

DEVELOPMENT OF ECOFRIENDLY LIGHTWEIGHT BRICK USING WASTE PAPER

Veenu Rani¹, Er. Vikram², Er. Sunil Kumar³

¹M.Tech, JCDMCOE Sirsa, Haryana, India,

²Assistant professor & HOD, ³Assistant professor Civil Engineering department, JCDMCOE, Sirsa, Haryana, India

Abstract: Brick is one of the most common masonry units as a building material due to its properties. Many attempts have been made to incorporate wastes into the production of bricks, for examples, rubber, limestone dust, wood sawdust, processed waste tea, fly ash, polystyrene and sludge. Such waste is used in building material is a practical solution for pollution problem. Most manufactured bricks with different types of waste have shown positive effects on the properties of bricks. Paper is mixed with fly ash, granulated blast furnace slag and give different properties of brick. Many types of waste papers such as newspaper, paper mill waste, office paper mixed with cement and sand to make papercrete brick. By using these waste papers in building material usually give positive effects on the properties such as lightweight bricks with improved porosity and strength. Most of the paper mill discharges the waste paper in to the rivers or as land fill with no treatment. The discharging of waste paper in to water body which effects aquatic organisms, and human bodies. Mix of cement, sand and paper are used in different ratios 1:2:4, 1:2.5:5, 1:3:6 and water as per requirement. Bricks have been manufactured through hand molding and drying for 7 days. The samples were tested as per standard methods given in Indian standard codes. The brick are Parameters such as hardness, structure, shape and size, soundness, weight, mass density, compressive strength and water absorption are studied as per BIS (Bureau of Indian Standards) procedure.

Keyword: Waste paper, cement, sand, compressive strength test, water absorption test, hardness, shape and size test, structure test, efflorescence test, weight test etc.

I. INTRODUCTION

Day by day need of construction of improved infrastructure resulted in increased demand for building material. Being a basic building materials, Brick is a prime need of construction industry. Today, we want taller and more complex infrastructure to meet the standards of future. For country like ours where housing shortage is a major issue because people living in slums have to bear harsh strokes of weather and epidemic broke out due to lack of housing facility. To provide proper housing facility we need two things which is requisite building material and funds. To meet these requirements we have to find a midway because of developing country like India with lacking resources it is not easy to raise funds. Thus papercrete can serve as an alternative which can reduce the cost of construction and easily available. As the paper and pulp industries are among

the pollution causing industries. The waste from pollution paper and pulp industry can either find its way in water bodies or landfill for disposal, but both ways cause environment pollution. To make the disposal ecofriendly these waste paper can be used in formation of bricks.

II. LITERATURE REVIEW

K. Anandaraju et al. (2015) studied and they defined the term 'Papercrete' as a mix of concrete and waste paper. Their exists different types of Papercrete with varying percentage of waste paper. They had not given any thumb rule to inculcate the percentage of waste paper. They used trial mix proportions and determine a standard proportion of Papercrete which provides required physical properties. In their study, they carried out test for many physical properties to determine the best mix, some of these are density, mechanical properties, flame retarded and thermal properties. Shivangni Khandelwal et al. (2015) studied the trend of density with varying Papercrete proportions. The conclusion reported that with increase in percentage of waste paper, the density of resulting mix will decrease. In their research, they tested Papercrete for compressive strength and shear strength. The compressive strength ranged between 140-160 lb/square inch and the R-value of Papercrete was in between 2-3 per inch in the test of Papercrete block for shear strength. They also stressed over the inflammability of Papercret as it was not burnt in an open flame.

Issac I. Akinwumi et al. (2014) worked over two categories of Papercrete former was prepared by waste newspaper whereas waste office paper were used in the later. The specimen thus formed has the respective ratios of cement: sand : waste paper as 1:1:0.2, 1:1:0.4, 1:1:0.6 and 1:1:0 and were tested for density, compressive strength, water absorption and fire resistance. The conclusion drawn revealed that the specimen with waste paper had improved test result than the specimen without waste paper.

M. Rame Gowdal, K. Prasanna (2014) Studied the Some Properties of Papercrete Concrete and they carried various experimentations on the cubes made with different proportions of cement, sand, paper and fly ash for determination of some engineering and physical properties. They concluded from the results of these experiments that the conventional blocks prepared without paper were bulky and not properly moulded and finished to desired shape whereas the blocks with modified mix had light weight, could be easily moulded to any shape and the finished surface was also very good.

M.S.SUGANY (2012) Investigated on Papercrete bricks has

reported as Papercrete bricks are relatively light weight, and more flexible, these bricks are potentially an ideal material for earthquake prone areas. Papercrete bricks are good sound absorb.

Dunster Andrew et al. (2007) concluded from their research work that the addition of 20% calcined paper sludge with cement paste modified initial setting-time by accelerating the process in 60 minutes. The incorporation of 10% and 20% thermally activated paper-sludge leads to an increase in the drying shrinkage of mortar 2 and 2.5 times more than that shown by the ordinary Portland cement used as control.

III. PREPARATION OF SPECIMEN

A. Collection of materials: Waste paper is collected from the Jagdambe Paper Mill and college library which locates at SIRSA. The materials like cement and sand are collected from sirsa region.

B. Proportion of materials: To know the best proportion, we make total 60 bricks for 3 different proportions.

Sr.No	Mix Proportions	Mix Designation	Material Requirement per meter cube(kg)		
	C:S:P		Cement	Sand	Paper
1	01:02:04	A1	185	370	740
		A2	185	370	740
		A3	185	370	740
2	01:2.5:05	B1	152	381	762
		B2	152	381	762
		B3	152	381	762
3	01:03:06	C1	129.5	388.5	777
		C2	129.5	388.5	777
		C3	129.5	388.5	777

C. Mixing of paper pulp in other ingredients: All ingredients were in dry state except then paper pulp. Dry state mixing can be done with hand mixing method and pour water according to requirement. Now ingredients were mixed properly and paper pulp is mixed with other ingredients and poured into the mixed and mixed uniformly .

D. Placing: Form the test sample by placing material mix in the mould (Size 190 x 90 x 90 mm) in three layers of approximately equal volume.

E. Drying of bricks: To remove the moisture content drying process take place. Free circulation of air between the spaces of brick. In present investigation bricks are dried with natural dry method. Drying is done by natural method for 7 days.

F. Testing of bricks: The different type of tests are conducted on the modified brick such as hardness, weight, water absorption, soundness, Structure, shape and size, efflorescence, Mass density and compression strength test of brick

IV. EXPERIMENTAL STUDY

(i) Test on cement

The testing of the materials was an important study for the fitness of material at desirable location in the structural system. The calcined product is used as clinker in cement. In small quantity gypsum is added to the clinker and it is then grind into very fine powder, which turns into cement. Test

results on OPC 43 grade cement.

Table 1: Results of cement test

Properties	Results Obtained	Requirements of IS 8112 - 1989
Fineness (by sieve analysis)	4.7%	Less than 10%
Specific Surface Area (cm ² /g)	2,890	Not less than 2250
Specific gravity	3.14	3.15
Initial setting time (Minutes)	33	Not less than 30
Final setting time (Minutes)	492	Not more than 600
Compressive Strength (MPa)	28.5	23
At 3 days	40	33
At 7days	52.3	43
At 28 days		

(ii) Hardness test: This test is carried out on the brick to check the hardness of the brick.

Table 2: Result of Hardness Test

Sr No	Specification	MIX Proportion	Average result of hardness test
1	Conventional brick	-	No mark on surface of brick
			No mark on surface of brick
			No mark on surface of brick
2	Papercrete brick	1:02:04	No mark on surface of brick
			No mark on surface of brick
			No mark on surface of brick
3	Papercrete brick	1:2.5:5	No mark on surface of brick
			No mark on surface of brick
			No mark on surface of brick
4	Papercrete brick	1:03:06	No mark on surface of brick
			No mark on surface of brick

(iii) Weight test of papercrete brick: This test is conducted on the brick to check the weight of the brick. We can weigh the bricks in the dry state with weight machine. A dry brick put on the weigh machine and note down the weight of the all modified brick.

Table 3: Result of weight test of brick

Sr No	MIX Proportion	Result of weight test	Average result of weight test	INFERENCE
1	Conventional brick	3.5	3.5	Weight of papercrete brick is less than conventional brick
		3.5		
		3.5		
2	1:02:04	2.94	3	
		2.96		
		3.1		
3	1:2.5:5	2.55	2.65	
		2.6		
		2.8		
4	01:03:06	2.7	2.5	
		2.3		
		2.5		

