Experimental Study of Papercrete Concrete and Bricks

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Abstract: *The paper waste collecting from the countries all over the world reflects certain dangerous environmental problems. The present study focuses on utilizing the waste materials like wastepaper into cost effective building bricks and recycle the wastepaper without any serious affects to the surrounding. The study was evaluated regarding the durability, strength and structural properties of papercrete building bricks and concrete .The paper pulp were added into the concrete and bricks. The paper pulp was added by 10%, 20 and 30% into concrete and the bricks casted into various trail mixes. Then the results were compared with those of conventional bricks and concrete. The strength and durability of cement composites containing waste paper have been studied in detail and the optimum mix proportions have been obtained. This optimum mix was considered for casting the papercrete bricks and their properties have been studied. This paper concluded that the papercrete bricks are comparatively light weight, low cost and more flexible and they are most suitable for earthquake prone areas.*

Key Words: *Papercrete, Durability, Compressive Strength, Water absorption, Brick Masonry.*

1. INTRODUCTION:

Papercrete is a cementitious fibre compound includes waste paper and Portland cement. The above mentioned materials are blended with water to create a paper cement pulp, which has to be poured into a mould and made to dry and then to be used as a building material. The fibrous concrete is a combined mixture of paper, Portland cement and water. Earth is being used in this type of brick, instead of cement. The clay content in this earth should be more than 30%. In usual brick, if the clay content is very high during drying the brick may crack, but adding paper fiber to the earth mix which will strengthens the drying block. It gives flexibility and also it will cracking. Fidobe is like padobe, but it may contain other fibrous material.

In construction industry, building technology is moving towards a new aeon because of the usage of industrial wastes in the various forms of building material production. For instance, the use of industrial waste fibers, wood sawdust wastes, glass powder, and waste rubber in building material production has received diligent attention over the past few years. Recently waste papers were also used in the concrete. Papercrete is used in the form of bricks, blocks, etc.

2. TESTS AND PROPERTIES OF MATERIALS:

Table 1. PHYSICAL PROPERTIES OF CEMENT

S. No	Tests of cement	Results
1	Specific gravity	3.08
2	Standard consistency	36%
3	Initial setting time	120mins
4	Final setting time	5hours 30 mins
5	Fineness	2%

Table 2. PHYSICAL PROPERTIES OF FINE AGGREGATE

S. No	Tests of fine aggregate	Results
1	Sieve analysis	3.16
2	Water absorption	2.6%
3	Specific gravity	2.649

Table 3. PHYSICAL PROPERTIES OF COARSE AGGREGATE

S. No	Tests of coarse aggregate	Results
1	Sieve analysis	3.34
2	Water absorption	0.6%
3	Specific gravity	2.78

Table 4. PHYSICAL PROPERTIES OF WATER

S. No	Tests of water	Result
1	pH-value	6.9

3. PREPARATION OF PAPERPULP:

The papers, which were collected, cannot be used directly. It should be made into paper pulp before mixing with other ingredients. The following are the steps involved in the generation of pulp. First the pins, threads and other materials in the papers were removed and then the papers were teared into small pieces of papers. Then, a 200 litre water tank was taken. And 2/3 rd of it was filled with water. Then the small pieces of paper were immersed in the water tank. The paper pieces were immersed individually not in a bulky manner in order to make the pieces completely wet. Before immersing it into the water, the papers were weighed. The papers were kept in the tank for 2 to 3 days otherwise until the papers degrade into a paste like form. Then the paper was taken out from water and taken to the mixer machine to make it as a paper pulp.

Fig.1 Preparation of paper pulp

4. PAPERCRETE BRICK:

SPECIMEN SIZE:

- Size of the mould : 230 x 110 x 90 mm
- Size of the brick : 225 x 100 x 80 mm

Fig.2 Mixing

Fig.3 Moulding of bricks

DEMOULDING OF THE BRICKS:

The papercrete brick specimens were removed after 30 minutes from the mould.

Fig.4 Demoulding of bricks

Fig.5 Demoulded brick

DRYING OF THE BRICKS:

The casted papercrete bricks were sun dried for 14 days.

