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EXPERIMENTAL STUDY ON FLY ASH BRICK MASONRY PRISM WITH VARIES MIX COMBINATION OF CEMENT MORTAR

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Abstract: The experimental carried out to determine the efficiency of chicken meshes in strengthening of masonry wall. Masonry walls have been built using Fly Ash bricks and three mix ratios Cement Mortar such as 1:3, 1:5, and 1:6 were investigated. Total of six walls have been built, in which three walls using chicken meshes for plastering and the other three walls are without using chicken meshes for plastering. The parameters such as ultimate load and stress strain behavior are measured.

1. INTRODUCTION

Brick masonry is a common construction material in India because of its abundance, low cost, good sound, heat insulation properties and availability of skilled lab our. Masonry is extensively used in India as infill walls in reinforced concrete buildings. Fly ash brick masonry is a popular construction throughout India and in developing countries. Fly ash bricks have better durability, strength and reliability and are easily available.

In recent years, growing awareness on environmental impact of using fertile top soil for brick manufacturing has prompted the search for alternative systems of masonry units. On the other hand fly ash and pond ash is produced in large amount from thermal plants which causes environmental pollution. To overcome above problems fly ash and pond ash can is effectively utilized in making bricks as an alternative to clay in bricks and recommended to use in masonry construction.

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The structural behavior of masonry is influenced by the mechanical properties of the constituent materials. There for a full mechanical characterization is required for proper non linear analysis of masonry structures. Hence uniaxial compressive test is carried out on unreinforced masonry and its constituents. In this study, the finite element analysis approach is used to find stress strain behavior of masonry. Stress-Strain properties of material are required in the nonlinear analysis of structures. Stress-Strain relationships for some construction materials such as concrete and steel are available in the literature and design codes. However such relationships are not easily available for one of the most widely used construction material, i.e masonry. In the present experimental study, compressive stress-strain relationships for masonry are determined by testing masonry wall specimens constructed using Fly ash brick with cement mortar proportion of 1:3, 1:4 & 1:5. .[5] discussed about Microwave Semiconductor Devices such as Tunnel diode, Gunn diode and valanche transit time devices and analyzes Monolithic Microwave Integrated Circuits (MMIC)

Buildings which are properly designed and detailed on the basis of modern seismic building codes are less affected because these buildings dissipate energy through inelastic behavior. Improper design and detailing of buildings can make these buildings vulnerable to earthquakes. Application of wire mesh increases the lateral strength capacity of unreinforced masonry walls significantly. In this context a study was carried out to strengthen the existing unreinforced brick masonry walls with Ferro cement. The walls were cured in open air and were tested after 28days by confining them with chicken meshes.

1.1. FLY ASH BRICK

Coal 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.

1.2. BRICK MASONRY

Masonry is the assemblage of individual units laid in and bound together by mortar. The common materials of masonry construction are brick, stone, marble, granite, travertine, limestone, cast

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stone, concrete block, glass block, stucco, tile and cob. Masonry is generally a highly durable from of construction. However, the materials used, the quality of the mortar and workmanship, and the pattern in which the units are assembled can significantly affect the durability of the overall masonry construction. There are many types of bond is available. In this project, stacked bond was used for construction of brick masonry wall.

APPLICATIONS OF MASONRY

1. Brick and concrete block are the most common types of masonry used all over the world.
2. Concrete blocks, especially those with hollow cores, offer various possibilities in masonry construction. They generally provide great compressive strength, and are best suited to structures with light traverse loading when the cores remain unfilled.
3. Masonry is commonly used for the construction of walls in buildings, retaining walls.

1.3. SCOPE

Scopes of the project are the effective utilization of fly ash which is an industrial waste product to mark bricks using it and to increase the response of the brick masonry walls. In this project perform the stress-strain behavior of fly ash brick masonry prism using the varies cement mortar proportions such as 1:3, 1:5 & 1:6.

2. CASTING

2.1. CASTING OF MORTAR CUBES

Cement mortar is a mixture of cement, river sand and water. The materials are mixed with care and the mortar cubes of size 70.6 x 70.6 x 70.6mm were cast. The mortar cubes are cured for 28 days in laboratory. Then mortar cubes are tested in laboratory to get their compressive strength value and stress strain behavior. Mortar cubes of ratio 1:3, 1:5 and 1:6 were cast as per IS 1905: 1981.

