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Research Article

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Research on Storage Stability of SBS Modified Asphalt

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Abstract This paper summarizes the research status of storage stability of SBS modified asphalt to study the storage stability of SBS modified asphalt and the new process to improve its stability. The results show that the storage stability can be improved mainly by reducing the particle size of SBS and improving the stability of SBS and asphalt interface layer. And dry SBS modification technology will be a new process in the future.

Keywords SBS modified asphalt, Storage stability, Dry modification process, Road performance

1. Introduction

China's highway traffic construction has entered a period of the fastest development, the largest scale and the most dynamic in the last few years. Asphalt material has become the most important material in highway construction due to the excellent performance of asphalt pavement, such as shock absorption, sound absorption, driving comfort and safety in the construction of high-grade highway. The demand for high-quality asphalt also increases with the increase of traffic mileage and quality requirements. The output and distribution of heavy oil asphalt with good road performance are limited among the asphalt used in China. However, the common asphalt with large output has common defects in performance and can't meet the requirements of high-grade highway. Scholars in the world have done a lot of work in improving the performance of asphalt to make the road asphalt meet the needs of modern traffic development. And the most significant effect is modified asphalt.

SBS modified asphalt is the most widely used modified asphalt. It can significantly improve the low temperature performance, ductility and adhesion of asphalt, which is higher than that of matrix asphalt, and the aging resistance is also improved. However, the property of SBS determines that it has poor compatibility with matrix asphalt. They are only physically miscible. Phase separation is easy to occur during high-temperature storage, and the thermal stability is insufficient [1]. A large number of studies show that there is no obvious chemical reaction between SBS polymer and asphalt, which is evenly dispersed in the asphalt at the nano level. After high-temperature storage, SBS polymer is separated from the modified asphalt and distributed in the upper layer of the system, while the modified asphalt in the lower half is easy to degrade to the level of matrix asphalt. The adhesion between aggregate and asphalt will be uneven, the performance of mixture will be reduced, and the road performance will be seriously affected if the separated modified asphalt is applied to the project.

This paper summarizes and analyzes the mechanism and relevant laws to improve the storage stability of SBS modified asphalt by expounding the research progress on the storage stability of SBS modified asphalt in the world. The research results have certain scientific significance and theoretical support for improving the storage stability of SBS modified asphalt, weakening the segregation phenomenon, improving the road performance of modified asphalt and strengthening the construction of traffic quality.

2. Relevant Research

Yao et al modified CNOOC asphalt by blending SBS, desulfurization rubber powder and compatibilizer in an internal mixer to improve the thermal storage stability of CNOOC asphalt, and determined the optimal

proportion of admixture through experimental analysis [2]. The results show that the desulfurized rubber powder and SBS will chemically bond to reduce the density difference with asphalt, and the compatibilizer will increase the bond between SBS and asphalt and improve the thermal storage stability of asphalt. Wang et al studied the effects of vitamin linker (TOR), polyphosphate (PPA) and vulcanization crosslinking system on the storage stability of modified asphalt [3]. The results show that TOR and PPA reduce the segregation softening point difference of modified asphalt to a certain extent and improve the storage stability. Qian et al studied the curing process of chloroprene rubber (CR) modified asphalt and the effect of SBS content on the conventional properties and storage properties of CR / SBS composite modified asphalt [4]. The results show that the high curing method can improve the workability and storage stability of modified asphalt. And the large-size strip rubber disappears due to the degradation of CR, which makes the modified asphalt obtain better storage stability. Xiong et al adopted the method of combining test and theory for SBS polymer blue refining modified asphalt with poor compatibility and stability, and added a petroleum fraction with high aromatic content into the modified asphalt [5]. The results show that adding a certain amount of solubilizer and stabilizer to SBS blue refining modified asphalt greatly promotes the swelling of SBS in asphalt and makes the relationship between asphalt and SBS. And the crosslinking reaction between SBS improves the storage stability of SBS modified asphalt. Liu et al added organic montmorillonite (OMMT) into SBS modified asphalt, and conducted storage stability test, and used | RS | to characterize storage stability [6]. The smaller the value, the better the characterization stability. The results show that the value of | RS | gradually decreases with the increase of OMMT content, because OMMT is a layered structure. When SBS modified asphalt is added, the molecular chains of asphalt and SBS modifier will enter the interlayer of OMMT, form a spalling structure, cross-linked with asphalt and SBS molecular chains, enhance the force between asphalt and SBS molecules, and improve the storage stability of modified asphalt.

The research on the storage stability of modified asphalt started earlier in other countries. In 1958, Welborn and others tried to add single finger sulfur into rubber emulsified modified asphalt according to a certain proportion, which greatly improved the storage stability of modified asphalt [7]. Namjun et al discussed the influence of SBS on the performance index of matrix asphalt, focusing on the effect of SBS modifier of each concentration, and characterized it by colloidal instability index (CII) [8]. Faheem et al added Nano Al_2O_3 to SBS modified asphalt to study the effect of its concentration on various indexes of modified asphalt [9]. The results show that with the increase of Al_2O_3 concentration, the difference of softening point between the top and bottom of the material gradually decreases and the storage stability improves. Uchoaet al prepared epoxidized cashew nut shell oil (CNSL) from renewable resources cashew nut as an additive and added it to SBS modified asphalt, and conducted a series of tests (infrared spectrum, nuclear magnetic resonance, storage stability, etc.) [10]. The results show that the sample prepared with CNSL is considered to be a storage stable mixture over time.

