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Experimental Study on Strength Behaviour of Plastic Sand Bricks

M. Suriyaa[1], P. Hareharan[2], J. Nageshwaran[3], S. Nandhini[4], R. Sathyamoorthy[5]

Assistant Professor[1], U.G Students[2, 3, 4, 5]Department of Civil Engineering
Vel Tech High Tech Dr. Rangarajan, Dr. Sakunthala Engineering College, Chennai, India
Email: suriyaa.mohan01[at]gmail.com

Abstract: ***Brick is an essential one for construction works. Generally, bricks are made by clay, sand and cement. In our project we are making bricks by using waste recycled plastic due to shortage of cement and clay. Waste plastics are widely available in all areas. We are using recycled PET bottles, carry bags, HDPE, LDPE and thermocol to make plastic bricks. Primarily recycled plastic PET bottles, carry bags, HDPE, LDPE and thermocol was collected in nearly areas. It was cut into small pieces and was melted to liquid state in 90 to 110^{o} C. By sieve analysis, sand was sieved to 600 microns. The sieved sand is added to the liquid plastic and was stirred continuously. A handmade wooden mould is taken and the mixture was poured in that and compacted. It is allowed to dry for a period of 24 hours. The curing period was 7 days and 28 days. By this process plastic bricks are obtained and it is compared with conventional bricks. To check its properties several tests were conducted. They were Compression test, Water absorption Test, Efflorescence test, Hardness test and Soundness test.***

Keywords: Waste Plastic, Conventional bricks, Compression Test, water absorption Test, Efflorescence Test

1. Introduction

Brick is one of the most common masonry units used as building materials. Building materials like bricks, concrete block, tiles are popularly used in construction and these materials are expensive and find it difficult to afford easily. A large demand has been placed on building material industries especially in the last decade owing to the increasing population which causes a chronic shortage of building materials. Recycling of waste plastic in construction work as raw material alternative may contribute in the exhaustion of the natural.

Plastic is a non- biodegradable waste material. Plastic waste is increasing due to increase in population, urbanization and development. Many people throw out plastic after using it. It is not decomposed easily and affect the growth of plants. So, vegetation gets affected. It is also harmful to animals when consumes it. Plastic waste is increasing due to increase in population, urbanization and development.

To overcome these defects, we can use the plastic in construction sector as raw materials in different ways. The reuse of plastic waste in building constructions, industries are considered to be the most practicable applications. Plastic can be reused in various sectors like marketing, manufacturing and transportation etc.

The aim of the project is to minimize the non-biodegradable plastic wastes and to provide an effective way to minimize plastic wastes by producing quality bricks in the construction. The main objectives are:

- To develop an efficient way to utilize the plastic wastes
- To produce cost effective materials
- To promote effective method of recycling of plastic wastes
- To reduce the consumption of natural resources such as clay for manufacturing of bricks & tiles.
- To reduce land pollution by avoiding the dumping area of waste plastics.
- To minimize land and water pollution and consequent pollution hazard.

To produce profitable time-saving bricks in the construction.

2. Materials and Methods

2.1 Manufacture of mould

Handmade wooden mould has made in the dimension of 23 cm X 10 cm X 8 cm. since dimension of normal brick was 19 cm X 9 cm X 9 cm is recommended as per BIS.

Figure 1: Manufacture of handmade wooden Mould

2.2 Sand

Natural river sand was used as a fine aggregate. The properties of sand were determined by conducting tests as per IS: 2386 (Part-1). The results are shown in test data of materials.

Table 1: Properties of Sand

Properties of Sand		
S. No	**Tests**	**Results**
1	Specific Gravity	2.68
2	Bulk Density	1631 kg/m^3.
3	Fineness Modulus	2.92

2.3 Waste 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 moulded into solid objects. While most plastics are produced from petrochemicals, bio plastics are made substantially from renewable plant materials such: as cellulose and starch. The widespread generation of plastics waste needs proper end of-life management. The highest number of plastics is found in containers and packaging's (i.e., bottles, packaging, cups etc.), but they also are found in durables (e.g. tires, building materials, furniture, etc.) and disposable goods (e.g. medical devices). Post-production and postconsumer plastics are utilized in a wide range of applications. The following Results were taken from Chennai central institute of plastic engineering and technologies.

Figure 2: Plastics

Table 2: Properties of Plastics

Properties of Plastics		
S. No	**Properties**	**Results**
1	Density at 23˚C	0.958
2	Elastic modulus	9
3	Tensile creep strength	8
4	Bending creep modulus	1
5	Tensile strength at 23˚C	2
6	Elongation at break (%)	> 600
7	Thermal conductivity	0
8	Ignition temperature	3

Due both to the finite limits of the petrochemical reserves and to the threat of global warming, the development of bio plastics is a growing field. They are broadly classified into two categories they are thermoplastics and thermosetting plastics.

Thermoplastics are the linear polymers, which become soft on heating and become hard on cooling. The molecule of these polymers is synthesized in the shape of long threads and undergoes no chemical change in the molding operation. Some of the common examples are polyethylene, PVC, polystyrene, Nylon and acetate.

Thermosetting plastics are cross linked polymers, which become soft only on first heating with pressure and get hard permanently on cooling due to chemical change by condensation and polymerization, and becomes unaffected by the heat or solvents. Some of the common examples are epoxy resins, phenolic resins and unsaturated polyester resins.

