

Properties of Non Conventional (Fly Ash) Brick: An Experimental Study

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Abstract- India is a developing country due to huge need of infrastructure there is demand for that is why construction. In the construction the main material is cement and brick. Bricks are normally made by clay. Clay is main part of productive land. To solve this problem we are making brick by using non conventional (fly ash). This brick is stronger, effective and also economical than the clay brick. This process also helps in converting industrial waste material into quality building material. In the present study we are making four types of non conventional (fly ash) bricks in different percentage of cement such as 0%, 2%, 4% and 6%. And after making these bricks various tests were performed such as compressive strength test, water absorption test, efflorescence and these results were compared with conventional bricks results.

Keywords- Flyash, productive soil, industrial waste, light weight, new building material

I. INTRODUCTION

The importance of product is not complete without knowing its economics & various characteristics relating to its quality. It has been acknowledged that making bricks with the conventional material is becoming costlier day by day. This is more predominant for making conventional brick of higher compressive strengths. It is already known that the conventional brick are susceptible to efflorescence. Also, in area of high moistures the weakness of conventional brick masonry due to great absorption of water is well known and needs to be improved to prevent and failure of the structure during its lifetime, further these bricks are kiln made the causing Emission of harmful gases. Therefore the manufacturing process making these bricks is not eco friendly hence, in the ongoing search for finding new material of construction, which can replace conventional materials to save cost and natural resources which are depleting fast, it has been found that using non conventional bricks in masonry structures can make the structure get rid of the above problem and it can also make the structure more durable. non conventional bricks possess a high degree of toughness, durability, ductility, strength and crack resistance. This controls the cost factor involved in the construction of the structure. It also increases the flexibility and ductility of a building which is a sought after characteristic in the earthquake prone area.

Large-scale use of this waste material has not been done in India, perhaps due to lack of evidence and lack of education. With industrialization, it is now time that these materials are used in the manufacture of bricks, which can cause an overall economy and can give us a less polluted environment. Fly ash is one such material.

II. OBJECTIVE AND MOTIVE OF THIS STUDY

The objective is to compare the structural of non conventional brick with conventional brick and to determine the most suitable brick and cost optimization of non conventional brick.

Motive of this study is to prepare material used for low cost housing project without compromising with the durability and compressive strength. Effort has been made by making different proportions of ingredients having composition of fly ash, cement, lime, gypsum, and sand these standard size of brick used in structural work has been adopted low cost non conventional brick will be easy to handle and transport and it will required less labour used for handling during industrial work. That will reduce the cost of construction without compromising the strength of construction.

Manufacturing of commercial brick produce a lot of air pollution. In whole world lot of industries which produce large quantity of fly ash as a waste material. But in non conventional bricks manufacturing any kind of pollution not produced. It is eco friendly. As the fly ash used in manufacturing of non conventional bricks the storage of waste reduces and reduced the soil pollution.

III. REVIEW OF LITERATURE

In 1898, brick made of lime and sand, popularly known as calcium silicate bricks and hardened by high-pressure steam curing, were commonly manufactured first in the Germany. This process required finely ground sand. So, it was thought that fly ash, which already if fine size, could replace ground sand totally or partially, thus conserving the cost. Being a pozzolan fly ash also reacts with lime at low temperature resulting in brick of superior quality and although the non conventional brick masonry has been a subject for past many years, yet not much literature is

available on this subject. The non conventional brick have characteristics different from the latter bricks but some of the major problems and constraints in this way of large-scale utilization of these bricks are:

- Reluctance of the consumer to accept fly ash base product due to lack of knowledge.
- Quality variation in the fly ash and non available of certified quality of fly ash.
- Bulk of fly ash is available in wet states.

Butter worth [2] of England in 1953 and 1954 did exhaustive work on Fly Ash Bricks. He suggested that addition of fly ash for the manufacture of bricks gave improved physical properties.

Peter George [10] in 1960 recommended the use of fly ash in the brick marking, due to its easy availability.

Thorne D. J. et. al. [12] England in 1950 examined the chemical and physical properties of fly ash with a view to utilize fly ash in brick marking.

Capp J.P et. al. [3] USA in 1970 recommended fly ash in brick marking.

