Florida Department of Transportation
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STRENGTH AND DURABILITY OF BACKFILL GEOGRIDS FOR RETAINING WALLS

PROBLEM STATEMENT

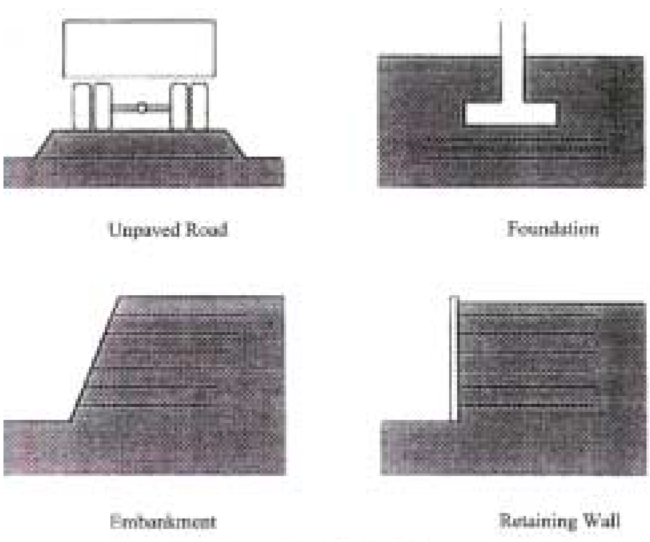
Unpaved Road
Foundation
Embankment
Retaining Wall

Fig 1.1 Typical examples of soil reinforcement application

Due to economic advantages, the use of polymeric reinforcement in soil-reinforced struc-tures has in-creased considerably. With the rapid develop-ment of the geosynthetic in-dustry, there is a wide range of applications for geogrid reinforcement in soil, such as retaining walls, embankments, paved roads, foundations, and slope stabilization (fig. 1-1).

The main polymers currently used for reinforcement include polypropylene (PP), polyester (PET), and polyethylene (PE). Geogrids are the latest generation of polymeric geosynthetics designed specifically to provide soil reinforcement. Their three-dimensional open structure, which interlocks with the surrounding soil, creates a positive connection between the two components of the mechanically stabilized earth (MSE) structure (Koerner, 1994). This bonding between soil and reinforcement creates a more efficient, cost-effective structure.

Given relatively modest experience with these polymeric materials, there remains uncertainty regarding their durability, with respect to the retainment of design properties after being subjected to construction stresses and exposed to in-soil environments over the expected design life. Potential degradation of polymeric reinforcement, with time, will depend on the characteristics of a specific polymer, its configuration, and the environment to which it is exposed. Consequently, more research is needed in this area.

OBJECTIVES

The objectives of this study are to evaluate and resolve, through experimental and analytical investigation, some of the concerns related to long-term performance of geogrids by determining (1) the pullout resistance of HDPE and PET geogrids in sand and limerock, under dry and saturated conditions, and (2) the creep, creep rupture, and durability characteristics of HDPE and PET geogrids exposed to accelerated testing, with super-ambient temperatures for different simulated exposure conditions, and soil water related to the soil conditions in Florida. This will enable cost-effective applications of geogrids.

FINDINGS AND CONCLUSIONS

The research focused on experimental and analytical investigation of two types of geogrids: Tensar High Density Polyethylene (HDPE) and Matrex Polyester Terephthalate (PET). The tasks included the study of (I) long-term pullout resistance, (II) creep and creep rupture, and (III) durability and degradation.

I. Based on the tests and theoretical analysis, when used in fine sand (sliding coefficient is 1.12 under unsaturated working condition) the PET geogrid demonstrated better pullout resistance performance than the HDPE geogrid. Since fine sand can provide more contact surface, a larger friction resistance is mobilized. The HDPE geogrid worked better in coarser sand with good gradation.

II. Accelerated exposure was used, with super-ambient temperatures, for different simulated exposure conditions, and soil water related to the soil conditions in Florida. The temperatures were 30^0 C, 45^0 C, 55^0 C, and 65^0 C, with submergence in the following groundwater-simulating solutions: HDPE specimens--calcareous (pH 9.0), phosphate (pH 4.5), limerock and seawater; PET--freshwater only. The load levels were 30%, 40%, and 50% of the ultimate load value. Elongations were measured at 30 seconds, at 1, 2, 4, 6, 8, 15, 30, and 75 minutes, at 3 and then 7 hours, and thereafter every 24 hours, up to 10,000 hours. It was observed that HDPE geogrids undergo larger creep than PET geogrids. The different exposures did not play an important role in the rate of creep, since there was greater variability from specimen to specimen than from different solutions. Creep rupture occurred in all the HDPE specimens exposed to 50% of the ultimate load. For the specimens exposed to 40% of the ultimate load, creep rupture occurred for specimens exposed to 55^0 C and 65^0 C temperatures. Only two PET specimens experienced creep rupture, in which cases the ruptures could be attributed either to defects in the specimens or to defective clamping.

III. Accelerated exposure was used, with super-ambient temperatures for different simulated exposure conditions, and soil-water related to the soil conditions in Florida. The temperatures were 35^0 C, 50^0 C, and 65^0 C, with submergence in the following groundwater-simulating solutions: HDPE specimens--calcareous (pH 9.0), phosphate (pH 4.5), limerock and seawater, and PET specimens--calcareous (pH 9.0), phosphate (pH 4.5), limerock, seawater, and freshwater. The immersion periods were 30 days, 60 days, 90 days, 120 days, 365 days, and 417 days. Long-term performance at ambient temperatures was extrapolated, based on the Arrhenius method. The data will enable reliable life cycle analysis of geogrids based on durability.

    The results indicate excellent performance of HDPE geogrids in the solutions to which they were exposed. The PET geogrids showed a small degradation, mainly for the 65^0 C. The variation in degradation between the different solutions was minimal, indicating hydrolysis as the main cause.

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