Testing and Performance of

Geosynthetics in Subsurface Drainage

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Foreword

This publication, *Testing and Performance of Geosynthetics in Subsurface Drainage*, contains papers presented at the symposium of the same name held in Seattle, Washington, on 29 June 1999. The symposium was sponsored by ASTM Committee D 35 on Geosynthetics and Committee D 18 on Soil and Rock in cooperation with The National Transportation Research Board (Committees A2K06 and A2K07). L. David Suits, New York State Department of Transportation, John S. Baldwin, West Virginia Department of Transportation, and James B. Goddard, Advanced Drainage Systems, Inc., presided as co-chairmen and are editors of the resulting publication.

Contents

Overview

The effectiveness of subsurface drainage in prolonging the service life of a pavement system has been the subject of discussion for many years across several disciplines involved in the planning, designing, construction, and maintenance of pavement, and other engineered systems. One of the first workshops that I attended on first coming to work for the New York State Department of Transportation over thirty years ago was presented by the Federal Highway Administration in which the benefits of good subsurface drainage in a pavement system were promoted. Even at that time there were many different components of a drainage system that contributed to its overall performance. With the advent of geosynthetics, and their incorporation into subsurface drainage systems, another component has been added that must be understood in order to insure proper performance.

As indicated above, the subject crosses many disciplines. It is with this in mind that four different committees of two different organizations jointly sponsored this symposium. Those co-sponsoring committees and their organizations were: Transportation Research Board (TRB) Committee A2K06 on Subsurface Drainage, TRB Committee A2K07 on Geosynthetics, ASTM Committee D18 on Soil and Rock, and ASTM Committee D35 on Geosynthetics. The purpose of the symposium was to explore the experiences of the authors in the testing and performance of geosynthetics used in subsurface drainage applications. The symposium was divided into three sessions: Session I—Field Performance Studies; Session II—Pavement Design and Drainage; Session III—Testing. This special technical publication (STP) is divided into these three sections.

In Session I, on Field Performance Studies, the authors presented discussions on the performance of three different geocomposite materials. They include a geonet with a geotextile, a geopipe wrapped with a geotextile, and a geocomposite capillary drain barrier.

A study to determine the most effective repair of a shallow slope failure on a racetrack in Singapore showed that an internal drainage system consisting of a geonet and geotextile, placed from depths of 8 to 15 m in the slope, would result in a stable slope. However, with the difficulty of installing a geonet to these depths, an equivalent system consisting of a geopipe wrapped with a geotextile was determined to be more feasible. The paper details the finite element analyses that were performed in relation to the design.

It is pointed out in the paper on the geocomposite capillary barrier drain that drainage of water from soils is generally considered a saturated flow process. It further points out that there are a range of applications where there would be benefit in draining the water prior to saturation. The paper describes the development of a geocomposite consisting of a separator geotextile, a geonet, and a transport geotextile for use in a drainage system that operates under negative pore water conditions associated with unsaturated conditions. The paper describes the study to confirm the geocomposite capillary drain concept.

In Session II, on Pavement Design and Drainage, the papers described the use of geocomposite drainage layers in the base and subgrade of a roadway system, the use of geosynthetics in pavement drainage in cold climates, the development of performance-based specifications for highway edge drains, and some key installation issues in the use of geocomposite edge drain systems.

On a project done in conjunction with the Maine DOT, the University of Maine, and the U.S. Army Cold Regions Research Laboratory, the data from monitoring drainage outlets indicate that a tri-planar geocomposite drainage net placed at or below subgrade was successful in rapidly removing water from beneath the roadway. In addition, the geocomposite facilitated construction in areas where the subgrade was weak, without requiring additional undercuts. In a control section where geosynthetics were not used, an additional 600 mm of stabilization aggregate was required.

