STRUCTURAL RESPONSE OF BLACK COTTON SOILS FROM WESTERN KENYA TREATED WITH LIME ACTIVATED SUGAR CANE BAGASSE ASH FOR ENGINEERING APPLICATIONS

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DECLARATION

I declare that this thesis is my original work and has not been submitted to any other institution for a degree or any academic award.

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CERTIFICATION

The undersigned certify that they have read and hereby recommend for the acceptance of Masinde Muliro University of Science and Technology a Thesis entitled "**Structural Response of Black Cotton Soils from Western Kenya Treated with Lime Activated Sugar Cane Bagasse Ash for Engineering Applications**"

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ABSTRACT

Black cotton soils, which are categorized as expansive soils, present significant geotechnical and structural engineering challenges all over the world, with damage costs associated with expansive behaviour estimated to run into billions of shillings annually. The expansive nature of these soils is a geological hazard, which threatens infrastructural development. The damages result in disasters due to collapse of structural works founded on them. In Kenya, these soils cover about 273809km^2 and commonly occur in flat and gently sloping landscapes such as on the highland plateau, lowland flood plains and valley floors. They are fine-grained soils that are susceptible to swelling and shrinking. Cracking of buildings due to foundation failure is more prevalent with these black cotton soils, especially in areas that undergo wetting and drying. The soils are never recommended for block making which is one of the low cost building methods. It is therefore necessary to find ways to stabilize these soils before using them in foundations or making soil blocks. On the other hand, 1.6 million tons of sugar cane bagasse ash is generated annually in Kenya. The bagasse when burnt under controlled temperatures result into pozzolanic ash. If the ash is activated by alkalis, it can form cementitious materials. This will lead to reduction in environmental impact leading to sustainable development as a result of cascaded use of by-products of other processes. This study sought to determine the effect of lime-activated sugar cane bagasse ash on engineering properties of black cotton soil in Kenya. Properties of black cotton soils from different sites were identified through secondary data. The soil sample used for experimental study was taken from Ahero-Kisumu road. Samples of sugarcane bagasse were collected from Nzoia sugar factory in Western Kenya. The bagasse was dried and burnt in a special made kiln for complete combustion. The resulting ash was ground and sieved through 75μm BS sieve size. Several mixes of the soil, lime and ash were made to establish the effect of the lime activated ash on black cotton soils. The plasticity of the soil generally reduced with increase in sugarcane bagasse ash. The maximum dry density decreased while the optimum moisture content increased with increased percentage of ash. Lime stabilization of black cotton soils improved their compressive strength. The strength further improved by addition of sugar cane bagasse ash to some optimum level. At 7 and 14 days the optimum were obtained at 2% SCBA addition for all lime stabilized samples. At 28 days, the optimums were obtained at 2% SCBA addition for 2 and 4% lime stabilized samples. For 6 and 8 % lime stabilized samples, the maximum were achieved at 4 and 6% SCBA addition respectively. Potential swell for samples cured for 28 days significantly reduced with increase in ash content for all lime stabilized black cotton soil samples. Correlations were established between MDD and CBR, MDD and PI of untreated soil, MDD and q_u lime activated ash treated soil, and finally compressive strength and ash content for lime stabilized soil. Model depicting compressive strength of black cotton soils stabilized with lime activated ash cement was developed. The developed model can be applied in stabilization of black cotton soils to suit specific structural requirements in wide engineering applications such as road construction, block production and foundation improvement.