International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)
Impact Factor: 5.22 (SJIF-2017), e-ISSN: 2455-2585
Volume 5, Issue 03, March-2019

AN EXPERIMENTAL STUDY ON PAPERCRETE BRICKS MANUFACTURED USING PAPER PULP, GGBS, QUARRY DUST, AND FLY ASH.

Priyanka V[1], K Sai Gopi[2], T Joshmitha[3], B Deepchand[4], K Prasad[5], M Sai Charan[6], G Yogendra Pavan[7], Ch Veerottam Kumar[8]

[1,2,3,4,5,6&7] Student, BTech, Department of Civil Engineering, Ramachandra College of Engineering, Eluru, Andhra Pradesh, India.
[8] Associate professor, Department of Civil Engineering, Ramachandra College of Engineering, Eluru, Andhra Pradesh, India

Abstract: Papercrete is nothing but paper and concrete wherever the papers like newspaper, cardboards etc. are chopped into paper pulp and thereby adding hydraulic cement and sand to it. The chemical element bonds gift in microstructure of paper offers strength to it. Same as concrete, this thick combine may be poured to any moulds and solid into any desired form or size. As most of the materials employed in it are industrial wastes and construction materials in reduced quantity, it's a sustainable material. This idea conjointly helps in reducing environmental hazards caused by construction industry. However there's no correct code for the combo proportioning of papercrete bricks. So a combination proportion of [Cement: Paper: sand] 1:1:2 was chosen unproved and error basis. During this study, cement is partly replaced by GGBS because it has cement properties and composition. Rather than sand, Quarry dust is employed that is partly replaced by fly ash to boost the strength to weight quantitative relation. All the required engineering properties are studied and compared with the standard bricks and discussions on its potential uses are created.

Key words- Papercrete, Ground Granulated Blast Furnace Slag (GGBS), Fly Ash, Quarry dust, Compressive strength, Sustainable building and Paper waste.

I. INTRODUCTION

1.1 General:

The civil engineers are demanded to use industrial wastes instead of building materials due to the shortage of materials. As the population increases demand for building industry increases which in turn need bulk amount of building materials. There is an increase in popularity of using environmental friendly, low-cost and sustainable construction materials in building industry. This made engineers to find how this can be achieved by benefiting the environment and also to meet the material requirements affirmed in the standards. Consequently this experimental study is carried out to resolve these issues.

1.2 Needs to select papercrete:

Generally great deal of paper is employed for various activities and four hundred and fifty (450) million heaps of paper is created across the planet. It involves chopping off trees that poses a significant environmental drawback long-faced by our society within the current scenario, as forty second of all international wood harvest is employed to supply paper.

The production and use of paper incorporates a variety of adverse effects on the surroundings that are called paper pollution. As forty fifth of discarded papers are recycled annually and 55%thrown away or goes in to the land fill, it's troublesome to spot lowland sites to deposit them. Ultimately it results in threat to developing countries. This study aims to form the simplest of worst by victimization paper waste as artefact. The aim of this analysis is to require advantage of the waste materials like paper and to exchange the expensive and rare standard building materials.

1.3 Objective of the project:

The major Objective of the project is replacement of the expensive and scarce typical building bricks by an innovative and different building bricks, that satisfies the subsequent characteristics, required

- Price effective
- Environmental friendly
- Less weight
- Ignitable
- Less water absorption
- Simply obtainable

1.4 Innovation of papercrete:

Papercrete could be a material originally developed eighty years ago. However it's recently rediscovered. Papercrete was 1st proprietary in 1928 by Eric Patterson and electro-acoustic transducer McCain; World Health Organization 'invented' it severally as 'padobe' and 'fibrous cement'. In 1976, John Hall, associate educate majoring in sculpture, experimented with paper Mache and additional mineral plaster within the combine. Papercrete got its name from the terribly formula accustomed to create it —a mixture of cement with polysaccharide fibre and water. Paper was big-ticket within the early decennary, thus no industrial trade was ever emerged.

