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The influence of tensile strain on the pore size and flow capability of needle-punched nonwoven geotextiles

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ABSTRACT: This work studies the effect of tensile strain on the pore size and the flow capability of needle-punched nonwoven geotextiles. Laboratory tests were conducted to investigate the variations of pore size, thickness, porosity and mean discharge velocity of water through geotextile samples (permittivity) while under different uniaxial and biaxial tensile strains ranging from 0 to 20%. Comparison of test and predicted results suggests the values of the shape factor β, describing path tortuosity and the dimensionless parameter ξ to account for the evaluations of permeability and filtration opening size for needle-punched nonwoven geotextiles under various tensile strains. The experimental data collected from three needle-punched nonwoven geotextiles show that strained geotextiles exhibit smaller pore size than unstrained geotextiles. The mean discharge velocity of water through strained geotextiles tends to decrease initially, with an increase in tensile strain for geotextiles in low strain regions, but this decreasing trend of mean discharge velocity then reverses for the same geotextiles submitted to higher strain.

KEYWORDS: Geosynthetics, Discharge velocity, Experimental test, Needle-punched nonwoven geotextiles, Permittivity, Pore size, Tensile strain, Uniaxial and biaxial

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1. INTRODUCTION

The retention, permeability and anti-clogging capability of geotextiles are important design concerns when geotextiles are employed in filtration applications. Current design criteria for ensuring the retention and permeability capability of geotextile filters are generally dictated by the relationship between the characteristic geotextile pore size and soil grain size, as well as the relative permeability of the soil and the geotextile (Giroud 1982; Fischer *et al*. 1990; Christopher and Fischer 1992; Luettich *et al*. 1992). The clogging potential of a soil–geotextile system is evaluated through experimental tests using specific on-site soil and the proposed geotextile (for instance, ASTM D5101-06). All test methods to determine the filtration characteristics (i.e. pore size, permeability, and clogging potential) of a geotextile are carried out with unstrained geotextiles.

In most engineering applications, a textile filter is usually subjected to various degrees of in-plane stress/strain. Dissipation of excess pore pressure on geosynthetics under considerable strain have been investigated and reported in the literature. These studies included a 10% strain in an embankment case (Rowe and Mylleville 1990), a 6% strain in a 5-m high geosynthetic-reinforced soil wall (Won and Kim 2007) and a greater than 7% strain in warp and fill directions for a geotextile-reinforced containment dyke (Schimelfenyg *et al*. 1990). Koerner (2005) investigated 'sheet drain' geocomposites, which consist of a quasi-rigid plastic sheet core protected by geotextiles on one or both sides, subjected to earth pressure with in-plane and out-of-plane strains. Several studies on liquefied soil or dredged materials filling process in geotextile tubes/geotextile containers that introduce a circumferential tensile stress on geotextiles have also been reported in the literature (Pilarczyk 2000; Moo-Young and Tucker 2002; Moo-Young *et al*. 2002; Koerner and Koerner 2006; Muthukumaran and Ilamparuthi 2006).

The effect of compressive stress perpendicular to the plane of a geotextile on geotextile filtration characteristics has long been recognised (Gourc *et al*. 1982a, 1982b; McGown *et al*. 1982; Giroud 1996, Palmeira and Gardoni 2002). Any increase in compressive stress tends to reduce the pore sizes and the permittivity of needle-punched

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