



## **WASTE PLASTIC SYNTHESIS: ECOLOGICALLY SOUND AND ALTERNATIVE POWER SOURCE**

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### **Abstract:**

A large amount of non-renewable resources is consumed by the construction industry throughout the world. Everyday tons of waste papers are discarded as landfill or dump sites than those recycled. It is learnt that it takes about fifteen trees to make a ton of paper which means that 720 million trees are used once and then buried as landfill each year.

In order to address these issues it has become imperative to push the boundaries of research in the field of innovative sustainable construction materials. This study is one such kind of efforts. Papercrete is a new composite material comprising of waste papers and cement. In this investigation, an attempt is made to produce an alternative material using waste papers. This could help eradicate a few of the environmental hazards caused by the construction industry. But there is no proper code for the mix proportioning of Papercrete bricks. Therefore, a mix proportion of [Cement: Paper: Sand] 1:1.25:2 was chosen on trial and error basis. All the necessary engineering properties are studied and compared with the conventional bricks and discussion on its potential uses are made.

**Keywords**-Papercrete, Paper Sludge, Lightweight, Structure, Strength

### **1. Introduction:**

#### **1.1 General**

The building materials or construction materials are the major requirement in this modern age of technology. There are many types of building materials used for different construction works. According to research more than 450 million tons papers are produced worldwide every year. Paper mills will be producing 500 million tons of paper and paperboard each year. We obviously need this product and a reduction of use is not in the prospect. Pulp and paper is the 3rd largest industrial polluter of air, water, and soil. In recent year paper and paperboard constitute a greater portion of many countries municipal solid waste generation [1]. In present scenario, the whole world is facing a major of environmental pollution by the waste industrial materials like as they are dumped as landfills. Fly ash, micro silica, steel slag etc., are a few examples of the waste materials. Hence these materials can be used as



alternatives in the construction industry which will help meeting the sustainable development requirements.

This experimental study investigates the potential use of waste paper for producing a low cost and light weight brick composite brick as building materials. These alternative bricks were made with papercrete. Papercrete will offer a way to turn trash paper into inexpensive houses that are quite strong, well-insulated and easily built. There is no specific codal provision for the mix design of papercrete as it is still in its developing stage [2]. Papercrete is complex materials comprising of cement, waste paper, water and sand. It gives to produce economical housing in large scale. Papercrete have been appeared to low cost stand in building material to have good sound absorption and thermal insulation, to be light weight and fire resistant material although it is originally developed last 80 years ago but recently rediscovered and only few research works have been done to determine their structural suitability [4]. This study aims in taking the best out of the paper waste, by utilizing it as a building material. The thrust on the construction material increases in proportion to the generation of waste paper [5]. For example; taking a regular brick, which cost at Rs.5.00per unit, cost of brick materials required for a regular brick wall of 3000X3000mm is around Rs.2250/-and for the four walls it cost upto Rs.9000/- alternatively paper brick cost less than Rs.2.00 per unit reducing the materials cost uptoRs.3600/-with the difference of Rs.5400/- (about 60%of cost required for regular brick material.)[3]

This consistency can be managed with the use of papercrete bricks .The paper bricks was found by us that 15% of the paper taken in left to sit in a landfill as sludge [6]. “Recycle paper mill (RPM) contributes 30% of the total pulp and paper mill segment in India. With 85% being the average efficiency of RPM, 5% waste (RPMW) is produced annually. In manufacturing this brick, burning is not requiring so these brick is eco-friendly. This bricks were made with papercrete. It should be noted that papercrete is comparatively new concept with limited scope. It involves cutting down and deforestation that poses a main environmental problem, as 42% of all global wood harvest is used to make paper [7].It not only protects the natural resources but will also harvest better ways of tackling residuals and by-products.