Gupta R. L. et. al. [5] India in 1977 recommended use of fly ash in the brick marking with suitable quantity of fly ash in mixture.

Rai Mohan G. et. al. [11] India in 1985 showed that fly ashes available nearby thermal power stations could easily be used in suitable proportions and thus a major economy in coal consumption could be achieved during manufacture of Non Conventional Bricks.

Day R. L. et. al. [4] of Ireland in 1988 recommended fly ash as a substitute for clay.

According to is code is 12894 :1990 [6] i.e. 'Fly Ash-Lime Bricks-Specification' states that the natural source can be profitably utilized for makeup of fly ash-lime bricks as a addition to ordinary burnt clay building brick most important to saving of natural resources and enhancement in environmental quality.

Khurana I. J. S Commissioner-cum Secretary to Government, Industries Department, Government of Orissa, in a supplement to the Orissa Gazette, 1994, announced on the behalf of government to promote fly ash based brick/building material and other products.

Suresh N. [13] of India in 1995 recommended the use of fly ash in brick making.

Bhanumathidas N., Director General, and N Kalidas, Director, Institute for Solid Waste Research and Ecological

Balance (INSWAREB) Visakhapatnam, in 1999, have recommended use of fly ash as a precast product.

Kumar Vimal, [8] Director and Chandni Nath Jha, Senior Scientific Officer-II , Fly ash mission , Technology Information Forecasting and Assessment Council, Department of Science and Technology, New Delhi in 1999 recommended use of Non Conventional Bricks in construction .

Parul R. Patel [9] Nirma Institute of Technology Ahmadabad, in 2002 in her paper titled "Use of fly ash in manufacturing" has recommended the use of fly ash in brick manufacturing so as to reduce the cost of bricks without compromising on quality .Author has concluded that the survival of any product in the market depends on the demand of product in the market. There is a strong consumer preference on conventional bricks, the use of Flyash Brick is very limited today and with a small market, production cost is higher due to diseconomy of scale. Public is not aware of fly ash bricks and its advantages. So public awareness needs to created explaining the benefits of Flyash Bricks.

Ravi Kumar and Deepankar Kumar Ashish [15] "Study of Properties of Light Weight Fly Ash Brick" has recommend the new and innovative building materials and ecofriendly technologies, covering waste material like flyash is the need of the hour.

IV. EXPERIMENTAL PROGRAM

The main objective of this experimental program is to study and compare the compressive strength, water absorption and efflorescence test of non conventional brick with the conventional brick.

A. Testing of Bricks

In the present study, Non Conventional Brick is developed with different composition

TABLE 1
MIX COMPOSITION OF NON CONVENTIONAL BRICKS

Sr. No.	MIXTU RE ID	Cement (%)	Gypsum (%)	Lime (%)	Sand (%)	Fly ash (%)
1	CB-00	0	7	22	25	46
2	CB-02	2	7	22	25	44
3	CB-04	4	7	22	25	42
4	CB-06	6	7	22	25	40

The results of non conventional bricks as per IS 12894-1990 that is code for pulverized fly ash-lime bricks and the conventional bricks were tested as per procedure laid down in IS 3495-1992 (Part-I, Part-II & Part-III) for the following test:

- Compressive Strength
- Water absorption
- Efflorescence

A. COMPRESSIVE STRENGTH TEST:



Fig 1: Experimental Setup For Compressive Strength Test

The Conventional Bricks and Non Conventional Bricks were tested on the UTM of capacity 100 tonnes which read to the nearest 0.5 tonne. Load was applied uniformly and steadily. Five numbers of bricks each type were tested for compressive strength results. The average value of compressive strength was calculated. The test's are performed as per IS 3495-1992 (Part-I)

TABLE 2
COMPRESSIVE STRENGTH OF CONVENTIONAL BRICK

Specimen No	Load at failure (KN)	Compressive Strength (Kg/cm ²)	Average Compressive Strength (Kg/cm ²)
1	195	86.66	92.26
2	215	95.55	
3	198	88.00	
4	210	93.33	
5	220	97.77	

TABLE 3
COMPRESSIVE STRENGTH OF NON CONVENTIONAL BRICK (CB-00)

