

ENHANCING THE STRENGTH OF BRICKS USING WASTE MATERIALS

Submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in civil engineering

By

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INSTITUTE OF SCIENCE AND TECHNOLOGY (DEEMED TO BE UNIVERSITY)

Accredited with Grade "A" by NAAC

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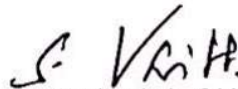
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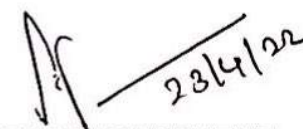
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BONAFIDE CERTIFICATE

This is to certify that this project report is the bonafide work of **M. DEEPA (38200007)** and **C.P SUHI CHELSEA (38200033)** who carried out the project "**ENHANCING THE STRENGTH OF BRICKS USING WASTE MATERIALS**" under our supervision from December 2021 to April 2022.


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DECLARATION

We M.Deepa (38200007) and C.P.Suhi Chelsea (38200033) hereby declare that the project report entitled " **ENHANCING THE STRENGTH OF BRICKS USING WASTE MATERIALS**" done by us under the guidance of Mrs. **VANITHA M.E.**, is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Civil Engineering.

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ABSTRACT

Concrete blocks have been a significant material in the construction industry because of their high compressive strength. However, the growth in urbanization has led to severe problems such as a shortage of construction material, and an increase in waste. Blocks made from waste have a wide transition compared to conventional blocks. In recent times, eco-friendly bricks are accepted among the citizens, because of their environmental impact. To reduce the cost of concrete blocks, and to protect the environment, many countries have implemented eco-friendly bricks. Nowadays, bricks can be made from different waste materials such as organic sludge, paper sludge, agriculture waste, and much more. Considering the current scenario, discarded PPE kits, and masks are increasing therefore, this study will emphasize the reduction in biomedical wastes by using them to make the concrete blocks and examine the tests on the block, also comparing the results with the conventional block.

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List of Abbreviations and Symbols:

Symbols	Abbreviations
%	Percentage
°C	Degree Celsius
POFA	Palm Oil Fuel Ash
N	Newton
mm ²	Millimeter square
RHA	Rice Husk Ash
CP	Ceramic Powder
MD	Marble Dust
kN	Kilonewton
s	Seconds
Kg	Kilogram
cm	Centimeter

CHAPTER 1 - INTRODUCTION

1.1 General

From one side of the planet to the other, it was assessed that almost 500-550 million tons of paper squander were delivered consistently. Indeed, the all-around created nations have just 45% as their reusing pace of paper waste. 50% is being unloaded unkindly. The need for materials or expanded interest in development materials utilized this situation. The term called 'papercrete' developed subsequently. However it was found around 80-90 years back, just now it is being placed into the fields of study. Without a doubt, exceptionally less measure of study has been done in this region.

Residual solids from pulp and paper mills, also known as sludge, are composed primarily of cellulose fibers, moisture, and paper-making fillers. The dry paper sludge mainly contains silica and calcium oxide, aluminum oxide and magnesium. Therefore, the demand for concrete and the necessary raw materials is very high. Very often there is a shortage of these materials. To overcome these problems alternative materials should be incorporated in the construction industry such as paper waste, biomass, shredded mask. This will eventually reduce the problems occurring to the environment due to the construction industry.

However, about 3 million masks per day are being thrown into the waste. Mask can be recycled and used for making brick and concrete as this will act as a good water-absorbing agent. It has been referenced all the time as a viable apparatus against ecological dangers. The test is to create the filtration covers with higher productivity to diminish the entrance rate in the nastiest circumstances. To accomplish this idea, information about the components of the infiltration of the sprayers through the veils at various compelling natural circumstances is important.

CHAPTER 2 - LITERATURE STUDY AND METHODOLOGY

2.1 Literature review

To begin with, a wide range of publications, articles, and videos are referred to and analyzed before starting the project to have an overview of the process. Considering the current scenario, this can be used as a construction material for minimum load-carrying structures.

Reuse of natural waste material for making lightweight bricks, Mohammad shahid Arshad, DR.P.Y.Pawade, June 2014,

This study suggests that the natural wastes can be reused to form lightweight bricks which give high absorbing ability and good compressive strength because of the fibrous nature of the brick. The experiment has been taken out with different materials such as orange peels, coconut fiber, however, paper sludge is a constant material in both the experiment. The amount of orange peel and paper sludge gives a lower compressive strength than paper sludge and coconut fiber.