Provisions for good highway drainage include surface drainage, ground water lowering, and internal drainage. The focus of the paper on the use of geosynthetics in pavement drainage in cold climates is on the most difficult of these, internal drainage. It reviews the authors' experiences with several types of geosynethetic drainage systems installed in the Canadian province of Ontario. They include pipe edge drains with geotextiles, geocomposite edge drains, and geotextile wrapped aggregate edge drains. Several of these were also used in different types of subgrade. As a result of their experiences, the authors present several recommendations that they feel will result in the effective use of geosynthetic drainage systems in cold climates.

Two problems that arise with any type of drainage system are improper installation and lack of proper maintenance after installation. A study by the Kentucky Transportation Research Center and the Kentucky DOT revealed that at least 50% of the drains investigated were significantly damaged during installation. As a result of further research, a detailed quality control/quality assurance program was established, the intent of which was to decrease the percentage of failures and increase the performance of geosynthetic drainage systems.

In a second paper discussing geosynthetic drainage installation issues, two case histories are reviewed. The first being a site in Virginia, the second being a site in Ohio. The specific issues examined are backfill selection, positioning of the drain within the trench, timely installation of outlets, and selection of outlet piping. The conclusions drawn from the two cases are: (1) proper construction techniques, including verticality, position in the trench, aggregate type, and outlet spacing and installation are critical; (2) proper maintenance, including periodic video inspection of the edge drains, is essential.

In Session III, on Testing, the authors described four different laboratory testing programs that were undertaken to evaluate different aspects of geosynthetic drainage systems. They included the laboratory testing of a toe drain with a geotextile sock, two reports on a modified gradient ratio test system with micro pore pressure transducers inserted into the system, and a discussion on the influence of test conditions on transmissivity test results for geotextile drains.

As the result of the plugging or blinding of 460 and 600-mm-diameter perforated toe drains that had been installed at Lake Alice Dam in Nebraska, the U.S. Bureau of Reclamation undertook a full-scale laboratory test program to determine the best solution to the problem. As a result of the full-scale laboratory test program using a 380-mm perforated pipe with a geotextile sock, several conclusions were drawn regarding the use of geotextile-wrapped toe drains. When used in conjunction with a sand envelope, the socked toe drain's performance was optimized as a result of the absence of any clogging. The socked toe drain allowed the use of a single stage filter that could be installed with trenching equipment at a significant cost savings over the traditional two-stage filter that had been used previously. The use of the socked drain increased flow rates by a factor of 3 to 12.

A study carried out at the National University of Singapore compared the differences of two different transmissivity testing devices. The study was carried out using prefabricated vertical drains and geonets under varying test conditions. The traditional transmissivity device was compared to a newly designed device that has the geosynthetic drain installed in the vertical position encased in a rubber membrane. It was shown that the flexibility of the filter and core material can significantly affect the discharge rate that is attainable in prefabricated vertical drains. Comparing the two test apparatuses showed the ASTM transmissivity device to produce the least conservative results. Thus, knowing the actual site conditions under which to perform transmissivity testing is critical.

A study conducted at Chung Yuan University in Taiwan investigated what the researchers considered to be disadvantages to the current gradient ratio test. Previous research had indicated that the current gradient ratio device was unable to clearly identify geotextile clogging conditions. The test program inserted piezometers at the same locations as the current method, plus an additional one right on top of the geotextile specimen, and inserted 10.0 mm into the test device to eliminate the effects of disturbance.

The installation of the pressure probe directly on top of the geotextile provided a precise understanding of the pressure distribution within the test system. The results also indicated that the current practice of a gradient ratio equal to or less than 3.0 being necessary to avoid system clogging might not be the best criterion to reflect the clogging potential of soil-geotextile systems.

A brief overview of the papers presented in this STP has summarized the basic conclusions reached by the authors and symposium presenters. The papers include summaries of case histories of field experience, field testing, and laboratory testing that has been performed in an effort to better understand the performance of geosynthetic drainage systems. In each instance the importance of providing good subsurface drainage is emphasized. In some instances recommendations are made to improve material specifications, laboratory testing, and the field performance of these systems. It is felt that these recommendations will help to ensure the proper, long-term performance of geosynthetic drainage systems.

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