International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 06, June-2021

# An Experimental Study on Papercrete Bricks Manufactured using Paper Pulp, Lime and Fly Ash

[1st]Arjun Dileep
U G Student , Dept. of Civil Engineering
Ilahia College of Engineering and Technology
Mulavoor P.O, India

[2nd] Atheesh Lal
U G Student, Dept. of Civil Engineering
Ilahia College of Engineering and Technology
Mulavoor P.O, India

[3rd]Jesna Jamal
U G Student, Dept. of Civil Engineering
Ilahia College of Engineering and Technology
Mulavoor P.O, India

[4th] Adila Abdulla Kunju
Assistant Professor, Dept. of Civil Engineering
Ilahia College of Engineering and Technology
Mulavoor P.O, India

***Abstract*—Concrete is one of the most widely used construction material in the world and it must keep evolving to satisfy the increasing demands of all its users. The emission of $CO_2$ from cement production is a major issue for all the countries. Also the majority of abandoned paper waste accumulating from all over the world causes certain serious environmental problems. The present study focuses on utilizing the materials like fly ash and lime in papercrete bricks, thereby reducing the amount of cement in the bricks and also to reuse the waste papers without causing any environmental issues. Experimental investigation was carried out to evaluate the compressive strength, water absorption and dry weight of fly ash - lime based papercrete bricks. The maximum compressive strength is obtained for 20% replacement of cement with fly ash and lime respectively. The test results shows that, further replacement of cement with fly ash and lime decreases the compressive strength &increases the water absorption of papercrete bricks. Papercrete bricks are light weight and relatively more economic and they can be used for partition walls& non load bearing walls.**

***Keywords—Papercrete, Fly Ash, Lime, Compressive Strength, Water Absorption***

## I. INTRODUCTION

The environment impact of paper is significant, which has led to changes in industry. With the use of modern technology, harvesting of wood, disposable paper has become a cheap commodity which has led to a high level of consumption and waste. The production and use of paper has a number of adverse effects on the environment which are known as paper pollution. Discarded paper is a major component of it. Taking this issue into account, construction material known as papercrete is invented. Papercrete is an innovative composite material developed to build an environmental friendly house made up of paper, cement and water. It has been reported to be a cheap alternatively building construction material, to have a good absorption and thermal insulation, to be a light weight and fire resistant material. The paper used in making are those that need to be recycled. It is perceived as an environmental friendly material due to the vital recycled content. It is made by mixing the dry ingredients with water to form slurry and cast the slurry into blocks and let it dry. It holds its shape even when it is wet and is remarkably strong. Using papercrete helps to reduce waste gives people job in making papercrete and also help in developing the economic state of each individual. The product is highly sustainable as it was around 80% recycled material, hence capturing carbon dioxide emission by using waste as raw material. Papercrete is an emerging new concept however it has limited scope.

### *A. History Of Papercrete*

Papercrete was first patented in 1928 by Eric Patterson and Mike McCain, who 'invented' it independently as 'padobe' and 'fibrous cement' respectively. The pair has both contributed to the debate on potential applications and best practice for its production. While there is a perception that the material is environmentally-friendly given its use of paper that would otherwise end up in landfill, the use of cement means it's not quite as 'green' as would be ideal. As a building material it's enjoyed new-found popularity since the 1980s, particularly among DIY builders, with a burgeoning community online sharing applications and innovations.

Papercrete is a material originally developed 80 years ago but it is only recently rediscovered. Papercrete is a fibrous cementious compound comprising waste paper and Portland cement. These two components are blended with water to create a paper cement pulp, which can then be poured into a mould, allowed to dry and be utilized as a durable building material. It should be noted that Paper Crete is a relatively new concept with limited scope. Papercrete has three derivatives, namely fibrous concrete, padobe and fidobe. The fibrous concrete is a mixture of paper; Portland cement and water.

There are no harmful by-products or excessive energy use in the production of Papercrete. Padobe has no Portland cement. It is a mix of paper, water and earth with clay. Here clay is the binding material. Instead of using the cement, earth is used in this type of brick. This earth should have clay content of more than 30%.With regular brick, if the clay content is too high the brick may crack while drying, but adding paper fiber to the earth mix strengthens the drying block. It gives flexibility which helps to prevent cracking. Fidobe is like padobe, but it may contain other fibrous material.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 06, June-2021

*B. Objectives*

- To analyse and improvise the properties of normal papercrete brick by using fly ash and lime.
- To determine the compressive strength of normal papercrete bricks and papercrete bricks made using fly ash and lime at 14 & 28 days .
- To conduct water absorption test and weight test on normal papercrete bricks and papercrete bricks made using fly ash and lime.
- To compare the compressive strength, water absorption and weight test of papercrete brick with conventional brick.