Team using plastic waste, foundry dust to form bricks for the construction industry, Marie Donlon on June 23, 2020,

This article has acknowledged the usage of plastic in reforming brick. The primary aim is to reduce plastic waste around the world, by including foundry waste and sand mixed with recovered plastic wastes. The composition of foundry waste is 80% and sand and 20% plastic waste make the brick much stronger because of the benefits of foundry waste.

Utilization of waste plastic manufacturing of bricks, Ms.RambhaThakur Assistant Professor,

Described the use of plastic such as crisp bags and polythene bags. The condition that has been implemented is A solar grill oven or an electric

oven with a heating capacity of 100 to 500o C. It seems to be more Durable and economically efficient than conventional brick.

Discarded PPE suits, masks repurposed into eco-friendly bricks by Namita Devidayal, Jul 9, 2021,

These bricks are called P-blocks 2.0, which are majorly used in Gujarat, India to construct public toilets. These bricks are fire-resistant, and durable which is also cost-effective. By producing these bricks, enormous wastes are recycled, along with PPE wastes, paper industry wastes are shredded in a massive amount.

Reuse of cotton and recycled paper mill waste as building material by Rajput et al. (2012),

This study suggests that the compressive strength on the block will be around 21-30Mpa. The proportion of each material is given as 1%-5%cotton mill waste + 85%-89% paper mill waste + 10% Portland cement

and this will be carried out in certain conditions, Thermally stable up to a temperature of 280 °C.

Manufacturing of eco-friendly brick: a critical review by S.V. GiriBabu, Dr.S. Krishaniah,JNTUA 2018.

The waste utilized here was different extent of wheat husk and coal. The extent was taken between 10% to 15%. The interaction was by terminating the block in temperature of 900°C considered on collecting of square made of various degrees of wheat husk and coal autonomously as added substance close by the components of soil earth. Mud blocks are prepared by mixing 5%,10%, 15%, 20%, 30%, 40% and half wt. of coal and wheat husk only with basic trimmings Thus, soil block containing 5%-15% wt. in which wheat husk and coal added to it that shows incredible results are seen as inside quite far.

Development of Bricks from waste material: A review paper

The waste materials used here is sugar base, oil palm fruit, pineapple Eave etc. The condition used according to the type of waste like baked and non baked conditions. The are compressive strength of the bricks were fulfilled the minimum requirement and fiber inclusion was more benefit. The brick can be used in the minimum load buildings.

Manufacturing of sustainable clay bricks: Utilization of waste sugarcane bagasse and rice husk ashes by Kazmi 2016

The waste materials is 5% sugarcane bagasse and rice husk + 5% to 15% clay. The brick is prepared in the condition under industrial brick kiln plant. The brick is done with different proportions. The brick has lower compressive strength than normal compressive brick. These bricks can bear minimum amount of load, so it can'tbe used for normal construction.

Improved fired clay brick compressive strength by recycling wastes of blacksmiths'workshops 18th august 2021, Eman Shaqour

This studio has recognized the utilization of steel rather than squander materials and concrete. It is arranged utilizing steel filings added substance with various proportions (0%, 1%, 2%, 3%, and 4%). It is done under the condition is consuming the example. It is seen that on expanding the steel filings proportions by the blend's weight, the model's compressive strength additionally increments.

Produce Eco-Friendly Bricks. International Journal of Innovative Technology and Exploring Engineering, Dhanlaxmi etal.,2019

This journal has used different materials for making the brick. The materials used here is Paint Remnants, Cement Robs sand and Fly Ash. The condition used to make bricks is Dehydration of bricks at lower temperature. The amount of material used gives increased compressive strength Sustainable and Eco Friendly.

BRICKS: AN EXCELLENT BUILDING MATERIAL FOR RECYCLING WASTES – A REVIEW, Aeslina Abdul Kadir, Abbas Mohajerani, July 4 2021

The waste material utilized here is Recycling of various squanders into terminated dirt blocks. The condition that has been finished by Firing with temperature of 900 to 1000° C. The blocks appear to emphatically affect the properties of terminated dirt blocks, for example, further developed porosity when we contrast and regular block.

Utilization of Blended Waste Materials in Bricks, Muhammad Ekhlaur Rahman, 29 January 2018

The waste material used here is Cement, palm oil fuel ash(POFA), fly ash, and river sand. The experiment was carried out by wrapped with plastic and kept in the lab for either 28 days or 90 days. Overall, the density of blended POFA and fly ash-based bricks were significantly higher than that of the conventional bricks.

