EXPERIMENTAL INVESTIGATION ON UTILIZATION OF WASTE PLASTIC IN MANUFACTURING OF BRICKS ALONG WITH QUARRY DUST AND SAND

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Abstract
Plastic waste is a non-biodegradable waste which cannot decompose and this creates water, land and air pollution. Also, while we burn the plastic waste in Dumping Ground, the percentage of plastic waste is increasing rapidly. It is estimated that the plastic waste will double after a decade as we use hundreds of grades of plastic in our daily life. We can recycle, reuse the plastic waste. As a civil engineer we have to innovate something new related to this, which is a boon for civil engineering. So, here we try to do something innovative as plastic sand bricks/ tiles. Basically, in bricks and tiles, we used earth-based clay. Due to excessive use of the clay, it shows the result of resources depletion and environmental degradation. In plastic waste we consider Drinking Water Bottles (polyethylene terephthalate), Carry Bags, Bottles Caps, house hold Articles (High Density Polyethylene), Milk Pouches, Sacks, Carry Bags, Bin Linings, Cosmetics and Detergent Bottles (Low Density Polyethylene), Bottle Caps and Closures, Wrappers of Detergents, Biscuit (Poly Propylene), Electricals Fittings, Handles and Knobs (Urea Formaldehyde), Casting, Bonding Fibers (Polyester resin) etc. In this, we get to crush the plastic waste into fine particles and heated on a furnace (Bhatti). We use stone dust as fine aggregates (size below than 4.75mm), heated on a furnace (Bhatti). Now, we mix heated plastic waste and heated stone dust and pour into mould and form bricks and tiles. We observed that the characteristics of bricks and tiles is far much better than normal bricks and tiles as minimum water absorption, highly compressive strength, smooth surface, unbreakable, less weight etc.
Kewords: Quarry dust, waste plastic, non-biodegradable, Carry Bags, Bottles Caps, compressive strength, water absorption

Introduction
The quantity of plastic waste in Municipal Solid Waste (MSW) is expanding rapidly. It is estimated that the rate of usage is double for every 10 years. The Plastic usage is large in consumption and one of the largest plastic wastes is polyethylene (PE). In this project these waste plastics are effectively utilized in order to reduce the land space required to dump these wastes. This creates the prevention from various harmful diseases. Building materials like bricks, concrete block, tiles, etc. are popularly used in construction. However, these materials are expensive and hence common people find it difficult to easily afford them. Moreover, these building materials require certain specific compositions to obtain desired properties. Plastic is one of the recent engineering materials which have appeared in the market all over the world. It is a material consisting of a wide range of synthetic or semi-synthetic organic compounds that are malleable and can be molded into solid objects. By definition, plastics can be made to different shapes when they are heated. It exists in the different forms such as cups, furniture, basins, plastic bags, food and drinking containers and they become waste material. Accumulation of such wastes can result into hazardous effects to both human and plant life. Therefore, need for proper disposal, and if possible, use of these wastes in their recycled forms arises.

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Fig 1 Plastic bricks made from plastic waste

Introduction to plastic

Today, the generation of plastics waste is a major issue, as the plastics are non-biodegradable, the waste today can be produced wherever human footprints be existed, and remind him that they have not chosen the appropriate method of exploitation of the nature at the present time. The concept of manufacturing the plastic bricks was to utilize the plastics waste, which is generated by people from door to door. Main important thing while using waste in plastic bricks is that we need to just burn the plastic waste without adding any additives and it can also be used for at least 30-40 years in a construction industry. Plastic is a very common material that is now widely used by everybody in the world. Plastic plays a predominant role as it is compact and light in weight. Common plastic items that are used are covers, bottles, and food packages. The great problem with plastic is its decomposition. Plastic is made of polymer chemicals and they are non-biodegradable. Though plastic is a very useful material that is flexible, robust and rigid they become waste after their use and they pollute the air and land. Recycling is processing waste materials into new products to prevent waste of potentially useful materials. The increase in the popularity of using eco-friendly, low cost and lightweight construction materials in building industry has brought about the need to investigate how this can be achieved by benefiting to the environment as well as maintaining the material requirements and their standards. From the advantages of plastic recycling procedure is used. For the production of plastic bricks is an optimal method for controlling the problem by decomposition of plastic waste and also it costs economical for the production of building materials.

