

Research Progress of Modified Asphalt

Urbanik

School of Civil Engineering, University of Newcastle, Maryland, 21201, America

Abstract: In order to get better performance of modified asphalt, more and more material is used as a modifier, also the new evaluation standards and methods and other areas of new chemical analysis method was also used to more complete and accurate evaluation of modified asphalt performance. The research status and progress of modified asphalt at home and abroad are summarized, and the general situation of various modified asphalt are introduced from the aspects of modification mechanism, influence factors and evaluation method, and the development direction of the modified asphalt is summarized.

Keywords: Modified asphalt; Modifier; Mechanism; Development

1. Introduction

Ordinary road asphalt due to its composition and structure determines its poor temperature performance, flexibility and anti aging performance is poor, high temperature and easy flow, low temperature cracking. And in the past 10 years, the axle load increase, the traffic increase, the weather condition is bad, it is difficult to meet the requirements of the use of the high road, it must be modified to improve the use of performance. Adding natural or synthetic organic or inorganic materials in the asphalt or asphalt mixture, melt or disperse in the asphalt and the asphalt reaction or wrapped in the asphalt aggregate surface, can improve or improve the performance of asphalt pavement.

2. Classification of Modified Asphalt

In the modified materials of asphalt, polymer is one of the most widely used and the most concentrated. Other modified materials have two major categories: mineral fillers and additives. Mineral filler, such as diatomite, lime, cement, carbon black, sulfur, lignin, asbestos and carbon cotton, the physical modification of asphalt, can improve the asphalt abrasion resistance, cohesion and weather resistance. Additives, including antioxidants and anti stripping agents, such as organic acid soap, amine type or phenolic antioxidant or anionic, cationic or non-ionic surfactants, can improve the adhesion of asphalt, anti-aging or antioxidant capacity. Polymer modified asphalt. According to different modifier can generally be divided into three categories: thermal plastic rubber, thermal plastic elastomer, mainly block copolymer, SBS, SIS, SE/BS, is now in the world the most widespread use of road asphalt modifier, and with SBS at most; rubber, such as NR, SBR, Cr, Br, IR, EPDM, IR I, sir and Sr, used in the form of latex, which the application of SBR most widely; resin, such as EVA, PE, PVC, PP and PS.

3. All kinds of Modified Asphalt and its Development Status

3.1. Mineral material modified asphalt

Mineral materials as modifier of less, mainly for diatomite, nano calcium carbonate, slag powder and silica, and asphalt to form uniform and stable blends to improve the performance of the asphalt.

Yan Ni Bao from the separation mechanism, test analysis aspects of diatomite modified asphalt compatibility was studied, provide certain theoretical basis for the practical application of diatomite modified asphalt, and in China's Yunnan Dabao high speed laying the road test. The results showed that the actual performance better. Zhang Zhiqing and other think that the earth has a special micro structure, can absorb the oil of asphalt, help to improve the performance of asphalt pavement. Diatomite can not only play a role, but also the main modification effect. When the content of diatomite is 14%, it can significantly improve the high temperature stability of the mixture and improve the low temperature cracking resistance. Ma Feng, such as the use of asphalt four components analysis, infrared spectroscopy and differential scanning calorimetry analysis experiments found that nano calcium carbonate was added into the matrix asphalt can form uniform and stable blends, and improves the performance of asphalt. Xing you Zhang by SHRP plan dynamic shear test method of diatomite and silica were studied and found that it is a good way to improve the high temperature performance, low temperature performance, water stability and anti fatigue performance.

3.2. Additive modified asphalt

With the appropriate anion and cation mixed surfactants significantly, but the current development and application of research is not enough. The potential of this technology application is very large, all areas should be actively developed, as long as the master of the laws of its mix,

improve the application of technology, will have a significant economic benefits.

Under the condition of 5: 1, the O/W emulsified asphalt was prepared by the ratio of the amount of Fan Zhiyun and other cationic surfactant and anionic surfactant, and its application in water conservancy project was studied. The results show that the stability of the asphalt emulsion prepared by anionic and cationic mixed surfactants is improved, and the amount of surfactant is greatly reduced, thus the cost is reduced. They also this kind of yin / cationic surface active agent mixture emulsified asphalt for the preparation of emulsified asphalt concrete, the permeability coefficient of the meet the requirements of water conservancy anti-seepage, and has thermal stability and mechanical properties are influenced by temperature and advantages, for general water conservancy anti-seepage engineering, is especially suitable for exposed in the atmosphere is affected by temperature, the large part of, bring great convenience to the construction.

