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A REVIEW ON

PAPERCRETE BRICK: AN ECO-FRIENDLY AND SUSTAINABLE BUILDING MATERIAL

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Abstract

All the renewable sources are being used now-a-days for the purpose of construction in the construction industry as all the conventional sources are at the edge of extinction or their continuous use is affecting the nature in a dangerous way. So, they are being banned by the government sometimes which causes hurdle to the construction process that is not bearable by the civil engineer's or by the construction industry for its development. Everyday millions of tons waste papers are dumped at the landfills and dump sites.

Approximately 15 trees are required for making per ton of these papers and near about 720 million of trees are used and buried as landfills. So, to overcome this situation and also for saving the trees or deforestation coming in picture this waste papers are to be used by recycling it in a unique manner. That is a papercrete brick: an eco-friendly and sustainable building material which can replace the traditional bricks and make a building a lightweight structure, with good fire resistance ability, requirement of less water, proper well finished surface and that too at a low cost than the traditional bricks. Also, the other materials required such as cement, sand, admixtures, epoxy or silicon as a waterproofing agent are easily available in the market and addition of this will also increase the compressive strength of the brick. Also, it is passed on the criteria of testing of bricks by performing different test such as efflorescence, water absorption, fire resistance, etc. as comparative to the traditional brick.

Index Terms: Eco-friendly, Papercrete, Waste recycle, Fire resistant, Lightweight etc.

1. INTRODUCTION

From the last decade, there is the huge demand of building material industry owing to the increasing population of country which is causing a scarcity of building materials. This is leading to create a challenging situation for the civil engineers. To overcome this, invention and use of different eco-friendly materials are coming in picture now-a-days by using different methods.

As the structure now-a-days is becoming more and more taller and complex therefore the materials which will be required for the construction of the same should meet the required high standards of the demanding performance of the building. India's present housing shortage is calculated to be as high as 31 million according to census. Such a large housing construction works requires a huge amount of money. Out of this total estimated cost of housing construction, building materials contributes to above 70% of cost in developing countries like India.

The increase in the popularity of using eco-friendly materials, low cost and light weight construction materials in building industry has brought about the need to investigate the new

technique for this which is also beneficial to the environment and for maintaining the eco-friendly material.

This experimental study investigates the equivalent potential use of the waste paper from newspaper, magazines, and posters for manufacturing of the light weight composite bricks using different building materials such as paper pulp, cement, sand and fly ash, micro-silica, binding admixtures can also be added to this making it stronger and more efficient for the purpose required for the construction of the critical structures of the construction industry known as the papercrete bricks.

This papercrete bricks are alternative units of constructions in this modern era of the 21st century, which will help meeting the sustainable requirements of the development of construction industry.

2. RESEARCH OBJECTIVES

A mixture of the papercrete bricks contains waste paper sludge, cement, R-sand. Also, micro silica, steel slag and other binding agents can be added for increasing strength.

The main objective of inventing this papercrete eco-friendly bricks:

- Light weight
- Less water absorption
- Fire resistant
- Eco-friendly materials
- Low manufacturing cost
- Recycling of waste papers
- Easily available
- High performance etc.

3. METHODOLOGY

3.1 Materials used:

To achieve this goal, materials were gathered from various sources as follows:

1.Paper: In this study paper is main constituent material different types of papers are like newspaper record sheets, magazines, old books etc. paper is nothing but the wood cellulose, which is considered as a fibrous material. Cellulose is the second most easily available material on earth after rock. Cellulose is a natural polymer with along chain of linked sugar molecules i.e. β -D-glucose.

The chain bristles with polar -OH groups These groups form many hydrogen bonds with -OH groups on adjacent chains, bundling the chains together. The hydrogen bonding forms the basis and strength. The typical cellulose structure is shown in fig.1.



Fig1: - Cellulose

2.Cement:In this experiment performed the cement used was ordinary Portland cement of 53 grade (OPC-53) conforming to the IS:8112-1989.

