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Technical Note

New procedure for measuring adherence between a geosynthetic material and a bituminous mixture

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A B S T R A C T

The aim of this investigation was to analyze the adherence between two layers of bituminous mixture when a geosynthetic material is placed between them. A new monotonic test procedure was developed that enables the evaluation of the influence of the binder type and content, and the typology of the geosynthetic material used. The validity of the procedure was demonstrated using dynamic tests. The results confirmed that highest adherence between layers is obtained through geogrids, with optimal residual binder content of 0.30 kg/m^2. In contrast, the tests with geotextiles were found to be less sensitive to binder content, with lower shear resistance for higher contents of binder.

1. Introduction

When a bituminous mixture is spread over an existing pavement, it must adhere perfectly to the layer on which it rests so that it achieves a shear resistance that is greater than the tension produced during its service life. Moreover, a lack of adherence between layers produces the appearance of parabolic cracks on the surface. The problem is more likely to appear in vehicle braking or turning zones.

Traditionally, scientific studies have assessed the relationship between applied geosynthetics and their characteristics and the design life of the pavement, e.g. Komatsu et al. (1998), and recently Khoddaii et al. (2009). These tests help propose different models (Lytton, 1989; Virgili et al., 2009) that explain asphalt behaviour when different geosynthetics are present.

Other authors have studied geosynthetics according to their functions. Koerner (1998) compiles information on geosynthetics for reflective crack prevention in bituminous pavement overlays.

Studies on adherence between geosynthetics and asphalt are less developed. The starting premise is that when a geosynthetic material is included, the overlayer prevents water penetration and increases the reinforcement of the surface. It might be thought that the presence of this element would cause a weakening in the joining zone of the two layers with the consequential shortening of the useful life of the covering. However, there are studies, such as Button and Lytton (1987), which conclude that adherence between layers, with a correctly impregnated and installed geotextile material, is not in fact adversely affected. These studies determine that by increasing the binder content used in the installation of the geotextile material, the shear resistance between layers also increases. Moreover, it is also concluded that geotextile materials generate a small increase in shear resistance at high temperatures, precisely when the shear resistance of the pavement can become critical.

Static and dynamic tests have been developed to measure the adherence strength between the two bituminous mixture layers both when they are joined together directly and when there is a layer to prevent crack reflection between them.

For the former, the Leutner test is used, which is a straightforward, direct shear test, and which can be used with cores directly extracted from the pavement structure (Molenaar, 1993; De Bondt, 1999). The LCB shear test is a similar test, developed at the University of Catalonia, (Pérez, 2005), which enables the measurement of the resistance to tangential forces that are produced at the joining surface of the two asphalt mixture layers when a shear force is applied.

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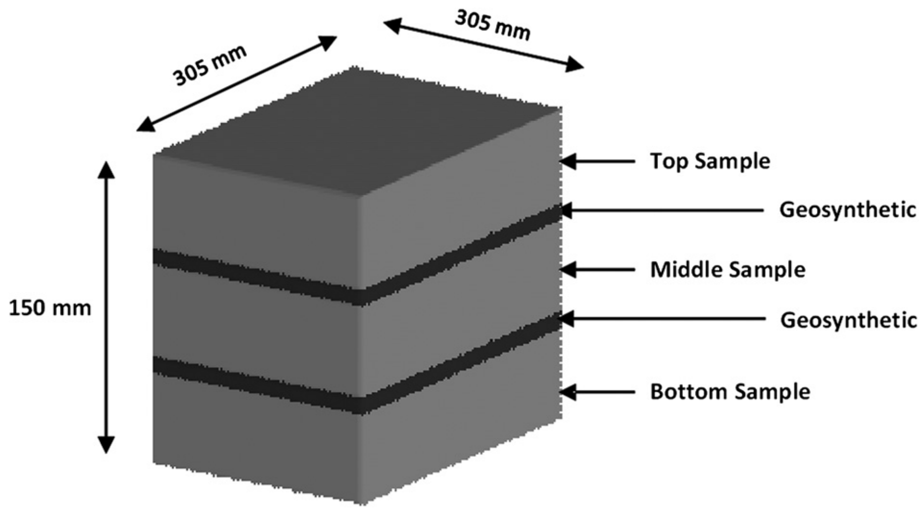

Fig. 1. Adherence test samples.

