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Comparison of Compressive Strength in Mud Bricks with Shred Tires and Concrete Particles as Sustainable Materials

Hamed Niroumand

Department of Geotechnical Engineering, Faculty of Civil Engineering, University Technology Malaysia (UTM), Skudai, Johor, Malaysia
e-mail:niroumandh@gmail.com

Khairul Anuar Kassim

Deputy Dean, Faculty of Civil Engineering, University Technology Malaysia(UTM), Skudai, Johor, Malaysia

ABSTRACT

Mud bricks consist of clay, water and different materials. Comparing mud bricks to concrete blocks, an evolution in reducing the cost and also in increasing the compressive strength, can be made. A weakness in mud block was shown during the experiments in the absence of additional materials. In consequence, a number of testing took place in mud bricks with different additional materials consisting of shred tires and particles waste concrete. Concrete particles are recycling materials as solid waste that is exported by concrete. To make the mud bricks, in this research different materials were used and concrete particles and shred tires were added in two layers in test boxes. This paper presents the role of different materials in mud brick strength that came as a result of our survey to their effect. The materials used are cheap one because we took them from solid waste and only a little part of them is used in the automotive industry. In this paper has been shown the change in compressive strength under additives materials in mud bricks. As a conclusion performances of mud bricks with shred tires were better than concrete particles.

KEYWORDS: Mud Brick, Shred Tire, Concrete Particle, Compressive Strength, Sustainable Material, Solid Waste

INTRODUCTION

The use of recycled materials in construction provides an opportunity to reduce the unnecessary wastage of not only diminishing materials stocks but also valuable laboratory space. Over the past 30 years a combination of diminishing natural aggregate supply and a chronic shortage has necessitated a growing use of recycled crushed concrete in Japan and Europe. Similar incentives for greater use of recycled crushed concrete are developing in Australia. By the early 1990s, significant use of recycled crushed concrete aggregate was being made by a number of Australian municipalities for many tests and other engineering uses. H.Niroumand(2004) analyzed physical characteristics of recycled crushed concrete for examples density, particle size and shape in Tehran. Jordan and Richardson compared the physical characteristics of recycled crushed concrete such as particle size distribution and shape, plasticity index, density, foreign material content and Los Angeles abrasion loss for typical commercial product runs with those required in the standard projects specifications produced in Victoria. A need was identified to investigate, in greater detail, the properties of locally produced recycled crushed concrete in combination with a number of available cementations binders which was seen as a mechanism by which the performance of crushed concrete as a sub base material could be improved.

Mud 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. At this stage, it is helpful to have a general idea about the crystal structure of the clay. The actual clay minerals are the hydrated aluminum silicates, which may be divided into three basic groups, the kaolin group, the montmorillonite 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 if this water evaporates, drastic shrinkage and cracking will occur. They are also very strong, with a high heat resistance, and they show little water damage even if they are shortly wet after they have been made. Pure kaolin is white and usually is found 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 appeals us because we can tramp the soil down very firmly. The sizes of the brick should be carefully considered in this research. The sizes for the brick used in our case are 10cm×10cm×10cm.

Figure 1: Moulds in Laboratory

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. 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.

The shred tires, which are linked together by earth, support a tensile strength in earth bricks.

This research tested on compressive strength of shred tires reinforced mud bricks and concrete 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.

