DETERMINATION OF STRESS-STRAIN BEHAVIOUR OF I ASH BRICK MASONRY PRISM

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Abstract

I-ash brick can be extensively used in all building constructional activities similar to that of common burnt clay bricks. The I-ash bricks are comparatively lighter in weight and stronger than common clay bricks. Since industrial ash is being accumulated as waste material in large quantity near thermal power plants and creating series environmental pollution problems. It utilization as mane raw materials 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 plant. In this proper, I-ash brick to improve the strength and stress strain performance compared to conventional clay brick.

Keywords: *burnt-clay, stress, strain.*

I.Introduction

A brick is block or a single unit of kneaded clay bearing soil, sand and lime, or concrete material, fire hardened or air dried, used in masonry construction. Fired brick are the most numerous types and are laid in course and numerous patterns known as bonds, collectively known as brick work, and may be laid in various kinds of mortar to hold the bricks together to make a durable structure. Brick are produced in numerous types, materials and sizes which vary with region and time period, and are produced in bulk quantities. Tow most basic categories of brick are fired and non fired brick. Fired brick are one of the long lasting and strongest building materials sometimes referred to as artificial stone and have been used since circa 5000 BC. Air dried bricks have a history older than fired bricks.

I-ash brick is the mixture of pond ash, fly ash, lime, gypsum and stone dust .the manufacturing process of the coal ash brick is similar to the fly ash brick. It is not yet used in field of construction. It is new innovative type of brick, which have property better than clay brick and fly ash brick. In this present study of ultimate load and stress and strain behaviour of I-ash brick, mortar and I-ash brick masonry prism are determined and compared with clay brick and present in the paper.

II.Literature review

Bharathi et al (2011) studied the engineering properties of pond ash for sustainable concrete construction. The characterization of coal ash material was suitable for road and embankment works and also proved economical by partial replacement of cement and sand. Coal ash material showed better possibilities in geotechnical applications and specifications irrespective of its material properties.

Freeda Christy & Tensing (2011) conducted experiments on fly ash bricks and conventional bricks. The bricks were tested for their mass, water absorption, compressive strength and flexural strength. The compressive strength of fly ash bricks was 40 % to 80 % higher than that of conventional clay bricks and the weight density of fly ash brick was 10 % lighter than conventional clay brick. The study concluded that the fly ash brick is cost efficient, energy efficient and environmental friendly.

Hakan et al (2013) conducted studies on the behaviour of masonry wall with reinforced plaster mortar. Masonry brick of size 100 mm x 50 mm x 30 mm were used to construct a masonry wall of size 400 mm x 400 mm x 100 mm. Masonry wall specimens constructed with steel fiber reinforced plaster and poly propylene mortars. In masonry wall, vertical load was applied at different angles such as 30, 45, 60 and 90 degrees. The strength, stiffness and ductility of masonry walls with and without reinforcement were determined. The performance of reinforced plastered mortar masonry wall was evaluated to determine the failure envelope.

Thomas et al (2012) studied the properties of mortar and structural behaviour of masonry. During the triplet shear test, four types of failure modes were observed. Shear strength of masonry was calculated based on normal stress from Mohr-Coulomb relationship.

Vidhya & kandasamy (2016) conducted an Experimental Investigations on the Properties of Coal-Ash Brick Units as Green Building Materials. In this investigation, an attempt was made to devise ways for the optimal use of pond ash in manufacturing coal-ash bricks. This article presents the experimental results for coal ash brick made up of pond ash with fly ash, lime, gypsum, and stone dust. The fundamental strength and durability tests were conducted to evaluate the basic properties of bricks.

III.Mix proportion and casting of fly ash brick

The proportioning of I-ash brick mix is a process of arriving the right combinations of materials such as fly ash, pond ash, lime, gypsum, sand, stone dust, and water for making bricks according to the given specifications based on the literature. The purpose of mix proportioning is to obtain a product that will perform according to certain pre determinate requirements, the most essential requirements being the properties of bricks, stress-strain behaviour of I-ash brick masonry. Another purpose of mix proportioning is to obtain a brick mix satisfying the performance requirements at a lower possible cast by suitably selecting available materials.

