Experimental Study on Innovative Bricks at Varying Temperature

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Abstract

The guideline degree is to recognize the lead of the innovative square when it is presented to fluctuating temperature. To study the development of the destruction in flyash block when it is presented to various condition. To study the mechanical properties, durability and fire contradicting execution of flyash block.

I. INTRODUCTION

General

Beat fuel flotsam and jetsam normally known as fly trash is a useful outcome from thermal power stations using pounded coal as fuel and has huge pozzolonic activity. This public resource has been profitably utilized for collecting of beat fuel trash lime blocks as an upgrade to fundamental burned-through earth structures blocks provoking conservation of ordinary resources and improvement in environment quality. Beat fuel garbage lime blocks are procured from materials containing pulverized fuel trash in huge sum, lime and a gas pedal going probably as a stimulus. Beat fuel garbage lime blocks are generally made by intergrading blending distinctive rough materials are then shaped into squares and presented to assuaging cycles at different temperatures and squeezing factors. Sometimes as and when required, crushed base fuel garbage or sand is moreover used in the construction of the rough material. Crushed base fuel trash or sand is furthermore used in the piece as a coarser material to control water digestion in the inevitable result. Beat fuel garbage reacts with lime in presence of moistness from a calcium hydrate which is a cover material. In this way beat fuel garbage – lime in presence of clamminess structure a calcium – silicate hydrate which is clasp material. In like manner beat fuel flotsam and jetsam – lime block is a falsely completed squares. These squares are sensible for use in workmanship advancement really like essential devoured earth blocks. Making of beat fuel garbage lime blocks has viably started in the country and it is typical that this standard would uphold creation and use on mass scale. This stand sets out the central essentials of beat fuel trash squares to achieve consistency in the collecting of such squares.

The properties of the square are taken apart and concentrated by testing the materials only. so testing is the best way to deal with dissect the properties of the materials. In this endeavor, the fly trash block was test by using compressive strength testing machine for analyze the compressive strength of the square. The fly trash block was presented to the wetting and drying followed by the testing and moreover going before by the testing. This test was driven at various temperature at various temperature for 3 models 100oC, 200oC and 300oC separately and the time length of the wetting and drying is identical for every one of the 3 models.

Characteristic of Flyash Brick

- The standard size of the square is 230 mm x 110 mm x 75 mm.
- The square are made and had a go at as indicated by IS 12894-2002.
- Fly trash block are sound, limited and uniform perfectly healthy, size and concealing, smooth rectangular faces of the square are went with sharp and square comers.
- They are freed from breaks, warpage, defects and regular matter.
- Economical and environment pleasing.
- 28 % lighter than standard mud blocks.
- Compressive strength: 7.5 N/mm² generally speaking.

Comparison between Clay Brick and Flyash Brick

Table 1.1: Difference between clay brick and Flyash brick

Clay brick	Flyash brick
Heavy weight	Light weight
Compressive strength- 35 kg/cm ²	Compressive strength- 100 kg/cm ²
Plastering requires	No plastering required
Thermal Conductivity 1.25-1.35 w/m2 °C	Thermal Conductivity 0.90-1.05 w/m2 °C, Water absorption 6-12%

II. OBJECTIVES

- The essential degree is to perceive the lead of the imaginative square when it is presented to moving temperature.
- To study the development of the obliteration in flyash block when it is presented to various condition.
- To study the mechanical properties, strength and fire contradicting execution of flyash block.

Scope of the Work

- To obtain the variation in the properties of the innovative brick subjected to wetting and drying process.

Uses and Application of the Project

- This squares can be used at high temperature domain since its fortitude augmentations persistently.
- This can be used in locales having robust precipitation too since the water maintenance of this square lessens.
- This can be used in the advancement of fireplace stack, nuclear power plant, etc
- This blocks are less in voids, so strength increases doesn't open to ingestion of soil particles.

