Preparation and Characterization of Roof Tile Waste for Internal Curing Agent in Green Concrete

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1) ABSTRACT: Roof Tile Waste (RTW) is identified as having the potential to replace the natural aggregates and act as internal curing material for concrete. The aim of the study is to analyze the physical properties of sand, recycle glazed fired RTW and unglazed fired RTW aggregates. Percentage distribution curve was plotted based on British Standard. The microstructure of the roof tile waste was identified using the scanning electron microscopy (SEM). Results showed the glazed fired RTW has lower porosity sizes compared to unglazed fired RTW. From the SEM image, sand does not show any porosity on the surface. The oxide elements of roof tile waste and sand was identified using X-Ray Fluorescence (XRF). The results show sand has the highest percentage of Silicate phase (SiO_2) which is 76%, then followed by Glazed Fired RTW (65.9 %) and Unglazed Fired RTW (65.2 %). For aluminous phase (Al_2O_3), Sand does not show any presence of (Al_2O_3). However, in contrast with Glazed and Unglazed Fired RTW where both has presence of 24% Aluminous phase (Al_2O_3). The presence of CaO is only identified in Glazed Fired RTW. It is concluded, Silicate and Aluminous phase in the RTW will has the probability to form the minerals to get the good bonding behavior when react with water during concrete mixing.

Keywords: *Roof Tile Waste; Concrete; Aggregates*

1. INTRODUCTION

One of the goals of the current waste reuse and recycling policies in the building and industrial sectors is to use recycled aggregates as a replacement for traditional natural aggregates which reducing both the use of natural resources and the environmental effects of waste. [1]. Roof tile waste materials can solve problems such as lack of aggregates at construction sites and environmental problems [2].

Besides, RTW also improving the curing process of concrete. Recently, the strength behaviour of concrete by use of damaged roof tiles as a concrete aggregate has been discussed. One of the alternatives to the virgin aggregate is the use of waste clay tiles as a partial substitution of aggregates in concrete [3]. Concrete shrinkage is stated to be minimized by the use of recycled roof tile aggregate due to the impact of internal curing by the moisture delivery of aggregate particles to the surrounding cement paste [4]. While the strength of recycled roof tile aggregate particles is typically smaller than the standard crushed stone aggregate, the compressive strength of concrete with roof tile aggregate comparable to greater than the normal crushed stone [5].

2. METHODOLOGY

The roof tile waste used in this study are fired RTW from industrial waste with two types, through glazed process and unglazed and sand as control sample. RTW pieces were crushed using crusher and grinded using ball mill with 20 minutes each and sieved into fine aggregates.

Prepared RTW then will through testing particle size distribution using particle analyzer and the results will analyze using Mastersizer 2000 software. XRF analysis was use XRF machine. SEM analysis were using SEM machine, the samples are using carbon tape to allow the SEM scan the surface of samples.

3. RESULTS AND DISCUSSION

3.1 Percentage Distribution Curve

Figure 1 shows sand, glazed fired RTW and unglazed fired RTW are within the upper and lower limits in percentage distribution curve. From the results, sand has most lower passing percentage, Glazed Fired RTW are balance for all sieves opening, and unglazed fired RTW has the midrange between lower and upper limits.

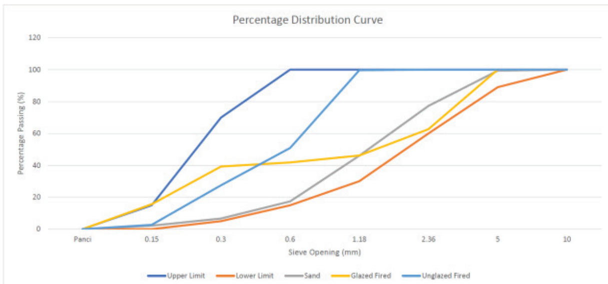


Figure 1 One- Percentage Distribution Curve of Sand, Glazed Fired and Unglazed Fired

a. Particle Size Distribution

Particle size distribution of crushed roof tile waste are presented in Figure 2. The results indicate the differences of particle size distribution between Sand, Glazed Fired RTW and unglazed fired RTW. The high volume (%) of Sand is very narrow which is only between particle size 15.157 µm to 51.371 µm. If compared to the crushed roof tile waste, they have a wide range of particle size which are between 2.15 µm to 550.102 µm. The various size of particle will be affecting the compressive strength of the mix concrete. With the wide range of particle size in fine aggregate, the fine aggregate will be compacted bulk density because the aggregate will fill the gap between the particles that have a void [6].