*C. Scope of Study*

The main objective of project is to improve the properties of papercrete brick by utilizing the waste materials like fly ash and lime. Also a further investigation to study the compressive strength, absorption test and weight test of papercrete brick manufactured using fly ash and lime. The mix proportion is 1:1:2. [7]

## II. LITERATURESURVEY

Bhupesh Pandey (2019)investigated the use of waste paper for producing a low cost and light weight concrete. The work was carried out in different stages using different mix. Different ratios of cement, fine aggregate, paper and water proofing admixtures were considered and tested. The waste paper collected was shredded up to a size of 10mm x 1mm and immersed in water to convert into paste. The pulp was added with dry ingredients and mixed manually. Slump test, Compaction factor test, Water absorption test, Compression test and Structural test were conducted and determined the slump value (78mm & 83mm), compaction factor (0.87 & 0.84), water absorption (12.13% & 14.37%) and examined the concrete blocks to be compacted and free from defects. In this study they were intended to manufacture concrete by partially replacing cement with waste paper to achieve an economical & environmental concrete. [1]

G B Rameshkumar (2017) Papercrete is a sustainable building material due to reduced amount of cement usage and recycled paper being put to good use. The high volume of concrete offers a holistic solution to the problem of meeting the increasing demands for concrete in the future in a sustainable manner and at a reduced or no additional cost and at the same time reducing the environmental impact of industries that are vital to economic development. As natural sources of aggregates are becoming exhausted, it turns out urgent to development. The majority of abandoned paper waste is accumulated from the countries all over the world causes certain series environmental problems. This project deals a parametric experimental study which investigates the potential use of paper waste for producing a low-cost and light weight concrete as a building material. An experimental investigation has been carried out to optimization of mix for papercrete depending upon the compressive strength and flexural strength. An experimental program has been carried out to investigate the mechanical properties of papercrete with 0%, 50% and 100%. The tests performed which are compressive strength, flexural strength and also determining the workability of fresh prepared papercrete. The workability test such as slump cone test is performed for fresh concrete mix. For compressive strength test was undertaken in accordance with the technical requirements, a universal testing machine is used for performing compressive tests, the papercrete specimens size 150mm x 150mm x 150mm are to be casted and tested after curing period of 7 days and 28 days.[2]

J S Sudarsan (2017) in the study, abandoned paper waste was used as a partial replacement material in concrete The study was based on potential use of light weight composite brick as a building material and potential use of paper waste for producing at low-cost. Experimental investigation was carried out to analyse optimization of mix for papercrete bricks depending upon the water absorption, compressive strength and unit weight. Papercrete bricks were prepared out of waste paper, and quarry dust with partial replacement of cement by another industrial by-product Fly Ash in varying proportions of 25%, 40% and 55%. The properties like mechanical strength, standard quality comparisons with the conventional bricks through standard tests like hardness, soundness, fire resistance and Cost-Benefit Analysis were performed and studied. The specimens of dimension 230mm x 110mm x 80mm were subjected to 7 days and 28 days air curing and sun drying before tests were performed on them. The bricks when tested in accordance with the procedure laid down, the rating of efflorescence was 'Nil'. [3]

Isaac I. Akinwumi (2014) aimed at determining the density, water absorption capacity, compressive strength and fire resistance of papercrete produced using waste newspaper and office paper in order to ascertain their suitability for use as a building construction material. For each of the waste newspaper and waste office paper mixtures, the ratios of cement: sand: waste paper used were 1:1:0.2, 1:1:0.4, 1:1:0.6 and 1:1:0.8. The cubes produced using each of the papercrete mix ratios and those of the sandcrete were cured for 7, 14 and 28 days, by immersion in water. The curing period was limited to 28 days. For each of the mix proportions considered, the bulk density, water absorption, compressive strength and fire resistance of papercrete made with newspaper were found to be higher than those made with office paper. The water absorption and fire resistance of papercrete were found to be high and increased with increasing waste paper content while the bulk density and compressive strength of papercrete were low and decreased with increasing waste paper content. Papercrete was recommended to be an effective and sustainable material for the production of lightweight and fire-resistant hollow or solid blocks to be used to make partition walls of especially high-rise buildings. Mix proportions were recommended for production of hollow and solid blocks using papercrete. [4]