Plastic bricks are plastic drinking bottles packed with non-biological waste to make a reusable building block. A plastic brick is a plastic bottle stuffed solid with non-biological waste to create a reusable building block. These bricks are used to make modular furniture, garden spaces and full-scale buildings such as schools and houses. Plastic bricks are a collaboration powered technology that provides a zero-cost solid waste solution for individuals, households, schools and communities.

Literature review

1.Amit Gawande (2012) - The quantum of plastic waste in municipal solid waste (MSW) is increasing due to increase in population, urbanization, development activities and changes in life style which leading widespread littering on the landscape. Thus, disposal of waste plastic is a menace and become a serious problem globally due to their non- biodegradability and un aesthetic view. Since these are not disposed scientifically & possibility to create ground and water pollution. This waste plastic partially replaced the conventional material to improve desired mechanical characteristics for particular road mix. In conventional road making process bitumen is used as binder. Such bitumen can be modified with waste plastic pieces and bitumen mix is made which can be used as a top layer coat of flexible pavement. This waste plastic modified bitumen mix show better binding property, stability, density and more resistant to water.

2.Sunil J. Kulkarni (2015) - Minimization of waste material is important aspect of the modern growth and development initiatives. Plastic is used in various domestic and industrial applications. Use of plastic bags and bottles is very common. The disposal of plastic waste is major problem due to non-biodegradable nature of plastic. The plastic can be used as feedstock for ethanol like products. It can be used for road construction and other construction related activities. The current review summarizes the research on use of waste plastic.

3.Rishi Singh Chhabra (2014) - In the highway infrastructure, a large number of originates materials and technologies have been invented to determine their suitability for the design, construction and maintenance of these pavements. Plastics and rubbers are one of them. Also considering the environmental approach, due to excessive use of polythene in day-to-day business, the pollution to the environment is enormous.

Materials used

The following materials which are used in this project to achieve the objectives are:

1. Waste Plastic
1. Sand
2. Quarry dust

Waste plastic

By definition the plastics Can be made to different shapes when they are heated. in closest environment it exists in the different forms such as cups, furniture's, basins, plastic bags, food and drinking containers, and they are become waste materials. Accumulation Of such wastes can result into hazardous effects to both human and plant life.

Table 1 Availability of waste plastic

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, cosmetics and detergent bottles.
Poly propylene (PP)	Bottle caps and closures, wrappers of detergents, biscuit etc.
Urea formaldehyde	Electrical fittings, handles and knobs
Polyester resin	Casting, bonding fibers (glass, Kevlar, carbon fiber)

Plastics, being one of the most used materials by humans are also hazardous material. It is often used as a short-term replacement for any other alternatives which are usually costlier than plastic. For example, polyethylene bags are used instead of its more organic counterparts like Jute bags. It is a nonbiodegradable substance that stays as it is for centuries. Moreover, the amount of plastic waste generated per year is increasing every year. Approximately, every 10 years the rate of expansion is doubled. This can be attributed to the factors such as population growth, urbanization, industrialization, and change in trend and lifestyle. Plastic waste along with being non-biodegradable also causes land and water pollution. Among the various types of plastics used, Polyethylene (PE) is one of the most used. It is usually used in single use plastics such as carry bags, plastic bottles etc.

Origin of plastic

Poly ethylene terephthalate (PET):

Bottles made of polyethylene terephthalate (PET, sometimes PETE) can be used to make lower grade products, such as carpets. To make a food grade plastic, the bottles need to be hydrolysed down to monomers, which are purified and then re-polymerized to make new PET. In many countries, PET plastics are coded with the resin identification code number "1" inside the universal recycling symbol, usually located on the bottom of the container. The majority of the world's PET production is for synthetic fibres (in excess of 60%), with bottle production accounting for about

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30% of global demand.[8] In the context of textile applications, PET is referred to by its common name, polyester, whereas the acronym *PET* is generally used in relation to packaging. Polyester makes up about 18% of world polymer production and is the fourth-most-produced polymer after polyethylene (PE), polypropylene (PP) and polyvinyl chloride (PVC).

