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Geosynthetics with enhanced lateral drainage capabilities in roadway systems

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ABSTRACT

While moisture-induced distress is one of the major causes of premature pavement failure, geosynthetics are only seldom used to provide internal drainage within the structure of roadway systems. This is likely because conventional geosynthetic drains are only suitable to manage flow under saturated soil conditions, whereas unsaturated conditions prevail in pavement systems. Recent insight into the interaction between geosynthetics and unsaturated soils has led to new advances in geosynthetic manufacturing, including the development of geotextiles with enhanced lateral drainage (ELD), which allow drainage even under unsaturated conditions. This paper highlights the benefits of ELD in a number of roadway situations, including: (1) enhanced lateral drainage of moisture migrating upward from a high water table, (2) enhanced lateral drainage of moisture infiltrating downward from the surface, (3) control of frost heave-induced pavement damage, (4) control of pavement damage caused by expansive clay subgrades, and (5) enhanced lateral drainage in projects involving soil improvement. The mechanisms of moisture migration, as well as the impact of ELD are evaluated in each of these situations. Additionally, case histories involving recently constructed pavements involving the use of ELD geosynthetics are presented for each specific drainage application. The selected case histories involve post-construction evaluation of the ELD geosynthetic's performance either through assessment of lateral drainage, condition surveys of pavement sections with and without ELD geosynthetics, or in-situ monitoring of moisture content. Assessment of the data collected illustrates the beneficial impact of ELD used in the various pavement scenarios. Overall, this paper illustrates that incorporation of enhanced lateral drainage in roadway systems results in a range of improvements for pavement performance.

Contents

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Introduction

Geosynthetics have been used to improve the performance of roadway systems by performing multiple functions including separation, filtration, stiffening, reinforcement, and drainage. In particular, geosynthetics have been in use since the 1970s to improve the performance of unpaved roads on soft subgrade soils. Beginning in the 1980s, geosynthetics were utilized to minimize reflective cracking in asphalt overlays as well as to improve the performance of base aggregate layers. Although one of the major causes of premature pavement failure is moisture-induced distress, implementation of geosynthetics as internal drainage for roadway systems has been comparatively limited. This is likely because conventional geosynthetic drains are only suitable to manage flow under saturated soil conditions, whereas unsaturated soil conditions prevail within pavement systems. Greater understanding of the interaction between geosynthetics and unsaturated soils has led to new advances in geosynthetic manufacturing, including the development of geotextiles with enhanced lateral drainage (ELD), which promote drainage under unsaturated conditions.

The advent of geosynthetics with ELD capabilities is particularly promising for roadway applications, as these products allow lateral drainage under unsaturated soil conditions and can facilitate drainage even under conditions of reverse gradient (e.g. caused by differential settlements). The presence of moisture within a roadway system is a major source of distress that eventually requires costly pavement maintenance. As an example, U.S. state highway agencies reported spending approximately $27 billion on pavement maintenance in 2013 alone [8].

Fig. 1 illustrates the various sources of moisture in the relevant layers of a paved road. The specific conditions and sources of moisture for a given roadway project may result in a number of situations that would benefit from enhanced lateral drainage in particular. One such situation involves upward moisture migration into the subgrade and other roadway layers, due to capillary action, in locations where the phreatic surface is relatively high. While minimizing downward water infiltration is an important objective of paved roadways, a second situation pertains to cases in which water still reaches the relevant roadway layers through cracks in the asphaltic layer, infiltration through the pavement shoulders, or water losses in surface water drainage systems. A third situation, also involving upward moisture migration, occurs in cold regions subject to soil freeze, where the presence of moisture may result in particularly detrimental frost heave. A fourth situation, also related to downward or lateral moisture migration, occurs in roadways founded on expansive subgrade soils, where water migration from roadway shoulders results in major longitudinal cracks. Finally, a last situation corresponds to projects involving soil improvement techniques that would benefit from the enhanced de-watering capabilities provided by geosynthetics.

While water does not necessarily trigger all pavement-related distresses, once a crack or distress has developed, the presence of moisture will almost always exacerbate the problem [18]. Even though drainage layers have been considered for use as a subbase layer across the entire pavement section, such alternatives are only rarely implemented due to concerns of high cost, constructability, and potential aggregate loss with time. Although uncommon, geocomposite drainage layers consisting of conventional geotextiles and a core geonet have been adopted within roadway systems. However, both granular and geocomposite drainage layers provide only lateral drainage under saturated conditions and do not provide such drainage under the most typical unsaturated conditions. Presented in this paper is an alternative

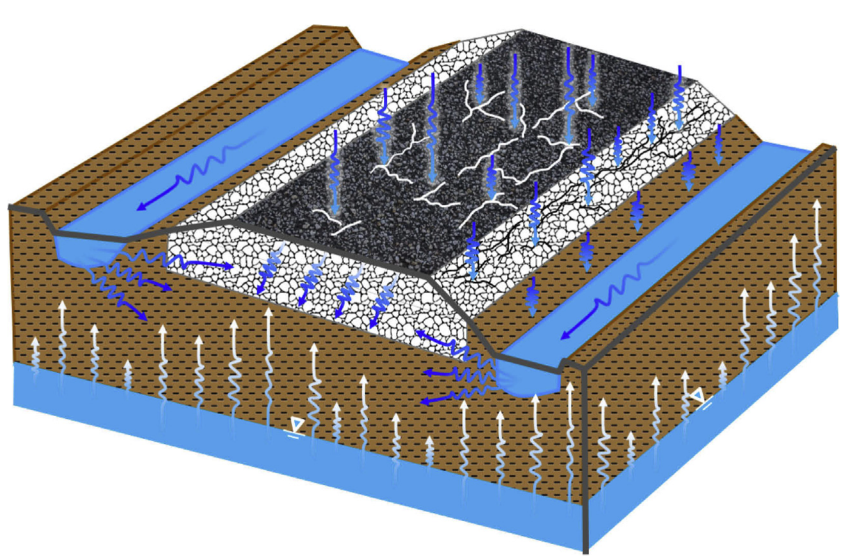

Fig. 1. Multiple sources of moisture migration into a roadway.