Specimen No	Load at failure (KN)	Compressive Strength (Kg/cm ²)	Average Compressive Strength (Kg/cm ²)
1	267.8	119.02	122.44
2	276.8	123.02	
3	280.3	124.57	
4	282.3	125.46	
5	270.3	120.13	

TABLE 4
COMPRESSIVE STRENGTH OF NON CONVENTIONAL BRICKS (CB-02)

Specimen No	Load at failure (KN)	Compressive Strength (Kg/cm ²)	Average Compressive Strength (Kg/cm ²)
1	327.7	145.6	142.48
2	320.30	142.35	
3	319.7	142.08	
4	322.72	143.43	
5	314.9	139.95	

TABLE 5
COMPRESSIVE STRENGTH OF NON
CONVENTIONAL BRICKS (CB-04)

Specimen No	Load at failure (KN)	Compressive Strength (Kg/cm ²)	Average Compressive Strength (Kg/cm ²)
1	328.5	146	148.34
2	330.8	147.02	
3	335.1	148.93	
4	339.2	150.75	
5	335.3	149.02	

TABLE 6
COMPRESSIVE STRENGTH OF NON
CONVENTIONAL BRICKS (CB-06)

Specimen No	Load at failure (KN)	Compressive Strength (Kg/cm ²)	Average Compressive Strength (Kg/cm ²)
1	348.5	154.88	154.51
2	350.2	155.64	
3	345.1	153.37	
4	349.2	155.2	
5	345.3	153.46	

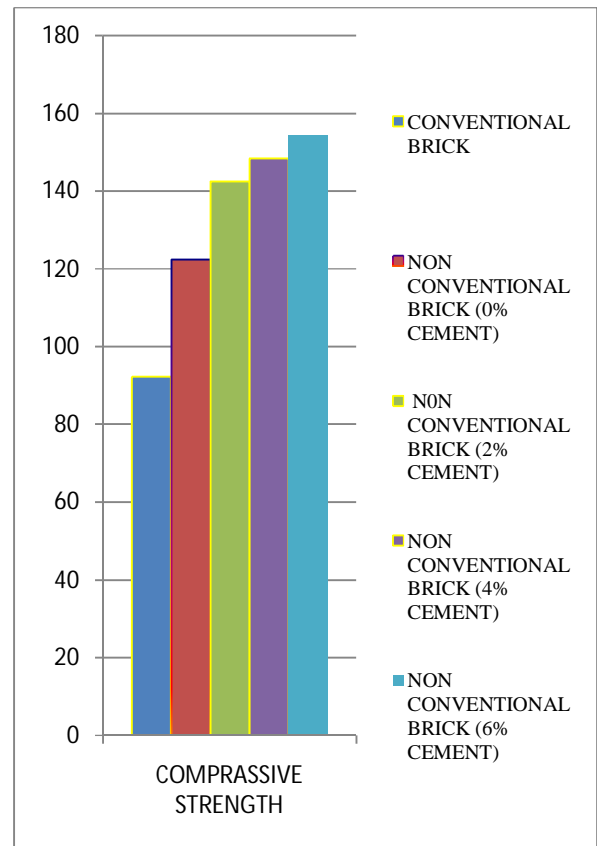


Fig 2 Comparison of Compressive Strength Results

B. Water Absorption

The test's are performed as per IS 3495-1992 (Part-II)

TABLE 7
WATER ABSORPTION TEST OF CONVENTIONAL
BRICK

Specimen No	Dry Weight (Kg)	Wet Weight (Kg)	Water Absorption (gm)	Water Absorption %	Average Water Absorption %
1	3.050	3.502	452	14.81	12.32
2	2.945	3.325	380	12.90	
3	3.050	3.425	375	12.29	
4	3.160	3.510	350	11.07	
5	2.850	3.150	300	10.52	

TABLE 8
WATER ABSORPTION TEST ON NON CONVENTIONAL BRICKS (CB-00)

Specimen No	Dry Weight (Kg)	Wet Weight (Kg)	Water Absorption (gm)	Average Water Absorption %	Average Water Absorption %
1	2.620	2.780	160	6.10	5.78
2	2.550	2.730	180	7.05	
3	2.650	2.820	170	6.41	
4	2.660	2.780	120	4.51	
5	2.570	2.695	125	4.86	