Material Collection

General

In current circumstance of the world, people are changing their lifestyles so individuals are using a lots of ordinary resources. The ordinary resources are lose their sum bit by bit. Thusly, individuals are resolved to convey new elective material for the usage as opposed to the trademark resources. That is something fundamentally the same as being developed industry people are using the innovative materials instead of the ordinary resources like lime, stream sand, blocks, etc The inventive materials are generally as the mix of materials which will be brought either from the outcomes or waste materials. This endeavor moreover subject to the examination on warm effect in imaginative square. This endeavor is done on the examination of the properties of the creative square subject to wetting and drying measure.

MATERIAL USED

The going with material are used in this assessment,

- Fly garbage
- Lime
- Gypsum
- Quarry buildup
- Ecosand

Fly Ash

Fly flotsam and jetsam is finely isolated development coming about in light of the start of powdered coal and moved by the vent gases and accumulated by electrostatic precipitator.

ASTM completely arranges fly flotsam and jetsam into two classes.

C class: Fly garbage consistently made by devouring lignite or sub-bituminous coal. Some class C fly garbage may have CaO content in bounty of 10%. Despite pozzolanic properties, class C fly garbage similarly has cementious properties. Fly flotsam and jetsam used is of type class C with a specific gravity of 2.19. Garbage conveyed from the burning-through of more young lignite or sub-bituminous coal, just as having pozzolanic properties, moreover has some self-building up properties. Inside seeing water, Class C fly trash cements and gets more grounded as time goes on. Class C fly garbage overall contains more than 20% lime (CaO). As opposed to Class F, self-hardening Class C fly flotsam and jetsam needn't bother with an activator. Solvent base and sulfate substance are generally higher in Class C fly soot.

F class: Fly trash commonly made by devouring anthracite or bituminous coal, ordinarily has under 5% CaO. Class F fly flotsam and jetsam has pozzolanic properties so to speak. The burning-through of harder, more prepared anthracite and bituminous coal normally makes Class F fly garbage. This fly trash is pozzolanic in nature, and contains under 20% lime (CaO). Possessing pozzolanic properties, the cleaned silica and alumina of Class F fly garbage requires a hardening subject matter expert, for instance, Portland solid, quicklime, or hydrated lime mixed in with water to react and convey cementitious combinations. Then again, adding a compound activator like sodium silicate (water glass) to a Class F garbage can outline a geo-polymer. class F fly trash is combination from Mettur Thermal Power Station Mettur and the figure 2.1 shows the case of class f fly flotsam and jetsam.

Fig. 2.1: Fly Ash Sample

Lime

Lime is a critical confining material in building advancement. It is essentially Calcium oxide (CaO) in typical relationship with magnesium oxide (MgO). Lime reacts with fly trash at standard temperature and designs a compound having cementitious properties. After reactions among lime and fly flotsam and jetsam, calcium silicate hydrates are made which are responsible for the high strength of the compound. Hydrated lime is used for fly-trash block making should conform to class C assessment as shown in IS: 712:1984. The CaO faultlessness in the lime should not be under 85% which can be found by testing and similarly as venturing through test assertion from the lime suppliers. It has tendency to react with CO₂ present observable all around in presence of soginess and produces CaCO₃ which doesn't have confining properties and royal gems the idea of lime to be used for Fly Ash Bricks.

Smart Lime or hydrated lime or both can be mixed in the creation. Lime should have least 40% CaO content. Monetarily open slaked lime is sieved and used. It might be viably open from the unmistakable acctelyne endeavors as a waste. Commercially open misleadingly unadulterated lime (CaCO₃) got from industry. Lime is huge component for amassing of fly garbage block, which goes probably as a restricting material Lime should satisfy the going with need.

- During lime slaking, it should not achieve under 600°C temperatures and slaking time.
- should not be more than 15 min.
- Availability of CaO should be least of 60%.
- MgO substance should be cutoff of 5%.
- Should be in fine powdered construction.

