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Manufacturing and Experimental Investigation of Bricks with Plastic And M-Sand

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ABSTRACT: Modern world is facing a serious situation of waste management, especially plastic waste. Everyday thousands of tonnes of plastic is dumped to the garbage but there is no enough method to treat and recycle the plastic world. A large amount of plastic is been discarded or burned daily which leads to the contamination of environment and air. Accumulation of plastic waste in the environment is hazardous to both plant and animal life. The plastic waste bottles in the form of PET (Poly ethylene terephthalate) has an important environmental challenge and its recycling faces a big problem due to its non-degradable nature. The large volumes of materials required for infrastructure construction is potentially a major area for the reuse of waste materials. Thus to overcome this problem the plastic waste bottles are been treated with M-sand to make brick for construction purpose. This paper studies the properties of bricks manufactured by mixing Manufactured Sand (M-Sand) and Poly ethylene terephthalate (PET) bottles and its suitability as a building unit. PET bottles were chopped in to small pieces and heat was supplied from below. M-sand was added in 1:2, 1:3, 1:4, 1:5 & 1:6 (plastic and M-sand respectively) proportions into the molten plastic paste for the manufacturing of plastic soil bricks and is poured into moulds of required size. This alternatively saves the quanta of sand/clay that has been taken away from the precious river beds/mines, and is the one of the best ways to avoid the accumulation of plastic waste which is non-biodegradable pollutant.

KEYWORDS: Waste Management, Plastic waste, building units, PET bottles.

I. INTRODUCTION

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. Therefore, need for proper disposal, and if possible, use of these wastes in their recycled form arises. Hence these plastics are to be effectively utilized. Today it is impossible for any vital sector to work efficiently without usage of plastic starting from agriculture to industries. Thus we cannot prohibit the use of plastic. So reusability of plastic should be the better option. Plastic is one of the recent engineering materials which has many good characteristics which include versatility, lightness, hardness, resistant to chemicals, water and impact. It is a material consisting of a wide range of synthetic or semi-synthetic organic compounds that are malleable and can be moulded into solid objects. Plastic can be made to different shapes when they are heated. It exists in different forms such as cups, furniture, basins, plastic bags, food and drinking bottles and they become waste material. Recycling the plastic has advantages since it is widely used worldwide and has long service life, which means that waste is been removed from the waste stream for a long period.

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II. METHODOLOGY

Materials used are PET bottles and M-sand. Plastic wastes are collected and PET bottles are sorted out. The collected PET bottles are to be cleaned with water and dried. Then it is added to the pan and heated. M-sand is added in required proportion when plastic turns into hot liquid and mixed thoroughly. Mould (19x9x9cm) is oiled for easy removal of bricks and the mixture is poured into the mould and it is compacted in 3 layers with 25 blows each with a tamping rod. Surface finished with trowel. The brick can be easily demoulded by just lifting the wooden mould after 30 minutes. Various experiments are carried out to determine the properties such as compressive strength, durability, thermal resistance, water absorption etc. of the prepared plastic soil bricks.



Fig 1: Casted plastic soil brick

III. EXPERIMENTAL INVESTIGATIONS

- **Effect of water curing on strength of plastic-soil bricks**

Bricks (1:4) after 3 days, 7 days and 28 days of water curing and 24 hours of air cooling were tested for compressive strength in order to know the effect of water curing on Plastic soil bricks.

Table 1: Average compressive strength for the ratio 1:4

Days of water curing	Average compressive strength (N/mm ²)
3 days	18.30
7 days	18.50
28 days	18.10
24 hrs of air cooling	18.13

The table shows that there is no much effect on compressive strength of plastic soil bricks on water cooling.

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- Compressive strength**

Average compressive strength for different ratios of plastic soil bricks were determined.