M. Manoj Kumar (2017) focused on utilizing the waste material like waste paper and flyash into cost effective building bricks and recycle the waste paper without any environmental problem to the surroundings and the society. The investigation was carried out to evaluate the strength, durability and structural properties of flyash based papercrete building bricks. The constituents used in preparing the papercrete mixtures were Ordinary Portland Cement (grade 53), flyash, fine aggregate, coarse aggregate, paper and water. The specific gravity of cement flyash was 2.3 and the percentage by weight of water with respect to cement to produce consistency was 29%. Then cubes were casted and

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 06, June-2021

dry curing (Air dry curing) method was adopted. At the 18th day from the date of casting the brick, the compression test was carried out.The thesisconcluded that the papercrete bricks were relatively low cost, light weight & more flexible and also more suitable for earthquake prone areas. The bricks don't expand or contract, so that the sheets of glass or glass block can be embedded and trimmed with papercrete and they can be used in inner partition walls.[5]

Mr.Yogesh D Shermale (2017) focused on the study to obtain the compressive strength and mass density of papercrete by doing some trial mixes using different ingredients and observed that the papercrete was a light weight material and can be used as an infill material in high rise buildings. Papercrete cube specimens of size 100x100x100mm and 18 different cases were investigated. Cement, sand, flyash and glass fibre proportions were the different variables included. The weight of samples were taken before testing to calculate the density of the material. Ordinary Portland Cement of 43 grade was used for the entire work. The fineness modulus and specific gravity of sand confirming to Zone – 1 was also calculated. The flyash were collected from the Drik India Private Ltd, Nasik and confirming to the Class - F and Cem – FILL Anti – Crack HD Glass fibres, specially developed for the reinforcement of cementation mortars and cement mixes were also added. From the study it was observed that, in each group of papercrete mixes, compressive strength of concrete decreased with the increase in the amount of waste paper and vice versa and the low density of papercrete indicates that they were light weight & can be used in the form of either hollow or solid blocks for making the walls of buildings, in high-rise buildings. [6]

Selvakumar T (2018)focused on utilizing the waste materials like wastepaper into cost effective building bricks and recycle the wastepaper without any serious affects to the surrounding. The study was evaluated regarding the durability, strength and structural properties of papercrete building bricks and concrete. The paper pulp were added into the concrete and bricks. The paper pulp was added by 10%, 20% and 30% into concrete and the bricks casted into various trail mixes. The experiments were carried out to analysis the characteristics and properties of papercrete additives like cement, sand, aggregate and paper pulp. The properties like compressive strength and percentage of water absorption with various proportions were found out. The combined effect of additives with and without paper pulp on the papercrete, the mix was optimized. Finally, the strength and water absorption on papercrete concrete cubes and also the compressive strength, water absorption, soundness, hardness, structure test, efflorescence test on papercrete bricks were studied and found out. The usage of 10% paper pulp added with concrete gives better result for compressive strength test and water absorption test, compared to the other two combinations of 20% and 30%. The compressive strength for papercrete bricks with different mixes of paper pulp were studied and found that the trial mixes with 1:1:2 gives the optimum value. The water absorption for papercrete bricks with different mixes of paper pulp was studied and it was found that the trial mix with 1:3:6 gives an optimum value. The analysis showed that the water absorption value was minimum for the brick with more usage of paper pulp. The papercrete bricks perform better when tested for soundness, hardness, structure and efflorescence. [7]

## III. MATERIALS FOR PAPERCRETE

The major materials used in making of papercrete

### *A. Paper*

Paper is a natural polymer which consists of wood cellulose, which is the most abundant organic compound in the planet. Cellulose is made of units of monomer glucose (polysaccharide).The links in the cellulose chain are a type of sugar as ß-D-glucose. Despite containing several hydroxyl groups, cellulose is water insoluble. The reason is the stiffness of the chains and hydrogen bonding between two OH groups on adjacent chains. The chains pack regularly in places to form hard, stable crystalline regions that give the bundled chains even more stability and strength. This hydrogen bonding is the basis of papercrete strength. By applying a force on the paper the hydrogen bond between the water and the cellulose molecule is broken. Coating cellulose fibers with Portland cement creates a cement matrix, which encases the fibers for extra strength to the mix. The links in the cellulose chain are a type of sugar: ß-D-glucose and the cellulose chain bristles with polar -OH groups. These groups form many hydrogen bonds with OH groups on adjacent chains, bundling the chains together.