3.Fine Aggregates:The sand used for making the bricks was derived from the riverbed and was IS 4.75 mm passing sand.(manufactured sand can also be used for the same of 4.75 mm passing).

3.2 Procedure Adopted:

There is not anymentioned procedure for manufacturing of this bricks or performing this experiment but the procedure which was taken by volume batching (prefer weight batching as the results will be more effective and accurate.) was in the ratio of 1:1.25:2(cement: paper sludge: sand). Here, the use of river sand was made due to good water absorption capacity of the river sand.

- A) Preparation of paper sludge:**The ped from the waste papers of magazines, old books, posters, record sheets, newspapers etc. firstly this paper were torn into the small pieces and then was soaked into the water for 3-4 days until they started degrading in the paste like form (fig 2). Then those papers were removed from the water and grinded into the mixer

for making a workable proper paper sludge. Afterwards the paper sludge was placed on a non-absorbent plate to squeeze out all the excess water(fig.2). Generating this paper sludge is little bit a tedious job to be performed but for the mass production the tow mixers can be used which are mechanically operated and recommended to use for reducing the cost of manufacturing.



Fig2: - Soaking and Squeezing out the waste paper

- B) Mixing of dry ingredients:** The constituents of the mixture such as cement, sand, paper sludge, (other adhesives can also be added) were mixed thoroughly until the mixture comes in a uniform colour.

The constituents of the mixture such as cement, sand, paper sludge, (other adhesives can also be added) were mixed thoroughly until the mixture comes in a uniform colour (fig .3).



Fig3: - Uniform mix of papercrete

- C) Mould Specifications:** The mould used for moulding the brick was a standardized mould of size 19cm×9cm×9cm. This mould can be easily prepared with the help of plywood sheets with the proper measurements by just making sure that there is no leakage in the mould which will affect the water by cement ratio and decreases the strength of the brick. But over here the mould used was of steel which was brought from the brick kiln nearby



Fig4: - Mould used for casting of the brick

- D) Casting of bricks:**The bricks were casted by moulding it into the mouldwithin the initial setting time of 30 minutes from mixing of the constituents.

The mould was first well-greased and then the mix was poured into it making sure that there are no voids in it and It was compacted by tamping it with a tamping rod giving sufficient number of blows to it and fairly levelled by removing all the excess material making the surface well finished.

Then the bricks were sun-dried for 7,21 days respectively and then were cured for 14 days. After this the results were noted down for the weight of the bricks as follows:

Table -1: Weight of papercrete bricks

Sr, No.	Types of papercrete bricks	Weight(in Kg)
01.	Sun-dried	1.526
02.	Water-cured	1.695

As per the results shown in the table no. 1, the maximum weight of the papercrete brick is less than 2 kg per brick in both the situations which is less than the weight of traditional brick of 3-3.5 Kg.

4. TESTS PERFORMED

4.1 Compressive strength test:The compressive test was performed by using compression testing machine(CTM). The test was carried out on the 7th, 14th and 21st day respectively. And after testing the specimens the bricks were not totally crushed or ruptured but just got squeezed like a rubber. So, the load was applied half of the compression. The test results are shown below in the table 2.

Table -2: Compressive strength (MPa)

Sr, No.	Types of papercrete bricks	Compressive strength		
		7days	14days	21days
01.	Sun-dried	1.015	1.19	1.61
02.	Water-cured	1.015	1.06	1.37

The graph below shows the values and compressive strengths of the bricks which are sun-dried and water-cured.

