World Academy of Science, Engineering and Technology
International Journal of Civil and Architectural Engineering
Vol:8, No:11, 2014

Environmental Benefits of Corn Cob Ash in Lateritic Soil Cement Stabilization for Road Works in a Sub-Tropical Region

Authors : Ahmed O. Apampa, Yinusa A. Jimoh

Abstract : The potential economic viability and environmental benefits of using a biomass waste, such as corn cob ash (CCA) as pozzolan in stabilizing soils for road pavement construction in a sub-tropical region was investigated. Corn cob was obtained from Maya in South West Nigeria and processed to ash of characteristics similar to Class C Fly Ash pozzolan as specified in ASTM C618-12. This was then blended with ordinary Portland cement in the CCA:OPC ratios of 1:1, 1:2 and 2:1. Each of these blends was then mixed with lateritic soil of ASHTO classification A-2-6(3) in varying percentages from 0 – 7.5% at 1.5% intervals. The soil-CCA-Cement mixtures were thereafter tested for geotechnical index properties including the BS Proctor Compaction, California Bearing Ratio (CBR) and the Unconfined Compression Strength Test. The tests were repeated for soil-cement mix without any CCA blending. The cost of the binder inputs and optimal blends of CCA:OPC in the stabilized soil were thereafter analyzed by developing algorithms that relate the experimental data on strength parameters (Unconfined Compression Strength, UCS and California Bearing Ratio, CBR) with the bivariate independent variables CCA and OPC content, using Matlab R2011b. An optimization problem was then set up minimizing the cost of chemical stabilization of laterite with CCA and OPC, subject to the constraints of minimum strength specifications. The Evolutionary Engine as well as the Generalized Reduced Gradient option of the Solver of MS Excel 2010 were used separately on the cells to obtain the optimal blend of CCA:OPC. The optimal blend attaining the required strength of 1800 kN/m2 was determined for the 1:2 CCA:OPC as 5.4% mix (OPC content 3.6%) compared with 4.2% for the OPC only option; and as 6.2% mix for the 1:1 blend (OPC content 3%). The 2:1 blend did not attain the required strength, though over a 100% gain in UCS value was obtained over the control sample with 0% binder. Upon the fact that 0.97 tonne of CO2 is released for every tonne of cement used (OEE, 2001), the reduced OPC requirement to attain the same result indicates the possibility of reducing the net CO2 contribution of the construction industry to the environment ranging from 14 – 28.5% if CCA:OPC blends are widely used in soil stabilization, going by the results of this study. The paper concludes by recommending that Nigeria and other developing countries in the sub-tropics with abundant stock of biomass waste should look in the direction of intensifying the use of biomass waste as fuel and the derived ash for the production of pozzolans for road-works, thereby reducing overall green house gas emissions and in compliance with the objectives of the United Nations Framework on Climate Change.

Keywords : corn cob ash, biomass waste, lateritic soil, unconfined compression strength, CO2 emission
Conference Title : ICCBE 2014 : International Conference on Civil and Building Engineering
Conference Location : Cape Town, South Africa
Conference Dates : November 06-07, 2014