

Papercrete

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Abstract— This project is mainly concerned with the efficient usage of waste materials in a beneficial way in order to make it economical as well as eco friendly. For this purpose concrete made of paperpulp are considered and a new methodology is adopted in them. The basic components such as paper pulp, cement, coarse aggregate, fine aggregate, are used. In this project, four proportions of papercrete mixes comprising of the above mentioned materials in various quantities are made and tested for its compressive strength, water absorption etc. and the results are compared with normal concrete..The developed use of paperpulp in the concrete is found also to be economical, weightless and very eco friendly and this project will definitely give the solutions for the solid waste management and will lead for low cost housings.

Keywords—Compressive strength; flexural strength; split tensile strength;OPC;papercrete

I. INTRODUCTION

Papercrete is kind of fibrous cement, made by shredding paper into pulp in water and adding Portland cement to it and in some cases sandy soil can be used as an additive. It gains the inherent strength with the presence of hydrogen bonds in microstructure of paper. This thick mix is poured into molds the cast like concrete, to make it into any desired shape and size. Papercrete can be called as a sustainable building material with the reduced amount of cement usage and recycled paper being used effectively. It has numerous advantages on construction industry and they are its low carbon footprint, usage of recycled paper, low embodied energy, high strength for weight ratio, higher thermal insulation, higher sound absorption, aesthetic and cost effective. Much research was being carried out globally on the material but it was to be acknowledged by Indian standard practices and codes were recognized by major building material organizations in India.

Papercrete is a recently explored construction material that consists of re-pulped paper fiber and cement or clay. It was an experimental material that replaces a certain proportion of cement with paper present in the normal concrete mix. It was perceived as an environment friendly material due to the vital recycled content. By doing it, its total weight, cost and carbon emissions during production were reduced. Its use remains limited, because the lack of official data about the structural property, mechanical property and durability. To establish papercrete as the standard material, further experimentation are to be needed.

The main objectives are to effectively utilize the waste paper to reduce the problem of disposal of waste, to prove that the recycled paper pulp can be a replacement for fine aggregate. This is an experimental study showing replacement of the fine aggregate by recycled paperpulp with different ratio such as 5%, 10% and 15% in M30 mix concrete and determined the compressive strength and Split tensile strength. Hence it is compare it with the conventional concrete.

There is a lot of scope for further research and meaningful work in the endeavour. Some of it include the study of the effect of other supplementary cementitious materials like metakoline, blast furnace and slag, ground granulated blast furnace slag, etc., the strength and durability of light weight papercrete could be rewarding. The strength and durability of other papercrete building elements like wall panels and floor slabs, etc, were studied. The structural behavior of reinforced papercrete structural members like beams and slabs, etc needed to be investigated in depth. The performance of infilled frame with papercrete bricks under earthquake was to be studied further with respect to ductility and other performances with more number of specimens and to be validated analytically also.

Major limitation of papercrete is the suffocating smell of paperpulp. Modification of mix proportions can help achieve optimum properties. Addition of reinforcement such as coconut fiber (5%-10%) with the fly ash could be used to improve the compressive strength of papercrete. Colour, texture can be added in the papercrete for better aesthetics and design versatility. Addition of silicon and concrete sealer or epoxy compound can help in waterproofing of papercrete. Admixtures is also added to improve setting and bonding properties. Higher strength is obtained by using higher grade of cement. Papercrete made with the certain mixes are resistant to fire, fungi, and pests to a larger extent. Papercrete blocks were made with a sufficient quantity of Portland cement and sand have the improved fire resistance.

II. METHODOLOGY

A. Main Tests Conducted

Tests On Cement

- Test on consistency of cement
- Initial and final setting time
- Specific gravity of cement
- Fineness of cement

Tests On Fine And Coarse Aggregates

- Specific gravity of fine and coarse aggregates
- Sieve analysis

Tests On Recycled Paper Pulp

- Moisture content
- Specific gravity

Tests On Fresh Concrete

- Slump test
- Compaction factor test

Tests On Hardened Concrete

- Compressive strength test
- Splitting tensile strength test
- Flexural strength test