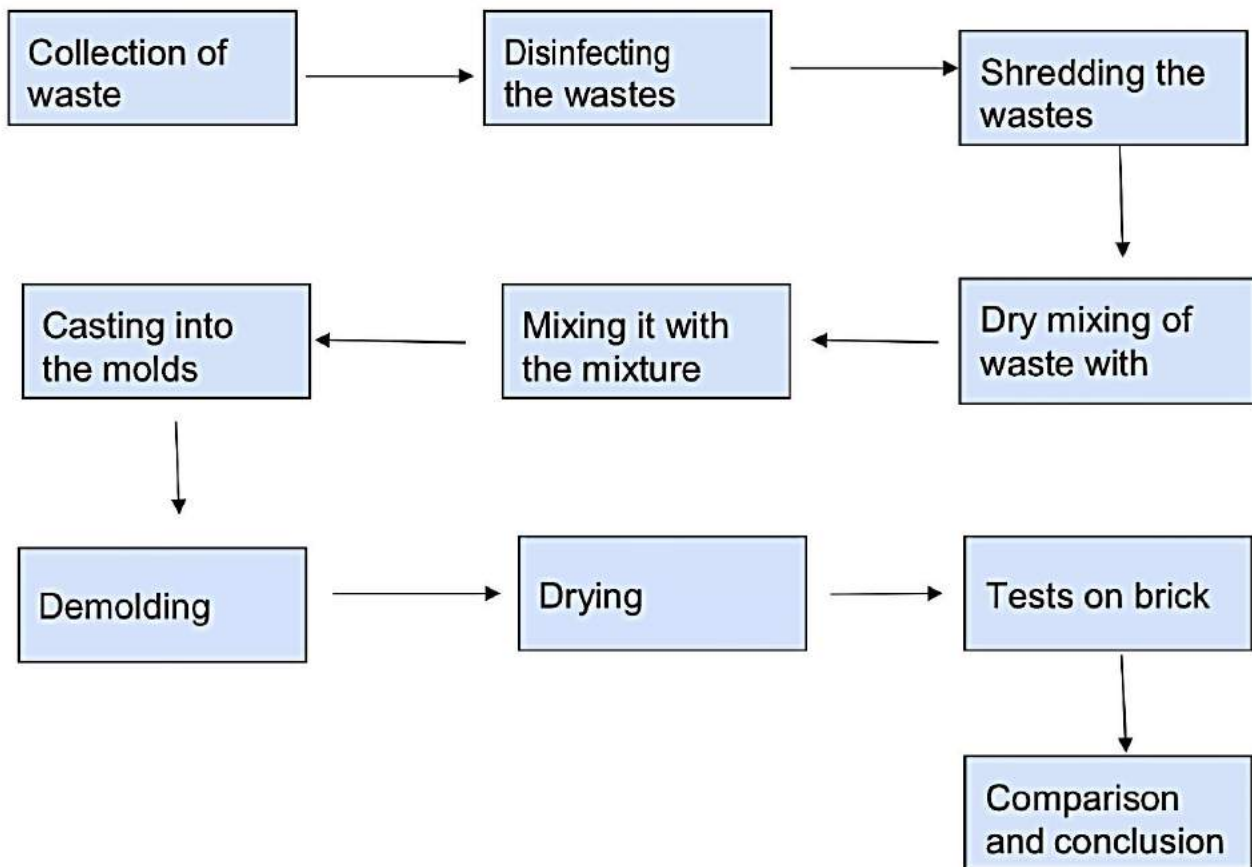
Study of Plastic dust brick , Ronak Shah, Himanshu Garg, ParthGandhi,(2017),

Produced using squander plastic the concentrate on introduced above helps in lessening the plastic garbage removal issue as it uses the waste even in its best structure and converts that futile material into a valuable development material. Temperature is for the most part past 220 degrees Celsius. Also, the water retention limit is higher in contrast with ordinary block with a lower weight. This end result from plastic block was tried for the compressive strength and it was viewed that as the compressive strength of 6.66N/mm². It is higher than regular blocks which have strength between 3-5N/mm².

Ecofriendly Brick construction using waste materials, Salman shah, vidya Jose (2018)

"this study centers around the examination of properties of earth block" created by the incomplete supplanting of the earth with risk husk ash(rha), ceramic powder (cp),and marble dust(md) in differing rates of 0% ,4%,8% and 12%. Blocks created by halfway substitution of dirt with the, fired powder and marble dust fulfilled compressive strength of 12.23N/mm².

