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Manufacture of Bricks using Laterite Quarry Dust and Melted Plastic

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Abstract:
Plastic is a non-bio degradable substance which causes pollution to the environment if not disposed effectively. The quantity of plastic waste (PET, PP etc.) is expanding rapidly day by day. On an average in India 0.5 grams of plastic waste is generated by per person per day. Laterite quarry dust is the minute particles available abundantly during the extraction of laterite stone. These dusty particles scatter in the air and cause air pollution. On the other hand, there is depletion in the availability of building materials. This project aims on manufacturing an alternative building material by combining plastic, laterite quarry dust and some amount of bitumen as binding material. To find the optimum dosage of plastic so that the brick has high compressive strength and less water absorption, bricks are made of various percentages of plastic varying from 20% to 70% plastic with 2% bitumen as binding material. It is a sustainable and effective way of managing laterite quarry dust and plastic waste to minimise environmental pollution.

Keywords: plastic waste, laterite quarry dust, bitumen, alternative building material, high compressive strength and less water absorption.

1 .INTRODUCTION

There has been considerable imbalance in demand and supply of raw materials for construction and due to rapid growth in construction there is huge depletion of natural resources which in turn causes harm to nature. Laterite stone is a type of stone found commonly in southern Asia and is named by Henry Buchannan in 1807. The word 'later' stands for brick in Latin. These stones can be cut into brick shape and used directly in construction. Laterite soils contain iron, aluminium, manganese and titanium oxides. Iron and aluminium oxides are prominent in laterite soil which gives the reddish-brown colour to it. It is commonly formed in hot and wet tropical areas. Laterite quarry dust is the minute particles produced at laterite quarry during extraction of laterite stone. Laterite quarry dust is a by-product of laterite quarry which is abundantly available but not used in any construction and disposal of this requires huge land area and it also is a reason for air pollution and this causes nuisance to the surroundings. Plastic is useful as well as a hazardous material. Plastic, a non-biodegradable that remains as a hazardous material for decades. It is estimated that the rate of expansion is double for every decade. This is due to rapid growth of population, urbanization, developmental activities and changes in life style, and economic growth of people which leading widespread littering on the landfills. Research have found that the plastic materials can remain on earth for 4500 years without degradation. In India approximately 40 million tons of the municipal solid waste is generated annually. Hence, these waste 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 ban the use of plastic but the reuse of plastic waste in building constructions, industries are considered to be the most practicable applications. A brick is a building material used for the construction of walls, pavements and other masonry elements. A brick can be fabricated of clay bearing soil, sand, lime or concrete materials. Bricks are usually made of clay which is put in the moulds and then baked in oven. The colour of these bricks depends on the type of clay from which it is manufactured. Laterite quarry dust and plastic both are waste materials which when left without use causes pollution and harm to environment. In order to preserve and protect the environment and to fulfil the construction demands, it is required to promote the use of these waste materials to form beneficial building materials.

Laterite quarry dust and plastic can be merged together to obtain eco-friendly bricks. The aim of our project is to manufacture bricks in different proportions of plastic and laterite quarry dust so that an optimum percentage of each ingredient is obtained which gives high strength and less water absorption. Various tests are done on laterite quarry dust and its results are obtained. A small percentage of Bitumen is used as a binding material for these bricks.

2. LITERATURE REIVEW

Maneeth P D, et.al, (2014), [1]

In this paper, bricks of different mix proportions were prepared with varying plastic (PET, PP), laterite soil (passing 2.36mm IS Sieve) and bitumen content, and the bricks were tested for compressive strength and water absorption. This study showed that strength of these bricks was dependent on plastic percentage and minimum 60% of plastic by weight is required for plastic soil bricks by trial and error method. 70% of plastic by weight was considered as the optimum dosage of plastic in the view of workability criteria and 2% of bitumen was taken as optimum binder content which resulted in compressive strength of 8.16N/mm^2 which is higher than laterite stone (3.18N/mm^2)and has less water absorption of 0.9536% than laterite stone. So, it can be a better alternative material and solves the problem of safe disposal of plastics and effective utilization of quarry waste is achieved.