The purpose of this research is to take advantage of the waste materials like paper and to replace the costly and rare conventional building materials. The uses of those materials particularly made from are renewable or a recycled material is papercrete. Paper waste is causes certain series environmental problems [8].Some researchers carried out in the past used waste papers in building material production. In this study, sand, cement and waste materials like paper, rice husks ash mixed in suitable proportions which gave more strength, less water absorbance and more eco-friendly. The country consumes about 180 million ones bricks, exhausting approximately 340 billion tons of clay every year and about 5000 acres of soil land is made unfertile for a long period. Waste paper reusing has not been able to able to match waste paper generation [9]. Use of waste paper for producing a low-cost and light



weight composite brick as a building material [10]. Is known by alternative name such as fibrous concrete, padobe and fidobe. Fibrous concrete is mixture of paper, Portland cement and water. There is no harmful byproduct of excessive energy use in the production of papercrete. Padobehas no Portland cement here instead of Portland cement clay is the binding material. It is mix of paper, water and earth with clay. Fidobe is like padobe but it may possibly contain other fibrous materials [1].

### **1.2 Bricks:**

A brick is a materials of building utilized to make partition walls, road pavements and other elements in masonry construction. The term brick relate to unit tranquil of clay, but is now used to refer any rectangular units laid in mortar. A brick can be combination of clay bearing soil, sand and lime or concrete materials. Bricks are made in many classes, sort, materials and sizes which differ with region and time period and are produced in mass quantities.

### **1.3 Paper:**

Paper is a natural polymer which includes wood cellulose. Cellulose is made units of monomer glucose. Although comprising various hydroxyl groups, Cellulose is water insoluble. Paper is a thin material made by the adjuratory un-neurotic moist fibers of cellulose pulp taken from wood, rags or grasses and air dried them into flexible sheets. It is a versatile material with many utility, including writing, printing, packaging, cleaning and a many of industrial and constriction processes.

### **1.4 Problem Identification:**

According to the Environment Protection Agency (EPA), the United States recycles about 45% of discarded paper annually. This means that about 55% or 48 million tons of paper ends up in landfill sites while some are incinerated. It causes certain serious environmental problems.

The present study focuses on utilizing waste materials like waste paper, fly ash into cost effective building bricks and recycle the waste paper without any environmental problem to the surrounding environment. Since the large demand has been placed on the construction industry, especially in the last decade due to increase in pollution which cause a chronic shortage of building resources, the civil engineers have been challenged to convert the industrial waste to useful building and construction materials.

### **1.5 Objectives of Present Work:**

The objective of study is to study properties of papercrete bricks which were prepared out of waste paper, sand and fly ash in varying proportions of 25%, 40% and 55%. The main objective of this project is:

- The main objective of the project is replacing the costly and scare conventional building bricks by innovative and alternative building bricks.
- To extend the investigation further to study the structural behavior of the papercrete brick by experimentally and theoretically.
- It is optimize the papercrete mix with desirable properties.



- To manufacture and study the strength and durability of the papercrete bricks in order to effectively use these papercrete bricks commercially for construction purposes.

## **2. Materials and Methodology:**

### **2.1 Materials Used in Present Study**

Materials collection is the basic and important step in any project. Also the materials which are used in a project should not cause any damage to the environment. In this research, waste materials were used to make building bricks.

#### **2.1.1 Cement**

The Portland cement was invented by John Aspidin which is fine gray powder. Cement is a binder substance used in construction that sets, hardens and adheres to other materials, binding them together. Cement is one of the binding materials in this research. Cement is the important binding material in today construction world 53 grade Ordinary Portland Cement (OPC) conforming to IS: 8112-1982 cement used.

#### **2.1.2 Fly Ash**

Fly ash refers to the ash produced during combustion of coal. Pulverized fuel ash commonly known as fly ash shall conform to Grade 1 or Grade 2 of IS 3812. The proportion of the Fly ash is generally in the ratio 60-80%, depending upon the quality of raw materials. The Fly ash is From Raichur Thermal Power Plant, Karnataka, INDIA – 584170.

#### **2.1.3 Sand**

Sand particles consist of small grains of silica ( $\text{SiO}_2$ ). It is formed by the decay of sand stones due to various effects of weather. According to natural resources from which the sand is obtained, it is termed as pit sand, river sand and sea sand. According to the size of grains, the sand is classified as fine, coarse and gravel. The properties were analyzed as per BIS standard.

