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Investigation of agro-concrete using by-products of rice husk in Mekong Delta of Vietnam

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Abstract

Agro-concrete concept seems to create interesting links between agriculture sector and building industry. Over the last years, researcher around the world have reported their investigation on such material made out of different type of agricultural by-products mixed with lime-based binder. Based on the locally use natural aggregate and good thermo-physical properties, they are considered as as eco-material for more comfortable low carbon building. Indeed, energy efficiency or thermal conform are improved from optimization of building envelopes. In this paper, we focus on producing concrete block under mechanical compaction method from two types of rice husk (natural and reusing) mixing with binder (hydrate lime and metakaolin). Physio-mechanical properties of concrete block were characterized at appropriate period of curing condition in dry air. Empirical results show that both compressive strength and splitting strength of concrete block evolve over time due to pozzolanic reactivity and natural carbonation reaction. Low thermal conductivity 0.27 W/mK with normal density 880 kg/m3 in mixed formulation deal with the purpose of using in thermal and acoustic insulating solution. In the current context of rural development in the delta region, the objective of using rice husk concrete for non-load bearing wall building as filling material or non-fired brick would be discussed.

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Keywords: Rice husk; agro-concrete;hempcrete;non-fired brick, metakaolin; carbonation, sustainable.

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1. Introduction

In building sector, the passive house is now a sustainable construction concept that provides for affordable, high-quality buildings as well as comfortable, healthy living conditions [1]. In general, specific requirement of passive house standard are rigorous for helping us to improve energy efficiency and to reduce environmental impact of house building. Researchers and professional engineers around the world contribute to practical implementation of passive house certificate from this point of view after considering local climate condition for regionally optimised. For example in tropical climate, they require protecting measure from solar load such as using fixed shading devices for windows, using reflective, cool colours, low-e solar windows with high selectivity and moderate level of insulating materials for thermal comfort. Technically, good practice to build a passive house combine firstly an appropriate architecture design, secondly a new technology in energy saving system and thirdly a relevant material solution. The third one should be negative carbon building material or eco-friendly material. Currently, that is the case of hemp concrete that met such requirement and becoming increasingly demand in some European country and US. We mainly use in housing as filling material or casting material around load-bearing wooden structure for wall application (figure 1). Neutral carbon footprint of vegetable aggregate deduce from the fact that plants store carbon during their growth and the carbon remains locked within the plant material until it decays. Moreover, the absorption of CO2 by lime partially offsets its release during the production of the binder. Furthermore, using lime helps regulate temperature and humidity within building because it is moisture permeable [2]. In the same way of hemp concrete, eco-friendly materials using locally available agriculture waste are in full development, for example bagasse fibres [3], flax shives [4], hemp hurds [5–8], sawdust [9] and rice husk [10].

Fig. 1. Hemp concrete and practical application in wall building, redrawn with photo from ref. [11].

In Mekong delta (South of Vietnam), rice cultivation is one of the most important economic sector in agriculture. It contributes to overall performance of rice export 6.7 million ton per year of Vietnam. Rice husk is protective shell of the grain, represent about 20 wt% of the whole grain. Hence, in Mekong delta of Vietnam, rice farming produces nearly 1.9 million ton per year of rice husk and almost Vietnamese farmer regard this by-product as waste materials often buried in the ground. In larger scale, recently rice husk was consumed for electricity generation because of their high calorific value. Amorphous silica resulted from rice husk burning process could be used in cement industry as pozzolanic admixture. However, burning process in general makes impact on the environment and not easy to obtain high content of silica in rice husk ash because of their peculiar silica–cellulose structural arrangement [12]. Therefore, rice husks cause critical problems in Mekong delta of Vietnam because significant volumes are generated and not used in a beneficial way. The fact that using of raw and whole rice husk in concrete has rarely been investigated is due to common concern about durable properties of natural aggregate and about mechanical performances essentially studied in practical application of concrete material. This study combines the use of lime-based binder and rice husk to design lightweight concrete block or commonly name non-fired brick. In this regard, rice husks would be considered as natural aggregates like hemp hurds in above hemp concrete. In the following paragraph, we investigate using two types of rice husks as raw product for concreting. Different mix proportions of