There are also tests that include the presence of an intermediate membrane, such as the Krakow Technological University test, which calculates the maximum force when a prismatic sample undergoes loading at an angle of 45° respect to the plane of the geotextile (Grzybowska et al., 1993).

The University of Delft (Molenaar, 1993; De Bondt, 1999) developed a pure shear test (without the appearance of a flexural moment in the contact zone) with a cylindrical test-piece undergoing four-point pulling, as if it were a beam, in which a uniform stress state is obtained in the central zone.

Another way of determining shear resistance in the interlayer zone is to use the Layer-Parallel Direct Shear (LPDS) test, developed by the Swiss EMPA in 1995. This test uses a test-piece resting on a U-shaped support. A pneumatic clamp is placed above the test-piece to hold it in place. Then a shear force is applied in the plane of the geotextile.

In Italy, equipment has been developed which is similar to the direct shear test used on pavements. The creators (Canestrari et al., 2005) called the apparatus ASTRA (Ancona Shear Testing Research and Analysis). The device is a direct shear box permitting the application of a vertical load along with a horizontal load in the interlayer zone. The objective of the test is to measure the adherence force between the two layers.

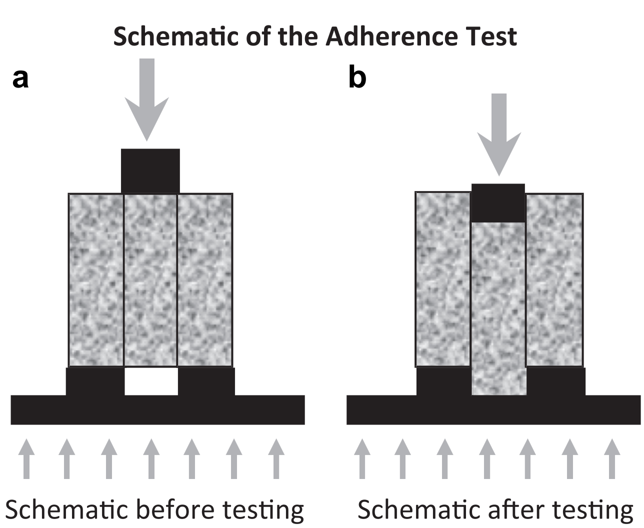

Fig. 2. Central test-piece slippage scheme.

The Technical University of Vienna (Austria) has developed the Tschegg method, which enables the evaluation of the influence of different types of geotextile materials for use in crack-reflection prevention systems. It is based on the introduction of a wedge into a core extracted from the road in which a series of previous cuts are made to define the fracture surface.

In the present case, a new procedure has been developed, that enables the measurement of adherence considering two aspects: it can be used either with a geotextile or a geogrid material indistinctly (because it lets introduce a representative number of cells); and, besides, the failure is produced in the plane where the geosynthetic material is located. The objectives are:

To determine the adherence strength in a geosynthetic layer impregnated with binder, between two bituminous mixture layers, depending on the type of geosynthetic material and the binder content and type.

To determine the optimum content of binder for obtaining the highest adherence stress.

2. Test method

2.1. Characteristics of the samples

Unlike other tests with direct shearing, such as the one carried out with the ASTRA equipment developed by Canestrari et al. (2005), which uses an interlayer of tack coat and geotextile between two layers of bituminous mix, in this case a procedure has been sought that does not require special testing equipment. It can be performed with any static press which can control the rate of straining. To develop a simple test, specimens were manufactured with three layers of bituminous mix with two interlayers of tack coat and geosynthetics between them. Although this configuration does not correspond to the one used in roads, it helps determine the adherence between geosynthetics and bituminous mix using a static press without needing other special accessories.

Table 1
Test conditions.

Summary of test conditions	
Velocity of test	5 mm/min
Surface to which load is applied	152.5 cm^2
Area of adherence of each face	Variable (approx. 305 × 150 mm).
Conditioned temperature of the test-piece	15 °C (minimum 24 h)