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Enhancing the Compressive Strength of the Fly Ash Brick by Fiber Reinforcement

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ABSTRACT: In the present scenario, an alternate for clay bricks is fly-ash bricks which plays a key role in the construction of framed structures because of its less weight which will reduce the dead weight of the structure, due to its light weight concept and another advantage is low cost. Such fly ash bricks are not subject to load bearing structure because of its slight reduction in compressive strength compared with nominal clay brick. So majority of the fly ash bricks were used in the framed structures construction. In this study a concern to increase compression strength using basalt fiber is carried out, with this another proportion of replacement to the fly ash is done with rice husk ash. By varying the proportion of fiber and rice husk ash of 5% and 10%, with basalt fiber's aspect ratio of 150, is mixed separately and also in the combined proportion of 5% and 10% of basalt fiber and rice husk ash. A comparison has been carried out for the normal brick to the fiber reinforced brick and fiber reinforced rice husk ash by replacing fly ash in brick. From the comparison the test result has shown a significant change in the compressive strength by the addition of basalt fiber than the addition of rice husk ash to the normal fly ash brick and also the test results showed significant changes in the water absorption quality and other properties of the fly ash brick.

KEYWORDS: Fly Ash Brick; Rice Husk Ash; Basalt Fiber; Aspect Ratio; Fiber Reinforced Brick; Ordinary Portland Cement(OPC);

1. INTRODUCTION

1.1 Introduction

About 180 billion tonnes of clay brick production per year consumes 540 million tonnes of clay, makes 26305 hectares of land barren, and consumes 30 million tonnes of coal equivalent, generates 26 million tonnes of Carbon Dioxide. A 10% switchover to fly ash bricks will use 30 million tonnes of fly ash every year, save environment and coal. There has been impressive increase in the power generation in India from a low capacity of 1362 MW in 1947 to about 112050 MW in 2004. Indian coal has high ash content around 35-45% and low calorific value 35004000 KCal/Kg as a result of which huge quantity of ash is generated. A typical 200 MW unit produce around 50-60 M.Tons of ash per hour in India. Generally 0.40 hectare land is needed per M.W. of power production. Power being considered as an engine of growth, has always been a focus area for most of the developing countries including India. The power generation in India has increased from 1362 MW in 1947 to 200000 MW in 2012 and ash generation will reach a figure of around 200 M. Tons per year. This would require about 40000 hectares of land for the construction of ash ponds. Further, Government of India has planned for enhancement of installed capacity to 3, 00,000 MW by 2017 (Vimal et al. 1995). Coal based power plants not only produce of millions of megawatts of power but also millions of tons of fly ash. Most of the coal based power plants were set-up with sole aim of power generation (Dhar, 2001). Environmentally safe disposal of large quantity of fly ash is not only problematic but also expensive. Keeping in view the gravity of the fly ash disposal problem, global efforts are mooted to utilize fly ash in bulk quantities.

1.1.1 Background

As per the studies done on this flyash bricks show some reduction in the strength when compared to conventional bricks, to overcome that issue and to increase the strength of the brick fibers and agricultural wastes were added. Agricultural wastes such as oil palm, pineapple leaves, sugarcane bagasse ash, paper pulp, basalt coir, rice husk, rice straw, jute, hemp, corncob and sawdust were used in production of cement-based composites. Based on literature, the utilization of natural fiber reinforced cement composites offer several advantages, e.g., increased flexural strength, post-crack load bearing capacity, improved bending strength, etc. and also stated that the use of basalt fibers in polymer concrete shows better flexural strength than artificial fibers. So, to increase the strength and to have better performance than the conventional bricks, basalt fibers were incorporated and the performance of the bricks were analysed. These basalt fibers has shown great Other than basalt coir, rice husk ash is used as a filler material though, the rice husk ash is also having pozzolonic properties like fly ash it can be used as a replacement material for the fly ash. When the rice husk ash is used as additive to increase strength it shows poor performance, because it is also in the powdery form, so it cannot engage to the strength parameters of the brick so it can be only used as a filler material.

1.1.2 Motivation

The bonding material used in the fly ash bricks are lime or Ordinary Portland Cement (OPC). On comparing both the binders, the OPC has many advantages when compared to lime. The setting time and the load bearing capacity of the OPC is somewhat greater than the lime. The project deals to increase the compressive strength of the fly ash brick, among the two binders, OPC is used as a binder for the brick. Quarry dust is another material used in the brick to fill the remaining space. It is used in the combination form of powdery and gravel particles, though the powdery particles does not enhance the strength parameters, somewhat coarser particles were mixed which helps to the strength parameters of the brick. Quarry dust is a obtained from the granite crushing process produced during quarrying activities and due to the easy availability and the low cost it is used in plenty of applications like cement mortar, building block, concrete and in controlled low strength material these quarry dust is incorporated as a main ingredient in the building industries.

