

# **Economical Eco-Friendly Light-Weight Building Blocks Using Waste Paper**

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**ABSTRACT:** The major component in any construction activity is the cost of the material. In developing countries, the untapped or unused resources are needed to be identified for its potential use in the construction sectors. The one such resource is waste paper. Paper pulp added with cement and sand hardens and forms a light weight construction material called Papercrete, which satisfies many of the engineering properties needed for construction. Papercrete has advantages like low-cost, economical and it is eco-friendly. In this research, papercrete blocks are created and their engineering properties are studied. It is to be noted that under compression papercrete fails slowly in a ductile manner but there was no earlier reliable research findings relating compressive stress with compressive strain which is covered in this paper.

**KEYWORDS:** Papercrete blocks, Low cost bricks, Paper bricks, Light weight bricks, Low cost blocks, Eco-friendly bricks

## **I. INTRODUCTION**

In the year 2015 people in India utilized nearly about 11 million tons of fresh paper in which only 27 percent of paper was recycled for further use as newspapers and cardboard boxes etc... Compared to the other countries this is relatively very low (USA - 50%, Japan - 60%, Germany - 73 %). Recycling one tons of paper could save 17 trees, 32,000 litres of water, 2.5 barrel of oil, 4100 KW of electricity.

Paper is a fibrous material made from trees. When the paper is pulped and allowed to dry, the broken fibres reconnect with each other through hydroxyl (-OH) bond and forms continuous chain which is the basis of the strength of papercrete. Adding cement and sand enhances the strength and reduces the drying shrinkage of papercrete.

Papercrete not only decreases the cost but also could help reducing environmental problems produced by the construction industries by saving cement and sand in concrete and blocks. It also shows some extraordinary properties like lightweight and high insulation due to high air voids. Under compression load, it fails in a ductile manner. These properties are important not only in building construction but also in other construction sectors like Highway engineering, Interior decorations etc., Thus it is necessary to further investigate such properties of papercrete to fully utilize its potential.

## **II. MATERIALS USED**

Paper is available in wide range of forms and hence its properties also vary based on them. For example, good quality papers have long cellulose fibres with high strength and high flexibility. Choosing best quality papers to produce papercrete may not be eco-friendly and economical as they can be recycled once again. However, once the paper is recycled, length and strength of the fibre in paper decreases. Hence paper can only be recycled for four to six times

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effectively. Therefore paper used in this study is a mixture of material made from recycled paper like cardboards, note covers and newspapers collected from college premises which have low salvage value. Results from this study may not be same everywhere as the quality of paper cannot be same everywhere. Since very low-quality paper materials are used in this study if a moderate quality of paper were used results may be higher.

53 grade OPC Cement conforming to IS12269, Dry River sand belongs to zone II as fine aggregate conforming to IS383 - 1970 and Potable water is used. Tests were performed in these materials to ensure its properties in agreement with the standards.

### III.MIX PROPORTION

There is no proper code for the mix proportioning of materials required to create papercrete. Hence several trial and error experiments are carried out and following observations are made.

1. Approximately 25 Litres of water is needed to mix 1kg of paper to a good homogenous slurry state.
2. Adding sand increases shrinkage resistance, fire proof and strength but decreases insulation capacity and increases weight. Hence 1:1 is taken as a basic mix ratio for paper and sand.

Mix proportion of 1 : 1 ( Paper : Cement) and 1 : 1 : 1 (Paper : Cement : Sand) by weight are chosen as a basic mix proportion. Engineering properties for different mix proportion are studied through series of experiments.

Mix	Mix Proportion (Paper : Cement : Sand)
PP1	1:1:0
PP2	1:2:0
PP3	1:3:0
PPS1	1:1:0.5
PPS2	1:1:1
PPS3	1:1:1.5
PPS4	1:1.5:1
PPS5	1:2:1

### IV.PREPARATION OF PAPERCRETE BLOCK

Paper is torn and chopped into smaller pieces and soaked in water for 2 days. Mixie and Driller machine with mixer attachment is used to grind and mix paper to a slurry form. Tow Mixers and Batch Mixers can be used for large batches. Excess water is drained through drain holes at the bottom to ensure homogeneity and workability. Finally, cement and sand is added and mixed to a homogeneous slurry state.

Papercrete mix is poured in the plastic brick mould of size (230mm x 110mm x80 mm).Papercrete have the ability to stick to everything it touches. Hence mould is placed above oiled tiles before pouring of papercrete mix. Tamping and dressing are done atthe end.

From trial, it is found that papercrete takes weeks to dry inside the building hence Papercrete blocks are allowed to dry in natural sunlight in open space. It took two weeks (14 days) for papercrete blocks to dry and got its strength. Hence tests are carried out on the 14th day from the day of casting.

