iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: Issue **Issue:** ssue-1 **Month of publication:** October 2014

DOI:

www.ijraset.com

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International Journal for Research in Applied Science & Engineering Technology(IJRASET)

Innovative Brick Material

M.Scinduja[1], S.Nathiya[1], C.V.Shudesamithronn[1], M. Harshavarthana Balaji[1],T.Sarathivelan[1], S. Jaya pradeep[2]

[1]*Assistant Professor,* [2]*U .G Student ,*
Department of Civil Engineering, Knowledge Institute of Technology, Kakkapalayam, Salem – 637 504, Tamil Nadu, India

I. INTRODUCTION

Since the large demand has been placed on building material industry especially in the last decade owing to the increasing population which causes a chronic shortage of building materials, the civil engineers have been challenged to convert the industrial wastes to useful building and construction materials. This experimental study which investigates the potential use of waste paper for producing a low-cost and light weight composite brick as a building material. These alternative bricks were made with papercrete.

II. OBJECTIVES

The major Objective of the project is replacing the costly and scarce conventional building bricks by an innovative and alternative building bricks, which satisfies the following characteristics,

- Required
- Cost effective
- Environmental friendly
- Less weight
- Inflammable
- Less water absorption
- Easily available

The main objective of this project is optimize the papercrete mix with desirable properties, which satisfies the above mentioned needs.

III. MATERIALS USED

In this project waste materials were utilized to produce building bricks. The following materials were used in this investigation

CEMENT: Cement is one of the binding materials in this project. Cement is the important building material in today's construction world 53 grade Ordinary Portland Cement (OPC) conforming to IS: 8112-cement used.

Properties of cement

Description of test	**Test results obtained**	**Requirements of IS: 8112 1989**
Initial setting time	65 minutes	Min. 30minutes
Final setting time	270 minutes	Max. 600minutes
Fineness	412.92 m^2/kg	Min. 225 m^2/kg

Fig . Cement

GROUND GRANULATED BLAST FURNACE SLAG (GGBS): Ground-granulated blast-furnace slag (GGBS) is a byproduct which is obtained during the manufacturing process of pig iron in blast furnace. This process produces a glassy, homogeneous, non-crystalline material that has cementitious properties. GGBS powder was collected from Quality polytech, Mangalore. It is off white in colour by

appearance. The specific gravity is 3.09. The GGBS powder is shown in fig

Fig GGBS

QUARRY DUST: Getting good Quarry dust free from organic impurities and salts is very difficult in now a day. While adding the Quarry dust to the mix. And the Quarry dust should be in uniform size i.e., all the Quarry dust particles should be fine. The Quarry Dust obtained from local resource was used in concrete to cast test bricks. The physical and chemical properties of Quarry Dust obtained by testing the samples as per Indian Standards are listed in table

Properties of Quarry dust

Property	**Quarry dust**	**Natural sand**
Specific gravity	2.54-2.60	2.60
Bulk relative density (kg/m^3)	1720-1810	1460
Absorption (%)	1.20-1.50	Nil
Moisture content (%)	Nil	1.50
Fine particles less than 0.075mm (%)	12-15	06
Sieve analysis	Zone II	Zone II

Fig Quarry Dust

Paper: Paper is principally wood cellulose. Cellulose is natural polymer. And Fig.3.4.1 shows the links of cellulose bonds. The cellulose chain bristles with polar-OH groups. These groups form hydrogen bonds with -OH group on adjacent chains, bundling, and the chain together. The chains also pack regularly in places to form hard, stable crystalline region that give the bundled chains even more stability and strength.