Fig.6 Drying of bricks

5. PAPERCRETE CONCRETE:

SPECIMEN SIZE: Size of the cube :150 x 150 x 150 mm

Fig.7 Mixing of the papercrete concre

CASTING OF SPECIMENS:

After mixing, the concrete should be placed in the mould within 30 minutes from the time water is added. Three moulds were casted for each combination.

Fig.8 Casting of cubes

DEMOULDING OF CUBES:

The cube specimens were kept for 24 hrs in the mould. After 24 hrs the cubes were removed from the mould for curing.

Fig.9 Demoulding cubes

Fig.10 Demoulded cubes

Curing was done for two different samples that are for 14 days and 28 days.

Fig.11 Curing of cubes

6. RESULTS AND DISCUSSION:

PAPERCRETE CONCRETE:

C - Controlled concrete specimen without paper pulp

SV_1 - Papercrete concrete cube with 10% of paper pulp in addition
SV_2 - Papercrete concrete cube with 20% of paper pulp in addition
SV_3 - Papercrete concrete cube with 30% of paper pulp in addition

Table 5. CS OF CUBES WITH & WITHOUT PAPER PULP AT 28 DAYS

S. No	Concrete specimen	Compressive Strength (CS) at 28 days (N/mm^2)
1	C_1	52.800
2	C_2	53.337
3	C_3	50.844
4	SV_{11}	28.533
5	SV_{12}	26.577
6	SV_{13}	35.244
7	SV_{21}	29.733
8	SV_{22}	23.022
9	SV_{23}	19.511
10	SV_{31}	22.622
11	SV_{32}	22.622
12	SV_{33}	20.755

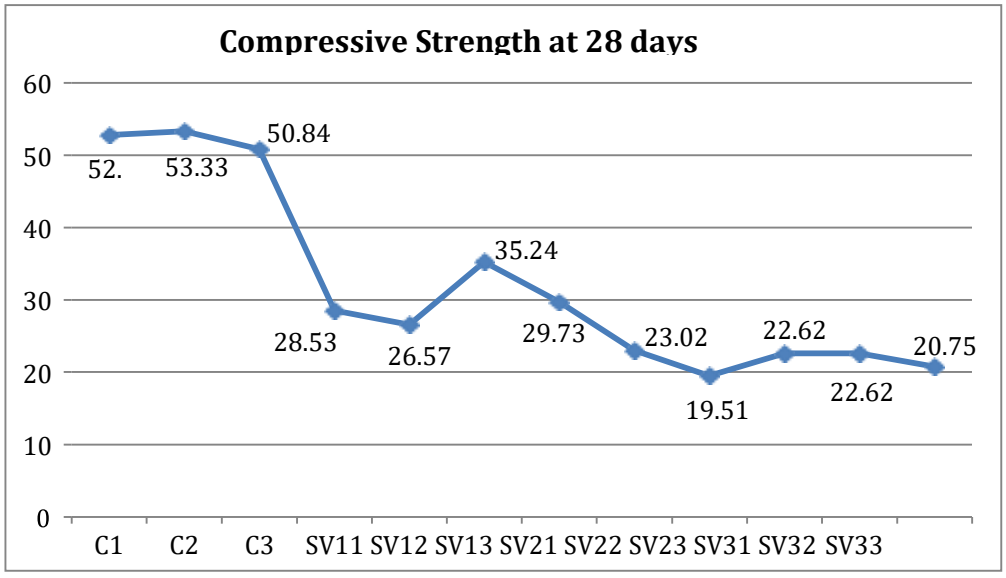

Fig.12 Compressive strength of cubes at 28 days

- Average compressive strength of controlled concrete without paper pulp = **52.340 N/mm^2**
- Average compressive strength of papercrete concrete cubes added with 10% paper pulp = **30.118 N/mm^2**
- Average compressive strength of papercrete concrete cubes added with 20% paper pulp = **24.088 N/mm^2**
- Average compressive strength of papercrete concrete cubes added with 30% paper pulp = **21.999 N/mm^2**
- The optimum compressive strength at 28 days is obtained for concrete with 10% of paper pulp added by weight of cement.

