"ANALYSIS AND UTILIZATION OF WASTE PLASTIC IN BUILDING BLOCKS THROUGH MOULDING PROCESS''

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ABSTRACT: ***Industry by considering several parameters for developing infrastructure in the field of commercial & residential sectors rapid urbanization leads lots of development. In this paper, study shows the reuse of waste plastics bricks & paver blocks as concrete for the wall construction and pavers for the pavement area development & their utilization. Different tests were conducted for the mechanical properties of bricks and strength of the paver product to determine their life in physical environment. The result shows that the plastics bricks & paver blocks product which can be used for long term applications and their durability & strength is also so high in absorbed test results. Ultimately, it will increase the raw materials for the construction's purposes and, it will solve the solid waste management problem.***

1. Introduction

History of the industry, focusing on day-to-day human practices which can help to reduce the disposal problem. Plastic is one of the daily increasing useful as well as a hazardous material. plastic is found to be very useful at time of need, but after its use is over it is simply thrown away, creating all kinds of hazards. As we all know plastic is a non-biodegradable that remains as a hazardous material for more than centuries. Municipal Solid Waste (MSW) is expanding rapidly in term of quantity of plastic wastes. Researchers have also found that the plastic materials can remain on earth for 4500 years without degradation, as they are non-degradable. In India approximately 40 million tons of the municipal solid waste is generated annually, with evaluated increasing at a rate of 1.5 to 2% every year. As a result, these waste plastics are to be effectively utilized. Waste is increasing in landfills in different forms.

Table 1: Different plastic wastes products development

Plastic composition	Physical properties	Possible construction application
HDPE	Rigid	Plastic lumber, table, chairs
LDPE	Flexible	Bricks and blocks
PP	Hard and flexible	Aggregates in asphalt mixture
PS	Hard and brittle	Insulation material
PET	Hard and flexible	Fibers in cementitious
PC	Hard and rigid	Composites Aggregates in cementitious composites

Apart from the application of plastic wastes for construction purposes, there are other products that have been developed for general engineering and indoor uses too. Various secondary products developed using waste plastics as raw materials.

Environment Influencing Recycling Plastic Wastes

Conventional block, brick or wood walls can also be replaced by PW. These plastic walls are made by placing recycled plastics in heat moulds and pressing the moulds together to form blocks. Although these types of walls cannot be used for load-bearing applications but are suitable for wall construction applications such as partition walls. In comparison with conventional bricks, waste plastic bottles can be arranged in a same format as bricks and used for walls. The waste bottles are connected to each other by inserting the bottleneck of each bottle in the base of another bottle. Their study showed that sand blocks that are strong and durable can be made with no need for water for the manufacturing process.

A. Although, the optimum amount was concluded to be 5% of plastic waste that can be incorporated into asphalt mixtures without any detrimental effect on its viscosity.
B. Depending upon the basic usage of plastics, several types of PW composing of polyethylene terephthalate (PET), High-density polyethylene (HDPE), low-density polyethylene (LDPE), polypropylene (PP), polystyrene (PS), etc. are being generated.
C. Waste plastic bags, which are non-biodegradable, have been recycled to produce floor and wall tiles with lesser flammability and enhanced tensile strength.

Block Designs

The process of identifying building blocks involves looking for collections of different functions which require integration to draw them together or make them different. Consider the different classes of building blocks:

i. Re-usable building blocks such as legacy items
ii. Building blocks to be the subject of development, for example in new applications.
iii. Building blocks to be the subject of purchase.
iv. Using the desired level of integration to bind or combine functions into building blocks.
v. For example, legacy elements could be treated as large building blocks to avoid breaking them apart.

The building blocks are often kept at a broad integration definition, in the early stages and during views of the highest-level enterprises. The services definitions can often be best viewed during these exercises. For implementation considerations are addressed, more detailed views of building blocks can often be used to address implementation decisions, focus on the critical strategic decisions, or aid in assessing the value and future impact of commonality and re-usability.