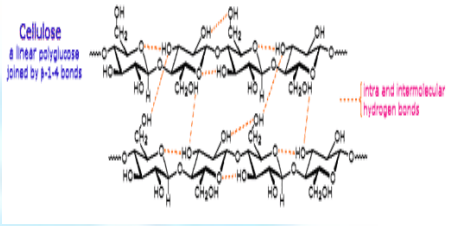


Fig. Cellulose hydrogen bonds

Fig.shows the network of cellulose fibers and smaller offshoots from the fibers called fibrils. In this, fibers and fibrils network forms a matrix, which becomes coated with Portland cement. When these networks of fibers and fibrils dry, they intertwine and cling together with the power of hydrogen bond. Coating this fiber with Portland cement creates a cement matrix, which encases the fibers for extra strength. Of course paper has more in it than cellulose. Raw cellulose has comparatively rough texture. Clay, rice husk ash is added to make the cellulose very smooth.

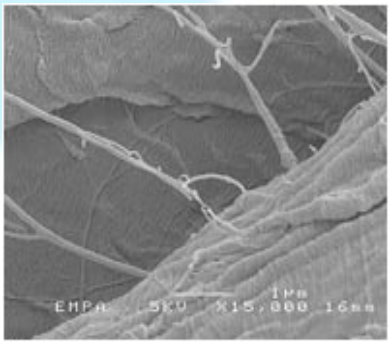


Fig. Microscopic view of cellulose

While adding more sand or glass to the mix results in a denser, stronger, more flame retardant material, but adds weight and reduces R- value

Heavy mixes with added sand, glass etc., increases strength and resistance to abrasion, but also reduces flexibility somewhat, adds weight and may reduce R-value. So the trick is finding the best mix for the application. This mould was collected from ACC brick suppliers in the size of 230mm length, 110mm wide and 80mm deep. The papers, which were collected, cannot be used directly. It should be made into paper pulp before mixing with other ingredients.

Water: Water is an important ingredient of papercrete as it actively participates in the chemical reaction with cement. It should be free from organic matter and the pH value should be between 6 to 7.

Fig Materials Used

WATER PROOFING COMPOUND FOR CONCRETE AND PLASTER

Fig. Water Proofing Compound

Dr. Fixit Pidiproof LW+ is specially formulated integral liquid waterproofing compound composed of surface active plasticizing agents, polymers & additives. It is used as an additive for cement concrete, mortar & plasters. It makes concrete cohesive and prevents segregation.

Features & Benefits:

- Corrosion resistant - Makes concrete more cohesive, hence protects steel better against corrosion.
- Compatibility – Being a liquid, easily dispersible & compatible with concrete/mortar mixes.
- Permeability – It reduces the permeability of water into concrete.
- Strength –. The setting time and compressive strength of the concrete remains within the specification limits
- Shrinkage – Reduces shrinkage crack development in plaster & concrete.
- Workability – Improves workability of freshly mixed cement concrete.
- Durability – Increases durability by improving waterproofing of concrete.

MODIFIER CUM BONDING COMPOUND: Dr. Fixit Super Latex is a highly potent and versatile SBR based liquid for high performance applications in waterproofing and repairs.

Features & Benefits:

- Excellent Coverage - 70-80 sq.ft per kg/ in 2 coats
- Less material wastage- material does not fall baclV rebound
- Highly cost effective due to better coverage & lesser wastage
- High Bonding Strength
- Prevents leakages & dampness
- Enhances strength & provides durability

Fig. Modifier cum Bonding Compound

IV. MATERIAL CHARACTERISTICS BRICKS

The bricks are obtained by moulding clay in a rectangular block of uniform size and then by drying and burning the blocks. As the bricks are of uniform size, they can be properly arranged and further, as they are in lightweight, no lifting appliance is required for them. The common brick is one of the oldest building materials and it is extensively used at present as a leading material in construction. In India, process of brick making has not changed since many centuries except some minor refinements. There has been hardly any effort in our country to improve the brick-making process for enhancing the quality of bricks.

A brick is generally subjected to the following tests to find out its suitability for the construction work.