1.2 Problems Statement

In Existing scenario, an alternate for clay bricks is fly-ash bricks which plays a key role in the construction of framed structures because of its less weight which will reduce the dead weight of the structure, due to its light weight concept and another advantage is low cost

1.3 Objectives of the Project

1. To study and develop fly ash bricks that are not subject to load bearing structure because of its slight reduction in compressive strength compared with nominal clay brick.
2. To increase compression strength using basalt fiber is carried out, with this another proportion of replacement to the fly ash is done with rice husk ash.
3. To study and comparison has been carried out for the normal brick to the fiber reinforced brick and fiber reinforced rice husk ash by replacing fly ash in brick.
4. To perform test result has shown a significant change in the compressive strength by the addition of basalt fiber than the addition of rice husk ash to the normal fly ash brick and also the test results showed significant changes in the water absorption quality and other properties of the fly ash brick.

1.4 Scope of the Work

In this project By varying the proportion of fiber and rice husk ash of 5% and 10%, with basalt fiber's aspect ratio of 150, is mixed separately and also in the combined proportion of 5% and 10% of basalt fiber and rice husk ash.

1.5 Research Methodology

The experimental study was carried out in three phases. The first phase is to prepare a mix design of concrete as per the properties obtained and gradation of materials for making fly ash brick. The Second phase of the experimental

investigation is to find the optimum percentage of BF mixed into the concrete under compression test. Addition of different percentage of BF For a mix designed concrete is scheduled, from which optimum percentage of BF available for experimental investigation was to be found out. The third phase includes preparing a concrete for cylinder and beam specimens by adding optimum percentage of BF. Casting of 6 brick is carried out and further by using basalt rebars with same (Optimum Percentage) BF casting of 12 beams will be carried out. A comparison of experimental results with normal concrete specimens will be carried out using FRC and basalt rebars by conducting split tensile and flexural strength tests into the laboratory.

1. A mix design for M-30 grade of concrete is adopted for trial. Cubes were casted for curing period of 28 days. These cubes were tested for compression strength.
2. A total 18 number of cubes were casted with addition of BF percentage into the concrete by volume, such as 0%, 0.5, 1, 1.5, 2 and 2.5% at an increment of 0.5%.
3. By adding different percentage of BF into the concrete, optimum percentage of BF will be obtained.
4. Further, by using optimum percentage of basalt fibers into the concrete, 6 brick were allowed to cast and comparison the split tensile strength results with normal concrete brick is proposed.
5. Further beam specimens were proposed to cast by using optimum percentage basalt fibers and basalt rebar instead of steel bars as a Basalt Fiber Reinforced Concrete (BFRC). A total number of
6. beams were casted for flexural strength test. After the test, load-deflection data and flexural strength of different beams specimens was compared with normal concrete specimens.

1.6 Limitations of Study

- Mechanical strength is low, but this can be rectified by adding marble waste or mortar between blocks.
- Limitation of size. Only modular size can be produced. ...
- It is only good for the places like subtropical area or area where climate is warm because it doesn't absorb heat. But during cold it is not helpful.

II. LITERATURE SURVEY

1. M. N. Akhtar” Feasibility of coal fly ash based bricks and roof tiles as construction materials: a review (2017)

The aim of present study is to investigate about the potential use of coal fly ash along with other natural and solid wastes for the production of coal fly ash based bricks and roof tiles. The study is based on the comprehensive reviews available from the previous experimental data on coal fly ash based bricks and roof tiles. The study intendeds to provide the essential technical information and data for the use of fly ash mix with other solid wastes and reveal their suitability as construction materials. It has been found that samples were non-hazardous in nature and vigorously used as an additional construction materials and their compositions are perfectly fit to make the strong composite material for bricks and tiles. The three past studies have been demonstrated that, fly ash based bricks and roof tiles provides a sustainable supplement to the traditional clay bricks and roof tiles, that not only increases the efficiency of traditional bricks and roof tiles but also helps significantly to reduce the environmental issues associated with the disposal of these waste materials. In addition to this study highlights the potential use of fly ash for producing sustainable construction materials.

2. Mamta Mishra “Improving Strength of Soil using Fiber and Fly ash -A Review”(2016)

Soil is very important in civil engineering constructions. The poor engineering properties of the local soils may present many difficulties for construction and therefore need to improve their engineering properties. Stabilization techniques can be used to improve the properties of soil. Soil stabilization improves various engineering properties e.g. bearing

capacity, compressibility, strength, and various other properties of soil. In this paper we study the impact of fly ash and coir fiber to improve the strength of soil.

