

Experimental Study of Waste Paper to Produce Environmental Eco-Friendly Brick

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Abstract— Another nature examine gauges the world has 3.04 trillion trees. Just about 4 billion trees worldwide is chopped during each time for making paper. The development business has been known as one of the biggest buyers of non-sustainable assets. Then again, more waste paper winds up in landfill or dump locales than those reused. The reason for this exploration is to decide the weight, compressive quality, water assimilation limit, imperviousness to fire, hardness and so on of paper Crete block by utilizing waste papers (daily papers, welcome cards, magazines and so forth.) keeping in mind the end goal to decide their bent for use as a building development material. While utilizing paper mash with bond and sand the heaviness of the block is roughly half lesser than the ordinary mud block. In this manner paper Crete blocks will diminish the dead weight of the structure to a noteworthy sum. So it changes our outline and building cost as in a prudent perspective.

Key words: Paper Crete, Cellulose, Light Weight, Compressive Strength, Recycling, Cost

I. INTRODUCTION

According to a research, more than 450 million tons of papers are produced worldwide every year. It is estimated that by 2020, 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 3 rd 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. According to the Environment Protection Agency (EPA), the Unites 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. Waste paper reusing has not been able to match waste paper generation. 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.

II. OBJECTIVE

The major Objective of the project is replacing the costly and scarce conventional building bricks by an innovative and alternative building bricks, which satisfies the

A. Following characteristics,

- Required
- Cost effective
- Environmental friendly

- Less weight
- Inflammable
- Easily available

The main objective of this project is optimize the paper Crete mix with desirable properties, which satisfies the above mentioned needs.

- 1) Accumulation of material
- 2) Experimental procedure
- 3) Results and discussions
- 4) Utilization of waste materials.

III. REVIEW OF LITERATURE

The constant developmental activities in civil engineering and growing industrial activities have created a continuous demand for building materials which satisfy all the stringent requirements regarding the short-term and long-term performance of the structure. As the structures tomorrow become taller and more complex, the materials of construction will be required to meet more demanding standards of performance than those in India's present housing.

Subramani et al [7] carried out experimental investigation of paper Crete Concrete, and concluded that the use of paper waste for producing a low-cost and light weight composite brick as a building material. An experimental investigation has been carried out to optimization of mix for paper Crete bricks depending upon the compressive strength, unit weight, and water absorption.

Ramji Karr et al. [8] carried out research work, application of paper Crete in concrete due to use of cement is a worldwide concern., the use of cement is continuously used people's desire to live in an eco-environment is continuously increasing. To resolve these issues various innovative ideas are being developed. Paper Crete is an innovative composite material made by imparting waste paper as a partial replacement of Portland cement. Use of waste paper as Paper Crete not only reduces the amount of cement but also makes environment friendly building materials.

IV. METHODOLOGY

A. Materials use in present study

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

Property	
SiO ₂ content (%)	21.9
Al ₂ O ₃ content (%)	6.9
Fe ₂ O ₃ content (%)	3

CaO content (%)	63
MgO content (%)	2.5
SO ₃ content (%)	1.7

Table 3.1: Components of Cement

Description of test	Results Obtained	Requirement of IS:8112-1989
Specific gravity	3.12	3.15
Initial setting time	65 minutes	30 minutes
Final setting time	270minutes	600 minutes
Fineness	410.92 m ² /kg	225 m ² /kg

Table 3.2: Properties of cement

S.NO	PROPERTIES	RESULT OBTAIN	Requirement of IS
1	Fineness	4.40%	2.7
2	Specific gravity	2.40	2.60

Table 3.3: Properties of Sand

B. Paper

Paper is a thin material produced by pressing together moist fibers of cellulose pulp derived from wood, rags or grasses, and drying them into flexible sheets. It is a versatile material with many uses, including writing, printing, packaging, cleaning, and a number of industrial and construction processes. To make pulp from wood, a chemical pulping process separates lignin from cellulose fibers. This is accomplished by dissolving lignin in a cooking liquor, so that it may be washed from the cellulose; this preserves the length of the cellulose fibers. Paper made from chemical pulps are also known as wood-free papers—not to be confused with tree-free paper; this is because they do not contain lignin, which deteriorates over time. The pulp can also be bleached to produce white paper, but this consumes 5% of the fibers; chemical pulping processes are not used to make paper made from cotton.