2.2 Methodology



CHAPTER 3 - OBJECTIVES AND SCOPE

3.1 Objective

- ı To utilize waste materials.
- ı To determine the strength of block made from waste materials.
- ı To reduce the cost of concrete blocks.

3.2 Scope

- ı To create awareness regarding reducing the usage of waste materials.
- ı To protect nature by recycling the waste products.
- ı To make blocks that are cost-effective and efficient for the environment.
- ı Conserve the environment by disposing of the waste.

CHAPTER 4 - EXPERIMENTAL TESTING

4.1 Material used

4.1.1 M Sand

M – sand is good for construction as it creates durable, workable, and high-strength concrete. M sand is a type of counterfeit sand, produced by squashing enormous hard stones, principally shakes or rock, into fine particles, which is then washed and finely evaluated. It is generally utilized as a substitute for stream sand for development purposes, for the most part in the creation of cement and mortar blend. M sand is added in very few amounts and varies in a different mix. It is mixed with cement and used as a binding agent.



Experiments in M sand	Result
Silt content	8%
Water absorption	3.76%
Specific gravity	2.7

4.1.2 Cement

Concrete and cement are a key piece of the present world and essential to the worldwide development area. Concrete is a pressure driven cover (it solidifies when water is added) and blended in with sand and totals it structures concrete. Concrete blended in with water, lime and sand structures mortar. A concrete is a binding substance utilized for development that sets, solidifies, and sticks to different materials to bind them together. Ordinary Portland cement of grade 53 cement has been used after investigating the strength of cement at 28 days.



Experiments in cement	Result
Specific gravity	2.79
Consistency	32%

4.1.3 Paper Sludge

It is porous and fibrous, and it holds the moisture content by providing a barrier for moisture to move towards the surface. It is permeable and stringy, and it holds the dampness content by giving a hindrance to dampness to move towards the surface. As it holds dampness, it is relied upon to be fireproof.



Chemical Constituent	Paper sludge
Lime	34-35%
Silica	20-30
Alumina	13-20%
Magnesia	2-3.5%
Remaining oxides	1%

4.1.4 Mask

Surgical masks are made with non-woven material, which has been demonstrated to have higher microorganism filtration and airflow than a woven fabric. The fabric most extreme regularly used to make those covers is polypropylene - a type of material made from a "thermoplastic" polymer. Since it has good airflow and filtration, the mask hold the moisture which is a great water absorbing ability.



4.2 Proportion

- 1) 52% mask + 45% paper sludge + 3% cement & m sand
- 2) 52% mask + 40% paper sludge + 8% cement & m sand
- 3) 50% mask + 40% paper sludge + 10% cement & m sand
- 4) 48% mask + 40% paper sludge + 12% cement & m sand

4.3 Experimental Procedure

4.3.1 Testing properties

Test the properties of M sand and cement (ultra-tech 53 GRADE) need to be mixed with waste materials. Test the properties of paper sludge before preparing the mixture.

4.3.2 Collection of waste

Surgical Masks:

Collect 50 - 100 masks, we must first leave them aside for 72 hours. Later, it is washed with water and disinfectant. Post this washing, the waste is shredded. The shredded mixture is once again disinfected and then finally used to make the brick. It has liquid penetration resistance which will hold the moisture and it is permeable.

4.3.3 Disinfecting the waste

After leaving the masks in the disinfecting container for 72 hours, then it is shredded. As it soaked, it is easy to shred in your home.

4.3.4 Shredding the waste

After disinfecting the waste which includes paper sludge and mask, it is then shredded with the help of scissors in home. However, if the quantity of the waste is higher, it is then given to a shredding mill in order to shred the waste evenly.

4.3.5 Dry Mixing

After combining all the waste together, it is then mixed dryly with the binding agent which is cement and m sand. It is measured and kept aside while the shredding process is done.

4.3.6 Preparing the mixture

Dry mix all the materials. With correct proportion add cement, m sand, paper sludge and mask together. Mix with enough water in order to mix all the materials. The materials should be solid to hold the shape, but at the same time, they should be liquid enough to fill in the mold.

4.3.7 Prepare the mold

The size of bricks is 9*3*4 inches (22.8*7.6*10.1 cm) can make molds for single brick. This mold contains 3 divisions.

4.3.8 Casting into the mold

After preparing the mold and the mixture, the mixture is then poured into the mold with respect to the proportion.

4.3.9 Making block made from waste

After Pour the prepared mixture into the mold and let it set for 24 hours. It will be kept for natural drying and after making the block.