Dinesh.S, et.al, (2016), [2]

This paper is the attempt made to study regard the properties of the bricks and paver blocks which are manufactured using plastic wastes, river sand and some colouring agents like red oxide. Various mix proportion of plastic and river sand (1:2, 1:3, 1:4, 1:5, and 1:6) were made and tested for compressive strength using compressive testing machine and water absorption test. From this study it was concluded that plastic soil bricks possess more advantages like cost effective because the natural resources consumed for the manufacturing of these bricks and paver blocks are very much less when compared to conventional one. The manufacturing cost could be reduced further by replacing the river sand with fly ash/quarry dust or other waste products. These bricks and paver blocks also abolish the land requirement problem for dumping plastic wastes and this method is more suitable for countries which has difficult to dispose/ recycle the plastic wastes.

LairenlakpamBillygraham Singh, et.al, (2017), [3]

In the present paper, bricks or building blocks were manufactured from sand and waste plastics after heating at 200^{o}c and tested for some physical and mechanical properties. On the basis of results obtained from the study it was concluded that these bricks can be used as alternative for available traditional clay bricks because of its lower water absorption, bulk density, apparent porosity and high compressive strength. This process of brick making provides an effective way of disposing waste plastic thereby can help reduce the environmental pollution making environment clean and healthy.

Keerti M Nashimath, et.al, (2016), [4]

In this paper, the authors are attempting to manufacture the bricks by using waste plastic in the range of 65% to 85% by weight of laterite soil and bitumen as a binding material in the range of 4% to 12% by weight of soil. From the test results, it is found that the bricks are with negligible water absorption and satisfactory compressive strength in comparison with normal bricks. The tests are conducted for different percentages of bitumen for varying plastic content. It is found that the compressive strength increases with increase in plastic content. When the content of plastic and bitumen is maximum higher value of compressive strength is observed. For 85% plastic and 12% bitumen content the compressive strength was found to be 6.56N/mm^2. For varying plastic contents and with bitumen content 8% the compressive strength decreased. The maximum compressive strength obtained is 6.56 N/mm^2 which is almost same as the compressive strength of second class brick [7 N/mm^2].

Puttaraj Mallikarjun Hiremath, et.al, (2014) [5]

This paper makes an attempt to manufacture the bricks by using waste plastics in range of 60 to 80% by weight of laterite quarry waste and 60/70 grade bitumen was added in range of 2 to 5% by weight of soil in molten form as a binding material. This bitumen- plastic mixture is then mixed with laterite quarry waste to manufacture the bricks. The bricks manufactured has various properties such as neat and even finishing, negligible water absorption and adequate compressive strength in comparison with laterite stone to fulfil the increasing demand of conventional building materials.

The compressive strength for plastic-soil bricks with 70% plastic content by weight of soil with bitumen content of 2% by weight of soil gives a compressive strength of 8.16N/mm^2 which is greater than laterite stone (3.18N/mm^2). It also has a lesser water absorption (0.9536%) than laterite stone (14.58%). This proves that, it can be a better alternative building material. It is also observed that on increasing the percentage of binder material (bitumen) the compressive strength of brick increases up to 5% (10 N/mm^2), but further increase in bitumen decreases the strength(2.04N/mm^2). But by considering the economy, 2% of bitumen content is taken as optimum binder content which results in compressive strength 8.16 N/mm^2 which is greater than laterite stone (3.18 N/mm^2). The efficient usage of waste plastic in plastic-soil bricks has resulted in productive usage of plastic waste and thereby can solve environmental problems by safely disposing the plastic waste and avoiding its wide spread littering. The utilization of quarry waste has also reduced the problem of its disposal to some extent.

3. OBJECTIVES

The main objectives of our project are:

- To obtain eco-friendly bricks from waste materials, that is, plastic and laterite quarry dust.
- To reduce pollution which is caused by plastic and laterite quarry dust.
- To arrive at the optimum dosage of plastic that could result in building material with good strength and less water absorption.
- To develop an alternative building material.
- To compare conventional and fusion bricks.

4.MATERIALS USED IN PROJECT

Laterite quarry dust

Laterite soil or rock is seen in hot and wet tropical areas like coastal region and some northern regions of Karnataka and also in the northern parts of Kerala, due to which lot of quarrying of laterite bricks takes place. Laterite is rich in in iron and aluminium and because of its iron oxide content it gets its rusty red colour. Laterite rock is usually cut into brick shaped blocks for building construction. Laterite rocks in laterite quarries are cut into laterite stones with the help of cutting machines, during this process 15-20% of soil wastes are generated and it is termed as quarry dust. These dusty particles scatter in the air and cause air pollution. For the present study the samples are collected from the laterite stone quarry nearer to Mudipu.

Plastic

Plastic is a material consisting of any of different types of synthetic or semi-synthetic organic compounds that are shapable and so can be moulded into any solid objects.It is produced from a wide range of organic polymers such as polyethylene, PVC, nylon, etc., that can be moulded into various shapes while it is soft, and then set into a rigid or slightly elastic form. Plastics have a number of properties that make them superior to other materials in many applications. Plastic waste is obtained from various sources such as residential, commercial, institutional and industrial sources. The highest amount 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).

The plastic used in our project is procured from Moogambigai metal refinery, industrial area in Baikampadi.

Bitumen

Bitumen is form of petroleum consisting essentially of hydrocarbons and their derivatives. It is a black, sticky and highly viscous solid or semi solid material. Bitumen is mainly used in road construction. Bitumen possesses the characteristics properties like Adheres, Elastic, Plastic and Viscoelastic. Bitumen is mainly used in plastic-laterite bricks to improve the binding property of melted plastic and it coverts thermoplastic plastic into thermosetting plastic. Use of 2 to 5% of bitumen by weight results resistivity and better resistance to water of plastic-laterite brick is severed because of usage of bitumen content. In strength gain because of its good bondage in the molten soil plastic mix. Improved thermal resistivityand better resistance to water of plastic-laterite brick is severed because of usage of bitumen content.

5. METHODOLOGY

The dimensions of the mould used in our project is 17.5 ×10.5 ×7.5 cm.

Initial tests on laterite quarry dust:

Table.1. Initial tests

Sl.no	Tests conducted	Results
1.	Specific gravity	2.56
2.	Moisture content (%)	10.84
3.	Liquid limit (%)	37.7
4.	Plastic limit (%)	29.05
5.	Optimum moisture content (%)	1.84
6.	Optimum dry density (g/cc)	22.3

Initial test on bitumen:

Penetration value = 67.33mm

Procedure for manufacture of bricks:

- Raw materials were procured.
- Initial tests were conducted for all the materials.
- Initially the bricks were casted in trial and error method to find out proper brick casting procedure.
- Mix design was calculated for various percentage of plastic and were accordingly proportioned.
- Plastic and laterite quarry dust was mixed and heated in furnace till the mass is of pouring consistency.
- Bitumen was added in small amount (2 to 5 %).
- Bricks were casted when the mix is in molten state in 3 layers and consolidated.
- Bricks are allowed to cool.
- After an hour mould is removed bricks are allowed to set and cool further.

Figure. 1. Soil-plastic brick casted

6. TESTS CONDUCTED ON BRICKS

To know the quality of bricks of various percentages of plastic mixed with laterite quarry waste with small amount of bitumen, following tests are performed. The water absorption test and Compressive strength on bricks of size 17.5x10.5x7.5cm was conducted and the test result is as shown Table 2 and 3 respectively.

Table .2. Water absorption test

Sl.no	Plastic %	Dry weight	Wet weight	Water absorption %
1.	20	2.9075	3.015	3.7
2.	40	2.43	2.477	1.9
3.	50	2.234	2.255	0.94
4.	60	1.989	2	0.55
5.	70	1.649	1.657	0.48

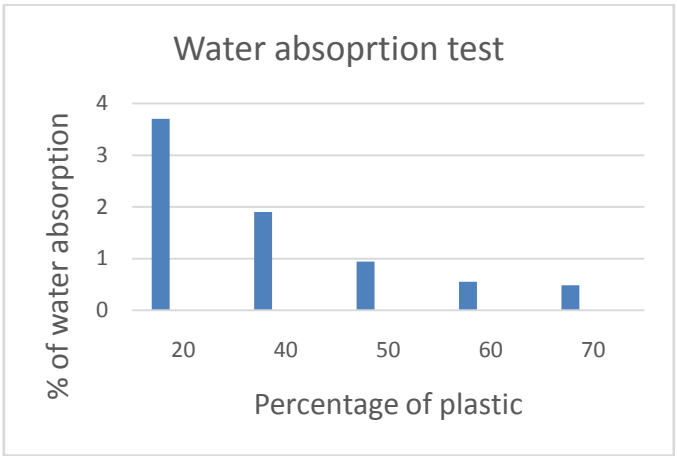

Figure.2. Bar graph showing the results of water absorption test

It was found that Water absorption percentage decreases with increase in percentage of plastic content because of water resistant property of plastic and bitumen.

