Banana fiber-reinforced geopolymer based textile reinforced mortar

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Abstract: Textile reinforced mortar (TRM) are effective method of confining concrete elements to elevate the axial load resistance and upgrade the overall performance of concrete. TRM is a promising alternative for carbon fiber reinforced polymer (CFRP) which are commonly used in strengthening concrete and are known to be expensive since it requires huge amount of energy in processing these materials. Green technologies can be applied in this process following the same TRM principles of confinement replacing conventional cement or epoxy-based mortar and synthetic textiles towards sustainable concrete strengthening technology. This is through the utilization of geopolymer mortar reinforced with short banana fibers (BF) and long BFs as textiles. Geopolymer mortar presented in this paper is composed of fly ash and silica fume as binder, sand as filler, sodium hydroxide (NaOH) and sodium silicate (Na_2SiO_3) as activator and BFs as reinforcement and textile. Geopolymerization generates significantly lesser carbon dioxide (CO_2) while BFs are known for having attractive mechanical properties, cost effective and abundant in nature for which making use of its fiber will significantly minimize the huge waste produced from banana plantations after a one-time fruit harvest only. The geotextile or geogrid used to wrap the concrete cylinder samples is made up of 2mm diameter long BF yarns with weights ranging from 150 to 450 grams per square meter that varies with grid sizes from 10mm, 15mm to 25mm for both orthogonal directions considering the lightweight characteristic of BFs. Twelve TRM designs were used to strengthen the concrete cylinders with three samples each. TRM design parameters varies with thickness of geopolymer mortar covering and the size of geotextile grids. Eighteen of the geotextiles used were coated with polymer to protect the fibers while the other eighteen geotextiles remained uncoated. A total of thirty-nine concrete cylinders with 150mm base diameter and 300mm height cured within 28 days were prepared, for which 36 cylinders were confined with green TRM with different parameters while three of the plain concrete cylinders served as control specimens. This is to maximize the investigation on the potential of green TRM in confining concrete and to determine the variations in compressive strengths and mode of failures of confined and unconfined concrete specimens. Results highlighted notable enhancement in the mechanical properties of the modified plain concrete after 28 days of TRM curing using universal testing machine (UTM). Likewise, a confinement theory of the optimum TRM design was modeled mathematically to evaluate the effects of concrete confinement and overall load carrying capacity enhancement gained from additional strength transferred by TRM to the concrete element.

Keywords: green TRM; concrete confinement; natural fiber; modified concrete; compressive strength