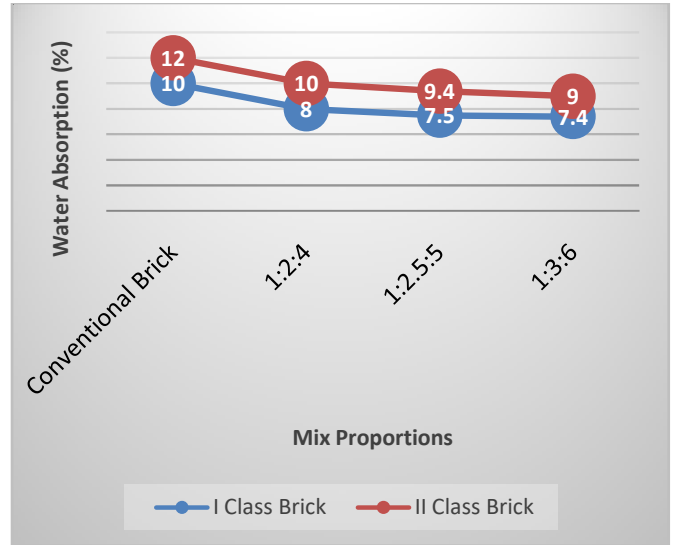


Fig2: Comparison of water absorption between conventional and modified papercrete brick

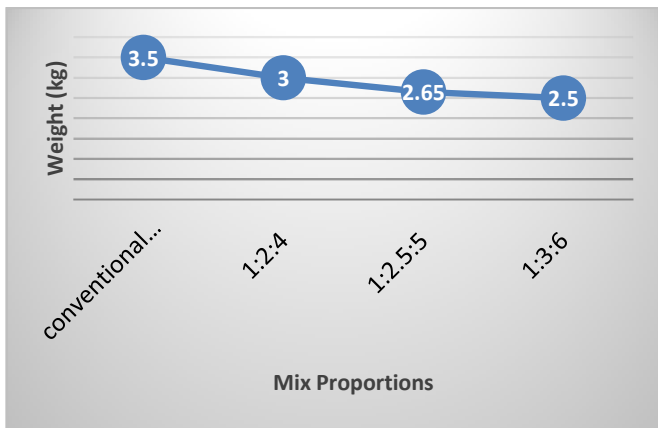


Fig 1: Compression of weight test of brick between conventional and papercrete brick

(iv) Water absorption test: This test is performed to determine the quantity of water which a brick can absorb in it.

Table 4(a): Result of water absorption for 1st class brick

Sr. No	Specificatio n	Mix proportio n	water absorption(%)	Inference
1	Convention al brick	-	10%	Water absorptio n is less in papercret e brick
2	Modified papercrete brick	1:02:04	8%	
		01:2.5:5	7.50%	
		1:03:06	7.40%	

Table 4(b): Result of water absorption for 2nd class brick

Sr. No	Specificatio n	Mix proportio n	water absorption(%)	Inference
1	Convention al brick	-	12%	Water absorptio n is less in papercret e brick
2	Modified papercrete brick	1:02:04	10%	
		01:2.5:5	9.40%	
		1:03:06	9.00%	

(v) Soundness test:

Table 5: Result Soundness Test

Conventional bricks	Modified papercrete bricks
A clear ringing sound produce	Good sound

(vi) Structure test: This test is carried out on brick to see the structure of the brick when the brick is broken.

Table 6: Structure Test

Conventional bricks	Modified papercrete bricks
When the brick are broken no any lumps and holes are there in it.	No lumps and holes are given in it.

(vii) Efflorescence test:

Table 7: Efflorescence Test

Sr No	Mix Proportion	Average result efflorescence test
1	Conventional brick	No perceptible deposit of salt is there in it
2	1:02:04	No perceptible deposit of salt is there in it
3	01:2.5:5	No perceptible deposit of salt is there in it

4	1:03:06	No perceptible deposit of salt is there in it
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(viii) Mass density: The weight of papercrete brick samples and volume of the samples was also measured.

Table 8: Result of mass density of brick

Sr. No	specification	MIX Proportion	Result of mass density test(g/cm ³)	Avg. Mass density(g/cc)
1	Conventional brick	-	2.22	2.12
			2.11	
			2.05	
1	Papercrete brick	1:02:04	0.793	0.8
			0.813	
			0.8	
2	Papercrete brick	01:2.5:5	0.62	0.61
			0.6	
			0.61	
3	Papercrete brick	01:03:06	0.42	0.433
			0.43	
			0.44	

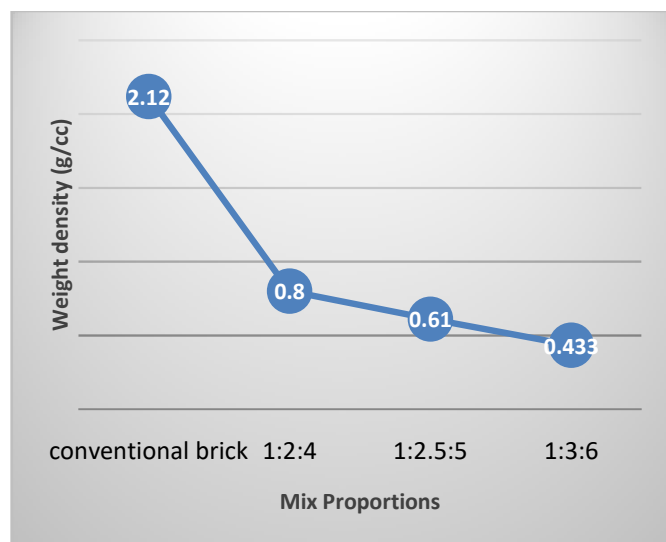


Fig 3: Compression of mass density between conventional and papercrete brick

(ix) Compressive strength test: The compressive strength of the brick can be found out by placing it in a compression testing machine.

