Experimental Investigation on Strength of Fly Ash Brick with the Addition of Lime, M-sand and Gypsum

*Mr.S.Kamaraj, Surya kumar.k[#1], Vinoth kumar.k[#2], Jeyabal.k[#3]

*Assistant professor, [#]Students, Department of Civil Engineering, Kings College of Engineering, Punalkulam, Pudukottai, Tamilnadu – 613303, India.

[1] Suryakumar920@gmail.com

[2] vinothkumarcivil1997@gmail.com

[3] jeyak2165@gmail.com

Abstract

Bricks are a commonly used building material all over the world for constructing walls, pavement and other elements in masonry construction. Burnt clay bricks are commonly used in construction of masonry structures. Conventional bricks are manufactured by firing of clay in high temperature kilns. Extensive research is going on production of bricks from industrial wastes as there is a shortage of natural resources that are used as raw materials for the manufacturing of bricks. An experimental investigation has been carried out to study the behaviour of fly ash bricks by taking different proportions of fly ash, lime, gypsum and Manufactured Sand (M-sand). This investigation also aims to use waste materials effectively since fly ash is a waste obtained from thermal power plants and lime powder is crushed from lime stone. Fly ash brick are an alternative for the conventional bricks which can be used effectively to replace the conventional brick. The properties of the fly ash bricks are investigated by conducting various tests like Compressive strength test, water absorption test.

Keywords —*Fly Ash, Lime, gypsum, compressive strength and water absorption*

I. INTRODUCTION

Pulverized fuel ash commonly known as fly ash is a useful by-product from thermal power stations using pulverized coal as fuel. The high temperature of burning coal turns the clay minerals present in the coal powder into fused fine particles mainly comprising aluminium silicate. Fly ash produced thus possesses both ceramic and pozzolanic properties. Fly ash is a hazardous waste. The problem with fly ash lies in the fact that not only does its disposal require large quantities of land, water, and energy, its fine particles, if not managed well, by virtue of their weightlessness, can become airborne. When not properly disposed, fly ash is known to pollute air and water, and causes respiratory problems when inhaled.

Fly Ash bricks are made of fly ash, lime, m-sand and gypsum. These can be extensively used in all building constructional activities similar to that of common burnt clay bricks. The fly ash bricks are comparatively lighter in weight and stronger than common clay bricks. Since fly ash is being accumulated as waste material in large quantity near thermal power plants and creating serious environmental pollution problems, its utilization as main raw material in the manufacture of bricks will not only create ample opportunities for its proper and useful disposal but also help in environmental pollution control to a greater extent in the surrounding areas of power plants.

Manufacturing of commercial brick produce a lot of air pollution. The technology adopted for making. The fly ash bricks are eco-friendly. It is no need fire operation in production unlike the conventional bricks among the traditional fossil fuel sources, coal exists in quantities capable of supplying a large portion of nation's energy need.

II. MATERIALS USED

Materials used are fly ash, lime, m-sand and gypsum.

A. Fly Ash

Fly ash is finely divided residue resulting from the Combustion of powdered coal and transported by the flue gases and collected by electrostatic precipitator. ASTM broadly classify fly ash into two classes Class F: Fly ash normally produced by burning anthracite or bituminous coal, usually has less than 5% CaO. Class F fly ash has pozzolanic properties only. Class C: Fly ash normally produced by burning lignite or sub-bituminous coal. Some class C fly ash may have CaO content in excess of 10%. In addition to pozzolanic properties, class C fly ash also possesses cementious

properties. Fly ash used is of type class C with a specific gravity of 2.1***9.***

B. Lime

Lime is an important binding material in building construction. It is basically Calcium oxide (CaO) in natural association with magnesium oxide (MgO).Lime reacts with fly ash at ordinary temperature and forms a compound possessing cementitious properties. After reactions between lime and fly ash, calcium silicate hydrates are produced which are responsible for the high strength of the compound.

C. Gypsum

Gypsum is a non- hydraulic binder occurring naturally as a soft crystalline rock or sand. Gypsum have a valuable properties like small bulk density, incombustibility, good sound absorbing capacity, good fire resistance, rapid drying and hardening with negligible shrinkage, superior surface finish, etc. In addition it can strengthen material or increase viscosity. It has a specific gravity of 2.31 grams per cubic centimeter. The density of gypsum powder is 2.8 to 3 grams per cubic centimeter.