### *B. Cement*

The Portland cement was invented by John Aspidin which is fine gray powder. Among the various kinds cement it is the most commonly used as binding material. It is a mixture of chalk or limestone together with clay. It is a binder, a substance used in construction that sets, hardens and adheres to other materials, binding them together. They are seldom used solely, but is used to bind sand and gravel (aggregate) together and is used with fine aggregate to produce mortar for masonry, or with sand and gravel aggregates to produce concrete. In India are manufactured the three grades of OPC, namely 33grade, 43 grade and 53 grade. As per the standard testing procedure, the compressive strength of cement will be obtained after 28 day. In the study 53 grade OPC is used.

### *C. Sand*

The sand particle consists of small grains of silica (SiO2). It is formed by the decomposition of sand stones due to various effects of weather. According to the natural resources from which the sand is obtained, it is termed as Pit sand, River sand and Sea sand and according to the size of grains, the sand is classified as fine, coarse and gravel. The properties were studied as per BIS standard. A disadvantage of fine-aggregate concrete is the increased consumption of binder compared to other types of concrete and the associated greater shrinkage and creep. The M sand which was locally available and passing through 4.75mm IS sieve is used.

### *D. Water*

Water is an important ingredient of papercrete as it actively participates in the chemical reaction with cement. It should be free from organic matter and the pH value should be between 6 and 7.

### *E. Fly Ash*

Fly ash, is additionally referred to as fuel-ash, is one in every of the residues generated in combustion, and includes the fine particles that rise with the flue gases. The employment

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 06, June-2021

of ash as a replacement of sand contains a nice potential to profit our society in terms of reducing. In this study, ash is employed as an exchange material for cement so as to improve the properties of papercrete. Class F flyash is used for the present study.

*F. Lime*

Lime is a calcium-containing inorganic mineral composed primarily of oxides, and hydroxide, usually calcium oxide and/ or calcium-hydroxide. These materials are still used in large quantities as building and engineering materials, as chemical feed stocks, and for sugar refining, among other uses. Lime used in building materials is broadly classified as "pure", "hydraulic", and "poor" lime; can be natural or artificial; and may be further identified by its magnesium content such as dolomitic or magnesium lime. The qualities of the many types of processed lime affect how they are used.

## IV. METHODOLOGY

*A. Pulp Generation*

The waste paper collected for the manufacturing of papercrete cannot be used directly. Firstly the pins, threads and alternative materials within the papers were removed and were shredded to small size as shown in Fig. 1. Then the papers were weighed and immersed in water as shown in Fig. 2for about 3 to 5 days to convert it into a paste. After the period, the papers were removed from water and ground in a mixer to obtain the paper sludge as shown in Fig. 3. The pulp is later taken on non-absorbent plate after having the extra water squeezed out.

*Fig.1 Shredded paper*

Fig 2 Paper immersed in water

*Fig.3Paper sludge*

*B. Mixing Of Specimen*

*a) Mixing of Dry ingredients*

The other constituents of papercrete – cement/fly ash/lime and sand were dry mixed until a uniform colour was formed. The mixing was manually done and the paper sludge thus obtained was then mixed with it to get the desired papercrete mix. No additional water was added unless it was essential.

*Fig.4Mixing of dry ingredients*

*b) Mix Proportion*

The proportion adopted for the project was 1:1:2 (cement: sand : paper). There is no code for taking mix proportion of papercrete. Different types of bricks were to be casted. First type of brick made of cement, sand and paper pulp at different mix proportions were used for making the brick. The next bricks were to be cast by replacing cement with fly ash and also lime, at different mix proportions along with sand and paper pulp.

TABLE I.MIX PROPORTIONING

| Sl. No | Type of Brick | Ingredients | | | | |
|---|---|---|---|---|---|---|
| | | Cement | Sand | Paper pulp | % of Weight of Fly ash | % of weight of Lime |
| 1 | PBFL0 | 1 | 1 | 2 | 0% | 0% |
| 2 | PBFL5 | 1 | 1 | 2 | 5% | 5% |
| 3 | PBFL10 | 1 | 1 | 2 | 10% | 10% |
| 4 | PBFL15 | 1 | 1 | 2 | 15% | 15% |
| 5 | PBFL20 | 1 | 1 | 2 | 20% | 20% |
| 6 | PBFL25 | 1 | 1 | 2 | 25% | 25% |

*C. Preparation and Casting of Bricks*

The size of the mould used in this work was 200×100×100 mm and 20 different types were investigated. The variables

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 06, June-2021

include different cement, sand, fly ash, paper and lime proportions. OPC 53 cement was used as a binding material. Sand was used as per Indian standard specifications: 383-1970.