1.5 Papercrete:

Papercrete may be a type of fibrous concrete, or cement with fibres of some kind in it. These fibres add strength to the cement, even as glass fibres add strength to covering material. Within the case of papercrete, these fibres will truly structure the majority of the combination, leading to a product that's each light-weight and robust. It includes cement and paper. These 2 parts are homogenised with water to make a paper cement pulp, which might then be poured into a mould, allowed to dry and be utilised as a sturdy artefact.

1.6 Advantages of papercrete:

- Papercrete is mould resistant and has the flexibility to soak up energy and may be employed in several applications requiring sound-proofing material.
- Also, Papercrete blocks won't deteriorate if missed within the rain, since the paper fibres bind the blocks along.
- Papercrete blocks created with a comfortable amount of Portland cement and sand are heat resistant.
- Due to the less weight of Papercrete building blocks it is used for interior walls in high-rise buildings in seismically active areas.
- Using papercrete building blocks in situ of typical or concrete bricks/blocks might scale back the loading of structure and scale back the steel proportion and also the depth of foundations needed.
- Use of wastepaper in concrete might become a cost-effective and profitable substitute to landfills, furnace, or alternative use choices.

II. MATERIALS USED:

In this project waste materials were adopted in producing building bricks. The following materials were used,

2.1 Paper:

Paper could be a natural compound that consists of wood cellulose. It is created of units of chemical compound aldohexose (polysaccharide). The explanation is that the stiffness of the chains and hydrogen bonding between two OH groups on adjacent chains. The chains pack often in places to create firm, stable crystalline regions that offer even additional stability and strength.

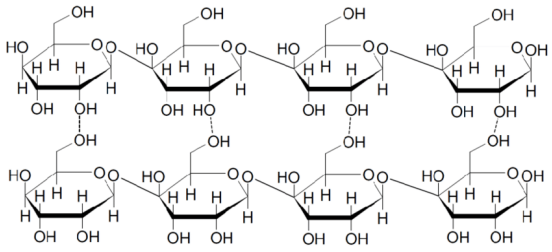

Fig. 1 Cellulose Hydrogen Bonds in Paper

Newspapers are best in producing papercrete. Water resistant papers should not be used in the preparation of papercrete.

2.2 Cement:

Cement could be a binding substance used as a construction material that sets, hardens and may bind alternative materials along. Ordinary Portland Cement (OPC) of 53 Grade (Ramco cement) was used throughout the course of the investigation. It was fresh and without any lumps. In this project cement is partially replaced by GGBS i.e. Ground Granulated Blast Furnace Slag.

2.3 Ground Granulated Blast Furnace Slag (GGBS):

It is a by-product from the furnace that is employed to create iron. The composition basically depends on the raw materials employed in the iron production method. Chemical composition of GGS is calcium oxide 40%, silica 35%, alumina 13% and magnesia 8%.

2.4 Quarry Dust:

Quarry dust could be a by product of the crushing method that could be a focused material to use as aggregates for concreting purpose, particularly as fine aggregates. In production activities, the rock has been crushed into numerous

sizes; throughout the method the dust generated is termed quarry dust and it's shaped as waste. Thus it becomes as a useless material and conjointly leads to pollution. During this project sand is absolutely replaced by quarry dust.

2.5 Water: Water is an important ingredient of papercrete as it actively reacts with cement in the chemical reaction and the pH value should be between 6 and 7. Water plays vital role in the preparation of paper sludge.

2.6 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 of ash as a replacement of sand contains a nice potential to profit our society in terms of reducing. Ash is employed as an exchange material for quarry dust so as to decrease the density of the brick.
All the materials were undergone laboratory tests and their properties have been clearly studied.

III. EXPERIMENTAL PROCEDURE

4.1 Mould Preparation:
After grouping all the materials, a mould was ready. A typical mould is shown within the below figure

Fig. 2 Brick Mould

This mould was non-water fascinating within the size of 270mm length, 130mm wide and 95mm deep. And joints were created with no void or gap to avoid run.

4.2 Pulp Generation
The papers, that were collected, cannot be used directly. It ought to be created into paper pulp before mixture with alternative ingredients. The subsequent square measure the steps concerned within the generation of pulp.

