Indian J.Sci.Res. 17(2): 274 - 278, 2018 ISSN: 0976-2876 (Print)
ISSN: 2250-0138(Online)

COMPARATIVE STUDY ON BOTTOM ASH BASED CLAY BRICKS WITH ORDINARY CLAY BRICKS

[1] Arivudai Nambi .R, [2]Jayakumar. V
[1]Department of Structural Engg, Prathyusha Engg. College, Thiruvallur
[2]Department of Civil Engg, IFET College of Engg. Villupuram

Abstract - This paper presents the results of investigation done on bottom ash based clay bricks. This is an approach to improve the properties of clay with the inclusion of non plastic additive such as bottom ash, to reduce the shrinkage and to improve the properties of clay. Bricks were produced at various percentage of bottom ash mixed with ordinary clay. Tests for strength, water absorption and efflorescence were done under Indian standard code provisions. The results demonstrate that the compressive strength of the burnt bricks of minimum percentage bottom ash added posses' excellent strength and other properties with contrast to normal burnt clay bricks. It is noted that good quality bottom ash based bricks contributing to sustainable development for the future and also this bricks are superior to the normal bricks.

Keywords: Clay Bricks, Plastic Limit, Shrinkage Cracks, Efflorescence, Compressive Strength.

I. Introduction

Green technology in building industry is becoming increasingly significant now-a-days to address issues of environmental pollution and sustainability. This makes engineers to use waste materials in construction. Coal fired thermal power plants generate large volumes of bottom ash which are currently sent to landfills. In the brick making industry, there has also been research into how to reuse different waste products in order to manufacture better quality bricks. Such risks have paved the way to extensive studies on the physical–chemical properties of bottom ash. The increase in the popularity of using environmental friendly, low cost and lightweight construction materials is needed for building industry. Recycling of industrial wastes as building materials appears to be viable solution for pollution problem and economic design of buildings. This project deals about the attempt of using the bottom ash, as a material in the clay brick production, and the effects on the bricks property like physical and mechanical properties are enhanced.

A. Literature Review

Several materials was used for the production of brick, the type of material used and the key aspects of every project was economy and sustainability. Thus the clay brick developed by using bottom ash (BA) indirectly contributing for environmentally friendly substituent and is made as per the by Indian standard code provisions (IS: 2117-1991). Thus water absorption and shrinkage cracks have been considerably reduced by using additive material in brick. Some of the author described some new concepts in brick development are as follow.

Paki.et.al.2012: Physical-mechanical and thermal performances of newly developed rubber-added bricks.Use of crumb rubber–concrete combination for producing a low cost and lightweight composite brick with improved thermal resistance. The obtained compressive strength, flexural strength, splitting strength, freezing–thawing resistance, unit weight and water absorption values satisfy with the relevant international standards.

kidsarin et al 2001 : A new approach to the production of bricks made with 100% Fly ash. Developed a new approach in making bricks from 100 % lignite fly ash. Bricks contained 25% SF and 50% sludge showed superior mechanical properties as compared with conventional bricks.

Cheng et al 2006: Recovery of municipal waste incineration bottom ash and water treatment sludge to water permeable pavement materials. Investigated the properties of water permeable bricks made of water treatment sludge and bottom ash (BA) without involving an artificial aggregate step. The mechanical properties of the sintered bricks were examined with respect to relevant standards. Bricks run into the textin their sections, and are followed by a colon.

B. Material used

Bottom ash consists of heavier particles that fall to the bottom of the furnace. Bottom ash is also composed primarily of amorphous or glassy alumina silicate materials derived from the melted mineral phases. Most bottom ash is produced in dry-bottom boilers, where the ash cools in a dry state Boiler slag is a type of bottom ash collected in wet-bottom boilers (slag tap or cyclone furnaces, which operate at very high temperatures), where the molten particles are cooled in water quench.

Physical properties of bottom ash

Blaine fineness (cm^2/g) = 2.7

[1]Corresponding Author

Density (kg/m3)	= 1.93
Specific gravity	= 10.06
Plasticity	= None
Dry Unit Weight (kN/m^3)	= 7.07 - 15.72
Fineness modulus	= 2.7
Specific gravity	= 2.1-2.7
Water absorption	= 10.062

C. Mix Proportions

It is very similar to the ordinary brick but the addition of bottom ash in various proportions to the clay soil defines the project. Addition of water is about 1/4th of weight of bottom ash mixed soil. As per the code (IS: 2117-1991) the water may be sprinkled to the surface of the soil so as to retain the moisture before the moulding process.