ABSORPTION

A brick is taken and it is weighed dry. It is then immersed in water for a period of 24 hours. It is weighed again and the difference in weight indicates the amount of water absorbed by the brick. It should not, in any case, exceed 20% of weight of dry brick.

CRUSHING STRENGTH

The crushing strength of a brick is found out by placing it in a compression-testing machine. It is compressed till it breaks, as per BIS: 1077-1957, the minimum crushing strength of brick is 3.50 N/mm^2 .The brick with crushing strength of 7-14 N/mm^2 are graded as 'A' and those having above 14 N/mm^2 is graded as 'AA'.

HARDNESS

In this test, a scratch is made on the brick surface with the help of finger nail. If no impression is left on the surface, the brick is treated to be sufficiently hard.

PRESENCE OF SOLUBLE SALTS

The soluble salts, if presents in brick will cause efflorescence on the surface of bricks. For finding out the presence of soluble salts in brick, it is immersed in water for 24 hours. It is then taken out and allowed to dry sunshade. The absence of grey or white deposits on its surface indicates absence of soluble salts.

If the white deposit covers about 10% surface, the efflorescence is said to be slight and it is considered as moderate, when the white deposit cover about 50% surface. If grey or white deposits are found on more than 50% of surface, the efflorescence becomes heavy and it is treated as serious, when such deposits are converted into powdery mass.

SHAPE AND SIZE

In this test, a brick is closely inspected. It should be of standard size and its shape should be truly rectangular with sharp edges. For this purpose, 20 bricks of standard size (190mm X 90mm X 90mm) are selected at random and they are stacked length wise, along the width and along the height.

For a good quality brick, the results should be within the following permissible limits:Length: 3680mm to 3920mm

Width : 1740mm to 1860mm

Height: 1740mm to 1860 mm

SOUNDNESS

In this test, two bricks are taken and they are struck each other. The bricks should not break and a clear ringing sound should be produced.

STRUCTURE

A brick is broken and its structure is examined. It should be homogeneous, compact and free from defects such as holes, lumps etc.

PAPERCRETE

Papercrete is a tricky term. The name seems to imply a mix of paper and concrete, hence papercrete. But more accurately, only the Portland cement part of concrete is used in the mix-if used at all. Arguably, it could have been called "paperment" papercrete may be mixed in many ways. Different types of paperecrete contain 50-80% of

waste paper. Up to now, there are no hard and fast rule, but recommended standard will undoubtedly be established in future.

The basic constituents are waste nearly any kind of paper, board, glossy magazine stock, advertising brochure, junk mail or just about any other types of "mixed grade" paper is acceptable. some types of paper work better than other, but all types of works, newsprint are the best. Water proofed paper and card board, such as butcher paper, beer cartons ect., are hard to break down in water. Catalogs, magazines and other publication are fine in and of themselves, but some have a stringy, rubbery, sticky spine, which is also water resistance. Breaking down this kind of material in the mixing process can't be done very well. Small fragments and strings of these materials are almost always in the final mix.

When using papercrete containing the unwanted material in a finish, such as stucco or plastering ,the unwanted fragment some time shown up on the surface, but this is not the serious problem.

In the optimization work the admixture like conplast WP90, Dr.Fixt 105 water proof and polymer like nitrobond SBR are as the water repellent agents

Papercrete's additives can be,

- Cement
- GGBS
- Quarry dust
- Paper

Papercrete is having the following derivatives,

- Fibrous concrete
- Padobe
- Fidobe

FIBROUS CONCRETE

Fibrous concrete is a mixture of paper, Portland cement, water. There are on harmful by-products or excessive energy use in the production of papercrete. While it can be argued that the Portland cement is not environmental friendly, it is not used in all types of papercrete, and when it represents a fairly small percentage of cured material by volume. Once of the most advantageous properties of papercrete is the way paper fibers hold the Portland cement or perhaps the way Portland cement adheres to paper fibers when the water added to the Portland cement drains from the mix, it come out almost clear.