#### **2.1.4 Paper**

Paper is a natural polymer which consists of wood cellulose. Cellulose is made of units of monomer glucose. Although containing several hydroxyl groups, cellulose is water insoluble. The reason is the stiffness of the chain and hydrogen bonding between two OH groups on adjacent chains. The chains also pack regularly in places to form hard, stable crystalline region that gives the bundle chains even more stability and strength.

The below figure show the network of cellulose fibers and smaller offshoots from the fibers called fibrils. Coating this fiber with Portland cement creates a cement matrix, which encases the fibers for extra strength.

Different type of papers like newspaper, magazines, old invitation cards, paper tickets etc. can be used for making papercrete. The papers which were collected cannot be used directly. It should be made into paper pulp before mixing with each other ingredients.

#### **2.1.5 Water**

Water is an important ingredient of papercrete as it is involved in the chemical reaction with





cement. Portable water should be used for both soaking and mixing of papercrete. It should be free from organic matter and the pH value should be between 6 and 7.

### **2.1.6 Papercrete Additives**

Cement is added to the matrix as a binding material. In addition to that, waterproofing admixtures such as Dr. Fixit 101 LW+ is added to the mix for minimizing the percentage of water.

### **2.2 Brief Methodology:**

There is no hard procedure for casting of bricks. So the procedure will followed by our own. And the equipment's which will be used in this project are to our convenience only. After collecting all materials, we will prepare a mould. The mould size was 230mm length, 110mm wide and 80mm deep. The shorter sides of the mould are slightly projecting to serve as handle. To avoid leakage the joint shall not contains any hole or gap. The papers which are collected, cannot be used directly. The collected papers will be converts into paper pulp before mixing with other ingredients. The papers are brought into small pieces and known quantity of water. The paper pieces will immersed individually not in a bulky manner in order to make the pieces completely wet. Before immersing it into water, the papers will be weighed. After preparing all ingredients mixing will be carried out. In this project mixing will be done manually. As we will be knowing exact proportion we will use trial proportion in this project. Weigh batching is carried out in this project. So the materials are measured in kilograms. According to the particular proportion the materials will measured first and kept separately. It was done just before the mixing starts. The non- water absorbing and smooth surface is made for mixing. Water is sprinkled over that surface. And this mixing place is selected nearer to the casting place. The paper pulp, which is in a wet condition, is placed separately. Paper pulp should contain less water. So the excess water is squeezed out. After mixing, it should be placed in the mould within 30 minutes. So two moulds are used at the time to make the process very fast. The bricks were moulded manually by hand and on the table. After casting the bricks, they are analyzed for using a brick. Varies tests are carried out to check properties of the brick water absorption test, specific gravity test, sieve analysis, bulk density, hardness test, compression test, fire resistance test.

## **3. Experimental Procedure:**

### **3.1 Manufacturing Process:**

**Collect Waste Papers:** The papers used were from a variety of sources. Newspapers, record sheets, magazines etc., Paper is nothing but wood cellulose, which is considered as a fibrous material.

**Paper Pulp:** These papers were torn into small pieces and soaked in water for 3 – 4 days until they started degrading to paste like form. Then the papers were removed from water and ground in a mixer to obtain the paper sludge. The pulp is later taken on non-absorbent plate



after having the extra water squeezed out. This pulp generating procedure consumed a lot of time and was tedious.

**Weighing:** Weighing the cement and sand separately. Samples should be free from vegetable matters, foreign matters or any pieces of paper, wood etc. while weighing the sand. The cements should be free from lumps.

**Ingredients mixing:** After paper pulp was generated, first dry ingredients were taken out on the weight basis and all the dry mixes were mixed uniformly. Then, these dry mixes were sprinkled over the required amount of paper pulp and mixed uniformly manually.

**Papercrete Mould:** Brick mould of ply wood sheets was made, the sheet is extended to outside for holding the mould while preparation of brick. After mixing, the mixes were placed in the mould of size 10x10x10cm.

**Pour the Mix:** The hand compaction was done for proper compaction of the papercrete. Before mixing, the mould was ready for casting the cube specimen. Machine oil was applied to the inner surfaces of mould for easy removing of mould and without causing any damage to the specimen.

