An Experimental Study on the Strength & Characteristics of Eco-Bricks from Garbage Dump

S. Madan Raj[1], M. Nandha Gopal[2], T. Palani Kumar[3], G. Guru Prasath[4], Sofia Rajesh M.E[5]
[1, 2, 3, 4]*UG Students, Civil Engineering, AAA College of Engineering & Technology, Tamil Nadu, India*
[5]*Civil Engineering, AAA College of Engineering & Technology, Tamil Nadu, India*

***Abstract*—Bricks are a widely used construction and building material around the world. Majority of the people prefer burnt bricks for the construction purpose which emits nearly about 1 ton of CO_2. For environmental protection and sustainable development, extensive research has been conducted on production of bricks from waste materials. Bricks are prepared from garbage waste material which comprises of organic and non-organic waste. This paper presents a review of research on utilization of waste materials to produce bricks. Clay is used as a binding material for natural waste material and paper mill waste. The main objective of the present study is to reduce the quantity of clay with natural waste material. The garbage waste which otherwise is land filled has been utilized to make construction bricks that serves a purpose of solid waste management. The purpose of this research is to determine the weight, compressive strength, water absorption capacity, fire resistance, hardness etc. of bottom ash brick by using garbage waste. These brick will decrease the dead weight of the structure to a significant amount. So it changes our design and building cost as in an economical point of view.**

***Keywords*—bottom ash, plastic, lightweight, eco-friendly**

I. INTRODUCTION

According to a research, the process of converting waste materials into new materials and objects. It is an alternative to "conventional" waste disposal that can save material and help lower green house gas emissions.The amount of garbage generated in India during FY 14–15 is 141000 Tons per day (TPD). In this they have collect around 127000 TPD and treated is 35000 TPD (27%) and incinerated is 4500 TPD and land filled is 87500 TPD. Here treated doesn't mean recycled. most of this will end up a power generation unit or composing or RDF producing plant. The major problem garbage not being able to recycle is due to unsegregation.. You see all house hold waste like plastic, glass, paper, cloth, wood, etc..can be recycled easily but, only if segregated and it cannot be done after it reaches a landfill site.. Only bio degradable waste cannot be recycled, for which the processes like composting and energy production are necessary..now lets say there is absolutely no segregation, still we can manage through minimal segregation at collection and disposal to a company which can dispose it. these companies make profit by creating a monopoly and demanding more money for disposal, but they earn from the product that is generated from the garbage.

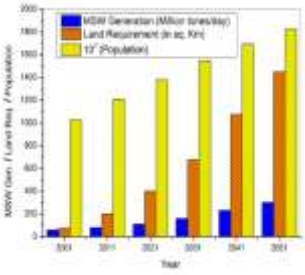
The TNPC Board has a special monitoring cell at its head office, Chennai to monitor the 17 categories of highly polluting industries, specified by the Government of India .There are 190 large and medium units identified under 17

Categories of highly polluting industries and these are being closely monitored by the Board. In order to generate an updated inventory for hazardous waste in the State, an exercise in different districts was initiated by the Government of Tamil Nadu. At present, around 181,856,699 Metric tonnes of hazardous wastes are generated in the State of which nearly 42,916,982 Metric tonnes are recyclable, 128,984.214 Metric tonnes are disposable and 10,072,612 Metric tonnes is incinerable waste.

II. LAND FILLING

Land-filling would continue to be extensively accepted practice in India, though metropolitan centers like Delhi, Mumbai, Kolkata and Chennai have limited availability of land for waste disposal and des-ignited landfill sites are running beyond their capacity.

From landfills mainly methane (CH_4) and carbon dioxide (CO_2) gases are produced. These gases have significant greenhouse effect. CH4emission from landfill is about 13% of global CH_4 emission and is about 818 million metric tons per annum in terms of CO_2.In India, estimated methane emission is about 16 million metric CO_2 equivalents per annum through landfills.



III. PROJECT VIEW POINT

A. Society Clean

Due to our project, the society should be clean and reduce the landfill waste because in India there are only 8 plants for collecting the waste and treating process .Over 377 million

urban people live in 7,935 towns and cities and generate 62 million tonnes of municipal solid waste per annum. Only 43 million tonnes (MT) of the waste is collected, 11.9 MT is treated and 31 MT is dumped in landfill sites.

B. Pollution Control

To minimize the air pollution, water pollution and land pollution for garbage dump.

- ✓ Air Pollution

Landfills create a clear and obvious threat to human health as well as a threat to our environment from the hazardous contaminated air emissions emitted from the landfill biodegradation. There are over ten toxic gases released from landfills, of the most serious of which is methane. Methane gas is naturally produced during the process of decay of organic matter. As methane gas is formed, it builds up pressure and then begins to move through the soil. In a recent study of 288 landfills, off-site migration of gases, including methane, has been detected at 83% of these landfill sites. Methane is a more potent greenhouse gas than carbon dioxide.

- ✓ Ground Water Pollution

The key environmental problem we face as a result of landfills is groundwater pollution from leachates (the liquid that drains or 'leaches' from a landfill). Although they intended to protect human beings from toxins, due to natural deterioration the protective barriers only delay the inevitable. The major issue caused with landfill leachates is the leakage of a large number of toxins into fresh water waterways, which ultimately end up in our homes as drinking water or water for everyday use.

- ✓ Land Pollution

When we talk about air or water pollution, the reactions garnered are stronger. This is because we can see the effects caused by the pollutants and their extent very clearly. It is normal human psychology to believe in what you see firsthand. Our land on the other hand is living a nightmare too. We may not be able to see the effects with clarity, but land is being polluted and abused constantly and we are unable to calculate the damages incurred. Land Pollution has come to become one of the serious concerns that we collectively battle.The effects of land pollution are very hazardous and can lead to the loss of ecosystems. When land is polluted, it directly or indirectly affects the climate patterns.

C. Easily Available

The materials should be easily available for generation of waste by increasing population and industries day by day. For more survey there are 376,639 Total MSW Generation (tonnes/day) in 2025

D. Environmental Friendly

To reduce the pollution and reuse the waste materials

Control Spread of Diseases

Cost of the brick should be minimum

E. Fire Resistance

The bricks can be resists heat upto 1500 ^{o} c. If good quality mortar is used, to increase the durability.

F. Cost Effective

The materials should be easily available so that cost is more effective than the normal brick.

IV. MANUFACTURING PROCESS

In order to achieve the above mentioned, objective study work has been divided into three main parts:

A. Required materials
B. Manufacturing of bricks
C. Results and conclusion

A. Required Materials

The properties and the detail of the all kind of material to be used in the brick mix design are as given bellow.

1) Bottom ash (garbage dump waste)
2) Soil
3) Lime
4) Gypsum
5) Cement
6) Plastic

- ✓ BOTTOM ASH :

Bottom ash is part of the non-combustible residue of combustion in a furnace or incinerator. In an industrial context, it usually refers to coal combustion and comprises traces of combustibles embedded in forming clinkers and sticking to hot side walls of a coal-burning furnace during its operation.

- ✓ SOIL :

Soil is a mixture of organic matter, minerals, gases, liquids, and organisms that together support life. The Earth's body of soil is the pedosphere, which has four important functions: it is a medium for plant growth; it is a means of water storage, supply and purification; it is a modifier of Earth's atmosphere; it is a habitat for organisms; all of which, in turn, modify the soil.

- ✓ LIME :

Lime is a calcium-containing inorganic mineral in which carbonates, oxides, and hydroxides predominate. In the strict sense of the term, lime is calcium oxide or calcium hydroxide. It is also the name of the natural mineral (native lime) CaO which occurs as a product of coal seam fires and in altered limestone xenoliths in volcanic ejecta.

The word lime originates with its earliest use as building mortar and has the sense of sticking or adhering.

These materials are still used in large quantities as building and engineering materials (including limestone products, cement, concrete, and mortar), as chemical feedstock, and for sugar refining, among other uses.

Lime industries and the use of many of the resulting products date from prehistoric times in both the Old World and the New World. Lime is used extensively for wastewater treatment with ferrous sulfate.

- ✓ GYPSUM :

Gypsum is a soft sulfate mineral composed of calcium sulfate dihydrate, with the chemical formula $CaSO_4 \cdot 2H_2O$.

It is widely mined and is used as a fertilizer, and as the main constituent in many forms of plaster, blackboard chalk and wallboard.

A massive fine-grained white or lightly tinted variety of gypsum, called alabaster, has been used for sculpture by many cultures including Ancient Egypt, Mesopotamia, Ancient Rome, the Byzantine Empire and the Nottingham alabasters of Medieval England.

Mohs scale of mineral hardness, based on scratch hardness comparison, defines hardness value 2 as gypsum.

It forms as an evaporite mineral and as a hydration product of anhydrite.

- ✓ CEMENT :

Cement is one of the binding material in this research. Cement is the important binding material in today's construction world 53 grade Ordinary Portland Cement (OPC) confirming to IS: 8112-1989 cement used it gives the properties of cement used.

A cement is a binder, a substance used for construction that sets, hardens and adheres to other materials, binding them together. Cement is seldom used on its own, but rather to bind sand and gravel (aggregate) together. Cement is used with fine aggregate to produce mortar for masonry, or with sand and gravel aggregates to produce concrete.