Table 2: Average compressive strength (N/mm²)

Plastic soil brick(Ratio)	Average Compressive strength(N/mm ²)
1:2	11.70
1:3	13.06
1:4	18.13
1:5	15.88
1:6	11.50
Burnt clay bricks	8.92

From the results, the ratio of plastic soil brick 1:4 has maximum compressive strength so it is chosen for doing all the other tests on bricks. It shows that as the plastic content increases, the compressive strength increases up to a certain limit and then decreases. This may be due to the decrease in adhesive strength between plastic and M-sand. It seems that bonding between plastic particles and M-sand is weak after certain limit as the increase in plastic content might have caused the brick to be much flexible, which in turn reduces its compressive strength.

- Water absorption test**

Water absorption for different ratios of plastic soil bricks were determined and is shown in table below

Table 3: Water absorption for different ratios of plastic soil bricks (%)

Plastic soil brick(Ratio)	Water absorption(%)
1:2	1.10
1:3	0.31
1:4	0.27
1:5	1.47
1:6	1.66
Burnt Clay bricks	15.28

Water absorption test showed excellent performance of plastic soil bricks. Water absorption value is least for plastic soil brick of ratio 1:4 and the percentage reduction of water absorption compared to burnt clay bricks is 98.2%.

- Prism test**

Prism test was done for different mortar ratios for plastic soil bricks (1:4) and it was compared with that of the burnt clay bricks.

Table 4: Compressive strength of masonry prisms of plastic soil bricks and burnt clay bricks (N/mm²)

Cement Mortar Ratio	Compressive strength of masonry prism (N/mm ²)	
	Plastic soil bricks	Burnt clay bricks
1:3	12.7	7.5
1:4	11.3	6.6
1:5	10.2	4.1

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It is observed that the compressive strength of masonry prism increases with increase in mortar strength and is greater than that of burnt clay bricks.



Fig 2: Failure of masonry prism

- **Efflorescence test**

The efflorescence test showed an excellent performance on the plastic soil bricks. There were no formation of grey or white layer on the brick surface. From this test we can conclude that no traces of alkalis were presented in this plastic soil brick whereas the burnt clay bricks showed a slight deposit of alkali on the brick surface.

- **Hardness test**

In this test, a scratch was made on brick surfaces. This test was carried out for all proportion of bricks. While the scratch was made with the help of a finger nail on the bricks, no impression was left on the sand brick surface whereas the burnt clay bricks showed a light impression on the brick surface.

- **Soundness test**

In this test, two bricks from same proportion were taken and they were struck with each other. The bricks were not broken and a clear ringing sound was produced same as that of burnt clay bricks. So the bricks are good.

- **Impact test**

In this test, the bricks were made to drop from a height of 1m on one of its corner. The bricks were not broken or shattered and it indicates the brick are of good quality.

- **Thermal resistance test**

A brick was kept in the oven at 100°C for 24 hours and then the compressive strength for the brick was determined. The compressive strength of the brick was found to be 16.67 N/mm². The compressive strength of burnt clay bricks after thermal resistance test was found to be 8.12 N/mm². Hence both the bricks show the same reduction in compressive strength which is about 9%.

IV. COST ANALYSIS

Cost of burnt clay brick of same size is 8 Rs./ brick. Cost of plastic soil bricks is calculated to be 4.01Rs/brick which is about half of burnt clay bricks of same size and hence is economical

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V. CONCLUSIONS

Plastic soil bricks possess more advantages than burnt clay bricks and it is cost effective. Brick made with 1:4 ratio of Plastic to M-sand gives a compressive strength of 18.13N/mm², which is greater than the requirement for a first class brick. It can be used as a permanent structure in the construction of walls. The water absorption for the brick is almost negligible. It is 98.2% less compared to burnt clay bricks. The compressive strength of Masonry Prism made of plastic soil bricks, were found to be more than that of conventional brick Masonry Prism. The compressive strength of masonry prism increases with increase in mortar strength. Thus, the efficient usage of waste plastics in plastic soil bricks has resulted in effective usage of plastic wastes.

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