4.3.10 Demolding

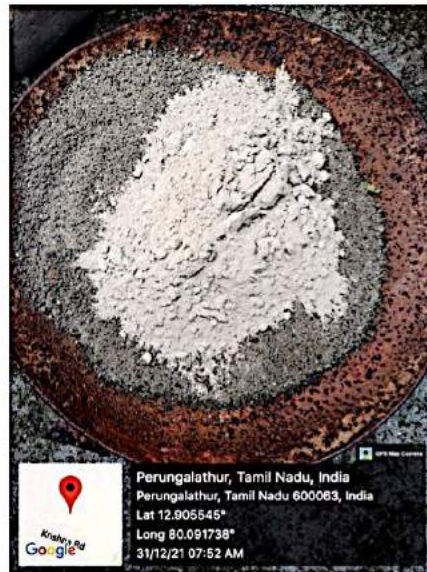
After the process and sun drying for 24 hours, it is demolded and kept for further drying process.

4.3.11 Tests and result

The next step is to take dried specimens to test. Various tests will be conducted in order to know the specimen can be used for construction. Tests such as compression, water absorption, Efflorescence, shape and size etc.



This is the mold used to make block. The size of the mold is mentioned above as 9*3*4 inches. Therefore 20 specimens are made with the mold.







4.4 Tests

After molding the blocks, it has been set for 24 hours in order to dry and use for testing. Various tests are done to know the ability of the block. Tests like compression, water absorption, efflorescence, shape and size.

4.4.1 Compression test

The compressive strength of the brick is tested in the lab. The load was applied and gradually increased until it collapses. The increase was at the approximate rate of 3KN/s.





4.4.2 Water absorption test

The blocks are taken, and it is weighed dry. The specimen is soaked into a container filled with water for 24 hours and it is tested in accordance with the Indian standard. It is weighed again and the distinction in weight shows how much water consumed by the square. It shouldn't, regardless, surpass 20% of weight of dry block.



4.4.3 Shape and size

The block is closely looked into to acknowledge the shape and size of the specimen. It is viewed and correct with the mold used. All the 15 specimens are checked according to the mold size in terms of length, width, and breadth.

4.4.4 Efflorescence test

Efflorescence is a translucent store of salts that can frame when water is available in or on block or square. There was no formation of grey or white layer on the brick surface. Therefore, the efflorescence was NIL on 52%+45%+3% (Mix 1), 52%+40%+8% (Mix 2), 50%+40%+10% (Mix 3) and on conventional mix (1:1.5:3).



CHAPTER 5 – RESULT AND DISCUSSION

There are three different tests that has been taken. They are

- 1) Compression test
- 2) Water Absorption test
- 3) Efflorescence test

5.1 Compression Test

Apparatus:

- a) Compression machine
- b) Compression plate

Process:

- The specimen is first taken to the weighing machine to know the weight of the specimen. Then the length, breadth, and width are measured.
- It is placed in the compression machine between the plate and looked closely for proper alignment
- The load is gradually applied (kN).
- The value is noted when the specimen is collapsed.

Result:

