Illinois Asphalt Pavement Association Scholarship

Laboratory Testing of Tack Coat Materials

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Introduction

Tack coat is essential to an asphalt pavement surface. Tack coat is the material sprayed on an existing asphalt surface before another layer of asphalt can be placed. This tack coat allows the pavement layers to bond and act as one system and endure the stress from traffic and the surrounding environment (National Cooperative Highway Research Program, 2012). Tack coat can be made of many different materials and differs for each project. The materials used for the tack coat should be based on the type of pavement surface. In the past, the tack coat for a project has been chosen based on experience, convenience or empirical judgment (National Cooperative Highway Research Program, 2012). However, lab tests can help during the selection process of tack coat materials by determining the strength of the tack coat at the interface of the pavement.

Tack coat can be made of many different materials; however, it is typical for tack coat to be made of hot paving asphalt cement, cutback asphalt, or emulsified asphalt. Cutback asphalt consists of asphalt that is dissolved in solvents such as kerosene or diesel and is no longer used due to environmental concerns (National Cooperative Highway Research Program, 2012). Emulsified asphalt is the most common material used for tack coat. This type of tack coat consists of asphalt mixed with water and an emulsifying agent. Some emulsifying agents that may be used are soap, dust, or certain clays (National Cooperative Highway Research Program, 2012). These asphalt emulsions may either be fast or slow setting. The choice between these types of emulsions is based on the expected life of the pavement as well as the type of pavement where the tack coat will be applied.

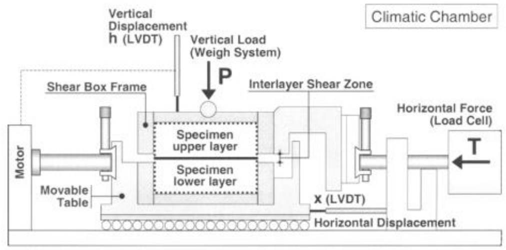
Since the type of tack coat is chosen based on the type of pavement project, it is important to choose a tack coat material to support the stresses the pavement will experience due to traffic and environmental conditions. In order to determine the type of tack coat material to be used, laboratory tests may be used. There are two main types of tests for determining the strength of tack coat materials: shear tests and tensile tests. While finding the shear and tensile strength of the tack coat materials are the primary focus of these laboratory tests, the tests can measure other characteristics of the tack coat. For example, the maximum displacement of a specimen can be measured, as well as the maximum loading rate and the optimal tack coat application rate. However, laboratory tests have some limitations. Many of the laboratory tests for tack coat are performed under laboratory conditions and do not account for the conditions that the tack coat and pavement will be placed under once they are constructed. However, some of these tests are performed in a climatic chamber. This allows for the strength of the tack coat between the layers to be better evaluated since the testing conditions are closer to that of what the material will be subjected to in the field.

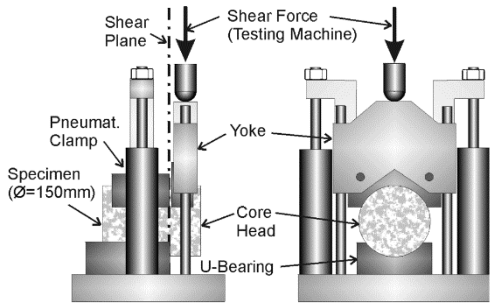
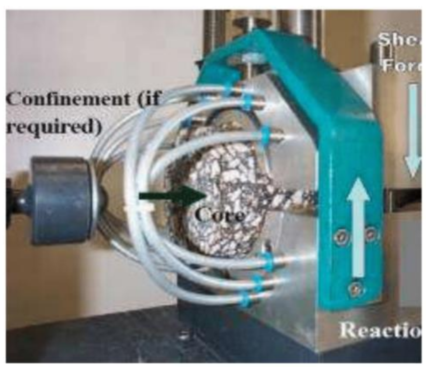
Objective