The process of making papercrete includes soaking waste paper in water overnight so that the fibers are softened and then agitating the mix thoroughly to obtain a homogeneous pulp. The Portland cement, sand and water are added to the pulp and mixed. The mixture is then poured into moulds to create bricks and the forms are removed after 24 hours. After 28 days of air curing the bricks were ready for testing.

*Fig. 5Casting of brick*

*D. Curing*

Curing can be described as keeping the concrete moist and warm enough so that the hydration of cement can continue. More elaborately, it can be described as the process of maintaining a satisfactory moisture content and a favorable temperature in concrete during the period immediately following placement, so that hydration of cement may continue until the desired properties are developed to a sufficient degree to meet the requirement of service. If curing is neglected in the early period of hydration, the quality of concrete will experience a sort of irreparable loss. Curing of bricks can be done by two methods. They are

1. Wet Curing
2. Dry Curing

In preparation of papercrete we used dry curing method (Air dry curing).

*Fig.6 Curing of bricks*

## V. EXPERIMENTAL STUDY

*A. Initial Tests Conducted*

*a) Tests on Cement*

*a) Standard Consistency Test*

Standard consistency of cement paste is defined as that consistency which permits the vicat plunger to penetrate to a point 5 to 7 mm from the bottom of the vicatmould in this test. It is expressed as amount of water as a percentage (by weight) of dry cement. Standard consistency is also called normal consistency.

*b) Specific Gravity of Cement*

The purpose of this test is to find out the percentage by weight of water of water to be added to cement to make a paste of standard consistency.

*c) Initial Setting Time of Cement*

The period from the time water is added to the cement to the time when it looses plasticity is called initial setting time of cement.

*b) Tests on Fly Ash*

*a) Standard Consistency Test*

Standard consistency of fly ash paste is defined as that consistency which permits the vicat plunger to penetrate to a point 5 to 7 mm from the bottom of the vicat mould.

The test covers the procedure for determining the quantity of water required to produce a fly ash paste of standard or normal consistency.

*b) Specific Gravity of Fly Ash*

The purpose of this test is to find out the percentage by weight of water to be added to fly ash to make a paste of standard consistency

*c) Tests on Fine Aggregate*

*a) Specific Gravity Of Fine Aggregate*

The purpose of this test is to find out the percentage by weight of water to be added to fine aggregate to make a paste of standard consistency

*b) Seive Analysis*

Test for grain size analysis or sieve analysis of aggregates are done to determine its particle size distribution, fineness modulus. For fine aggregate- 4.75mm, 2.36mm, 1.18mm, 600 microns, 300 microns, 150 microns, were used

*B. Final Tests Conducted*

*a) Compressive Strength Test*

- Test is carried out using a Compression Testing Machine
- $14^{th}$&$28^{th}$ day compressive strength is found out from the date of casting of brick

*Fig. 7 Compression test*

*b) Water Absorption Test*

- All the specimens are taken for water absorption test
- Water absorption, W= $\frac{M2-M1}{}$X100

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 06, June-2021

M1

M1=Weight of dry specimen
M2=Weight of wet specimen

*c) Weight Test*

Weight of the specimen is found out using a weigh balance.


*Fig. 8 Weight test*

## VI. RESULTS AND DISCUSSIONS

*A. Test results of cement*

*a) Standard consistency of cement = 38%*
*b) Specific gravity of cement = 3.1*
*c) Initial setting time of cement = 44 minutes*

*B. Test results of fly ash*

*a) Standard consistency of fly ash = 24.2%*
*b) Specific gravity of fly ash = 6.5*

*C. Test results of fine aggregate*

*a) Specific gravity of fine aggregate = 2.6*
*b) Fineness Modulus = 3.1*

*D. Test result of brick*

*a) Compressive Strength for 14 days*

The compressive strength for 14th day obtained is maximum for PBFL20 papercrete brick ie, brick in which cement is replaced with 20% flyash and 20% lime.

