Analytical Methodology to Evaluate the Basal Stability of Column-Supported Embankments

Graduate student Danilo Botero-Lopez, Ph.D. Aaron P. Gallant, Civil and Environmental Department of University of Maine

Abstract

Column-supported embankments (CSE) are becoming more popular in infrastructure projects. The current design methodology in the Federal highway Administration (FHWA) [1] for evaluating the global stability of column-supported embankments (CSE) does not account for the mechanisms that govern the stresses in CSE such as: soil arching and soil-column interface. The goal of this study is to develop a simplified physics-based methodology to compute the factor of safety (FS) against lateral spreading or basal stability applying lateral equilibrium of a three-wedge system (Fig. 1) for a given depth. A 3D parametric Finite Element (FEM) was carried out and informed about the typical failure mechanism of the CSE, the lateral pressure at the fill (active wedge), the arching mechanism, the soil-column interaction, and passive resistance (passive wedge). The factor of safety was computed applying the strength reduction technique to the native materials. Although the finite element analysis is an excellent tool to estimate the factor of safety against basal stability of the CSE, it is very time consuming. An analytical method is developed applying lateral equilibrium of the three-wedge system (Fig 1), where the estimation of the depth of the failure surface and the associated factor of safety can be computed. Good agreement was found for the factor of safety and the location of the depth of failure between the analytical and numerical method. This work will help practitioners in optimizing the column spacing of the system by determining a more accurate factor of safety against basal stability, thereby making it more economical and efficient

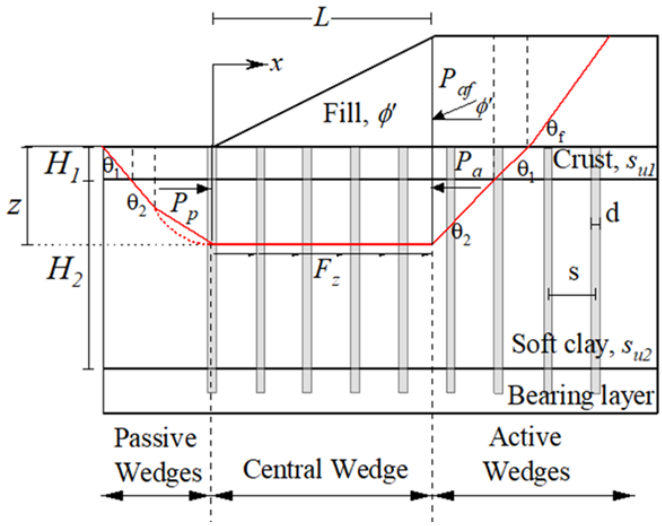

Fig. 1 Force body diagram of the three wedge CSE, Red Line is the assumed failure slip surface at a depth z

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References

[1] Schaefer, V., Berg, R., Collin, J., Christopher, B., DiMaggio, J., Filz, G., Bruce, D., and Ayala, D. (2017). "Ground modification methods reference manual—volume ii." Washington, DC: Federal Highway Administration [