ELSEVIER

Computers and Geotechnics 28 (2001) 209–233

COMPUTERS AND GEOTECHNICS

www.elsevier.com/locate/compgeo

Structural behaviour and parametric study of reinforced embankments on soft clays

José Leitão Borges *, António Silva Cardoso

Department of Civil Engineering, Faculty of Engineering, University of Porto, Rua Dr. Roberto Frias s/n, 4200-465 Porto, Portugal

Abstract

Geotechnical behaviour of a reinforced embankment on soft ground is studied by a numerical model based on the finite element method. Special emphasis is given to the stress states (stress levels and pore pressures), displacements, tensile forces in the geosynthetic and overall stability, during and after construction. The influence of some parameters, namely geosynthetic stiffness and viscosity, embankment width and construction sequence, is also analysed. Several conclusions are obtained. © 2001 Elsevier Science Ltd. All rights reserved.

Keywords: Embankment; Geosynthetic; Reinforcement; Soft soils; Parametric analysis

1. Introduction

The increasing occupation of the ground over the last decades, due to economical and social development of the populations, has led to the necessity of using soils with bad geotechnical characteristics as foundation of multiple engineering works. Particularly, the construction of embankments on soft soils, characterised by their low strength, high deformability and low permeability, has become nowadays an increasing reality, despite the difficulties associated to these works, generally related to overall stability deficiency and to high settlements that develop slowly.

Geotechnical engineers have developed several alternatives to solve these problems and, in recent years, geosynthetic reinforcement has been added to the list of possible solutions when embankments must be constructed on very soft foundations. In many

* Corresponding author. Tel.: +351-2508-1928; fax: +351-2508-1440.
E-mail address: leitao@fe.up.pt (J.L. Borges).

0266-352X/01/$ - see front matter © 2001 Elsevier Science Ltd. All rights reserved.
PII: S0266-352X(00)00021-5

cases, the use of a geotextile or geogrid can significantly increase the safety factor, improve performance in terms of displacements and reduce costs in comparison with more conventional solutions.

Over the two last decades, with the availability of faster computers with larger data storage, it has been possible to perform finite element analyses with increasingly complex formulations. The earliest analyses used elastic models for the materials but quickly moved to non-linear elastic and elasto-plastic models. A critical state model was used by Wroth and Simpson [24] on a trial embankment and coupled analyses have been capable of predicting the pore pressure response in the field and in centrifuge tests [33–36]. Using reinforcement and interface elements, Kwok [25] performed a parametric study to investigate the effect of the reinforcement stiffness, the subsoil conditions, the geometry and the embankment constitutive model. Hird and Kwok [26] used interface elements and showed that useful information regarding the transmission of shear stresses from the soil to the reinforcement could be extracted. Hird and Kwok [27] carried out a parametric study and concluded that sufficiently stiff and strong reinforcement may significantly reduce subsoil deformations and, for a subsoil of constant strength, the effect of reinforcement reduces with increasing depth. Undrained plane strain finite element analyses have been compared with limit equilibrium solutions [28,29] and with plasticity solutions for strip footings [30–32]. Rowe and Soderman [30] found that the finite element results were within 7% of the predicted plasticity failure heights for highly reinforced embankments. In Jewell [37,38], the mechanisms of reinforced embankments on soft foundation soils were examined and design formulations were provided. Jewell [38] concluded that limit equilibrium methods can be applied to reinforced embankments on soft soil and also presented approximate analytical solutions for foundation of uniform strength and limited depth and foundation with strength increasing with depth.

In this paper, the geotechnical behaviour of a reinforced embankment on soft soil is simulated by a numerical model, developed by Borges [3], based on the finite element method. Basically, the model uses the following theoretical hypotheses: (a) plane strain conditions; (b) coupled formulation of the flow and equilibrium equations, considering soil constitutive relations formulated in effective stresses (extension of Biot's consolidation theory) [6,16]; this formulation is applied to all phase of the problem, both during the embankment construction and in the post-construction period; (c) utilisation of the critical states model [p, q, θ] [3,4,6,16] to simulate constitutive behaviour of the foundation and embankment soils; (d) utilisation of a hardening elasto-plastic model to simulate 'instantaneous' constitutive behaviour of the reinforcement; (e) simulation of viscous behaviour of the geosynthetics (time-dependent constitutive relations) using a rheological model based on a series of Kelvin's models [20]; (f) simulation of constitutive behaviour of the soil–geosynthetic interfaces using a hardening elasto-plastic model.

The study includes analyses of a reference embankment. The effect of some parameters, like geosynthetic stiffness and viscosity, embankment width and construction sequence, is also studied.

In order to verify accuracy of the numerical model used in this paper, Borges [3] compared numerical and field results of two reinforced embankments on soft soils,

دریافت فوری ← متن کامل مقاله

ISIArticles
مرجع مقالات تخصصی ایران

- ✓ امکان دانلود نسخه تمام متن مقالات انگلیسی
- ✓ امکان دانلود نسخه ترجمه شده مقالات
- ✓ پذیرش سفارش ترجمه تخصصی
- ✓ امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
- ✓ امکان دانلود رایگان ۲ صفحه اول هر مقاله
- ✓ امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
- ✓ دانلود فوری مقاله پس از پرداخت آنلاین
- ✓ پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات