Incorporation Of Rice Straw Into Clay Bricks

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ABSTRACT

The number of manufacturing/processing industries has currently been increasing. However, this rapid development has consequently resulted to an increase in the amount of sludge (solid residue) generation, which in most times disposed by open burning,incineration, land disposal etc. either of the disposal methods used can result to an endangering degradation of our environment and the ecosystem. This research paper report the utilization of fibre sludge (Rice Straw) generated from agricultural activities as raw material in clay brick manufacturing, In order to offer an alternative solution to the environmental effects cause by the disposal of the rice straw, at the same time making sure that the required brick properties such as compressive strength, water absorption, firing shrinkage etc were within the standard acceptable range. After the clay was obtained as the main raw material, the physical and chemical characterization of the raw material was carried out and some properties of the rice Straw as well, in order to determine the feasibility of incorporating the raw materials and to identify, if necessary, any pre-treatment requirement. Bricks were produced with the rice straw ranging from 1.5% to 10% by dry-weight. The general production sequence involves moulding, drying, firing and testing. During the testing period, experiments were done to analyze some important brick properties such as water absorption, firing shrinkage, compressive strength and weight loss. The result obtained shows that the 1.5 wt. %, 2.5 wt.% and 5 wt. % rice Straw can be utililized as brick material, because the properties analyzed were within the standard limit.

Keywords: *clay brick, brick, sludge, fiber sludge. rice straw*

INTRODUCTION

Rice straw is an agricultural sludge generated from rice production activities. It is one of the most abundant lignocellulosic waste materials in the world [1]. Its annually production is 731 million tons, in Africa 20.9 million tons, Asia 667.6 million tons and Europe 3.9 million [1]. The disposal method of rice straw is one of challenging problem faced by many countries, the most commonly used and cheap method of disposing rice straw is through open burning; however there are numerous concerns regarding the environmental effect cause by this disposal method, due to the potential CO_2 emission into the atmosphere, air pollution and formation of haze. However it has been reported that alternative methods of utilizing rice straw are making breakthrough; such as commercial scale production of bioethanol from rice straw [3], incorporating rice straw into soil, use of rice straw as one of the ingredient to synthesis marginal food for animals [11] etc .

Even though the above mention potential methods of useful utilization of rice straw are signs of progressive approach toward tackling this problem related, the environmental concern are still worrying because of the annual increase in rice production, which is geared by the increasing world population. For example in Malaysia, according to the survey from Food and Agriculture organization of United Nation, the total rice production of the country increase from 2.20 million MT in 2002 to 2.54 million MT by the year 2010 [4]. Therefore, the need for the evolution of more potentially effective and environmental friendly methods of proper utilization of rice straw is necessary to upset this increase.

It is obvious that the recovery of sludge and utilization of sludge as building and construction raw material can be considered as an alternative to the right direction [5]. This study investigated the incorporation of rice straw into clay bricks. A proper characterization of clay was made and the effect of rice straw composition on the properties of the final products was examined.

EXPERIMENTAL PROCEDURES

Raw Materials

The raw materials used in this study were clay which was obtained from local clay brick manufacturer from Kuang, Malaysia, while the rice straw was obtained from local paddy field in Sekinchan, Malaysia.

Preparation of Raw materials

Clay bricks of 1.5%, 2.5%, 5% and 10% mixture of rice straw were prepared. The formulation of raw materials involved mixing the rice straw with the clay and appropriate amount of water added for each proportional increase of rice straw as reported in Table 1. The rice straw amended clay brick were hand moulded into a custom made wooden brick mould of 212mm x 95mm x 70mm dimension. The brick mould was coated with formica layer and lubricating oil applied to the surface to avoid the mixture sticking on to the wall of the brick mould. This sticking effect prevents the brick from being gently removed from the mould after casting. During moulding, the brick was compacted using hammer to enhance the cohesiveness of the raw material, hence resulting into less pore space or holes.