Locally open lime is used for this endeavor. Figure 2.2 shows the case of lime

Fig. 2.2: Lime Sample

Gypsum

Gypsum is a non-water driven folio happening regularly as a fragile clear stone or sand. Gypsum have a significant properties like minimal mass thickness, incombustibility, incredible sound holding limit, extraordinary impenetrability to fire, quick drying and setting with unessential shrinkage, unparalleled surface fruition, etc

Similarly it can brace material or augmentation consistency. It has a specific gravity of 2.31. The thickness of gypsum powder is 2.8 to 3 grams for each cubic centimeter. Hydrated calcium sulfates are called gypsum. (CaSO₄+2H₂O).

Gypsum should have least 35% goodness and 5 to 15% may be used. It is gotten from the business.

Gypsum decided for making fly trash blocks should be freed from abnormalities, it should be had a go at as per IS 1288-1982. It should be stressed that its righteousness must be more than 80%, if any assortment in faultlessness the degree of gypsum should be changed in the mix to get extraordinary nature of squares.

Locally available gypsum is used for this endeavor. Figure 2.3 shows the model gypsum

Fig. 2.3: Gypsum Sample

Quarry Dust

It is development taken from stone quarry. Due to pointless cost of transportation from typical sources locally available stream sand is exorbitant. Moreover makes characteristic issues of colossal degree utilization of these sources. Use of stream sand being developed ends up being less charming, a substitute or trade thing for strong industry ought to be found. Whose continued with use has started introducing critical issues concerning its availability, cost and normal impact. In such a case the Quarry rock buildup can be a monetary alternative as opposed to the stream sand. Usually, Quarry Rock Dust is used in gigantic degree in the streets as a surface finishing material and moreover used for amassing of void squares and lightweight concrete pre-collected Elements.

It looks like sand anyway commonly dull in concealing. It is mineral particles. The thickness of Quarry dust is 1650 kg/m³. After getting ready fine particles of size under 4.75 mm is used in this work. It suggested a waste material got from beating coarse all out which are amply available.

Fig. 2.4: Quarry dust Sample

Eco Sand

Eco sand are especially fine particles, a bi-thing from solid collecting which can be used to fabricates capability in concrete. Its small scale filling sway diminishes pores in concretes and gives better sogginess resistivity and consequently strength. It has more dependable evaluating than many eliminated aggregates. Effective use for waste material and thusly smart and continues similarly as ordinarily happening sand. The usage of eco sand rather than removed or burrowed basic sand will help makers and undertaking laborers address issues of legitimacy. The current assessment is checking the compressive strength of strong square using eco sand, concrete and overabundance stream. The eco sand has various advantages, for instance, energy successful, heat confirmation, lessening of dead weight, innocuous to the environment, solid, light weight,

low help low advancement cost. This Eco sand was accumulated from ACC solid creation line, Coimbatore. The going with Fig.2.5 shows the case of Eco sand.

Fig. 2.5: Eco Sand Sample

Casting of Innovative Brick Procedure

For 100 bricks, the constituents of innovative brick with various proportions are manually feed into a pan mixer where water is added to the required proportion for homogeneous mixing.

Proportion of raw material may vary depending upon quality of raw materials. After mixing, the mixture are allowed to belt conveyor through feed in to automatic brick making machine were the bricks are pressed automatically.

Than the bricks are placed on wooden pallets and kept as it is for two days there after transported to open area where they are water cured for 7 -14 days. The bricks are sorted and tested before dispatch.

The actual dimensions for fly-ash bricks shall be: 230mm x 110mm x 75 mm

Fig 2.6: Manufacture process diagram

Proportion of Innovative Bricks

Mechanical Properties of Innovative Brick Compression Testing

Compressive strength is one of the important fundamental properties of bricks. The compressive strength test on bricks was conducted as per IS 3495 (Part-I):1992- Methods of Test Fly Ash Building Bricks- Determination of compressive strength using compression testing machine of capacity 100 tones. 30brick specimens were tested for determination of compressive strength. Figure 3.1 shows the compression test setup. Table 3.1 represents Testing result of compression strength of brick.

