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Technical Note

Pore size distribution of hybrid nonwoven geotextiles

Amit Rawal*, Harshvardhan Saraswat

Department of Textile Technology, Indian Institute of Technology Delhi, Hauz Khas, New Delhi, India

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ABSTRACT

Pore size distribution has become a prerequisite in determining the performance of geotextiles for various functions including filtration, separation and reinforcement. The pore structure and morphology in a nonwoven geotextile are known to be complex and it becomes further complicated in hybrid nonwoven geotextiles consisting of two types of fibers. In this study, a modified model of pore size distribution of hybrid nonwoven geotextiles has been proposed based on sieving-percolation pore network theory. A comparison has been made between theoretical and experimental pore size distributions of hybrid needlepunched nonwoven geotextiles consisting of predefined weight proportions of viscose and polyester fibers. The weight proportions of the constituent fibers have been theoretically analysed for obtaining the desired pore size distributions of hybrid nonwoven geotextiles.

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1. Introduction

Pore size characteristics play a key role in the performance of geotextiles that are not limited to filtration and separation based applications but also has a paramount importance in soil–geotextile interaction where geotextiles are acting as reinforcement (Babu and Srivastava, 2007; Kabeya et al., 1993; Koerner, 1986; Liu and Chu, 2006; Narejo, 2003). The pore structure and morphology in a nonwoven geotextile are highly complex and can be easily pointed out by determining the differences in the entrance and exit pore dimensions, thus described in terms of pore size distribution. Therefore, the pore size distribution in a nonwoven geotextile becomes a prerequisite especially for investigating the retention capacity of soil particles *whilst* allowing free flow of water. Few analytical models based on sieving-percolation pore network theory for predicting the pore size distribution of nonwoven geotextiles have been found in the literature (Faure et al., 1986, 1990; Lombard et al., 1989). In these models, the fibers are assumed to be stacked in elementary longitudinal planes and the pore size distribution has been calculated based on Poissonian polyhedra theory. The main drawbacks of these models were that the effect of fiber orientation was not accounted and these models can only be employed to random nonwoven geotextile. To overcome these limitations, recently we have predicted the pore size distribution of nonwovens by combining stochastic and geometrical probability approaches and elucidated the role of fiber orientation (Rawal, 2010; Rawal et al., 2010). In addition to analytical models, a semi-empirical approach has been earlier reported by Giroud (1996). Numerous experimental techniques, namely, dry sieving, hydrodynamic sieving, wet sieving, image analysis, bubble point and mercury intrusion porosimetry have been employed to determine the pore size distribution of nonwoven geotextiles but no single method has been accepted universally (Bhatia and Smith, 1994, 1996; Bhatia et al., 1996a,b; Faure et al., 1990; Gerry and Raymond, 1983). Nevertheless, the bubble point method has shown repeatability and reproducibility in determining the pore size distribution of nonwoven geotextile (Bhatia et al., 1996b).

Pore size characteristics in natural fiber based geotextiles are *non-uniform* primarily due to inherent variation in properties (Rawal and Anandjiwala, 2007). Nevertheless, the natural fiber based geotextiles are environment friendly, less expensive, easily available, and ecologically compatible and thus, used in numerous civil engineering applications (Basu et al., 2009; Bera et al., 2009; Chauhan et al., 2008; Lekha, 2004; Lekha and Kavitha, 2006; Park, 2009; Sarsby, 2007; Subaida et al., 2008, 2009). Furthermore, we have recently demonstrated the potential of cellulosic regenerated fiber such as viscose rayon having uniform inherent properties in combination with synthetic fibers in the form of hybrid nonwoven geotextiles for soil stabilisation applications (Rawal and Saraswat, in press). These hybrid nonwovens can be potentially used for other applications of geotextiles specifically for filtration and separation provided the pore size distribution can be well predicted. Therefore, the objectives of the research work are to

* Corresponding author.
E-mail addresses: arawal@textile.iitd.ac.in, amitrawal77@hotmail.com (A. Rawal).

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