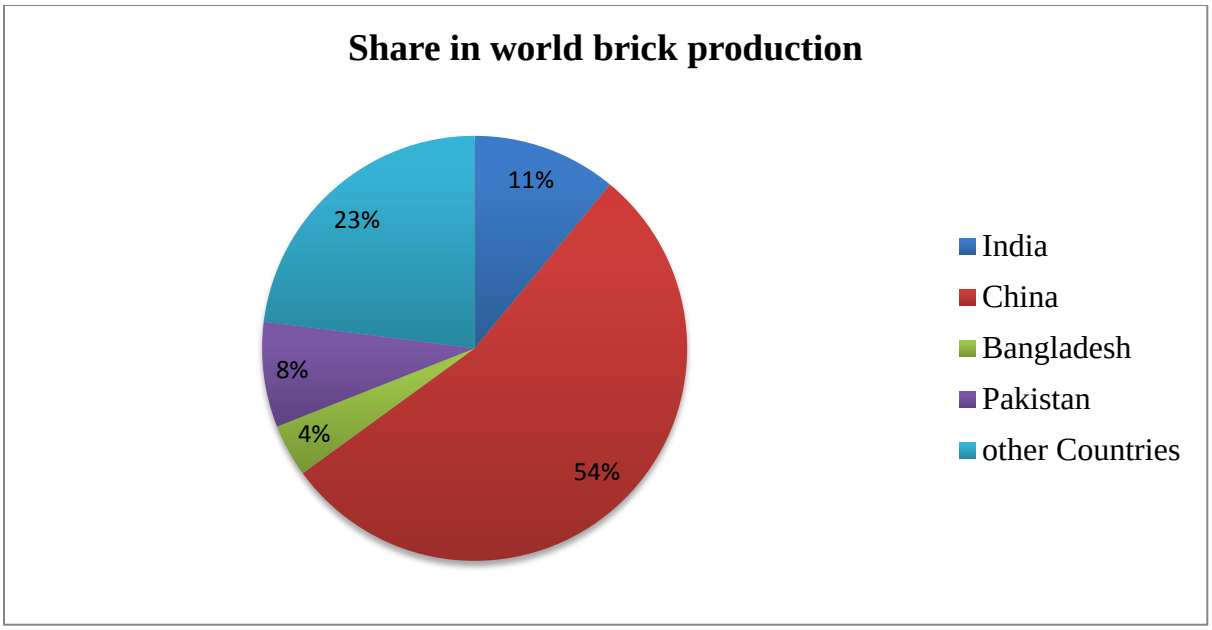


Fig 1 Share in world brick production

The GOI (Government of India) on 14th September 1999, published in the Gazette under S.O. 763 (E), Directions under the Environment (Protection) Rules, notifying the "**Use of fly ash, bottom ash or pond ash in the manufacture of bricks and other construction activities.**" *(Annex 14).* **It requires brick-makers within a radius of 50 KM from thermal coal or lignite-based power plants to use at least 25% by weight of ash to be mixed with soil for brick-making.**

2. RAW MATERIALS- The raw materials which are used for the making of bricks are as follows-

(i) Clay- Clay is a fine grained soil. It is a cohesive soil. The particle size is less than 0.002 mm. It is usually dark grey or black in colour. It is conspicuous odour. They differ from other grains in their chemical composition and physical properties. In chemical terms they are hydrated alumina-silicates formed by the leaching process acting on the primary minerals in rock. Physically speaking, clay very often assumes a platy elongated shape. Their specific surface is infinitely greater than that of rougher round or angular particles. Clay is one of the most mineral materials on all over the earth for bricks.

Clays occur in three principal forms, all of which have similar chemical compositions but different physical characteristics.

1. **Surface Clays-** Surface clays may be the up thrusts of older deposits or of more recent sedimentary formations. As the name implies, they are found near the surface of the earth.
2. **Shale-** Shale is clays that have been subjected to high pressures until they have nearly hardened into slate.
3. **Fire Clays-** Fire clays are usually mined at deeper levels than other clays and have refractory qualities.