The wet brick were dried in the laboratory scale drying oven at approximately 115°C for 48 hours. After drying before putting into the furnace for firing, the length and weight of each brick were measured, and then the brick was put into furnace with temperature stir step increase from 150°C to optimum of 900°C for 8 hours and then left at this constant optimum temperature for 12 hours and finally cooled down to the ambient room temperature for 7 hours.

Table 1: Amount of water and mass of raw materials required per brick

Ratio of clay: rice straw Mixture (wt %)	Clay (g)	Rice Straw (g)	Total Mass of Raw Material (g)	Water Added (mL)
100:0 (control)	2000	0	2000	550
98.5:1.5	1970	30	2000	553
97.5:2.5	1950	50	2000	600
95:5	1900	100	2000	650
90:10	1800	200	2000	800

RESULT AND DISCUSSION

Characteristics of clay

The PH value of clay was found to be 3.87 and the moisture content was found to be 0.67% which is a very low value and this was caused due to the dryness of the clay sample obtained from the local brick manufacturer from Kuang, Malaysia, while the moisture content of rice straw was 9.7% .

Plasticity is another important parameter that describes the ability of material to undergo irrevocable deformation at constant volume without crumbling or crushing [6], in this study clay sample showed a plastic limit of 32.37% and liquid limit of 36%, hence, the plasticity index is 3.63%. The occurance of plasticity in clay may be due to the presence of clay minerals that give rise to its cohesive nature, thus, causing it to act as a cement or paste [7].

Physical and mechanical properties of rice straw amended brick

Water Absorption

One important property in determining the strength of clay brick is the water absorption, the extend of cohesiveness and firmness of the brick is measured by the level of water absorption and it has been reported also depends on type of clay and method of production used [8]. From Figure 1 and Table 3, it can be analyze that water absorption of bricks increased with addition of rice straw, the observed increase in water absorption was due to poor application of compacting pressure due to the hand-moulding using manual compaction and the formation of voids due to the burning of organic matter in the rice straw.

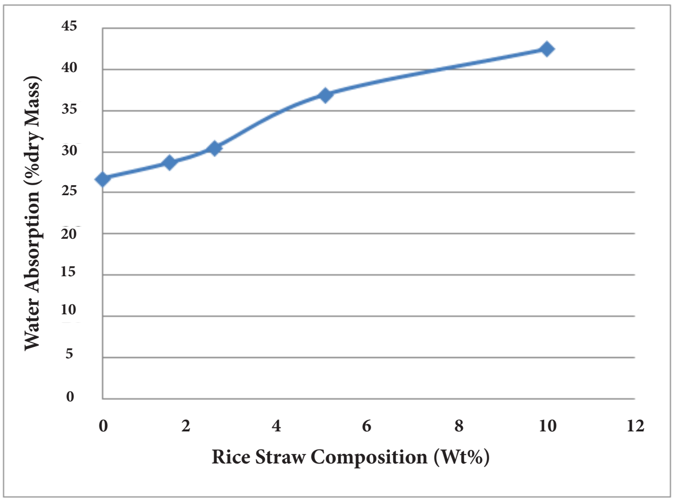

Figure 1: Effect of Rice Straw composition on Water Absorption

Compressive Strength

All construction or building materials without any exception must resist stress due to the load of building, therefore the strength of material is equivalent to the stress at which it failed or crumbled. In contract to water absorption, the compressive strength of the brick material decreased as a result of rice straw addition. From Figure 2, the resulting compressive strength ranges from 8.30 N/mm2 for 1.5 wt % rice straw amended brick to 3.95 N/mm2 for 10 wt % rice straw amended brick. In fact, 5% rice straw addition caused a 32% reduction in compressive strength compared to the reference specimen (with clay: rice straw ratio of 100:0) which is 8.68 N/mm.