TABLE I. Mix Proportions

S.NO	Mix proportions		
	Bottom ash	***clay***	***Water***
1	0%	100%	1/4th Of weight of soil
2	10%	90%	
3	20%	80%	
4	30%	70%	

Figure 1: Addition of bottom ash and various proportioned bricks

D. Types of test

Bricks are tested for its durability in building components. As per (IS: 2117-1991) two types of test should be taken as follow

1. Test before the moulding process of soil (preliminary test).
2. Test after the burning of bricks (final test).

II. Preliminary Test

A. Plastic Limit of Soil

Plastic limit of the soil is found for the clay soil to know the plasticity of soil is as follow.

Three samples are taken to found the plastic limit

Plastic Limit (PL) = Average w % = 14.3

This test should be done by means of rolling thread of mass of soil to crumble into small pieces.

B. Initial shrinkage test(ball test)

To find the shrinkage properties of clay there are one preliminary test to be done as per (IS:2117-1991.The soil is prepared as plastic mass and form a ball of about 80 mm diameter. The ball should be kept in the sun for drying after drying the ball is examined for loss of shape and surface cracks.The increase in bottom ash reduces the shrinkage crack after sun drying. It is noted that over addition of bottom ash leads to decrease in bond strength of soil.

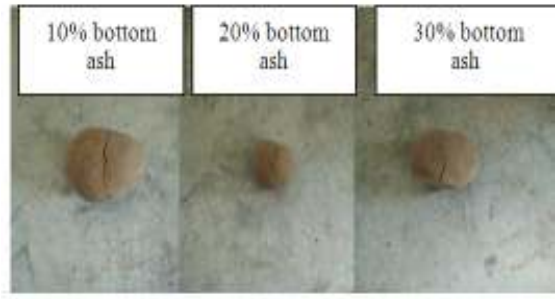

Figure 2: Ball test for shrinkage cracks

The shrinkage cracks of ordinary clay are very high compared to the bottom ash mixed soil. But the amount of addition of bottom ash would be important criteria in bond strength of clay particles.

III. Final Test

Final test are done after the process such as kneading, moulding, drying followed by burning of bricks under a temperature range from 900-1000^{0}c in a kiln. The bricks will undergo changes in its strength properties and also the physical appearance.

A. Weight test

A weight comparison of ordinary clay brick with bottom ash based clay bricks.

TABLE II. Weight of Bricks

S. No	Average weight of bricks		
	Type of brick	***Weight of bricks***	***remarks***
1	Ordinary clay brick	2.92 kg	These weights of bricks are average of 3 brick in each
2	10% addition of bottom ash clay brick	2.87 kg	
3	20% addition of bottom ash clay brick	2.63 kg	
4	30% addition of bottom ash clay brick	2.56kg	

S. No	Average weight of bricks		
	Type of brick	*Weight of bricks*	*remarks*
			type.

Results of brick suggest that more addition of bottom ash leads to weight less bricks compared to the ordinary clay brick.

B. Efflorescence Test

The ends of bricks are kept in a 150 mm diameter dish and immersed in 25 mm depth of water at room temperature(i.e. the bricks are placed vertical in the dish to absorb water) . Water may go through absorption or evaporation it is again filled till 25 mm and made to be absorbed or evaporated.

TABLE III. Efflorescence of Brick

S. No	Efflorescence of brick		
	Type of brick	*Liability to efflorescence*	*remarks*
1	Ordinary clay brick	nil	There is no perceptible deposit of efflorescence.
2	10% addition of bottom ash clay brick	nil	
3	20% addition of bottom ash clay brick	nil	
4	30% addition of bottom ash clay brick	nil	

This test is usually done to know the salt content of the bricks otherwise I would affect the appearance as well as react with other components to produce some serious effects on masonry.

C. Dimension test (IS: 1077)

The dimension of brick will deviate because of shrinkage in the clay soil. During firing the clay may experience loss of water which leads to surface cracks and less in dimension as compared to the mould dimension. This may disturb the regular specified type of pattern (bond) and may impair the strength and consequently cracks may develop.

TABLE IV. Dimensions of Bricks

No	*Type of brick*	*Dimension after burning of bricks(mm)*	*remarks*
1	Ordinary clay brick	180×84×86	These dimensions of bricks are average of 3 brick in each type.
2	10% addition of bottom ash clay brick	187×88×89	
3	20% addition of bottom ash clay brick	189×87×90	
4	30% addition of bottom ash clay brick	189×89×90	

It is noted that the clay bricks are experienced too much of variation in dimension but the bottom ash based clay bricks nil or little susceptible for shrinkage during firing.

D. Water absorption(IS: 3495)

All bricks absorb water due to its pores in surface and also dryness of brick. But some permissible limits are there to suggest the quality of brick against water absorption. The absorption of water by the bricks is not over 3 per cent after 48 hours of immersion.