(ii) Fly Ash- A fine glass powder recovered from the gases of burning coal during the production of electricity is fly ash. These micron sized earth elements consist primarily of silica, alumina and

iron. The combustion of powdered coal in thermal power plants produces fly ash. The high temperature of burning coal turns the clay minerals present in the coal powder into fused fine particles mainly comprising of aluminum silicate. Fly ash produced thus possesses both ceramic and pozolanic properties. A fine glass powder recovered from the gases of burning coal during the production of electricity is fly ash. These micron sized earth elements consist primarily of silica, alumina and iron. The combustion of powdered coal in thermal power plants produces fly ash. The high temperature of burning coal turns the clay minerals present in the coal powder into fused fine particles mainly comprising of aluminum silicate. Fly ash produced thus possesses both ceramic and pozolanic properties.

Table 1: Physical Properties of Fly Ash

Sl. No.	Constituent/Property	Value
1	Colour	Grey
2	Percent passing 75μ sieve	76%
3	Size of particle	0.002-0.30mm
4	Maximum Dry Density (MDD)	1.183g/cc
5	Optimum Moisture Content	22%
6	Specific Gravity	2.02 at 27^0C
8	Plastic Limit	Non-plastic
9	Classification	Class C and Class F

3. METHODOLOGY OF MAKING BRICKS-

Clay fly ash brick manufacturing is most suitable for transition with minimum changes from existing practices and manual molding of bricks, which is most common. CBRI technology is well tried and tested. These can also have semi-mechanized operations, but manual operations are most effective cost. There are many processes which are used for the manufacturing of Bricks. The major steps in preparation of bricks by Chimney Kilns process are as follows:-

1) Collection of Different clay and Fly ash.
2) Mixing and preparation of clay-fly ash mix.
3) Preparation of Bricks through moulds.
4) Moulding Procedure
5) Drying of Bricks.
6) Filling of Kiln.
7) Burning of kiln.
8) Inspection and sorting of Bricks according to grades.

Fly Ash-Clay Brick: (As per CBRI) Brick Composition: Fly Ash - 30% and Clay- 70%.We have taken five samples of clay and fly ash i.e.

1) Clay- 75% and Fly Ash -25%
2) Clay- 70% and Fly Ash -30%
3) Clay- 65% and Fly Ash -35%
4) Clay- 60% and Fly Ash -40%
5) Clay- 55% and Fly Ash -45%