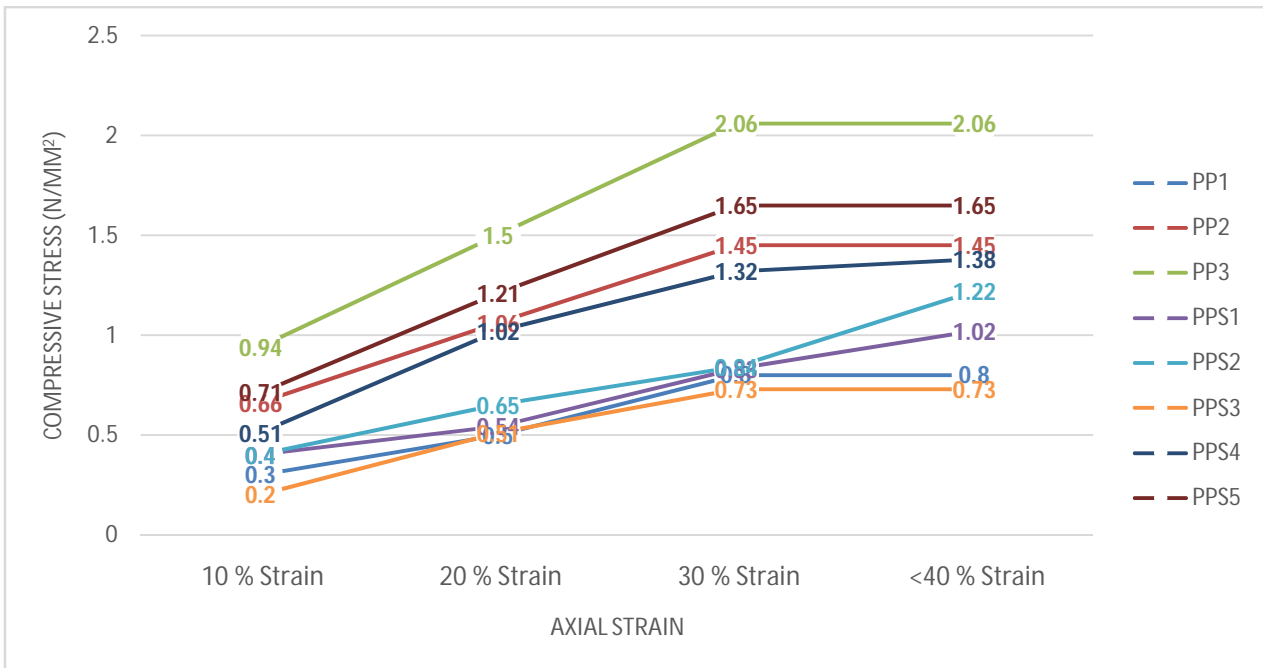
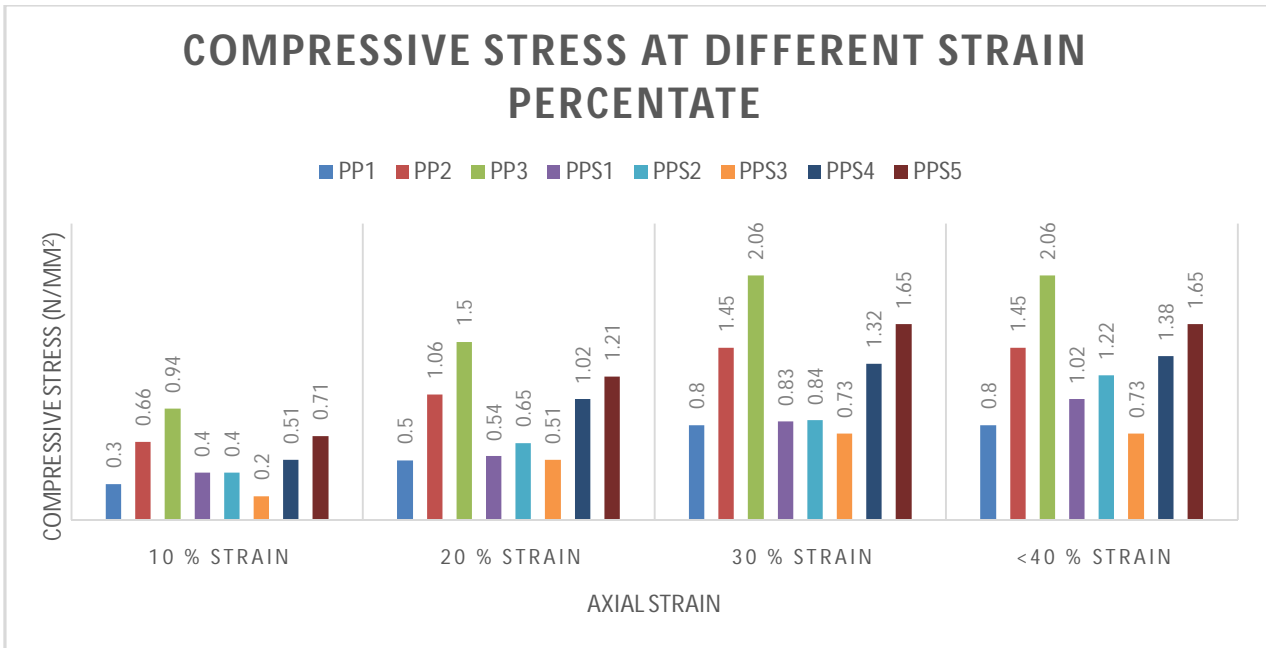