TABLE V. Water Absorption of Brick

S. No	Water absorption of bricks			
	Type of brick	*Initial dry weight (w1)*	*Final wet weight(w2)*	*Percentage of water absorbed (%)*
1	Ordinary clay brick	3.2kg	3.5 kg	9.3
2	10% addition of bottom ash clay brick	3.2kg	3.5 kg	9.3
3	20% addition of bottom ash clay brick	3.2kg	3.6 kg	12.5
4	30% addition of bottom ash clay brick	3.3kg	3.7kg	12.5

The water absorption in % =(w2-w1)/(w1)X100% .....(1)

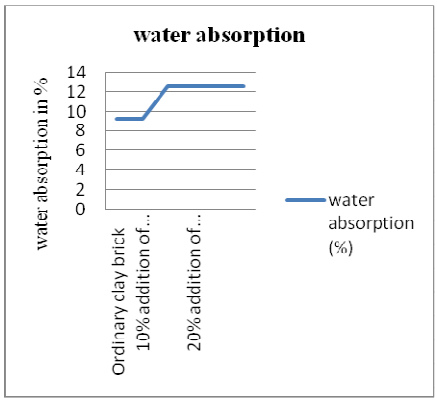

Figure 3: Water Absorption

E. Compressive strength test (IS:3495 (part II)

The compressive strength of brick is important for the masonry construction. It may differ from brick to brick because of burning in kiln. permissible stressess are taken into account while selecting the class of brick.

Compressive strength in N/mm^2 = max. Load at failure N(kgf) / (avg net area of two faces in compression $mm^2(cm^2)$ ……(2)

Table 6: Compressive strength of brick

S. No	Compressive strength of brick		
	Type of brick	*Compressive strength in N/mm^2*	*remarks*
1	Ordinary clay brick	3.67	Test is done by placing brick in horizontal direction.
2	10% addition of bottom ash clay brick	5.79	
3	20% addition of bottom ash clay brick	4.6	
4	30% addition of bottom ash clay brick	4.70	

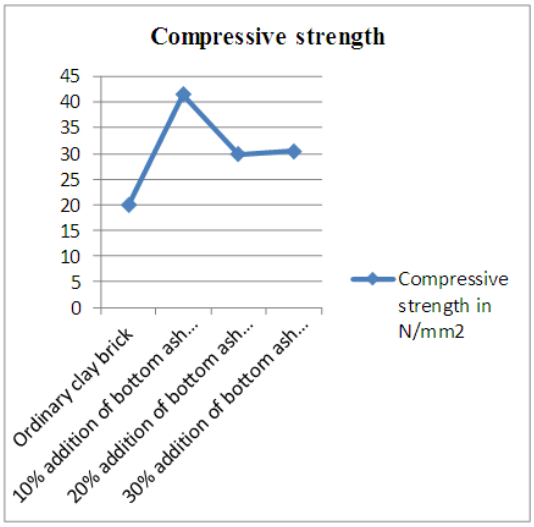

Figure 4: Compressive Strength

F. Result and discussion

Although fly ash is used for making bricks but bottom ash is left and dumped as a waste so utilising this waste material in the brick will be so important for the sustainable development. In this project utilization the bottom ash as a additive material in brick making clayey soil, which will bring a change in the brick making industry to reuse the waste material in the brick making process. It wills way for a sustainable option to design the green building. Need of this project is to rectify the defects in the brick as experienced in the past by taken into account the shrinkage cracks that are developed during drying and firing are completely eliminated by adding such waste material to enhance the properties of clay. Producing such kind of bricks will be high in strength as well as water resistance properties is improved and utilizing a waste material will leads to a sustainable development.

Acknowledgement

We express our immense gratitude with pleasure to those individuals who have either directly contributed to our needs at time for the development and success of the work". we take this opportunity to record my sincere thanks to our management **IFET COLLEGE OF ENGINEERING** for providing the infrastructure facilities required to complete our project work. We thank all the staff members in our department for their cooperation they have rendered to us and the sustained interests shown at every stage of our endeavour in making project work a success. Last but not the least we profoundly thank our parents without them we could not have achieved this height.

References

[1] Naganathan S, Razak HA, Nadzrian AH (2010) "Effect of kaolin addition onthe performance ofcontrolled low-strength material using industrial waste incineration bottom ash", Waste Management and Research, Volume 28, pg. 848–60.

[2] Domínguez EA, Ullmann R (1996) "Ecological bricks, made with clays and steel dust Pollutant", Applied Clay Science, Volume 11, pg.237–49.

[3] Wiebusch B, Seyfried CF (1997), "Utilization of sewage sludge ashes in the brick and tile industry", Water Science and Technology, Volume 36,pg. 251–8.

[4] Lin KL (2006),"Feasibility study of using brick made from municipal solid waste incinerator fly ash slag", Journal of Hazardous Materials, Volume 137, pg.1810-6.

[5] Yang J, Liu W, Zhang L, Xiao B (2008) "Preparation of load-bearing building materials fromautoclaved phosphogypsum", Construction and Building Materials.