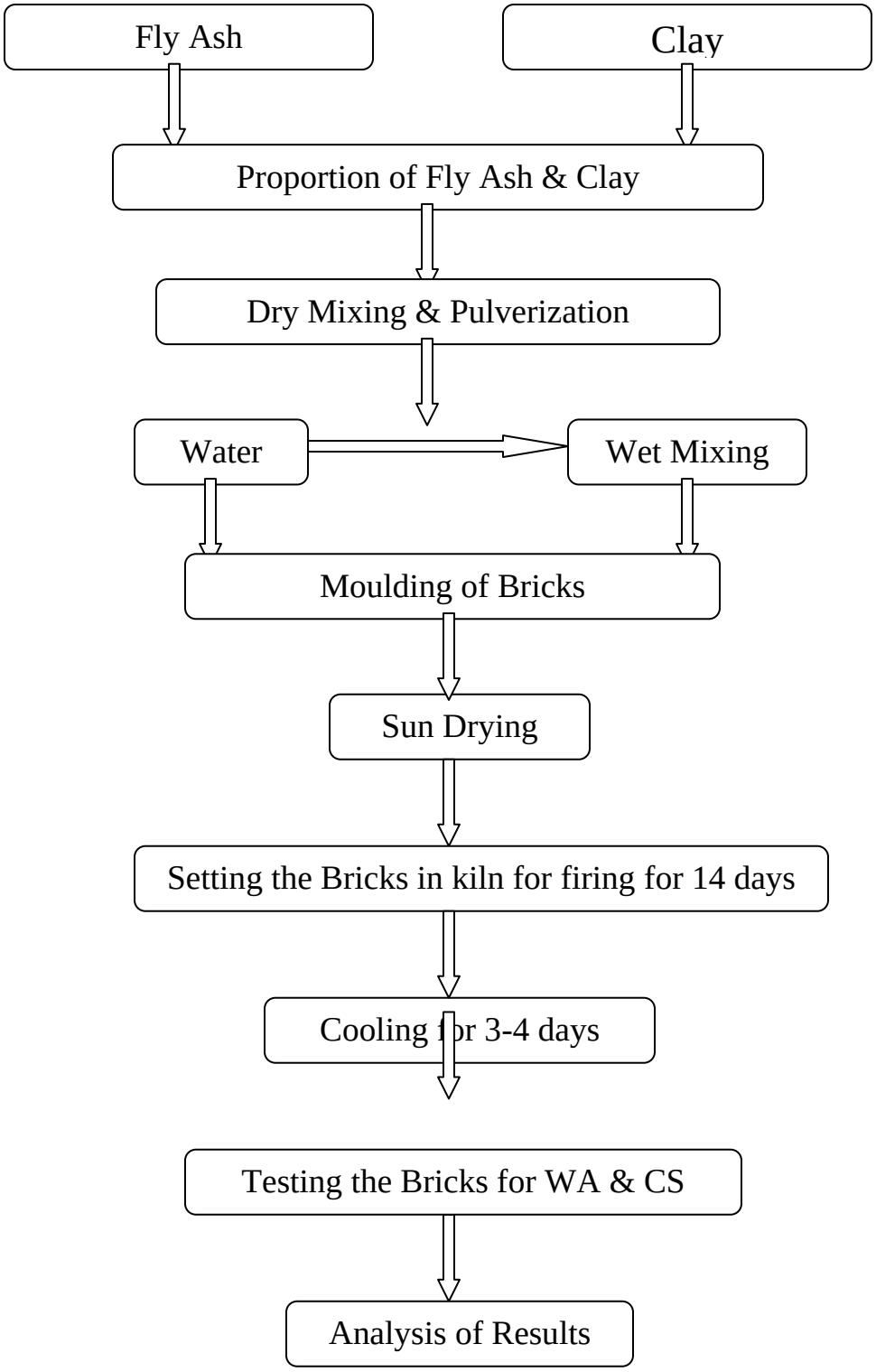


Fig 5.8 Flow chart showing methodology of bricks

4. EXPERIMENTAL SET UP & PROCEDURE-

Tests are conducted for the acceptance of bricks for building construction. We have to be very sure about strength and worthiness of basic building unit i.e. Bricks. Following tests are performed to check the quality of bricks-

4.1. DIMENSION AND TOLERANCE TEST-

For the bricks dimensions measurement, the procedures is based on Clause 5.2.1, IS 12894:2002. The required apparatus in this test is measuring tape. The number of specimens for the test shall be selected according to IS 5454:1976. In this test, a total of 10 bricks are selected randomly from the bricks stack. Any blister, small projections or loose particles of clay that adhered to each brick are removed.

Table 2: Size of bricks

SIZE OF BRICK	LENGTH (mm)	WIDTH (mm)	HEIGHT (mm)	PLAN AREA (mm^2)
	230	120	75	27600

4.2 WATER ABSORPTION TEST

The Bricks are weighed dry. Then they are immersed in water for a period of 24 hours. Samples are taken out and wiped with cloth. The weight of samples in wet condition is determined. The differences in weights indicate that the water is absorbed. The total water absorption is defined as the increase in the weight of a material due to moisture in air, and procedure is as follows-

Water absorption in (%) = $\frac{W_2 - W_1}{W_1} \times 100\%$

Sl. No.	% OF FLY ASH ADDED	WATER ABSORPTION (%)					
		SA-1	SA-2	SA-3	SA-4	SA-5	AVERAGE
1	25	14.785	14.774	14.919	14.457	14.822	14.751
2	30	18.857	17.575	18.329	17.441	17.106	17.861
3	35	16.636	16.961	17.047	16.949	17.366	16.991
4	40	17.909	17.495	17.780	17.523	17.988	17.154
5	45	16.566	17.091	17.047	17.338	17.731	17.739

Sl. No.	WATER ABSORPTION OF CLAY BRICKS (%)					
	SA-1	SA-2	SA-3	SA-4	SA-5	AVERAGE

N1	14.571	12.527	13.812	13.295	12.484	13.337
N2	14.976	14.785	14.042	13.426	14.085	14.262
N3	14.746	15.079	12.305	14.542	13.469	14.028
N4	14.961	14.774	12.416	14.263	13.787	14.032
N5	15.152	13.888	14.944	14.065	14.960	14.601

4.3 COMPRESSIVE STRENGTH TEST

The Test is conducted as per IS-3495, Part-1, 1992. The load is applied axially at a uniform rate of 15 N/mm2. The crushing load is noted as IS an (Indian Standard) code permitting the limits for the good quality bricks. Calculation of the compressive strength the following dimensions are taking as average dimension. The calculation for the compressive strength of bricks is as:

$$\text{Compressive Strength} = \frac{\text{Maximum loat at failure (N)}}{\text{Average area of bed face (mm2)}}$$

Sl. No.	COMPRESSIVE STRENGTH OF CLAY BRICKS(N/mm²)					
	SA-1	SA-2	SA-3	SA-4	SA-5	AVERAGE
N1	9.601	9.782	9.420	9.239	9.420	9.420
N2	9.963	9.601	9.782	9.963	9.963	9.601
N3	10.14	10.32	9.963	9.782	9.420	9.420
N4	9.420	9.601	9.782	9.963	10.50	10.32
N5	9.601	9.239	9.420	9.420	9.420	9.782

Sl. No.	% OF FLY ASH ADDED	COMPRESSIVE STRENGTH OF FLY ASH CLAY BRICKS (N/mm²)					
		SA-1	SA-2	SA-3	SA-4	SA-5	AVERAGE
A	25	6.34	6.15	6.08	6.34	6.88	6.35
B	30	6.70	7.06	6.34	7.24	7.42	6.95
C	35	8.69	8.51	9.23	8.87	9.42	8.94
D	40	5.61	7.24	6.15	6.08	5.43	6.10
E	45	5.97	5.79	5.61	5.97	5.79	5.82

4.4 EFFLORESCENCE TEST

In bricks presence of the soluble salts cause efflorescence on the surface of brick. Brick is immersed in water for 24h. It is then taken out and allowed to dry in shade. The absence of grey

or white deposits on its surface indicates absence of soluble salts.

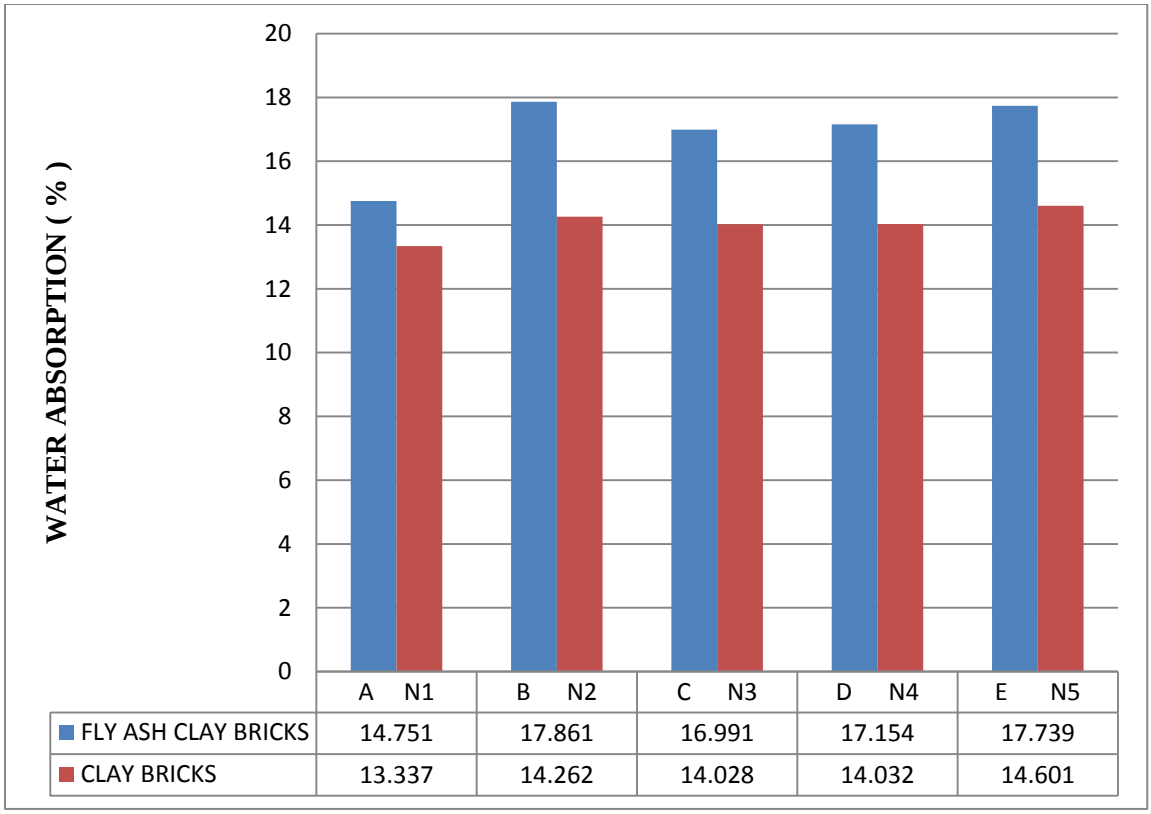
Observation is made with naked eyes and classified as below.