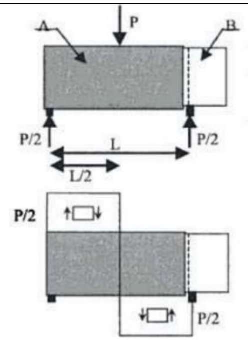
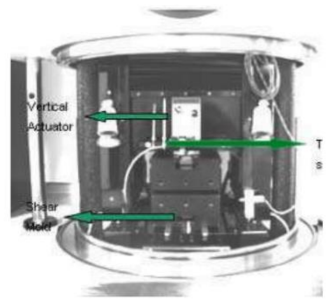
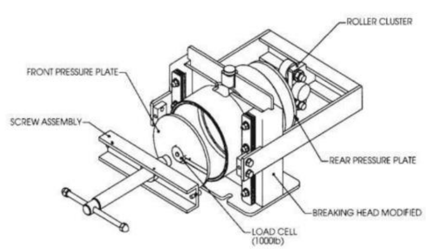
The objective of this paper is to understand the purpose and types of laboratory testing for tack coat materials. The scope of this research involves finding and summarizing other research papers on the testing of tack coat materials.

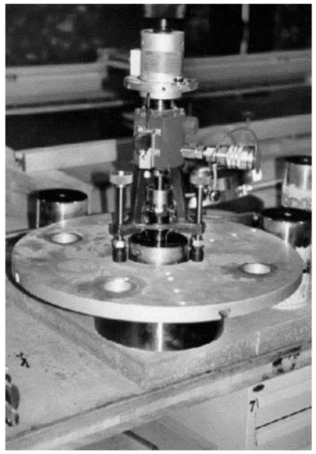
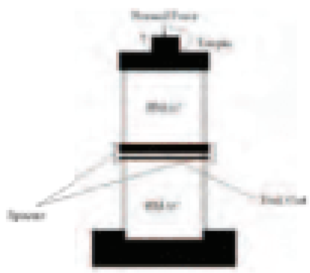
Laboratory Tests on Tack Coat Materials:

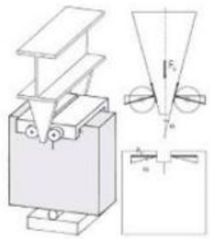
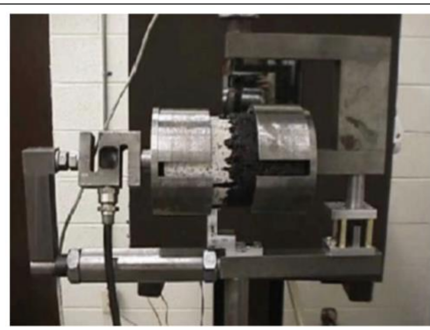
Since pavement interface failure is typically the result of both shear and tensile stresses, pavement samples can be placed under one or both stresses to determine its strength (National Cooperative Highway Research Program, 2012). As previously mentioned, the type of tack coat is selected based on the type of project, traffic loading, and surrounding environmental conditions. Since each project is unique, there are many different laboratory tests that can be used to test the performance of tack coat. While many of these tests fall under the category of being a shear or pull-off test, each test has different test parameters and can measure different characteristics of the tack coat. For example, the Louisiana Transportation Research Center Direct Shear Test and the Texas Transportation Institute Torsional Shear Test are both shear tests, but they each measure something different about the tack coat and pavement specimen. The LTRC Direct Shear Test measures the shear stress at the point of failure in the sample, while the TTI Torsional Shear Test measures the shear strength of the specimen but also measures the cohesion of the sample and the tangent of the internal friction angle (National Cooperative Highway Research Program, 2012). . Table 1 shows 17 different laboratory tests that can be used to determine the strength of a tack coat in a pavement sample using either shear or pull-off tests. The purpose of this table is to compare multiple different test methods and to show how one test may be better to use than another for the strength required of the tack coat for a given project.

