Geotextiles and Geomembranes 29 (2011) 567–580

Contents lists available at ScienceDirect

Geotextiles and Geomembranes

journal homepage: www.elsevier.com/locate/geotexmem

Centrifuge model study on low permeable slope reinforced by hybrid geosynthetics

D.V. Raisinghani [1], B.V.S. Viswanadham*

Department of Civil Engineering, Indian Institute of Technology Bombay, Powai, Mumbai 400 076, India

ARTICLE INFO

Article history:
Received 27 October 2010
Received in revised form
31 May 2011
Accepted 17 July 2011
Available online 10 August 2011

Keywords:
Geosynthetics
Low permeable soils
Reinforced slopes
Hybrid Geosynthetics
Seepage
Centrifuge modeling

ABSTRACT

The objective of this paper is to study the performance of hybrid geosynthetic reinforced slopes, with permeable geosynthetic as one of its components, for low permeable backfill slopes subjected to seepage. Four centrifuge tests have been performed to study the behavior of hybrid geosynthetic reinforced slopes subjected to seepage, keeping the model slope height and vertical spacing of geosynthetic reinforcement layers constant. Centrifuge model tests were performed on 2V:1H slopes at 30 gravities. One unreinforced, one model geogrid reinforced and two hybrid geosynthetic reinforced slope models with varying number of hybrid geosynthetic layers were tested. The effect of raising ground water table was simulated by using a seepage flow simulator during the flight. Surface movements and pore water pressure profiles for the slope models were monitored using displacement transducers and pore pressure transducers during centrifuge tests. Markers glued on to geosynthetic layers were digitized to arrive at displacement vectors at the onset of raising ground water table. Further, strain distribution along the geosynthetic reinforcement layers and reinforcement peak strain distribution have been determined using digital image analysis technique. The discharge for the performed model tests is determined by performing seepage analysis. It was confirmed by the centrifuge tests that the hybrid geosynthetics increases the stability of low permeable slope subjected to water table rise. The hybrid geosynthetic layers in the bottom half of the slope height play a major role in the dissipation of pore water pressure.

1. Introduction

Geosynthetic reinforced soil walls and slopes are being widely used because of their low cost, flexibility and simple construction techniques. The backfill material forms one of the major constituents of a geosynthetic reinforced soil wall and slope and accounts for 30–40% of their cost. Granular backfill with good permeability characteristics is the preferred material for constructing reinforced soil walls and slopes. Zornberg and Leshchinsky (2003) evaluated the design criteria put forth by agencies worldwide for geosynthetic reinforced soil structures. A vast variation exists between the design procedures adopted in various countries. AASHTO (2002) (American Association of State Highway and Transportation Officials) permits the use of 0–15% fines whereas NCMA (National Concrete Masonry Association, 1997), permits fines up to 35% for carefully engineered structures. Most of the geosynthetic reinforced soil walls are conservatively designed using soils with low percentage of fines in the reinforced zone as per the design criteria put forth by various agencies worldwide. However the lack of availability of such backfill at construction site and high transportation costs involved in importing such material has often led to the use of locally available low permeable soil as backfill material for constructing geosynthetic reinforced slopes and walls. Use of backfill with relatively low permeability may lead to a situation where the wall, initially designed to work under drained conditions, is actually working under undrained conditions. In this case, excess pore water pressures are generated within the soil mass which may reduce the strength of the soil, particularly at the soil-reinforcement interface (Lee and Bobet, 2005; Sandri, 2005). Cases have been reported about failure of reinforced soil walls constructed with relatively low permeability and investigations have revealed that the use of backfill with relatively high percentage fines coupled with insufficient precautions considered for drainage were the prominent reasons (Yoo and Jung, 2006). The economic advantage of a geosynthetic reinforced structure is completely eliminated by the need of such a select fill within the reinforced zone, with the cost of the fill depending on its availability. The potential savings for replacing conventional backfill

* Corresponding author. Tel.: +91 22 25767344; fax: +91 22 25767302.
E-mail addresses: dvrais70@gmail.com (D.V. Raisinghani), viswam@civil.iitb.ac.in (B.V.S. Viswanadham).
[1] Tel.: +91 22 25764311; fax: +91 22 25764311.

0266-1144/$ – see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.geotexmem.2011.07.003