International Journal of Scientific Research & Engineering Trends
Volume 6, Issue 2, Mar-Apr-2020, ISSN (Online): 2395-566X

Partial Replacement of Soil by Plastic Waste for Manufacturing of Bricks

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***Abstract* – This paper outlines the use of plastic waste (PW) in construction industries. Utilizing PW as construction materials especially in production of bricks is one of a promising step towards a sustainable resources and waste management. Since the massive demand has been placed on artifact industry especially within the last decade due to the increasing population which causes a chronic shortage of building materials, the civil engineers are challenged to convert waste to useful building and construction material. Recycling of such waste as staple alternatives may contribute within the exhaustion of the natural resources; the conservation of non renewable resources; improvement of the population health and security preoccupation with environmental matters and reduction in waste disposal costs. This reviewed approach on brick making from waste is beneficial to supply potential and sustainable solutions.**

***Keywords* – Bricks, Brick Properties, Bricks manufacturing, Plastic Waste.**

I. INTRODUCTION

Now a day rapid industrial & enormous population growth has resulted in increasing various type of waste such as plastic. These materials pose environmental pollution in nearby locality because many of them are non- biodegradable. Industrial & Domestic waste has a significant percentage of polymeric material in its constitution which occupies a considerable volume on landfills. Therefore, recycling of waste is interesting to research and development of technologies for minimizing the problems caused by the waste. These technologies are user friendly but not eco-friendly as they are non-biodegradable. Generally, it is disposed by way of land filling or incineration of materials which are hazardous. Plastic is versatile material & a friend to common man but becomes a problem to the environment.[1]

This plastic types are referred to as phenolic, melamine, unsaturated polyester, epoxy , silicone, and polyurethane. Due to the economic revolution, and its large-scale production plastic appeared to be a cheaper and effective raw material. Now a days every essential sector of the economy ranging from agriculture to packaging, automobile, electronics, electrical, building construction, communication sectors has been virtually revolutionized by the applications of plastics. Several studies have proven the health hazards caused by improper disposal of plastic waste. The hazardous effect includes reproductive problems in human and animal, genital abnormalities etc., Looking forward the scenario of present life style a whole ban on the utilization of plastic can't be put, although the waste plastic taking the face of devil for the present and future generation As Per recent studies, plastics can stay unchanged for 4500 years on earth with increase in the global population and therefore the rising demand for food and other essentials, there has been an increase within the amount of waste being generated daily by each household. Plastic in several forms is found to be almost 5% in municipal solid waste, which is toxic in nature. It's a standard sight in both urban and rural areas to seek out empty plastic bags and other sort of plastic packing littering the roads also as drains. Due to its non biodegradable nature it creates stagnation of water and associated hygiene problems. To contain this problem experiments are administered whether this waste plastic are often reused productively. Construction activity needs several materials like concrete, steel, brick, stone, glass, clay, mud, wood, and so on. However, the cement, concrete and bricks remain the main construction material used in construction industries. For its suitability and adaptability with respect to the changing environment, the materials must be such that it can conserve resources, protect the environment, economize and cause proper utilization of energy.[1]

The increase within the popularity of using environmental friendly, low cost and light-weight construction materials in building industry has caused the necessity to research how this will be achieved by benefiting the environment as well as maintaining the material requirements affirmed in the standard. Reprocess of waste emerged from industrial and agricultural activities as building materials appears to be feasible solution not only to such pollution problem but also to the matter of economic design of buildings. Brick belongs to the wide family of construction materials since it's mainly used for the development of outer and inner walls in buildings. [1]

The brick industry is the most indicated technological activity sector to soak up solid waste. Attempts were made to include various waste in bricks production like

natural fibres, textile laundry wastewater sludge, foundry sand, granite sawing waste, perlite, processed waste tea, sewage sludge, structural glass waste, PC and television waste, fly ash, sugar cane bagasse ash, organic residue, steel dust, bottom ash, rice husk ash, silica fume, marble and granite waste, municipal solid incineration fly ash slag [1]

This review highlights the consequences of varied waste on the bricks property like physical and mechanical properties also as thermal insulation. Globally the estimated quantity of wastes generation was 12 billion tonnes within the year 2002 of which 11 billion tonnes were industrial wastes and 1.6 billion tonnes were municipal solid wastes (MSW). About 19 billion tonnes of solid wastes are expected to be generated annually by the year 2025 [2].