There is no messy eco-unfriendly cement sediment left on the ground, running in to waterways ect., papercrete can be produced using solar energy. The only power needed is for mixing and pumping water. Its R-value is in 2.0-3.0 per inch. Since walls in a one or two storey house will be12-16 inch thick, the long energy saving of building with papercrete will be a bonanza for the home owner and the environmental.

PADOBE

Padobe has on Portland cement. it is admix paper, water, earth with clay. Here clay is binding material instead of using the cement, earth is used in this types of brick. This earth should have clay content more than 30%. With regular brick, if clay content is too high the brick may crack while drying, but adding paper fiber to the earth mix strengthens the drying block and give some flexibility helps to prevent cracking.

FIDOBE

Fidobe is like padobe,but it may content other fibrous materials

ECO – FRIENDLY

Phenomenal growth in the construction industry depends upon the deflectable resources of the country.

Production of building materials lead to irreversible environmental impacts. Using eco-friendly materials is the best way to build an eco-friendly building. Eco-friendly, describes a product that has been designed to do the least possible damage to the environment.

V. EXPERIMENTAL PROCEDURE

MANUFACTURING OF BRICKS

There was no clear past details about the project. And there is no hard procedure for casting the bricks. So the procedure that is given below was followed by our own. And the equipments which were used in this project are for our convenience only.

MOULD PREPARATION

After collecting all the materials, a mould was prepared. A typical mould is shown in the below figure.

Fig. Mould

This mould was non-water absorbing in the size of 230mm length, 110mm wide and 80mm deep. The shorter sides of the mould are slightly projecting to serve as handle. And joints were made without any hole or gap to avoid leakage.

5.3 PULP GENERATION

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.
- 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 figure shows the papers were being immersed in the water tank.

Fig. Immersed Paper

Fig. Paper Pulp

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.

The pulp generating process was tedious and time consumption. For lab purpose only these procedures were followed. While going for mass production, the Tow mixers were recommended to reduce the cost. The Tow mixers have sharp blades and it can operate mechanically or electrically. Table : PAPERCRETE MIX RATIO

Trial Mix							
S.No.	Identification Mark	Ingredients (%)					
		Cement	Paper	Quarry dust	GGBS % of weight of cement	Dr Fixit 101	Dr Fixit 302 Super Latex
1.	P1	1	2	4	20%	20%	50ml
2.	P2	1	2	4	30%	20%	50ml
3.	P3	1	2	4	50%	20%	50ml

MIXING: After all the ingredients were ready, the mixing was done. In this project, mixing was done manually. The mixing process of fibrous concrete bricks and padobe bricks are different, and that processes are given below. The exact mix proportion was not known. So, trial proportions were used in this project.

Fig. Mixing

PAPERCRETE MIX RATIO

- Weigh batching was carried out in this project .So the materials were measured in Kilograms. According to the particular proportion the materials were measured first and kept separately .This was done just before the mixing starts.
- Glows, shoes, masks were wearied before the mixing.
- Then, the non–water absorbing and smooth surface was made for mixing.
- Water was sprinkled over that surface. And this mixing place was selected nearer to the casting place.
- First the ingredients like Quarry dust/ GGBS were placed.
- Then cement was placed over that ingredient.
- These two were dry mixed with shovel thoroughly still uniform color was formed.
- Then the paper pulp, which was in a wet condition, was placed separately. Paper pulp should contain less water. So the excess water was squeezed out.
- The already mixed cement and GGBS/Quarry dust was placed over the paper pulp and mixed thoroughly to get the uniform mix.
- There was no further water was added separately unless it was essential. The water in the pulp was utilized for mixing the papercrete.
- After the mix, the required amount of papercrete was taken to the site and the remaining amount was kept free from evaporation.