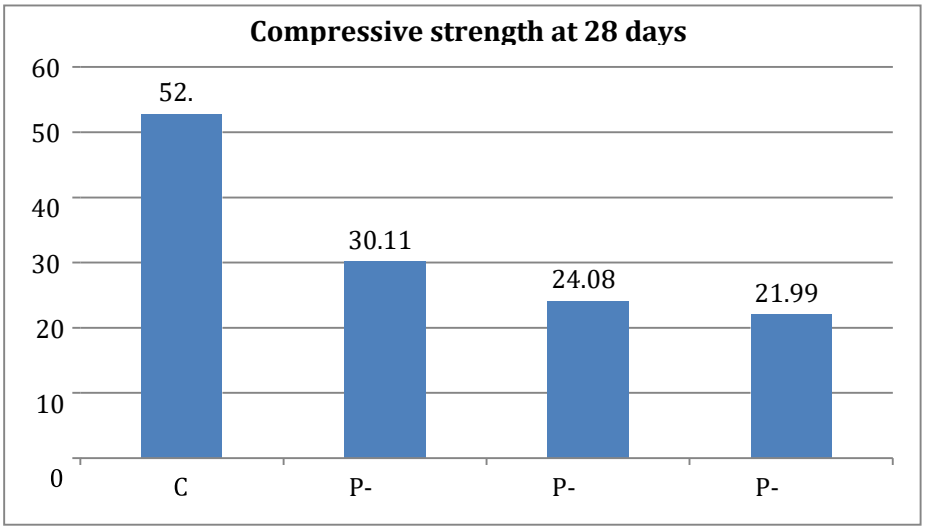

Fig.13 Average value of Compressive strength of cubes at 28 days

Table 6. CS OF CUBES WITH & WITHOUT PAPER PULP AT 14 DAYS

S. No	Concrete specimen	Compressive Strength (CS) at 14 days (N/mm^2)
1	C_1	42.933
2	C_2	40.177
3	C_3	34.844
4	SV_{11}	29.422
5	SV_{12}	18.655
6	SV_{13}	18.222
7	SV_{21}	24.355
8	SV_{22}	16.311
9	SV_{23}	22.088
10	SV_{31}	21.022
11	SV_{32}	21.288
12	SV_{33}	19.777

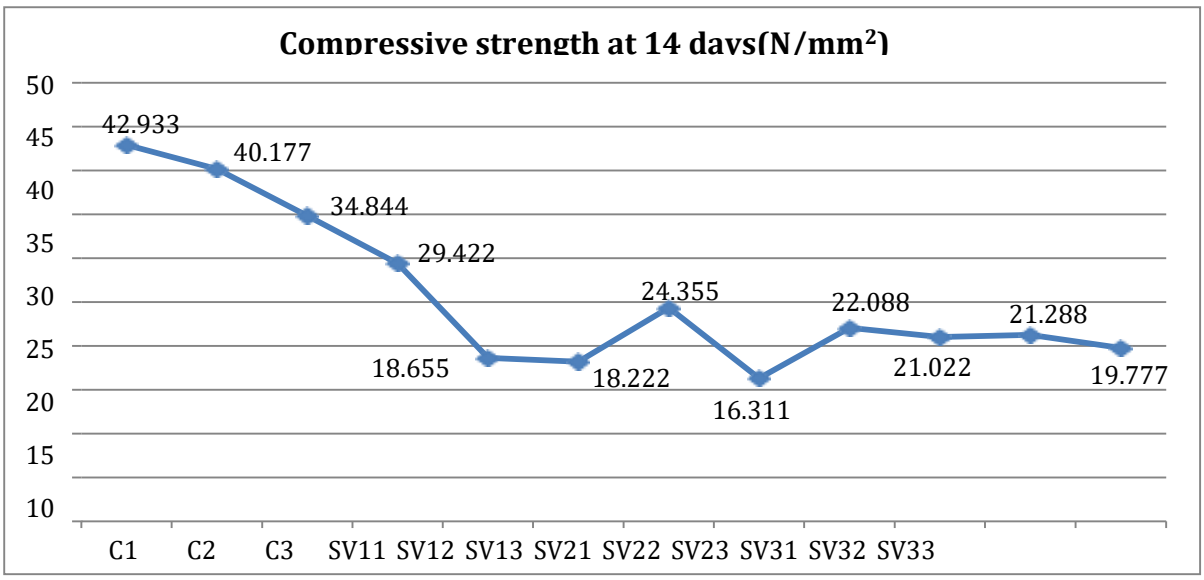

Fig.14 Compressive strength of cubes at 14 days

- Average compressive strength of controlled concrete without paper pulp = **39.118 N/mm^2**

- Average compressive strength of papercrete concrete cubes added with 10% paper pulp = **22.099 N/mm^2**
- Average compressive strength of papercrete concrete cubes added with 20% paper pulp = **20.918 N/mm^2**
- Average compressive strength of papercrete concrete cubes added with 30% paper pulp = **20.675 N/mm^2**
- The optimum compressive strength at 14 days is obtained for concrete with 10% of paper pulp added by weight of cement.

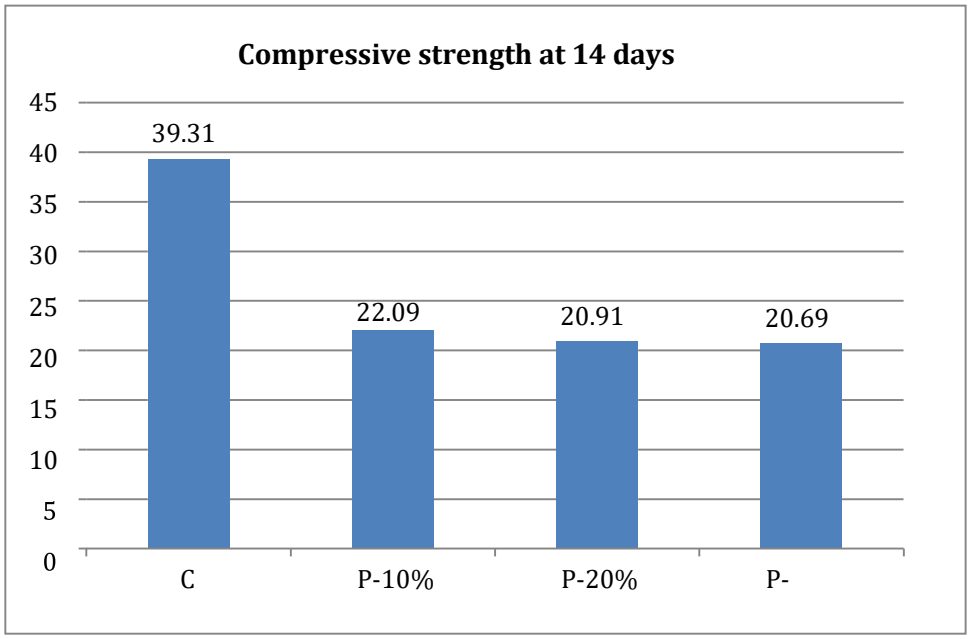

Fig.15 Average value of Compressive strength of cubes at 14 days

Table 7. WA OF CONCRETE CUBES WITH & WITHOUT PAPER PULP AT 28 DAYS

S.No	Concrete cubes	Water absorption (WA) in %
1	C_1	3.911
2	C_2	0.992
3	C_3	2.744
4	SV_{11}	4.217
5	SV_{12}	1.176
6	SV_{13}	6.790
7	SV_{21}	5.422
8	SV_{22}	5.488
9	SV_{23}	6.707
10	SV_{31}	8.485
11	SV_{32}	3.756
12	SV_{33}	6.667