**Remove Forms:** Curing the bricks 20 days and for 20 minutes before removing the forms because of excess water can drain out from the moulds. Then remove the mould and expose the bricks to the sun 3 to 4 days for drying purpose.

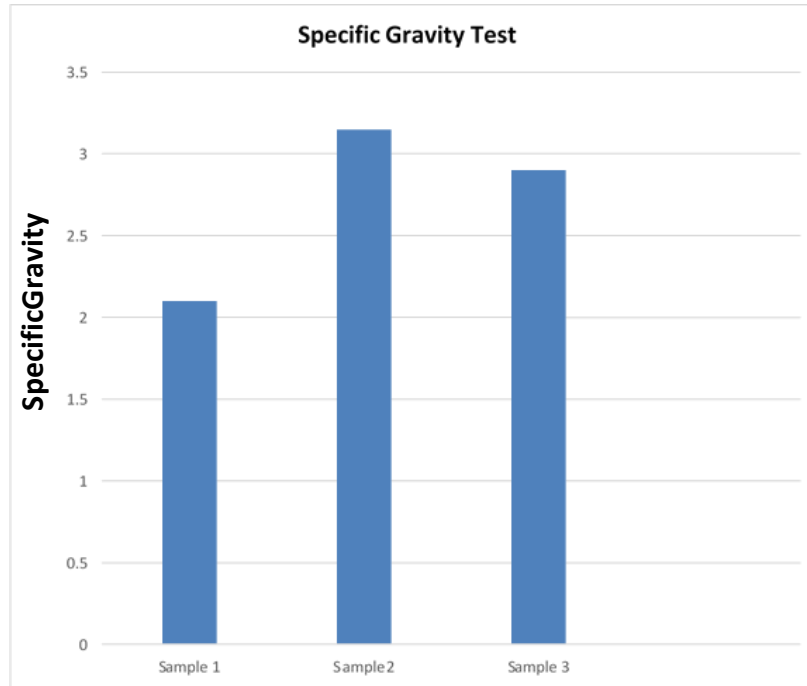
**Papercrete Bricks:** Papercrete fibrous mix was poured into the mould by three layers and fully compacted manually. Casting was completed after 24 hours, the mould was removed carefully from the specimen. After 28 days of air drying, the specimen was ready to test.