- First the pins, threads and alternative materials within the papers were removed.
- Then the papers were teared into little items of papers.
- Then, a two hundred litre cistern was taken. And 2/3rd of it had been crammed with water.
- Then the little items of paper were immersed within the cistern. The paper items were immersed severally not in a very large manner so as to form the items utterly wet. Before immersing it into the water, the papers were weighed. The figure shows the papers were being immersed within the cistern.
-

Fig. 3 Immersed Papers

- The papers were unbroken within the tank for two to three days otherwise till the papers degrade into a paste like kind.
- Then the paper was taken out from water and brought to the mixer machine to form it as a paper pulp.
- The pulp generating method was tedious and time consumption.
- For workplace purpose solely these procedures were followed.
- While going for production, the Tow mixers were used to scale back the value.
- After pulp generation squeeze the pulp such there's no high water share in pulp.

4.3 Mixing:
After all the ingredients were prepared, the blending was done. During this project, commixture was done manually. The blending method of fibrous concrete bricks and padobe bricks square measure completely different. The precise combine proportion wasn't familiar. So, trial proportions were utilized in this project.

Fig. 4 Mixing

4.4 Papercrete Mix Ratio:

- Weigh batching was applied during this project .So the materials were measured in Kilograms. According to the actual proportion the materials were measured 1st and kept on an individual basis.
- The proportion adopted during this project was 1:1:2 (paper: cement: quarry dust). According to this proportion weigh batching is carried out.
- Glows, shoes, masks were wearied before the blending.
- Then the non–water fascinating and sleek surface was created for commixture.
- Water was sprinkled over that surface.
- First the ingredients like Quarry dust/ GGBS/ fly ash were placed.
- Then cement was placed over that ingredient.
- These 2 were dry mixed with shovel completely still uniform colour was formed.
- Then the paper pulp that was in a very wet condition was placed individually. Paper pulp ought to contain less water. so the excess water was squeezed out.
- The already combined cement and GGBS/Quarry dust was placed over the paper pulp and mixed completely to urge the uniform mix.
- There was no additional water was added separately unless it absolutely was essential. The water within the pulp was used for mixing the papercrete.
- After the mix, the desired quantity of papercrete was taken to the location and therefore the remaining quantity was kept free from evaporation.

4.5 Casting of Bricks:

After compounding, it ought to be placed in the mould within half-hour. So, 3 moulds were used at the time to make the process in no time. The bricks were moulded manually by hand over the table.
The following are the steps concerned in moulding,

- The mould was over a table
- The lump of mix was taken and it had been placed within the mould.
- The further or surplus mix was removed either by picket strike or the metal strike or frame with wire.
- After placing vibratory compaction is done to avoid the voids and gaps within the mould.

Fig. 5 Vibratory Compaction

- The casted papercrete bricks are dried for 28days.
- Size of the brick is 230mm long, 110mm wide, 80mm deep.

Fig. 6 Air curing of bricks

IV. PAPERCRETE MIX RATIO AND EXPERIMENTAL TESTS

As there were no clear past details before, there is no particular mix proportion to this papercrete.

Table-1 Papercrete Mix Ratio Adopted

S.NO	Identification mark	Ingredients				
		Cement	Paper pulp	Quarry dust	GGBS % of weight of cement	Fly ash % of Weight of quarry dust
1.	B1	1	1	2	0%	0%
2.	B2	1	1	2	20%	20%
3.	B3	1	1	2	30%	30%
4.	B4	1	1	2	40%	40%
5.	B5	1	1	2	50%	50%

Various tests that are to be conducted on papercrete bricks are as follows:

Compression Test:
Brick is one in every of the building parts employed in the development of a wall and therefore the wall could be a compression member. This test is alloted as per the rules given in IS 3495-1992. Compression test is that the main and vital test for bricks. This test was dispensed by a Compression Testing Machine (CTM). This test was carried out on the seventh, fourteenth and twenty first day from the date of casting. It had been discovered while testing the specimens that the bricks didn't crush or fully collapse, it simply compressed like compressing a rubber, even supposing the brick unsuccessful at the upper load, the structure didn't collapse. Solely the outer faces cracked and raw out.