Asia alone generates 4.4 billion tonnes of solid wastes and MSW comprise 795 million tonnes (MT) of which about 48 (6%) MT are generated in India [2,3]. By the year 2047, MSW generation in India, is expected to succeed in 300 MT and land requirement for disposal of this waste would be 169.6km2 as against which only 20.2 km2 were occupied in 1997 for management of 48 MT [3]. It is studied that apart from municipal wastes, the organic wastes from agricultural source alone contribute more than 350 MT per year. However, it is reported that about 600 MT of wastes have been generated in India from agricultural sources alone [6].

The paramount quantity of wastes emerged from agricultural sources are sugarcane bagasse, paddy and wheat straw and husk, wastes of vegetables, food products, tea, boring , jute fibre, groundnut shell, wooden mill waste, coconut husk, cotton stalk etc., [5,4,7]. The major industrial non- hazardous inorganic solid wastes are coal combustion residues, bauxite red mud, tailings from aluminium, iron, copper and zinc primary extraction processes. Generation of all these inorganic industrial wastes in India is estimated to be 290 MT per annum [4, 8]. Hence utilising plastic waste in brick production can solve plastic waste disposal and demands for construction materials. Studies showed the likelihood of using plastic waste as binder with the help of catalyst through depolymerisation of PET to exchange cement.

1. Materials:-

Plastic Waste :- Light strong waste material that is made with chemical and used for making many different sorts of objects.

Fig. 1. Plastic waste.

2. Classification of plastic is done under two category

1. Thermoplastic & Thermosetting
2. Thermoplastic are used for plastic paver

Table –I:
Origin of Plastic Waste [5]

Waste Plastic	Available As
Poly ethylene terephthalate (PET)	Drinking water bottles etc.
High Density Poly ethylene (HDPE)	Carry bags, bottle caps, house hold articles etc.
Low Density Poly ethylene (LDPE)	Milk pouches, sacks, carry bags, bin linings,
Poly propylene (PP)	Caps of bottels and closures, wrappers of detergents, biscuit etc.
Urea formaldehyde	Electrical fittings ,handles and knobs
Polyester resin	Casting, bonding fibers (glass, Kevlar, carbon

3. Polyethylene Terephthalate Plastic:-

For the assembly of (PET) monomer like ethylene terephthalate are used which consists of the ethylene molecule (-CH2 - CH2-), two ester molecules (-COO-), and therefore the terephthalate ring molecule. The sole atomic species present in PET are therefore hydrogen, oxygen, and carbon. Burning Poly ethylene terephthalate-late generates only carbon dioxide (CO2) and water (H2O). So there's no potential risk of dangerous gas emission even when PET is burnt but within the present work only melting of PET was required.

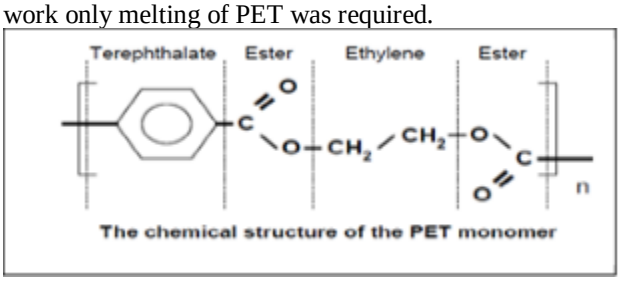


Fig. 2. Chemical structure of PET.