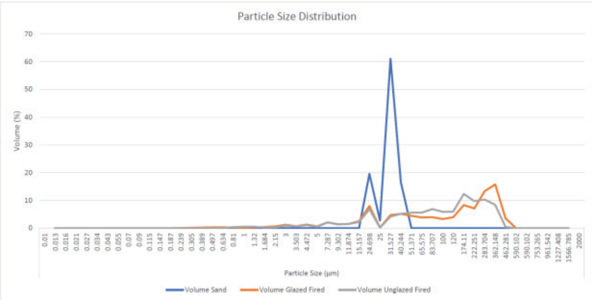
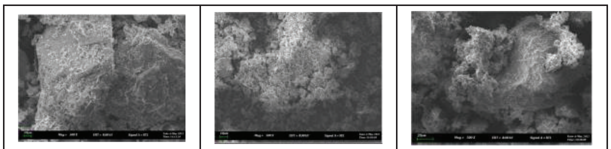


Figure 2 Two- Particle Size Distribution of Sand, Glazed Fired and Unglazed Fired

b. *Scanning Electron Microscopy (SEM)*

From Figure 3, it can be seen from the image that sand has smooth surface. The glazed fired RTW showing that the surface is not fully smooth, it has the cracked glaze coat and also porosity of the ceramics surface. While unglazed fired RTW also show somewhat porosity of the ceramics surface microstructure. But the microstructure of unglazed fired RTW does not show the glazing coat and its porosity looks more fragile compared to glazed fired RTW. From this point of view, we can predict the compression strength of glazed fired RTW will be higher compared to others. However, there are still no study to proves the impact of porosity and glaze layer to the compressive strength of concrete.



(a)	(b)	(c)

Figure 3 Three- (a) SEM Image for Sand, (b) SEM Image for Glazed Fired, (c) SEM Image for Unglazed Fired

c. ***X-Ray Fluorescence (XRF)***

From Figure 4, the results show Sand has the highest percentage of Silicate phase (SiO_2) which is 76%, then followed by Glazed Fired RTW (65.9 %) and Unglazed Fired RTW (65.2 %). For aluminous phase (Al_2O_3), Sand does not show any presence of (Al_2O_3). However, in contrast with Glazed and Unglazed Fired RTW where both has presence of 24% Aluminous phase (Al_2O_3). Meanwhile, the presence of CaO is only identified in Glazed Fired RTW. From the results, it is showing the best bonding behaviour will be Glazed Fired RTW because it has all of the silicate and aluminous phase and calcium to form the minerals that will improve the bonding behaviour after react with water [7].

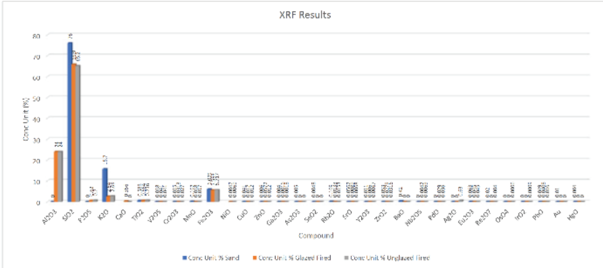


Figure 4 Four- XRF Results for Sand, Glazed Fired RTW and Unglazed Fired RTW.

4. CONCLUSION

This paper included a preliminary study of roof tile waste as curing agent in green concrete. It can be deduced that the production of green concrete is beneficial not only to the creation of a sustainable and durable infrastructure, but also to meeting potential demand for concrete, which assist in further growth and urbanization.

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