Fig 1: Pattern formation & casting of Building Blocks

Building Blocks

- Plastic bricks are economically cheap and are light too. Many forms of plastics are present in the market, if we talk about the design then bricks, pavers and tiles are available. Plastic is more durable and have better strength as compared to conventional bricks and some other products of plastics.
- There is enough plastic present in the market that can be used for making our homes. To press the issue of plastics it will be resolved by utilizing it. Recycled plastic to address 80% of the population resides in urban areas and their employment.
- Pavers have fast curing and low water absorption properties. Therefore, by using it in bricks it reduces the damping inside the homes.
- If we talk about the ordinary concrete and compare it with plastics bricks then we have lots of plastics bricks and it is more beneficial to us.

Paving Blocks

- Concrete blocks are mass manufactured to standard sizes. These blocks have excellent interlocking characteristics, durability and have great aesthetics.
- Brick pavers, concrete paver, granite paver, rubber paver and stone pavers are present in various types and are widely used. Cement, quarry dust, crushed aggregates, coarse aggregates, and plastic waste are essential, for the manufacturing plastic paver blocks.
- Both ordinary and plastic paver blocks are design for same grade and compared by its durability and compressive strength.

Gap Analysis

Building block formation for their strength and weakness in the product. existing systems or new systems are being met and, if not, what steps should be taken to ensure they are met successfully. So, gap analysis formed, and the review of papers taken for the existing systems and their gap, which are as bellows.

- Crucial role in determining Plastic & Sand ratios and their superior strength is the point of discussion.
- Traditional Building materials and the developed Building Blocks and Paver blocks will be more effective in their comparison to the traditional clay paver blocks and brick.
- Size of the sand grains and their binding is the point of discussion.
- The discussion over the tensile strength & compressive strength in the paver & Building blocks to the range of 1.26 - 3.15 N/mm2, which ultimately worked in the strength of the sand concentration and increase of sand.
- New approaches set and analysis method will be taken into consideration to show that it will be better as per energy point of view to use in the building.

2. Experimental Methods

The study looked at a lot of material for purposive and simple sampling plastic waste. In this regard, various collection of materials and recycling it for products.

Construction and Prototype Design of PW Brick

1. PW from the prototype design and the block made through that.
2. Idea of how the block can be used in real life.
3. as a kind of fundament for the houses, design block will be used, to maintain the look as from clay.

4. As they need to do it today the house will still be existing. It will be the roof to build up the house again from the scars, even after completion of the monsoon seasons.

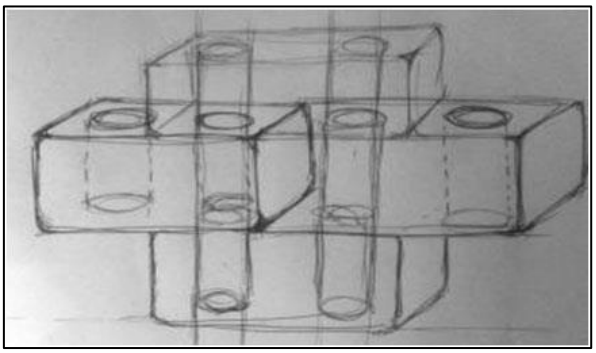


Figure 2: Design sketch of model brick.

Composition of the PW materials

i. As per the requirement PW (i.e., polythene bags and crisp bogs)
ii. Preparation of the brick for the dimension (230*100*75) cms for the standard brick mould.
iii. Used the electric oven of heating which is solar grill oven with capacity 175 to 200º C.
iv. A compressing/tamping rod with a metal cover plate and water sprinkler.

Table 2: Sand Mixing Proportions and their composition fixed for Sand ratios

Sand Mixing Proportions	1:2	1:3	1:4
For 1 brick (in gram)	1100:2200	850:2550	650:2600
For 2 bricks (in grams)	2200:4400	1700:5100	1300:5200

3. *Results & Discussion*

Analysis of brick from plastic scrap

3.1 Compression Strength Test

The purpose of the experiment to find the properties, and the brick specimen is placed on a crushing machine and pressure is applied until it breaks in this test. And the reading is considered. It is considered the ultimate pressure at which bricks are crushed. Each of the four brick examples were tested individually, and the load at crushing was recorded.

Figure 3: Specimen testing for the brick under compression

The compressive strength was calculated as follows:

Compressive strength (MPa) = Failure load / cross sectional area.

Table 3: Below Table for Test (1:2) Ratio, plastic sand ratio vs Compressive strength

Test (1:2 Ratio) for the Plastic Sand Brick	Compressive Strength(kg/cm2)	Maximum Load (KN)
Test S1-Specimen 1	193.87	500
Test S2-Specimen 2	203.56	525
Test S3-Specimen 3	189.99	490

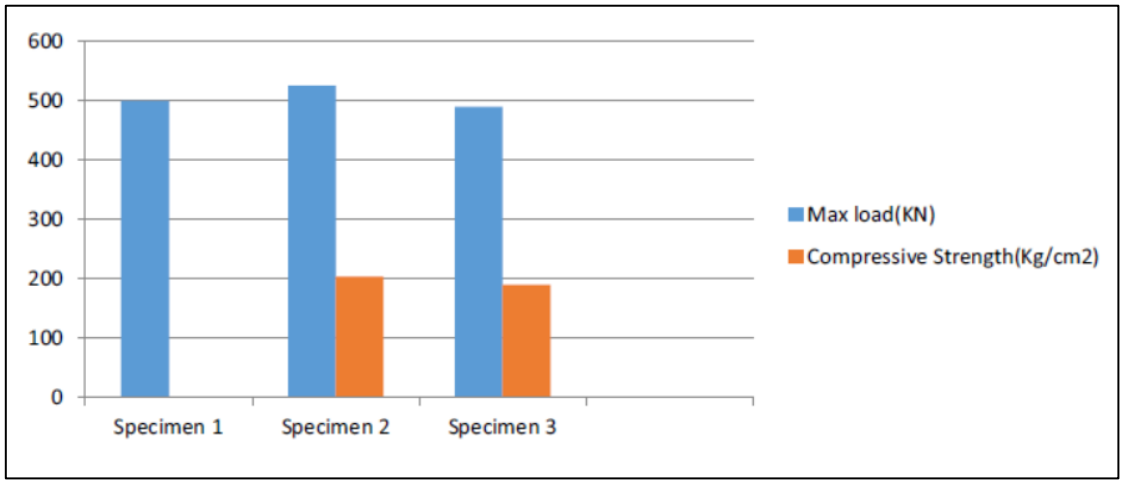


Table 4: Below Table for Test (1:3) Ratio, plastic sand ratio vs Compressive strength

Test (1:3 Ratio) for the Plastic Sand Brick	Compressive Strength(kg/cm2)	Maximum Load (KN)
Test S1-Specimen 1	135.71	350
Test S2-Specimen 2	124.07	320
Test S3-Specimen 3	129.89	335