Table –II: Physical properties of PET

Coefficient of Thermal Expansion	7 x 10-3/°C
Long Term Service Temperature	115 - 170°C
Melting point	260°C
Specific Gravity	1.3 – 1.4
Water Absorption	0.07 – 0.10%

4. **Laterite Soil:-** Reddish clay material hard in dry status forming a topsoil of some tropical and sub-tropical region which is rich in iron oxide

Fig. 3. Laterite Soil.

Laterite soil occurrences are wide spread in the country. Almost all Indian bauxite deposits are related to laterite, except those in Jammu & Kashmir. Laterite generally occurs as capping on the hills and plateaus of Madhya Pradesh and in some states of the Deccan peninsula at altitudes starting from coastal to 2,000 m with thickness up to 60 m.

As per the NMI database supported UNFC System as on 1.04.2015, the entire reserves/resources of laterite were estimated at 706 million tonnes. Out of those, 124 million tonnes are placed under Reserves category and 581 million tonnes are under Remaining Resources category. Major share of about 74% resources is found in two states, namely, Madhya Pradesh (55%) and Rajasthan (17%). The remaining 28% of resources are spread over in the States of Andhra Pradesh, Kerala, Gujarat, Maharashtra and Jharkhand.

5. Bitumen:-

A black viscous mixture of hydro- carbons optioned naturally or as a residue from petroleum distillation

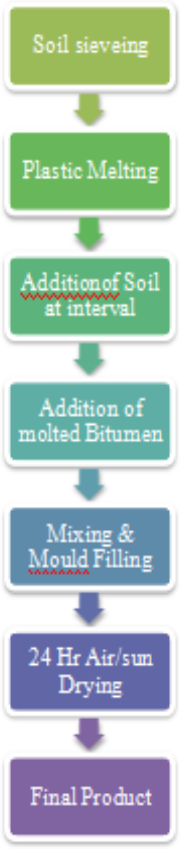
Bitumen is commonly used to build highways, motorways and rail networks. Bitumen has excellent water-proofing properties and is widely used for making roofing products along with a range of other household and industrial applications, from emulsion paints to sound- proofing.

Bitumen could also be a mix of Organic Liquids that are highly Viscous, Black, Sticky, Entirely Soluble in compound, and composed primarily of highly condensed Polycyclic Hydrocarbons. Naturally occurring or crude bitumen may be a sticky, tar-like sort of petroleum which is so thick and heavy that it must be heated or diluted before it'll flow. At temperature, it's very similar to cold molasses. Refined Bitumen is that the residual (bottom) fraction obtained by fractionation of petroleum. It is the heaviest fraction and therefore the one with the highest boiling point, boiling at 525 oC.

Fig .4. Bitumen.

Bitumen is primarily used to improve the binding property of molten plastic and also its serves the purpose of transforming a thermoplastic into thermosetting plastic

II. METHODOLOGY



1. Equipment Used for Plastic Melting

- **Burner:**

The fuel used was kerosene. It provided the necessary heat of the flame for the plastic to melt.

Fig. 5.Burner (google).

2. Working of Burner

- The operation principle of this machine is as follows:
- Start the burner and allow maximum air flow through the burner
- Provide the plastic waste into the drum for a quantity for single brick
- Switch on the motor and the starts rotating at 150 rpm.
- The waste plastics starts to get melted in about 5 to 10 minutes
- Suitable proportion of M sand and thermocol is added into the molten plastic.
- As the drum rotates the plastic gets mixed to the M sand and forms a paste.
- After complete mixing the motor and burner is switched off.
- The handle is tilted and the paste is poured into the mould and is allowed to settle.
- The final product is removed from the mould box and is sent for compression testing using Hydraulic Brick testing
- machine.

Test to be perform on casted bricks ;- Compression Test :- This test is completed to understand the compressive strength of brick. It's is also called crushing strength of brick. Four units of bricks were taken to laboratory for testing and tested one by one during this test, a brick specimen is placed on crushing machine and applied pressure till it breaks. The last word pressure at which brick is crushed is taken under consideration. All four brick specimens are tested one by one and therefore the load at crushing was noted.