#### V. EXPERIMENTAL RESULTS AND DISCUSSIONS

On compression, papercrete fails slowly by getting squeezed like rubber. Hence in addition to its compressive strength, it is also important to measure its deformation character. Therefore compressive stress in papercrete at 10%, 20% and 30% **axial strain deformation** were tested in the Universal testing machine in order to measure the compressive strength and axial strain accurately.

Mix	Proportion	Mass (kg)	Compressive Stress (N/mm <sup>2</sup> )			
			@ 10% Strain	@ 20% Strain	@ 30% Strain	below 40% Strain
PP1	1:1:0	1.235	0.30	0.50	0.80	0.8
PP2	1:2:0	1.354	0.66	1.06	1.45	1.45
PP3	1:3:0	1.421	0.94	1.50	2.06	2.06
PPS1	1:1:0.5	1.408	0.40	0.54	0.83	1.02
PPS2	1:1:1	1.300	0.40	0.65	0.84	1.22
PPS3	1:1:1.5	1.562	0.20	0.51	0.73	0.73
PPS4	1:1.5:1	1.412	0.51	1.02	1.32	1.38
PPS5	1:2:1	1.451	0.71	1.21	1.65	1.65





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1. **Weight** of sample blocks are less than 1.6 kg which is 1/3 of the weight of the same size of the brick block. Adding sand increases the weight of papercrete.
2. From the first three samples, it is evident that increasing **cement content** profoundly affects the strength of papercrete. Sample PP3 shows the high initial strength of 0.93 N/mm<sup>2</sup> at 10% axial strain and 2.06 N/mm<sup>2</sup> at 30% axial strain.
3. Samples PP1, PPS1, PPS2 shows that **increasing sand** increases the strength of papercrete. But in PPS3, strength decreases which shows that when the ratio of weight of sand to weight paper increases above 1, strength will decrease. This might be because increasing the sand content decreases the presence of paper and cement which are the reason for strength of papercrete. Also, sand could interrupt the formation of bond between cellulose fibres. Hence ratio of paper to sand shall be 1 : 1 for better strength.
4. It is observed that samples with more **cement content** dries faster than other samples.
5. **Highest compressive stress** was found during 30% axial strain. PPS1 and PPS2 showed highest compressive stress in 40% axial strain.
6. If excess water is present during mixing of paper slurry then **shrinkage** of samples is observed after 14 days.
7. All samples readily **absorb water** immediately. However after drying there is no negligible change in the volume of the samples.
8. **Surface** of cured papercrete is rough, even greyish in colour. Cured papercrete absorbs water unless it is coated with water resistant material like stucco.

## VI. CONCLUSION

From the study, it is found that papercrete is economical, eco-friendly and it has high ductility, high insulation capacity, high energy absorption capacity and very low density. They could find its application in fill walls, partition works, highway structures, interior designing, partition works and other minor structures. It cannot be used as a high load bearing material in major structures because of its low compressive strength.

## REFERENCES

- [1] Selvaraj R, Priyanka R, Amirthavarshini M, Dr. Prabavathy S, "EVALUATION OF PAPERCRETE: An Innovative Building Material", in IJEART, Volume-1, Issue-6, December 2015
- [2] Fuller, B., Fafitis, A., and Santamaria, J., (2006). "Structural Properties of a New Material Made of Waste Paper". Building Integration Solutions: ASCE Publication, pp. 1-16
- [3] Mohammad Ismail, et al, (2009). "Fabrication of bricks from paper sludge and palm oil fuel ash". Asia Pacific Structural Engineering Concrete, Vol. 1, No.2
- [4] D.G.Nair, K.S.Jagadish, A.Fraaij, Reactive Pozzolanas from rice husk ash: An alternative to cement for rural housing, Cem.Concr.Res. 36 (2006) p 1062-1071
- [5] Anil Kumar, Devika Rani, "Performance of Concrete Using Paper Sludge Ash and Foundry Sand", in IJIRSET, Vol - 5, Special Issue - 9, May 2016
- [6] AGilan. V., (2012), "Energy saving lightweight bricks using waste newspaper", Quest for advancement in Civil Engineering
- [7] Fuller, B. J., Fafitis, A., & Santamaria, J. L. (2006). The paper alternative. Civil Engineering, 76(5), 72-77
- [8] Kelly Hart "Green Home Building" <http://www.greenhomebuilding.com/>
- [9] <http://www.thehindu.com/todays-paper/tp-miscellaneous/tp-others/want-that-waste-paper/article2765272.ece>
- [10] <https://en.wikipedia.org/wiki/Papercrete>