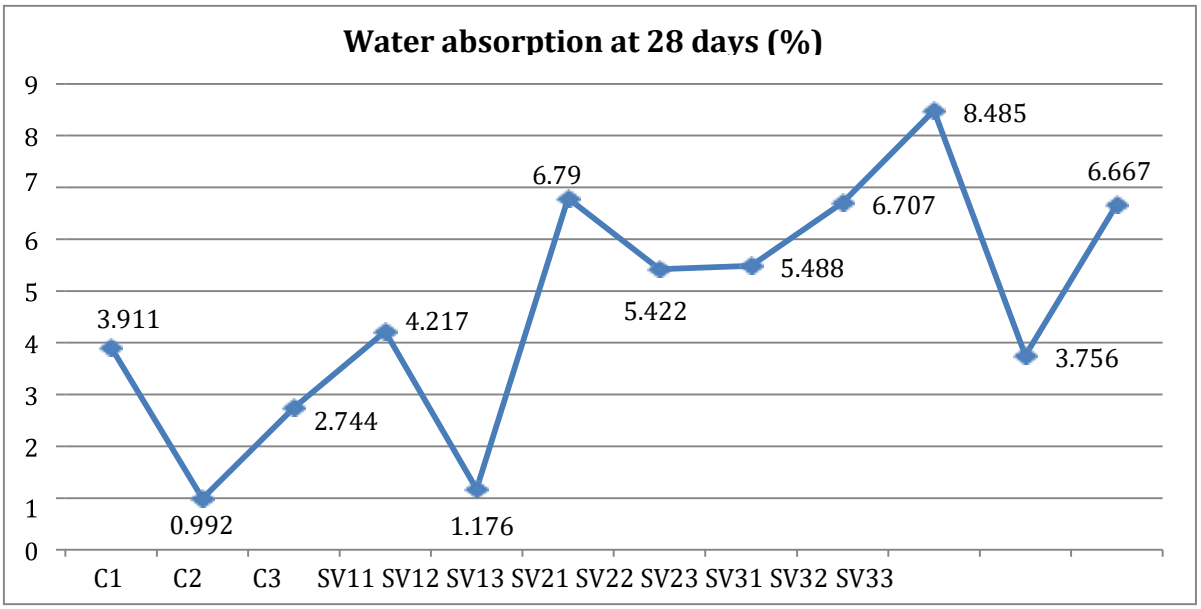

Fig.16 Water absorption for cubes at 28 days

- Average water absorption of controlled concrete without paper pulp = 2.549%
- Average water absorption of papercrete concrete cubes added with 10% paper pulp = **4.061%**
- Average water absorption of papercrete concrete cubes added with 20% paper pulp = **5.872%**
- Average water absorption of papercrete concrete cubes added with 30% paper pulp = **6.303%**
- The optimum value of water absorption at both 14 days and 28 days is for the concrete with 10% of paper pulp added by weight of cement.

