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Effect of tack coat application on interlayer shear strength of asphalt pavement: A state-of-the-art review based on application in the United States

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Abstract

The effect of tack coat application on pavement interlayer shear strength attracts strong interest during asphalt paving. Given its extensive use, tack coat is known to behave as a bond material to reduce pavement distresses such as slippage crack. The effectiveness of tack coat in increasing shear strength may be affected by multiple factors, such as tack coat material, test condition, pavement surface condition, and moisture. This article is a literature review focus on how the interlayer shear strength varied when relevant influential factors are changing. Review results indicate that the interlayer shear strength increased with the decreased test temperature, increased traffic load (within design limit), and increased test confinement pressure. Additionally, the milled pavement surface always has higher shear strength then the non-milled pavement surface. It is also found that laboratory-prepared specimens resulted in higher interlayer shear strength than field pavement cores. The effect of other factors on tack coat application may follow different trends depending on mix type and existing pavement condition. For instance, optimum tack coat rate that corresponds to peak shear strength is widely reported, while it is also found that tack coat does not greatly affect shear strength on dry, clean and milled pavement surface. Furthermore, shear strength reduced when mixture is designed with high percentage of air voids or coarse aggregate structure, such as porous asphalt and stone mastic asphalt (SMA) mixtures. More findings and recommendations can be found in this paper.

Keywords: Tack coat; Interlayer shear strength; Asphalt pavement; Temperature; Milling; Mixture type

Contents

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1. Introduction

De-bonding between pavement layers could have significant effect on pavement behavior which may cause large tensile strains to occur at overlay bottom. When de-bonding appears, the hot mix asphalt (HMA) at either side of the slipped surface distorts in different directions, and horizontal loads could only be supported by the slipped layer, and therefore the structural bearing capacity of a pavement is decreased [1]. Problems commonly associated with de-bonding are premature slippage cracking, top-down cracking, and fatigue cracking [2–6]. These distresses can dramatically reduce pavement life up to 25–50% and prompting the need for extensive repairs such as full-depth patches or complete reconstruction [1,2,7].

To reduce the distresses that may be caused by de-bonding of HMA layers, tack coat is typically used to endure adequate adhesive bond between existing pavement surface and new asphalt mixture surface, or between two new asphalt mixture layers. According to *ASTM D8, Standard Terminology Relating to Materials for Roads and Pavements*, "Tack coat (bond coat) is an application of bituminous material to an existing relatively non-absorptive surface to provide a thorough bond between old and new surfacing".

In laboratory, interlayer shear strength has been found the most fundamental parameter to express the effectiveness of tack coat in increasing interlayer bonding [8–10]. However, it is not clear how the tack coat affect interlayer shear strength when other conditions varied, such as tack coat rate, test temperature, aggregate gradation and pavement age. For instance, the optimum tack coat rate corresponds to the maximum interlayer shear strength can be found in most cases while some researchers reported that the application of tack coat rate in specific conditions do not improve bonding since tack coat introduced a slippage plane. The situations that tack coat may create a slippage film including (1) extreme high application rate or residual rate is used; (2) the density of existing pavement is very high and tack coat cannot thoroughly penetrate into the pavement surface can be found in this paper, and (3) construction issue such that low ambient temperature/construction temperature in which the tack coat may not be totally melted when overlay mixture is placed on.

This article reviews the effect of various factors on the interlayer shear strength when tack coat is used. These factors consisting of material properties (i.e., tack coat

Table 1
Tack type and major composition of tack coat.

Tack name	Tack type	Asphalt, %	Water, %	Anti-strip, %	Polymer modifiers, %
NTSS-1HM	Trackness	30–70	70–30	0	0–6
CRS-1	Cationic emulsion	57–70	30–43	0	0
CRS-2P	Cationic emulsion	57–70	30–43	0	0
CRS-2L	Cationic emulsion	57–70	30–43	0	0
SS-1	Anionic emulsion	30–80	20–70	0–1	0–25
SS-1h	Anionic emulsion	30–80	20–70	0–1	0–25
SS-1hp	Anionic emulsion	30–80	20–70	0–1	0–25
SS-1L	Anionic emulsion	30–80	20–70	0–1	0–25
RC-70	Cutback	60–90	10–40 (stoddard solvent)	0	<0.1
PG 64–22	Liquid asphalt	94–100	0	Varying	Varying
PG 67–22	Liquid asphalt	94–100	0	Varying	Varying
PG 76–22M	Liquid asphalt	78–96	0	0–1	4–20

Note: RS-rapid setting, SS-slow setting, QS-quick setting, L-latex, 1-low viscosity, 2-high viscosity, h-hard grade asphalt (low penetration), RC-rapid curing, PG-performance grade, cationic emulsion-positively charged, anionic emulsion-negatively charged.