PET is used as a raw material for making packaging materials such as bottles and containers for packaging a wide range of food products and other consumer goods. Examples include soft drinks, alcoholic beverages, detergents, cosmetics, pharmaceutical products and edible oils. PET is one of the most common consumer plastics used. Polyethylene terephthalate can also be used as the main material in making water-resistant paper. The physical properties of the cement are listed in Table

Fig 2: Collection of waste plastic

Table 2: Physical Properties of PET

Coefficient of Thermal Expansion	7 x 10-3 /ºC
Long Term Service Temperature	115 - 170ºC
Melting point	260ºC
Specific Gravity	1.3 – 1.4

Quarry dust

Quarry dust which is a waste product from aggregate crushers could replace sand. Construction of pavements and building materials in expansive soils creates a lot of problems for civil engineers, stabilization with industrial waste like quarry dust gives results. AP state new capital is purely a black cotton soil area, which leads to the problems of swelling and shrinkage. It is found that the swelling of expansive soils is controlled and improvement in soil properties is observed by adding quarry dust. The particular properties are given are given in table-2.

Table3: Properties of quarry dust

Property	**Quarry Dust**
Specific Gravity	2.54-2.60
Bulk Relative Density (Kg/M3)	1720-1810
Absorption (%)	1.20-1.50
Moisture Content (%)	Nil
Fine Particles Less Than 0.075mm (%)	12-15
Sieve Analysis	Zone-II

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Fig 3: Quarry dust

Sand

Sand is a granular material composed of finely divided rock and mineral particles. Sand has various compositions but is defined by its grain size. The composition of sand varies, depending on the local rock sources and conditions, but the most common constituent of sand in inland continental settings and non-tropical coastal settings is silica (silicon dioxide, or SiO_2), usually in the form of quartz.
Sand is a non-renewable resource over human timescales, and sand suitable for making concrete is in high demand.

Fig 4: River Sand

Methodology

The main objective of this research work is to develop an efficient way to effectively utilize the waste plastic.

- Collection of materials
- Batching
- Melting
- Mixing
- Moulding
- Curing

Table4: Mix design

Ratio	Plastic in Kg	Sand+ Quarry Dust
1.2	0.7089Kg	1.65Kg
1.3	0.53Kg	1.85Kg

Collection of plastic materials:

As we know that the plastics can be made of different shapes when they are heated. In the environment the plastic exists in different forms such as cups, plastic bags, food and drinking containers and they become waste. Accumulation of such wastes can result into hazardous material effects to both human and plant life.The plastic waste is collected from the factories, hospitals, and from the industries and also food packages and the plastic bottles and these wastes come under LDPE (Low density polyethylene) plastic type.

Fig 5: Collection of Waste Plastic

Batching

Measurement of materials for making brick is called Batching. So, after the collection of materials we separate the types of plastic and remove waste which is present in the collected materials and check whether the water content is present in collected sample and then proceed for burning.

Fig6:The weighing of sand and plastic for batching process

Burning

After completion of batching the plastic waste are taken for burning in which the plastic bags are dropped into the container and allowed it to melt. These would be done in the closed vessel because to prevent the toxic gases released into atmosphere .these will be melted at the temperature of 90-100 degree centigrade.

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Fig7: The plastic is melted at 90-100 degree centigrade

Mixing

Mixing of the materials is essentials for production of uniform and strength for brick. Generally there are two types of mixing - Hand mixing and mechanical mixing. In this project, we adopted hand mixing. These plastic liquids is thoroughly mixed by using trowel before it hardens. The mixture has very short setting bags and are turned to molten state; the river sand is added to it. Hence mixing process should not consume more time.