- **Nil** – No patches or imperceptible efflorescence.
- **Slight –** 10% of area covered with deposits.
- **Moderate** – 10 to 50% area covered with deposit but unaccompanied by flaking of the surface.
- **Heavy** – More than 50 per cent area covered with deposits but unaccompanied by flaking of the surface.
- **Serious** – Heavy deposits of salt accompanied by flaking of the surface

5. RESULTS AND CONCLUSION-

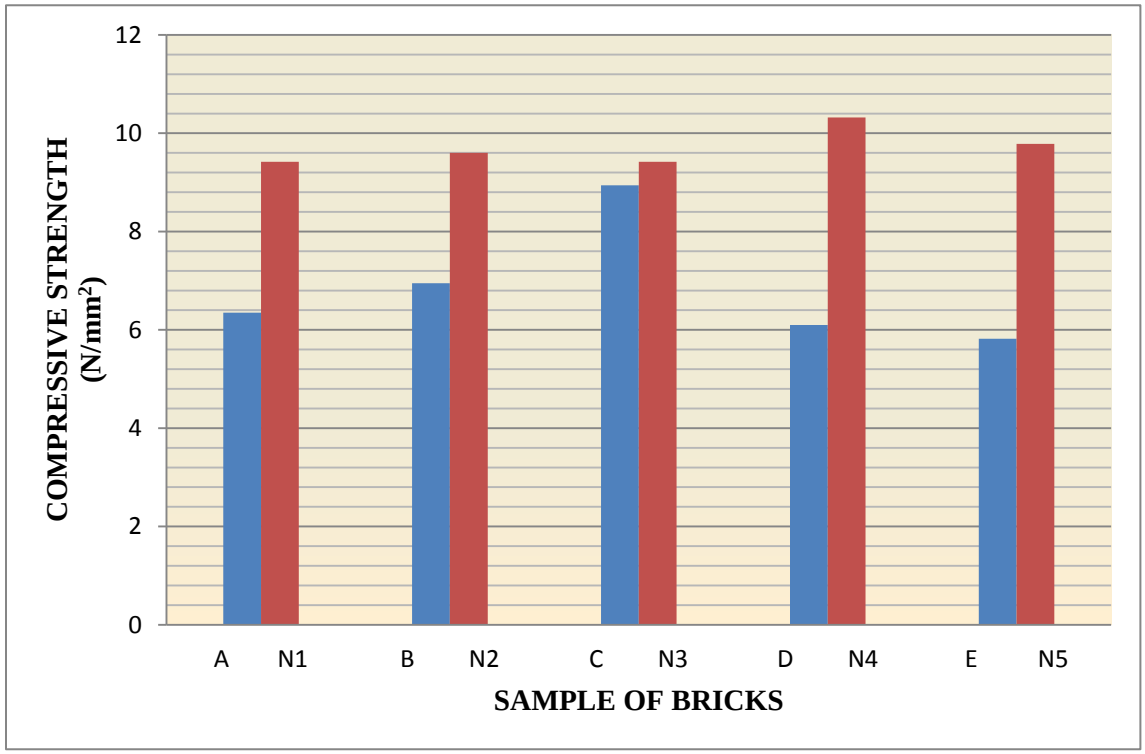
After all the efforts and learning of local technologies and practices and with the help of experimental investigation, the following observations are made from fly ash clay bricks with different percentage of fly ash and also minimize impacts on the environmental by utilization of Class F fly ash in the manufacturing of bricks .The present research replicate the effect of waste product like Fly Ash on compressive strength of brick and results is obtained. The results of Fly Ash Clay Bricks and Clay Bricks are as per IS-1077 – 1992 and IS-13757 – 1993 respectively**.** From the experimental results obtained, it can be concluded that