3. New process for storage stability of modified asphalt

In the modification process, most of them still adopt the traditional wet modification process, that is, the modifier is added into asphalt in the factory, and SBS is ground, dispersed and fully swelled by large shear or colloidal mill. However, the traditional wet SBS modified asphalt still has technical defects and management difficulties. Fan pointed out that the wet modification process has the problems of segregation and thermal storage stability [11]. The dry SBS modified asphalt process came into being to solve this problem. It uses the modifier and matrix asphalt separately, that is, the SBS modifier is directly put into the mixing plant to melt rapidly with the aggregate and asphalt in a short time, so as to achieve micron dispersion. Many scholars have studied it in recent years. Su [12] determined that 7% is the best content of SBS-T by studying the influence of dry SBS-T content on the performance of different oil source matrix asphalt systems. And it shows that dry modified asphalt has better storage stability through comparison. Liet aldirectly put dry epoxy modifier into asphalt [13]. Through fluorescence dispersion observation and Fourier infrared spectrum analysis, it is confirmed that dry modifier will disperse evenly in asphalt and gradually react to form cross-linked structure, so as to improve its storage stability. Moreover, the dry modification process not only improves the storage stability, but also significantly improves the performance of asphalt mixture. Rodríguez et al added the crushed rubber (CR) recovered from the tire to the asphalt mixture through the dry process [14]. The results show that

the dispersion of rubber powder is better with the increase of adjustment time (the time when the asphalt mixture remains at high temperature after mixing). Duan et al found that the dry LM-S modified asphalt mixture with 5.5% content has better high temperature stability by comparing the road performance of dry LM-S and wet SBS modified asphalt mixture [15].

See Table 1 for the process flow of dry modification and wet modification, and see Table 2 for the comparison of advantages and disadvantages.

Table 1: Comparison of modification technology and process

Raw material	Transport	Production
Wet SBS modifier	Traditional SBS modified asphalt enterprises	Finished SBS asphalt and stone
Dry SBS modifier	Cancel the modified asphalt plant, and the energy consumption is 2% of that of the wet process	Dry SBS modifier, asphalt and stone

Table 2: Comparison of advantages and disadvantages of modified technology

Modification technology	Dry SBS modified asphalt	Wet SBS modified asphalt
Advantages	High economic benefit, no segregation, no need for high-temperature storage andtransportation	Excellent high and low temperature performance
Disadvantages	It has not been widely used	Large production consumption, easy segregation, easy decomposition when heated, and insufficient storage stability

It can be seen from table 1 and table 2 that dry modification technology has many advantages over wet modification technology. It not only has advantages in energy conservation and environmental protection, but also solves the problems brought to the industry by traditional wet modification technology.

4. Development direction of storage stability of modified asphalt

At present, the world is moving towards circular economy, which focuses on reducing waste and prolonging the service life of materials as much as possible [16]. In order to respond to the call of "green water and green mountain is Jinshan and Yinshan", the development of storage stability of SBS modified asphalt should be more economic, environmental protection and benefit. Cui [17] prepared a new environmentally friendly molding material PEG / ASB according to the characteristics of green and energy saving of phase change materials, which proved that it has good storage stability and phase change performance. Yao et al discussed the effects of different regeneration methods on the performance of recycled asphalt [18]. The results show that the recycled asphalt made of fresh SBS modified asphalt has higher thermal stability. On the other hand, considering the sustainability and environmental protection, the use of biomaterials in pavement construction has also become an important issue. Biological additives have great potential as asphalt adhesives because they have similar chemical properties to the original [10]. Geng et al prepared SBS modified asphalt with three self-developed biological stabilizers [19]. It was found that the stabilizer made of bio-based formaldehyde resin would greatly improve its high-temperature performance and storage performance. Jing and others prepared microcapsule / SBS modified asphalt with polyurea formaldehyde (as microcapsule wall) and biological asphalt (as microcapsule core) as raw materials [20]. It is concluded that its high-temperature stability and viscoelasticity are better than pure SBS modified asphalt through experimental comparison.

It can be predicted that the storage stability of SBS modified asphalt will be more diversified in the future. Economic and environment friendly composite asphalt modifier is its main development direction in the future.

5. Conclusion

SBS modified asphalt is the most widely used type of modified asphalt. The separation of SBS modifier will occur during asphalt storage, and the fracture of SBS molecules will occur at high temperature due to the thermodynamic incompatibility between SBS phase and asphalt phase. Aiming at this problem, this paper summarizes the research on the storage stability of SBS modified asphalt, the following conclusions are obtained:

- The main measures to improve the storage stability of SBS modified asphalt are as follows. First, further reduce the particle size of SBS to make the modifier better dispersed in asphalt. Secondly, the chemical reaction between SBS and asphalt interface layer can be made to improve the interfacial bonding strength by adding compatibilizer and stabilizer.
- In the modification process, compared with the traditional wet modification process, the dry SBS modification process has the characteristics of non-segregation, low cost and simple process. It fundamentally solves the problem of storage stability. It will become the mainstream technology of SBS modified asphalt. Moreover, composite modifier, biomaterial modifier and environment friendly modifier will become the development direction of storage stability of SBS modified asphalt.