2.4: Mix proportion

In order to find the plastic soil bricks that they possess high compressive strength with various mix proportions are made and they are tested using compressive testing machine [CTM]. The mix proportions were in the ratio of (1:2, 1:3, and 1:4). These are the ratio which represents the plastic, river sand respectively.

Table 3: Mix Proportion of Plastic Bricks

Mix Proportion of Plastic Bricks				
S. No	**Mix ratio**	**Plastic (kg)**	**Sand (kg)**	**Weight of bricks (kg)**
1	1:2	0.910	2.220	3.238
2	1:3	0.710	2.470	3.184
3	1:4	0.520	2.620	3.13

3. Result and Discussion

As per the code **IS 3495 (1992)**: Common Burnt clay building brick - specification the following tests are to be performed. Compressive strength test, Water absorption test and Efflorescence test.

In addition, there two more tests to be conducted to know the quality of Plastic bricks. In these tests some are to performed in a laboratory and rest on the fields with a reference of literatures and journals.

1. Hardness test.
2. Soundness test.

3.1 Compressive strength test

Compressive strength test on bricks are carried out to determine the load carrying capacity of bricks under compression with the help of compression testing machine. Bricks are generally used for construction of load bearing masonry walls, columns and footings. These load bearing masonry structures experiences mostly the compressive loads. Four specimens of bricks (1:2, 1:3, 1:4 and conventional Bricks) were taken and tested one by one. In this test, a brick specimen is put on compression testing machine and applied load till its breaks. The load at failure shall be the maximum load at which the specimen fails to produce any further increase in the indicator reading on the testing machine.

Table 4: Comparison of compressive strength of plastic Brick for various ratio

Sl. No.	**Mix ratio**	**Maximum load (KN)**	**Compression strength (N/mm^2)**
1.	(1:2)	232	9.17
2.	(1:3)	162	6.40
3.	(1:4)	88	3.50
4.	C.A	32	1.27

Table 5: Comparison of compressive strength of Plastic Bricks and Normal Conventional Brick

S. No	**Type of Bricks**	**Compression strength (N/mm^2)**
1.	Plastic sand Bricks	9.17
2.	Conventional Bricks	1.27

3.2 Soundness test

The soundness test is also done in the field. The Plastic bricks and conventional bricks are were taken. The bricks are made to hit each other the ring sound produced during the process, which denotes the quality of the brick that it is good. Good quality bricks produce the clear ringing sound. In our project both fly ash bricks and plastic sand bricks clear ringing sound produced.

3.3Water absorption test

Four specimens of bricks (1:2, 1:3, 1:4 and conventional Bricks) were taken and weighed in dry condition (W_1). Let them immersed in fresh water for 24 hours. After 24 hours of immersion, those are taken out from water and wipe out with cloth. Then brick is weighed in wet condition (W_2). The difference between weights is the water absorbed by bricks. The percentage of water absorption is calculated. The less water absorbed by bricks the greater its quality. Good quality brick doesn't absorb more than 20 % water of its own weight.

Table 6: Water absorption test of Plastic bricks for various ratio

Sample no	Mix ratio	Water absorption (%)
1.	1:2	0.346
2.	1:3	1.57
3.	1:4	1.469
4	Conventional bricks	7.08

Table 7: Comparison of water absorption test of Plastic Bricks and Normal Conventional Brick

S. No	Type of Bricks	Water absorption (%)
1.	Plastic sand Bricks	1.57
2.	Conventional Bricks	7.018

3.4 Efflorescence test

In this test, a brick is immersed in distilled water for 24 hours. Then, it is taken out from distilled water and allowed to dry in shade. If the whitish layer is not visible on surface, it proofs that absence of alkalis in brick. If the whitish layer visible about 10% of brick surface, then the presence of alkalis is inacceptable range. If that is about 50% of surface, then it is moderate. If the alkali's presence is over 50%, then the brick is severely affected by alkalis.

Table 8: Efflorescence Test Results

Efflorescence Test Results			
S. No	Mix ratios	Nil	Slight
1	C.B	--	✓
2	1:2	--	--
3	1:3	--	--
4	1:4	--	--

3.5 Hardness test

In this test a scratch is made on brick surface with steel rod (any hard material can be used) which was difficult to imply the bricks or blocks were hard. This shows the brick possess high quality.

4. Conclusion

The test results show the compressive strength of conventional brick for a maximum load of 32KN is 1.27N/mm^2. In the case of plastic sand bricks the compressive strength decreases with increasing the plastic sand ratio. The various mix proportions used are 1:2, 1:3 & 1:4. The crushing values of plastic brick for the loads 232KN, 162KN and 88KN are 9.17N/mm^2, 6.2N/mm^2 and 3.50N/mm^2 respectively.

There is no alkali in plastic brick whereas it is present in conventional brick. In water absorption test presence of alkali is highly reduced. Hence plastic sand bricks could reduce a large amount of water absorption and shows resistance to alkali reaction. The bonding between plastic and sand can be achieved by using general purpose resin. It also shows improved quality and durability than conventional bricks. Weight is also lesser for plastic sand bricks compared to conventional bricks.

In comparison with conventional brick, the strength of plastic sand bricks is high. Strength wise we can go for 1:2 (Plastic: Sand) mix, which is giving high strength compared to other mixes. But in economic wise if we need a brick similar to conventional brick we can go for 1:4 ratio. Since its process charge is lesser than other two. The applications of plastic sand bricks are numerous in civil engineering namely precast bricks, partition wall and canal lining.

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