Table .3. compression test

Sl no.	% of plastic	Compressive strength (N/mm^2)
1	0	2.16
2	20	3.38
3	40	4.52
4	50	5.66
5	60	7.4
6	70(2% bitumen)	8.0
7	70(5% bitumen)	9.1

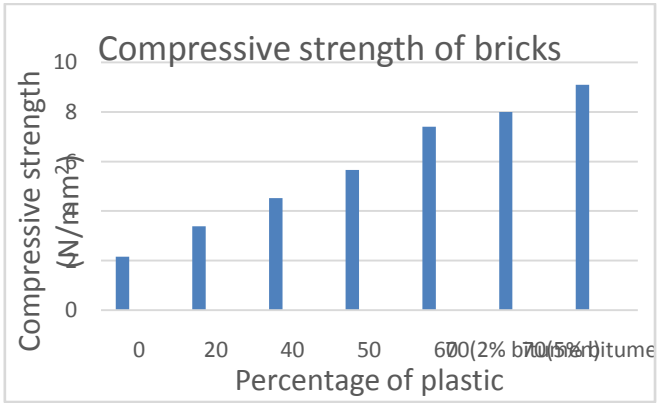

Figure.3. Bar graph showing the results of compressive strength

From the results obtained it was found that compressive strength increases with increase in percentage of plastic. So, it is concluded that strength of these bricks depends on percentage of plastic.

7. RATE ANALYSIS

Rate of 5000 units of plastic bricks for mix design of 70% of plastic content, and it was estimated that cost of one brick is approximately 4 rupees.

Table.4. estimation for 5000 units

Sl no	Item	Quantity	unit	Rate/unit	Amount
1.	Laterite quarry dust (rate includes collection and transportation charges)	4350	kg	0.75	3262.5
2.	Bitumen	100	kg	40	4000
3.	Plastic	6000	kg	0.5	3000
4.	Labour	Ls			1750
5.	Total				12012.5

Rate comparison of conventional brick wall and plastic bricks

For 1 m^3 of Conventional brick masonry wall in cm 1:6 was estimated to be approximately Rs.7046.85whereas laterite quarry dust and plastic bricks it was found to be Rs.4546.875.

8. COMPARISON OF CONVENTIONAL AND PLASTIC BRICKS

Particulars	Conventional bricks	Plastic bricks (70%)
Raw materials	Clay, other muds	Laterite quarry dust, plastic
Casting	Ground moulded or table moulded	Melting in furnace
Compressive strength	2.16 (N/mm^2)	8 (N/mm^2)
Water absorption (%)	3.7	0.48
Cost per unit	Rs.8	Rs.4
Cost of construction for $1m^3$	7046.85	4546.874
Effect on environment	Depletion of natural resources.	Utilisation of two waste materials.

9. CONCLUSION

It was concluded that properties of these fusion bricks depend on the percentage of plastic content. Compressive strength of the bricks increases with increase in percentage of plastic and Water absorption percentage decreases with increase in percentage of plastic content because of water resistant property of plastic and bitumen. It was also concluded that the 70% of plastic content was the optimum plastic content because the compressive strength of brick with 70% of plastic content by weight of soil with 2% of binder which is bitumen is 8.00N/mm^2 which is higher than late-rite stone which has compressive strength of 2.16N/mm^2.And has a lesser water absorption percentage (0.48%) than laterite stone (14.58%). So, it can be a used as alternative building material. From the compressive strength test results of fusion bricks for constant plastic percentage and varying bitumen percentages by weight of soil, it is observed that compressive strength increases with increasing of bitumen percentage. Compressive strength of brick with 70% of plastic and 5% of bitumen is 9.10N/mm^2. But from economic considerations bricks with 2% of binder (bitumen) content is taken as optimum binder content. The cost estimation for both laterite stone and fusion bricks was done and it was found that that fusion bricks are cheaper than laterite stone. Therefore, these bricks are more economical compared to ordinary laterite stone. Manufacturing bricks using laterite quarry dust and waste plastic provides an efficient usage of waste plastic and thereby contributes for the solution for the problem of safe disposal of plastics, also avoids its wide spread littering. Utilization of quarry waste has reduced to some extent of air pollution and the problem of its disposal. And thereby reducing pollution and creating safe and sound environment.

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