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Technical Note

Puncture resistance of polyester (PET) and polypropylene (PP) needle-punched nonwoven geotextiles

George R. Koerner^{a,*}, Robert M. Koerner^b

^a Geosynthetic Institute, Folsom, PA, USA

^b Department of Civil, Architectural and Environmental Engineering, Drexel University, Philadelphia, PA, USA

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ABSTRACT

It is common practice to use needle-punched nonwoven geotextiles as puncture protection for geomembranes against sharp objects like gravel or stones in either the soil above or the underlying soil/rock below. There are several design and experimental methods available for geotextile selection in this regard. None, however, directly address the type of resin or fiber from which the geotextile is made. This paper does exactly that insofar as a direct comparison of similar mass per unit area polyester (PET) versus polypropylene (PP) geotextiles are concerned. Furthermore, two types of PP geotextiles are evaluated; one made from continuous filaments and the other from staple fibers. Three different size and shaped puncture probes are used in the testing program. All three are ASTM Standards, i.e., D4833, D5495 and D6241.

The test results clearly indicate that geotextiles made from PP fibers outperform those made from PET fibers at all masses evaluated. Clearly, the present trend of using PP resin for heavy nonwoven protection geotextiles seems justified on the basis of these test results. In addition, the continuous filament PP and staple fiber PP geotextiles performed equivalently over all mass ranges for the three different types of puncture tests.

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1. Introduction

Over the past 15–20 years there has been a major shift in the type of polymer used in the manufacturing of needle-punched nonwoven geotextiles. In the past, the majority were from polyester (PET) resin whereas presently polypropylene (PP) resin is used almost exclusively. That said, the geotextile manufacturing process itself has continued to be similar at least for the relatively thick needle-punched nonwoven fabrics used in this study.

One of the major uses for high mass per unit area (or simply "mass") geotextiles of this type is for puncture protection of geomembranes when used as barriers for geoenvironmental and hydraulic engineering applications. Some of the major applications are as follows; Koerner (2005);

- landfill liner systems,
- landfill cover systems,
- waterproofing of all types of dams,
- liner systems for reservoirs and surface impoundments, and
- liner systems for canals and tunnels.

In this paper we present a laboratory study of using equivalent masses of needle-punched nonwoven fabrics made from either PET (continuous filament) or PP resins. For the PP geotextiles both continuous filament and staple fiber are used. All of the tests are evaluated in-isolation, i.e., without an accompanying geomembrane, using three different ASTM puncture test methods.

2. Properties and test methods

Since the mass of the geotextiles to be evaluated is the major variable in this series of tests, differences in the intrinsic polymer properties of the two resin types should be kept in mind in viewing the results. Table 1 presents various properties of polyester (PET) and polypropylene (PP) fibers from the perspective of the basic resin.

Using fabrics of different mass per unit area (from 135 g/m² to 1220 g/m²) in this laboratory study, each was evaluated for their puncture resistance using three different standardized puncture tests. The tests are as follows:

- (i) ASTM D4833, the "pin" puncture test (there is no ISO equivalent test)
- (ii) ASTM D5494, the "pyramid" puncture test (there is not ISO equivalent test)



^{*} Corresponding author. Tel.: +1 610 522 8440; fax: +1 610 522 8441. *E-mail addresses:* gkoerner@dca.net (G.R. Koerner), robert.koerner@coe.drexel. edu (R.M. Koerner).

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