TABLE 11
WATER ABSORPTION TEST ON NON CONVENTIONAL BRICKS (CB-06)

Specimen No	Dry Weight (Kg)	Wet Weight (Kg)	Water Absorption (gm)	Average Water Absorption %	Average Water Absorption %
1	2.925	3.015	90	3.07	3.57
2	2.980	3.068	88	2.95	
3	2.990	3.120	130	4.34	
4	2.970	3.090	120	4.04	
5	2.880	2.980	100	3.47	

TABLE 9
WATER ABSORPTION TEST ON NON CONVENTIONAL BRICKS (CB-02)

Specimen No	Dry Weight (Kg)	Wet Weight (Kg)	Water Absorption (gm)	Average Water Absorption %	Average Water Absorption %
1	2.655	2.770	115	4.33	4.62
2	2.705	2.810	105	3.88	
3	2.730	2.86	130	4.76	
4	2.670	2.810	140	5.24	
5	2.625	2.754	129	4.91	

TABLE 10
WATER ABSORPTION TEST ON NON CONVENTIONAL BRICKS (CB-04)

Specimen No	Dry Weight (Kg)	Wet Weight (Kg)	Water Absorption (gm)	Average Water Absorption %	Average Water Absorption %
1	2.720	2.840	120	4.41	4.13
2	2.910	3.010	100	3.41	
3	2.960	3.110	150	5.06	
4	2.780	2.890	110	3.90	
5	2.830	2.940	110	3.88	

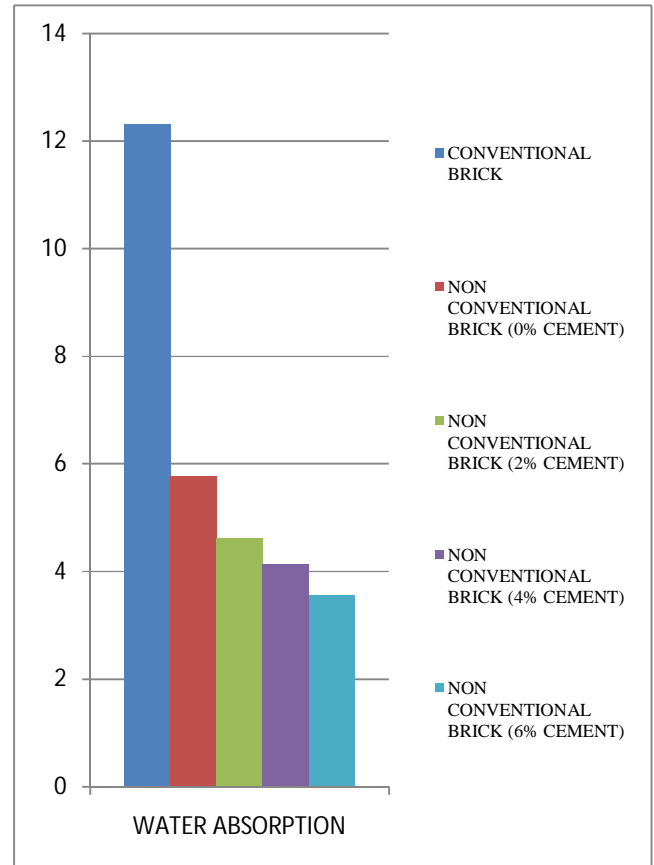


Fig 3 Comparison of Water Absorption Results

C. Efflorescence Test

The test's are performed as per IS 3495-1992 (Part-III)

TABLE 12
EFFLORESCENCE TEST

Conventional brick	Slight to moderate
Non Conventional Brick (CB-00)	Grey deposits found less than 11%
Non Conventional Brick (CB-02)	Grey deposits found less than 9%
Non Conventional Brick (CB-04)	Grey deposits found less than 8%
Non Conventional Brick (CB-06)	grey deposits found less than 6%

V. DISCUSSION

A. Compressive Strength Test

As per the Table & Figure the compressive strength of conventional brick is observed 92.26 kg/cm², for non conventional brick (CB-00) is observed 122.41 kg/cm², for non conventional brick (CB-02) is observed 142.48 kg/cm², for non conventional brick (CB-04) is observed 148.34 kg/cm² and for non conventional brick (CB-06) is observed 154.51 kg/cm².