Proportioning of raw materials is an important aspect of making of I-ash brick of desired quality. There is no specific method to find out the mix design of I-ash bricks. so the following mix combination of fly ash, pond ash, lime, gypsum, stone dust were adopted for making I-ash bricks based on the literature. Table 1 shows the mix combination of the I-ash brick.

Table 1 mix combination of I-ash brick

Materials	Percentage
lime	10
Gypsum	5
Fly ash	30
Pond ash	30
Stone dust	25

The quality of coal ash bricks produced depends on the following factors:

1. Quality of raw materials
2. Proportioning of raw materials
3. Handling and mixing of raw materials
4. Handling and pressing of the mix
5. Curing period

IV.Details of mortar cube specimen

Cube specimens are cast as per the given 1:5 mix ratio is given in table 2.toally 12 specimens was cast for compressive strength and stress strain behaviour.

Table 2 Details of the cube specimens

Test	Mix ratio	Size (mm x mm x mm)	No. of specimens
Compressive strength	1:5	70.6 x 70.6 x 70.6	6
Stress-strain behaviour	1:5 and 1:6	100 x 100 x 100	12

V.Casting of brick masonry prism

Masonry prisms were constructed using brick and mortar. The prisms thus cast are shown in Figure 1. Size of brick specimen was 230 mm x 110 mm x 75 mm. The height of five-brick high masonry prism with 10 mm thick mortar joints was about 400 mm for I-ash brick prism. Totally 12 specimens were used for the study of stress-strain behaviour of I-ash brick masonry prism compared with the conventional brick masonry prism.

Figure 1 Casting of brick masonry prism

VI.Stress-strain behaviour of brick

The stress - strain behaviour of clay brick and I-ash brick was studied by using universal compressive testing machine of capacity 100 tones. A dial gauge with least count of 0.01mm was used to measure the deflection. The dial gauge was fixed with respect through lateral and longitudinal direction of brick specimen. Two dial gauges were fixed in lateral direction and one dial gauge was fixed in longitudinal direction. Figure 2 shows the experimental set up for brick. The experimental setup for stress strain behaviour test of bricks. Compressive load was applied gradually at uniform rate and at equal intervals of loading and the corresponding deflections were measured with the help of dial gauges. The dial gauges were removed before the failure was occurred in the specimen. The failure load was noted.

The stress – strain curves for the 2 types of brick were obtained by averaging the stress – strain data from 3 samples of each type of brick. Modulus of elasticity of the various bricks was found by using stress strain curves of bricks. Totally 3 brick specimens of each type were used for the determination of young's modulus of two types of bricks.

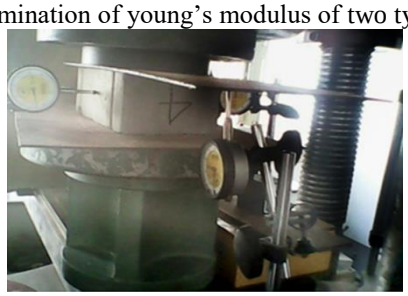

Figure 2Experimental setup for brick unit

VII.Stress-strain behaviour of mortar

The mortar cubes of size 100 mm x 100 mm x 100 mm were cast for determining stress - strain behaviour of mortar. The mortar proportion of 1:5 and 1:6 was used for determination of stress - strain behaviour using universal compressive testing machine of capacity 100 tonnes. The mortar cubes are placed at the centre of the UTM without eccentricity. The dial gauge with least count of 0.01 mm was used to measure the deflection. The dial gauge was fixed with respective lateral and longitudinal directions of mortar specimen. Two dial gauges were fixed in the lateral direction and one dial gauge was fixed in the longitudinal direction. Figure 2 shows the experimental setup for stress - strain behaviour of mortar cubes.

Figure 2 Experimental setup for mortar cube

VIII.Stress-strain behaviour of I-ash brick masonry

The masonry prism was tested by the Universal Testing Machine (UTM) of capacity 100 tonnes for stress-strain characteristics of brick masonry prism. A five-layer height of masonry prism was used to find the secant modulus of the masonry prism. A compressometer with least count of 0.01 mm was used to find the deformation of the prism. The prism was placed with the frame setup in which a compressometer was fixed at lateral directions to the frame. The adjustment screw with pivot rod was used to place the specimen at the centre and tighten the frame with masonry prism.