Table 9: Compression Strength Test

Sr. No	Specification	MIX Proportion	Result of compressive strength test (Mpa)	Avg. compressive strength (Mpa)
1	Conventional brick	-	4.5	4.7
			4.6	
			4.9	
2	Papercrete brick	1:02:04	5.65	5.7
			5.7	
			5.55	
3	Papercrete brick	01:2.5:5	5.9	6.1
			6.1	
			6.3	
4	Papercrete brick	1:03:06	6.6	6.5
			6.4	
			6.55	

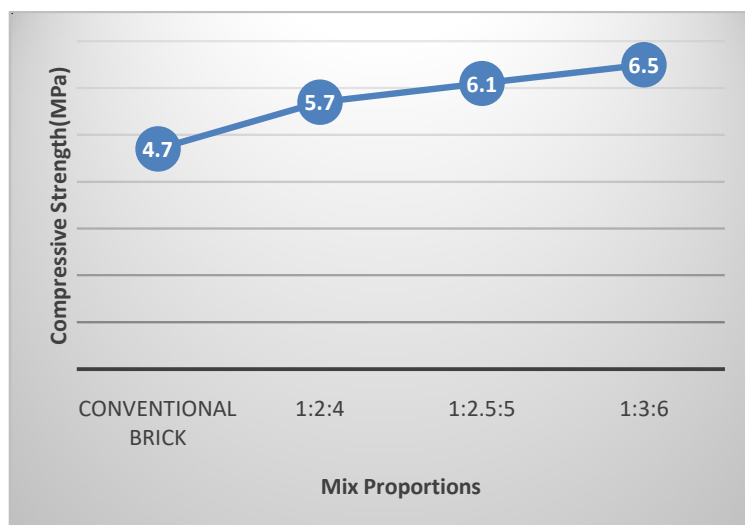


Fig 4: Compression of compressive strength test between conventional and papercrete brick

V. CONCLUSION

Present investigation shows the effect of waste paper which is generated by peoples and paper mills which improves the engineering properties of bricks as well as on environment. Waste paper is mixed with cement, sand and water in different proportion like 1:2:4, 1:2.5:5 and 1:3:6 (C:S:P) and investigate the properties of papercrete brick.

- Brick can be produced from waste paper when added with cement, sand and water in different proportions.
- Using hardness test the characteristics of papercrete brick in comparison to the conventional bricks are studied in this investigation. It was observed that modified papercrete brick with different proportions

has improved its hardness which so that all proportions of paper, cement and sand produce a hard brick.

- It was concluded from experiments when we increase the paper in mix then weight of brick is reduced. Weight of conventional brick according to indian standard is 3.2 kg. When paper is added with different proportion then weight of brick is reduced when paper proportion increase.
- Water absorption for 1st class conventional brick is 10% and for 2nd class it is 12% but in papercrete brick water absorption is less as compared to conventional brick. When we increase the paper in cement the water absorption is reduce . From experiment we observed that water absorption is less in 1:3:6 (c:s:p) because paper is in large amount as compared to other mix for 1st class as well as for 2nd class .
- The soundness of the modified papercrete bricks was good and clear sound is produce.
- It was observed that no lumps and holes are given when the brick are broken. So that the structure of the modified waste papercrete bricks are good like as a conventional bricks.
- Papercrete bricks can be moulded easily in any shape.
- It was observed that no perceptible deposit of salt is produced on modified papercretebrick when the efflorescence test is conducted.
- It was observed in the above test that the fibrous concrete bricks did not burn with an open flame. They fumed like charcoal. When these bricks burned for several hours it would be reduced to ashes.
- The compressive strength of the papercrete brick increased with increase the paper in it. The compressive strength of 1:3:6 is 6.5 Mpa which is increased as compare to conventional brick which is 4.7 Mpa.
- Addition of more paper in mix proportion due to which weight loss is also higher. Papercrete bricks are light in weight which can handled by any person. Mass density of papercrete brick is less as compared to conventional brick.
- Papercrete brick has crushing failure while conventional brick have brittle failure.

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