Review on the Research of Road Performance of Modified Bio-asphalt and Its Mixture

Haowu Wang
Chongqing Jiaotong University, School of Civil Engineering, Chongqing, 400074, China

Abstract: With the shortage of asphalt materials, domestic and foreign countries began to explore how to reduce the dependence on asphalt and find asphalt substitutes. The bio-asphalt prepared by biomass resources meets the requirements of asphalt use to some extent, and makes full use of a large amount of biomass resources. It is a new type of environmentally friendly energy source and has great development prospects. The abundant biomass resources make the types of bio-asphalt more complicated. Therefore, a large number of tests are needed to verify their performance, form specific technical specifications and evaluation systems, and accelerate the promotion of bio-asphalt.

Keywords: Biomass; Biological asphalt; Modified asphalt

1. Introduction

With the needs of social development, the development of expressways in my country is accelerating, and the transportation industry plays a basic but important role in the development of social economy. China has a vast territory and heavy road construction tasks. It is also a heavy workload for the maintenance and repair of built roads. It is also faced with the constraints of raw material resources and the pressure of economic costs. At the end of 2011, China's highway mileage reached 4.1 million, and the part of the highway that had been opened to traffic reached 110,000 kilometers at the end of 15, and about 90% of the road surface was made of asphalt binder. In the total investment of high-grade highways, asphalt costs account for about 10%, so the price of asphalt has a great impact on the cost of the entire project [1]. In recent years, China has used an average of 15 million tons of road asphalt per year, of which one-third depends on imports [2]. Moreover, in recent years, international crude oil prices have continued to rise. As a by-product of crude oil, the price of petroleum asphalt has also continued to rise. Therefore, the increasing domestic demand and the rising price of asphalt not only have an extremely adverse impact on the construction of highways in China, but also bring great economic pressure to the construction and maintenance of highway infrastructure in China, which has a certain impact The quality and speed of highway construction.

Not only that, asphalt materials are also widely used in the fields of construction, water conservancy, civil engineering, etc., social demand leads to the scarcity of asphalt resources, and asphalt is a non-renewable disposable fossil energy. With the uncontrolled exploitation of human beings, petroleum energy is about to Exhausted, taking China as an example, the current petroleum resources are only enough to be exploited for 14 years. In this general environment, seeking alternatives to asphalt has become an important research direction for scholars at home and abroad. If it is possible to reduce the amount of asphalt while still meeting the performance requirements of the asphalt pavement through some means, this is of great significance to the sustainable development of the asphalt pavement. At present, there are methods to use some considerable amounts of by-products from other industries to replace part of the asphalt to reduce the amount of asphalt and improve the performance of the asphalt pavement. This method is of great significance for solving the problem of scarce asphalt resources.

Nature is rich in organic matter such as decaying plants, animal feces, and municipal waste, which can be converted into biomass energy. Bio-asphalt is made from biomass pyrolysis oil, and biomass pyrolysis oil is derived from biomass energy. Biomass resources in my country are very rich, such as drain oil, etc. According to relevant research, bio-asphalt made from biomass resources is more than 20% lower in production cost than petroleum asphalt. Bio-asphalt is of great significance to the sustainable development of asphalt pavement, but currently bio-asphalt has poor water stability and other characteristics cannot be applied to the road, so it needs to be modified to improve performance.

2. Research Status of Bio-Asphalt Abroad

In a seminar called "Alternative Binders for Sustainable Asphalt Pavements" held by the US Transportation Research Board (TRB) sub-committee in early 2012, Robert Kluttz [3] of Kraton Polymers introduced the need for alternative asphalt production processes Considering the factors, he pointed out that in the process of preparing alternative asphalt, the difference between the chemical composition of some products and asphalt materials should be considered. Therefore, it should be noted that the existing asphalt test methods may not be suitable for the performance inspection of alternative asphalt. And pay attention to its economic benefits when choosing asphalt substitutes. French scholar Emmanuel Chailleux and others have explored the feasibility of using by-products obtained from algae as biofuels as a substitute for asphalt. After analyzing the basic components and rheological properties, it is found that the by-products have thermal viscoelasticity similar to asphalt, so they can be used as A consideration for asphalt substitutes. American scholar Joseph C. Seidel and others have done many experiments to study the effect of soybean fatty acid on asphalt. They believe that a small amount of soybean fatty acid can improve the performance of hard asphalt. Joana Peralta and others from Iowa State University studied plant residues, such as straw, and prepared bio-asphalt by rapid cracking technology. The results show that plant residues can be used as asphalt modifiers, and the product performance meets the requirements of use. In addition, they also pointed out that the addition of rubber can greatly improve the performance of bio-asphalt. Dutch scholar G. Liu et al. conducted an experimental study on organic montmorillonite nanoclay and analyzed its feasibility as an asphalt additive. Haifang Wen of Washington State University and others used waste oil to prepare a kind of bio-asphalt and tested its road performance. In addition, Adam Zofka from the University of Connecticut also proposed to add waste coffee grounds to asphalt for modification and analyze its effect. The studies of these participants initially confirmed the feasibility of replacing part of asphalt or modification by waste materials.

In addition to these researchers who participated in the conference, there are many studies around bio-asphalt. Mohamed Abdel Raouf et al. conducted a large number of experiments to determine whether bio-oil can play the role of asphalt substitute, and concluded that untreated bio-oil could not play the role of asphalt substitute. The research on bio-oil asphalt requires new specifications.

