Utilization of Waste PET Bottles and Brick Kiln Dust as Construction Material for Low Cost Housing

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***Abstract*—This paper proposes the use of waste plastic PET bottles as construction material substitute to the standardized bricks. As plastics are non-biodegradable its disposal has always been a problem. Waste plastic bottles are major cause of solid waste disposal. Polyethylene terephthalate is commonly used for water bottles and carbonated beverage. This is an environmental issue as waste plastic bottles are difficult to biodegrade and involves processes either to recycle or reuse. Today the construction industry is in need of finding cost effective materials for increasing the strength of structures. Brick kiln dust, a waste generated by brick production industry is as such a big environmental concern. The investigation reported in this paper is carried out to study the utilization of brick kiln dust in plastic bottle as a partial replacement of soil as well as an additive so as to provide an environmentally consistent way of its disposal and reuse. This project deals with the possibility of using waste PET bottles as a partial replacement. It can be concluded that benefit of the use of PET bottles include both improved ductility in comparison with raw blocks and inhibition of crack propagation after its initial formation. The solution offered in the paper is one of the answers to long standing menace of waste disposal and also provide solution for the construction of low cost housing.**

***Index Terms*—brick kiln dust, construction cost, industrial by product, PET bottles, Waste Management.**

I. Introduction

Plastic bottles are increasingly becoming an ominous to the environment due to the manufacturing process, improper use and disposal. The quantity of plastic waste in Municipal Solid Waste (MSW) is expanding rapidly. It is estimated that the rate of expansion is double for every 10 years; this is due to rapid growth of population, urbanization, developmental activities and changes in life style which leading widespread littering on the landscape. Thus disposal of waste plastic is a serious problem globally, since they are non biodegradable and also researchers have found that the plastic materials can remain on earth for 4500 years without degradation. Plastic have many good characteristics which include versatility, lightness, hardness, and resistant to chemicals, water and impact. This large number of plastic PET bottles which are very much of in need to be managed as a waste as the use of these bottles can't be deprived. While the brick kiln dust is the waste left in the sidelines of brick kiln industry which is of no use and have numerous hazard to the environment. Brick manufacturing plant uses many different raw materials and produces many intermediates, by-products and products. Among these, there are many substances potentially harmful to the health of brick kiln workers and citizens residing nearby. There are various respiratory health hazards and these have showed that chronic bronchitis and decreased lung function values are associated with atmospheric pollution, especially in the firing and unloading section. Major part of it contributes to the air pollution and also indoor air pollution which is causing a lot of nuisance to the people living nearby. So for waste management of this hazardous brick kiln dust is very much of an importance for environmentalist and different government bodies. As there is no proper disposal management system for disposal of these brick kiln dust, so this provide a alternate use of these dumped dust which can be used as a cost effective construction material. The Maharashtra government has asked plastic bottle manufacturers and mineral water firms to set up recycling plants for bottles, without which they have to down their shutters. The companies were asked to comply with the plastic waste management rules, according to which they are required to recycle plastic bottles. However, none of the units have recycling facilities.[source: Hindustan times] A significant percentage of urban populations are facing housing shortage which is becoming an acute problem in modern age of development. Migration, from rural to urban sector in search of better living condition and better employment opportunities, is yet one of the most visible factor leading to increasing urban density. But with unavailability of affordable housing in housing markets, most people face housing problems giving rise to squatting and slum settlements. The estimate of housing shortage in urban areas of Indian cities has reached to 18.78 million in 12th Five-Year plan according to the report by technical committee [1]. Most housing shortage are pertaining to economically weaker section (EWS) and Low-income groups (LIG) who have monthly income below the standard of living condition and they lack potential to afford basic amenities. Un-affordability by such households forced them to build slums comprising of scrap materials, shabby items, unhygienic and prone to harsh weather. Most houses which are congested, non-serviceable or obsolescent are administered as homeless. Almost 80% of houses are congested and need reconstruction or relocation, while 12% of houses are vacant or need to be destroyed and rebuild [2]. According to the policy of new government under Prime Minister Narendra Modi, India is expected to be free from housing shortage by

2022. To take such action, new schemes and guidelines have been launched to encourage providing housing for all. For this purpose of providing the low cost housing we have to find some alternative materials which are cost effective and provide the suitable strength required. As both the materials are scrap or waste materials so these product are cost effective as these materials are available free of cost. So this will give you a alternate construction material which will reduce the total cost of construction and somehow provide a solution for low cost housing and also a better of way using these waste materials without harming the environment.