V. MATERIAL CHARACTERISTICS

A. Bricks

The bricks are obtained by molding clay in a rectangular block of uniform size and then by drying and burning the blocks. As the bricks are of uniform size, they can be properly arranged and further, as they are in lightweight, no lifting appliance is required for them. The common brick is one of the oldest building materials and it is extensively used at present as a leading material in construction. In India, process of brick making has not changed since many centuries except some minor refinements. There has been hardly any effort in our country to improve the brick-making process for enhancing the quality of bricks. A brick is generally subjected to the following tests to find out its suitability for the construction work.

B. Absorption

A brick is taken and it is weighed dry. It is then immersed in water for a period of 24 hours. It is weighed again and the difference in weight indicates the amount of water absorbed by the brick. It should not, in any case, exceed 20% of weight of dry brick.

C. Crushing Strength

The crushing strength of a brick is found out by placing it in a compression-testing machine. It is compressed till it breaks, as per BIS: 1077-1957, the minimum crushing strength of brick is 3.50 N/mm². The brick with crushing strength of 7-14 N/mm² are graded as 'A' and those having above 14 N/mm² is graded as 'AA'.

Hardness In this test, a scratch is made on the brick surface with the help of finger nail. If no impression is left on the surface, the brick is treated to be sufficiently hard.

D. Presence of Soluble Salts

The soluble salts, if presents in brick will cause efflorescence on the surface of bricks. For finding out the presence of soluble salts in brick, it is immersed in water for 24 hours. It is then taken out and allowed to dry sunshade. The absence of grey or white deposits on its surface indicates absence of soluble salts. If the white deposit covers about 10% surface, the efflorescence is said to be slight and it is considered as moderate, when the white deposit cover about 50% surface. If grey or white deposits are found on more than 50% of surface, the efflorescence becomes heavy and it is treated as serious, when such deposits are converted into powdery mass.

E. Shape and Size

In this test, a brick is closely inspected. It should be of standard size and its shape should be truly rectangular with sharp edges. For this purpose, 20 bricks of standard size (190mm X 90mm X 90mm) are selected at random and they are stacked length wise, along the width and along the height. For a good quality brick, the results should be within the following permissible limits: Length: 3680mm to 3920mm, Width : 1740mm to 1860mm, Height: 1740mm to 1860 mm.

F. Soundness

In this test, two bricks are taken and they are struck each other. The bricks should not break and a clear ringing sound should be produced.

G. Structure

A brick is broken and its structure is examined. It should be homogeneous, compact and free from defects such as holes, lumps etc.

H. Paper Crete

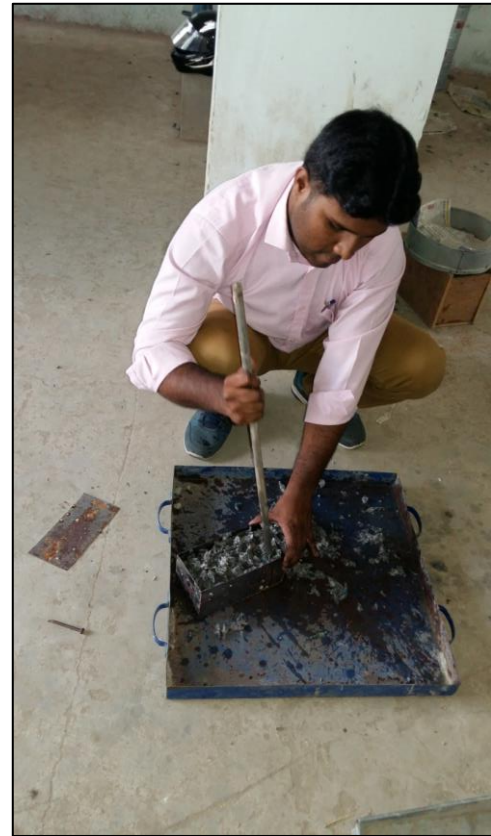
Paper Crete is a tricky term. The name seems to imply a mix of paper and concrete, hence paper Crete.

I. Eco – Friendly

Phenomenal growth in the construction industry depends upon the deflectable resources of the country. Production of building materials lead to irreversible environmental impacts. Using eco-friendly materials is the best way to build an eco-friendly building. Eco-friendly, describes a product that has been designed to do the least possible damage to the environment.

VI. EXPERIMENTAL PROCEDURE

According to research, up to now, there is no hard and fast rule for formal mix design of paper Crete, and in that respect no hard procedure for casting the bricks. Thus, in this research, some laboratory tests were performed to obtain some mechanical properties of paper Crete.