Rubab et al. made relevant research on whether the recovered engine oil residue can partially replace asphalt, and on this basis, the aging performance of asphalt mixed with recycled engine oil residue was studied. Test data shows that the addition of engine oil residues will reduce the anti-aging properties of asphalt and make the asphalt's low-temperature crack resistance worse.

3. Domestic Research Status of Bio-Asphalt

In recent years, as the research heat of bio-asphalt has increased, many universities in my country are actively carrying out research on biomass pyrolysis to produce oil. Anhui Yineng Biomass Technology Co., Ltd. has developed a biomass pyrolysis device with an annual output of 10,000 tons, which provides sufficient raw materials for bio-oil.

In the research of bio-asphalt, Wang Hainian and others used DSR and RV methods to study their phase angle, viscosity and other properties; using the existing asphalt mixture road performance evaluation method, the analysis of the change of biomass heavy oil for bio-asphalt road the impact of performance.

He Min et al. studied the conventional performance of modified bio-asphalt through penetration, softening point, ductility and other tests, and found that all the conventional performance indexes of modified bio-asphalt have been greatly optimized, including the degree of plasticity improvement maximum.

Yu Qing and Tong Zhihua analyzed the basic properties such as the high-temperature stability of modified bio-asphalt, and pointed out that the high-temperature stability of bio-asphalt added to modified asphalt has been improved. Not only that, but also higher plasticity and consistency than before modification.

Song Zhaorui et al. conducted an experimental study on how the preparation process of modified bio-asphalt affects its performance and environment. Their conclusion is that the modified bio-asphalt obtained by adding modified asphalt to bio-asphalt has good quality at 95~110℃ Mix the two asphalts and mix for 30 minutes.

Zeng Menglan and Pan Haozhi of Hunan University studied the characteristics of bio-asphalt aging and found that the residual penetration ratio of bio-asphalt was significantly reduced during short-term aging; however, the high-temperature stability, residual ductility ratio, relative Plasticity has improved. To a certain extent, bio-asphalt modified asphalt mixture has good anti-aging properties.

Zhou Kuan studied the bio-asphalt made of wood chips and focused on analyzing the correlation with the rheological properties of the asphalt binder. Through dynamic shear rheological experiments, he found that increasing the content of wood chips will increase the composite modulus of wood chip modified asphalt, and the phase angle will decrease accordingly; the greater the amount of wood chips, the more obvious the separation effect.

Ding Zhan, Zhao Junkai and others analyzed the bio-asphalt synthesized by wood chip liquefaction products and found that the performance improvement of bio-asphalt comes from the modification of synthetic resin

and the change of microstructure caused by the change of asphalt functional group.

4. Conclusions

In summary, due to the non-renewability of asphalt and the dependence of society on it, domestic and foreign countries have begun to explore how to reduce the amount of asphalt and find resources that can partially replace asphalt. For now, biomass energy has broad prospects in solving the oil resource crisis. my country is rich in biomass resources, and is currently mainly used for rural living fuels, fertilizers, or burning waste, resulting in a large amount of carbon dioxide emissions. Compared with these methods of use, the production of bio-asphalt emits 30% less greenhouse gases. It can be seen that bio-asphalt is a low-pollution and environmentally friendly new material. Therefore, substituting bio-asphalt for petroleum pitch can not only relieve the pressure of petroleum pitch supply, but also realize the reasonable and efficient utilization of biomass resources, and form the sustainable development of bio-energy cycle.

5. Problems and Solutions

However, there are still some limitations in promoting the use of bio-asphalt as a new low-pollution and environmentally friendly material. First of all, the source of bio-asphalt is too wide, and different biomass processing techniques are also different, which makes the performance of the obtained bio-asphalt different, and a lot of tests need to be done to compare the performance of different bio-asphalts. Moreover, the research on bio-asphalt started late in our country, there are few experts on bio-asphalt, the research direction is not comprehensive, and there is no systematic and comprehensive research, and it is limited to indoor test research and a few test road paving tests. It is also why so far no corresponding technical specifications and evaluation methods have been formed, which largely limits the promotion of bio-asphalt.

In view of this situation, we need to broaden the research scope of bio-asphalt, not only focusing on some existing bio-asphalt research, but also discovering bio-asphalt from other sources and conducting related research. Through a large number of test data, analyze the conventional performance indicators of modified bio-asphalt and matrix asphalt, such as penetration softening point, etc.; use different bio-asphalt and control the different blending amount to prepare modified bio-asphalt, from high temperature performance to low temperature performance , Temperature-sensing performance, anti-aging performance and other aspects of analysis and comparison, and then summarize the best content of bio-asphalt; you can use the modified bio-asphalt to configure the mixture, pave the test section, analyze the road performance, and summarize the two The correlation between the two parties to determine a reasonable evaluation index; comprehensively analyze the economic and environmental benefits of bio-asphalt from the aspects of the price, environmental protection and energy consumption of bio-asphalt from different sources, and discuss the performance advantages of different bio-asphalt.

References

[1] Wang Guoqiang, Ren Jinlan. Comparison of economic performance between cement pavement and asphalt pavement under high asphalt price. Shanxi Highway Cost. 2006, (4).

[2] Ma Suyue. When the creature falls in love with asphalt. China Communications News. 2012, 09, 19006.