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Performance of Shred Tires and Wood Particles in Earth Bricks

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ABSTRACT

The earth brick are including of clay, water and different materials. The earth bricks can make an evolution for reduce of cost and increase of compressive strength compared to concrete blocks. The last experiments showed weakness in earth blocks without additional materials. Thus we had many testing in earth bricks with different additional materials. In this paper we had survey role of shred tires in earth brick strength compared to wood particles. This paper showed change of compressive strength in earth bricks with different additional material due to made different bricks with shred tires and wood particles by sizes 10cm×10cm×10cm in compressive tests 3,7,14 and 21 days and bricks had 20% moisture content. The tires are one of which environmental pollution and less is used after consumption in the automotive industry, thus we used a cheap material for survey of strength in earth brick.

INTRODUCTION

Earth bricks should ideally be made with earth containing a clay content of not more than 80% and not less than 50%, the reminder being sand and granular material. It’s, at this stage, helpful to know a little about the crystal structure of clays [Deer 1992]. The actual clay minerals are the hydrated aluminum silicates, which may be divided into three basic groups, the kaolin group, the montmorillite group and the illite group. Kaolin clays have a non-expanding crystal structure, while clays of the other two groups have expanding crystal structures. Clays with expanding crystal structures will expand in volume when water is added, and at this water is evaporated, drastic shrinkage and cracking will occur [Niroumand 2007]. Thus earth bricks made using kaolin clays (even in a high percentage) will show little cracking. They are also very strong, with a high heat resistance, and show little water damage even if wet shortly after they have been made. Pure kaolin is white and usually occurs as subsurface clay.

A mould may be nothing more than four boards nailed together with handles attached at either end. Our first choice will be whether to have a single or a multiple mould. Single brick moulds appeal to us because we can tramp the soil down very firmly. Consideration should be given to the size of the brick. The different sizes of mould are 10cm×10cm×10cm in this research.

Tire shreds are typically shaped and vary in size, with most in the range of 1 to 25 cm long. The shredding process usually exposes the tire's internal steel belt or bead, particularly along the edges of the shreds. The average loose density of tire shreds typically ranges from 26.8 lb/ft to 37 lb/ft [5]. The average compacted density ranges from 42.6 lb/ft to 59 lb/ft. Tire shred fill has the permeability of clean gravel, approximately 1.5 to 15 centimeters/second, depending on the void ratio [4]. The shred tires, which are linked together by earth, support a tensile strength in earth bricks.

Fig1.View of Mineral Kaolinite

Fig2.View of Shred Tires & Tires

The wood particles, which are linked together by earth, support a tensile strength in earth bricks.

Fig3.View of Wood Particles

This research tested on compressive strength of shred tires reinforced mud bricks and wood particles reinforced mud bricks with moisture content of 20% in pure kaolin due to compaction test in on kaolin with different water content in geotechnical laboratory. The compaction tests were performed by the standard proctor test that the kaolin compacted by 5.5lb hammer and the mold was filled with three equal layers of kaolin and each layer is subjected to 25 drops of the hammer.

Fig4.Compaction Test of Kaolin

EXPERIMENTAL TEST

Materials

The materials of this research were pure kaolin, shred tires, wood particles and water. The Shred tires were same size due to cutting in a shredder tire. The shred tires used deterioration tires that used in vehicle cars. The tires were include of cotton its , thus they can use for tension condition in earth bricks.Tire recovery is the process of recovery vehicles tires that are no longer suitable for use on cars due to wear or irreparable damage[9]. These tires are among the largest and most problematic sources of waste, due to the large volume produced and their durability [6]. Those same characteristics which make waste tires such a problem also make them one of the most re-used waste materials, as the rubber is very resilient and can be reused in other products. Approximately one tire is discarded per person per year. The most of cost of these scrap tires were used to make automotive and truck tire re-treads with landfills minimizing their acceptance of whole tires and the health and environmental risks of stockpiling tires, many new markets have been created for scrap tires. Growing markets exist for a majority of scrap tires produced every year, being supported by State and Local Government [7]. Tires are also often recycled for use on basketball courts and new shoe products. However material recovered from waste tires, known as "shred" is generally only a cheap "filler" material and is rarely used in high volumes. It is arguable that tire crumb in applications such as basketball courts could be better described as "reused" rubber rather than "recycled".