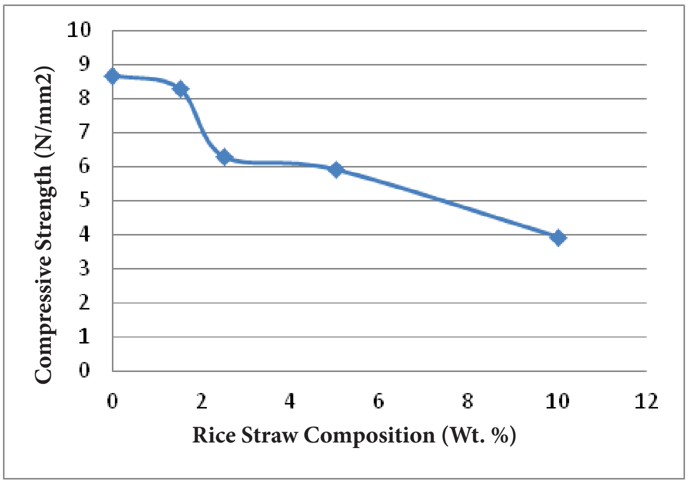

Figure 2: Effect of Rice Straw composition on Compressive Strength

Furthermore, by making comparison to the British standard BS 3921:1985 for compressive strength of brick, as shown in Table 2, the value obtained for compressive strength of 1.5, 2.5 and 5 wt. % were well above the standard compressive strength for the "Damp-proof course" and "All others" classes of brick, hence they can be utilize for normal brick application, however, the compressive strength for the 10 wt. % rice straw brick exceeded the limit

Table 2: Classification of Rice straw-Amended Clay bricks by compressive strength according to BS 3921:1985

Rice Straw Composi-tion (Wt %)	Commpressive Strength (N/mm²)					Value obtained
0	Engineering		Damp-proof course		All Others	8.68
1.5	A	B	1	2		8.30
2.5						6.30
5	>70	>50	>5	>5	>5	5.92
10						3.95

Linear Shrinkage and Weight loss

Shrinkage during firing is unavoidable. In this study firing shrinkage increased with higher addition of sludge, similar finding was reported by Alleman [9]. Table 3 highlights the effect of rice straw addition on the properties of brick, the highest shrinkage occur for the 10 wt. % rice straw addition while the lowest is for the control specimen (0% rice straw composition). Fortunately, the firing shrinkage value obtained in this study for all the rice straw amended brick samples and the control specimen were quite below the acceptable shrinkage limit of between 6% and 8% [10].

The results from the analysis on weight loss highlighted that as the proportion of rice straw increase from 1.5 wt. % to 10 wt. % the percentage weight loss increased and was caused due to the burning of the organic matter present in the rice straw as a result of excessive firing at the high temperature of 900°C. This findings was also confirmed from previous study conducted by other researcher utilizing other type of sludge that contained significant amount of organic contents [11]. Hence from an economical point of view the reduction in weight of the final brick production can resulted into a prosperous financial saving in terms of brick transportation cost.

Table 3: Effect of Sludge Addition on the properties of brick

Proportion of rice Straw added (wt. %)	Shrinkage on firing (%)	Weight loss due to firing (%)	Water absorption (wt. %)	Compressive Strength (Nmm2)
0	0.48	4.4	26.78	8.68
1.5	2.38	10.73	28.67	8.30
2.5	4.76	11.53	30.50	6.30
5	5.58	12.28	36.96	5.92
10	6.04	24.85	42.53	3.95

Appearance of the Rice Straw-Amended Clay Brick

Most of the rice straw supplemented brick simple were subjected to development of minor crack on the surface. The problem of cracking is an indication of an undesirable gas (such as steam and CO_2) evolution from the decomposition of organic matters present in the chemical constituents of the rice straw during firing.

From the esthetic point of view, the surface finishing of the brick body was quite less appealing due to the appearance of many pore spaces and effect of manual hand-moulding, thereby it can't be use as facing brick.

