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Utilization of cassava trunk waste mixed with cement to particle board wall for thermal resistance in building

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Abstract

This research aims to study the properties of cement bonded particle boards mixed with cassava trunk wastes. The Portland cement type1: fine sand: tap water ratio was equal to 1: 0.5: 0.416 by weight. The ratios of cassava trunk waste to cement were added following: 0.05, 0.06, 0.07, 0.08, 0.09, and 0.10 by weight. The cassava trunk wastes were crushed by the wood grinder with sieve no.4. The casting of particle board walls used the compression machine in room temperature (30 – 35 degree of Celsius) and control 0.75 g/cm^3 of density. The TIS 878-2537 standard (cement bonded particle board: high density) was cited to the property tests of cement bonded particle boards. Resulting, the ratio 0.08 of cement board mixed with cassava trunk can use as the particle board walls which have good thermal insulation property.

Keywords: Cement bonded particle board, Cassava trunk waste, Wood grinder, Thermal insulation

1. Introduction

Cassava is a crop that can be grown in more than 40 provinces of Thailand. These crops are used in the many industrials such as food, beverage, substance sweetness, medicine, cosmetics, adhesives, lime, textiles, paper, plywood, materials subsidiaries, naturally decomposes, alcohol and ethanol. The important waste from cassava farm is the cassava trunks which usually dispose by burning [1]. The previous study found that the cassava trunks could mold into thermal insulation sheet with similar efficiency to fiberglass [2]. If cassava trunks are mixed to the construction materials, these construction materials will be more proper to use in energy saving buildings. The cement bonded particle boards or cement boards are favorite construction materials of prefabricated buildings which used as the walls instead of bricks [3]. Thus, the objective of this research is to study the cement boards mixed with cassava trunks which possible to improve the thermal insulation property of cement boards and can generate the additional income to cassava farmers.

2. Materials and methods

2.1 Grind cassava trunks through the wood grinder with sieve no.4 (4.76 mm) (Figure 1 to 3).

2.2 Design 6 mix ratios of the cement boards mixed with cassava trunk by weight as Table 1.

2.3 Weight and mix the mixtures by using the measure and concrete mixer.

2.4 Cast the cement boards mixed with cassava trunk size 30x30x1.5 cm by using the vibrate compression machine (Figure 5) and flip stand. These cement board casting are controlled by density (must higher than 0.75 g/cm^3) [4].

2.5 Cure the cement boards mixed with cassava trunk in the air and shade.

2.6 Test the properties of cement board mixed with cassava trunk by follow the standard of TIS.878-2537 [5] and ASTM C177 [6]. There are consists of general characteristic, density, moisture, swelling, bending strength and elastic modulus, tensile strength perpendicular with surface (Figure 6), and thermal conductivity.

2.7 Analyze and conclude the results of cement boards mixed with cassava trunk test.

Table 1 Ratios of mixture of cement boards mixed with cassava trunk by weight

Ratio	Cement	Fine sand	Cassava	Tab water
1:0:05	1	0.5	0.05	0.416
1:0:06	1	0.5	0.06	0.416
1:0:07	1	0.5	0.07	0.416
1:0:08	1	0.5	0.08	0.416
1:0:09	1	0.5	0.09	0.416
1:0:10	1	0.5	0.10	0.416

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Figure 1 Waste of cassava has grinded through sieve no. 4