3. Procedure :-

- Four bricks with different proportions were manufactured.
- Each brick was placed within the test area within the ascending order of plastic content.
- Load was applied until the brick broke.
- The utmost load at crushing in KN was noted

4. Water Absorption Test :-

In this test, bricks are weighed in dry condition and allow them to immersed in water for twenty- four hours. After 24 hours of immersion bricks are taken out from water and wipe out with cloth. Then, brick is weighed in wet condition. The difference between weights is that the water absorbed by brick. the share of water absorption is then calculated. The less water absorbed by brick the higher its quality. Good quality brick doesn't absorb quite 20% water of its own weight. Fabrication of Plastic waste Brick Manufacturing Machine and Brick Analysis

5. Procedure:

- Dry the specimen during a ventilated oven at a temperature of 105°C to 115°C till it attains substantially constant mass
- Cool the specimen to temperature and acquire its weight (M1) specimen too consider touch shall not be used for this
- purpose
- Immerse completely dried specimen in clean water at a temperature of 27+2°C for twenty-four hours
- Remove the specimen and wipe out any traces of water with damp cloth and weigh the specimen after it's been removed
- from water (M2).
- Water absorption, % by mass, after 24 hours immersion in cold water as shown in equation

6. Efflorescence Test:

The presence of alkalis in bricks is dangerous where it forms a gray or white layer on brick surface by absorbing moisture. to seek out out the presence of alkalis in bricks, this test is performed. during this test, a brick is immersed in water for twenty-four hours. Then, it's taken out from water and allowed to dry in shade. If the whitish layer isn't visible on surface, it proofs that absence of alkalis in brick. If the white layer visible about 10% on brick surface, then the presence of alkalis is in acceptable range. If that's about 50% of surface, then it's moderate. If the alkali's presence is over 50%, then the brick is severely suffering from alkalis

- **Procedure:**

1. Suitable size of dish should be filled with distilled water. The dish should be made from glass, porcelain or glazed stone ware.
2. Place the top end of the bricks within the dish, the depth of immersion in water being 25mm. Place the whole arrangements in a warm (for example,200 C to 300 C) well ventilated room until all the water within the dish is absorbed by the specimen and the surface water evaporate
3. Cover the dish with suitable cover, so that excessive evaporation from the dish may not occur.

4. When the water has been absorbed and bricks appear to be dry, place an identical quantity of water within the dish and permit it to evaporate as before
5. Examine the bricks for efflorescence.

7. Analysis of Brick From Plastic Waste :-

The fabrication process was completed and 4 bricks were made with different ratios. The composition of bricks are shown in the table below.

Table – III: Percentage composition of various bricks.

SAMPLE	Soil (%)	Plastic (%)	Bitumen (%)
1	90	05	05
2	80	15	05
3	70	25	05
4	60	35	05

8. Result;-

Effect of Different Ratio of Plastic Waste with brick on Compression Test:

Table – IV: Effect of Different Ratio of Plastic Waste on Compression Test

Brick number	SAMPLE 1 (90:05:05)	SAMPLE 2 (80:15:05)	SAMPLE 3 (70:25:05)	SAMPLE 4 (60:35:05)
Length(mm)	175	175	175	175
Breadth(mm)	100	100	100	100
Area(mm2)	17500	17500	17500	17500
Max. load on crushing(KN)	172.63	183.06	192.55	186.14

III. CONCLUSION

The various wastes that are currently recycled in bricks manufacturing are reviewed. The effects of those wastes on the bricks properties are reviewed Enhance performance in terms of creating more environmental and a cheap brick neither consumes energy resources nor emits pollutant gases gives an economical option to design the green building. Certain bricks are produced without firing which is an advantage over other manufacturing of bricks in term of low embodied energy material.

For the proportion (70:25:05) i.e. (soil: plastic: bitumen) compression strength is high hence this proportion will be recommended for implementation.

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