2.2 CASTING OF BRICK MASONRY WALLS

A masonry wall is an assemblage of brick units and mortar that is constructed to serve as a test specimen for determining properties of masonry assemblages. In this investigation, walls were constructed by assembling masonry units, one on top of the other, using cement mortar as the bonding material in the contact surface of the masonry units.

2.2.1 MATERIAL

The Fly Ash bricks were used for making the masonry walls. Cement and sand are used for making cement mortar of ratio 1:3, 1:5 & 1:6.

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2.2.2 CASTING OF BRICK MASONRY WALL

The walls are constructed in stacked bond using cement mortar of thickness 20mm. Walls were cast for size of 0.90x0.98x.07m with a mortar thickness of 20mm.

Figure-2.1 Casting of brick wall

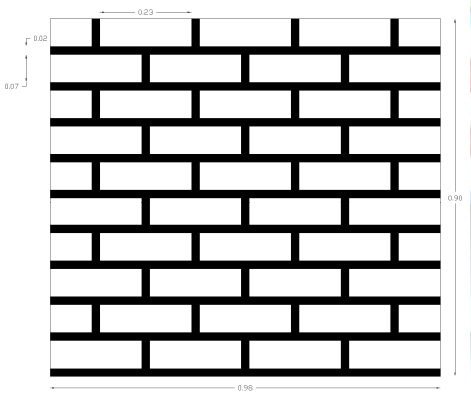

Figure-2.2 Geometry of brick wall

Figure-2.3 Chicken Mesh

2.2.3 CONFINING OF BRICK WALLS

Brick walls were confined with chicken meshes as shown in figure 1 to increase its strength and durability. Then they were plastered as shown in figure 2.4 to provide a pleasing appearance. The chicken meshes of 1mm thick were used for the confinement of wall.

Figure-2.4 Confining of brick walls

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Figure-2.5 Plastering of confined brick walls

3. TESTING OF SPECIMEN

3.1 GENERAL

Tests carried out on brick by using cement mortar proportion of 1:3, 1:5 and 1:6 different types of confined brick wall such as Fly Ash brick wall confined with chicken mesh (C_C).

3.2 TESTING OF BRICKS

The tests were carried out on two types of brick for determination of their properties. The basic properties bricks are determined as per IS 3495:1992

Tests carried out on bricks are as follows:

1. Compressive strength test
2. Water absorption test
3. Weight density test
4. Efflorescence test
5. Hardness test

3.2.1 COMPRESSIVE STRENGTH TEST

Compressive strength is one of the important fundamental properties of bricks. The compressive strength test on bricks was conducted as per IS 3495 (Part-1):1992- Methods of Test Fly Ash Building Bricks- Determination of compressive strength using compression testing machine of capacity 100 tones. 30 brick specimens were tested for determination of compressive strength.

PROCEDURE:

1. Sand was used to fill the frog or air voids present in the bricks. The bricks were placed with flat faces horizontal and sand filled face facing upwards.
2. Two steel plates, each of 3mm thickness, were placed on top and bottom of the brick.
3. The brick specimen was carefully centered between plate of the compressive testing machine.
4. The compressive strength test was carried out by applying a uniform rate of loading to the brick by

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compressive testing machine as shown in figure.

5. The load was applied till failure occurred on the brick. The maximum load at which the specimen failed was noted.

Compressive Strength = (Failure Load / Cross sectional area) N/mm^2

3.2.2 WATER ABSORPTION TEST

The water absorption test was conducted as per IS: 3495(Part-2): 1992. Method of Test of Fly Ash Building Bricks. Determination of water absorption. A batch of 30 brick specimens of each type were tested for water absorption capacity. Figure shows the experimental setup for water absorption test.

PROCEDURE:

1. The dry brick specimen was kept in oven at a temperature of 105^0C to 115^0C till it attained substantially constant mass. The bricks were taken out from oven and kept to cool at room temperature and the weight of the brick was measured (M_1).
2. The dried bricks were immersed in clean water at room temperature of 27 ± 2^0C for 24 hours. After 24 hours, all the bricks were taken out from water and saturated brick was measured (M_2). Water absorption value of brick is the percentage ratio of the change in mass to original mass.

