Three-dimensional modelling of an embankment built on a soft soil improved with prefabricated vertical drains

P.J. Venda Oliveira *, R.F.P.M.L. Cruz **, L.J.L. Lemos* and J.N.V. Almeida e Sousa †**

* Assistant Professor at the Department of Civil Engineering, University of Coimbra, Polo II, Rua Luis Reis Santos, 3030-788 Coimbra, Portugal, Email: pjvo@dec.uc.pt.

** Civil Engineer, Rio de Janeiro, Brazil. E-mail: francisco.cruz@gmail.com.

***Full Professor at the Department of Civil Engineering, University of Coimbra, Polo II, Rua Luis Reis Santos, 3030-788 Coimbra, Portugal, Email: llemos@dec.uc.pt.

†Associate Professor at the Department of Civil Engineering, University of Coimbra, Polo II, Rua Luis Reis Santos, 3030-788 Coimbra, Portugal, Email: jas@dec.uc.pt.

ABSTRACT

The construction of modern motorways and railways often requires embankments built on soils with poor geotechnical characteristics, frequently requiring the installation of vertical drains into the soil foundation to accelerate the consolidation process. Despite the developments in modelling, the design of vertical drain systems is still often based on Barron's [1] classical theoretical solution, i.e., considering an infinite discharge capacity, which is only realistic for sand drains with permeability greater than 500-1000 m/year [3].

Some three-dimensional (3D) consolidation analyses of embankments have been performed over the last twenty years, using various constitutive models, such as: a linear elastic law [3], p-q-θ critical state model [4] or Modified Cam Clay model [5, 6] to improve the predictions. However, generally, the water flow into the system's soil-drains is still simulated using an equivalent permeability [5], ignoring the real flow conditions.

Thus, this work compares the field measurements of a non-symmetric embankment built on Portuguese soft soils improved with prefabricated vertical drains (PVDs), with the numerical predictions of a 3D modelling where the PVDs are simulated according to the field flow conditions. The change in the permeability with the void ratio and the effect of the smear zone are also included in all numerical analyses. The numerical predictions are compared with the field data in terms of settlement, horizontal displacement and excess pore pressure. In general, the numerical results are very close of the field measurements, namely in terms of vertical and horizontal deformations.

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