Figure 2 Chips of cassava trunk after grinding through sieve no. 4

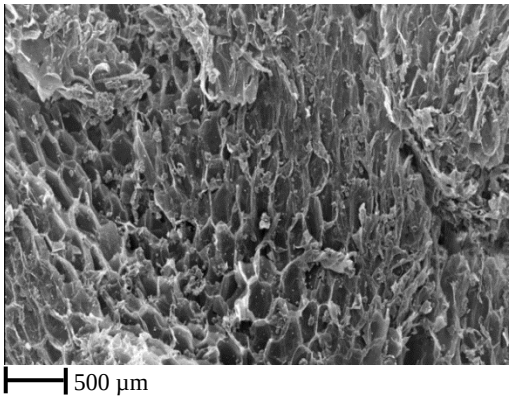

Figure 3 Image of cassava trunk by SEM at zoom 50 times

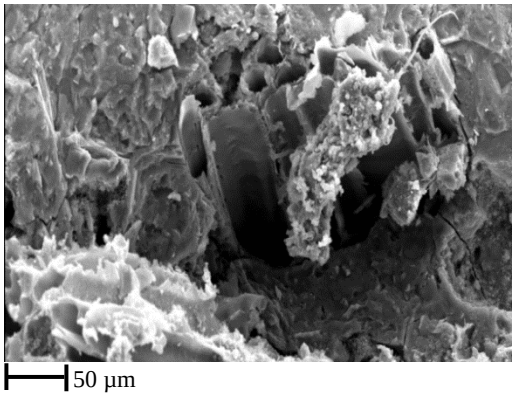

Figure 4 Image of cement board mixed with cassava trunk by SEM at zoom 500 times

Figure 5 Vibrate compression machine is used to cast the cement boards

Figure 6 Sample for tensile strength perpendicular with surface test

3. Results and discussions

The cement boards mixed with different quantities of cassava trunk were tested by the TIS.878-2537 standard which the results can indicate following.

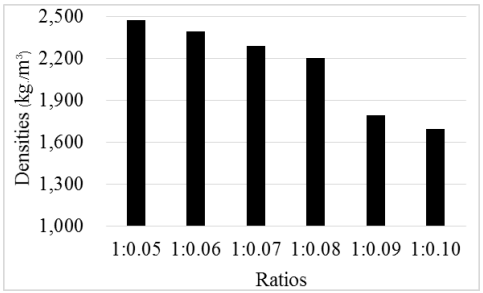

Figure 7 Density of cement boards mixed with cassava trunk at 28 days

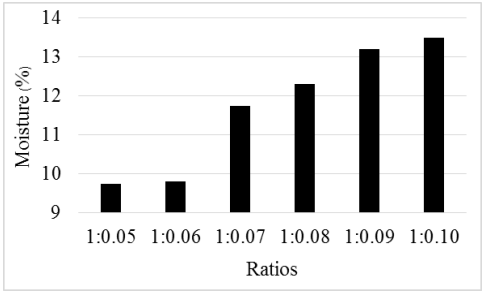

Figure 8 Moisture of cement boards mixed with cassava trunk at 28 days

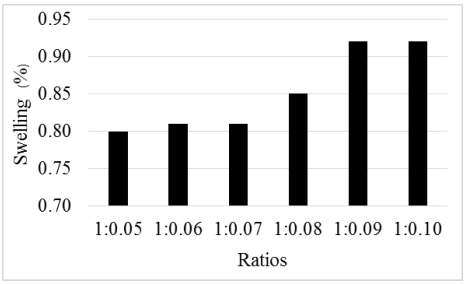

Figure 9 Swelling of cement boards mixed with cassava trunk at 28 days

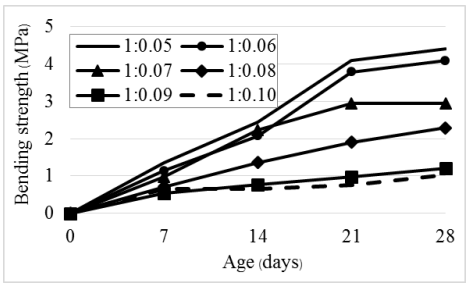

Figure 10 Bending strength of cement boards mixed with cassava trunk

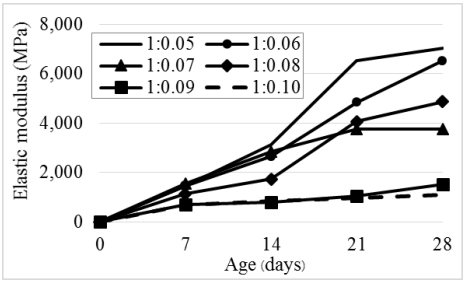

Figure 11 Elastic modulus of cement boards mixed with cassava trunk

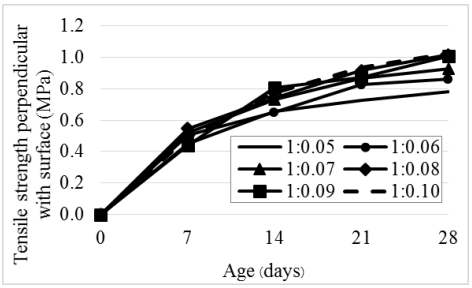

Figure 12 Tensile strength perpendicular with surface of cement boards mixed with cassava trunk