Fig. 7 Compression test

Water Absorption Test:
The two specimen of every proportion taken for water absorption test. Initial weight taken as w_1. Then the dried specimen was immersed fully in clean water at a temperature of 27 ± 2°C for twenty-four hours then the specimen was removed and worn out to get rid of any traces of water with a humid fabric. Later, the specimen was weighed when it had been removed from water as W_2. The proportion of water absorption by mass, when twenty four hours immersion in water was noted and therefore the average of the results of every proportion were noted.

Hardness Test:
In this test, a scratch was created on brick surfaces. Whereas the scratch was created with the assistance of finger nail on the bricks, Very light impression was left on the fibrous concrete brick surface. Thus this test results that fibrous concrete bricks are sufficiently hard.

Presence of Soluble Salts:
The soluble salts, if presents in bricks can cause efflorescence on the surface of bricks. for locating out the presence of soluble salts in an exceedingly brick, this check was applied. during this check fibrous concrete brick were immersed in water for twenty-four hours. Then the bricks were taken out of water and allowed to sun dry. And there was no any gray or white deposit on the bricks surface. It results that the bricks are free from soluble salts.

Soundness Test:
In this test 2 bricks from same proportion were taken and they were struck with one another. The bricks weren't broken and a clear ringing sound was made. So the bricks are good enough.

Fire Test:

A brick that is employed for construction shouldn't flammable in open flame, therefore this test was carried out for the bricks. First, the brick was wiped with cloths and all the foreign matters were removed. Then the inflammable sticks were fired. After that, the bricks were held on the flame for 5 minutes. after 5 minutes the bricks were observed. From the above check, it had been observed that the papercrete bricks didn't burn with an open flame. They smouldered like charcoal.

Fig. 8 Fire test

V. RESULTS AND DISCUSSIONS

Result of weight of papercrete brick:

Table-2 weight of papercrete bricks

S.NO	Mix ratio (1:1:2)	Dry weight of the Brick (kg)
1.	B1	3.01
2.	B2	2.85
3.	B3	2.73
4.	B4	2.41
5.	B5	2.07

Generally, the conventional bricks weight up to 3-3.5 kg. As compared to those bricks, papercrete bricks are of less weight.

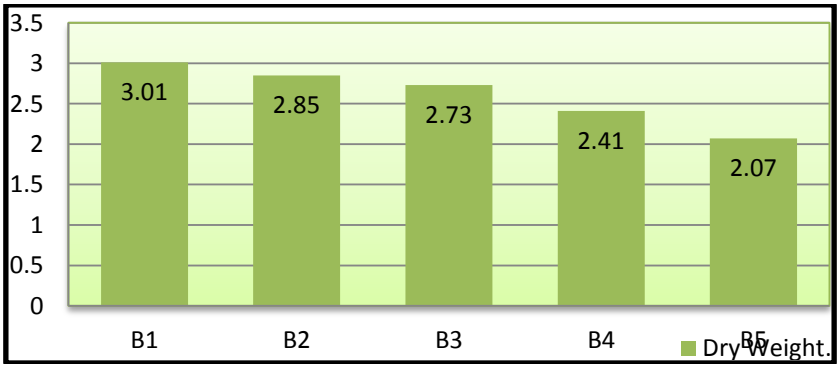

Fig. 9 Dry weight of brick

Result of compressive strength:

From the compression test, it was observed that the by increasing the GGBS and fly ash content in the brick the strength gradually increased.