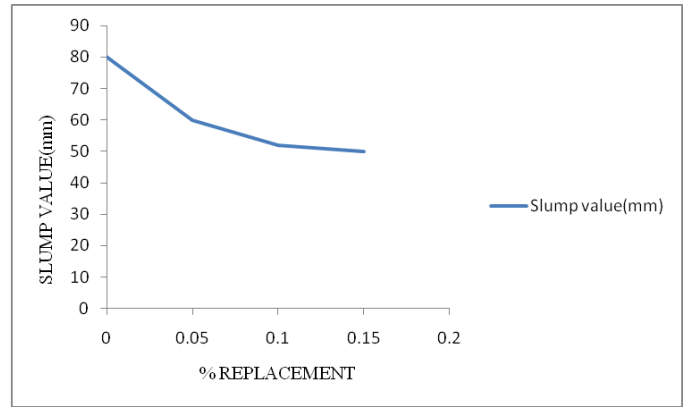


Fig 1. Slump Value Vs% Replacement

III. RESULTS AND DISCUSSIONS

A. TEST ON FRESH CONCRETE

1. Slump Test

Procedure

1. Clean the internal surface of the mould and apply oil and place the mould on a smooth horizontal non-porous base plate.
2. Fill the mould with the concrete mix in 4 approximately equal layers.
3. Tamp each layer 25 times with tamping rod distributing the strokes in a uniform manner over in the cross section of the mould.
4. Remove the excess concrete and level the surface with a trowel.
5. Clean away the mortar or water leaked out between the mould and the base plate.
6. Raise the slump cone from the concrete slowly in vertical direction and note down the type of slump occurred.
7. Measure the slump as the difference between the highest point of the mould & that of highest point of the specimen being tested.

TABLE I. TEST RESULT

Paper pulp %	Slump value(mm)
0	80
5%	60
10%	52
15%	50

This chapter deals with the test results of Normal Concrete (NC) with addition of paper pulp with various aspect ratio.

B. Test On Hardened Concrete

The hardened concrete properties such as compressive strength, flexural strength, split tensile strength were tested in the laboratory.

1. Compressive Strength

The compressive strength is measured using cubes on compression testing machine. The size of the cube used was 150mm x 150mm x 150mm. 6 concrete cubes were casted for each concrete mix proportions. The compressive strength of the three cubes were measured and an average was taken after 7 and 28 days of curing are as in Table II.

TABLE II. COMPRESSIVE STRENGTH FOR CUBES

Paper pulp %	7 days strength(N/mm ²)	28 days strength(N/mm ²)
0%	13.6	24.8
5%	18.9	25.84
10%	16.01	20.25
15%	15.42	20.09

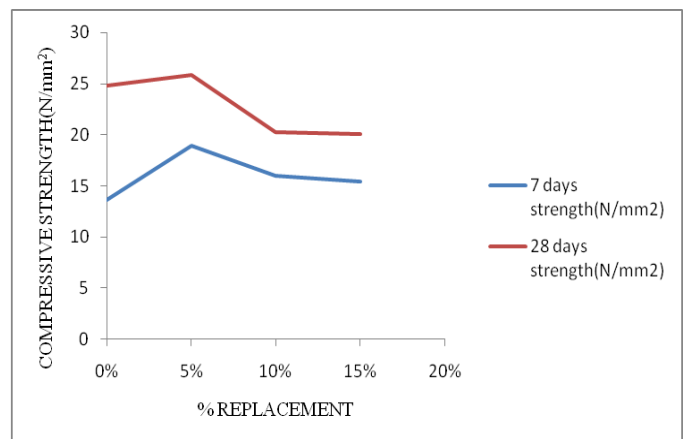


Fig2. Compressive Strength of Cube

TABLE III. COMPRESSIVE STRENGTH FOR CYLINDER

Paper pulp %	7 days strength(N/mm ²)	28 days strength(N/mm ²)
0%	14.01	26.74
5%	13.91	14.76
10%	21.05	23.74
15%	10.97	20.14