#### **4. Results And Discussion:**

##### **4.1 Determination on Specific Gravity of Cement:**

**Table 4.1 Specific Gravity of Cement**

Sample no	Specific Gravity of Cement
1	2.1
2	3.15
2	2.56

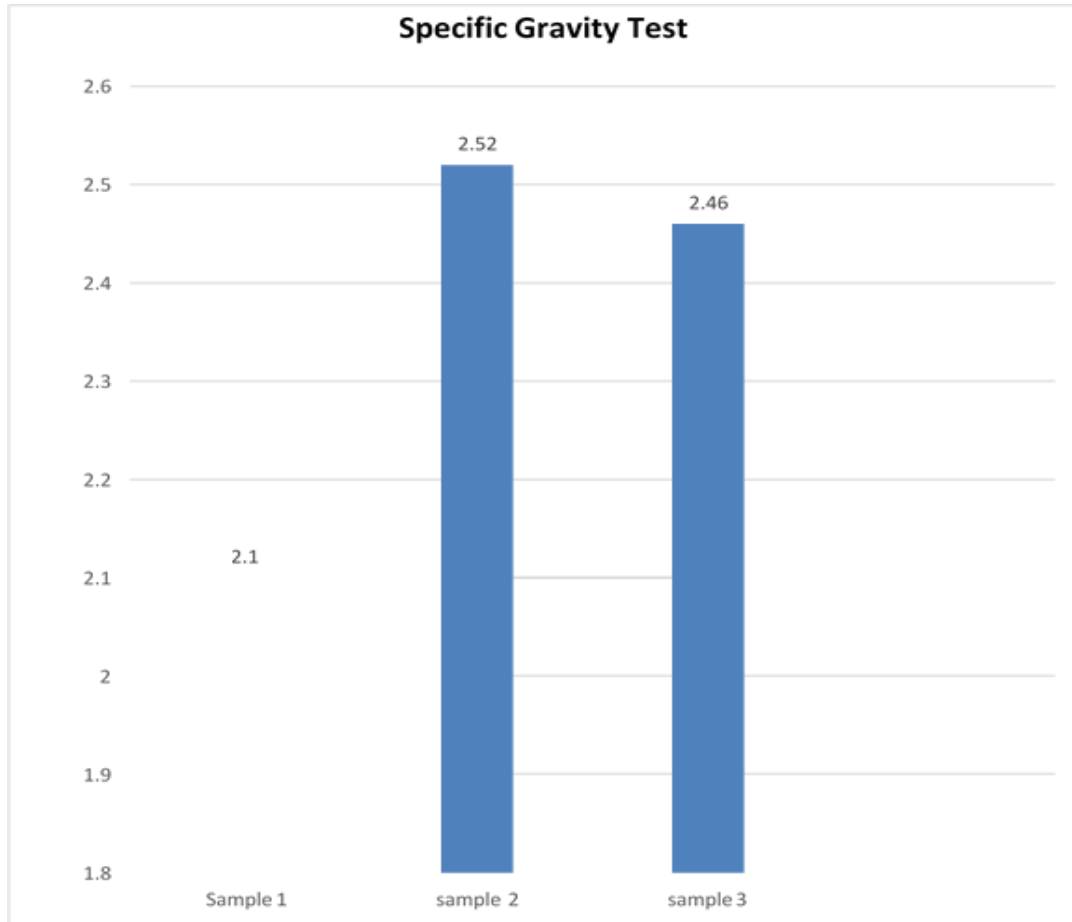


**Fig.4.1 Specific Gravity of Cement**

**4.2 Determination on Specific Gravity of Fine Aggregate:**

**Table 4.2 Specific Gravity of Fine Aggregate**

Sample No	Specific Gravity of Fine Aggregate
1	2.1
2	2.52
2	2.46



**Fig.4.2 Specific Gravity of Fine Aggregate**

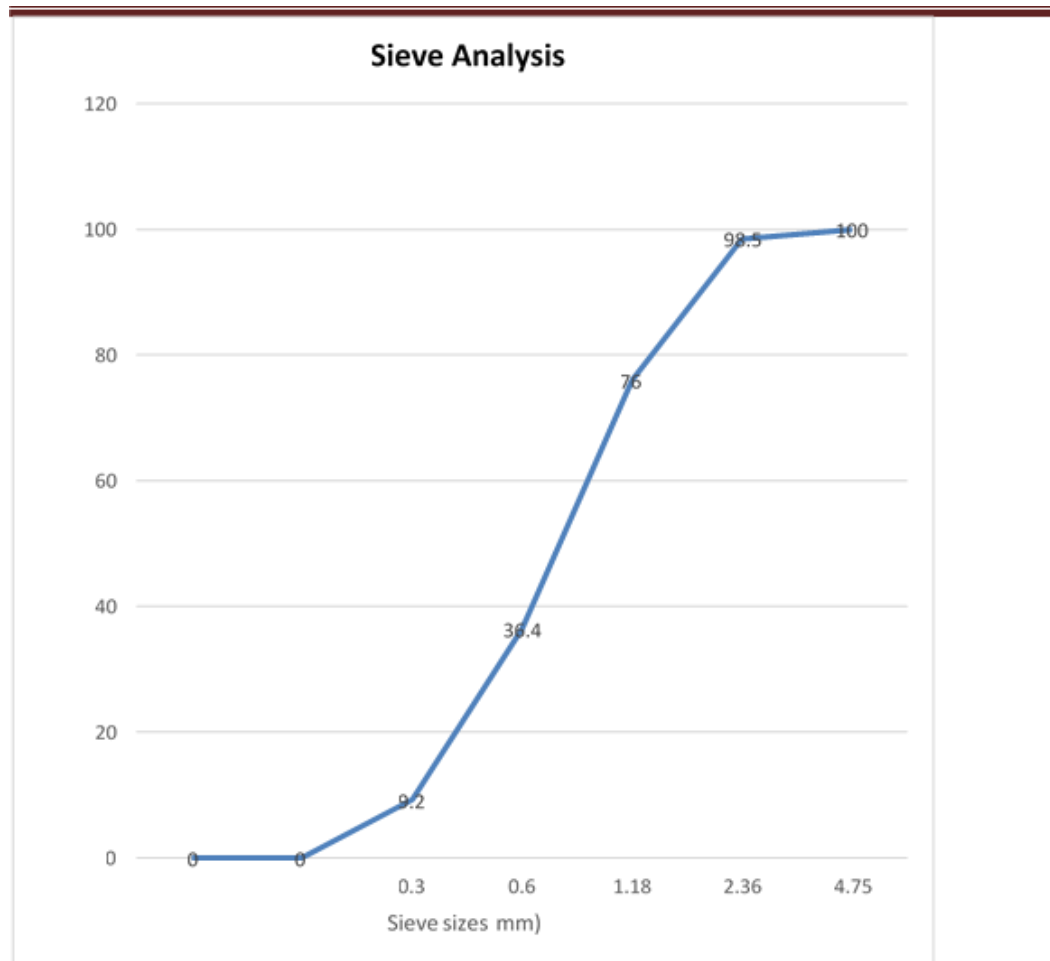
#### 4.3 Sieve Analysis of Fine Aggregate (Grain Size Analysis):