The materials of this research were pure kaolin, wood particles and water. Wood is an organic material; in the strict sense wood is produced as secondary xylem in the stems of trees. In a living tree it transfers water and nutrients to the leaves and other growing tissues, and has a support function, enabling woody plants to reach large sizes or to stand up for themselves [10]. However, wood may also refer to other plant materials with comparable properties, and to material engineered from wood, or wood chips or fiber.

People have used wood for millennia for many purposes, primarily as a fuel or as a construction material for making houses, tools, weapons, furniture, packaging, artworks, and paper [1]. Wood can be dated by carbon dating and in some species by dendrochronology to make inferences about when a wooden object was created. The year-to-year variation in tree-ring widths and isotopic abundances gives clues to the prevailing climate at that time [12].

The wood particles were same size due to cutting in a shredder wood. The wood particles were include of fiber its, thus they can use for tension condition in earth bricks.

Kaolin was used pure and without addition materials. Kaolin is a clay mineral with the chemical composition $Al_2Si_2O_5(OH)_4$ [11]. It is a layered silicate mineral, with one tetrahedral sheet linked through oxygen atoms to one octahedral sheet of alumina. Kaolin-type clays undergo a series of phase transformations upon thermal treatment in air at atmospheric pressure. Endothermic dihydroxylation (or alternatively, dehydration) begins at 550-600 °C to produce disordered metakaolin, Al2Si2O7, but continuous hydroxyl loss (-OH) is observed up to 900 °C and has been attributed to gradual oxolation of the metakaolin. Because of historic disagreement concerning the nature of the metakaolin phase, extensive research has led to general consensus that metakaolin is not a simple mixture of amorphous silica (SiO2) and alumina (Al2O3), but rather a complex amorphous structure that retains some longer-range order (but not strictly crystalline) due to stacking of its hexagonal layers.[2]

$$2\ Al_2Si_2O_5(OH)_4 \rightarrow 2\ Al_2Si_2O_7 + 4\ H_2O$$

Further heating to 925-950 °C converts metakaolin to a defect aluminuim-silicon spinel, $Si_3Al_4O_{12}$, which is sometimes also referred to as a gamma-alumina type structure:

$$2\ Al_2Si_2O_7 \rightarrow Si_3Al_4O_{12} + SiO_2$$

Upon calcination to ~1050 °C, the spinel phase ($Si_3Al_4O_{12}$) nucleates and transforms to mullite, $3\ Al_2O_3 \cdot 2\ SiO_2$, and highly crystalline cristobalite, SiO_2:[8]

$$3\ Si_3Al_4O_{12} \rightarrow 2\ Si_2Al_6O_{13} + 5\ SiO_2$$

Mixing of Different Materials

The dry kaolin combined with optimum moisture content due to compaction test in different tests, then it mixed by kneading until made cohesion soil.

Fig 5.Mixing of Kaolin with optimum moisture content

Preparation of Earth Bricks

The size of bricks to be made 10cm×10cm×10cm and the mixture placed in three layers in steel moulds. They are involving of two layers of additional material that are shred tires and wood particles placed at 1/3 and 2/3 heights.

