Review on Polyethylene Lateritic-Clay Brick

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Abstract - *Bricks are used as a building material for a past few decades. This single material can be used to enclose a structure with load-bearing wall which is durable and if properly constructed requires practically no maintenance. Generally clay is being used for making bricks but due to the environmental degradation mainly to the soil and to the vegetation an alternative to this is to be find out. Laterite is readily available thus making it easier to be used as a building and construction material. The main problem associated with earth based brick is its durability and service life. This can be improved in a laterite brick by the addition of recycled plastic which will act as a reinforcing element. Disposal of plastic waste is the serious threat that we are facing now mainly the disposal of PE and PET. This review paper explores the potential application of plastic waste (polyethylene) in the manufacturing of bricks, as an ingredient for alternative brick material. Utilization of plastic wastes in the production of bricks is a solution to pollution and landfilling problems, helps in reduction of high cost of building materials and leads to achieving the goal of developing a sustainable building material.*

Key Words: Laterite, Plastic, sustainable material, polyethylene, clay

1. INTRODUCTION

Brick is the simplest and most ancient of all building materials. This enduring public acceptance is based on the unique combination of the properties offered by brick to the owner and builder. This single material can be used to enclose a structure with a decorative, load-bearing wall, which is exceptionally durable and, if properly constructed in the first place, requires practically no maintenance. A brick can be composed of clay-bearing soil, sand, and lime or concrete materials. Utilisation of local materials is an important step to sustainable construction by reducing transportation cost, embodied energy and environmental protection . Laterite, a type of soil rich in iron and aluminium formed in hot and wet tropical conditions, is a popular building material utilised in tropical and subtropical regions of the world where it is readily available and economical compared to other natural stones . Despite its long term use in building applications worldwide, only few countries have scientifically documented its engineering properties and standards. Indian standards code IS 3620-1979 provides specifications and standards for laterite masonry construction in India (IS 3620-1979).

Laterites are products of the chemical weathering of naturally occurring rocks. The soil formed is usually rusty-red or reddish brown, due to the presence of iron in the oxides. It is often found in tropical regions, especially in wet and hot areas. Laterites have been recommended for the construction of roads and dams, as well as applications as fillers for soil reclamation. The uniform distribution and availability of well graded particle sizes of laterites, as well as their compressibility enable the moulding of bricks with improved mechanical properties. However, the use of laterites alone in bricks does not provide the required strengths for load-bearing structures. There is, therefore a need to mix them with binders, especially cement or lime, to enhance their mechanical properties.

Plastics are considered as one of the important invention which has remarkably assisted in different aspect of life whether in the scientific field or others. It is a fact that we can recycle the plastic and make it usable for number of times so that its wastage will be reduced remarkably. Plastic-waste materials are produced plentifully, such as polyethylene terephthalate plastic bottles, polypropylene (PP) of plastic sack, and polypropylene (PP) of carpet. But such materials have been used little for engineering purposes. Only 5 per cent of the world's plastic waste is recycled and the remaining 95 per cent ends up in landfills, litter or in the oceans. Plastic constitutes approximately 90 per cent of all trash floating on the ocean's surface, with 46,000 pieces of plastic per square mile. In contrast, there have been relatively few efforts to incorporate plastics into blocks, although plastics are often recycled into pipelines that are often used in buildings. Such recycling of plastics could facilitate the reduction in the cost of building blocks that are produced from laterite and concrete. They could also improve the strength and fracture resistance of laterite and cement matrix composites

This review is aimed at presenting different research updates on utilization of laterite soil and polyethylene for sustainable building applications. Although different types of material have been used for soil stabilization in the past but solid plastic pellet has never been used for replacement. If found to be useful as replacement, then, environmental risks and hazards caused by plastic wastes will be greatly reduced.