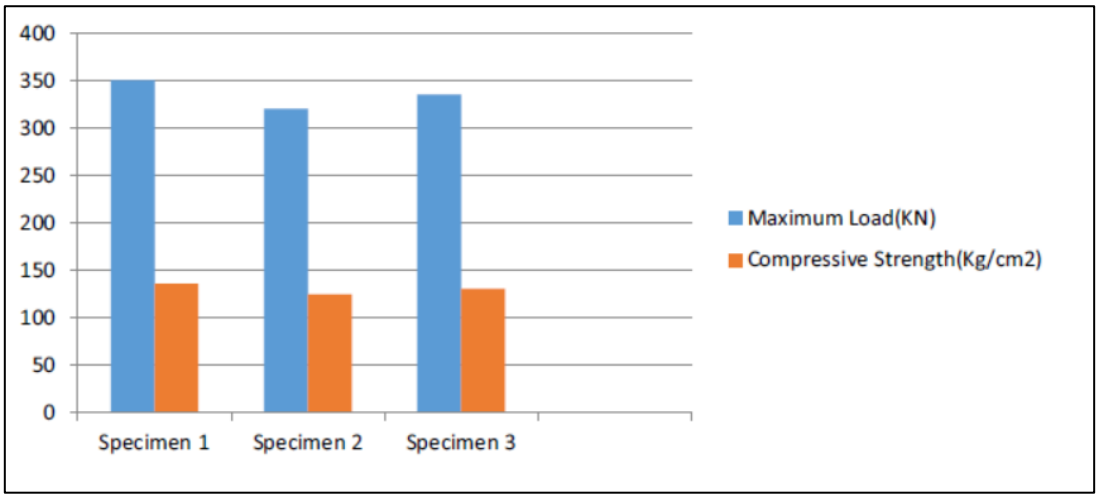


Table 5: Below Table for Test (1:4) Ratio, plastic sand ratio vs Compressive strength

Test (1:4 Ratio) for the Plastic Sand Brick	Compressive Strength(kg/cm2)	Maximum Load (KN)
Test S1-Specimen 1	63.97	165
Test S2-Specimen 2	58.16	150
Test S3-Specimen 3	60.10	155

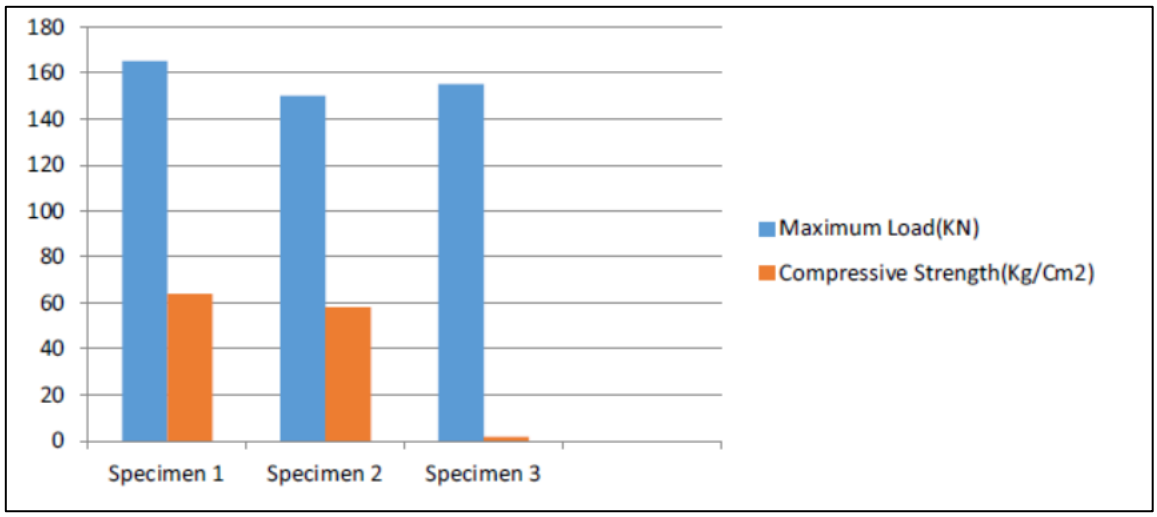


Fig 4: load carrying capacity of Brick under compression test

3.2 Tensile strength Test

In this test, we weigh bricks in dry condition before immersing them in fresh water for 24 hours. A good quality brick will form by using the less % of water. Initially, bricks wt. will be higher the grade of brick and the water will be out wiped out and clean, water absorption is computed. Thus, the less water it absorbs the better the quality of bricks. Tensile strength was calculated as follows as split tensile strength:

Where,

P = failure load,

D = diameter of cylinder,

L = length of cylinder.