MIX 1 - 52% mask + 45% paper sludge + 3% cement & m sand

S.NO	LOAD (kN)	COMPRESSIVE STRENGTH (N/mm ²)
1.	149	5.8
2.	178	8.36
3.	150	6.46
4.	164	7.21
5.	140	5.59

MIX 2 - 52% mask + 40% paper sludge +8% cement & m sand

S.NO	LOAD (kN)	COMPRESSIVE STRENGTH (N/mm ²)
1.	210	9.42
2.	205	8.65
3.	213	8.96
4.	209	8.89
5.	202	8.42

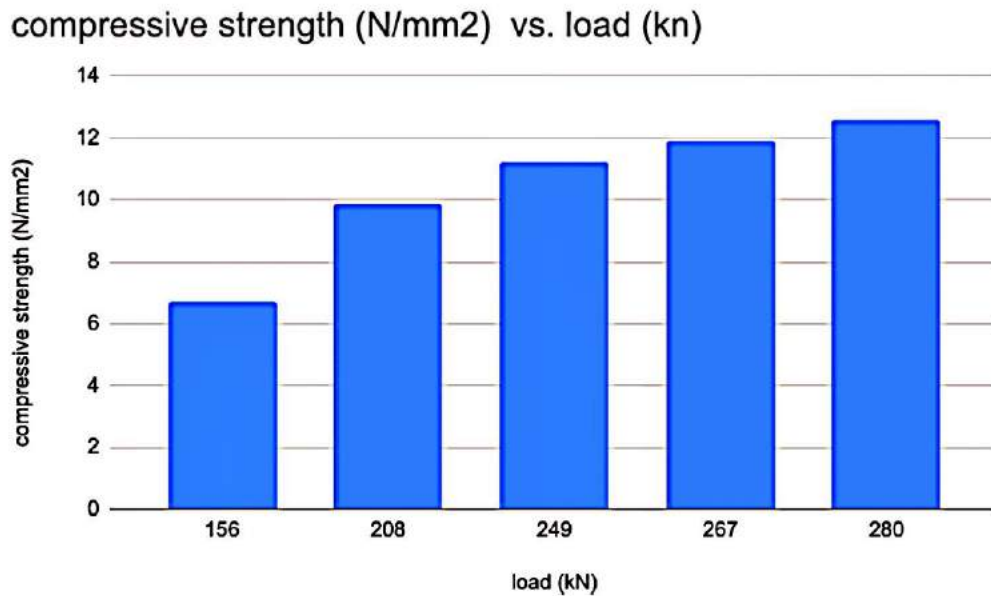
MIX 3 - 50% mask + 40% paper sludge + 10% cement & m sand

S.NO	LOAD (kN)	COMPRESSIVE STRENGTH (N/mm ²)
1.	253	9.92
2.	239	9.67
3.	250	9.88
4.	262	11.97
5.	242	9.51

MIX 4 – 48% mask + 40% paper sludge + 12% cement & m sand

S.NO	LOAD (kN)	COMPRESSIVE STRENGTH (N/mm ²)
1.	260	11.76
2.	265	11.80
3.	271	12.08
4.	270	11.89
5.	269	11.96

Overall Graph:



The gradual increase can be seen in the graph, although the conventional mix is higher than all the mix.

Mix 3, managed to attain certain strength of about 11.2 N/mm² and Mix 4 merely achieved its greatest value of 11.89. However the conventional mix has about 12.67 N/mm².

5.2 Water Absorption test

Apparatus:

1) Bucket with water

Process:

- The specimen is weighed before immersing in the water (dry weight), it is calculated.
- After calculating the dry weight, the specimen is soaked into the bucket filled with water for 24 hours.
- Later, the wet weight is calculated and kept for drying. The water absorption is calculated with formula

$$= (A-B)/B \times 100$$

A – wet weight in kg

B – dry weight in kg

Result:

MIX 1 - 52% mask + 45% paper sludge + 3% cement & m sand

S.NO	DRY WEIGHT (kg)	WET WEIGHT (kg)	WATER ABSORPTION TEST (%)
1.	2.481	2.771	11.69
2.	2.484	2.787	12.19
3.	2.421	2.707	11.81
4.	2.528	2.818	11.47
5.	2.581	2.892	12.05

MIX 2 - 52% mask + 40% paper sludge +8% cement & m sand

S.NO	DRY WEIGHT (kg)	WET WEIGHT (kg)	WATER ABSORPTION TEST (%)
1.	2.310	2.510	8.65
2.	2.374	2.600	9.52
3.	2.401	2.607	8.58
4.	2.437	2.518	7.74
5.	2.365	2.564	8.41

MIX 3 - 50% mask + 40% paper sludge + 10% cement & m sand

S.NO	DRY WEIGHT (kg)	WET WEIGHT (kg)	WATER ABSORPTION TEST (%)
1.	2.176	2.327	6.94
2.	2.163	2.289	5.83
3.	2.191	2.342	6.89
4.	2.188	2.348	7.31
5.	2.124	2.264	6.59

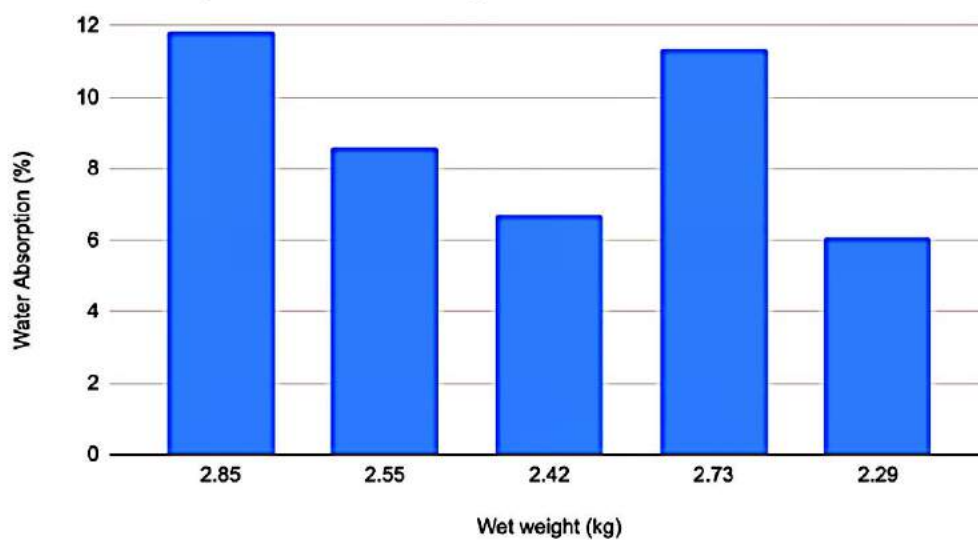
MIX 4 - 48% mask + 40% paper sludge + 12% cement & m sand