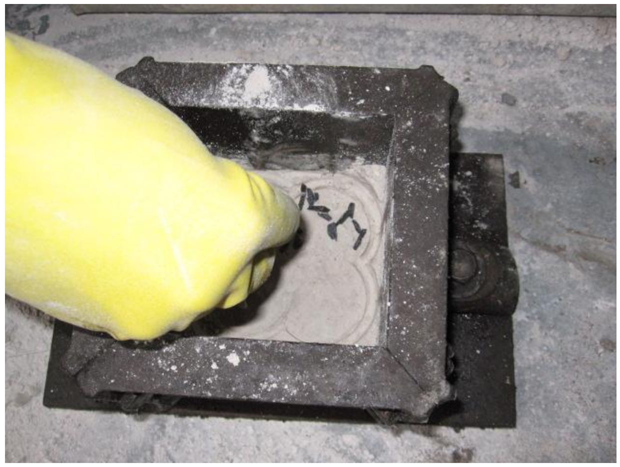

Fig6.View of Different Steps in Compressive Test

Fig7.View of 1/3 Layer with Shred Tire in Mould

Fig8.View of wood particles in 1/3 Layer of Mould

Test of Earth Bricks

The earth bricks made for 4 tests and taken out from the moulds, then they were tested for compressive strength for 3,7,14 and 21 days.

Table 1.The Results of Compressive Test of Earth Bricks with Shred Tires & Wood Particles

Type	Days			
	3	**7**	**14**	**21**
Kaolin + Water + Shred Tires	2.19 N/mm^2	2.62 N/mm^2	3.91 N/mm^2	2.28 N/mm^2
Kaolin + Water + Wood Particles	2.21N/mm^2	2.84N/mm^2	4.12N/mm^2	2.98N/mm^2

Fig 9.View of Different Cases in Compressive Test

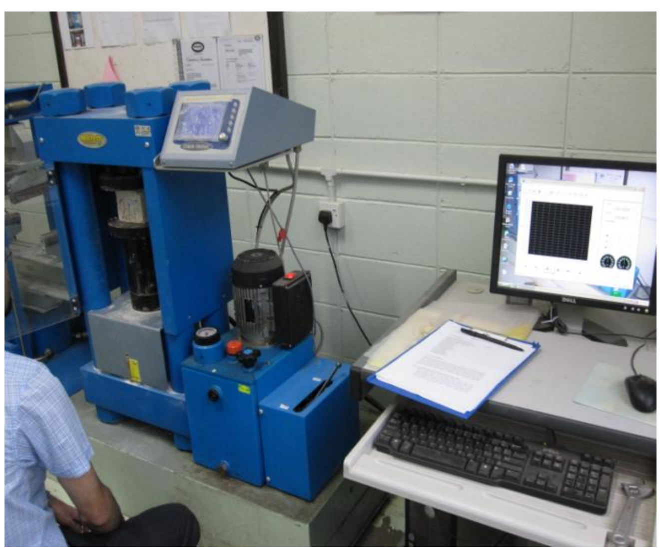

Fig 10.View of Compressive Test in Lab

DISCUSSION AND RESULTS

The compressive strength and other mechanical properties of shred tires and wood particles reinforced earth bricks are shown in Table1. The compressive strength values required by the Malaysian standard for earth brick is 0.55-1.2N/mm^2.

Although the values in the cases in the present research are much higher, namely 2.28 and 2.98N/mm^2. This research could use shred tires and wood particles for reinforced earth bricks that this means using additives reinforced earth bricks the thickness of the outer load bearing walls can be reduced substantially. The effects of geometric shapes on the compressive strength of different earth bricks were different and for this reason compressive strength shred tire reinforced earth bricks less than wood particles reinforced earth bricks.

The weather conditions are tropical climate with very warm days and fairly cool nights in Malaysia that it reduced compressive strength in earth bricks after 14 days due to climates effects on materials and their parameters such as density and moisture in earth bricks.

CONCLUSION

The result of compressive strength test on earth bricks that are include of shred tires and wood particles shown in table 1.The results of compressive strength have shown that performance of wood particles was better than shred tires with pass time. The results have shown increase of compressive strength until 14 days and then decreased. The performance of wood particles increased properties of compressive in different cases; although performance of without addition material earth bricks wasn't good in earthquake of Boroujerd-2007 in Iran but we hope wood particles and shred tires earth bricks can carry out high strength in future.

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