

The Influence of Factors on the Durability of Asphalt Pavement

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Abstract: The main factors that affect the durability of asphalt concrete pavement are the quality of rutting, cracks and semi-rigid base. The factors such as large traffic volume, high air temperature and improper composition of pavement materials lead to the formation of rutting. Due to different reasons, the cracks are divided into fatigue crack, temperature crack and reflection crack. The strength and erosion resistance of semi-rigid material and the quality of construction will affect the quality of semi-rigid base. It is found that the reasonable design of pavement structure and mixture ratio, and the correct construction methods and maintenance methods can improve the quality of the base to improve the durability of asphalt pavement.

Keywords: Asphalt pavement; Pavement structure; Mix proportion; Function; Durability

1. Introduction

In recent years, highway has been developing very fast in our country, especially the rapid development of high grade highway. The data shows that most of the high-grade highway pavement is asphalt concrete pavement, and the service life of the asphalt concrete pavement is 12 to 15 years. However, under the influence of environmental factors and heavy traffic load, the asphalt pavement is more common than the design service life, and the rutting and cracking phenomena appear in different degrees. Even in developed countries, the damage of asphalt pavement is very serious. The cost of paving asphalt pavement in the United States is as high as \$10 billion, and the annual maintenance cost for asphalt pavement is very high [1]. In this paper, the factors affecting the durability of asphalt concrete pavement are analyzed, and the corresponding measures to improve the durability of asphalt pavement are put forward.

2. Influencing Factors of Durable Asphalt Pavement

There are many factors that affect the durability of asphalt pavement. Practical experience shows that practical experience shows that the main factors are rut, cracks and semi-rigid base.

2.1. Rut

Rutting is one of the main diseases of asphalt pavement structure. There are many factors leading to rutting of asphalt pavement, and the internal factors are mainly the performance of asphalt mixture and pavement structure, and the external factors are mainly load and

environmental conditions such as temperature, rainfall and so on.

2.1.1. Road traffic condition

Due to the construction of high-grade highway, the traffic control becomes more and more mature, so the higher the amount of traffic load is heavy. The wheel track concentration leads to the obvious traffic channelization. The results show that the development speed of rutting decreases with the increase of load times. However, the rutting depth increases with the increase of the number of cumulative loads, so that the road loss of performance [2].

2.1.2. Weather conditions

Asphalt pavement under a certain temperature, sunshine and wind, the more white or colored road surface to absorb more heat, so the road surface temperature is higher, so the asphalt pavement in the south region is prone to rutting.

2.1.3. Pavement structure and material composition

At present, the asphalt pavement is mostly used as pavement material. The greater the thickness of asphalt layer, the greater the possibility of permanent deformation. The permanent deformation of soil aggregate mix crushed gravel and other gravel soils were also changed to some extent. The asphalt pavement with rigid base or semi-rigid base material has high temperature stability and shear deformation ability. In addition, the subgrade and pavement materials can also produce rutting under lateral displacement and additional compaction. The wear layer is accelerated by wheel wear. The results also show that the rutting of fine grained soil base is significantly larger than that of

coarse grained soil, so the temperature and rainfall have a positive effect on the formation of rutting [2].

2.2. Crack

The result of the crack is to destroy the continuity and integrity of the pavement, which affects the quality of the pavement. The existence of cracks in the road surface of the rain for a long time from the cracks into the soil, which reduces the strength and stability of the roadbed. The causes of surface cracking of semi-rigid base asphalt pavement can be roughly divided into 3 types.

2.2.1. Fatigue crack

Such as rutting, fatigue cracking of asphalt pavement is a kind of damage due to repeated load. The cracks produced by the wheel load are not separate, sparse, but dense, connected cracks, and even network cracks. If the asphalt mixture has better quality, the pavement structure under the load of the deformation is smaller than the fatigue cracking of the pavement. Therefore, it can not be simply attributed to the material quality. Fatigue cracking is generally caused by many factors, and the weak pavement structure, high road surface deflection and repeated load are very easy to produce fatigue cracking.

2.2.2. Temperature crack

The temperature cracking of asphalt pavement is mainly related to the ambient temperature, which is characterized by the transverse cracking of the pavement at a certain distance. There are two main types of temperature cracks: (1) low temperature shrinkage or low temperature crack. In the winter, as the temperature drops, the pitch becomes harder and harder. It is found

that the thermal stress produced in the confined asphalt layer will cause the cracking of asphalt surface when it exceeds the tensile strength. (2) Temperature fatigue cracking. This kind of crack mainly occurs in the area with strong solar radiation and large temperature difference between day and night. The results show that the thermal stress in asphalt surface layer. This kind of temperature stress is repeated, which can lead to asphalt surface aging and fatigue cracking. At the beginning of August 1989 opening to traffic of the Guangfo Expressway Asphalt Pavement with semi-rigid base that generated a lot of temperature fatigue cracks [3].