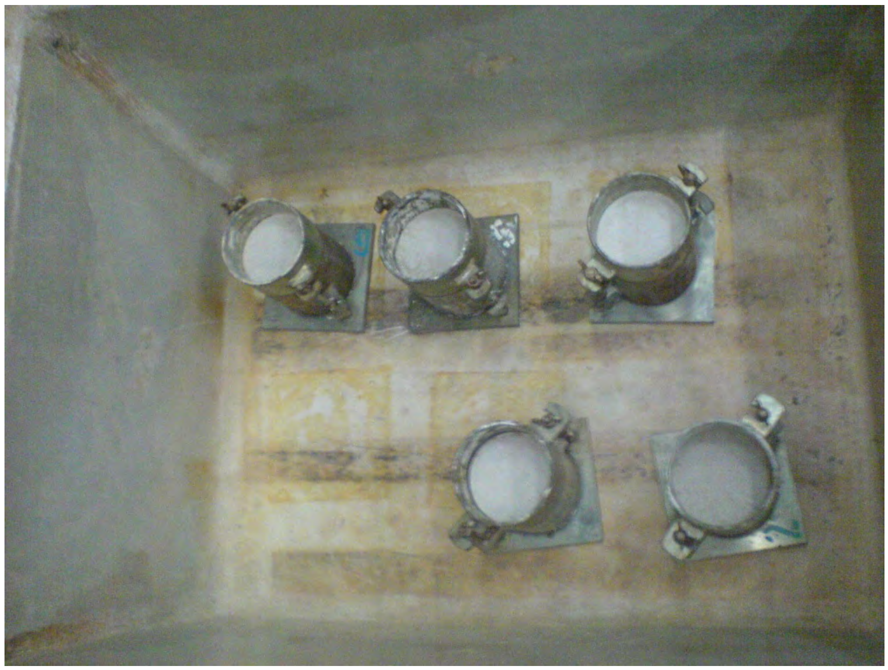

Figure 2: Compaction Test of Kaolin

The materials of this research were pure kaolin, shred tires, concrete 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. These tires are among the largest and most problematic sources of waste, due to the large volume produced and their durability. 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. 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".

Kaolin was used pure and without addition materials. Kaolin is a clay mineral with the chemical composition $Al_2Si_2O_5(OH)_4$. 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, $Al_2Si_2O_7$, 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 (SiO_2) and alumina (Al_2O_3), but rather a complex amorphous structure that retains some longer-range order (but not strictly crystalline) due to stacking of its hexagonal layers.

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

Further heating to 925-950 °C converts metakaolin to a defect aluminuim-silicon spinel, $Al_4Si_3O_{12}$, which is sometimes also referred to as a gamma-alumina type structure:

$$2\ Al_2Si_2O_7 \rightarrow Al_4Si_3O_{12} + SiO_2$$

Upon calcination to ~1050 °C, the spinel phase ($Al_4Si_3O_{12}$) nucleates and transforms to mullite, $3\ Al_2O_3 \cdot 2\ SiO_2$, and highly crystalline cristobalite, SiO_2:

$$3\ Al_4Si_3O_{12} \rightarrow 2\ Al_6Si_2O_{13} + 5\ SiO_2$$

Mixing of Different Materials

The main material mixed in this case is the dry kaolin. It is combined with optimum moisture content, due to the compaction test in different tests. Then it is mixed by kneading until cohesion soil is achieved. The sizes of the bricks to be made are 10cm×10cm×10cm and the mixture is placed in three layers in steel moulds. They consist of two layers composited of additional materials that are the shred tires and concrete particles are placed at 1/3 and 2/3 of its height.

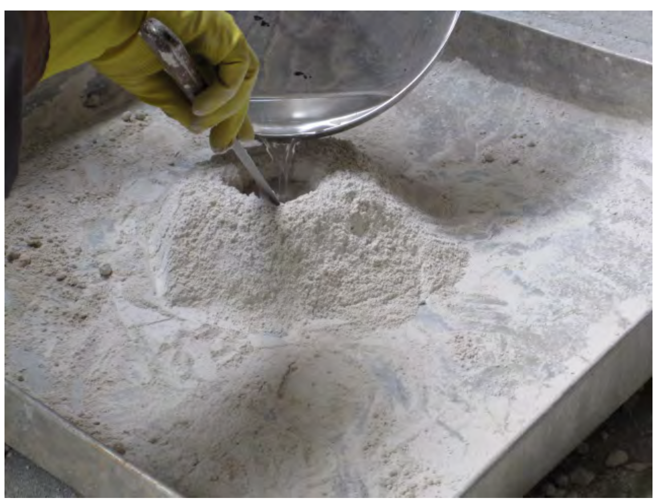

Figure 3: Mixing of Kaolin with optimum moisture content

The constituents of concrete can be recycled materials, and concrete it can also be recycled; these materials are usually available locally. Most concrete in urban areas is recycled as additives. The chloride content of recycled aggregates is of concern if the material will be used in reinforced clay. The alkali content and type of aggregate in the system is probably unknown, and therefore if mixed with unsuitable materials, a risk of alkali-silica reaction is possible.