Water absorption = $[(M_2-M_1) / M_1] \times 100$

3.2.3 WEIGHT DENSITY

Totally 3 brick specimens of each type were tested for weight density. The volume of the brick was calculated. The weight of the brick was measured by weighting balance. The weight density of the brick is defined as the ratio of weight of the brick to volume of the brick. Figure shows the experimental setup for weight density test.

Weight density = (weight / volume) KN/m^3

Size of bricks used for volume calculation is as follows:

- Fly ash brick : 230mm x 110mm x 70mm

3.2.4 EFFLORESCENCE TEST

The efflorescence test is performed to know the presence of any alkaline matter in the bricks. It was performed as per IS: 3495 (Part-3): 1992. Method of Tests of Fly Ash Building Bricks – Determination of Efflorescence. The efflorescence test was conducted on 15 brick specimens of each type.

The brick was placed in the container the depth of immersion in water being

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25mm. the whole arrangement was placed in warm and well ventilated room; the brick specimen absorbed almost all water in the container. When the water was the depth of 25mm water in the container and the same procedure was repeated. Figure shows the experimental setup for efflorescence test.

The brick was examined for white/grey patches after 24 hours. The development and appearance of white/grey patches could be described as nil, slight, moderate, heavy or serious.

3.2.5 STRESS STRAIN BEHAVIOUR OF BRICKS

The stress-strain behavior of clay brick, fly ash brick and coal 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 to 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 shows the experimental setup for stress strain behavior 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 failure load was noted. The stress-strain curves for the three types of brick were obtained by averaging the stress-strain data from 3 sample of each type of brick. Modulus of elasticity of the various bricks was found by using stress-strain curves of brick. Totally 3 brick specimens of each type were used for the determination of young's modulus of three types of bricks.

3.3. ULTIMATE LOAD BEARING CAPACITY OF MASONRY WALL

Ultimate load bearing capacity of the brick masonry walls were found by testing the walls under cyclic loading in loading frame using hydraulic jack. The geometry of the loading frame is shown in the figure 3.4. Loading frame of 2m height to 2m width was used to find the ultimate load bearing capacity of the masonry walls. Walls were placed under the loading for testing. Hydraulic jack has been fixed under the loading frame. A steel I section of 2m in length was placed above the masonry wall to transfer the load uniformly throughout the wall from the hydraulic jack. The weight of the I section is 50.8kg with an sectional area of 32.33cm^2. A dial gauge with least count of 0.01mm was used to measure the deflection. Two dial gauges were fixed, one in east direction and the other dial gauge was fixed in order to measure the strain from west direction. Figure 3.4 shows the experimental setup for stress strain behavior test of masonry walls. 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

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were removed before the failure occurred in the specimen. The failure load was noted.

Figure-3.4 Experimental setup

3.4. TESTING OF MORTAR CUBES

The cement mortar cubes of ratio 1:3, 1:5 and 1:6 were cast and subjected to determination the Compressive strength test.

3.4.1 COMPRESSIVE STRENGTH TEST

The mortar cubes of size 70.6mm x 70.6mm x 70.6mm were cast by using mortar ratio of 1:3, 1:5 and 1:6. The mortar specimens were tested for the determination of compressive strength. Figure shows the experimental setup of compressive strength test for mortar. The compressive strength test of cement mortar is done by using compressive testing machine.

PROCEDURE:

1. The specimen is taken out from the curing tank and allowed to dry for few hours.
2. The specimen is placed in compression testing machine of capacity 100 tones in such a way that the load is applied gradually in cast surface.
3. The load was applied in uniform rate until the specimen gets failed.
4. Then load at failure has been noted.

Compressive strength =

(Failure load / Cross sectional area)

4. RESULTS AND DISCUSSION

4.1 GENERAL

In this chapter result and discussion based on the experimental investigation carried out on Fly Ash brick, different mortar proportion of 1:3, 1:5 & 1:6 ratio and six types of masonry walls are presented and discussed.