1.1 Study On Laterite Soil As Construction Material

Samiullah Sohu et al (2016) Compressed Stabilized Earth Brick (CSEB) is a sustainable material utilizing locally available soils mixed with stabilizers to increase its strength. Two main factors affecting the strength of prototype are its compressive strength and water absorption rate. In there study they made a mix proportion ratio for producing Compressed Stabilized Earth Block prototypes from laterite soil and clay as 1:10 (cement : soil). And three different compactions (i.e. 2000, 3000, and 4000 Psi) were applied to produce prototypes with dimension of 100×50×40 mm. Then the samples were tested at the ages of 7 and 28 days. For laterite soil CSEB, the optimum strength was achieved by the sample subjected to 2000 Psi compaction, with its compressive strength of 9.0 N/mm^2 and water absorption rate of 14.9%. For clay CSEB the optimum strength observed was the sample subjected to 4000 Psi compaction, with the compressive strength of 5.8 N/mm^2 and water absorption rate of 17%. The study revealed that the increased in compression pressure would result in different strength performances for both CSEBs made from laterite soil and clay.

Laurent Mbumbia (2001) various studies conducted previously shows that the properties of some laterite building bricks abundant in tropical areas can be improved by stabilization through heat at low temperatures. Further investigations based on a series of laboratory tests were carried out on these brick specimens subjected to uniaxial compressive loading at room temperature. The characteristics of the stress-strain relationship are presented for predicting brick performance. When subjected to deformation, they behaved nonlinear plastic-elastic-plastic. They were found to exhibit linear elasticity in a domain where strain varied between 2 and 5% according to the type. These values of strain were found to be higher than the maximum elastic strain Ž0.5%. Observed for many ceramics.

P. Yohanna et al (2018) In this journal the effect of rice husk ash admixed with treated sisal fibre on properties of lateritic soil as a road construction material was studied. Treatment of the soil was done with Rice Husk Ash (RHA) and treated Sisal Fibre (SF) in varying concentrations of 0, 2, 4, 6, 8% and 0, 0.25, 0.5, 0.75, 1.0% by dry weight of soil, respectively. Preliminary test, compaction test and unconfined compressive strength (UCS) test were carried out. Outcome of the laboratory tests show that MDD decreased from 1.85 mg/m^3 for the natural soil to 1.73 mg/m^3 at 0% RHA/1% SF content. The OMC increased from 18% for the natural soil to 26.5% at 6% RHA/1% SF content. The UCS increased from 100.57 kN/m^2 for the natural soil to 139.38 kN/m^2 at 0% RHA/0.25%SF content by dry weight of soil. The increasing trend continued to 696.63 kN/m^2 at optimum 6% RHA/0.75%SF content by dry weight of soil, which met the regulatory minimum UCS value of 687–1373 kN/m^2 for pavement applications. Based on the results obtained, an optimum blend of 6%RHA/0.75% SF content by dry weight of soil is recommended for used as sub-based material for lightly trafficked roads .

Neelu Das & Shashi Kant Singh(2016) they conducted an experimental programme to study the effect of individual and combined inclusion of locally available brown waste materials (areca nut husk, water hyacinth stem) and commercial synthetic fibre (recron 3s) on the geotechnical characteristics of a lateritic soil. Two models of fibre reinforcement on soil were considered: firstly, the fibres were mixed randomly with the soil and secondly, the fibres were introduced sequentially in horizontal discrete layers in the direction of the major principal plane of the soil matrix. A series of laboratory tests including the compaction test, unconfined compressive strength and California bearing ratio were carried out on soil reinforced with areca nut coir, water hyacinth stem and recron fibre at systematically varying percentages of them to examine their influence on the strength of reinforced soil. Samples reinforced with recron and coir, individually and in combination showed increasing strength with increase fibre content in both the models, while water hyacinth stem showed an initial increase followed by a decline at higher fibre content. The optimum fibre content of 0.5% for areca nut coir, 0.5% for recron and 0.125% for water hyacinth stem by dry weight of soil were recommended for strengthening the lateritic soil.

R. Jibrin et al (2014) Reclaimed Asphalt Pavement (RAP) was used for stabilization of a deficient lateritic soil, classified as A-6 and CL according to AASHTO and Unified Soil Classification System, respectively. The RAP, in a cold state, was mixed with the lateritic soil at varying percentages of 0, 5, 10, 15, to 100 %. California Bearing Ratio (CBR) and Unconfined Compressive Strength (UCS) were used as evaluation criteria for specimens of the soil-RAP mixtures, compacted at British Standard Heavy (BSH) energy level. The strength evaluation was carried out at 60 % RAP mixture which was found to be the optimum RAP content that gave the highest MDD. Extraction test result on the RAP gave 7.3 % bitumen content which is slightly higher than the 7.0 % maximum recommended. There was 12.7 % increase in MDD which occurred at 60 % RAP content. The Optimum Moisture Content (OMC) decreased by 31.3 %. The result of CBR on the soil and soil mixed with 60 % RAP showed slight increase of 7.2 %, while 9.9 % increase was recorded for the Unconfined Compressive Strength. The slight increase in strength was attributed to the cold state of the asphalt, which makes its adhesive (plastic) properties not pronounced.

Aisyah Kasim et al (2017) This research was carried out in an attempt to know the physical properties of laterite soil with the appearance of difference percentage of sodium bentonite. When sodium predominates, a large amount of water can be absorbed in the interlayer, resulting in the remarkable swelling properties observed with hydrating sodium bentonite. There are some basic physical properties test conducted in this research which are Specific Gravity Test, pH Test, Sieve Analysis, Hydrometer Test, Shrinkage Limit and Atterberg Limit. The test will be conducted with 0%, 5%, 10%, 15% and 20% of sodium bentonite. Each test will be repeated three times for the accuracy of the result. From the physical properties test the soil properties characteristic react with the sodium bentonite can be determine. Therefore the best percentage of sodium bentonite admixture can be determined for laterite soil. The outcomes of this study give positive results due to the potential of sodium bentonite to improve the laterite soil particle.

Deepa G Nair et al (2015) Tropical countries are rich in lateritic soil, a naturally available raw material for building construction. But its potential in block making is not yet satisfactorily explored. This paper focuses on an experimental investigation for improvising stabilized lateritic blocks (SLB) with coir cutting wastes from coir industry as reinforcing elements. Lateritic soil used in this study showed a higher percentage of clay content. Hence it was pre-stabilized with sand and cement. Blocks were prepared by stabilizing it further with waste fibrous additives and tested for strength and durability. Considerable improvement in strength (compressive strength @19% and tensile strength @ 9%) and durability characteristics were exhibited by the new fiber reinforced lateritic blocks (FRLB) with fiber content of 0.5%. These blocks can be successfully proposed for load bearing construction and as well as for earthquake resistant structures

1.2 Study On Polyethylene As Construction Material

Bolaji Aremo (2008) in this study he investigated the enhancement of polyethylene properties through the use of additives to make it suitable as a roofing material. To function as a roofing material, weatherability (resistance to photo-oxidation), low flammability, and good strength were identified as the key requirements that must be met by the polymer. The additives: carbon black, clay, and ammonium chloride were compounded with the polyethylene. Carbon black was used to protect against photo-oxidation; ammonium chloride was used as a flame retardant, and clay served as a flame retardant while also imparting hardness. ASTM D638-46T tensile test pieces were used to determine the strength of the mixtures, the horizontal UL 94 incipient regime flame test was used to determine flammability, and a simulated weathering test was developed to evaluate weatherability. Results indicated that at about 8.96% clay and 17.42% ammonium chloride, the polyethylene matrix has an average strength of 3.04±0.42MPa3.04±0.42MPa. The horizontal UL 94 fire test showed a marked improvement of flammability properties over that observed for virgin polyethylene.

