Utilization of Varied Grades of Coir Fibers to Enhance the Subgrade Strength of Rural Roads Constructed on Soft Soils

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Abstract

With the continuous development of the urban areas in Sri Lanka, the shortage of land for the construction of pavements has become as a major issue. In such instances, Engineers are supposed to resort to constructing pavements in areas with soils that are known to be problematic. These problematic soils are most commonly known to be clays and silts due to their high swelling and shrinkage characteristics along with poor load-bearing behavior. The current method of "excavation and replacement" for altering the subgrade, is unquestionably expensive and time-consuming. Therefore, alternatives should be considered in modifying such subgrade. Such alternatives in modifying the subgrade are natural fiber reinforcement, synthetic reinforcement of the soil. Glass fibers, nylon fibers, steel fibers, polyvinyl alcohol fibers (PVA), polyester fibers (PET), polypropylene fibers (PP), and polyethylene fibers (PE) are examples of geosynthetics that are currently in use for subgrade modification. Natural fibers like palm, coir, sisal, jute, hemp, bamboo, and kenaf are becoming increasingly popular since they are more affordable and environmentally beneficial. The durability of natural fibers in subgrade enhancement is known to be 15 to 30 years in time for it to biodegrade fully, according to the soil condition it is reinforced with. The objective of this paper is to study the load bearing characteristics of soft soil when reinforced with different grades of coir fiber. Various studies have been conducted on soft soils such as clay or silt, reinforced with fibers. The most common length of fiber adopted for subgrade modification was seen to be within the range of 1cm to 5cm whereas the composition of fiber varied between 0.2% to 1.5% of the weight of soil. Hence, current studies on fiber reinforced subgrades were used to adopt the length and percentage of fiber in this study. Two commonly available grades of brown coir fiber, which are Mattress fiber and Bristle fiber were used in this study, with composition varying from 0.25% to 0.75% (with 0.25% increments) and lengths varying from 1cm to 3cm (as short fibers in random arrangement). The soil, that was collected from the flood prone area around the Kelani River basin was initially tested for the physical and mechanical properties with the aid of several laboratory experiments such as sedimentation analysis, Atterberg limits and Standard Proctor Compaction (SPC) tests where the soil was classified; this was considered as the control sample. The soil was classified as a fat clay (CH) with a liquid limit of 76% and a plasticity index of 41.34%. The compaction test results showed that the clay bears an optimum moisture content of 27.4% and a maximum dry density of 1.39g/cm3. The 96-hour-soaked California Bearing Ratio (CBR) test on the unreinforced sample showed a low CBR value of 1.21%. The clay was then reinforced with both mattress fibers and bristle fibers and were tested against a soaked CBR test. The sample of fat clay possessed a CBR value of 1.77% with 0.25% bristle fiber which was 1.46 times greater than that of the control sample. 0.50% composition of bristle fiber gained a strength of 2.09 times with a CBR value of 2.54%. The inclusion of 0.75% bristle fiber recorded a 2.61% CBR value by a factor of 2.15 times of

unreinforced clay. In the inclusion of mattress fiber, the 0.25% fiber sample recorded a CBR value of 1.68%, 0.50% fiber sample with a CBR value of 1.80% and 0.75% fiber sample with a CBR value of 1.98%. the strength gained were 1.39, 1.49 and 1.64 times respectively. The optimum percentage of fiber was observed as bristle fiber of 0.75% due to its stiff texture and good load distribution characteristics in the clay fiber matrix. The mattress fiber was as effective, in lower quantities due to its smooth texture. From this study, it was concluded that the use of bristle fiber from coir can be used to enhance the load bearing characteristics of soft soils to a considerable extent, with more room for improvement.

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