3. Irfaz ur Rahman Najar “Combine Effect of Silica-Fume, Fly-ash and Steel Fiber on Reinforced Concrete, A Review” (2018)

Cement is the mainly use construction material in recent trend cement concrete is replace by admixtures such as, slag, fly ash, silica fume to increase the characteristics strength of high performance of concrete in order to decrease the shrinkage and creep and to increase tensile strength, fibers are added. Strength Properties studies involve compressive strength flexural strength tensile strength and abrasion. Standard cubes 15cm x 15cm x 15cm, standard brick 15cm dia x 30cm height and standard beam 10cm x 10cm x 50cm were considered in the research. The study bring that the use of waste material like silica fume, fly ash with steel fibers develop the strength properties of concrete, which is otherwise unsafe to the environment and thus may be used as a fractionally replacement of cement.

4. Tabin Rushad S” Experimental Studies on Lime-Soil-Fly Ash Bricks” (2011)

Fly ash is generated in large quantities especially by thermal power plants. A lot of research has been carried out for effective utilization of fly ash in building industry. Use of fly ash in manufacturing brick is one such subject which is being studied by researchers. The aim of the present study is to investigate the strength and water absorption characteristic of fly ash bricks made of lime (L), local soil (S) and fly ash (FA). The experiments were conducted both on Hand moulded and Pressure moulded fly ash bricks. It was observed that none of the L-S-FA bricks satisfy all the requirements of standard codes. While some of the bricks satisfy the provisions in respect of strength only the L-FA (40: 60) bricks satisfy the requirement of Indian Standard Code in respect of strength as well as water absorption characteristics.

5. Adarsh Kumar S and Rame Gowda M “Behavior Study of Fly-Ash Based Bricks and Analysis of R.C Frame Infill Using ETABS (2017)

Abstract: In many green building materials fly ash brick also included. Fly ash bricks can be suitably used in masonry like clay bricks. The manufacture of fly ash bricks will be more economical if the manufacturing unit is nearer to the thermal power plant. In this work development of high strength and economical fly-ash bricks is carried out. It is also necessary to utilize some other material like lime, quarry dust and cement. Experiments are conducted for four proportions by keeping lime and cement constant, fly-ash and quarry dust quantity is varying in range. Tests are conducted for water absorption and compressive strength and flexure strength for 7, 14, 21 and 28 days age of curing. By considering the high strength fly ash brick infill property for building, analysis is carried out to evaluate strength and also to provide effective performance against the lateral loading. Analysis also done by taking sample of multi-storey building by using E-TABS and compare the results obtained with conventional clay brick.

6. S.V. Giri Babu “Manufacturing of Eco-Friendly Brick: A Critical Review(2018)

The oldest building material in the construction industry is the clay brick and in fact, it is the first manufactured one by man. Now-a-days, brick is one of the most common masonry units used as building material in the construction industry. Hence, the huge demand occurred in building material industry especially in the last decade owing to the increasing population. India is the second largest brick manufacturer in the world. India produces bricks using the traditional methods that are more than 125,000 registered / unregistered clay brick kilns, which meet the annual demand of more than 250 billion bricks. The traditional methods consume 350 million tons of fertile soil and 25 million tons of coal annually (KEN RESEARCH Pvt. Ltd). Consequently, it becomes a big issue of environmental concern. Recycling of waste materials such as fly ash, marble sludge, granite sludge, stone sludge, ceramic sludge, Plastic, coal and wheat husk, sawdust, Sugarcane Bagasse Ash (SBA), Rice Husk Ash (RHA), residual coal etc., are alternatives for the raw material instead of fertile clay that may contribute to the exhaustion of the natural resources. Hence, an eco-friendly brick manufacturing is utterly needed to overcome the conservation of non-renewable resources, improvement of the biotic health and security preoccupation with environmental matters and reduction in waste disposal costs. Previous researchers have demonstrated positive effects of using various waste materials in the manufacturing of bricks like physical and mechanical properties as well as its impact on the environment. This paper presents a review on the utilization of waste materials for manufacturing of bricks to provide a potential and sustainable solution for the eco-friendly environment.

7. Nutan C. Patel “FLY ASH BRICK: GLASS FIBER THE INNOVATIVE CONCEPT FOR GETTING HIGHER STRENGTH BRICK(2013)

Experiments have been carried out by several materials like Fly ash, lime, sand, Kheda dust, Glass fiber for the manufacturing of the brick. The fly ash of ‘F’ category was used as a raw material for making fly ash bricks. The combinations of fiber fly ash brick have different percentage of the Glass fiber adding like 0.2%, 0.4%, 0.6%, 0.8%, 1.0%. In the testing of the fiber fly ash brick there are main two type of the testing is done compressive strength test and water absorption test after 7, 14, 21days. With Changing (increasing) in the percentage of the Glass fiber of compressive strength of the fiber fly ash brick is increase and water absorption is decrease.