Fig 3.1: Compression of strength test setup

Table 3.1: Test Result of Compression Strength of Brick

Sample	Average compression (N/mm ²)
IB 1	8.1
IB 2	10.2
IB 3	7.5
Conventional	7.4

On comparing the test result compressive strength of innovative brick to his higher.

Calculation

$$\begin{aligned}
 \text{Compression strength} &= \frac{\text{load}}{\text{area}} (\text{N/mm}^2) \\
 &= \frac{25440}{23000} \\
 &= 10.2 \text{ N/mm}^2
 \end{aligned}$$

Water Absorption

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 3.2 the experimental setup for water absorption test. Table 3.2 represents test result for percentage of water absorption.

Fig 3.2: Water absorption test

Table 3.2: Test result of percentage of water absorption

Sample	Water absorption (%)
IB 1	10.9
IB 2	10.2
IB 3	11.2
Conventional	10.5

Percentage of water absorption of innovative brick varies from conventional brick.

Calculation

$$\text{Water Absorption} = \frac{W_2 - W_1}{W_1} \times 100\%$$

W1 = Weight of dry sample in Kg

W2 = Weight of wet sample in Kg

$$\begin{aligned}
 \text{Water Absorption} &= \frac{W_2 - W_1}{W_1} \times 100\% \\
 &= \frac{3.18 - 2.90}{2.90} \times 100\% \\
 &= 10.2\%
 \end{aligned}$$

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. Table 3.3 represents test result of weight density of brick.

$$\text{Weight density} = \frac{\text{weight}}{\text{volume}} \text{ Kg/m}^3$$

Size of bricks used for volume calculation is as follows:

Fly ash brick: 230mm x 110mm x 75mm

Table 3.3: Test result of weight density of brick

Sample	Weight density (Kg/m ³)
IB 1	1739.78
IB 2	1501.97
IB 3	1792.13
Conventional	1845.76

Weight density of innovative brick is lesser than conventional brick.

Calculation

$$\begin{aligned}
 \text{Weight density} &= \frac{\text{weight}}{\text{volume}} \text{ Kg/m}^3 \\
 &= \frac{3.35}{1.749 \times 10^{-2} - 1.026 \times 10^{-2}} \\
 &= 1739.78 \text{ Kg/m}^3
 \end{aligned}$$

Efflorescence

The blooming test is performed to know the presence of any fundamental matter in the squares. It was continued by IS: 3495 (Part-3): 1992. Technique for Tests of Fly Ash Building Bricks – Determination of Efflorescence. The blossoming test was driven on 30 square instances of every sort.

The square was set in the compartment the significance of submersion in water being 25mm. the whole approach was set in warm and all around ventilated room; the square model held for all intents and purposes all water in the compartment. Exactly when the water was the significance of 25mm water in the compartment and a comparative technique was repeated. Figure shows the exploratory course of action for sprouting test. the square was broke down for white/dim patches following 24 hours. The unforeseen development and presence of white/faint patches could be portrayed as nil, slight, moderate, significant or veritable. Figure3.4 shows sprouting test course of action. Table 3.4 locations of test result sprouting.

Table 3.4: Test result of efflorescence

Sample	Efflorescence
IB 1	Nil
IB 2	Nil
IB 3	white patch
Conventional	Nil

Fig 3.3 Efflorescence test setup

Soundness

Soundness test of brick shows the nature of brick against sudden impact. In this test, 2 brick are chosen randomly and struck with one another / or any harden object. Then sound produced should produce should be clear bell ringing sound and brick should not break. Then it is said to be good. Figure of test re 3.5 shows soundness testing. Table 3.5 represents of test result of soundness

Table 3.5: Test result of soundness

Sample	Soundness
IB 1	Good
IB2	Good
IB3	Good
Conventional	Good

Determination of Optimum Proportion of Brick

According to above test results, the value of IB 2 is optimum proportion 2 is the optimum. Thus IB 2 is taken for doing drying and wetting cycle.