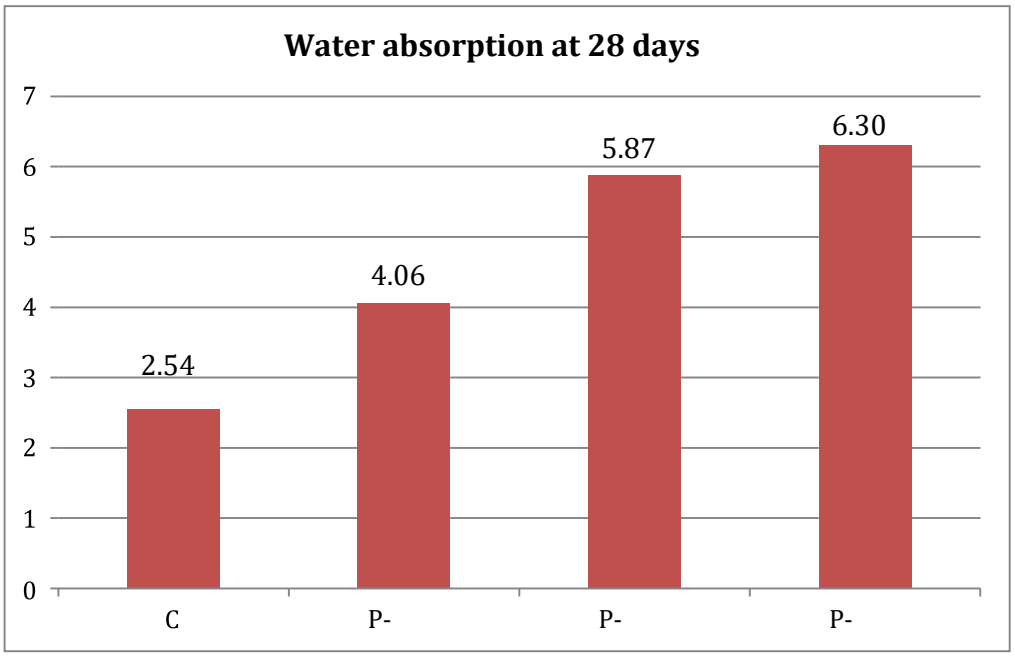

Fig.17 Water absorption test on cubes at 14 days

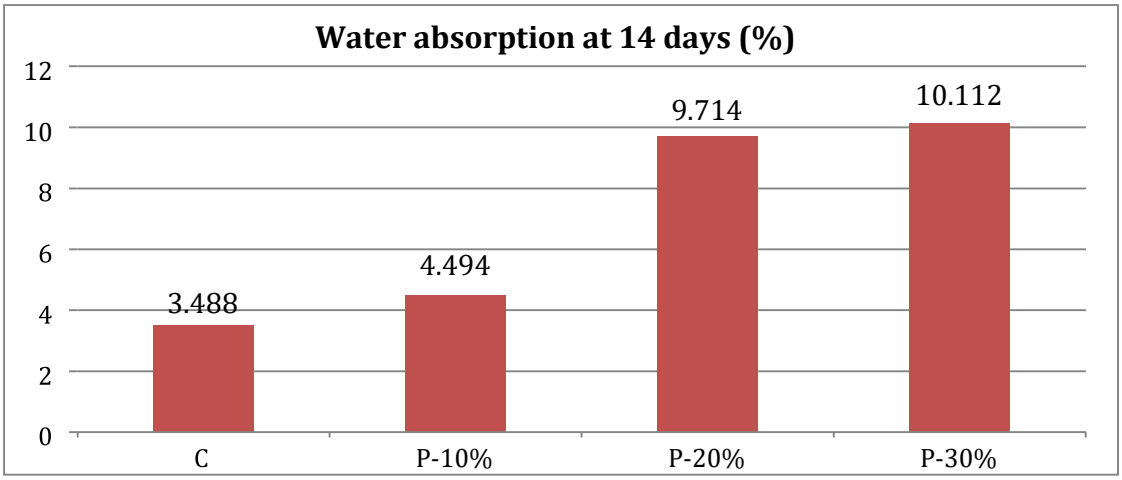

Fig.18 Average values of Water absorption test on cubes at 14 days

PAPERCRETE BRICKS:

Table 8. CS AFTER 14 DAYS SUN DRYING OF THE PAPERCRETE BRICKS

S.No	Trail mix ratio	Bricks specimens	Compressive Strength (CS) (N/mm^2)
1	1:1.5:3	A_1	2.755
2		A_2	2.267
3		A_3	2.533
4	1:1:2	B_1	7.511
5		B_2	3.289
6		B_3	4.933
7	1:2:4	C_1	1.60
8		C_2	2.711
9		C_3	2.578
10	1:3:6	D_1	1.733
11		D_2	1.688
12		D_3	1.822
13	1:1.83:3.43	E_1	3.511
14		E_2	3.244
15		E_3	3.200