Fig 8: Mixing of sand with the plastic liquid by using trowel

Moulding

After the completion of proper mixing we have to place the mix into the required mould. In this project we use the normal brick size(19*9*9cm) after 1hour remove the brick from the mould

Fig 9: The mixture is set into the required moulds

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Curing

The test specimens after moulding were allowed to dry for and then the specimens are kept in a curing tank for a period of 24 hours.

Fig 10: The bricks are kept for curing

Results and Discussion

Compressive strength test:

The compressive strength is then defined as the maximum load applied to crush the specimen divided by the cross-sectional area. Rock strength has been found to be size dependent because of the cracks and fissures that are often present in the material. The sample is placed between the two platens of the testing machine and a load is applied to opposing sides of the sample until it fractures. The *loading rate* is important since a loading rate that is too low has the potential to cause creep.

Factors such as mix proportions, the water/cement ratio and curing conditions all affect the compressive strength of the concrete.

Table 5: Compressive strength Result for the ratio (1:2)

For (1:2)

S. No	Force (KN)	Area	Compressive strength(N/mm^2)
1	121.23	17100	7.09
2	130.1	17100	7.61
3	135	17100	7.89

Avg = 7.53

Table 6: Compressive strength results for the ratio (1:3)

For (1:3)

S. No	Force	Area	Compressive strength(N/mm^2)
1	70	17100	4.38
2	85	17100	4.97
3	80	17100	4.67

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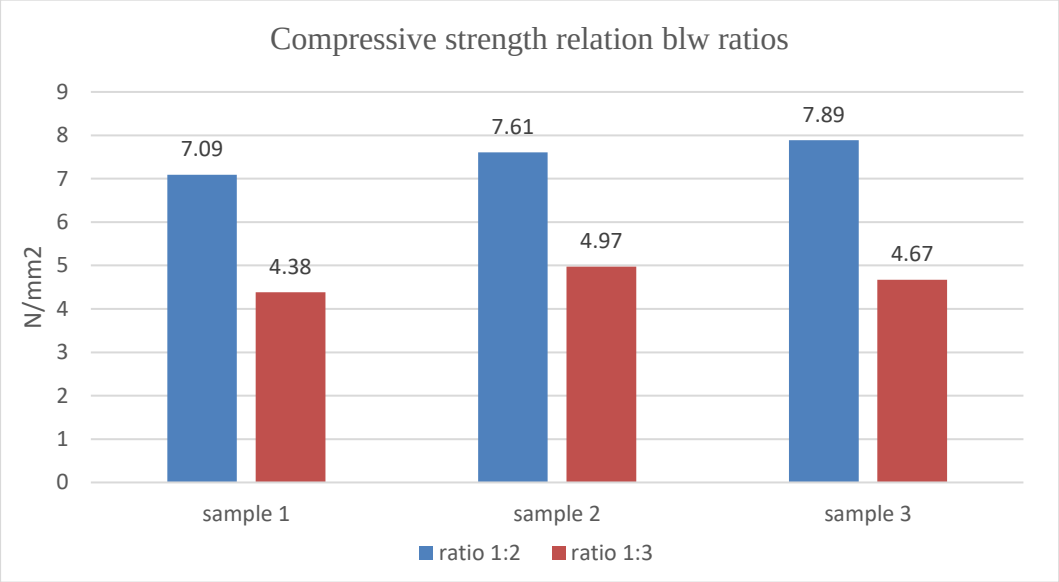

Graph1: Compressive strength results

Water absorption test

Water absorption is used to determine the amount of water absorbed under specified conditions. Plastics absorb water to a limited degree. The degree of moisture absorption depends on the type of plastic and the ambient conditions such as temperature, humidity and contact time. The average water absorption shall not be more than 20% by weight

$$W = \frac{W2-W1}{W1} * 100$$

W1 = Weight of dry sample
W2 = Weight of wet sample

Table 7 water absorption test for the ratio (1:2)

S. No	Weight of dry sample(W1) (Kg)	Weight of wet sample(W2) (Kg)	Water absorption%
1	3.2	3.250	1.56
2	3.27	3.29	0.61
3	3.2	3.24	1.85

Average = 1.34

Table8: Water Absorption test for the ratio (1:3)

