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Review

Characterizations of base and subbase layers for Mechanistic-Empirical Pavement Design

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HIGHLIGHTS

- Various base and subbase layers of highway pavement were influenced by numerous factors.
- Typical layers are unbound aggregate, asphalt and cement treated, permeable, and recycled.
- Influence factors include resilient modulus, materials, thickness, gradation, and moisture content.
- Performances are sensitive to changes of resilient modulus, moisture content, temperature, and load levels.

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ABSTRACT

The main feature of Mechanistic-Empirical Pavement Design Guide (MEPDG) versus AASHTO 1993 is the various variables as inputs including the material properties, traffic load and climate. Currently, the influences of material type and the thickness of surface layer on pavement performance have generated many interests but the importance of base and subbase layers for predicting the pavement performances is not paid enough attention. Therefore, this review explores the influences of different factors on pavement performances when various types of base courses are employed in pavement structure including unbound aggregate base layer, asphalt treated base layer, cement treated base layer, permeable base layer, and the recycled pavement base layer. And the influence factors of base layer on pavement performances include the resilient modulus, material type, thickness of base, gradation of aggregate, moisture content, and the property of subbase layer, which are divided into internal and external causes. In addition, the parameters of subbases layer are also regarded as individual factors to analyze the influence on pavement performance. The pavement performances are more sensitive to the change of resilient modulus, moisture content, temperature, and load levels, but they are not sensitive to the thickness of subbase layer and the Poisson's ratio of materials. In addition, temperature cycling per day is the major reason for resulting in reflective cracks for chemical stabilized base pavement.

Contents

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1. Introduction

The pavement distresses of Mechanistic-Empirical Pavement Design Guide (MEPDG) outputs include rutting, top-down fatigue cracking (longitudinal crack), bottom-up fatigue cracking (alligator crack), thermal crack (transverse crack) and international roughness index (IRI) [1]. The primary focus points of distresses vary for the pavement containing different types of bases. For instance, the permeant performance is majorly considered in the flexible pavement containing unbound granular base [2]. For chemical stabilized base, the fatigue cracking of base layer needs to be considered [3]. The detail information has been introduced as followings.

Currently, the common base courses include the unbound granular base, asphalt treated base, cement treated base, permeable base, and recycled pavement base. In fact, some bases were conducted based on the combination of several common bases. For instance, the permeable base includes asphalt treated permeable base, cement treated permeable base and so on. However, the influences of various input variables on pavement performances of base course are different.

For unbound material (soils and aggregates), the resilient modulus and Poisson's ratio are very important [4], especially, the resilient modulus can characterize the relationship between stress and strain. Therefore, the effects of stress state, temperature, moisture content, and aggregate gradation on resilient modulus are summarized. Furthermore, the influence of Poisson' ratio on pavement performance and the predicting model of rutting are also integrated.

For pavement containing asphalt treated base [5], the influences of binder type and content are analyzed firstly. The type of binder mainly includes hot mix asphalt, foamed asphalt and emulsified asphalt. As for the base stabilized by above mentioned asphalt binders, binder grades, binder contents and temperature have influences on the pavement performance.

Chemical stabilized base includes the rigid base and semi-rigid base. The lean concrete is the representative of rigid base. The cement, lime, fly ash, slag and calcium carbide residue (CCR) are regarded as the common stabilizers of semi-rigid base. The strength of chemical stabilized base is relatively higher, thus the influence of traffic volume on the pavement containing chemical stabilized base is not much than other pavements containing other types of base layers. But, the change of temperature plays a significant role in pavement performance of chemical stabilized base layer.

Permeable base is often used in urban road and public area such as park lots to improve the ability of drainage [6]. The common types of permeable base comprise the unbound aggregate base, asphalt treated permeable base, and cement treated permeable base. The influences of traffic volume, climate condition and binder content and type on pavement performance have been summarized in this review.

Recently, the recycled materials used in base layer have gained many interests. The common reclaimed materials include the reclaimed asphalt pavement, reclaimed cement pavement, and crushed brick. The type and content of recycled materials play significant roles on pavement performance.

The objective of this review is to investigate the main influences of various bases and subbases, including unbound aggregate base/-subbase layer, asphalt treated base/subbase layer, cement treated