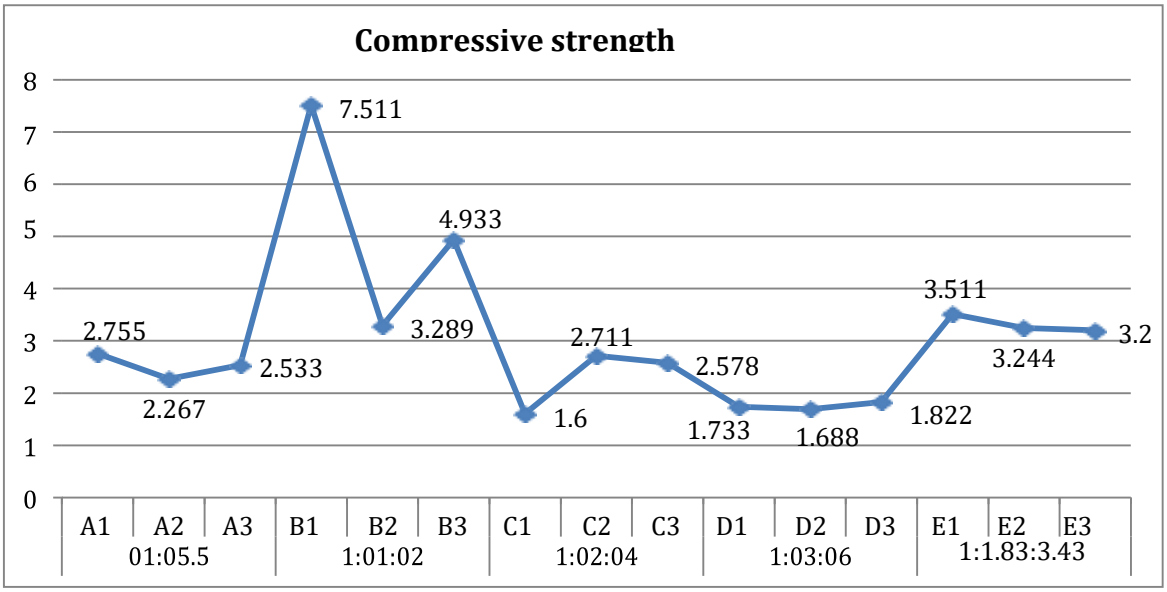

Fig.19 Compressive Strength of papercrete bricks

- Average compressive strength for papercrete brick of trail mix 1:1.5:3 is = **2.518N/mm^2**
- Average compressive strength for papercrete brick of of trail mix 1:1:2 is = 5.244 N/mm^2
- Average compressive strength for papercrete brick of of trail mix 1:2:4 is = **2.296N/mm^2**
- Average compressive strength for papercrete brick of of trail mix 1:3:6 is = **1.77 N/mm^2**
- Average compressive strength for papercrete brick of of trail mix 1:1.83:3.43 is = **3.318N/mm^2**
- The optimum compressive strength for papercrete bricks is obtained for the trail mix 1:1:2.

