TIDC Transportation Infrastructure Durability Center AT THE UNIVERSITY OF MAINE

Global Stability of Column-Supported Embankments

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Abstract

Rigid inclusions are vertical (columns) unreinforced concrete grouted into the soil in a geometry array to support embankments and reduced stresses in the foundation materials. It is typically the first option when a project schedule is constrained. The main responsible to alleviate the subsoil stress is the arching mechanism formed in the fill that partially transfer some of the filling weight to the top of the column head. As a portion of the fill load is carried by the foundation soils, some of this load is shared to the columns via downdrag due to the differential settlement between columns and the foundation materials, reducing stress applied to weak material. While these vertical load mechanics are well understood, they have not been considered when assessing the global stability. Certainly, the best option nowadays to capture the global stability of these systems is numerical analysis. But still, this method is time consuming, and they do not provide a convenient means to perform parametric studies that can test the sensitivity of model inputs and design assumptions. A new methodology is developed to assess the Global Stability of Column-supported earthwork system (Fig. 1). First, using a procedure to calculate the vertical stresses using stress-displacement compatibility and the vertical load mechanism. Then, these stresses are incorporated into a Limit Equilibrium Analysis (LEM) along with the Strength reduction technique (SRM) to assess the global stability in a more efficient manner compared with a numerical analysis. Validation is carried out with Numerical Analysis where good agreement was found with the magnitude of the factor of safety and the slip surface location and geometry. Additionally, a software is developed to capture the behavior of the system, helping engineers to optimize the column spacing or fill height in a more efficient manner.

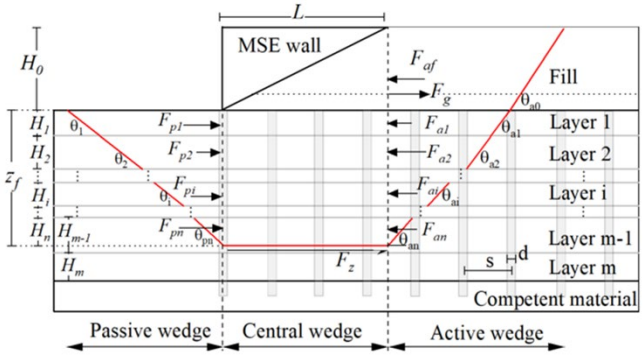

Figure 1. Free body diagram considered in the theoretical method of a multi-layer embankment supported in rigid inclusions in a three-wedges slip surface assumption (red line).

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