TABLE II. COMPRESSIVE STRENGTH FOR 14 DAYS

| Sl. No. | Type of Brick | Compressive strength (N/mm$^2$) |
|---|---|---|
| 1 | PBFL0 | 2.4 |
| 2 | PBFL5 | 2.8 |
| 3 | PBFL10 | 3.1 |
| 4 | PBFL15 | 4.0 |
| 5 | PBFL20 | 4.3 |
| 6 | PBFL25 | 3.9 |

*b) Compressive Strength for 28 days*

The compressive strength of conventional brick is 10.52 N/mm$^2$. All the papercrete bricks have lesser compressive strength than conventional brick. The maximum compressive strength for papercrete brick is obtained as 5.5 N/mm$^2$for PBFL20 and it has an increase in compressive strength of 96.42% than PBFL0.In PBFL20 cement is replaced with 20% flyash and 20% lime. Futher, replacement of cement with fly ash and lime decreases the compressive strength.

TABLE III. COMPRESSIVE STRENGTH FOR 28 DAYS

| Sl. No. | Type of Brick | Compressive strength (N/mm$^2$) |
|---|---|---|
| 1 | PBFL0 | 2.8 |
| 2 | PBFL5 | 3.2 |
| 3 | PBFL10 | 3.9 |
| 4 | PBFL15 | 4.9 |
| 5 | PBFL20 | 5.5 |
| 6 | PBFL25 | 4.6 |

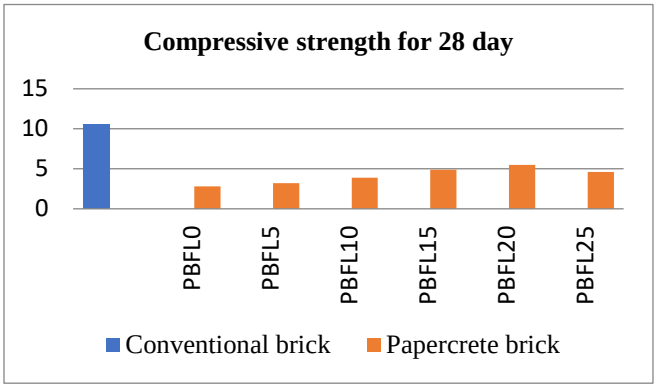


*Fig. 9Compressive strength of conventional brick and papercrete bricks*

*c) Water Absorption Test Results*

The water absorption obtained for conventional brick is 16.66%. All the papercrete bricks have higher water absorption than the conventional brick. The optimum water absorption for the papercrete was found out to be 20.17% for PBFL20 papercrete brick. All other papercrete bricks have higher water absorption than PBFL20 papercrete brick.

TABLE IV.WATER ABSORPTION

| Sl. No. | Type of Brick | Water absorption in % (24 hours) |
|---|---|---|
| 1 | PBFL0 | 30.07 |
| 2 | PBFL5 | 20.39 |
| 3 | PBFL10 | 20.35 |
| 4 | PBFL15 | 20.31 |
| 5 | PBFL20 | 20.17 |
| 6 | PBFL25 | 20.27 |

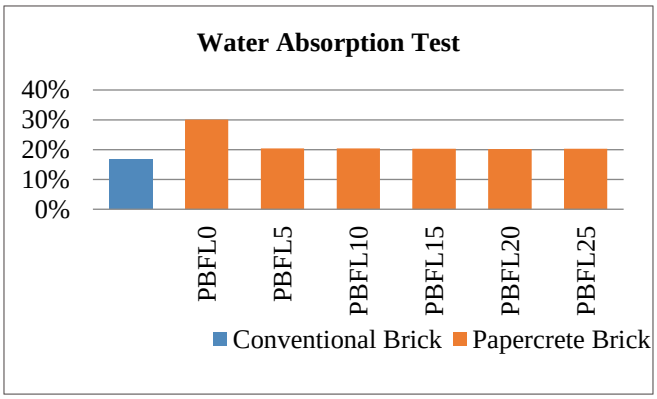


*Fig. 10 Water absorption of conventional brick and papercrete bricks*

*d) Weight test results*

The weight conventional brickobtained is 3.3 kg. As compared to the conventional brick, papercrete bricks are of lesser weight.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 06, June-2021

