Sensitivity of Factor of Safety in Vetiver Reinforced Slopes: A Parametric Study

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Abstract

Vegetative reinforcement using vetiver grass is increasingly used to improve the stability of shallow slopes, but numerical predictions depend strongly on how root mechanical parameters are chosen. This study investigates how changes in key vetiver root properties affect the factor of safety (FOS) in a finite element slope stability model. Baseline values for root diameter, Young's modulus, and tensile strength were taken from published studies, with 0.8 mm selected as a representative diameter. A root area ratio (RAR) of 0.025% was used to represent low-density field conditions. Sensitivity analyses were performed by varying both RAR and root diameter, and the related mechanical properties were updated using established empirical relationships. The results show that even small increases in RAR lead to clear improvements in stability. The baseline RAR of 0.025% produced an FOS of 1.15, which increased to 1.175 and 1.20 when RAR was raised to 0.03125% and 0.0375%. This indicates that slope stability improves as more roots contribute to reinforcing the soil. Changes in root diameter also affected the results. Using larger diameters of 1.0 mm and 1.2 mm, along with their lower stiffness and tensile strength, reduced the FOS to 1.13 and 1.12. Overall, the study shows that both RAR and diameter-dependent mechanical properties strongly influence predicted slope stability, with RAR having the larger impact in this study. These findings highlight the importance of selecting appropriate root parameters and performing sensitivity checks when modelling vetiver reinforcement in geotechnical design.

Keywords

Vetiver reinforcement, Root area ratio, Factor of safety, slope stability analysis, Finite element modelling, sensitivity study.