3.3. Polymer modified asphalt

SBS is a linear or star block copolymer obtained by anionic polymerization of 1, 3- butadiene and styrene. In SBS block copolymer, due to incompatibilities of polystyrene and poly but at room temperature, copolymer molecular chain between polystyrene cohesion can density is bigger, so the two ends of the firstly polystyrene with also gathered together, forming many of the constraint elements of physical cross linking area, but because the block is flexible poly but adiene block, formed reticular structure. The superiority of SBS modification is prominent in the increase of the softening point, while the low temperature ductility increases obviously, and the temperature sensitivity is greatly improved, and the elastic recovery rate is particularly high.

At present, most of the modified asphalt research is carried out around the SBS, SBS in the actual study of the modification effect is very good. Domestic do better is the Pavilion, they developed the SBS modified asphalt, emulsified SBS modified asphalt technology and complete sets of equipment and technology. The biggest problem of SBS modified asphalt is stability. Japan from improving the compatibility set to ensure the stability of the modified asphalt system: incorporation of a large number of aromatics to between SBS and asphalt formation interface adsorption layer, at the same time adding a lot of resin, used to compensate for hydrocarbon oil causes softening point to reduce the shortage, the cost of this method is high, the operation is very complex. The United States has used the method of curing, so that sulfur atoms into the SBS and the asphalt reaction, which is difficult to control the control, often cause the asphalt and asphalt become waste. Wend and so on, "SBS" through the study of 8] modified asphalt found that adding 10% of sulfur can effectively improve the storage

stability of modified asphalt. Pavilion has developed a WD thermal storage stabilizer, improve the thermal storage stability, but also improve the road performance of the product.

Low density ethylene LDPE and linear low density polyethylene used in asphalt modification. The study found that when the PE content is more than 5% in the asphalt, due to its high viscosity, the mixture will creep in the high speed stirring process, PE is more difficult to disperse. With the increase of PE molecular weight, the viscosity will increase with the same content. PE modified asphalt to Austria RF group's product ovophalt N as the representative. Novophalt, as a kind of high strength pavement material, is applied in the construction of a viaduct in Shanghai area. Through the research on the construction characteristics of the material, it is considered that the construction temperature, roughness, thickness and compactness of the material can meet the normal distribution characteristics, and can meet the engineering requirements.

Liu ke study found that, the thermal state of PE modified asphalt in the cooling process will soon segregation and formation of internal structure and surface morphology of different. When the dosage of PE modified asphalt is low, the skin is lighter, and the performance test results are heavily dependent on the production equipment, time, environment temperature, the shape of the container and the content of PE. When the dosage of PE is larger, the test results are more discrete, because the large dose of PE modified asphalt is more unstable. EVA ethylene vinyl acetate copolymer, soluble in some organic solvents become adhesives or hot melt glue, is has the certain elastic thermoplastic resin. The rubber state temperature range of EVA resin is very broad, and it is elastic, tough and impact resistance in this temperature range. Its thermal decomposition temperature is 230 to 250 degrees Celsius, industrial production control EVA temperature is not higher than 220 degrees Celsius, in order to prevent decomposition.

Bu and other fluorescence optical microscopy and Qwin-plus image analysis software to analyze the modified asphalt, image analysis, when the polymer content of 4% EVA modified dispersion was the best. EVA modified asphalt can improve the asphalt permanent deformation and thermal cracking performance, but it is more susceptible to the influence of the thin film oven aging test, this is because the thin film oven test accelerated the hardening of the large storage stage. SBR is an earlier and widely used polymer modifying agent. It is generally believed that SBR can increase the elasticity and viscosity of asphalt and reduce the temperature sensitivity of asphalt. At present, the simple use of SBR latex modified asphalt has become less and less in foreign countries. Instead, it has been replaced by modified SBR latex modified asphalt. Often in a modifier to SBR as the main body, appropriate

to add the other ingredients, the asphalt in maintaining good low temperature performance and improve the high temperature properties, such as Japanese JSR ROADDEX U-II is a modified SBR latex modified agent.