TABLE V. WEIGHT TEST

| Sl. No. | Type of Brick | Weight of bricks |
|---|---|---|
| 1 | PBFL0 | 1.945 |
| 2 | PBFL5 | 2.229 |
| 3 | PBFL10 | 2.230 |
| 4 | PBFL15 | 2.240 |
| 5 | PBFL20 | 2.260 |
| 6 | PBFL25 | 2.305 |

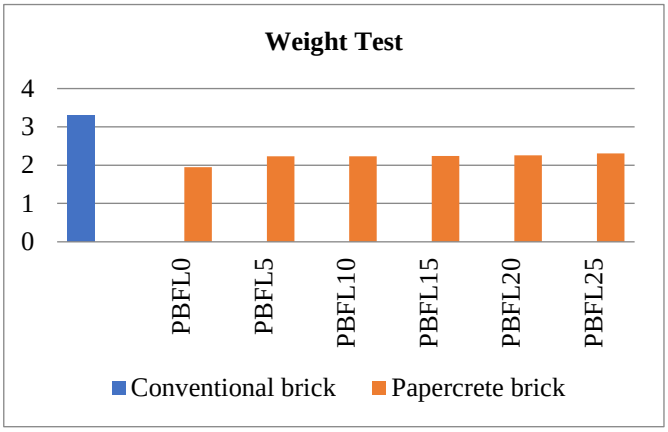


*Fig. 12Comparison between weight of conventional brick and papercrete bricks*

## VII. CONCLUSIONS

From the above experimental studies it can conclude that,

- Papercrete brick in which cement is replaced with 20% flyash and 20% lime ie, PBFL20 has the highest compressive strength ie 5.5 N/mm$^2$ than all the other papercrete bricks.
- Futher, replacement of cement with fly ash and lime decreases the compressive strength.
- PBFL20 papercrete brick has the least water absorption than all the other papercrete bricks.
- The water absorption of PBFL20 is 32.92% lesser than PBFL0 papercrete bricks.
- Compared to conventional brick, the papercrete brick is light in weight.
- Papercrete bricks are appropriate for non-load bearing walls
- These bricks don't seem to be appropriate for water logging and external walls. It can be utilized in inner partition walls.
- Due to less weight of the papercrete bricks, the dead load of the building will be reduced.

## ACKNOWLEDGMENT

Words cannot express our gratitude to the scholars we know, yet we would like to thank those who enabled the successful completion of this project. First and for most thank “THE ALMIGHTY” for his grace and mercy that enabled us to complete the work successfully. We express our sincere thanks to Prof. Dr. Abdul Gafur M, Principal, Ilahia College of Engineering and Technology, Muvattupuzha for his kind patronage. We express our sincere gratitude to Prof. Dr. Abdulla P K(Head of the Civil Engineering Department) for the encouragement and providing us the necessary facilities in the college for doing this project. We express our sincere gratitude to Ms. Adila Abdulla Kunju (Asst. Professor in Civil Engineering Department) for guiding us to do this project. We also take the opportunity to thank all the personal associated with this project ideas and cooperation have helping in doing this project. In addition, a special thanks to all my friends and parents for their consideration and motivation.

## REFERENCES

[1] Bhupesh Pandey (2019)Papercrete- Utilization of waste paper International Research Journal of Engineering and Technology (IRJET) Volume: 06 Issue: 04

[2] G.B.Rameshkumar, M. Chandu (2018)Papercrete – a sustainable building material International Journal of Pure and Applied Mathematics Volume 119

[3] JSudarsan, SRamesh, MJothilingam, VishalatchiRamasamy and Rajith J Rajan(2017)Papercrete brick as an alternate building material to control Environmental Pollution; IOP Conference Series: Earth and Environmental Science

[4] Isaac Akinwumi, Olasunkanmi M. Olatunbosun, Oluwarotimi M. Olofinnade, Paul O. Awoyer(2014) Structural Evaluation of Lightweight Concrete Produced Using Waste Newspaper and Office Paper Civil and Environmental Research Vol.6

[5] M.Manoj Kumar, G.UmaMaheshwari (2017)Papercrete International Journal of Science, Engineering and Technology Research (IJSETR) Volume 6, Issue 8

[6] Mr. Yogesh,D. Shermale, Dr.Mahaveer ,B. Varma (2017)Properties of Papercrete Concrete: Building Material IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) Volume 14, PP 27-32

[7] Selvakumar T, Sathiya R, Jayalakshmi B (2018)Experimental Study of Papercrete Concrete and Brick International journal for innovative research in multidisciplinary field Volume - 4, Issue - 9