D. M-sand

M-sand which conforms to Grading zone II as per IS: 383:1970 [5] having a specific gravity of 2.3, fineness modulus of 4.2 and bulk density of 1037 kg/m3 was used.

A. OBJECTIVES

- To study the strength of the fly ash brick by replacing the fine aggregates and cement.
- To reduce pollution in land.
- To produce better and low cost replacement product without compromising the strength of the fly ash brick.
- To minimize or to avoid the usage of clay brick and there by safeguarding the environment.

B. ADVANTAGES

- High strength, practically no breakage during transport and use.
- Minimize the usage and limits the over extraction of the conventional bricks.
- Cost effective when compared to conventional bricks.
- Lower water penetration.
- Eco friendly.

C. LITERATURE REVIEW

Ravi Kumar, Vandana Patyal, Balwinder Lallotra and Deepankar Kumar Ashish (2014), On the basis of the experimental work it is concluded that the compressive strength of fly ash brick with 0% cement is 27% more than that of class I conventional brick but when 3% cement is added in the fly ash brick then compressive strength is 51.8% more than that of class I conventional brick and also when 5% cement added in fly ash brick then the compressive strength is more than 63%.

Manish kumar sahu, lokeshsingh have a valuable properties like small bulk density, in combustibility, good sound absorbing capacity, good fire resistance, rapid drying and hardening with negligible shrinkage, superior surface finish, etc. In addition it can strengthen material or increase viscosity. It has a specific gravity of 2.31 grams per cubic centimetre. Gypsum should have minimum 35% purity and 5 to 15% may be used.

Sumathi , K. Saravana Raja Mohan (2014)
The study was conducted to find the optimum mix percentage of fly ash brick. However the brick specimen of size 230mm x 110mm x 90mm were cast for different mix percentage of Fly ash (15 to 50%), Gypsum (2%), Lime (5 to 30%) and Quarry dust (45 to 55%). However the specimens have been tested for seven mix proportions. The mechanical properties such as compressive strength were studied for different mix proportions, at different curing ages.

Tahmina banu, md. Muktadir billah, fahmida gulshan, asw kurny 2013. For optimum composition and pressure bricks exhibited following properties: 1 No shrinkage. 2 Unit volume weight: 1.81 gm/ cm3. 3 Initial rate of absorption (IRA): 14.84 gm. So these bricks need not be wetted before laying. 4 Absorption capacity: 11.58%. 5 Apparent porosity: 20.99%. 6 Open pore volume: 9.23 cm3. 7 Impervious pore volume: 34.74 cm3. Maximum compressive strength of 442.96 gm/cm^2.

Dr.R.kumuthadr.K.Vijai, S.noornasifa ,M.Nivedhidha and R.Mukila Preethi 2018) The compressive strength of bricks containing 75 % GGBS, 15% fly ash and 10% PPC satisfies the minimum compressive strength specified for Class 3.5 designated as per IS 12894: 2002. Hence these bricks can be used for framed structures and compound walls. The other mixes do not fall under any of the classes of bricks stipulated in IS 12894: 2002.

Nitin, tapesh behl, rachit, kapil dev patyal **(**2015) observed that the for the dry method of curing the compressive strength increases up to 20% quarry dust addition and then decreases for 30% and 40% quarry dust addition with fly ash for 14 and 28 days of curing period. In burlap curing method the compressive strength of the specimen increases with the increase in the quarry dust up to 40% for the 14 and 28 days of curing period.

Tahmina banu, md. Muktadir billah, fahmida gulshan, asw kurny (2013). For optimum composition and pressure bricks exhibited following properties: 1 No shrinkage. 2 Unit volume weight: 1.81 gm/ cm3. 3

Initial rate of absorption (IRA): 14.84 gm. So these bricks need not be wetted before laying. 4 Absorption capacity: 11.58%. 5 Apparent porosity: 20.99%. 6 Open pore volume: 9.23 cm3. 7 Impervious pore volume: 34.74 cm3. Maximum compressive strength of 442.96 gm/cm^2.