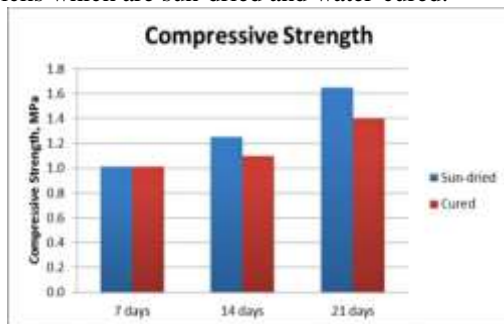


Fig 4: - Compressive strength of the papercrete brick

Observations:

From the above observations made in compressive strength of the sun-dried and water-cured papercrete bricks

- It was observed that the strength of the sun-dried bricks increased by passing days.
- Whereas the strength of the water-cured bricks is decreasing day by day.

4.2 Water Absorption Test: This test was conducted as per IS: 3495-part 2. The procedure adopted for the same is firstly a brick is taken and weighed dry. It was then immersed in the water for near about 24 hours. It was then weighed again and the difference observed in their weight indicates the amount of absorbed water same procedure as we follow in finding out the moisture content of the soil.

Observations: The observation made were

- It should not exceed 20% of weight of dry brick in any of the case.

As the water absorption value plays very crucial role in bond between the brick and the mortar. As if the water absorption value of the brick is more then after placing the mortar the brick will absorb water or moisture from the mortar which will be resulting into the poor strength of mortar and insufficient water will be available for the hydration process.

The test results for the papercrete bricks water absorption tests are as follows:

Table -3: Percentage water absorption of papercrete bricks

Sr, No.	Types of papercrete bricks	Water Absorption (%)
01.	Sun-dried	24.128
02.	Water-cured	19.847

4.3 Efflorescence test:

This test was conducted to know if there is presence of any alkaline material in the bricks. For this the bricks were taken and placed along their ends in a dish. The depth of the immersion was kept to be 2.5 cm. The whole arrangement is then placed in the warm and ventilated room unless and until the water from the dish evaporates completely. The same procedure is repeated for the second time and then after the second evaporation, observations made are

Observations:

- If the white deposit covers about 10% surface, the efflorescence is slight and considered as moderate.



Fig 5: - Efflorescence on the papercrete brick

4.4 Fire Resistance test:

This test was performed for the purpose of checking the resistance of the brick to inflammation. Hence the brick was kept in fire for 30 mins and observed that it just smouldered like charcoal and no any other harm has occurred.

And if the brick is in fire for several hours then it will give the ashes but the structure will be homogeneous, compact and free from defects afterward also only the plastering is to be provided for further protection.



Fig 6: - Fire test on the papercrete brick



Fig 7: - Papercrete brick after fire test

5. ADVANTAGES:

Following are the various advantages of the papercrete bricks observed by studying and performing experiments on the sample made by the required proportions:

- A papercrete brick is made from recycling of waste materials as papers from various sources so is having low cost than that of the traditional bricks.
- Very good surface finish can be maintained easily
- As it is lightweight units easy to displace from one place to other or at heights.
- They are best suitable for non-load bearing walls.
- Papercrete is having good fire resistance.
- Due to half the weight of traditional brick the dead load of the building gets reduced.
- These are flexible and lightweight hence the potential and efficient material for the earthquake prone areas.
- This is a best from waste use of the wastage newspapers, magazines, books, record sheets etc.

5. FUTURESCOPE:

This is the initial study and experiment of the papercrete so many more is to be added in this such as

- Colour and texture can be added and a proper aesthetics should be provided
- Addition of epoxy, silicon, concrete sealer for the waterproofing purpose.

- Materials like coconut fibres and fly ash can also be added for increasing compressive strength.
- Water is not needed for this hence the scarcity of water can also be prevented.
- Modification of optimum proportions to achieve the maximum strength.

6. CONCLUSION:

Finally, after completion of the experimental study, the final conclusion is that the papercrete brick is an efficient, eco-friendly and sustainable building material which can be replaced at the place of the traditional bricks as traditional bricks are threat to the nature and its sources like soil.

Therefore, these bricks are effective, low cost, fire resistant, units made from waste newspapers, a best solution to the replacement of the construction unit of the buildings or any other structures of the construction industry.

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