II. Objective

1) To estimate the possibility of recycling the waste PET bottles and brick kiln dust.
2) To compare the cost difference of bottle brick with conventional brick.
3) To test and compare the strength of the bottle brick and brick.
4) To construct a model dog house.
5) To evaluate if it can replace the conventional bricks for the construction purpose for low cost housing.

III. Materials and Methodology

The very first step of this methodology is to collect the waste PET bottles from stores, scrap collectors and any possible source. We have collected like hundreds of bottles on our own by storing the bottles we use in daily basis in our rooms. And for the big project, we have collected these bottles from a scrap shop nearby. We have collected some 1000 bottles from that scrap shop according to our requirements and could have easily be managed more. The brick kiln dust is easily and freely available on any brick kiln industry. After collection of material the bottles are cleaned and dried properly. Then brick kiln dust is filled and tamping it in instalment they are tightly capped and sealed. For checking the structural strength of the bottle brick various tests are performed and are compared with conventional brick. Also a comparative economic analysis is performed.

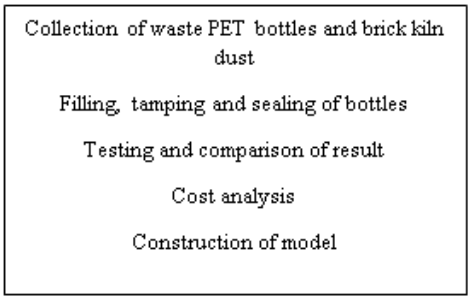

Fig. 1. Methodology adopted

IV. Testing and Result

Bottles are weighed before and after filling the brick kiln dust. The compressive strength of bottle brick is calculated by using a Universal testing machine and the average value was considered for analysis. Similarly, compressive strength of brick was calculated by taking the average value and the results were compared and analyzed.

Fig. 2. Model constructed with bottle brick and cement mortar

The formula used is:

$$Compressive\ strength = P/A(MPa) \quad (1)$$

Where P = Load at failure in kN. A = Area subjected to compression in mm^2

Table 1. Experimental testing data

Load (kN)	Area (mm^2)	Compressive strength (MPa)	Average (MPa)
249.65	11250	22.191	20.63
214.150	11250	19.036	
236.73	11250	21.04	
227.83	11250	20.25	

V. Cost Analysis

Calculation of bottle brick: Average weight of 1 litre empty bottle = 0.025 kg Cost of 1kg waste plastic bottle = Rs. 10 Number of plastic bottle in 1kg = (1000/25) =40 Cost of 1 waste plastic bottle = (10/40) =0.25 Quantity and cost of brick kiln dust:- Cost of brick kiln is free of cost. Total cost of bottle = Rs. 0.25 Cost of conventional brick = Rs. 5.5 Profit in one brick = (5.5 – 0.25) = Rs. 5.25

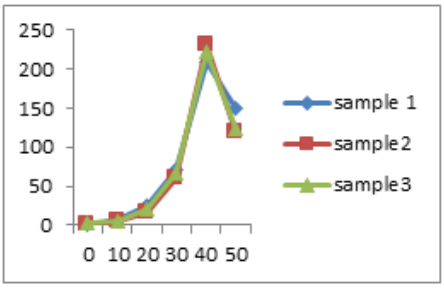

Fig. 3. Load vs. Elongation

Fig. 4. Testing of bottle brick in UTM

Fig. 5. Crushed bottle brick after testing

VI. Conclusion

From above result it can be easily concluded that the bottle brick are having higher compressive strength than conventional brick. Also it is way cheaper and economical than the conventional brick. So it is easily concluded that bottle brick can be a good alternate for constructing low cost housing facility for low income group. Implementation of the study will not lead to give only low cost housing but, also provide a better way reusing and managing the solid waste like PET bottles and brick kiln dust.

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