Maneeth P D (2014) studied the effect on Utilization of Waste Plastic in Manufacturing of Plastic-Soil Bricks. The gradation test conducted on laterite quarry waste showed that Cu > 15 and 1 < Cc < 3 which indicates, the laterite quarry waste is well graded this shows its suitability to be compacted into a denser state while manufacturing of plastic-soil bricks. The compressive strength test results for plastic-soil bricks with 70% plastic content by weight of soil with the binder(bitumen) content of 2% by weight of soil will gives a compressive strength of 8.16N/mm2 which is higher than laterite stone (3.18N/mm2).And has a lesser water absorption(0.9536%) than laterite stone (14.58%). So it can be a better alternative building material. The compressive strength test results for 70% plastic content by weight of soil with the binder(bitumen) content of 2% by weight of soil, it is observed that in place of Poly-ethylene teryphthalate (PET), if Poly propylene (PP) is used will result in high strength(10N/mm2). But the availability of PP waste is comparatively less.

Dinesh.S (2016) studied the effect on utilisation of waste plastic in manufacturing of bricks and paver blocks. High-density polyethylene (HDPE) and polyethylene (PE) bags are cleaned and added with sand and aggregate at various percentages to obtain high strength bricks that possess thermal and sound insulation properties to control pollution and to reduce the overall cost of construction, this is one of the best ways to avoid the accumulation of plastic waste which is an on-degradable pollutant. This alternatively saves the quanta of sand/clay that has to be taken away from the precious river beds/mines. This method is suitable for the countries which has the difficult to dispose /recycle the plastic waste. The natural resources consumed for the manufacturing of Plastic sand bricks and Paver blocks are very much less when compared to its counterparts. The manufacturing cost could be reduced further by replacing the river sand with fly ash/quarry dust or other waste products. Owing to the numerous advantages further research would improve the quality and durability of plastic sand bricks and paver blocks.

Puttaraj Mallikarjun Hiremath (2015) There has been a considerable imbalance between the availability of conventional building materials and their demand in the recent past. On the other hand the laterite quarry waste is abundantly available and the disposal of waste plastics (PET, PP, etc.) is a biggest challenge, as repeated recycling of PET bottles pose a potential danger of being transformed to a carcinogenic material and only a small proportion of PET bottles are being recycled. In this study an attempt has been made 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 and this bitumen- plastic resin was mixed with laterite quarry waste to manufacture the bricks. The bricks manufactured possess the properties such as neat and even finishing, with negligible water absorption and satisfactory compressive strength in comparison with laterite stone to satisfy the increasing demand of conventional building materials. The study concluded that laterite soil stabilized with 7% cement for manufacturing of interlocking bricks with a good compressive strength of 4.72 N/mm^2.

Shikhar Shrimali (2017) This study reviews one of the sustainable and effective ways of managing plastic waste in urban and rural parts of India in order to minimize their adverse environmental impacts. The requirement for such a research is validated as it is desirable to change the unsustainable arrangement of consumption, production and disposal associated with these materials. After studying the whole scenario, developed an effective way of utilizing the soft plastic waste and recycling it into plastic bricks which are very light in weight and can withstand high amount of pressure as compared to standard modular bricks. However due to some physical and chemical properties of plastic which can be disadvantageous to the brick created from it, some changes in its design and manufacturing processes can be made. The plastic brick is compressed by the two iron rods. Firstly the plastic waste is being collected in bulk amount. Then a modular brick mould is being taken and plastic waste such as crisp bags and polythene bags are filled in it. Air tight amount of plastic waste has to be filled in the mould. After that the mould is closed with a metal plate on it and allowed to heat in a solar grill oven for 1 hour. Then the mould is taken out from the oven and cooled down immediately with a jet spray. After this with the help of mechanical means the plastic brick is being removed from the mould.