**Table 4.3 Sieve Analysis of Fine Aggregate**

Sl. No	IS sievesizes	Weight retained in grams	% of weight retained	Cumulative % of weight retained	% Passing
1	4.75mm	0	0	0	100.0
2	2.36mm	15	1.5	1.5	98.50
3	1.18mm	225	22.5	24	76.0
4	600 $\mu$	396	39.6	63.6	36.40
5	300	272	27.2	90.8	9.2
6	150	92	9.2	100	0



7	0.075	0	0	-	-
8	pan	-	-	-	-
<b>Total</b>				$\Sigma=279.9$	



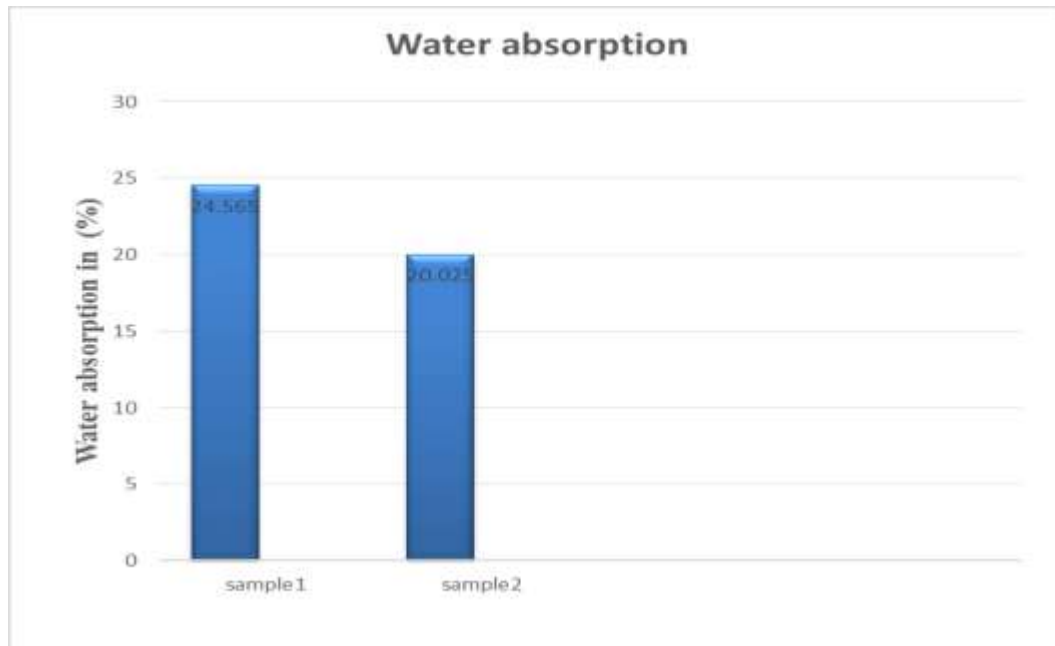
**Fig.4.3 Sieve Analysis of Fine Aggregate**