A. Mould Preparation

After collecting all the materials, a mould was prepared. A steel modular brick mould was prepared of size 230mm X 110mm X 80mm. Joints were made with hole or gap to avoid any leakage. but below the mould two hole are made.



VII. RESULT AND DISCUSSION

After casting the bricks they were analyzed for using as a brick. For this, various tests were conducted out to confirm the properties of bricks and the results of the test were analyzed by the existing and standard results. The following tests were carried out to check the strength of the brick.

A. Compression Test

This test was held out by Compression Testing Machine after the 14th, 21th and 28th day from the date of casting paper Crete brick. paper Crete bricks never fail catastrophically, it just compressed like squeezing rubber. Therefore great care must be considered while testing the paper Crete brick because in paper Crete load should be applied up to half compression only. The paper Crete bricks are having elastic behavior and less brittleness, due to this the structure was not fully collapsed, when the paper Crete brick fails at higher load. Only the outer faces cracked and peeled out.

No of days	No. of Samples	Compressive Strength	Avg. Compressive st.
14 days	Sample 1	4.76 N/mm ²	5.08N/mm ²
	Sample 2	5.42 N/mm ²	
	Sample 3	5.06 N/mm ²	
21 days	Sample 1	7.19 N/mm ²	7.44N/mm ²
	Sample 2	7.21 N/mm ²	
	Sample 3	7.93 N/mm ²	
28 days	Sample 1	11.17 N/mm ²	11.04N/mm ²
	Sample 2	10.43 N/mm ²	
	Sample 3	11.51 N/mm ²	

Table 4.1: Compressive Strength

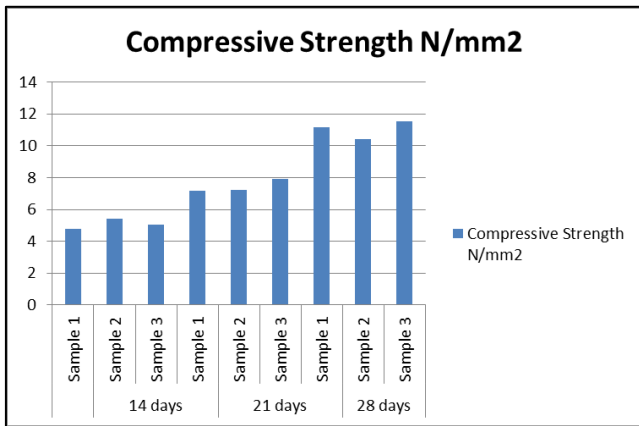


Fig 4.1: Variation in Compressive Strength of paper Crete brick with no. of days

B. Weight

The ordinary conventional clay bricks weight varies from 3 – 4 kg but the paper Crete bricks weight varies from 1 – 2 kg. The maximum weight is less than 2 kg only. All the bricks were weighed in a well conditioned electronic weighing machine. Sand based paper Crete bricks are having weight 2/3rd of the conventional clay brick only. So these bricks are lightweight and thus helpful to reduce the total cost of construction due to reduction in total dead load of the structure.

S.N	NO OF DAYS	WEIGHT
1	14days	1.90kg
2	21days	1.85kg
3	28days	1.81kg

Table 4.2: Weight Test

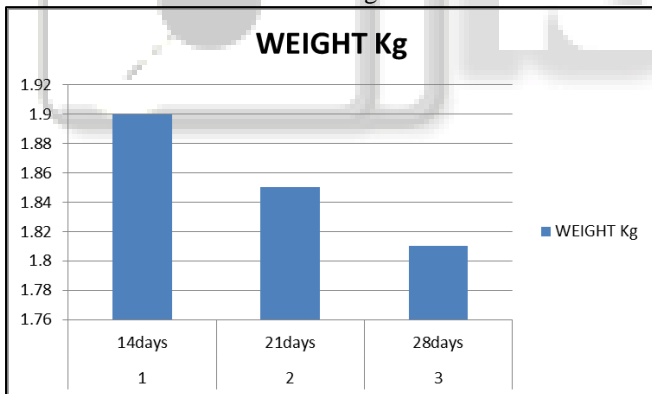


Fig. 4.2: Weight of paper Crete bricks with no. of days

C. Water Absorption Test

Water absorption test is required to check whether the bricks are suitable for water logged areas or not. As per standards the bricks should not absorb water more than 20% of its original weight.