As per IS: 1077 – 1970, the strength of common building brick is 3.5N/mm^2**.**

Table-3 Compression strength for 7days

S.NO	Mix ratio (1:1:2)	Compressive strength (N/mm^2)
1.	B1	3.20
2.	B2	3.66
3.	B3	4.00
4.	B4	4.30
5.	B5	4.98

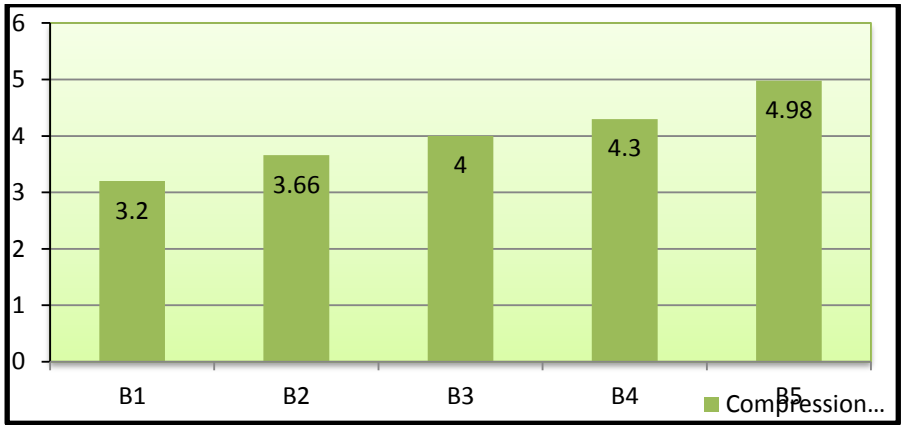

Fig. 10 compressive strength for 7 days

Table-4 compressive strength for 14days

S.NO	Mix ratio (1:1:2)	Compressive strength (N/mm^2)
1.	B1	3.87
2.	B2	4.30
3.	B3	5.21
4.	B4	5.79
5.	B5	5.92

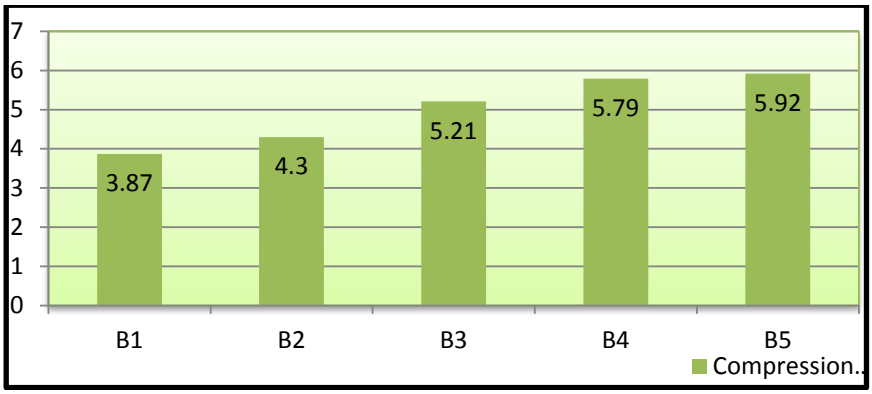

Fig. 11 compressive strength for 14 days

Table-5 compressive strength for 28days

S.NO	Mix ratio (1:1:2)	Compressive strength (N/mm^2)
1.	B1	4.21
2.	B2	4.78
3.	B3	5.92
4.	B4	6.24
5.	B5	6.56

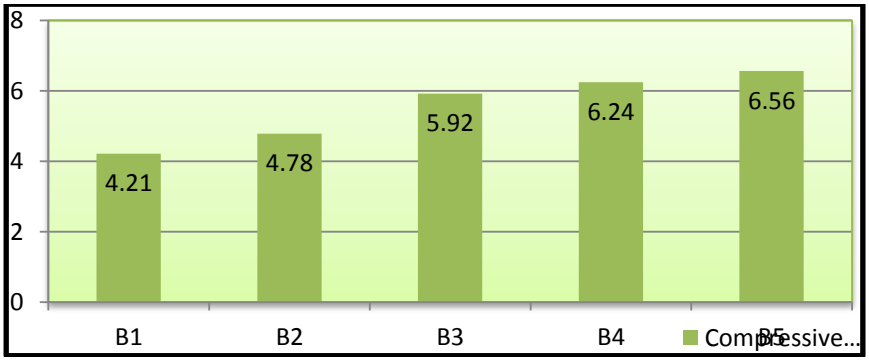

Fig. 12 compressive strength for 28 days

Result of water absorption:

