Construction and Building Materials 152 (2017) 856–871

Contents lists available at ScienceDirect

Construction and Building Materials

journal homepage: www.elsevier.com/locate/conbuildmat

Review

Application of tack coat in pavement engineering

Jiayu Wang [a], Feipeng Xiao [a,*], Zheng Chen [b], Xinghai Li [c], Serji Amirkhanian [d,*]

[a] Key Laboratory of Road and Traffic Engineering of Ministry of Education, Tongji University, Shanghai 201804, China
[b] College of Materials & Mineral Resources, Xi'an University of Architecture & Technology, Xi'an 710055, China
[c] Beijing Key Laboratory of Highway Engineering Materials and Testing & Authentication Technology, Beijing Road Engineering Quality Supervision Station, Beijing 100076, China
[d] State Key Laboratory of Silicate Materials for Architectures, Wuhan University of Technology, Wuhan 430070, China

HIGHLIGHTS

- Emulsified asphalt was the most common asphalt among all types of tack coats.
- Tack coat should be applied to a clean, dry and well-compacted under layer.
- The use of trackless emulsions was a solution to tack coat removed from the surface by construction equipment.
- The shear tests were the most commonly used approaches to verify the interlayer bonding strengths.
- The intrinsic factors and application conditions together influenced the properties of interlayer bonding.

ARTICLE INFO

Article history:
Received 24 April 2017
Received in revised form 28 June 2017
Accepted 4 July 2017

Keywords:
Tack coat
Asphalt emulsion
Shear strength
Application rate
Temperature

ABSTRACT

The interlayer bonding between pavement layers has significant effects on the pavement performance responses during the traffic loading. The insufficient bond adhesion may increase the transferred stresses and extended strains in the relevant layers when applied to traffic. Over the last 30 years, many research studies focused on these related fields and found some useful conclusions to help conduct field practices of tack coat materials. In this review, it was found that the shear mode tests were the most common methods to verify bond strength and some non-destructive tests were becoming more and more useful to investigate tack coat properties. In addition, some test parameters including shear strength, cracking resistance and fatigue performance were used to assess tack coat properties. The intrinsic factors such as tack coat type, application rate, curing time and the application conditions including temperature, moisture, and surface texture together influenced the characteristics of interlayer bonding. However, pavement failure mechanisms and the interactions between influence factors are needed to be investigated in the future.

Contents

* Corresponding authors.
E-mail addresses: fpxiao@tongji.edu (F. Xiao), serji.amirkhanian@gmail.com (S. Amirkhanian).

http://dx.doi.org/10.1016/j.conbuildmat.2017.07.056
0950-0618/

1. Introduction

For decades, performances and conditions of pavements (both flexible and rigid) have been improved to meet the increasing need of traffic loads. Pavement engineers generally followed the mechanistic design methods that are based on algorithms to compute pavement responses, such as stresses, strains and displacements. In order to simplify the structure, materials and its computation models, most of these approaches assume that the layers are completely bonded or fully unbounded to each other. However, many research results illustrated that the interlayer bonding between pavement layers had significant influence on the pavement response in term of stresses and strains subject to traffic loading [1,2]. A good layer bonding will disperse traffic stress from one layer into the next, while an insufficient interface bonding accompanied with unfavorable load conditions may increase tensile stresses and strains at the bottom of the respective layers, which may result in premature distresses (e.g. slippage cracking, potholes, raveling, deformations, bulging or cracking) and decrease the service life of pavement [3–8]. Thus, the interface bonding is important and must be considered in the design methods [9]. In addition, careful construction and maintenance are also needed in the field.

According to American Society for Testing and Materials (ASTM) D8-02 [10], the Asphalt Institute [11], and the United States Army Corps of Engineers (USACE) [12,13], tack coat can be defined as a light application of asphalt emulsion or liquid asphalt placed on an existing hot-mixed asphalt layer or Portland concrete cement layer as well as a new HMA pavement surface to create a thoroughly and strongly adhesive bond between two layers. A worldwide survey about tack coat conducted by Mohammad et al. indicated that asphalt emulsion was the most widely used tack coat type [14], which was small particles of carbohydrate binder (between 3 and 8 μm) in a water solution with an anionic, cationic or nonionic emulsifying agent [15]. In addition, tack coat is also able to enhance the bonding strength between steel plate and overlay on the bridge deck. Due to the far more stringent design requirements of bridge deck overlays than those of roadway pavement, the upgraded tack coat materials were introduced and developed to improve the interlayer bonding properties, including polymer modified asphalt [16], epoxy resin [17,18], rubber asphalt mastics [19], the Eliminator system [20], and so on.

Though the material design and performance evaluation methods of tack coat have been developed for many years, there are no standard specifications to determine tack coat material quality in the laboratory or in the field [14], because the properties of tack coat between the two layers were influenced by numerous factors and their interactions, including tack coat type, dosage, temperature, surface texture, moisture condition, surface cleanliness, and so on. In terms of performance evaluation methods, researchers have developed some approaches and corresponding test equipment to study the interlayer bonding properties under several conditions. The most frequently used test was designed by Leutner [21] in Germany. Some other specific equipment such as the wedge splitting test [22,23], torsion test [24], Anocona Shear Testing Research and Analysis (ASTRA) [25], the Louisiana Tack coat quality tester (LTCQT) [26], and so on were proposed. Moreover, some advanced approaches were developed for deeply analyzing bonding characteristics, including Finite Element (FE), X-ray Computed Tomography (CT), Falling Weight Reflectometer (FWD), and Digital Images Correlation (DIC).

The objective of this study was to summarize the evaluation methods and discuss the influence factors of tack coat material in the laboratory and in the field. The main contents below included the types of tack coat, field application methods, the test devices and characteristics of tack coat evaluation, and critical factors of tack coat.

2. Tack coat type

Generally, hot asphalt cement, asphalt emulsion, and cut back asphalt have been used as tack coat materials, but the latter one is not commonly used because of its environmental concerns [27]. Among these types of tack coat, asphalt emulsion was the most common one and its properties can be improved with polymer modifier and other additives. Moreover, research results [28,29] showed that tack coat types have critical influences on the interlayer bonding strength. In this section, several tack coat types were introduced and their comparisons were shown in Table 1.