S. No	Weight of dry sample(W1) (Kg)	Weight of wet sample(W2) (Kg)	Water absorption%
1	3.25	3.32	2.15
2	3.24	3.31	2.16
3	3.249	3.324	2.3

Average = 2.20

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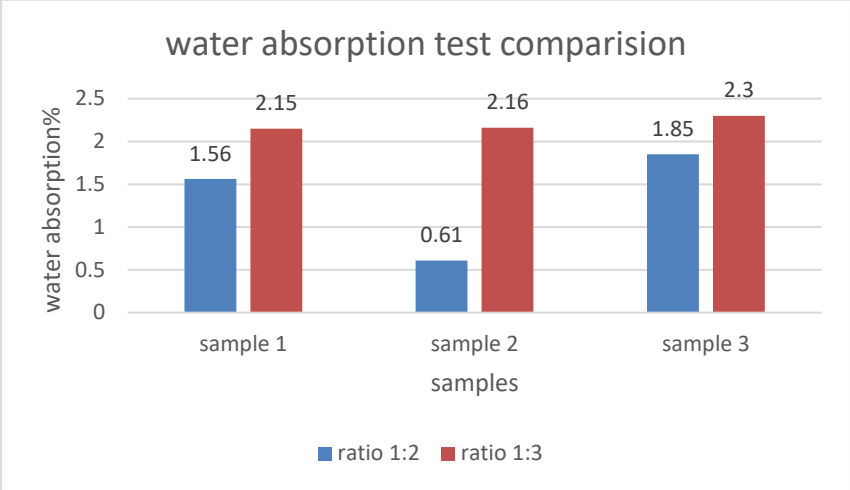

Graph 2: Water absorption test of a brick

Efflorescence test

Efflorescence is a whitish crystalline deposit on surface of the bricks. Usually magnesium sulphate, calcium sulphate and carbonate of sodium and potassium are found in efflorescence. The movement of groundwater into the foundations of buildings and by capillary action into brickwork is very often the cause of efflorescence. Results of efflorescence test shall be reported as nil, slight, moderate, heavy or serious.

- Nil- If there is no noticeable deposit of efflorescence.
- Slight- when less than 10% of exposed area of brick is covered by a thin layer of salt.
- Moderate- When there is a heavier deposit than under 'slight' and covering up to 50 percent of the exposed area of the brick surface but unaccompanied by powdering or flaking of the surface.
- Heavy – When there is a heavy deposit of salts covering 50 percent or more of the exposed area of the brick surface but unaccompanied by powdering or flaking of the surface.
- Serious-when there is heavy deposit of salt acquired by powdering and/or flaking of exposed surface.

Result: The liability to efflorescence shall be reported as nil.
Absence of white or grey patches on bricks, hence is no perceptible deposit of efflorescence

Fig 11: Efflorescence test

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Conclusion

All the experimental works taken up were discussed in detail in this chapter. The standard methodologies adopted for all the tests are also included, the corresponding values are carefully noted and the results are discussed clearly.

The conclusions stated from the above experimental tests conducted on the brick are stated below:

Compressive strength of bricks with ratio (1:2) is 7.53N/mm2 which is higher than or equal to the red burnt brick. It has a lesser water absorption (1.34%) than conventional brick . So, it can be a better alternative building material from the compressive strength test results of plastic bricks. The efficient usage of waste plastic in plastic-sand bricks has resulted in effective usage of plastic waste and thereby can solve the problem of safe disposal of plastics, also avoids its wide spread littering. And also, the utilization of quarry waste has reduced to some extent the problem of its disposal. On the basis of result obtained during the experimental investigation, following conclusion was drawn:

I. Making bricks from sand and waste plastics can be an alternative to the available traditional clay bricks.
II. Sand plastic bricks have lower water absorption, bulk density, and apparent porosity when compared with those of normal clay bricks.
III. Sand plastic bricks have higher compressive strength than normal clay bricks.
IV. Waste plastics which is available everywhere may be put to an efficient use in brick making.
V. Plastic bricks can help reduce the environmental pollution thereby making the environment clean and healthy.

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