#### 4.4 Water Absorption

**Table 4.4 Water Absorption**

Sl.No.	Sample No	Water Absorption in (%)
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1	Sample1	24.565
2	Sample2	20.025

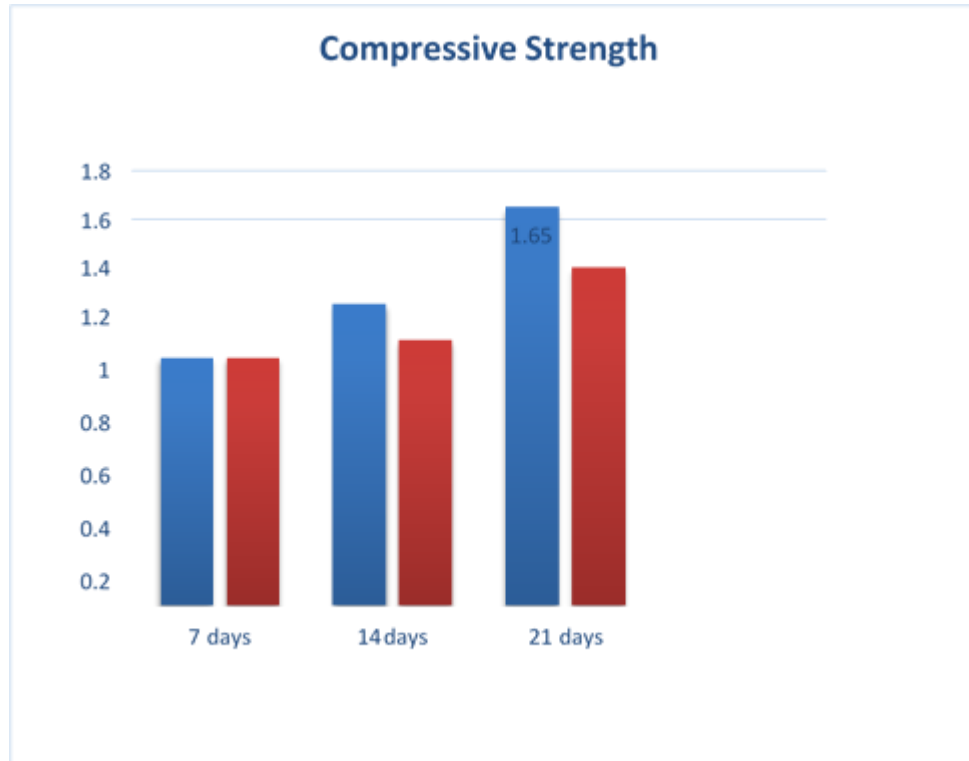


**Fig.4.4 Water Absorption**

#### 4.5 Compression Test:

**Table 4.5 Compressive Strength**

Sl.No.	SampleNo	Compressive strength (N/mm <sup>2</sup> )		
		7 days	14 days	21 days
1	Sample1	1.025	1.25	1.65
2	Sample2	1.025	1.10	1.40