S.NO	DRY WEIGHT (kg)	WET WEIGHT (kg)	WATER ABSORPTION TEST (%)
1.	2.167	2.287	5.54
2.	2.156	2.267	5.15
3.	2.177	2.327	6.89
4.	2.189	2.351	7.40
5.	2.110	2.226	5.49

Overall Graph:

1. Mix 1 has higher water absorbing ability than the other mix and conventional mix.
2. Mix 1 has about 11.87% and wet weight of 2.85kg and Mix 4 has the lowest water absorbing ability, conventional mix has 11.37% and wet weight of 2.73kg.

Water Absorption vs. Wet weight



5.3 Efflorescence test

Efflorescence is a crystalline deposit of salts that can form when water is present in or on brick or block. There was no formation of grey or white layer on the brick surface.

MIX	SAMPLE 1	SAMPLE 2	SAMPLE 3	SAMPLE 4	SAMPLE 5
MIX 1	NIL	NIL	NIL	NIL	NIL
MIX 2	NIL	NIL	NIL	NIL	NIL
MIX 3	NIL	NIL	NIL	NIL	NIL
MIX 4	NIL	NIL	NIL	NIL	NIL

The liability to efflorescence shall be reported as 'nil', 'slight', 'moderate', 'heavy', 'serious' in accordance with the following definitions:

1. NIL – when there is no deposit of efflorescence
2. Slight – not more than 10 % of exposed area is covered with thin layer of salt
3. Moderate – 50 % of the exposed area is unaccompanied by powdering or flaking
4. Heavy – more than 50% of the area is unaccompanied by powdering or flaking
5. Serious – heavy deposit of salts accompanied by powdering or flaking.

5.4 Comparison Table

Title	MIX 1	MIX 2	MIX 3	MIX 4	Conventional mix (1:1.5:3)
Compression test	6.70 N/mm ²	9.89 N/mm ²	11.21 N/mm ²	11.89 N/mm ²	12.67 N/mm ²
Load	156 kN	208 kN	249 kN	267 kN	280 kN
Water absorption test	11.87%	8.58%	6.71%	6.09 %	11.37%
Efflorescence test	NIL	NIL	NIL	NIL	NIL
Result	By adding more waste, the water absorption increases, however, the compressive strength decreases.	This mix cannot be as considered as the compressive strength is lower than the ideal average strength which is 10 N/mm ² .	Comparatively, the compressive strength is higher because of the usage of waste, although, the water absorption is lesser than all.	It seems adding more amount of mask tend to reduce the water absorbing ability and increase to compressive strength.	The compressive strength is higher than all mix, but water absorption is quite lesser than mix 1.

CHAPTER 6 – SUMMARY AND CONCLUSION

1. The experiments and test concluded that the concrete block made from mask is environmentally friendly and reduces the pollution that happens due to covid.
2. In addition, it can be clearly viewed that the compressive strength of conventional mix is higher than the block made from waste. The compressive strength conventional mix is 12.6 N/mm^2 whereas the Mix 3 has 11.2 N/mm^2 . Also, by adding more binding agent, the desired compressive strength can be achieved.
3. However, the water absorption test shows a visible difference. The value for conventional mix is 11.37%, however, mix 3 has 11.84% as its value. If the sludge and mask is more, the water absorption of the mix is higher than the conventional mix.
4. Efflorescence seems to NIL for all the mix including conventional mix.
5. To conclude, the compressive strength is less compared to conventional mix, however, water absorption is higher than the conventional mix.
6. However, large amount of usage can lead to decrease in strength. The main objective of this paper is to utilize the waste material to reduce the environmental impact.
7. In addition, to make a cost-effective block compared to concrete block. The block made from waste can be used in real life, however, it can be used in structures such as toilet.
8. Only minimal amount of load can be carried by this block.