Special Issue-1, October 2014
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology(IJRASET)

CASTING OF BRICKS

Fig. Manufacturing of Brick

After mixing, it should be placed in the mould within 30 minutes. So, two moulds were used at the time to make the process very fast. The bricks were moulded manually by hand and on the table. The following are the steps involved in molding,

- The mould was over a table
- The lump of mix was taken and it was placed in the mould.
- The extra or surplus mix was removed either by wooden strike or the metal strike or frame with wire.
- The casted papercrete bricks dried for 14 days.

VI. RESULT & DISCUSSION

After casting the bricks, they were analyzed for using as a brick. Various tests were carried out to check the properties of the bricks. And the results of the test were analyzed with the existing and standard results. The following tests were carried out to check the strength of the brick.

WEIGHT

Table : Weight of Papercrete Bricks

S.No.	Identification Mark	% 0f GGBS	Dry Weight (kg.)
1.	P1	20	1.773
2.	P2	30	1.842
3.	P3	50	1.862

Fig. Weight of bricks-(P1,P2,P3)

The ordinary conventional bricks weight varies from 3 to 3.5 Kg but the fibrous concrete and padobe bricks weight varies from 1 to 2 Kg. The maximum weight is less than 2Kg only. In this above proportion GGBS is

Special Issue-1, October 2014
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology(IJRASET)

having 1/3 rdof the conventional brick weight only. Sand based bricks are having weight 2/3 rd of conventional brick weight only. So this bricks are light weight and it will also reduce total cost of construction due to the reduction in dead load.

WATER ABSORBTION TEST : Dry the specimen in ventilated oven at a temperature of 105°C to 115°C till it attains substantially constant mass. Cool the specimen to room temperature and obtain its weight (M_1) specimen too warm to touch shall not be used for this purpose. Immerse completely dried specimen in clean water at a temperature of 27+2°C for 24 hours. Remove the specimen and swipe out any traces of water with damp cloth and weigh the specimen after it has been removed from water (M_2)

TABLE WATER ABSORPTION TEST OF PAPECRETE BRICKS

Trail Mix	**Water Absorption result in % (24 hours)**		
	20%	**30%**	**50%**
	40.11%	33.85%	23.74%

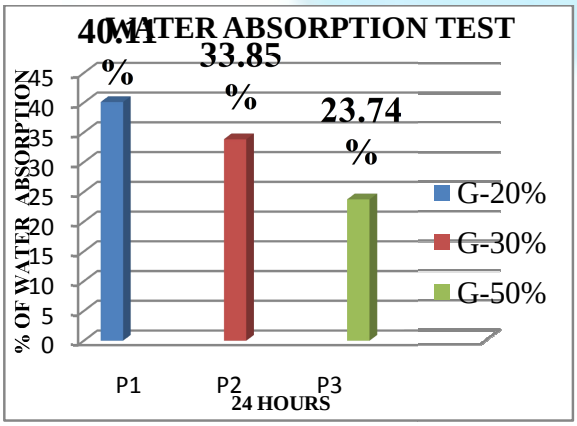


Fig. Water absorption test for Trial Mix

COMPRESSION TEST

Fig. Compression test

The test was carried out by a Compression Testing Machine. This test was carried out on 14th day from the date of casting papercrete brick. While testing the papercrete brick great care must be taken, because papercrete brick never failed catastrophically, it just compressed like squeezing rubber. So load was applied up to half compression.

When papercrete brick failed at the higher load, the structure was not fully collapsed. Only the outer faces cracked and peeled out. The papercrete brick are having elastic behavior and less brittleness.

The following steps were followed for compression testing.

- First the irregularities in the surface were removed.
- The brick was placed centrally on the bottom plate of the universal testing machine.
- Then the upper plate of the universal testing machine was lowered down up to the brick was hold tightly without any movement.
- Then the load was applied axially at a uniform rate
- This load was applied till the half of the brick.
- Three bricks from same proportion were tested every time.