Conclusion

The results presented and discussed in this project showed that rice straw from agricultural activities can be used constitutively as a supplementary raw material in clay manufacturing at various proportion. This project study involved the utilization of rice straw in the proportions of 1.5 wt. %, 2.5 wt. %, 5 wt. % and 10 wt. % and then analysis of some important brick properties such as compressive strength, water absorption, linear shrinkage and weight loss. The result obtained from the analysis shows that the brick amended with 1.5 wt. %, 2.5 wt. %, and 5 wt. % of rice straw can be utilised as brick material according to British Standard (BS 3921:1985).

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Study of Cocoa Pod Husk / Polyvinyl Alcohol (PVA) as A New Biodegradable Composite Film

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ABSTRACT

This paper present the possibility for the use of cocoa pod husk in composite with poly(vinyl alcohol) (PVA). In this study, we preparad a new green composite film from cocoa pod husk (CPH) and poly(vinyl) alcohol (PVA) and to characterize the morphology and mechanical properties of the composite film. The effect of fiber loading, plasticizer (glycerol) and effect of alkaline treatment were investigated. Poly (vinyl acohol) (PVA) with 5, 10, 15wt% cocoa pod husk (CPH) powder were prepared by aqueous mixing. The mixture was casted as composite film prior characterizations. The effect of plasticizer (glycerol) was investigated in the study and it was found that the film showed some good mechanical properties with addition of glycerol and increasing fiber loading. The effect of alkaline treatment on fiber was investigated.

Keywords: *Cocoa pod husk; Poly (vinyl) alcohol; Biodegradable polymer; alkaline treatment; Composite*

INTRODUCTION

Nowadays, thermoplastic composites produced from synthetic polymers filled with renewable natural resources start to gain the attention from world as they are considered as one of the environmental friendly biomaterials. Most of the researches focus on the use or the potential of inexpensive polymeric raw materials such as cellulose, starch, cellulosic resources and other. It is predicted and expected the resulting products are eco friendly and cost effective. Those biodegradable materials can be completely degraded into our ecosystem [1-2]. Moreover, the application of biodegradable polymers and renewable agro wastes as packaging materials is one of the alternatives to solve the problem of solid waste from inert polymers. There are several of synthetic aliphatic polyesters and natural resources are being used as biodegradable materials [3-4]. According to [5-6], most of the organic materials have the natural tendency to decompose or degrade. In our current century, the needs of degradable disposable containers or packaging materials are high. More and more researches and investigations are now being applied to produce plastic materials high biodegradability by involves abundant agro wastes, plant carbon hydrates, vegetables oils and etc. in their countries respectively.

Polyvinyl alcohol (PVA)-starch blend plastics are one of the most popular of the biodegradable plastics, and are widely used in packaging and agricultural mulch films [7-8]. However, according to [7,9], an amylose-PVA composite (PVA-starch blend) was biodegraded slower which was ~75% weight loss required 300 days in a degradation test with activated sludge [3]. PVA is non-toxic, water soluble, highly polar and synthetic polymer which has been used vastly in biomaterial technology. It has excellent film forming, emulsifying and adhesion properties. Degree of hydrolysis can affect properties of PVA and its film quality [10].

Cocoa pod husk (CPH) is a by product of the cocoa harvesting industry whereby it forms about 80% of the cocoa fruit and it is a waste product which can be utilized fully [11]. Besides, it can be used as filler in biodegradable mulch films as the high cellulose fiber content of CPH will provide reinforcing effect in the mulch films [12]. Besides that, the use of CPH as fertilizer can increase the soil macronutrients content because of high Na, P, K, Mg and Ca concentrations of CPH when it degrade in the soil [13]. Natural fibers with good biocompatibility, which can act as green filler in composites have gained interest to replace synthetic fiber. Natural fibers in composites are low cost, good thermal and low density. Combination of natural fiber and biopolymers where both are derived from natural has the potential to provide materials with enhanced mechanical properties. At present time, many studies have investigated the biodegradable polymers filled with natural fibres [14].