Table 3.6: Determination of optimum proportion of brick

Testing/Sample	IB 1	IB 2	IB3	Conventional
Compression (N/mm ²)	8.1	10.2	7.5	7.4
Water absorption %	10.9	10.2	11.2	10.5
Weight density (Kg/m ³)	1739.78	1501.27	1792.13	1845.76
Efflorescence	Nil	Nil	White patches	Nil
Soundness	Good	Good	Good	Good

Testing of Innovative brick with Varying Temperature

General

The properties of the brick are analyzed and studied by testing the materials only. so testing is the way to examine the properties of the materials. In this project, the fly ash brick was test by using compressive strength testing machine for analyze the compressive strength of the brick. The fly ash brick was subjected to the wetting and drying followed by the testing and also preceding by the testing. This test was conducted at varying temperature at varying temperature for 3 samples 50°C and 100°C respectively and the time duration of the wetting and drying is equal for all 3 samples.

Mechanical Property Testings of Innovative Brick

This test was conducted on innovative bricks after the processes of wetting and drying in elevated temperature at constant time for various samples. Take 3 samples of manufactured innovative bricks for testing which were subjected to test at various timing for each sample. Here, the temperature of first sample is 50°C and the time duration for wetting and drying was fixed at one hour respectively. First sample of dried manufactured bricks are first weighed, it is taken as W₁ and the weighed brick is immersed in water for 21 hours at room temperature. After 21 hours again it's weighed and taken as W₂. After that the wetted brick is heated at 50° C by using Hot air oven for one hour and again it's weight was measured, that is taken as W₃.

Then this dried brick was again immersed in water for 21 hours and again dried for one hour. The alternative process of wetting and drying is known as one cycle. This process is done about 10 cycles for one sample. After that the second sample of innovative brick was immersed in water for 21 hours at room temperature and weighed. After 21 hours the innovative brick was dried at 100° C by using Hot air oven for one hours and weighed. This sample is also subjected to 10 cycles. By using this weight W₁, W₂ and W₃ the water absorption of the brick was calculated and its variation was studied at each cycles. It was done for all three samples of innovative bricks. Figure 4.1 show temperature varying process. 4.1 show specimen detail for testing.

Fig 4.1: Temperature varying process

Table 4.1: Specimens detail for testing

S.No	Testing	No. of specimens
1.	Compressive strength	15
2.	Water absorption	15
3.	Weight density	15
4.	Efflorescence	15
5.	Soundness	6

Compressive Strength Test

Compressive strength test was coordinated by the Indian Standard IS 3495 (Part-1): 1992. The creative square had the components of 230mm x 110mm x 75mm, was taken for the compressive strength test.

The taken illustration of one square was presented to wetting and drying for 10 cycles and other model was ordinary created innovative square. These models were attempted by using the compressive strength testing machine. The ordinary creative square had been compacted by using the pressing factor testing machine and applied the uniform speed of 14 N/mm² every second till frustration occurs and saw the most limit trouble at dissatisfaction. Next the innovative square which was presented to wetting and drying was attempted in pressure testing machine. The best weight at frustration was noted. These readings were noted and ordered for extra assessment of finding the compressive strength of the imaginative squares. Five models in three unmistakable models was taken for compressive test. Table 4.2 tends to test result of pressing factor strength. Figure 4.2 compressive preliminary of innovative square.