S.N	SAMPLE	% OF WATER ABSORPTION(24 hours)	Avg %
1	Sample1	28.5	27.33
2	Sample2	26	
3	Sample3	27.5	

Table 4.3: Water Absorption test

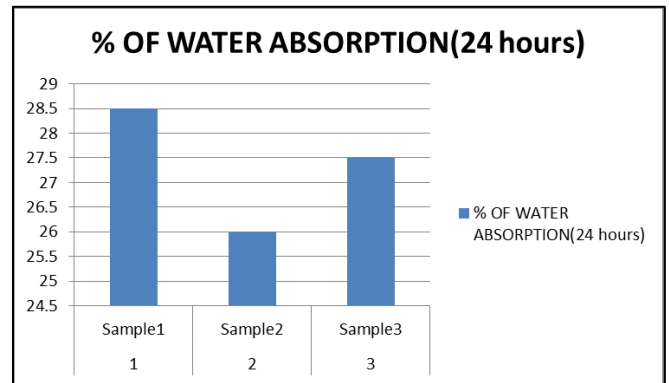


Fig 4.3: Water Absorption Test for Trial Mix

D. Hardness Test

In this test, a scratch was made on brick surfaces. While the scratch was made with the help of finger nail on the bricks, very light impression was left on the fibrous concrete brick surface. Hence, this test results that fibrous concrete bricks are sufficiently hard.

E. Soundness Test

In this test two bricks were taken and they were stuck with each other. The bricks were not broken and a clear ringing sound was produced. Hence the bricks are safe to use.

F. Nailing

Fibrous concrete bricks are less hard as compared to conventional clay bricks. Therefore, this test was performed to find out whether these bricks can hold the nails or not. A nail was hammered in the brick and a screw was also screwed into the brick. From this test it was observed that fibrous bricks can sufficiently hold the nail. Also screws worked well and holds a considerable weight.



G. Fire Test

the bricks. This test was conceded out only for fibrous concrete bricks and not for padobe brick. From the above

test, it was observed that the fibrous concrete bricks did not burn with an open flame. They fumed like charcoal. But these brick would be reduced to ashes after burning several hours. If the interior plaster and exterior stucco is provided on the fibrous concrete bricks, the bricks won't burn. The only weak spot is inside the block, near electrical outlets, switches and other situations where wires gives through walls, into boxes etc. Properly wired places never cause a fire. If we apply the plaster without any hole or leakage on the bricks, it won't burn or fume inside because there will be a lack of oxygen for combustion.



Fig. 4.4: Brick after burning for five minutes

VIII. CONCILIATION

From the results obtained, the following conclusions were made:

Considering the desirable compressive strength shown by the tested specimen, it is clear that paper Crete have the ability to provide an eco friendly, light weight concrete block with the use of less number of natural resources. Though the results obtained during compression test showed that paper Crete bricks are acceptable for non load bearing walls only.

As per research the bricks should not absorb water more than 20%. The water absorption capacity of paper Crete brick was found to be more than 20%, which makes it not suitable for water logging and external walls. However, by providing a waterproof coating (Geo bond or silicon based waterproofing) it can also be used as external wall.

The weight of the paper Crete brick was 1/3rd to 2/5th lesser than the conventional clay brick. Due to less weight of paper Crete bricks, the total dead load of the building will be reduced.

Due to lesser weight and more flexibility, these bricks are potentially ideal material for earthquake prone regions.

Paper Crete has a high fire resistance, good sound absorbent, good thermal resistance with an R value between 2 to 3 per inch. In walls 12 to 16 inches thick, the long energy saving of paper Crete will be a great advantage for the house owner and environmental.

These bricks does not expand nor shrinks hence, sheets of glass or glass block can be fixed in and trimmed with Since, paper Crete brick mainly consists of waste

material, it will reduce the landfills and pollution. Hence, the overall cost is very low as compared to conventional brick. It has been seen that by using paper Crete bricks in a building construction, the total cost was reduced from 20% to 50%.

IX. FUTURE SCOPE

- Establishing the industries
- Increase there strength by adding other materials
- Decrease the water absorption capacity.
- Increase fire resistance capacity
- Trying to reduce concrete required prepared with same strength.
- Ultimately reduced CO₂ amount.
- Decreases in the carbon footprint of the house.
- Use the different materials at the place of cement.

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