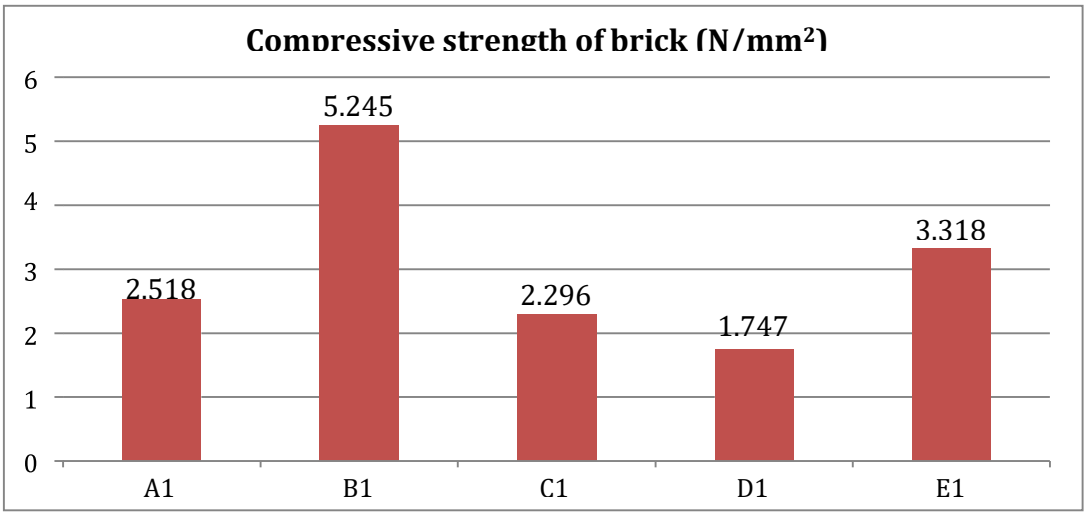

Fig.20 Average value of compressive strength of bricks

Table 9. WATER ABSORPTION ON PAPERCRETE BRICKS

S .No	Trail mix ratio	Water absorption (%)
1	1:1.5:3	17.787
2	1:1:2	18.450
3	1:2:4	16.809
4	1:3:6	12.161
5	1 : 1.83 : 3.43	15.755

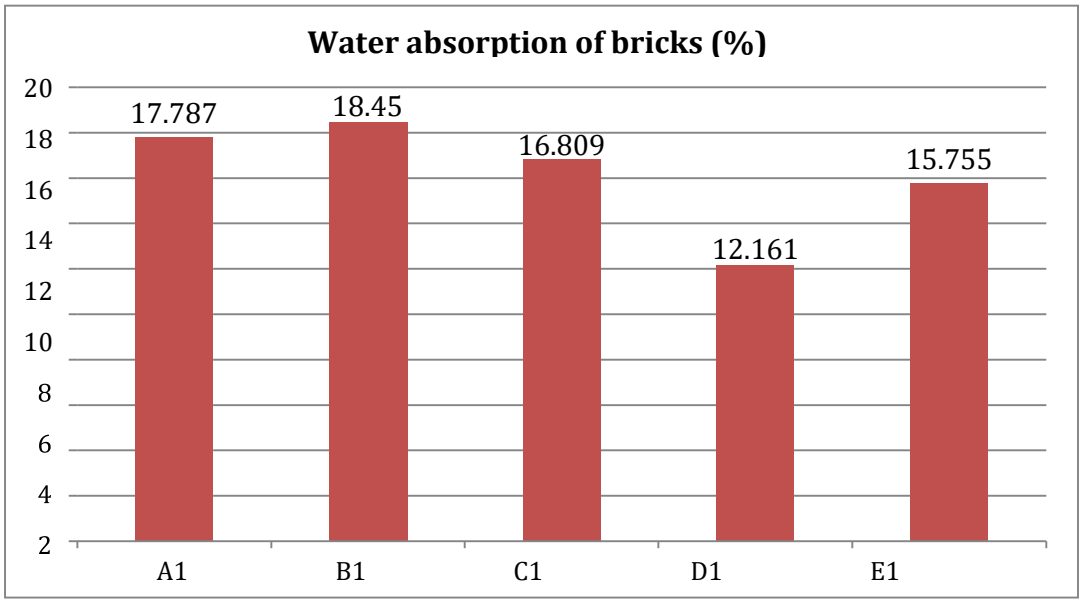

Fig 21. Average value of water absorption of bricks

7. CONCLUSION:

In this present work, experiments were carried out to analysis the characteristics and properties of papercrete additives like cement, sand, aggregate and paper pulp. The properties like compressive strength and percentage of water absorption with various proportions has been found out. The combined effect of additives with and without paper pulp on the papercrete, the mix has been optimized. Finally, the strength and water absorption on papercrete concrete cubes and also the compressive strength, water absorption, soundness, hardness, structure test, efflorescence test on papercrete bricks were studied and found out. The usage of 10% paper pulp added with concrete gives better result for compressive strength test and water absorption test, compared to the other two combinations of 20% and 30%. The compressive strength for papercrete bricks with different mixes of paper pulp has been studied and found that the trial mix with 1:1:2 gives the optimum value.

The water absorption for papercrete bricks with different mixes of paper pulp were studied and it is been found that the trial mix with 1:3:6 gives an optimum value. The analysis has showed that the water absorption value is minimum for the brick with more usage of paper pulp. The papercrete bricks perform better when tested for soundness, hardness, structure and efflorescence.

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