8. Shivsheesh Kaushik “Optimization of Compressive Strength for Fly Ash Building Bricks Using Taguchi Method” (2017)

Now days the Fly ash is used in many areas and it is available at Thermal Power Stations by burning of coal and lignite, it is stored in rooms or stock over fertile land for other uses. It is important for power plant that they should use the fly ash quickly, because fly ash contains sulphur, the place where it will be kept will become barren. In this study investigation was carried out to know the percentage of maximum use mixture of fly ash building brick so that we can use and recycle fly ash with most favorable outcome which is needed for making bricks. The size specimen taken for bricks is as follows, 230mm x 100mm x 90mm. According to Indian standard for different mixture percentage of fly ash (10 to 30%), gypsum (3%), cement (25-35%) and coarse aggregate (45-55%) with three different particles with three different particle size of fly ash 425micron, 600micron, 825micron, compressive strength, Water absorption, Efflorescence test were studied for different mix proportions. The results shows the variations in compressive strength, Water absorption, and Efflorescence test for different mixture proportions of different materials mentioned earlier at different curing time that is 7Days, 14Days, and 21Days. From the previous research based results it was evidently expected that, the maximum optimum compressive strength is obtained for optimum mixture percentage of Flyash-10% Cement-35% Gypsum-3% Coarse Aggregate dust-52%.

9. S. Shankarananth and B. Jaivignesh “Experimental Study on the use of Glass Powder, GGBS, & Perlite in Fly ash Brick(2016)

Bricks are manufactured by grinding or crushing the clay in mills and mixing it with water to make it plastic. This paper presents a parametric experimental study, by utilization of glass powder, GGBS, Perlite ore in fly ash brick manufacturing. Glass powder, Perlite ore is taken as constant of 2%, 10% and GGBS is replaced with 10%, 20% and 30% for each proportion that have been calculated. The physical and mechanical properties of fly ash brick are investigated. These bricks were tested for compressive strength, water absorption, efflorescence, Density and soundness test after 21 days curing as per Indian Standards. Based on the results obtained from these experiments, the suitability use of fly ash bricks is ascertained.

10. N.Sudharsan “FEASIBILITY OF USING WASTE GLASS POWDER IN FLY ASH BRICKS” (2018)

Fly ash is one of the major residues generated during combustion of coal in thermal power plants. Fly ash brick technology is the process of converting industrial waste material into quality building material. Glass waste is the problematic threat to environment and also to the developing countries. Fly ash, Lime, Gypsum and Crusher dust are used to manufacture the fly ash brick. In this study glass powder is used as a replacement material for fly ash. The fly ash was replaced by the glass powder in the various proportions. Two types of Fly ash bricks were casted. In first type Boron glass

replaced in Fly ash bricks and another type Soda lime glass lime replaced in Fly ash bricks. The prepared bricks are cured for 7days and 28days dried in regular temperature. The tests results shows the compressive strength of the brick with 20% replacement of boron and soda Lime glass powder revealed 6.723N/mm², 6.150 N/mm² provokes the excellent performance in compare to the Indian Standards. The water absorption, bulk density, hardness, efflorescence, initial rate of absorption and sorptivity of the brick are experimented as per IS code. The study was aimed to reduce the waste glass dumping in the earth to protect the environment from hazardous and also increment of low cost brick towards the construction industry for the sustainable development.

III. MATERIAL AND METHOD

1. Material and method A. Fly ash:

Fly ash consists primarily of oxides of silicon, aluminium iron and calcium. Magnesium, potassium, sodium, titanium, and sulphur are also present to a lesser degree. When used as a mineral admixture in concrete, fly ash is classified as either Class C or Class F ash based on its chemical composition. Class C ashes are generally derived from subbituminous coals and consist primarily of calcium aluminosulphate glass, as well as quartz, tricalcium aluminate, and free lime (CaO). Class C ash is also referred to as high calcium fly ash because it typically contains more than 20 percent CaO. Class F ashes are typically derived from bituminous and anthracite coals and consist primarily of an aluminosilicate glass, with quartz, mullite, and magnetite also present. Class F, or low calcium fly ash has less than 10 percent CaO.

B. Quarry dust:

Quarry dust is a by-product of the crushing process which is a concentrated material to use as aggregates for concreting purpose, especially as fine aggregates. In quarrying activities, the rock has been crushed into various sizes; during the process the dust generated is called quarry dust and it is formed as waste. It is grey in colour and it is like fine aggregate. Natural granite aggregate having density of 2700 kg/m³. The specific gravity was found to be 2.58 to 3. The concept of replacement of natural fine aggregate by quarry dust which is highlighted in the study could boost the consumption of quarry dust generated from quarries. The availability of sand at low cost as a fine aggregate in concrete is not suitable and that is the reason to search for an alternative material and the quarry dust is used in order to increase the strength of the brick. When we use lime, gypsum, their hardening period and due to powdery form they need to be compressed at high load, but when we use this quarry dust, their hardening period is reduced and it bonds quickly with cement and achieves strength.

