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Analysis of fluid discharge from a hanging geotextile bag

J. Richard Weggel [a,*], Jacob Dortch [a], Douglas Gaffney [b]

[a] Department of Civil, Architectural and Environmental Engineering, Drexel University, Philadelphia, PA 19104, USA
[b] Ocean & Coastal Consultants, Gibbsboro, NJ, 20 E. Clementon Rd., Suite 201N, Gibbsboro, NJ 08026, USA

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ABSTRACT

In order to investigate the use of geotextile bags for dewatering slurries, an analytical model for a fluid draining from a hanging geotextile bag is derived and presented in dimensionless form. A data analysis procedure is proposed. Experimental results using water as the fluid with specially constructed geotextile bags are compared with the model and show excellent agreement. The model is applied to data for slurry-filled bags and used to determine the overall permittivity of a hanging bag dewatering system and the fraction of the bag's volume drained as fluid.

1. Introduction

Large diameter geotextile tubes can be used to dewater various slurries ranging from contaminated dredged material to mine and chemical plant wastes (Lawson, 2008; Huang and Luo, 2007). The tubes are often about 9.1 m (30 ft) or 13.7 m (45 ft) in circumference since many geotextiles are woven in 4.6 m (15-ft) widths (see Fig. 1) but can be up to 25 m (82 ft) in circumference. They are commonly sewn with circumferential seams, and, less commonly, with longitudinal seams. The ends are closed to form the tube. Filling ports are spaced along the top of the tube. The slurry is pumped into the tubes and the liquid, under internal pressure and gravity, migrates to the surrounding geotextile and passes through it. The solids are retained and form a filter cake on the inside of the tube. The physical characteristics of the geotextile – its permeability or permittivity – determine its initial ability to pass the liquid; however, the solids in the slurry also migrate outward to the geotextile and reduce its ability to pass the liquid (Yaman et al., 2006). The rate at which a slurry is dewatered depends on both the characteristics of the geotextile and of the slurry. Very fine materials in the slurry can clog the geotextile and reduce its ability to dewater. Some slurries require the addition of flocculants for the geotextile tube to effectively dewater them. The selection of an effective geotextile for a dewatering tube is based on experience and, for an untested slurry, can be a trial and error procedure. One method of evaluating a geotextile's suitability for dewatering is to make a bag from the candidate geotextile, suspend it, fill it with a known quantity of the slurry and measure the rate at which the slurry liquid seeps from the bag. Various flocculants can also be evaluated in this way. The hanging bag test was originated by Fowler (1995). The "hanging bag" test is described in detail in GRI Test Method GT14 (GRI, 2004), in Koerner and Koerner (2006) and more recently in Koerner and Koerner (2010). A typical hanging bag setup and example bags are shown in Fig. 2. Similar test results can be obtained by using other forms of hanging bags as discussed in Gaffney and Wynn (2004).

This paper presents a hydraulic analysis of the process of fluid flow through a geotextile bag, initially for water alone and subsequently for a slurry. A procedure for analyzing the data that produces an *in situ* permittivity for the bag as well as an estimate of the dewatering rate is presented. The analytical model is presented in dimensionless form allowing its application to any geotextile and slurry.

2. Gravity flow through a vertical geotextile panel and bag

The horizontal flow of a fluid though a vertical permeable geotextile panel is shown in Fig. 3. The figure depicts a vertical geotextile acted on by a hydrostatic column of fluid. The height of the fluid column behind the geotextile is y. The flow through the geotextile is governed by Darcy's Law which is given by,

* Corresponding author.
E-mail addresses: weggel@drexel.edu (J.R. Weggel), jmd325@drexel.edu (J. Dortch), doga@ocean-coastal.com (D. Gaffney).

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