D. MATERIAL TESTING RESULTS

TABLE I
Test result of fine aggregate

Size of Sie6ve	Weight Retained in IS Sieve (gm)	Cumulative Weight Retained in IS Sieve	% of Retained	% of passing
10 mm	0	0	0	100
4.75 mm	0	0	0	100
2.36 mm	11	6	2.1	97.9
1.18 mm	34	30	4.5	95.5
600 micron	165	195	21	79
300 micron	622	832	83.2	16.8
150 micron	98	930	93	7

TABLE II
Various Mix Proportion

proportions	Fly Ash (%)	Lime (%)	Gypsum (%)	M-sand (%)
I	45	10	05	40
II	50	10	05	35
III	55	13	02	30

TABLE III
Quantity of Materials Used

Proportions	Fly ash (kg)	Lime (kg)	Gypsum (kg)	M-sand (kg)
I	1.440	0.432	0.216	1.728
II	1.860	0.432	0.216	1.512
III	2.176	0.561	0.086	1.196

TABLE IV
Compressive Strength Test

Mix proportion	Compressive strength N/mm^2		
	7 days	14 days	28 days
M1	8.63	12.49	13.97
M2	8.91	12.60	14.39
M3	9.23	13.21	15.20

TABLE V
Water Absorption

Sl. No	Material	Dry Weight (Kg)	Wet Weight (Kg)	% Of Water Absorption
1	Specimen 1	3.90	4.25	9.0
2	Specimen 2	3.87	4.12	8.62
3	Specimen 3	3.59	3.90	8.33

E. EXPERIMENTAL INVESTIGATION

A. Preparation and Casting of Specimen

This study included a preparation fly ash brick samples (230 × 105 × 75 mm) for compressive strength test. For each mix, 3 bricks were tested for compressive strength at 7 days 14 days and 28 days of curing.

B. Compression test Results

TABLE IV
Compressive strength (N/mm^2) of Fly Ash Bricks

Compressive strength of the specimen brick was calculated after 7, 14 & 28 days of curing.
Compressive strength = Applied Max load X 1000 (N)/Cross sectional Area (mm 2)

C. Water Absorption

TABLE V
Water Absorption of Fly Ash Brick

Fly ash Bricks should not absorb water more than12%.The bricks to be tested should be dried in an oven at a temperature of 105o to 115o C till attains constant weight cool the bricks to room temperature and weight (W1). Immerse completely dried and weighed (W1) brick in clean water for 24 hrs at a temperature of 27±20 Degree celsius. Remove the bricks and wipe out any traces of water and weigh immediately (W2). Water absorption in % by weigh = (W2 – W1/W1) x 100.

Table VI

Comparison between Fly Ash Brick and Clay Brick

Fly ash brick	Clay brick
Lighter in weight	Heavier in weight
Less porous	More porous
Uniform shape and smooth finish	Uneven shape as hand made
Environmentally friendly	Non environmentally friendly
Compressive strength is 11.81 N/mm^2	Compressive strength is 3.5 N/mm^2
Water absorption is 8.09%	Water absorption is 20-25%
Thermal conductivity 0.90-1.05 $W/m^2\ ^oC$	Thermal conductivity 1.25-1.35 $W/m^2\ ^0C$

VII. CONCLUSION

- ✓ Higher compressive strength are found in the fly ash brick with fly ash 55%, 13% of lime and 30% of M-Sand, gypsum 2%.
- ✓ Manufactured sand is cheaper than that of river sand and Fly ash and also available in large area
- ✓ The compressive strength of bricks increases with lime proportion.
- ✓ The bricks made under pressure has increased compressive strength according as the pressure was applied.
- ✓ Being lighter in weight, it will reduce the dead weight and material handling cost in multi storied constructions.
- ✓ The water absorption of fly ash brick is less than the conventional clay brick.
- ✓ From the Results of average water absorption of fly ash brick is 8.65%.
- ✓ Light weight and environmental friendly.

REFERENCES

[1] Parul, R. Patel, "Use of Fly ash in Brick Manufacturing", *National Conference On Advances in Construction Materials*, " *AICM*-India, 2004, 53-56.

[2] Peter George Kenneth Kingth, "Pulverized fuel ash as a construction material", *proceedings of institution of Civil Engineers,* 16, 1960, 419-432.

[3] I.S Code 12894-1990 for Fly ash – Lime Bricks-Specification.

[4] IS: 3495(P-I)-1976, Determination of Compressive Strength (Second Revision).

[5] IS: 3495 (P-II) -1976, Determination of Water Absorption (Second Revision).

[6] A.sumatrhi,k.saravanan,"Compressive Strength Of Fly Ash Brick With Addition Of Lime, Gypsum, And Quarry Dust, school of civil engineering, sastra university, thanjavur,IJCRGG,2014,28-36.