TECHBRIEF

Stress Cracking of HDPE Geogrids

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The Structures Research and Technology Program aims to foster increased durability of new bridges and observable increases in the service life of existing structures, placing an emphasis on increasing highway safety while preserving the environment. The program focuses on researching nondestructive evaluation technologies to identify structural deficiencies and support bridge management systems. It also uses high-performance materials to repair and rehabilitate the existing inventory of deficient bridges. This find-it and fix-it program is supplemented by research that examines all aspects of bridges and foundations, including planning, design, construction, management, maintenance, inspection, and demolition.

Specific expertise areas include bridge coatings, bridge infrastructure, bridge management, nondestructive evaluation, corrosion protection, foundations, scour, geotechnical research, high-performance materials, aerodynamics, seismic research, and structures instrumentation.

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Introduction

This report documents part of a comprehensive study entitled, "Durability of Geosynthetics for Highway Applications." The research described here was concerned with evaluating the stress-cracking potential of high-density polyethylene (HDPE) resins and the long-term performance of geogrids containing these resins with respect to stress cracking. Assessing the long-term performance of such geogrids is necessary in order to provide rational design procedures for their use in highway applications.

Purpose

The purpose of this study was to improve the understanding of environmental stress cracking (ESC) and the long-term performance of uniaxially drawn HDPE geogrid products.

Scope

The scope of the research was to:

- Develop a test protocol to evaluate the notched constant tensile load (NCTL) characteristics of different parts of uniaxially drawn HDPE geogrids.
- Conduct an NCTL and an unnotched constant tensile load (UCTL) elevated-temperature testing program on three HDPE resin materials and on a uniaxially drawn HDPE geogrid product.
- Evaluate the data from the testing program to develop recommendations concerning long-term design strength of geogrids with regard to ESC.

Methodology for ESC Testing of HDPE Geogrids

Initial Baseline Testing: Stress-cracking behavior of these materials was evaluated using procedures adapted from ASTM D5399, "Standard Test Method for Evaluation of Stress-Cracking Resistance of Polyolefin Geomembranes by Notched Constant Tensile Load Test."

Experiments were conducted to select the best notch location, specimen geometry, and notch depth for NCTL testing of the geogrid in order to develop a test protocol that could achieve repeatable stress-

Table 1. HDPE materials evaluated under this study.

Material Identification	Relative Stress-Cracking Resistance	Geosynthetic Product Type	Color	Approximate Thickness (mm)	Other Dimensions (mm)
Resin L	Low	Plaque	Milky-White	1.8	N/A
Resin M	Medium	Plaque	Translucent-White	2.1	N/A
Resin H	High	Geomembrane	Black	1.5	N/A
Geogrid P-1	Medium	Uniaxially Drawn Oriented Geogrid	Black	Node: 2.75 Rib Width: 6.0 Rib Length: 147	Node Width: 16
Geogrid P-1a	Medium	Uniaxially Drawn Oriented Geogrid	Black	Node: 5.8 Rib: 2.0	Node Width: 17 Rib Width: 6.2 Rib Length: 150

rupture time and to achieve repeatable ductile, transitional, and quasi-brittle fractures. The specimen configuration selected for the NCTL testing was also qualified for use in UCTL testing of the geogrid. By qualifying a geogrid UCTL specimen preparation protocol, the geogrid specimen selection study fulfilled an important part of the research program's ultimate purpose.

The recommendations of NCTL and UCTL testing protocols for uniaxially drawn HDPE geogrids are discussed in detail in the report. The standard test procedures given in ASTM D5397, "Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test," provide the basis for these protocols. Deviations from and additions to standard method ASTM D5397, necessary for Constant Tensile Load testing of HDPE geogrids, are provided.

Predicting Long-Term Performance: The primary goal of the present research was to develop long-term performance predictive information for P-1 geogrids when subjected to construction damage. Such predictive information will provide safe allowable strength numbers for design engineers.

Two predictive methods—the rate process method (RPM) and the bidirectional shifting method developed by Popelar et al.—were evaluated using data generated in this study. Details of the procedures used are given in the report; uncertainties in the Popelar et al. method as applied to geogrids led to the selection of the RPM as the desired method for the final analysis.

Researcher: This study was performed by the Earth Engineering Sciences, 3401 Carlins Park Drive, Baltimore, MD 21215. Subcontractor: GeoSyntec, Atlanta, GA. Contract No. DTFH61-91-C-00054.

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Availability: The publication will be available in September. Copies will be available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161. A limited number of copies will be available from the R&T Report Center, HRD-11, FHWA, 9701 Philadelphia Court, Unit Q, Lanham, MD 20706, Telephone: (301) 577-0818, Fax: (301) 577-1421.

Key Words: Geosynthetics, testing for stress cracking of geogrids, testing protocols.