Lairenlakpam Billygraham Singh (2017) studies performed to manufacture bricks or building blocks from sand and waste plastics. The bricks are produced by mixing waste plastic and sand after heating at 200^{o}c. Two specimens of bricks, one with sand and waste CDs; another with sand and waste water bottles are produced and tested for some physical and mechanical properties. The sand-plastic bricks are lightweight and present a waxy surface. The results of sand plastic bricks are compared with those of traditional local bricks. It is observed that sand plastic bricks have low water absorption, low apparent porosity and high compressive strength. The present research is performed to study the properties of bricks manufactured by mixing sand and waste plastics. This study is expected to provide some information regarding the suitability of such sand plastic bricks for use in construction industry.

Ayman M. Othman (2010) Conducted laboratory evaluations to study the effect of using low-density polyethylene (LDPE) additive on the fracture toughness of asphalt concrete mixtures. LDPE was mixed with asphalt at 160°C160°C and incorporated into the mixture. LDPE content of 1.5, 3, and 4.5% by total weight of asphalt was adapted. Fracture toughness evaluation was based on the J-integral concept. Innovative semicircular specimen geometry (76-mm radius and 57-mm thickness) is employed in fracture toughness evaluation. Notches with different depth-to-radius ratios were introduced at the middle of the flat surface of each specimen. Application of the J-integral concept revealed the fracture toughness superiority of the LDPE-modified asphalt concrete mixtures as compared to the unmodified mixture. The fracture toughness is sensitive to the LDPE concentration. Mixtures modified with 4.5% LDPE experienced the highest fracture toughness. LDPE modification has also enhanced the physical

Akinola Johnson Olarewaju (2016) studied the effect of Densification characteristics of lateritic soil stabilized with plastic pellets. The plastic was grounded into pellets and were sieved to determine the particle size distribution. For laterite mix, plastic pellets were substituted in the lateritic soil at 1%, 2%, 3%, 4%, 5%, 6%, 7%, 8% and 9% with 0% serving as control. The tests conducted in line with BS 1377 (1990) are the moisture content, specific gravity and compaction. From the soil classification, it was observed that the lateritic soil sample is sandy-clay-loam. It was also observed that plastic pellets slightly increases the bulk densities and dry densities in the same proportion at 1% to 9% plastic as the percentage water content increases. From the results, plastic pellets could be used as stabilizing material for road construction. This will reduce the environmental risk and hazard caused by plastic waste.

2. CONCLUSIONS

The challenges, opportunities and strategies for waste management in construction industry presented will help private and governmental agencies to develop sustainable construction methods. Sustainable approach of waste management by recycling and reuse will aid in reduced cost, environmental pollution, energy demand, and conservation of natural resources. Judging from the available literature the following conclusions can be drawn:

- Lateritic soils are well suitable with minimal stabilization as durable materials in the production of compressed earth bricks.
- Lateritic soils are readily available especially in the tropics and sub-tropical regions and possess adequate grading characteristics required for the production of durable CEBs. Other types of soil may be used but will need more added stabilizer or mixing.
- Strength and durability of CEBs depend on the parent rock material, which determines the mineralogy, grading characteristics and type of soil derived. These parameters will also determine the amount and type of stabilizer, compaction pressure in moulding of bricks, method and duration of curing.
- Finally, for the sake of the environment, firing of clay bricks should be discouraged as much as possible since adequate stabilization methods could be employed in achieving any required strength of bricks for various construction purposes. Equally, the use of fibers have proven efficient in improving strength and durability of bricks.
- The final product and whether only stabilization or additional firing of earth materials are needed will depend on the geology of the soil, including the mineralogy, weathering mode and stage as well as the climatic region
- The new approaches on the utilisation of plastic waste in cities as alternative materials for urban developmental programs, referred to as urban symbiosis, could help reduce green house gas emissions and fossil fuel consumption. Reinforcement of soil to improve its strength properties for civil engineering construction is a possible means to put to use the abundant plastic bag waste. This will tap into the plastic resource

that possesses great versatility and yet in the same vein poses a danger to the environment if not well managed in terms of responsible disposal that involves resource recovery which is vital in contributing to sustainable development

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