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DEVELOPMENT OF GREEN ALKALI-ACTIVATED MORTAR BASED ON BIOMASS WOOD AS

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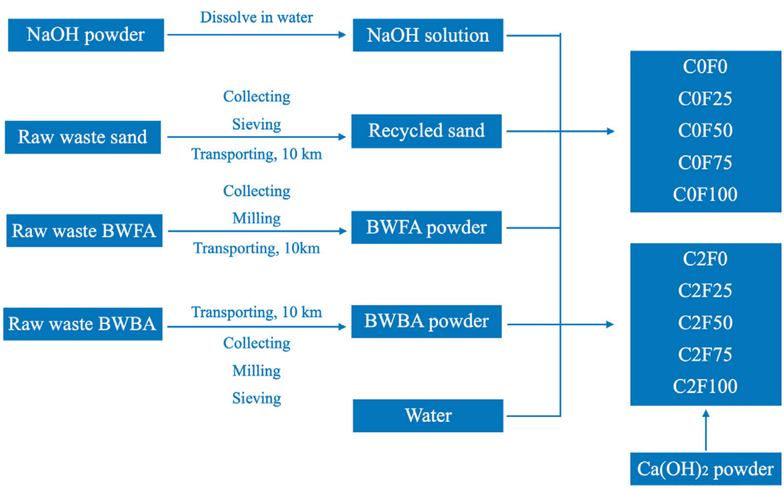
Abstract – Portland cement (PC) is the most commonly used binder material for producing concrete. Nonetheless, increasing concerns have been attached to its manufacture which is highly energyintensive and generates a large quantity of greenhouse gases. Developing cement-free alkali-activated materials as eco-binders is a sustainable replacement for PC, especially considering the possibility to utilize industrial by-products as precursors, which significantly reduces the environmental burden due to waste disposal. Many investigations have been reported successfully using coal fly ash, slag, and metakaolin as precursors. However, owing to the low reactivity, studies regarding biomass wood ashes (BWA) in the field of alkali-activated materials are still limited. To produce a green cementless alkali-activated mortar material, in this study, biomass fuel by-products – biomass wood bottom ash (BWBA) at 0 %, 25 %, 50 %, 75 %, and 100 % as well as biomass wood fly ash (BWFA) at 100 %, 75 %, 50 %, 25 % and 0 % were binarily used as precursors. Sodium hydroxide (NaOH) at 10 mol/L and calcium hydroxide ($Ca(OH)_2$) at 0 % and 20 % by binder mass were applied together as alkali activators. Recycled sand, substituting natural sand, was adopted as fine aggregate at an aggregate/binder ratio of 2 to reduce the consumption of non-renewable natural resources. The objective is to investigate the influence of various mix ratios of BWFA and BWBA on the produced alkali-activated mortar, and identify the effects of $Ca(OH)_2$. Compressive and flexural strength were tested to evaluate



Flowchart for lifecycle assessment of various mortar mixes.

the evolution of mechanical performance. A cradle-to-gate lifecycle assessment was conducted to analyse the environmental impacts. The results reveal that the alkali-activated mortar has less environmental impact compared to the traditional PC mortar. NaOH solution is the primary source of environmental influence and BWA only contributes to very limited impacts. When 50 % BWFA and 50 % BWBA are binarily used, the greatest mechanical properties are achieved. The usage of $Ca(OH)_2$ effectively improves the mechanical strength by a maximal 350 % (flexural strength) and 320 % (compressive strength), but meanwhile increases environmental burdens.

Keywords – Calcium hydroxide; compressive strength; flexural strength; lifecycle assessment; sodium hydroxide; recycled sand

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