2.2.3. Mixture ratio

The mixture shall be designed in accordance with the requirements of the specification, which takes into account the stability of the pavement structure (including low temperature cracking resistance and high temperature stability) and durability (including aging and water resistance). The Marshall test is usually used to determine the aggregate gradation and asphalt content, which ensures that the physical properties of the mixture meet the requirements of the pavement. Table 1 describes several main factors influencing the performance of asphalt mixture.

2.3. The quality of semi-rigid base

The quality of semi rigid base is a key factor in potholes and uneven cracks, the influence of asphalt pavement. The quality of semi rigid base includes two aspects: the strength and anti-erosion ability of semi-rigid material. After opening to traffic, local defects will cause the base asphalt pavement cracking, which will produce pavement damage.

Table 1. Main Factors Affecting The Performance of Asphalt Mixture

performance index	asphalt		aggregate		Aggregate		porosity
	Con-sump-tion	Characteristic	gradation	Characteristic	Con-sump-tion	Characteristic	
High temperature stability	less	Large viscosity	Dense gradation	Lipophilic and anti-wear properties	less	Oil absorption	large
Good flexibility	many	Small viscosity	Open gradation	Lipophilicity	less	Oil absorption	large
Good skid resistance	less	Large viscosity	Close or open gradation	Antiwear property	less	Oil absorption	large
High strength	many	Large viscosity	Dense gradation	Lipophilicity	many	Oil absorption	large
Watertightness	many	Large viscosity	Dense gradation	Lipophilicity	many	Oil absorption	Small
Strong fatigue resistance	less	Large viscosity	Close or open gradation	Antiwear property	less	Oil absorption	large
Durability	many	Small viscosity	Dense gradation	Lipophilic and anti-wear properties	many	Oil absorption	large

3. Quantitative Analysis of The Factors Affecting The Durability of Asphalt Pavement Based on Regression Analysis Model

Based on the experimental data of previous research scholars, and using STATA to carry on the Logistic regression. The results of regression analysis are shown in table 2. In addition, the goodness of fit of the model is tested by ROC, and the ROC value is above 0.75, which indicates that the regression model is better.

It can be seen from table 2 that the main factors affecting the durability of asphalt pavement are asphalt quality, mineral quality, mixture ratio, construction quality, water damage and fatigue damage.

Table 2. Results of Logistic Regression Model

independent variable	regression coefficient	t	P> t
Asphalt quality	0.1405	-2.79	0.008
Ore quality	0.1756	5.5	0
Mixture ratio	0.86	10.45	0
Construction quality	0.0329	2.76	0.007
temperature	-0.0151	11.42	0
Fatigue damage	0.033	2.45	0.001
Water damage	0.1047	2.06	0.003
Asphalt aging	0.0405	3.51	0.001
Constant term	0.1751	4.86	0

4. Measures to Improve The Durability of Asphalt Pavement

In order to improve the durability of asphalt pavement, in addition to the use of good asphalt and improve the performance of asphalt mixture, but also from the control of rutting, cracking and improve the quality of the base and soon.

4.1. Rut prevention

The reasonable pavement structure level and mix proportion design, the correct construction methods and reasonable maintenance can effectively prevent the occurrence of rutting. Asphalt pavement on semi-rigid base should not only crack resistance, but also anti rut, so we should take into account the needs of both of them. The fine aggregate gradation is favorable to crack resistance, but not conducive to anti rutting. It is unfavorable to crack resistance, but it is good for rutting resistance. Therefore, grain type or coarse asphalt concrete surface layer with continuous grading proposal (calculated by K) to bear the fatigue, durability, anti-broken task; using gradation asphalt concrete (calculated by variable K method) as a skid resistant layer [4]. The subgrade soil and the road surface all achieve the specified compaction degree and so on, which can

reduce the possibility of the rut to a certain extent. At the same time, do a good job of subgrade and pavement drainage, which can prevent the surface of the road by the rain and the rutting.

4.2. Crack prevention measures

In the prevention and cure of reflective cracks, the measures taken in our country are to improve the performance of asphalt concrete pavement. Such as the use of reinforced cover layer, the use of modified asphalt, etc.. Selection of semi rigid material with good erosion resistance, dry shrinkage coefficient and temperature shrinkage coefficient and high tensile strength [5]. Although the above measures have been used in practice, but at present all kinds of measures to prevent the effect in regulations and quantitative are inconsistent, so the need for systematic evaluation of various measures, and these measures to prevent the effect is very limited.

The main reason for the damage of asphalt pavement is the high intensity impact on the road surface. In order to respond to the pavement structure, the strength of the stress will increase with the speed of the vehicle. If the stress exceeds the tensile strength of the pavement structure, the structure will be destroyed.

5. Concluding Remarks

Factors affecting the durability of asphalt pavement in road and traffic conditions, weather conditions, pavement structure and material composition, cracks (fatigue crack, temperature crack, crack reflection and corresponding cracks) and the quality of semi rigid base. In addition to a good selection of asphalt and asphalt mixture performance should be improved, reasonable design of pavement structure level and mixture with the construction method and maintenance method than the right, and select the scour resistance, dry shrinkage coefficient and temperature shrinkage of semi rigid material coefficient, high tensile strength to improve the quality and to improve the durability of asphalt pavement.

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