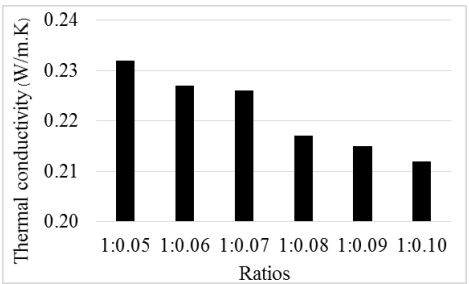

Figure 13 Thermal conductivity of cement boards mixed with cassava trunk at 28 days

The general characteristic of 6 ratios of the cement board mixed with cassava trunk can pass the TIS.878-2537 standard with smooth surface [5]. There were several effects to the properties of cement boards when the different ratios of cassava trunk were mixed. The comparing of density of cement boards mixed with cassava trunks (Figure 7 and 8) and the TIS.878-2537 standard found that the cassava trunks can reduce the weight of cement boards from 2,400 to 1,700 kg/m^3 (Figure 5), but it still cannot pass the standard (the density standard is 1,100 - 1,300 kg/m^3) [5]. For the properties of water resistance, there were 9.75 to 13.75 % of moistures (the moisture standard must in range of 9 to 15 %) and 0.8 to 0.92% of swellings (see Figure 9 and the swelling standard must less than 2%). These effects of density, moisture, and swelling were changed because the high porosity (see Figure 3 and 4) and low specific gravity (equal to 0.6) of cassava trunk in cement boards [7] which made the air void in the texture of cement boards. In Figure 10 and 11, the increasing of cassava trunks in cement boards affected the decreasing of bending strength and elastic modulus of cement boards. These bending strength and elastic modulus results of cement boards mixed with cassava trunks were under the TIS.878-2537 (the standard requires bending strength and elastic modulus must higher than 9 MPa and 3,000 MPa, respectively) [5]. While the tensile strength perpendicular with surface of all ratios of cement boards can pass the TIS.878-2537 standard (Figure 12) with the value higher than 0.5 MPa [5] that means the fiber and tapering shape of cassava trunk can improve the tensile strength of cement boards [4]. Moreover, the porous of cassava trunk texture also had affecting to decrease the thermal conductivity (Figure 13) and prevent the heat transfer [2] for every ratios of cement board mixed with cassava trunk. These thermal insulation values can pass the TIS.878-2537 standard (no greater than 0.25 W/m.K) [5].

4. Conclusions

This research indicated the possible of using cassava trunk wastes as mixtures in the cement boards. The cassava trunk wastes can improve the several properties include the density, tensile strength perpendicular with surface, and thermal conductivity. When compared the properties of cement boards mixed with cassava trunks and the TIS.878-2537 standard found that the every ratios of cement boards still cannot pass the standard because the density, bending strength, and elastic modulus values are out of requirement ranges. However, the TIS.878-2537 is the uncontrolled standard [5], the cement boards mixed with cassava trunks can use as same as the common cement board products which pass the TIS.878-2537 standard. According to the amount of cassava trunks and properties of cement boards, the most suitable ratio of cement board mixed with cassava trunk is 1: 0.08 which has the properties include density 2,200 kg/m^3, bending strength 2.2 MPa, elastic modulus 3,900 MPa, tensile strength perpendicular with surface 1 MPa, and thermal conductivity 0.217 W/m.K. With the properties of cement boards after mixed with cassava trunks, the cement boards can utilize to the cement board products which have the good thermal insulation, lightweight, and water resistance. Moreover, the production of cement board mixed with cassava trunk is more quickly (1 minutes of casting process) and low investment cost (use the machine as same as concrete block production) when compare to common cement board production (around 12 hours of casting process).

5. Acknowledgements

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