Test Name	Equipment Name/ Picture	Test Parameters	Specimen Preparation	Source of Picture
ASTRA Interface Shear Test		A horizontal load is applied along with the interface of the sample at a constant rate until failure (Santagata, Ferroti, Partl, & Canestrari, 2009). A normal force is also applied to the specimen during testing (Canestrari & Santagata, 2005).	A 100 mm diameter specimen is used for this testing method (Santagata, Ferroti, Partl, & Canestrari, 2009). The tack coat is applied to the bottom layer of the sample (Canestrari & Santagata, 2005). The test specimens can be prismatic or cylindrical shaped (Canestrari, Ferrotti, Partl, & Santagata, 2005).	(National Cooperative Highway Research Program, 2012)
Dynamic Interaction Test		A shear force is applied to the specimen (National Cooperative Highway Research Program, 2012). The interlayer reaction modulus is determined from this test (National Cooperative Highway Research Program, 2012).	A 3.94 in. diameter, dual-layered sample is used to conduct this test (National Cooperative Highway Research Program, 2012). The Dynamic Interaction test is used to determine the remaining life of the pavement that the sample was taken from (National Cooperative Highway Research Program, 2012).	(National Cooperative Highway Research Program, 2012)
Florida Direct Shear Test		A vertical shear load is applied to the specimen at a constant rate of 2.0 in/min (Ahn, 2014). This test is conducted at a temperature between 77.0 ± 1.8°F (McDaniel, Shah, & Lee, 2018).	A dual-layered, 6 in. diameter field core sample is used to perform this test (McDaniel, Shah, & Lee, 2018).	(West, Zhang, & Moore, 2005)

Test Name	Equipment Name/ Picture	Test Parameters	Specimen Preparation	Source of Picture
HasDell EBSTTM Emulsion Shear Test		A vertical shear force is applied at the interface of the specimen until failure (National Cooperative Highway Research Program, 2012). This test measures the bond strength between the layers of the sample (National Cooperative Highway Research Program, 2012).	A 5.9 in. diameter cylindrical specimen can be used for this test. A 2.95 in x 2.95 in. square specimen can also be used to conduct this test (National Cooperative Highway Research Program, 2012).	(National Cooperative Highway Research Program, 2012)
Layer-Parallel Direct Shear Test		A shear load is applied to the specimen using a semi-circular shear plate (Raab & Partl, 2004). This testing method measures the nominal average shear stress and shear stiffness (Ahn, 2014).	A 150mm diameter sample is used to conduct this test (Raab & Partl, 2004). Specimen conditioned for 8 hours at a temperature of 20°C (Mohammed, Hassan, & Patel, 2011).	(Raab & Partl, 2004)
Leutner Shear Test		A shear load is applied to the specimen with a strain control mode (Ahn, 2014). The maximum shear load and displacement are measured to determine the bonding property of the interface (Ahn, 2014). The results of this test are used to calculate the peak shear stress of the sample (de Souza Gaspa, Vasconcelos, & Bernucci, 2016).	A 150 mm diameter, dual layered specimen is used to conduct this test (de Souza Gaspa, Vasconcelos, & Bernucci, 2016). This test is conducted at a temperature 21.1°C (Ahn, 2014).	(Raab & Partl, 2004)

Test Name	Equipment Name/ Picture	Test Parameters	Specimen Preparation	Source of Picture
LCB Shear Test		A vertical load is applied at a constant rate of 0.05 in/min (Ahn, 2014). This testing method measures the shear strength of the interface of the sample (Ahn, 2014).	This test measures the shear strength at the interface of the sample (Ahn, 2014).	(Ahn, 2014)
LTRC Direct Shear Test		A horizontal shear force is applied to the specimen at a constant rate of 50 lb./min (Ahn, 2014). The shear strength of the tack coat layer is measured to determine the bonding strength of the tack coat material (Ahn, 2014). The test should be performed at a temperature between -20°C and 80°C (Ahn, 2014).	A dual-layered specimen is required to conduct this test (Ahn, 2014).	(National Cooperative Highway Research Program, 2012)
NCAT Direct Shear Test		A vertical load is applied at a constant rate with a strain control mode until failure (Ahn, 2014). The shear strength of the interface of the sample is measured to determine the interlayer bonding strength of the tack coat (Ahn, 2014).	A double-layered specimen is needed in order to conduct this test (Ahn, 2014).	(Ahn, 2014)