C. Rice husk ash:

Rice milling industry generates a lot of rice husk during milling of paddy which comes from the fields. This rice husk is mostly used as a fuel in the boilers for processing of paddy. Rice husk is also used as a fuel for power generation. Rice husk ash (RHA) is about 25% by weight of rice husk when burnt in boilers. A fire source was maintained under the furnace in which the husk was dumped for around 10 minutes, after which the husks slowly burned for more than one day. The ash was left inside the furnace to cool down before it was collected. The rice husk ash possesses a chemical composition similar to many of the organic fibers. Rice husk ash consists of Cellulose (C₅H₁₀O₅), Lignin (C₇H₁₀O₃), Hemi cellulose, SiO₂, Holo cellulose. These are compounds within them in common. The rice husk ash may vary depending upon the source as well as the type of treatment. Treatment in the sense the rice husk is burned to have proper properties.

D. Ordinary Portland cement:

OPC 53 Grade cement is required to conform to BIS specification IS:12269-1987 with a designed strength for 28 days being a minimum of 53 MPa or 530 kg/sqcm. 53 Grade OPC provides high strength and durability to structures because of its optimum particle size distribution and superior crystallized structure.

E. Chopped Basalt Fiber:

chopped basalt fibers which are manufactured in a single stage process by melting pure basalt rock raw material. Basalt filaments are made by melting crushed volcanic basalt rock of a specific mineral mixture to 1,700 degrees Celsius for 6 hours. The white hot material is drawn through special platinum bushings and then cooled into fibers.



IV. RESEARCH METHODOLOGY

After performing fineness test, initial setting time test and specific gravity test the results are tabulated. Table 1:- Raw Materials Test Results

<i>Raw Materials</i>	<i>Fineness</i>	<i>Initial setting Time</i>	<i>Specific Gravity</i>
Fly ash	4.3%	-	1.53
Quarry dust	3.4%	-	2.19
OPC	4%	33	3.16
Rice husk ash	6.2%	-	0.33

4.1 ASPECT RATIO OF FIBRE

Aspect ratio of a fibre is defined as the ratio to the length and the diameter of the fibre. Many researchers have shown that the addition of small closely spaced and uniformly dispersed fibre to concrete transforms the brittle cement composite into a more isotropic and ductile material. This may be due to the fact that a fibre of lower aspect ratio can be compacted well with slurry infiltration without producing more voids, which can exhibit higher absorption of impact energy and flexural energy thus giving rise to higher values of impact strength, flexural strength and compressive strength indices. The impact strength also shows a decreasing trend with increase in aspect ratio of fibres. Aspect ratio of coconut coir fibre taken for the investigation is 150. That the diameter of the fibre is about 0.2mm (avg.) and the length taken is about 3cm. The length of the fibre chosen for the investigation is based on the easy working condition while mixing and compaction of the brick and based on the studies. After the studies and the test results obtained from the raw materials, they were taken for the production of the brick.

4.2 PROPORTIONING

Before, the manufacture of the brick, the exact proportioning of the bricks have to be done in order to have a engineered quality of production and to maintain the quality and to know the quantity of the materials needed for an exact number of bricks. Totally, 63 count of bricks were moulded, the quantity of bricks is counted on the basis of that each proportion of brick has three days of compressive strength test, for each test three bricks are needed. So, totally single proportion will hold nine bricks. Totally, seven proportions were made, that each one proportion holds nine bricks which lead to a count of 63 bricks for the test. Water absorption test for three periods hold only three bricks for each proportion, so those bricks were not moulded separately, they were taken from that ninebricks. Proportioning of the brick is done by keeping the percentage of cement and quarry dust as same and from the percentage of fly ash, the replacement of coconut coir and rice husk ash is done. For a normal factory made brick without any extra addition of additives, the percentage of materials is kept at 60% flyash, 30% quarry dust and 10% cement. In this project, the percentage of the quarry dust and he cement is kept as same as 30% and 10% respectively.

In the 60% of fly ash, replacement is done up to 10% of the additives. Fly ash is replaced for 5% and 10% with the additives. The additives coconut coir and rice husk ash were added in the brick in 5% and 10% as separate proportions and also the additives were added in a combined form of 5% and 10%. In the combined proportion, for 5% the additives were added in a perfect proportion of 2.5% coconut coir and 2.5% rice husk ash. Likewise, for 10% the additives were added at 5% coconut coir and 5% rice husk ash. The additives proportion were done in a long stretch of 5 and 10 percent, because to find out a weaken part of percentage is occurring before 5 percentage or in between 5 to 10 percentage and or above 10 percentage.