Observations and calculation

- Material Name=Innovative brick
- Testing Apparatus=Compressivestrength testing machine
- No. of Samples= Threesamples
- (5 specimens each)
- Dimension of the brick = 230mm x 110mm* 75mm

Table 4.2: Test result of Compressive strength

Sample	Average compressive strength (N/mm ²)
Sample 1 dried at 50°C	8.51
Sample 2 dried at 100°C	10.36

Fig 4.2: Compressive test of innovative brick

Water Absorption Test

Water digestion test was coordinated by the Indian Standard IS 3495 (Part-2) : 1992. The inventive square had the segments of 230mm x 110mm x 75mm, was taken for the water maintenance test. The taken illustration of one square was presented to wetting and drying for 10 cycles and other model was normal created innovative square. These model's heaps were assessed when wetting and drying. After each example of wetting and drying the weight of the innovative square was assessed. By using this weight, the water osmosis of the creative square was resolved. The assortment of the water ingestion of the innovative square was concentrated with the help of the outline plotted, water digestion against the amount of cycles. This assessment was particularly for the inventive square presented to wetting and drying. After that the water maintenance of the commonplace and imaginative square subject to wetting and drying contemplated. The assessments of the water digestion are noted and masterminded the further calculations of the water maintenance.

Water maintenance test is used to find the water absorption extent. Since the fly garbage block, which are holding more water can't be used in water logging an area or outside dividers which is accessible to sky. The fly trash blocks from all of the degrees were attempted. By then the water ingestion extent was dictated by the formula,

$$\text{Water Absorption} = \frac{W_2 - W_1}{W_1} \times 100 \%$$

First all the fly garbage blocks were said something an electronic measuring machine and this weight was noted as W1 in kg. After 24 hrs the squares were taken out and cleaned with material. By then the fly trash block was checked and this weight was noted as W2 in kg. figure 4.3 shows water ingestion of square. Table 4.3 shows test delayed consequence of level of water digestion.

Fig 4.3: Water absorption of brick

Table 4.3: Test result of percentage of water absorption

Sample	Average Water absorption (%)
Sample 1 dried at 50°C	10.7
Sample 2 dried at 100°C	9.6

Weight Density

Totally 5 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. Table 4.4 shows test result of weight density. Figure 4.5 shows weight density test setup.

Weight density = (weight / volume) Kg/m³

Size of bricks used for volume calculation is as follows:

Fly ash brick: 230mm x 110mm x 75mm

Table4.4: Test result of weight density

Sample	Average of weight density (kg/m ³)
Sample 1 dried at 50°C	1571.21
Sample 2 dried at 100°C	1355.08

Fig. 4.4: Weight Density Test Setup

Efflorescence

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 10 brick specimens of each type. The brick was placed in the container the depth of immersion in water being 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. Table 4.5 shows test result of efflorescence.

Table 4.5: Test Result of Efflorescence

Sample	Efflorescence
Sample 1 dried at 50°C	Nil
Sample 2 dried at 100°C	Nil

Fig 4.5: Efflorescence test setup

Soundness

Soundness test of brick shows the nature of brick against sudden impact. In this test, 2 brick are chosen randomly and struck with one another / or any harden object. Then sound produced should produce should be clear bell ringing sound and brick should not break. Then it is said to be good. Table 4.6 shows test result of soundness.

Table 4.6: Test Result of Soundness

Sample	Soundness
Sample 1 dried at 50°C	Good
Sample 2 dried at 100°C	Good

III. CONCLUSION

Taking into account the test study, the going with closures can be drawn on advancement and execution of composite square. By differentiating the compressive strength of the multitude of mixes of Innovative bricks with the compressive strength of burned-through earth block class 3.5 which having the compressive strength of 3.5 N/mm² as given in the IS Code 13757: 1993 table 1, the going with mixes IB1, IB2, IB3 is essentially passing the base compressive strength expected to use as the squares as building material. Moreover the water ingestion cutoff of those mixes IB1, IB2, IB3 are under 12%. In this way the innovative square can be casted in four particular degrees of its raw materials including Flyash, Lime, Gypsum, Quarry dust, Eco sand which will yield the strength of class 3.5 of devoured mud blocks given. In any case an improvement is needed in the mixing, anticipating and assuaging to draw out the more suitable and profitable Innovative bricks with the rough material used in the undertaking.

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