Fig 5: Specimen graph for testing of building blocks for under split tension

Brick Water absorption =

{[Weight of wet brick= Weight of dry brick]/Weight of dry brick} *100

Table 6: Graph for testing of building blocks and Results of Specimen for Water Absorption Test (1:2 Ratio) for the Plastic Sand Brick

Test (1:2 Ratio) for the Plastic Sand Brick	Water Absorption (in %)	W1 (kg)	W1 (kg)
Test S1-Specimen 1	0.949	3.058	3.053
Test S2-Specimen 2	1.318	2.997	2.958
Test S3-Specimen 3	1.227	3.051	3.014

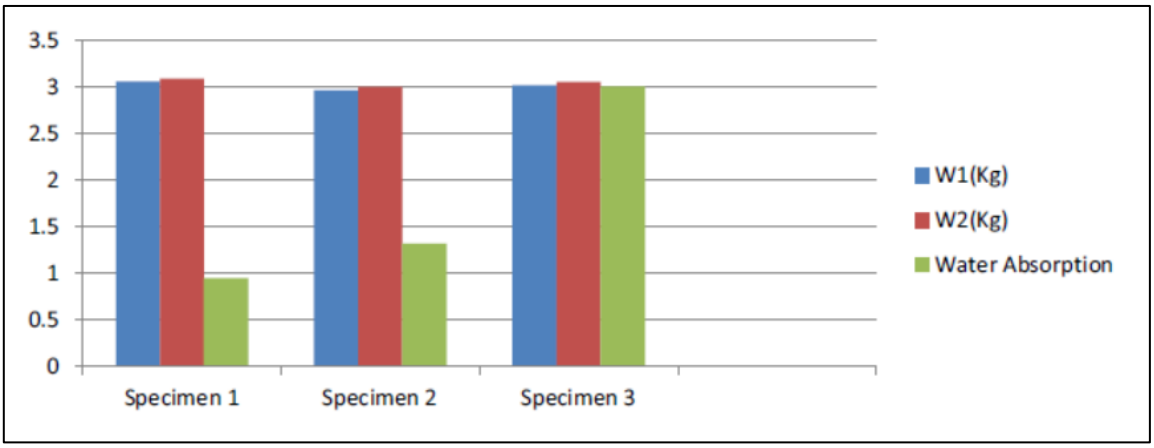


Table 7: Graph for testing of building blocks and Results of Specimen for Water Absorption Test (1:3 Ratio) for the Plastic Sand Brick (Source: Surveyor engineering)

Test (1:3 Ratio) for the Plastic Sand Brick	Water Absorption (in %)	W1 (kg)	W1 (kg)
Test S1-Specimen 1	2.723	2.601	2.532
Test S2-Specimen 2	2.642	2.564	2.498
Test S3-Specimen 3	3.238	2.678	2.594

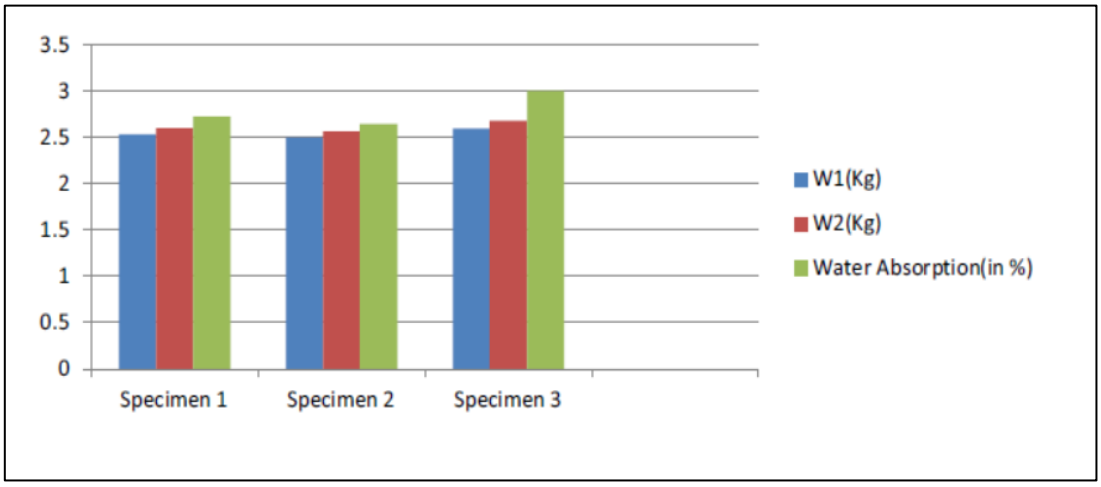
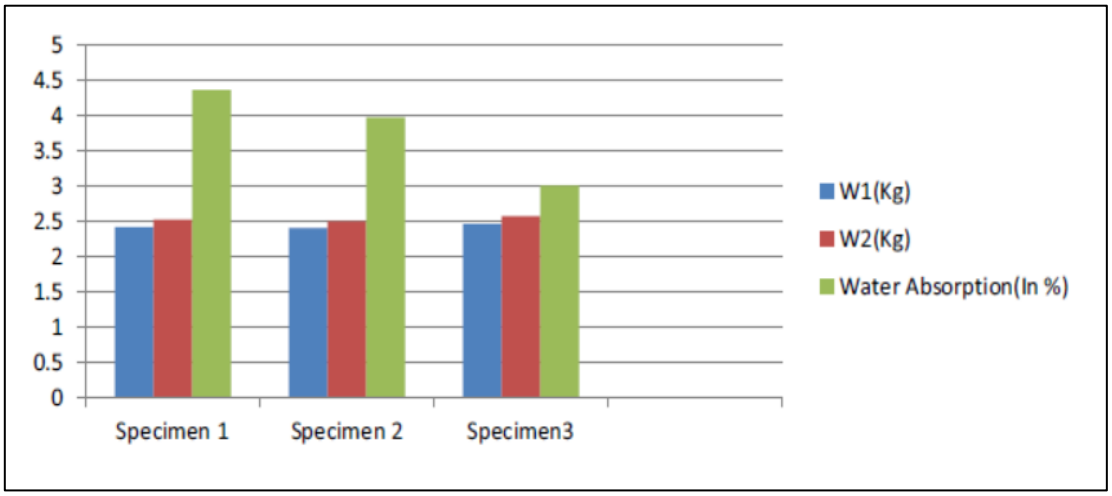


Table 8: Graph for testing of building blocks and Results of Specimen for Water Absorption Test (1:4 Ratio) for the Plastic Sand Brick

Test (1:4 Ratio) for the Plastic Sand Brick	Water Absorption (in %)	W1 (kg)	W1 (kg)
Test S1-Specimen 1	4.351	2.516	2.411
Test S2-Specimen 2	3.963	2.492	2.397
Test S3-Specimen 3	4.560	2.568	2.456



3.3 Efflorescence test

The test was conducted in accordance with ISS 1077-1970 requirements. This test is used to determine the presence of hazardous alkalis in PET bricks.

Table 8: Testing of building blocks for Alkali presence in the bricks as appeared on the surface

Nil	**0%**
Slight	Up to 10%
Moderate	10% to 50%
Heavy	More than 50% without powdered Flakes
Serious	More than 50% with powdered Flakes

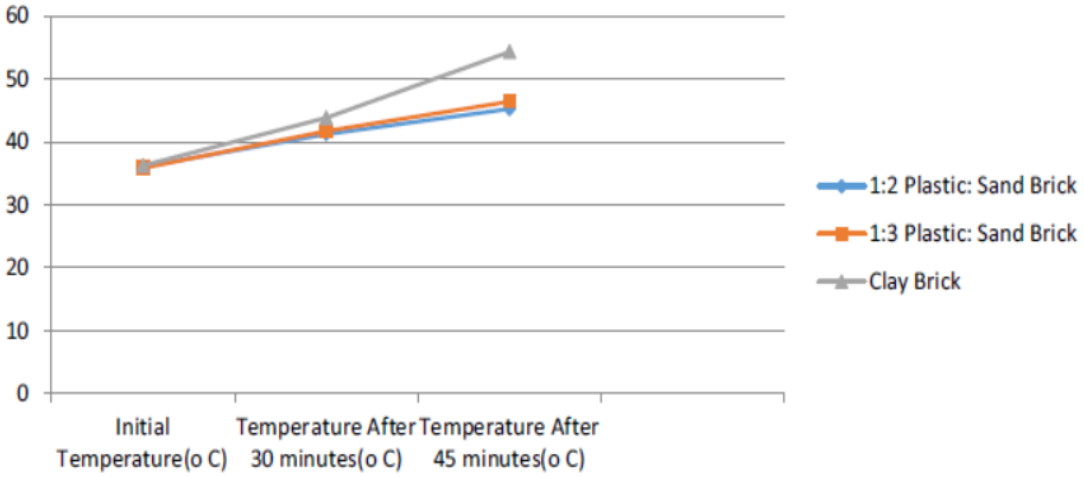
On the surface of the brick, excessive evaporation, into which distilled water is poured in suitable amounts. The immersion depth is 25mm. The block is soaked in distilled water for 24 hours before being used. To prevent, open container without the brick or sheet the container is covered with a glass sheet and taken from the container. To dry for the same period that the water in the must have evaporated. The efflorescence in the brick can be categorized into the above categories based on area covered by salt/alkalis.

3.4 Fire Resistance Test

The test was conducted in accordance with BIS 3809 1979. The plastic alone is easily vulnerable to high temperatures, if not flammable, and in the event of a fire, the sand and plastic mixture may be able to resist temperatures that plastics alone cannot. To retain the brick at the usual testing temperature structural integrity of the bricks in the furnace qualities, it will be found that it will be good up to 180oC.

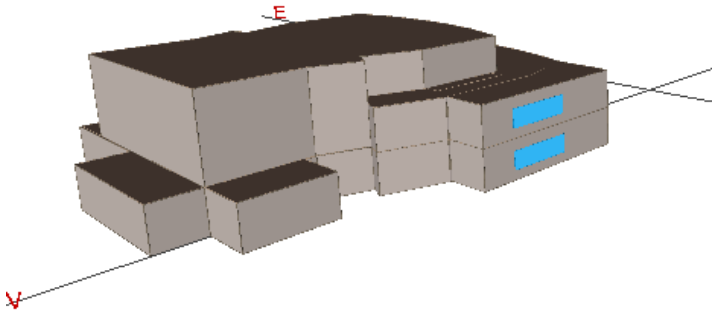
Table 9: Building blocks testing under temperature rise with Plastics Brick and Clay Bricks

Plastics Brick and Clay Bricks	Clay Brick	1:3 Plastic: Sand Brick	1:2 Plastic: Sand Brick
Initial Temperature (o C)	36.2	35.8	36.0
Temperature After 30 minutes (o C)	43.8	41.7	41.2
Temperature After 45 minutes (o C)	54.3	46.4	45.2



3.5 eQuest Output Summary

Heat transfer inside the building (Test Results Conducted over Model)



BUILDING NAME & TYPE	ASSEMBLY BUILDING
LOCATION	Bihar
CLIMATIC ZONE	Warm & Humid
FAR AREA (m^2)	150
ECBC compliance achieved	ECBC 2019
EPI (Baseline Case), kWh/m^2/year	14.51
EPI (Proposed Case), kWh/m^2/year	17.82
ENERGY SAVING ACHIEVED, kWh/ YEAR	15
EPI Ratio Achieved	0.81

Opaque envelope specification

OPAQUE ASSEMBLY	Construction Layers	Specification
Ext. WALL assembly	Assembly layers: a. 100mm Plastic Block b. 50mm XPS Insulation c. 100mm Plastic Block	U-value – 0.0634 W/m2K: Assembly thickness - 250mm
Roof Assembly	Assembly layers: a. (Innermost)20mm Cement Plaster b. 150mm RCC Slab c. 50mm XPS Insulation d. 100mm Screed	U-value – 0.0564 W/m2K: Assembly thickness - 320 mm:
Wall insulation	Type: XPS	R-value – 1.429 K m2/W: Thickness – 50 mm:
Roof insulation	Type: XPS	R-value 1.429 K m2/W: Thickness - 50 mm:

4. Conclusion

Plastics is playing vital role in the day-to-day life of our living. Society and their uses increase their consumption and wastes generated is inevitable. Application for the uses of plastics today is viable option for manage the sustainability of the present environment conditions. These plastic wastes generated at the end of the usage will be recycled to reduce the damage occurring to environment. Here, current research that has been done to discuss over the product behavior and the casting done to recycle the plastics LDPE to desired product and their best applications. Overview has explored extensively for the following conclusions can be drawn.

1. Using the PW as a recycle materials, it will increase the raw materials for the construction's purposes and, it will solve the solid waste management problem.

2. Using the PW for construction applications, it will form the product which can be used for long term applications and their durability & strength is also so high.
3. Using the PW for construction applications, it will support the circular economy and sustainability trend.
4. Using the PW for construction applications, their product composition will set the strength high and their life span which create the whole building as a tough one.
5. Using the PW for construction applications, we can increase the comfort level inside the building by reducing the heat transfer through the wall via conduction. Also, it reduces the overall energy consumptions of building.
6. Using the PW for construction applications, savings foe the energy and their cost will ultimately benefit the consumers.

All the limitations to the plastic wastes and their applications will lead for the change and increase in constructions materials, which is earlier having the progression in development of products and increase in research and technological advancement. Despite the numerous limitations government and construction regulatory body must think over some policies which might change the mind set of developers, architect, and designers for the use of recycled bricks, pavers, and other recycled plastics materials such as RPW for construction purposes.

REFERENCES

1. Aiswaria K, Khansa Abdulla, E B Akhil, Haritha Lakshmi V G, Jerin Jimmy “Manufacturing and Experimental Investigation of Bricks with Plastic And M-Sand” International Journal of innovative Research in Science, Engineering and Technology Vol. 7, Issue 6, June 2018
2. Nitin Goyal, Manisha, “CONSTRUCTION STRUCTURESPUSING ECO-BRICKS” International Journal of Recent Trends in Engineering & Research, ISSN 2455-1457.P
3. Central Pollution Control Board, “An overview of Plastic Waste Management” Delhi, pp. 1-22, 2012.
4. A.S. Manjrekar, Ravi, D. Gulpatil, Vivek P. Patil, Ranjit S. Nikam, Chetali M. Jeur (2017). "Utilization of Plastic Waste in Foundry Sand Bricks", International Journal for Research in Applied Science & Engineering Technology (IJRASET).
5. Gopu Mohan. C, Jikku Mathew, JithinX Ninan Kurian, John Thomas Moolayil, “FABRICATION OF PLASTIC BRICK OMANUFACTURING MACHINE AND BRICK LANALYSIS” International Journal of Innovative Research in Science and Technology, ISSN (online) 2349-6010, Volume 2, Issue 11th April 2016
6. Loukham Gerion Singh, Pongsumbam Boss Singh, Suresh Thokchom (2017). "Manufacturing Bricks from Sand and Waste Plastics", National Conference on Innovations in Science and Technology (NCIST-17).
7. Sina Safinia, Amani Alkalbani. "Use of Recycled Plastic Water Bottles in Concrete Blocks" Middle East College, KOM, Rusayl, Muscat PC 124, Oman 2016.
8. IS 1905, “Indian Standard code of practice for structural use of unreinforced masonry”, Bureau of Indian Standards, New Delhi, India, 1987
9. IS 3495 (Parts 1 to 4), “Indian Standard methods of tests of burnt clay bricks”, Bureau of Indian Standards, New Delhi, India, 1992.
10. Divya Chopra, Rafat Siddique, Kunal, (2015) “Strength, permeability and microstructure of self-compacting concrete containing rice husk ash”, Biosystems engineering, vol.130, pp.72-80.

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