The proportion of the materials in percentage for a single brick is done as,

Table 2:- Proportion of Materials in Percentage (%)

	Fly ash (%)	Quarry dust (%)	OPC (%)	Coconut coir (%)	Rice husk ash (%)
Normal	60	30	10	-	-
5 R	55	30	10	-	5
5 C	55	30	10	5	-
5 RC	55	30	10	2.5	2.5
10 R	50	30	10	-	10
10 C	50	30	10	10	-
10 RC	50	30	10	5	5

The proportion of the materials in kilograms for each proportion (i.e., for 9 bricks in each proportion) is done as,

Table 3:- Proportion of Materials in Kilogram

	Flyash (kg)	Quarry dust (kg)	OPC (kg)	Coconut coir (kg)	Rice husk ash (kg)
Normal	13.5	6.75	2.25	-	-
5 R	12	30	10	-	1.125
5 C	12	30	10	1.125	-
5 RC	12	30	10	0.5	0.5
10 R	11.25	30	10	-	2.25
10 C	11.25	30	10	2.25	-
10 RC	11.25	30	10	1.125	1.125

V. TEST ON BRICKS

A. Shape and size:

The shape and size of a brick should be uniform that when it is used for a structural component building purpose. So the brick has to be in a perfect shape of rectangular and also it is important that all the bricks should be in that rectangular shape without any odd one out. Then the size of the brick should also be perfect in size not only in shape.

B. Colour:

The colour of the flyash brick is greyish. It is important to maintain the colour uniformity of the brick. If the colour uniformity is not properly handled, then it will results to an anaesthetic appearance and also it indicates that the mixture used for casting of the brick is not homogenously mixed. If the mixture is mixed homogenously then it will not result to

nonuniformity in colour. And also the differences in the colour will be due to the water used in the mixture, if the water used is salty, then it will give efflorescence's and lead to colour variance in the bricks.

C. Compressive strength test:

For each proportion three bricks were tested and the values were tabulated and graphed and comparison is carried out within the designed proportions of the fly ash brick. The graphs were shown below for each above mentioned proportions.

Table 4:- Compressive Strength (N/MM2) Results

	7 days	14 days	28 days
Normal	3.626	3.903	3.69
5R	1.05	1.24	1.21
5C	7.9	9.697	15.679
5RC	12.76	13.26	14.274
10R	0.94	0.97	1.045
10C	12.7	15.982	19.968
10RC	3.7	11.622	13.91

a. Normal Proportion:

In normal proportion, the bricks were made out of using only flyash, quarry dust and Ordinary Portland Cement (OPC). From the test results, the load carrying capacity of the brick is found to be moreover equal and it is around 3-4 N/mm². The materials used in the proportion were taken of the quantity in percentage of about 60% flyash, 30% quarry dust, 10% OPC.

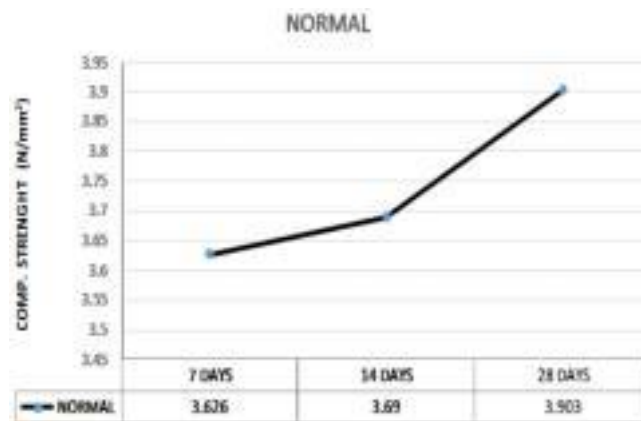


Fig 1:- Compressive strength test results of normal proportion

b.5 R Proportion:

In 5 R proportion, the materials used to cast the bricks are flyash, quarry dust and Ordinary Portland Cement (OPC) and the additive Rice husk ash (RHA). Here, the rice husk ash is used as a replacement in the percentage of flyash. So the percentage of the materials used in the proportion will be of about 55% flyash, 30% quarry dust, 10% OPC and 5% rice husk ash. From the compression strength test conducted, the results were found to be of around 1 N/mm².

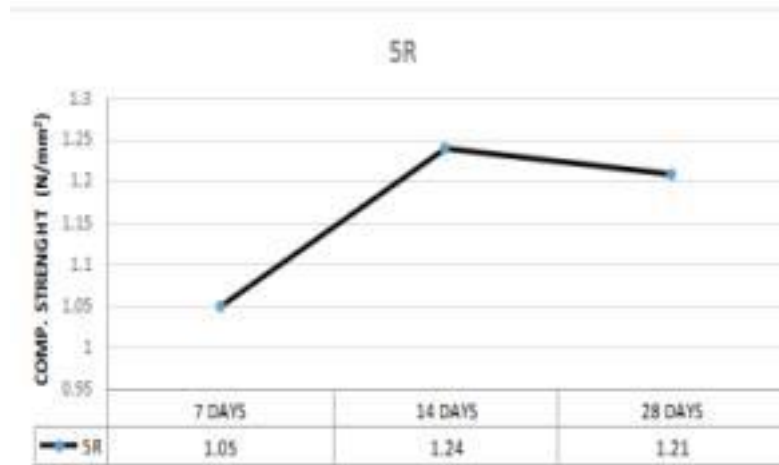


Fig 2:- Compressive strength test results of 5R proportion

c. 5 C Proportion:

In 5 C proportion, the materials used to cast the bricks are flyash, quarry dust and Ordinary Portland Cement (OPC) and the fibre coconut coir (CC). Here, the coconut coir is used as a replacement in the percentage of flyash. So the percentage of the materials used in the proportion will be of about 55% flyash, 30% quarry dust, 10% OPC and 5% coconut coir. From the compression strength test conducted, the results were found increasing gradually on increase of days.