Test of Mud Bricks

The mud bricks were used for 4 tests and taken out from the moulds. Then they were tested for compressive strength for 3,7,14 and 21 days.

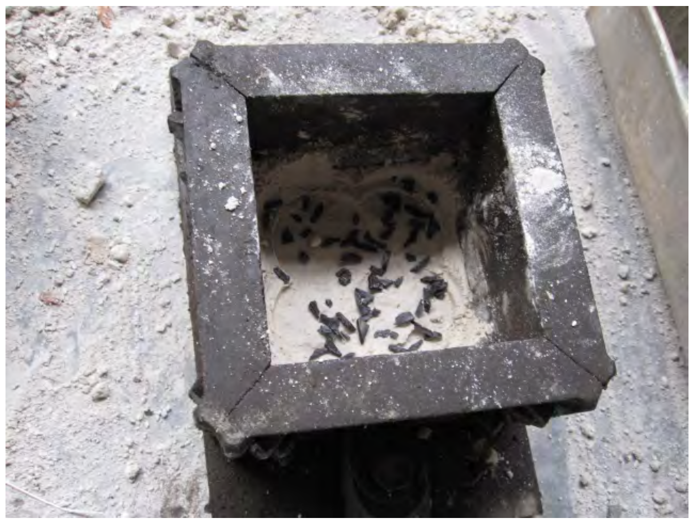

Figure 4: View of Shred tires in 1/3 Layer of Mould

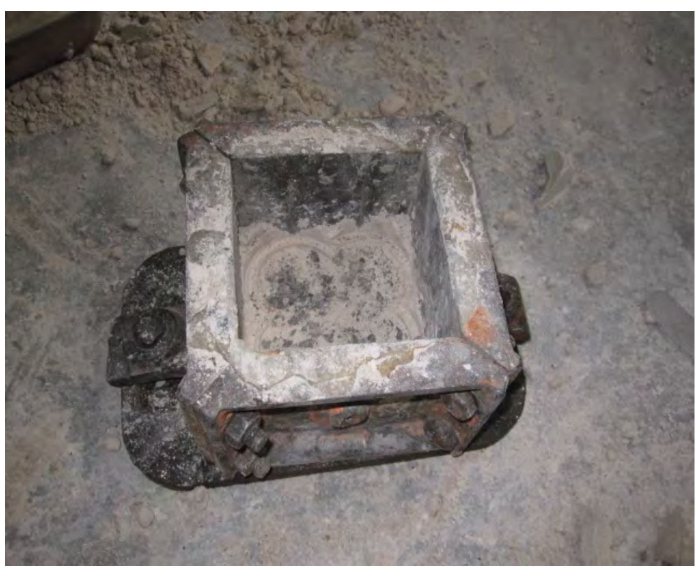

Figure 5: View of Concrete Particles in Mould

Figure 6: View of Different Cases in Compressive Test

Table 1: The results of compressive strength test of mud bricks with shred tires and concrete particles

Type	**Days**			
	3	**7**	**14**	**21**
Kaolin + Water + Concrete Particles	1.86 N/mm^2	2.45 N/mm^2	2.70 N/mm^2	1.70 N/mm^2
Kaolin + Water + Shred Tires	2.19 N/mm^2	2.62 N/mm^2	3.91 N/mm^2	2.28 N/mm^2

Figure 7: View of Different Cases of Concrete Particles in Compressive Test

CONCLUSION

The compressive strength test results on mud bricks that have additional material, such as shred tires are illustrated in Table 1. The results of compressive strength show that performance of shred tires are better than concrete particle mud bricks by time passing. They show an increase of the compressive strength until 14 days and then a decrease. The main reason that causes this decrease is the moisture range, due to the wet climatic conditions of Malaysia. The shape of additive materials can be as well, a factor that causes this decrease in the compressive strength in a long period of time. The first reason, regarding to the moisture has the highest impact on this compressive strength. The shred tires and concrete particles increased the status of tension in mud bricks. The performance of shred tires increased properties of compression in different cases, although performance of mud bricks without addition material wasn’t good in earthquake of Silakhor Disert - 2003 in Iran but there is a hope that shred tires and concrete particle mud brick s can carry out high strength in the future.

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