Test Name	Equipment Name/ Picture	Test Parameters	Specimen Preparation	Source of Picture
Switzerland Pull-Off Test		A tensile load is applied at the interface of the sample at a constant rate (Ahn, 2014). This test should be performed according to the German testing specification ZTV-SIB (National Cooperative Highway Research Program, 2012).	A dual-layered specimen should be used to conduct this test (Ahn, 2014). Specimens used for this testing method are not required to be glued together (Ahn, 2014).	(Ahn, 2014)
Texas TTI Torsional Shear Test		A twisting moment is applied at a constant rate of -2.9E-04 rad/sec (Ahn, 2014). During the test, a normal force is also applied to the top of the specimen (Ahn, 2014).	A dual-layered specimen should be used to conduct this test (Ahn, 2014).	(National Cooperative Highway Research Program, 2012)
The ATacker Test		A tensile or torque force is applied to plates that are covered intake coat (Ahn, 2014). This testing method measures the shear or tensile strength at the interface where the tack coat is applied (Ahn, 2014).	Plates that are part of the apparatus are covered with a tack coat (Ahn, 2014).	(West, Zhang, & Moore, 2005)

Test Name	Equipment Name/ Picture	Test Parameters	Specimen Preparation	Source of Picture
The Wedge-Splitting Test		A vertical load is applied to the specimen through a wedge until the specimen splits (Ahn, 2014). This test measures the maximum horizontal force and fracture energy of the sample (Ahn, 2014).	A 4.0 in. diameter specimen is needed to perform this test (Ahn, 2014).	(Ahn, 2014)
Traction Test		A tensile force is applied at a constant rate of 54 lb/sec to the sample (Ahn, 2014). The tensile strength of the tack coat layer is measured to determine the bonding strength of the tack coat material (Ahn, 2014).	A 4.0 in. diameter cylindrical specimen is required to perform this test (National Cooperative Highway Research Program, 2012).	(National Cooperative Highway Research Program, 2012)
UTEP Pull-Off Test & UTEP Simple Pull-Off Test		A torsional force is applied to the sample and measures the shear strength of the tack coat material (Ahn, 2014). This test measures the strength of the tack coat material before placement (Amelian & Kim, 2017).		(Ahn, 2014)
Virginia Shear Fatigue Test		A cyclical shear load is applied at the interface of the specimen (Ahn, 2014). Multiple shear loading failures are measured to determine the performance of the tack coat (Ahn, 2014).	A dual-layered, 100-150 mm diameter specimen is needed to perform this test (Ahn, 2014). The sample for this test should consist of Hot Mix Asphalt and Portland Cement Concrete (Ahn, 2014).	(Amelian & Kim, 2017)

Conclusion

Tack coat is a material that is sprayed onto an existing layer of asphalt pavement before another layer can be placed on top. Tack coat helps to bond the layers of pavement together so that they can act as one system instead of individual layers. In the past, tack coat materials were chosen based on experience and judgment but also the type of pavement surface that it is being sprayed onto. Tack coat can be made of many different materials including asphalt cement, cutback asphalt, or emulsified asphalt. Since there are multiple types of tack coat materials, laboratory tests should be used to help determine which type of tack coat is appropriate for a certain project. These laboratory tests can determine the shear and tensile strengths of different tack coats. While these tests can show the strength of each tack coat, they may also have some limitations. A major limitation is that laboratory tests cannot simulate the conditions of the field where the tack coat will be placed. A way to achieve better results that can mirror the actual field condition is to perform tests within a climatic chamber.

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