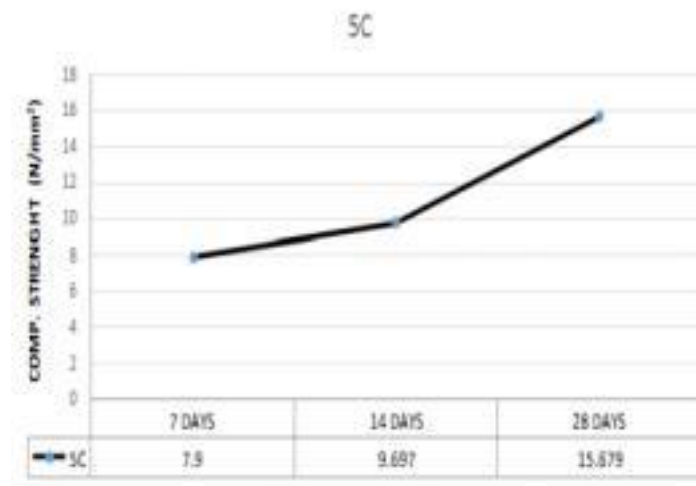


Fig 3:- Compressive strength test results of 5 C proportion

d. 10 RC Proportion:

In 10 R proportion, the materials used to cast the bricks are flyash 50%, quarry dust 30% and Ordinary Portland Cement (OPC) 10% and Rice husk ash (RHA) 10%. Here, the rice husk ash is used as a replacement in the percentage of flyash. From the test conducted, the results were found to be of around and below 1 N/mm². When compared to 5 R mix and this, the strength decreases due to the further addition of rice husk ash, the weight of the brick kept decreasing with increase of RHA, but it also shows reduced strength when compared to other proportions. So, rice husk ash can be only used as a filler materials and it cannot be used as a replacement material.

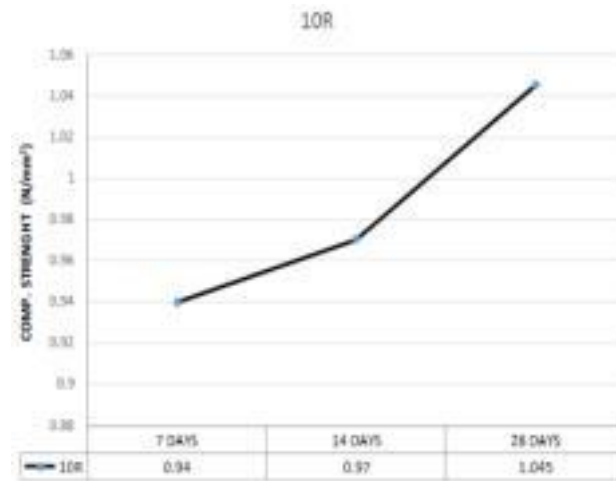


Fig 5:- Compressive strength test results of 10 R proportion

e. 10 C Proportion:

In 10 R proportion, the materials used to cast the bricks are flyash 50%, quarry dust 30% and Ordinary Portland Cement (OPC) 10% and the fibre coconut coir (CC) 10%. Here, the coconut coir is used as a replacement in the percentage of flyash. From the results, it were found to be the strength gets increasing gradually on increase of days. When compared to the other mixes, the strength increases due to the addition of fibre, also weight of the brick remains same. The usage of the fibre creates a strong link inside the brick thus it holds the brick even it gets cracks at its normal state, the further loading is carried by the fibre and makes the bricks to withstand heavy loadings. The addition of more coir then 5 C helps to increase the strength more, but when it overs a certain percentage it makes the brick to lose strength.