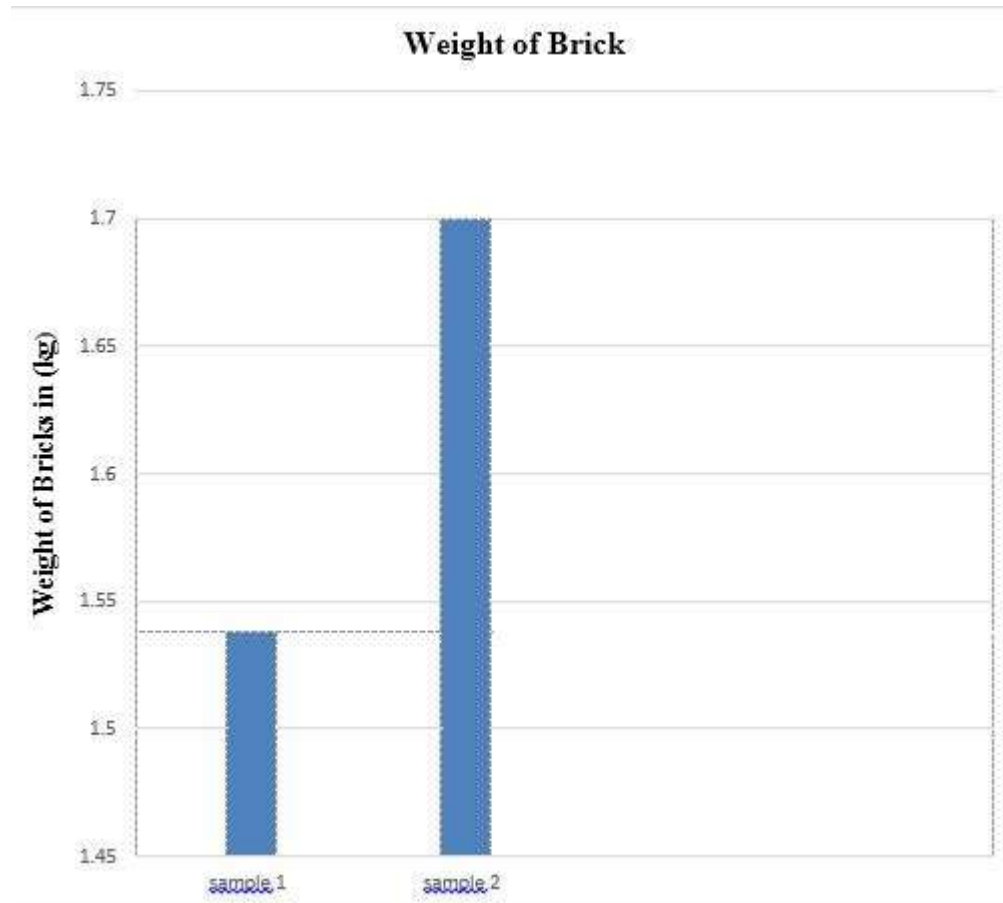


**Fig.4.5 Compressive Strength of Papercrete Bricks**

**4.6 Weight of Papercrete:**

**Table 5.6 Weight of Brick**

Sl. No.	Sample No	Weight(kg)
1	Sample 1	1.538
2	Sample 2	1.702



**Fig.4.6 Weight of Papercrete Bricks**

## 5. Conclusion:

From this investigation the following conclusions can be derived on the basis of the tests.

- A papercrete brick consists of recycled material and therefore cost is low compared to conventional bricks.
- Papercrete bricks can be easily moulded into any shape, bricks are much easier for someone to lift to any desired height and very good surface finish can be achieved.
- Papercrete bricks are suitable for non-load bearing walls only.
- Papercrete bricks has a good fire resistance.
- The weight of this brick is almost half the weight of conventional clay bricks. Due to less weight of these bricks, the total dead load of the building will be reduced.
- These bricks are potentially ideal material for earthquake prone areas as they are lightweight and flexible.
- These bricks are not suitable for water logging and external walls. It can be used in inner partition walls. This research is just an initiation to papercrete study. However, further



studies are required on following issues:

- Modification of mix proportions to achieve optimum properties.
- Addition of materials like coconut fibers or fly ash to improve the compressive strength of papercrete.
- Colour and texture for better aesthetic and design versatility.
- Addition of silicon, concrete sealer or epoxy compound to help in waterproofing of papercrete.
- Admixtures can also be added to improve setting and bonding properties.
- Studies on various other sustainable aspects.

#### **6. Future Scope:**

- Trying to reduce the amount of concrete required to prepare the papercrete with same strength and also ultimately reduce CO<sub>2</sub> amount.
- Decrease in carbon footprint of the house.
- Use of different materials at the place of cement such as gypsum and lime.
- Sustainable construction materials, decorating materials and etc.
- Large market in Africa, India, China because people has less money.

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