1) The burnt bricks manufactured with fly ash appearance when compared to the clay bricks, the percentage of water absorption for bricks is found to be less than that of conventional bricks but still within the prescribed maximum limit as per Indian Standards maximum is 20%. The Clay burnt bricks, when tested in accordance with the procedure



	A N1	B N2	C N3	D N4	E N5
FLY ASH CLAY BRICKS	14.751	17.861	16.991	17.154	17.739
CLAY BRICKS	13.337	14.262	14.028	14.032	14.601

2) The Clay bricks having fly ash as an admixture showed the best performance, having a compressive strength of near about conventional bricks. In this figure the compressive strength of Fly Ash Clay Bricks is similar to the Clay Bricks against the 35% fly ash added. Hence we can conclude that compressive strength of Fly Ash Clay bricks is good than the clay bricks. We can use it for future work as a building material.



3) Finally it can be concluded from the above experiments, the properties of the fly ash clay burnt bricks which are as given below-

Optimum % of fly ash addition	35%
Water Absorption (at 35% Fly Ash)	17 %
Compressive Strength (at 35% Fly Ash):	8.94 N/mm^2

The properties of clay bricks are as follows-

Water Absorption	14.6 %
Compressive Strength	10.32N/mm^2

Hence the bricks may be termed as Class 7.5 as per BIS: 3492 Part 2: 1992 and the Class 10 as IS 13757:1993, the water absorption up to class 12.5 should be less than 20% as per IS 3495 (Part 2): 1992. The bricks prepared confirm to this criterion too

Sl. No.	CLAY BRICKS	FLY ASH CLAY BRICKS
1	Varying colour as per soil	Uniform pleasing colour like cement
2	Uneven shape as hand made	Uniform in shape and smooth in finish
3	Lightly bonded	Dense composition
4	Plastering required	No plastering required
5	Heavier in weight	Lighter in weight
6	Compressive strength is around 10.02N/mm^2	Compressive strength is around 8.94 N/mm^2
7	More porous	Less porous

CONCLUSIONS-

1) Thermal conductivity Of Fly Ash Bricks is 0.90-1.05 W/m2 ºC while thermal conductivity Of Normal Clay Bricks is 1.25 – 1.35 W/m2 ºC so FACB (fly ash clay bricks) absorbs less heat than normal bricks, it keeps your building cool even in summer, hence most suitable for Indian conditions.

2) Fly ash bricks are light weight bricks compared to clay bricks. These are 25% lighter than the clay bricks, so it is suitable for multi storey building. Less weight means less stress on the building, safety assured. These bricks will reduce the structural load and also reduce the construction cost. Hence these bricks are suitable for the construction of buildings as well as houses and also no breakage during transport use.

3) Fly ash clay bricks have less porous, absorbs very little water, whereas burnt clay bricks absorbs more water during construction. Sprinkling of water before use is enough. Saves money on water during construction and even keeps your building strong during rainy seasons.

4) Fly ash clay bricks are high quality bricks and do not have the cracks on its surface. Surface is neat and clean and plaster (Plaster of Paris) can be directly applied on these bricks without a backing coat of lime.

5) Clay can be used as a chemical accelerator/binder for Fly ash clay bricks as fly ash is non-plastic. Fly ash clay bricks are

cheaper than ordinary "First class Clay Brick" and cost effective in use and environment friendly. Fly ash clay bricks result in efflorescence is less or negligible.

6) Clay which is used for manufacturing of clay bricks so need for conservation of natural resources. By consuming 80-82% fly ash, the cause of environmental pollution and hazards due to disposal is minimized.

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