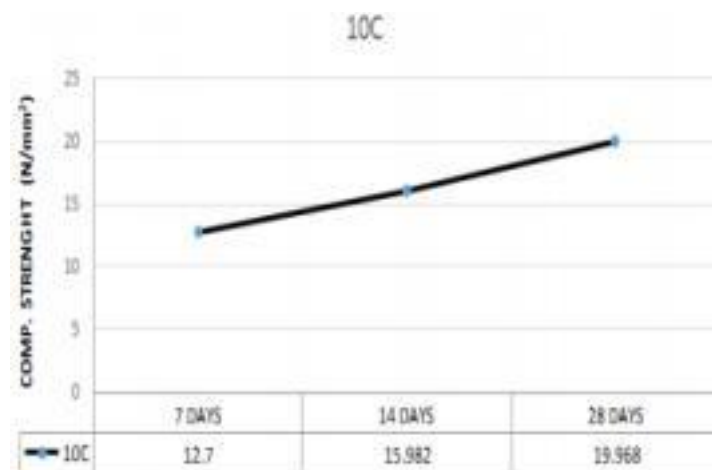


Fig 6:- Compressive strength test results of 10 C proportion

f. 10 RC Proportion:

In 10 RC proportion, the materials used to cast the bricks are flyash 50%, quarry dust 30% and OPC 10%, RHA 5% and CC 5%. Here, both additive were used as a replacement in the percentage of flyash. The test results were found to be increasing proportional to the period. When compared to the 5 RC mix and this, the strength is low at its initial state due to the addition of rice husk ash, but as the period increasing the brick attains high strength with the added coir fibre,



which makes the brick to withstand heavy loads. The weight of the brick is not having a huge changes but it increases the strength.

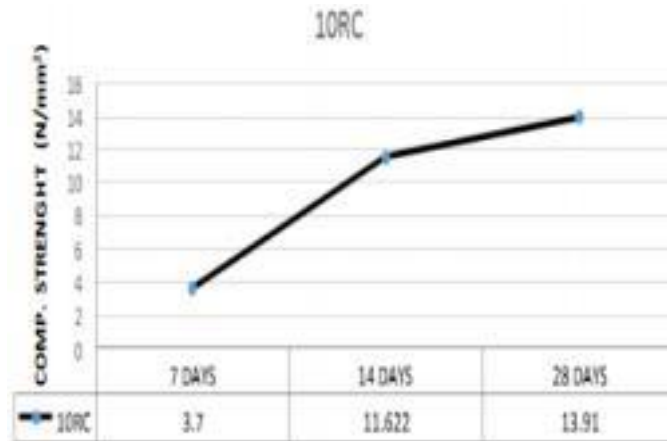


Fig 7:- Compressive strength test results of 10 RC proportion

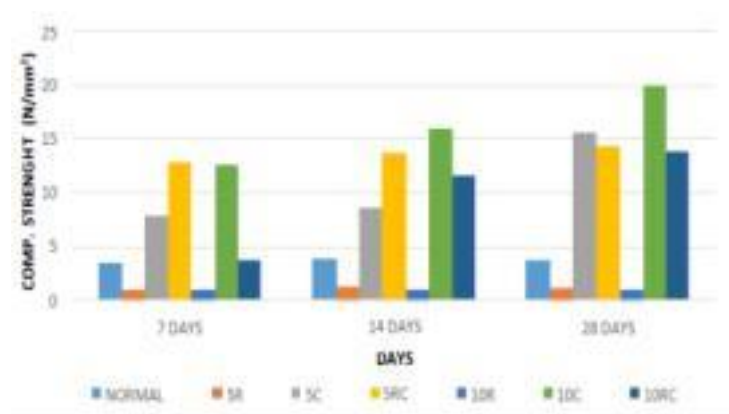


Fig 8:- Comparison compressive test results for different proportions

D. Water absorption test

Water absorption quality of the brick is the ability of the brick to absorb the water when it is exposed to condition like that. If the quality of the brick was needed to be high, then its water absorption quality has to be low. When the brick absorbs more water, it leads to reduction in its strength.



Fig 9:- Water absorption test result for different proportions

E. Efflorescence test:

It is the test to find out any presence of salt content on the surface of the brick or while the manufacture of the brick. The presence of salt content in brick leads to react with the external environment situations. So it is important to identify the presence of salt in the bricks. The efflorescence test results of the bricks are nil.

VI. CONCLUSION

From the investigation carried out on the bricks made with the incorporation of the basalt fiber and the rice husk ash at certain percentage with the normal ingredients and tested. From the test results it is concluded that, Use of normal fly-ash bricks for load bearing walls is very limited due to low strength and majorly used for framed buildings. By the addition of basalt fiber to the normal fly ash bricks has shown a huge enrichment in compressive strength. The use of basalt fiber in the brick up to 10% has shown good results, further addition of basalt fibers not still investigated. Rice husk ash usage in the brick has only having one advantage that it will reduce the weight of the brick from its original weight. Rice husk ash does not concentrate on the strength parameters of the brick. When coir is added, the strength of the brick varies from the 7 th day to 28th day. This says that the brick with basalt fiber will have a gradual increase in its strength. Strength parameters of the brick incorporated with rice husk ash will have equal values. Water absorption of the basalt fiber brick is lower than the rice husk ash added brick, but water absorption of normal brick is lower than the basalt fiber bricks

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