According to the JSR company's recommendation index and related research results, the optimal dosage of ROADDEX U-II modifier is 10%, which can be determined according to the actual needs. Xu An Hua through modification of the ROADDEX U-II admixture with Lanzhou Refinery heavy over 110, asphalt mixture was investigated and it is found that they have good compatibility, asphalt mixture has good low-temperature performance, very suitable for popularization and use in the alpine region asphalt pavement.

3.4. New technology of polymer modified asphalt

Due to a single modifier, modified asphalt, the common problems existing, this use of the a composite modified asphalt technology, for the lack of a addition can improve the performance of the modifier was modified, to learn from each other. Is generally believed that in the polymer modifiers, rubber like material to improve effect of asphalt properties at low temperature is more obvious, and plastic materials to improve the high-temperature asphalt properties compare favorably with, such as the use of EVA and SBR compound modification, low temperature ductility compared with individual modified improved and softening point was increased along with the increase of content of modifier. At present, the application of SBS/SBR and SBR/PE composite modification is also more. Composite modification can not only be carried out between the polymer, but also can be carried out between the inorganic and polymer materials. Zhang Bao chang and so on now, SBR/MMT composite modification can very good to improve asphalt softening point, viscoelastic properties, and effectively reduce the penetration; change of asphalt with high elasticity complex modulus and lower damping coefficient. Dong Yun through the white carbon black /SBS basic performance of modified asphalt mixture were tested, analyzed the different amount of carbon black effect of SBS modified asphalt, adding 3% silica SBS modified asphalt the ductility decreased slightly, equivalent brittle point decreased, that of SBS modified asphalt high temperature performance and temperature sensitivity increase, but the impact on low temperature performance remains to be seen.

Application of domestic modified asphalt engineering practice of SBS, SBR accounted for the vast majority of, especially by SBS most, but polymer agent of high cost prevented the modified asphalt in road construction, at home and abroad began to study of waste rubber powder modified asphalt and try with waste plastics as modifier of the preparation of the modified asphalt. The effective components of the waste rubber powder and waste plastics can improve road asphalt softening point and im-

prove road asphalt low-temperature flexibility and reduce the penetration, and improve the ductility and reversible elastic deformation of the asphalt. Waste rubber and waste plastics as road bitumen performance improved material, to provide a new way to solve China's increasingly serious plastic and waste rubber pollution problems, but also to achieve purpose of waste disposal and waste reuse, not only embodies the "circular economy" thinking and consistent with the national policy of China's "sustainable development".

The waste rubber, waste agricultural plastic film, food and commodity packaging and waste products are used for modifying agent. The waste rubber is vulcanized rubber, the molecule is three-dimensional space network structure, has the viscosity and the plastic and has the elasticity. Rubber powder in hot asphalt, asphalt rubber powder from softener, oil absorption and expansion, and under the influence of heat regeneration desulfurization. Hong Bo Shi and other research found that in the mixed temperature of 170 to 180 DEG C, shear rate 7000r / min, mixing time 30min conditions, crumb rubber modified asphalt preparation (mass): matrix asphalt 100, activated rubber crumb 10 to 20 mesh, furfural extract oil amount, can improve asphalt high temperature stability, low temperature anti fatigue performance, crack resistance and low temperature brittleness .

3.5. Nano modified asphalt

Due to its excellent properties such as small size effect, surface effect and macroscopic quantum tunneling effect, the nano materials can be changed from micro structure to the properties of asphalt. Eitd of polymer / layered silicate nano composites study found that it can be enhanced on the polymer, toughening effect, improve material heat resistance, high heat distortion temperature and decomposition temperature), flame retardant, resistance to ablative properties, barrier properties and dimensional stability.

4. Modification Mechanism and Influencing Factors of Asphalt

The performance of the modified asphalt is the comprehensive result of polymer modifier and asphalt. From the effect of modification terms, modifier and asphalt are selective, that is to change the of modifier and asphalt existing compatibility problems (compatibility), change of asphalt compatibility is a modifier to fine particles evenly and stably distributed in asphalt, no delamination and the phenomenon of condensation and separated from each other. The key to improve the effect of asphalt modification is to solve the compatibility problem between modifier and asphalt.