The following test results are tabulated and discussed,

A. Basic properties test on
    a. Fly Ash brick

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B. Ultimate load bearing test on
   a. Fly Ash brick wall confined with chicken mesh and cement mortar 1:3 ratios.
   b. Fly Ash brick wall confined with chicken mesh and cement mortar 1:5 ratios.
   c. Fly Ash brick wall confined with chicken mesh and cement mortar 1:6 ratios.
   d. Fly Ash brick wall confined without chicken mesh and cement mortar 1:3 ratios.
   e. Fly Ash brick wall confined without chicken mesh and cement mortar 1:5 ratios.
   f. Fly Ash brick wall confined without chicken mesh and cement mortar 1:6 ratios.

C. Stress strain behavior test on
   a. Fly Ash brick

4.2 PROPERTIES OF BRICKS

The basic properties Fly Ash bricks such as compressive strength, weight density, water absorption and efflorescence are given Table 4.1.

Table 4.1 Test results of bricks

SI. NO	DESCRIPTION	FLY ASH BRICK
1	Compressive Strength (N/mm^2)	8.54
2	Water absorption (%)	10.5
3	Efflorescence	Nil
4	Weight density (KN/m^3)	16.6

4.3 COMPRESSIVE STRENGTH TEST OF MORTAR CUBES

Compressive strength test was carried on mortar proportion of 1:3, 1:5 and 1:6 by casting cubes of size 70.6mm x 70.6mm x 70.6mm. Totally 6 specimens were tested for determining compressive strength test results of mortar.

Table 4.2 Compressive Strength values of mortar

SI.NO	Mortar Ratio	Compressive Strength (N/mm^2)
1	1:3	12.3
2	1:5	11.44
3	1:6	9.5

4.4 STRESS-STRAIN BEHAVIOUR

The test results of Ultimate compressive strength, Young's modulus, Failure strain of the Fly Ash brick and mortar of grade 1:3, 1:5 & 1:6 are presented in this section. Subsequently the compressive strength, Young's modulus and

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failure strain obtained for brick masonry wall by using these brick and mortar grade are presented and discussed.

SI NO	Cement Mortar	TYPE OF WALL	ULTIM-ATE LOAD (KN)	ULTIMA-TE STRESS (N/mm^2)
1	1:3	C_C	1279.1	11.4
2	1:3	Ordinary	998.58	8.9
3	1:5	C_C	841.5	7.5
4	1:5	Ordinary	617.1	5.5
5	1:6	C_C	740.52	6.6
6	1:6	Ordinary	504.9	4.5

4.4.1 STRESS-STRAIN BEHAVIOUR OF FLY ASH BRICK

Table 4.3 shows the values of ultimate load, ultimate compressive stress, failure strain and Young's modulus.

Table 4.3 Test results for Fly ash under axial loading

Solid Block	Ultimate load (KN)	Ultimate stress (N/mm^2)	Failure Strain	Young's Modulus (N/mm^2)
Fly ash	220.85	9.60	0.0059	1627.11

4.5 ULTIMATE LOAD ON BRICK MASONRY WALLS

The ultimate loads obtained by testing the walls are as follows:

Table-4.4 Ultimate load and stress obtained for walls

The above table shows the different ultimate load bearing capacities of the different walls which clearly explains that the masonry walls built using Fly Ash brick. More over the walls confined with chicken meshes shows better result. So it is clear that the wall that is built using Fly Ash brick confined with the chicken mesh shows good results against loading than the other three types of walls.

4.6 FAILURE MODES

The failure modes of the different brick walls are shows below. Different failure modes occur in the different types of masonry walls. The crack patterns obtained on the surface on the walls are marked clearly. The walls that are confined with chicken meshes. In the wall C_W the cracks are present only on the side, whereas in the wall P_W the cracks are present only in the top surface of the wall. The figures 4.1 shows the cracks of the walls C_C respectively.

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Figure 4.1 Failure Mode with conformed chicken mesh

5. CONCLUSION

- The fly ash brick masonry wall is constructed of size 1mx1m with various mix proportion of 1:3, 1:5, 1:6 and it is confined with chicken mesh and test is carried out.
- It is clearly noted that the ultimate stress of mortar wall plastered with chicken mesh was maximum when compared with the mortar wall plastered with ordinary concrete.
- While using different ratios of cement mortar the ratio 1:3 showed maximum ultimate stress compared with other ratios.
- The result shows that, the ratio of 1:3 was better in both ordinary and chicken mesh mortars that giving high ultimate stress.
- Increasing the mortar ratio, the ultimate stress is decreasing.

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