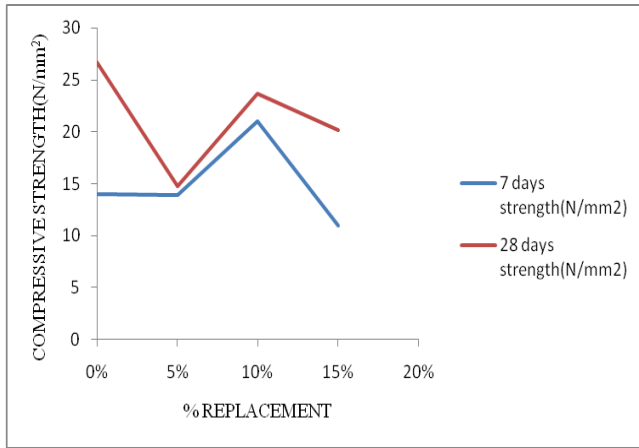


Fig3. Compressive Strength Of Cylinder

II. Split Tensile Strength

The split tensile strength is conducted on cylinder of 300mm x 150mm size. Six concrete cylinders were casted for each concrete mix proportions for 7 and 28 days. Splitting tensile strength can be calculated from the following equation using the maximum load applied on the compression testing machine.

$$\text{Splitting tensile strength, } f_{ct} = 2P/\pi dL = 2.56 \text{ N/mm}^2$$

where,

P - maximum applied load

d - diameter

L - length of cylinder

TABLE IV. SPLIT TENSILE STRENGTH

Paper pulp %	7 days strength(N/mm ²)	28 days strength(N/mm ²)
0	2.41	2.77
5%	2.29	2.5
10%	2.01	2.41
15%	1.89	2.3

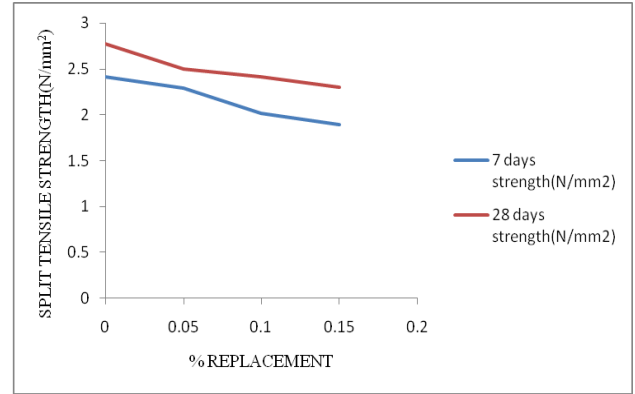


Fig 4. Variation In Split Tensile Strength

III. Flexural Strength

The flexural strength is conducted on beam of 500mm x100mm x100mm size. Six concrete beams were casted for each concrete mix proportions for 7 and 28 days. Flexural strength can be calculated from the following equation (1) using three point loading applied on the flexural machine.

$$f_b = PL/ bd^2 \tag{1}$$

where, P= max. load applied to the specimen

L = length of the span

b = width of the specimen

d = depth of the specimen at the point of failure

TABLE V. FLEXURAL STRENGTH

Paper pulp%	7 days strength(N/mm ²)	28 days strength(N/mm ²)
0%	5.2	7.2
5%	5	5.2
10%	5.4	5.8
15%	5.6	6

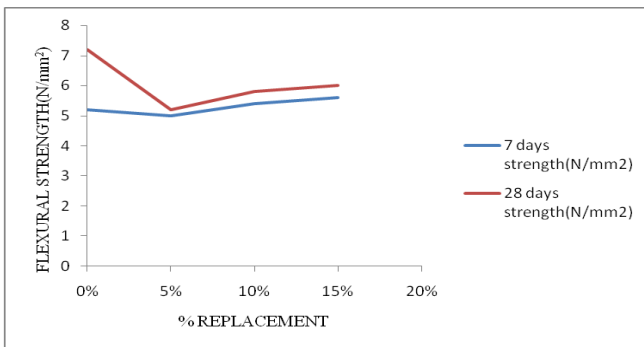


Fig 5. Variation In Flexural Strength

IV. CONCLUSIONS

From the above experimental studies we can conclude that

- Papercrete brick does not expand or contract, so glass block can be embedded in and trimmed with papercrete.
- The papercrete bricks are good sound absorbent, hence paper was used in these bricks. So, these bricks can be used in auditoriums.
- Since, the waste materials are used, it will reduce the pollution.
- Using the papercrete brick in a building, total cost will be reduced from 20% to 30%
- Compressive strength of cube is maximum at 5% replacement
- Flexural strength is maximum at 5% replacement
- Hence 5% replacement with recycled paper pulp will give the optimum result.

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