9. To justify the result, mix 4 has taken with different proportion such that the variation in values is determined.
10. Mix 4, the compressive strength is lot higher than other mixes because of the proportion of the mix. The value is 11.89 N/mm^2 and the load was 267 kN. However, the block made with no waste has higher compressive strength.
11. In water absorption test, the absorbing ability seems lower than any mix. Mix 4 has 6.09% which is lower than all other mixes.

REFERENCE

Aastha Ahuja, Aug 12,2020, "Waste Management During Coronavirus Pandemic: 27-year-old Recycles Bio-medical Waste Into Eco-friendly Bricks"

Alaa.A.Shakir, Sivakumar Naganathan, Kamal Nasharuddin Bin Mustapha, January 2013, Shahid" Development Of Bricks From Waste Material"

Anil kumar, devika (2016) " Performance of concrete using paper sludge ash and foundry sand"

B Dhanlaxmi et al.,2019, "Produce Eco-Friendly Bricks. International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, 8 - 4S2 : 295-299."

Cherian Varkey, Jefin P John, Neema V N, Namitha Joshy (2016) "Study On Utilization Of Waste Paper Sludge By Partial Replacement Of Cement In Concrete"

Dr.Nagarajan N, Dr.Karthikeyan K, and Dr.Sivaprakasam S 2019, "Experimental Investigation of Hypo sludge used in Fly ash bricks manufacturing with the partial replacement of lime"

Irshad Ahmad Malik, 12, August-2019, "Effect of paper sludge on the properties of cement concrete"

Namita Devidayal, July 9, 2021, "Discarded PPE suits, masks repurposed into eco-friendly bricks"

Jil Tushar Sheth¹, Saransh Joshi(2011), "Paper Crete: A Sustainable Building Material"

Marie Donlon on June 23, 2020, "Team using plastic waste, foundry dust to form bricks for the construction industry"

Mohammad arshad, DR.P.Y.Pawade, June 2014, "Reuse of Natural waste material for making light weight bricks"

MS. Rambha Thakur Assistant Professor, "Utilization of waste plastic in the manufacturing of bricks"

Muhammad Ekhlashur Rahman, 29 January 2018, "Utilization of Blended Waste Materials in Bricks"

Adlakha on August 7 2020, "India's 'Recycle Man' makes bricks from discarded Face masks"

P Bhargavi , S Kavitha Karthikeyan, G Sneha, A Vinothini (2016) "Experimental Investigation on Usage of Waste Paper Sludge (WPS) in Concrete Making"

Prof. Niklesh R. Murekar, prof.Roshan S. Satpute, Prof. Manish M. Chaudhari, January 2017, "Using Waste Material for Making Light Weight Bricks"

Rajput et al. (2012), "Reuse of cotton and recycled paper mill waste as building material"

Roshni muthukumar, August 15, 2020, "India's 'Recycle Man' Can Convert Used PPE Kits & Face Masks Into Bricks"

S.V. Giri babu, Dr.S.Krishnaiah, JNTUA 2018, "Manufacturing of eco-friendly brick:A critical review"

Sajad Ahmad M, Iqbal Malik, Muzaffar Bashir Wani, and Rafiq Ahmad 2013, "Study of Concrete Involving Use of Waste Paper Sludge Ash as Partial Replacement of Cement."

S. N. Joglekar, R. A. Kharkar, S. A. Mandavgane, and B. D. Kulkarni, "Sustainability of brick for low cost housing: a comparison between waste based bricks and burnt clay bricks," 2018.

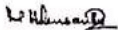
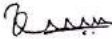
P. Darshan, P. Vivek, R. Viresh, S. Hardik, and V. Dipesh, "Comparsion of brick made from black cotton soil with various admixture to the normal," *IJIRST –International Journal for Innovative Research in Science & Technology*, vol. 1, no. 7, 2015.

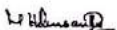
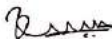
R. K. Raju Sarakar, R. Kurar, A. Gupta, A. Mudgal, and V. Gupta, "Use of paper mill waste for brick making," *Cogent Engineering*, vol. 4, no. 1, 2017.

K. Prem Kumar, M. Gomathi, "Production of construction bricks by partial replacement of waste plastic," *Journal of mechanical and civil engineering* **14**, 9–12 (2017).

L. B. Singh, L. G. Singh, P. B. Singh, and S. Thokchom, "Manufacturing bricks from sand and waste plastic" *International journal of engineering technology* **5**, 426–428 (2017).

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