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A new constitutive model for textured geomembrane/geotextile interfaces

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ABSTRACT

The paper presents a study of the frictional behaviour of geosynthetics used for municipal solid waste landfills. Direct shear tests of several geomembrane/geotextile interfaces were performed to investigate the shear behaviour. Furthermore, analytical and numerical models were developed to describe the observed behaviour, especially to simulate progressive geomembrane/geotextile interface failure and the factors controlling its significance.

1. Introduction

Safe disposal and storage of waste requires the design, construction and filling of repositories underlain by multi-layer liner systems. These liner systems typically contain a large number of material interfaces (geosynthetics/geosynthetics or geosynthetics/soil). Many of them have low shear strength. This can lead to potential failure surfaces inside the slopes or the base of the landfills.

Deeper understanding of the shear strength parameters and the constitutive relations of interacting geosynthetics is needed for safer design of landfills, being one of the weakest contacts between geotextile and geomembrane. This type of interface is the focus of this paper. The textured geomembrane/geotextile interface is used for both, the lining and the cover system of the landfills. An important characteristic of these systems with respect to stability is the shear resistance along the interface. The textured geomembrane increases the shear resistance and prevents the migration of leakage. The geotextile protects the geomembrane.

First of all, to carry out this investigation, a direct shear test methodology was developed based on the ASTM D5321-02 standard and the results from numerous authors (Fox et al., 1998; Gilbert et al., 1996a; Eid et al., 1999, Nye and Fox, 2007; Pasqualini et al., 2002; Stark and Poeppel, 1994; Sharma et al., 2007; Triplett and Fox, 2001; Zornberg et al., 2005; Bergado et al., 2006).

Through tests with different geotextile/geomembrane interfaces, the following relationships were obtained:

- shear stress–shear displacement,
- shear stress–normal displacement and
- shear stress–normal stress.

Normally, these results show strain-softening behaviour, very small dilatancy between 1/300 and 1/50 of maximum shear displacement (50 mm), and a non-linear failure envelope at normal stress ranges tested (25–450 kPa).

These results are in line with investigations from Giroud et al. (1990), Koutsourais and Sprague (1991), Giroud and Darrasse (1993), Stark et al. (1996), Gilbert and Byrne (1996), Jones and Dixon (1998) and Pitanga et al. (2009).

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