- ✓ PLASTIC :

Plastic is material consisting of any of a wide range of synthetic or semi-synthetic organic compounds that are malleable and so can be molded into solid objects.

Plasticity is the general property of all materials which can deform irreversibly without breaking but, in the class of moldable polymers, this occurs to such a degree that their actual name derives from this specific ability.

Plastics are typically organic polymers of high molecular mass and often contain other substances.

They are usually synthetic, most commonly derived from petrochemicals, however, an array of variants are made from renewable materials such as polylactic acid from corn or cellulosics from cotton linters.

B. Manufacturing of Bricks

According to research, up to now, there is no hard and fast rule for formal mix design of eco bricks, and in that respect no hard procedure for casting the bricks.

Thus, in this research, some laboratory tests were performed to obtain some mechanical properties of eco bricks.

- ✓ Mixing

Mixing was done after all the ingredients were ready. In this project, mixing was done manually.

Work at site with use of mix design of brick making materials (Quarry dust, Bottom ash, Lime, Gypsum, Cement, Waste plastic and Water).

S.NO	TOTAL QUANTITY	BOTTOM ASH	QUARY DUST+ PLASTIC WASTE	BINDING MATERIAL	WATER
1.	70kg	60%	30%	10%	14 lit
2.	70kg	55%	30%	15%	12 lit
3.	70kg	50%	37%	13%	10 lit
4.	70kg	45%	42%	13%	8 lit

- ✓ Brick Macking:

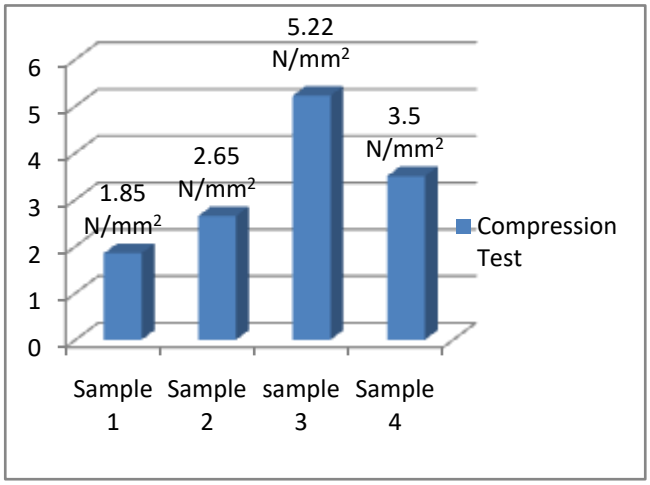
After the mixing, it should be put in the machine within 30 minutes and hydraulic pressure(150 PSI) and the surface of the brick should be finished. The casted eco bricks should be allowed for curing and sun drying for 20 days.

V. TESTING & RESULT

A. Compression Test

This test was held out by Compression Testing Machine after the 20th day from the date of casting eco brick. Only the outer faces cracked and peeled out.

Sample	Avg. Area of bed surface (mm^2)	Max load at failure (KN)	Compressive strength (N/mm^2)
1	23000	42.5	1.85
2	23000	61	2.65
3	23000	120	5.22
4	23000	80	3.5



B. Soundness Test

In this test two bricks were taken and they were stuck with each other. The bricks were not broken and a clear ringing sound was produced. Hence the bricks are safe to use.

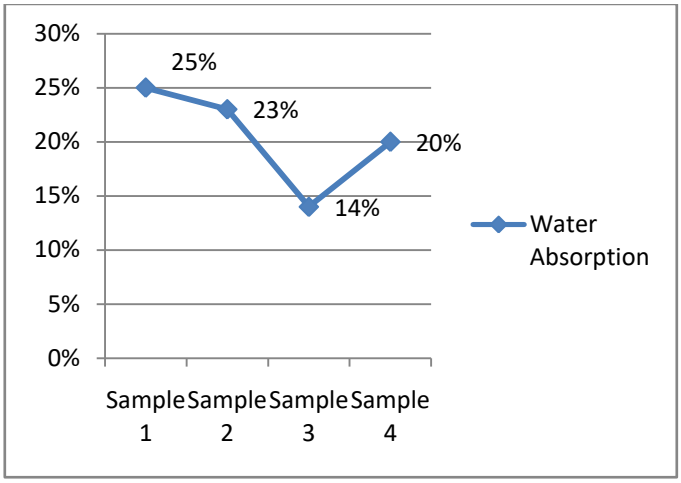
C. Nailing Test

Nail in the eco bricks are less hard as compared to conventional clay bricks. Therefore, this test was performed to find out whether these bricks can hold the nails or not. A nail was hammered in the brick and a screw was also screwed into the brick. From this test it was observed that fibrous bricks can sufficiently hold the nail. Also screws worked well and holds a considerable weight.

D. Water Absorption Test

Water absorption test is required to check whether the bricks are suitable for water logged areas or not. As per standards the bricks should not absorb water more than 20% of its original weight.

Sample	Weight (dry) gm	Weight (wet, after 24 hr) gm	% of water absorption
1	2.55	3.2	25%
2	2.53	3.13	23%
3	2.73	3.15	14%
4	2.71	3	20%



E. Brick Weight

The ordinary conventional clay bricks weight varies from 3 – 4 kg but the Eco bricks weight varies from 2 – 3 kg. The maximum weight is less than 3 kg only. All the bricks were weighed in a well conditioned electronic weighing machine. Sand based eco bricks are having weight 2/3rd of the conventional clay brick only.

VI. CONCLUSION

From this investigation, the following conclusions can be derived on the basis of the tests:

- ✓ A Eco brick consists of recycled material and therefore cost is low compared to conventional bricks.
- ✓ Eco bricks can be easily moulded into any shape, bricks are much easier for someone to lift to any desired height and very good surface finish can be achieved.
- ✓ Eco bricks has good fire resistance.
- ✓ The weight of this brick is almost $2/3^{rd}$ of conventional clay brick. Due to less weight of these bricks, the total dead load of the building will be reduced.
- ✓ These bricks are potentially ideal material for earthquake prone areas as they are lightweight and flexible.
- ✓ This research is just an initiation to Eco bricks study. However, further studies are required on following issues:
- ✓ Modification of mix proportions to achieve optimum properties.
- ✓ Addition of materials like bottom ash & some binding materials to improve compressive strength of Eco bricks.
- ✓ Colour and texture for better aesthetics and design versatility.

- ✓ Due to our project, the society should be clean and reduce the landfill waste.

REFERENCES

[1]. Rahu V, Abhilash C, Pavan M K, Myriam Marie Delcasse, Gangadhar "Papercrete Bricks-An Alternative Sustainable Building Material" International Journal of Engineering Research and Application(IJERA) *ISSN : 2248-9622, Vol. 7, Issue 3, (Part - 6) March 2017.*

[2]. Rohit Kumar Arya, Rajeev Kansal (2016) "Utilization of Waste Papers to Produce Ecofriendly Bricks" (IJSR – 2016, Volume : 5, Issue : 8) ISSN: 2319 – 7064.

[3]. Alaa.A.Shakir, SivakumarNaganathan, Kamal Nasharuddin Bin Mustapha "Development of Bricks from Waste Material" Australian Journals of Basic and Applied Science/ ISSN 1991-8178, September 2017.

[4]. Prof.J.S.Lambe, Prof.R.S.Chougule "A Pilot Scale Study on Use of Municipal Solid Waste in Making of Bricks" IOSR Journal of Mechanical and Civil Engineering(IOSR-JMCE)/ *ISSN: 2278-1684.*

[5]. R.Nithiya, Chris Anto.L, K.R.Vinodh, Dr.C.Anbalagan "Experimental Investigation On Bricks By Using Various Waste Materials" International Journal of Latest Trends in Engineering and Technology(IJLTET)/ *ISSN: 2278-621X, Volume 6, Issue 3, January 2016.*

[6]. ShikharShrimali "Bricks From Waste Plastic" International Journal of Advanced Research (IJAR)/ *ISSN: 2320-5407.*

[7]. A.Venkatesan, G.Anand, A.George Fernandez, V.V.Thillai Natarajan, A.Alex "A Compressive Strength and Water Absorption Test on Brick Made of Wood Ash, Charcoal With Clay" International Journal of Science and Technology(IJST)/ ISSN 2321 – 919X, Volume 3, Issue 3, March 2015.

[8]. Mohammad ShahidArshad, Dr.P.Y.Pawade "Reuse of Natural Waste Material for Making Light Weight Bricks" International Journal of Science and Technology Research(IJSTR)/ ISSN 2277-8616, VOLUME 3, ISSUE 6, JUNE 2014 .

[9]. PuttarajMallikarjunHiremath, ShanmukhaShetty, NavaneethRai.P.G, Prathima.T.B "Utilization of Waste Plastic in Manufacturing of Plastic Soil Bricks" International Journal of Science and Technology Research(IJSTR)/ ISSN 2347-4289, VOLUME 2, ISSUE 4.

[10]. Prof.Niklesh.R.Murekar, Prof.Roshan.S. Satpute, Prof.Manish. M.Chaudhari "Using Waste Materials For Making Light Weight Bricks" International Conference On Recent Trends in Engineering and Technology(ICRTEST)/ ISSN: 2321-8169, Volume: 5 Issue: 1(*Special Issue 21-22 January 2017*)