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Discussion of "Geosynthetic-encased stone columns: Analytical calculation model" by Bostjan Pulko, Bojan Majes, and Janko Logar, Geotextiles and Geomembranes 29 (2011) 29–39

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This paper presents a closed-form solution for analysis of pile-supported systems that utilize geosynthetic-encased stone columns as the deep foundation elements. The analytical model that is presented is an extension of earlier works (Balaam and Booker, 1985; Raithel and Kempfert, 2000), and its formulation and associated assumptions are clearly described. The validity of the proposed method is evaluated using finite element analysis, and the results of a parametric study are presented at the end of the manuscript.

Throughout this paper, the only performance indicators of interest that are presented are vertical and horizontal displacements, either in a non-dimensional form or indirectly, as a settlement reduction factor (β). Other significant design parameters of interest can also be found from the proposed analytical model; e.g., the stress concentration ratio (η_c) on the columns, or the hoop tension forces (F_R) in the encasement. The stress concentration ratio is a key parameter in the design of pile-supported systems, and selection of an appropriate geosynthetic for encasement of a stone column is directly related to the calculated hoop forces in the encasement.

For purposes of this discussion, finite element analyses were conducted using the commercial program ABAQUS (Hibbitt, Karlsson and Sorensen Inc. 2007) to investigate the capability of the proposed analytical model for capturing the stress concentration ratio and hoop forces in the geosynthetic. A unit cell resting on a rigid base was modeled using an axisymmetric idealization, with four-node quadrilateral elements used to discretize the soils and two-node membrane elements used to represent the encasement. The "no compression" option was activated for the membrane elements to more accurately model the behavior of the encasement, which can only carry tensile stresses. In the finite element analyses that were performed, in order to follow the assumption of uniform settlement on the column and the soft soil that was made by the authors, node points corresponding to both the column and the surrounding soft soil at the top of the unit cell were equally subjected to a series of vertical downward displacements. As vertical displacements were applied to the top of the unit cell, the resultant stresses were recorded. For a fair comparison between the finite element analyses that were conducted and the closed-form solution that is presented, all boundary conditions, interactions between the geosynthetic encasement and the surrounding soils (i.e., no relative displacement), and constitutive laws for the different materials that were modeled were selected to be the same as what was described by the authors.

Unfortunately, a direct comparison of the finite element results presented herein and the examples that are presented by the authors in the "Model Validity" section of the paper could not be performed, as not all of the necessary model parameters are provided by the authors for adequate reproduction (e.g., H, E_c, γ_c). The model parameters shown in Table 1 are used herein; a concerted effort was made to be consistent with the parameter ratios used by the authors (e.g., $H/d_c = 10$, $E_c/E_s = 30$, $\gamma_c/\gamma_s = 1.5$). In all of the analyses that were performed, the tensile stiffness of the geosynthetic (J), the depth of the unit cell (H), the diameter of the encased column (d_c), the unit weight of the soft soil (γ_s), and the coefficient of lateral earth pressure (K_{ini}) were assumed to be 3000 kN/m, 8.0 m, 0.8 m, 15 kN/m^3, and 0.8, respectively.

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