TABLE 13
COMPARISON COMPRESSIVE STRENGTH

Type of specimen	Mean load at failure (KN)	Average compressive Strength (kg/cm ²)	% Increase Average compressive strength
Conventional brick	207.6	92.26	-
Non Conventional Brick (0%)	275.5	122.41	32.71%
Non Conventional Brick (2%)	321.06	142.48	54.43%
Non Conventional Brick (4%)	333.78	148.34	56.08%
Non Conventional Brick (6%)	347.3	154.51	67.47

B. Water Absorption Test

As per the Table & Figure the average absorbed moisture content of conventional brick is observed 12.32%, for non conventional brick (CB-00) is observed 5.78%, for non conventional brick (CB-02) is observed 4.62% and for non conventional brick (CB-04) is observed 4.13% and for non conventional brick (CB-06) is observed 3.57%.

TABLE 14
COMPARISON WATER ABSORPTION TEST

Type of specimen	Mean Dry Weight (Kg)	Mean Moist Weight (Kg)	Average Water Absorption %	% Decrease in Water Absorption
Conventional brick	2.991	3.380	12.32	-
Non Conventional Brick (CB-00)	2.61	2.761	5.78	53%
Non Conventional Brick (CB-02)	2.67	2.800	4.62	62.5%
Non Conventional Brick (CB-04)	2.84	2.950	4.13	48.22%
Non Conventional Brick (CB-06)	2.94	3.050	3.57	71.10%

C. Efflorescence Test

The Efflorescence test of conventional brick, Non Conventional Brick (CB-00), Non Conventional Brick (CB-02), Non Conventional Brick (CB-04) & Non Conventional Brick (CB-06) and the result were compared in which white or grey deposits are slight to moderate in conventional brick, less than 11% on surface area in Non Conventional Brick (CB-00), less than 9% on surface area in Non Conventional Brick (CB-02), less than 8% on surface area in Non Conventional Brick (CB-04) and less than 6% on surface area in Non Conventional Brick (CB-06).

TABLE 15
EFFLORESCENCE TEST

Type of specimen	Efflorescence %	% Decrease in Efflorescence
Conventional brick	14%	-
Non Conventional Brick (CB-00)	11%	3%
Non Conventional Brick (CB-02)	9%	5%

Non Conventional Brick (CB-04)	8%	6%
Non Conventional Brick (CB-06)	6%	8%

VI. CONCLUSIONS

In the experimental work undertaken and discussion presented in above chapters the following conclusions are drawn:

1. The compressive strength of Non Conventional Brick (CB-00) without cement is 32.71% more than that of Class A conventional brick but when 2% cement is added in the Non Conventional Brick then compressive strength is 54.43% more than that of Class A conventional brick, when 4% cement added in Non Conventional Brick then the compressive strength is more than 56.08% and also when 6% cement added in Non Conventional Brick then the compressive strength is more than 67.47%.
2. Water absorption of Non Conventional Brick (CB-00) is 53% less as compared to that of Class A conventional bricks and 62.5% less as compared to Class A conventional brick when 2% cement is added when 66.47% less as compared to Class A conventional brick when 4% cement is added and when 71.1% less as compared to Class A conventional brick when 6% cement is added.
3. The Efflorescence test of conventional brick, Non Conventional Brick (CB-00), Non Conventional Brick (CB-02), Non Conventional Brick (CB-04) & Non Conventional Brick (CB-06) and the result were compared in which white or grey deposits are slight to moderate in conventional brick, less than 3% on surface area in Non Conventional Brick (CB-00), less than 5% on surface area in Non Conventional (CB-02), less than 6% on surface area in Non Conventional Bricks (CB-04) and less than 8% on surface area in Non Conventional Bricks (CB-06).
4. Being light weight in compression with conventional bricks, dead load of structure is reduced and hence saving is overall cost of structure.

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