From the test on percentage water absorption, it is seen that for GGBS percentage lower means (B1, B2), the water absorption is also high. But High percentage of GGBS mix specimen (B5) having low percentage of water absorption than the other mixes. Generally water absorption for a common building brick should be less than 20%.Following table shows water absorption of papercrete bricks

Table-6 Water absorption of papercrete bricks

S.NO	Mix ratio (1:1:2)	Water absorption in % (24Hrs)
1.	B1	26.11%
2.	B2	24.85%
3.	B3	21.94%
4.	B4	19.99%.
5.	B5	17.02%

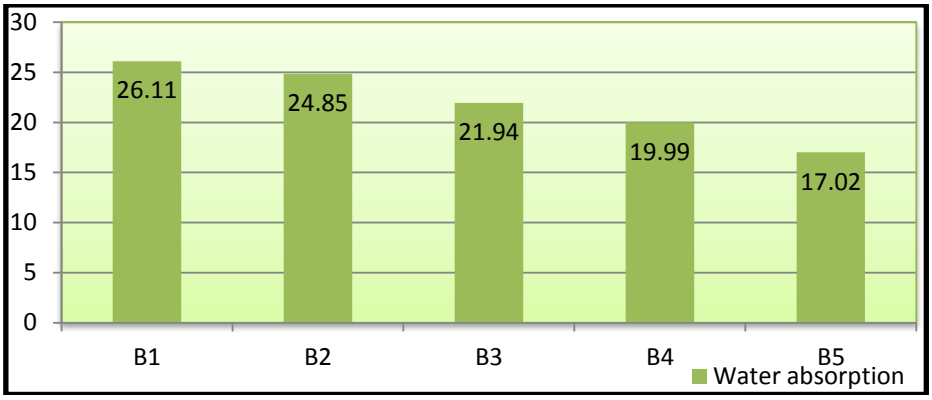

Fig. 13 Water absorption test

VI. CONCLUSIONS:

From the above experimental studies we can conclude that

- Papercrete bricks are appropriate for each load bearing and non-load bearing walls.
- The weight of this brick is lesser than typical clay brick.
- These bricks don't seem to be appropriate for water logging and external walls. It are often utilized in inner partition walls. If they're coated with waterproofing materials like Dr. Fixit, they're appropriate for external walls.
- Due to less weight of those bricks, the full load of the building is going to be reduced.
- Since, these bricks are comparatively lightweight weight and a lot of flexible; these bricks are probably ideal material for earthquake prone areas.
- The papercrete bricks are smart sound absorbent; hence paper is employed in these bricks. So, these bricks are often utilized in auditoriums.
- Since, the waste materials are used; it'll cut back the landfills and pollution.
- In the manufacture of typical clay bricks, an outsized quantity of fuel is required so as to burn the bricks. This causes social deforestation and also the no cultivation of land. It should be avoided or decreased by adopting papercrete bricks.
- The compressive strength of papercrete brick is beyond clay typical brick.

References:

[1]. " Methods of tests of burnt clay bricks" , IS: 3495 (Part I to IV) 1992 (reaffirmed 2002), third revision.
[2]. Chalamcharla venu gopal, Suresh .A, V. Gokul Nath, "Partial Replacement of Cement with GGBS in Concrete" International Journal of Advance Research, Ideas and Innovations in Technology", ISSN: 2454-132X, (Volume3, and Issue5).
[3] K.Chandraprakash, B.S.MD.Khadeer, Sreenatha.M, "Experimental Study On Papercrete Concrete By Adding Quarry Dust", International Journal Of Technical Innovation In Modern Engineering & Science , e-ISSN: 2455-2585 Volume 4, Issue 7, July-2018.
[4] M.Manoj Kumar, G.Uma Maheshwari, "PAPERCRETE", International Journal of Science, Engineering and Technology Research (IJSETR) Volume 6, Issue 8, August 2017, ISSN: 2278 -7798.
[5] Iqbal N. Gorgis, Harith M. Zaki, Shakir A. Salih, "Properties Of Papercrete", ARPN Journal of Engineering and Applied Sciences, ISSN 1819-6608, Vol. 12, No. 24, December 2017.