- And the compressive strength was calculated by this formula,

Compression strength= (load/surface area)

Fig. Brick after testing

TABLE COMPRESSIVE STRENGTH OF PAPECRETE BRICKS

Trial Mix	Best Compressive Strength in N/mm^2 (14 Days)		
	20%	30%	50%
	5.9	7.5	8.7

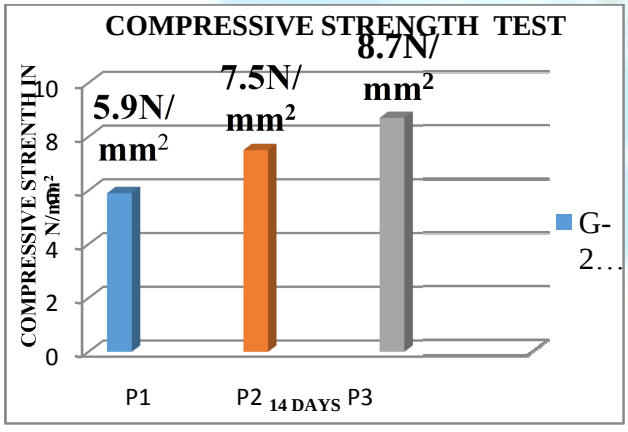


Fig. Compression test for Trial Mix

HARDNESS TEST

In this test, a scratch was made on brick surfaces. This test was carried out for all the three proportions of brick. While the scratch was made with the help of finger nail on the bricks, very light impression was left on the fibrous concrete brick surface. So this test results that fibrous concrete bricks are sufficiently hard.

PRESENCE OF SOLUBLE SALTS

The soluble salts, if presents in bricks will cause efflorescence on the surface of bricks. For finding out the presence of soluble salts in a brick, this test was carried out. In this test fibrous concrete brick were immersed in water for 24 hours. Then the bricks were taken out and allowed to dry in shade. And there was no any grey or white deposit on the bricks surface. It results that the bricks are free from soluble salts.

SOUNDNESS TEST

In this test two bricks from same proportion were taken and they were struck with each other. The bricks were not broken and a clear ringing sound was produced. So the bricks are good.

STRUCTURE TEST

In this test, the bricks were broken and the structures of that bricks were examined, whether they were free from any defects such as holes, lumps, etc.

Fig. Inner structure of fibrous concrete brick

In this test fibrous concrete brick were cut into equal parts. The fibrous concrete brick piece structure was homogenous, compact, and free from defects and this brick pieces look like a cake piece.

NAILING

Fig. Nail in the brick

Fibrous concrete bricks are less hard when compare to conventional bricks. So this test was carried out to find out whether bricks hold the nail or not. A nail was hammered in the brick and a screw is also screwed in the brick. In this two (Fig.6.8), fibrous concrete brick did not hold nails any better than dry wall, but screws worked well and hold a considerable weight. So, the screws are the anchors of choice for fibrous concrete bricks.

CUTTING AND GLUE

Fig. Brick pieces

In site lot of bricks are wasted while cutting only. The labors could not able to cut the bricks exactly what they need. But, fibrous concrete bricks can be cut into exactly two pieces (Fig. 6.9.1) by using conventional saw blades. So, we can get any shape and size of fibrous concrete brick.

Fig.6.9.2 Joined brick pieces

Many cut bricks are wasted in now a day. But the two fibrous concrete brick pieces can be hold together by putting a medium amount of glue on the bottom piece. This will not come apart (Fig.6.9.2). This would seem to indicate that papercrete could be used in application calling for quick assembly by cutting the pieces to size in advance and letting the user simply glue them together.

PLUMBING AND ELECTRICAL

Fig. Hole in the brick

Fig.Channel in the brick

Installing plumbing lines requires cutting holes and channels in papercrete. It was very easy in fibrous concrete bricks. Electrical runs were cut with a circular saw or chain saw. To make holes for outlets, horizontals and vertical slits was cut with a circular saw. Then unwanted pieces were removed with a screwdriver.

