NATURE BASED LANDSLIDE MITIGATION - AN APPLICATION OF BIO ENGINEERING

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The use of vegetation for slope stability has been practiced in developed countries such as Hong Kong. This study identifies the effect of roots of the tea plant *(Camellia sinensis)* and vetiver grass *(Chrysopogon zizanioides)* on slope stabilization in the central highlands of Sri Lanka. The main objective of this research is to compare the influence of clonal tea plants and seedling tea plants on slope stability, find the influence of vetiver on slope stability, and propose a combined slope stabilizing method for tea lands. This slope stability is studied according to the root indices based on root cohesion, root morphology, and root distribution with depth. Root morphology of tea is a tap root system and vetiver has a fibrous heart root system. The root depth of clonal tea plants is around 1 m, and it increased up to 2 m for seedling tea plants.

Slope stability analysis was done for selected vegetations and different slopes with different soil properties complying with Sri Lankan soil conditions. Deterministically, FOS was computed for slopes using Bishop's Limit Equilibrium analysis in Slope/W software. For the slope stability analysis, several soil parameters were selected for accurate results. Soil unit weight (γ) was taken as 18 kN/m^{-3} and analysis was done for cohesion values of 5,10,15 kPa and friction angle of 20,25,30 degrees. Analysis was done for the five different geotechnical parameter combinations for without vegetation soils where constant friction angle (20^0) with cohesion values of 5,10,15 kPa. And constant cohesion value (5kPa) under different friction angles (20^0,25^0,30^0). Slopes with vegetation were analysed as areas with increased soil cohesion. For areas reinforced with tea, cohesion was considered by adding 10kpa (root cohesion) to the existing soil condition and for vetiver, it is considered as 6kPa. Unit weight and friction angle were considered as the same. FOS for all vegetations types was calculated for the selected slope angles (30^0 45^0, 60^0, 70^0) and slope heights (5m,10m) with different soil properties (C, Φ). Critical slope angle where FOS = 1 and Safe slope angle where FOS = 1.2 for each type of vegetation was found and compared for each case. Further, terraced slope stabilization was analysed using a combination of tea and vetiver and road cut slope stabilization using tea and vetiver grass was analysed using Slope/W.

On analysis, the results show that the FOS for slope increases with the vegetation cover. Plantation beneficially affects slope stabilization. Vegetation increases the critical slope angle and safe slope angle for any soil condition. Seedling tea performs better than clonal tea in slope stabilization therefore seedling tea plantations can be recommended for unstable slope conditions and the combined analysis of tea and vetiver showed that adding vetiver zones at a sufficient contour interval increased the stability of terraced slopes and could be used to stabilize the unstable slopes cut within tea estates for purpose of access roads.

Keywords: slope stability; vetiver; clonal tea; seedling tea; roots; safe and critical slope angle

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