Reference

[1]. Yuan, Z. Y., Zhang, W. G., Jia, Z. R., & Gao, L. (2018). Formula of direct cast ethylene butadiene styrene block copolymer modified asphalt stabilizer based on vulcanization mechanism. Science, technology and engineering, 18(13):304-309.

[2]. Yao, H.R., Wang, S. F., & Zhang, Y. (2015). Thermal storage stability of SBS / rubber powder composite modified CNOOC asphalt. Polymer materials science and engineering, 31(6):102-106.

[3]. Wang, X. Q., Lu, J. Y., & Cao, M. N. (2014). Study on storage stability of waste rubber modified asphalt. Petroleum refining and chemical industry, 45(4):27-30.

[4]. Qian, C., Fan, W., & Liang, M. (2018). Rheological properties, storage stability and morphology of CR/SBS composite modified asphalt by high-cured method. Construction and Building Materials, 193(30):312-322.

[5]. Xiong, P., & Hao, P. W. (2006). Measures and mechanism analysis of improving storage stability of SBS modified asphalt. Journal of Tongji University: Natural Science Edition, (05): 613-618.

[6]. Heng, B. L., Zhang, Z. Q., & Xie, J. Q. (2021). Analysis of OMMT strengthened UV aging-resistance of Sasobit/SBS modified asphalt: Its preparation, characterization and mechanism. Journal of Cleaner Production, 315(15).

[7]. Wang, T., Xiao, F., & Zhu, X. (2018). Energy consumption and environmental impact of rubberized asphalt pavement. Journal of Cleaner Production, 180(10):139-158.

[8]. Nciri, N., Kim, N., & Cho, N. (2017). New insights into the effects of styrene-butadiene-styrene polymer modifier on the structure, properties, and performance of asphalt binder: The case of AP-5 asphalt and solvent deasphalting pitch. Materials Chemistry & Physics, 193: 477-495.

[9]. Faheem, S. B., & Mohammad, S. M. (2021). A study investigating the influence of nano Al_2O_3 on the performance of SBS modified asphalt binder. Construction and Building Materials, 271(15).

[10]. Uchoa, A. F.J., Rocha, W. S., Feitosa, J. P.M., Brito, D. H.A., & Gondim, L. M., et al. (2021). Exploiting epoxidized cashew nut shell liquid as a potential bio-additive to improve asphalt binder performance. Journal of Cleaner Production, 314(10).

[11]. Fan, Y. (2020). Study on Microstructure and pavement performance of dry SBS modified asphalt. Nanjing University of Aeronautics and Astronautics.

[12]. Su, D. X. (2020). Study on applicability of dry SBS modifier and performance of modified asphalt mixture. New building materials, 47(11):84-88.

[13]. Li, Y., Cao, D.W., Zhang, Y.J., & Jia, X.P. (2021). Performance of a dry-method-epoxy modifier and a modified epoxy-asphalt mixture. Construction and Building Materials, 266(10).

[14]. Rodríguez-Fernández, I., Tarpoudi, B. F., Cavalli, M. C., & Poulikakos, L. D. (2020). Microstructure analysis and mechanical performance of crumb rubber modified asphalt concrete using the dry process. Construction and Building Materials, 259(30).

[15]. Duan, X. B., Gao, Z. P., Yang, X. Y., Yang, Y. F., & Li, Q.D. (2019). Comparative study on road performance of dry lm-s and wet SBS modified asphalt mixture. Highway, 64(06):245-247.

[16]. Wahid, F., Allan, M., & Rafat, S. (2021). Recycling of landfill wastes (tyres, plastics and glass) in construction – A review on global waste generation, performance, application and future opportunities. Resources, Conservation and Recycling, 173.

[17]. Yang, M., Zhang, X. L., Zhou, X. C., Liu, B., & Wang, X., et al. (2021). Research and Exploration of Phase Change Materials on Solar Pavement and Asphalt Pavement: A review. Journal of Energy Storage, 35.

[18]. Yao, X.G., Wang, Y., & Xu, T. (2021). Development on recycling, aging simulation and regeneration methods of reclaimed styrene-butadiene-styrene modified asphalt. Journal of Cleaner Production, 312(20).

[19]. Geng, L.T., Liu, Y., Han, H.C., Zhang, Z., & Han, F.Y. (2021). Effect of bio based stabilizer on properties of SBS modified asphalt [J]. Journal of building materials.

[20]. Jing, L., Song, Y., Yaseen, M., Maria, S., & Zhao, R. Z., et al. (2020). Fabrication and application of polyurea formaldehyde-bioasphalt microcapsules as a secondary modifier for the preparation of high self-healing rate SBS modified asphalt. Construction and Building Materials, 246(20).