Outlet boxes can be angle screwed directly into the papercrete. Home fires start, where the wiring enters the outlet boxes. So, nonflammable mortar should be put behind the outlet boxes for safety. Once the electrical wiring and outlets are installed and then tested, the channels for the electrical runs are for filled with papercrete.

FIRE

Fig. Fire test

A brick which is used for construction should not flammable in open flame, so this test was carried out for the bricks. This test was carried out only for fibrous concrete bricks not for padobe brick. Because padobe brick was already heated in kiln at high temperature so, it won't burn. The following are the steps involved in this test,

- First, the brick was wiped with cloths and all the foreign matters were removed.
- Then the flammable sticks were fired. After that, the bricks were held on the flame for five minutes.
- After five minutes fixing was stopped and the bricks were observed.

From the above test, it was observed that the fibrous concrete bricks did not burn with an open flame. They smoldered like charcoal. But these brick would be reduced to ashes after burning several hours. If the interior plaster and exterior stucco is provided on the fibrous concrete bricks, the bricks won't burn. The only weak point is inside the block, near electrical outlets, switches and other places where wires gives through walls, into boxes etc.,. Properly wired places never cause fire. If we apply the plaster without any hole or leakage on the bricks, it won't burn or smolder inside. Because there will be lack of oxygen for burning.

VII. CONCLUSIONS

From the above experimental studies we can conclude that,

- Papercrete bricks are suitable for non-load bearing walls only.
- The weight of this brick is $1/3^{rd}$ to $2/5^{th}$ lesser than conventional clay brick.
- These bricks are not suitable for water logging and external walls. It can be used in inner partition walls.
- Due to less weight of these bricks, the total dead load of the building will be reduced.
- Since, these bricks are relatively light weight and more flexible, these bricks are potentially ideal material for earthquake prone areas.
- Papercrete brick does not expand or contract, so sheets of glass or glass block can be embedded in and trimmed with papercrete.

- The papercrete bricks are good sound absorbent, hence paper is used in these bricks. So, these bricks can be used in auditoriums.
- Since, the waste materials are used, it will reduce the landfills and pollution.
- Using the papercrete brick in a building, total cost will be reduced from 20% to 50%.

REFERENCES

[1] B J Fuller, AFafitis and J L Santamaria. (May 2006) "The Paper Alternative", ASCE Civil Engineering Vol. 75 No.5 pp. 72-77.

[2] J Pera and J Ambroise (2005) "Properties of Calcined Paper Sludge", Construction and Building MaterialsV0l.21, No.5 pp 405-413.

[3] Lex Terry, (2006)"Papercrete Construction"- Building Environment and Thermal Envelope Council (BETEC) Symposium was held on 13th to 16th October 2006 at the Northen New mexico Community College in EIRito.

[4] M O'Farrell and S Wild. (2006) "A New Concrete incorporating Watepaper Sludge Ash (WSA)" Cement & Concrete CompositesVol.17, No.3 pp 149-158. ,