The compressometer was centrally pivoted with the masonry prism so as to note the lateral movement of the prism under the load. The whole assembly of prism with the compressometer was placed at the centre of the loading platform of UTM under uniaxial compression without any eccentricity. The load was applied gradually at uniform rate and at equal intervals of loading and the corresponding deflections was noted from the compressometer till the failure occurred. The ultimate load or failure load of masonry prism was noted. The test setup for masonry prism is shown in Figure 3. The IS code - IS 1905:1987 – 'Codes of practice for structural use of unreinforced masonry' is used for this study.

Figure 3Experimental setup for brick masonry prism

IX.Test result of brick, mortar and brick masonry

Compressive load and corresponding deflection data are recorded. Stress versus strain curves are drawn for two different types of bricks. In table 3 shows this the values of ultimate load, ultimate compressive stress, failure strain and young's modulus of two different types of bricks used in this experimental investigation.

Table 3 Comparison test result of brick

Type of brick	Ultimate load (KN)	Ultimate stress (N/mm^2)	Failure strain	Young's modulas (N/mm^2)
Clay	122.85	5.85	0.0059	1727.2
I-ash	222.31	8.65	0.0066	2408.7

Ultimate compressive stress of I-ash brick is 31.97% greater than the clay brick. Failure strain for I-ash brick is 10.6% greater than clay brick. Young's modulus is directly proportional to the compressive strength. The young's modulus of I-ash brick is 28.9% greater than the clay brick.

The table 4 shows the values of ultimate load, compressive stress, and failure strain and young's modulus of mortar proportion 1:5 used for making prism in the experimental investigation.

Table 4 Test result of mortar

Mortar propor -tion	Ultimate load (kN)	Ultimate stress (N/mm^2)	Failure strain	Young's modulus (N/mm^2)
1:5	58.75	11.99	0.0264	5825.20
1:6	49.25	9.88	0.0243	5225.68

The compressive strength of 1:5 and 1: 6 mortar proportions are 12 N/mm^2 and 9.88 N/mm^2 respectively. The failure strain and young's modulus of the 1:5 and 1:6 mortar proportions are 0.00264, 0.0243 and 5825.20 N/mm^2, 5225.68 N/mm^2.

The 1:6 mortar proportion possessed the lower compressive strength and failure strain compared the mortar proportion 1:5. Table 5 shows the test results of the comparison brick masonry prism. As per the IS code - IS 1905:1987 – 'Codes of practice for structural use of unreinforced masonry' was used for this study. The ultimate stress, failure strain and Secant modulus of the brick masonry prism was determined and tabulated.

Table 5 comparison test result of brick masonry prism

Mortar grade	Brick masonry type	Ultimate stress (N/mm^2)	Failure strain	Secant modulus (N/mm^2)
1:5	Clay	2.53	0.0048	1612
	I-ash	3.22	0.0056	1711
1:6	Clay	1.85	0.0063	1125
	I-ash	2.52	0.0068	1546

The compressive strength value of the I-ash brick masonry prism was higher compared to conventional clay brick. The failure strain value of the clay brick masonry prism was 14.28 % lower than that of I-ash brick masonry prism in 1:5 mortar proportion.
The secant modulus of the I-ash brick masonry prism of 1:5 mortar proportion is 6.20 % higher than the conventional clay brick masonry prism. The brick masonry prism made up of the 1:6 mortar proportion possessed lower ultimate stress, failure strain and secant modulus compared to 1:5 mortar proportion.

X.Conclusion

The following points are concluded for this paper.

1. The Young's modulus of the I-ash brick is 31.97% greater than the clay brick.
2. Failure strain for I-ash brick is 10.6% greater than clay brick.
3. The young's modulus of I-ash brick is 28.9% greater than the clay brick.
4. The 1:6 mortar proportion possessed the lower compressive strength and failure strain compared the mortar proportion 1:5.
5. The secant modulus of the I-ash brick masonry prism of 1:5 mortar proportion is 6.20 % higher than the conventional clay brick masonry prism.

XI.References

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