Modifiers are added to asphalt, generally does not occur chemical reaction, but in asphalt in the role of light component, agent volume swell, swell. After the swelling of

the modifier, it is shown that the interfacial properties are different from that of the polymer. Swelling is the guarantee for the stability of modified asphalt. Due to the interfacial action between the modifier and the asphalt, the two are not separated, and the modifier particles are uniformly distributed in the asphalt. Modified asphalt absorption in oil, the volume swell to the original volume of 5 ~ 10 times. In the condition of high content of modifier, the swelling degree of the polymer in asphalt decreases, but the network structure can be formed, so that the properties of asphalt can be improved significantly.

The compatibility and stability of the modified asphalt are all need to be realized through the compatibility between the matrix asphalt and polymer and the suitable additives. The stability of the general sense refers to the storage stability of the modified asphalt. In fact, the factors that affect the stability of storage are very complex. Shell Research Institute believes that in addition to the temperature of the modifier dosage and storage period, storage stability is also affected by the molecular weight and content of asphalt, asphalt aromaticity, polymer surfactant molecular weight and structure factors. Through on SBS modified asphalt storage stability influence factor analysis Cao Zuguang etc. was found between asphalt and polymer compatibility, SBS in the asphalt dispersed, asphalt, interface layer, viscosity and shear rate, SBS dosage and processing technology will can have the influence to the performance of asphalt.

5. Performance Evaluation of Modified Asphalt

Bitumen is the highest boiling point, composition and structure of petroleum products. Adding the modifier not only increases the complexity of the asphalt system, but also changes the rheological properties of the asphalt. The traditional test methods such as penetration, softening point and the extension degree) can still be used, but it is difficult to accurately analysis and evaluation performance of asphalt modified. In order to adapt to the modified asphalt application needs some new modified asphalt evaluation methods, such as dynamic rheological shear, bending beam rheometer and direct tensile test, also some chemical analysis method such as fluorescence microscopy analysis, gel permeation chromatography (GPC), differential scanning calorimetry and infrared spectra and application in modified asphalt.

6. Development Trend of Modified Asphalt in China

6.1. Develops a new type of modifier

Polymer based nanocomposites have attracted interest in many fields because of their unique mechanical, thermal, barrier, optical, electrical, magnetic and other properties. Nano composite in the nano composite technology and

research and development ideas applied to the modified asphalt, will be expected to develop a high strength, high toughness, high temperature resistance, aging resistance of the road modified asphalt materials.

In modifier research, new functional modifier, such as nano material modified agent, powder SI3S modifier, polyethylene elastomer modified agent, organosilicon modified of agent and diatomite modified agent have appeared. The use of waste rubber powder, waste plastics and inorganic materials has obvious environmental benefits, economic and social benefits, which is of great significance to the highway construction.

6.2. The use of additives and improve the production process

Additives to improve asphalt high temperature stability and storage stability, in modified asphalt in the process of using additives, coupling agent, dispersing agent and initiator, the machining process produces impossible chemical bond to improve the performance of asphalt. Improve the processing efficiency of mixing equipment, and use the corresponding catalyst to accelerate the reaction of asphalt mixture.

7. Conclusion

At present, more and more materials are used to modify the properties of the modified asphalt, most of the production process has become mature. Front of the environmental problems in the increasingly serious pollution of waste plastic and waste polymer materials and recycling utilization rate is very low, if the used to modify asphalt production, not only can to find a good way for the waste material, but also reduces the cost of the asphalt modified, with good environmental and social benefits. The domestic and foreign research on crumb rubber modified asphalt and has reported more large-scale production. Used as modifier of waste plastics such as polyethylene, polypropylene, ABS and PVC, due to the compatibility and the production of modified asphalt with all kinds of defects and have not been widely used. The author in the study found that for these waste plastic attempt by solvent method and high shear mixing method combining can be achieved very good plastic and asphalt phase compatibility in, but it is difficult to meet the excellent high and low temperature performance, compared with SBS and waste plastics composite modification can improve this kind of situation, but increased the input of the solvent and the cost of reclaiming and SBS modified asphalt is also a slight gap. In the engineering practice, different modified asphalt should be chosen according to different needs.

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