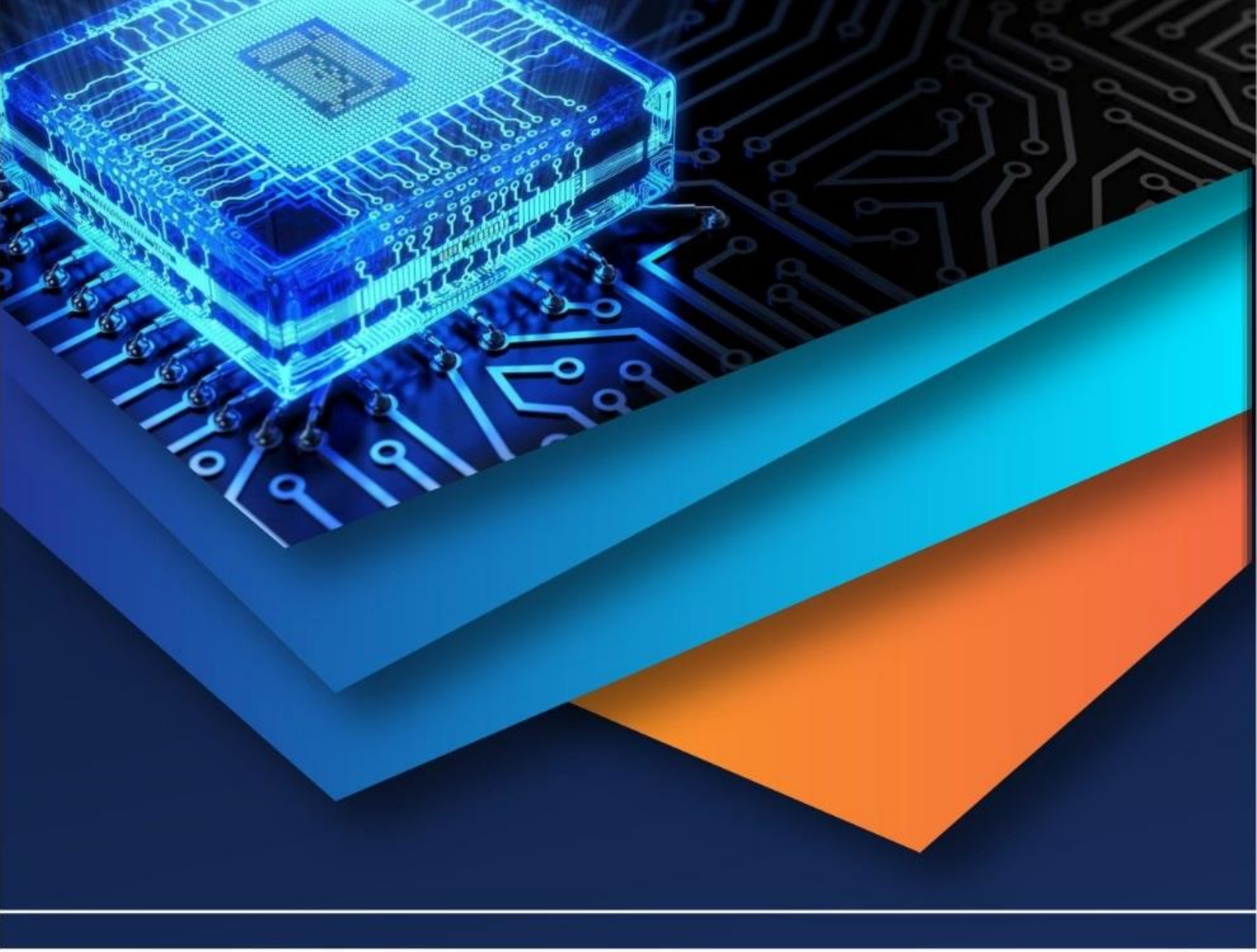
[5] ParvizSoroushian et al (February 1994) "Durability and Moisture Sensitivity of Recycled Wastepaper – Fiber – Cement Composites", Cement & Concrete Composites Vol. 16 No.2 pp 115-128.

[6] R.Garcia et al (2008) "Pozzolanic Properties of Paper Sludge Waste", Construction and Building Materials, Vol.22 No.7, July 2008, pp 1484 – 1490.

[7] Tarun R Naik et al (January 2004) "Concrete Containing Pulp and Paper Mill Residuals", Proceedings of International Conference on Fibre Composites, High Performance Concretes and Smart Materials, Chennai, pp 515-525.

[8] IS: 3495-1992 (Part 1 to 4), "Methods of Tests for Burnt Clay Bricks", Bureau of Indian Standards, Third Revision, New Delhi.

[9] IS: 383-1970, "Specification for coarse and fine aggregates from natural sources for concrete", Bureau of Indian Standards. New Delhi.



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