

Research Review on the Characteristics and Technical Characteristics of SMA Mixture

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Abstract: Summarized the raw materials technical and research results of SMA asphalt mixture, briefly analyzed the effect of asphalt and fiber on the performance of SMA mixture, finally concluding the existing problems of SMA mixture research and putting forward research direction of the future.

Keywords: SMA; Technical characteristic; Performance

1. Introduction

Transport under taking unprecedented prosperity, the rapid growth of traffic volume, the tonnage of transport vehicles is also growing, the road was overwhelmed by overloaded vehicles is widespread, so it proposes great challenges for the road of work, stability and durability. Meanwhile, the response to the national concept of harmonious development of ecological civilization, beautiful roads, environmental protection also referred to the agenda. Stone Matrix Asphalt is a kind of attractive new asphalt mixture, which has been appeared in China in recent years. It is the asphalt mixture which consists of asphalt, fiber stabilizer, slag and a small amount of fine aggregate which is composed of asphalt mastic filled gap broken graded rough set material skeleton space and composition of asphalt mixture [1]. Its excellent low temperature crack resistance, high temperature stability, good surface properties, durability and other characteristics have widely been used in the surface layer structure of highway, heavy traffic roads, airports, road and track steel bridge deck pavement and other major projects [2].

2. Research and Development at Domestic and Abroad

The world's first SMA pavement was built in the mid-1960s in Germany, and it has been 50 years of history and still has a good level of service. At that time, Germany in order to reduce the wear of the road surface by the buried nail tire. It is founded that the use of mineral cellulose stabilizer or lignin cellulose can increase the amount of slag and the use of modified asphalt mastic can either reduce the abrasion of the nails on the pavement performance of asphalt mastic by research. And significantly reduce the temperature susceptibility of the asphalt pavement, while the high-temperature asphalt pavement rutting resistance, low temperature crack resistance, fati-

gue resistance, water stability and road performance has been significantly improved and enhanced, thus forming the new asphalt - stone mastic asphalt mixture[3]. Since the 80's, SMA first in the Nordic countries, Sweden, Finland and other countries have been widely used, and soon spread to the whole of Europe. September 1990, the United States AASHTO, FHWA, WAPA, SHRP, TAI, TRB jointly sent a large delegation to Europe to look into the road in Sweden, Denmark, Germany, Italy and other countries, his delegation believed SMA and modified asphalt technology is worth promoting. The next year, the technology in the United States began a large-scale application. SMA in the United States has been rapid development and carried out in the asphalt mastic macadam mixture (SMA) project reached more than 100 items[4]. China has introduced a modified asphalt technology in Austria in 1991 and began a preliminary study SMA, a number of provinces and cities in late paved SMA pavement test sections, but because knowledge of the SMA technology is not systematic, many test period occurs more or less quality problems [5]. This means when use the new reference material must be fully taken country's environmental temperature, composition of traffic status and national conditions into account to study a suitable national engineering material on the basis of the material study in other country to arrive at satisfactory effect. In our continuous research and practice of stone mastic asphalt mix process, we have made great achievements. Such as: the Capital Airport Expressway, 107 State Road in Hubei, the Jingqin Expressway Hebei Province and other projects used Asphalt mastic macadam mixture and achieved good results. At present, the main problems existing in the application of Asphalt mastic macadam mixture:

- Absence of a standard SMA design.

- The work of SMA is more extensive, and quantitative indicators and test methods of SMA is not very mature.
- The quality requirements are very strict, and the need of asphalt is large, which increases the difficulty of construction.
- In order to ensure the construction temperature and environment protection, the transport system of SMA mixture should be further studied.
- Reduce the cost of the project is the key to promote the use of SMA pavement. In recent years, SMA pavement has been considerable size of the application, the vast majority have achieved good results, but because of higher investment, compared with ordinary asphalt pavement was up about 30%, and mixing plant efficiency reduced by about 20%, it will affect its application [6].
- The use of technology in different climatic regions remains to be studied.

3. Composition Characteristics of SMA Mixture

In order to improve the stone mastic asphalt mixture resistance to loose, crack resistance and durability, ultra limits on the shift of the aggregate (mass fraction is greater than the nominal maximum particle size of aggregate) and the ultra limits (less than nominal minimum size of aggregate quality score) should have certain limit, especially for lower limit value of 5-10 mm aggregate should be no greater than 6% [7]. The impact for coarse aggregate needle flake content on stone mastic asphalt mix porosity is relatively large, but the SMA internal porosity is relatively small, usually at 3% -4%. At the same time, the crushing value also has adverse effect on the strength of the mixture, so the mixture of coarse aggregate of needle, flake and crush value requirement is strict. GB50092-96 "asphalt pavement construction and acceptance of norms" prescribed limits were 15%, 25% [8]. At the same time, the content of coarse aggregate accounts for more than 70% of the mixture, so the influence of coarse aggregate index and properties on the mixture is very large.

Less than 4.75mm of fine aggregate content in the mixture is less, usually not more than 10%. But its effect can not be ignored, fine aggregates can be a good way to improve the texture of the surface of the road surface, thereby improving the anti-sliding performance of mixture [9]. At the same time, the technical indicators of fine aggregate should correspond with the coarse aggregate, and general use of artificial sand, as far as possible not to use natural sand, because natural sand is basically a spherical particle, small friction resistance, and poor adhesion of asphalt, and have an adverse impact on the mixture of high temperature rutting resistance.

Due to large dosage of asphalt, so need more mineral powder as the asphalt binder packing, commonly used for 8 ~ 12%, powder-cement ratio reach the average of 1.8 ~ 1.8 degree (beyond usually limit value of 1.2). Ore powder plasticity index is not greater than 4%, the hydrophilic coefficient is not more than 1 [10]. Mastic asphalt which is made up of mineral powder and asphalt and fine aggregate is filled in the gap of coarse aggregate skeleton, forming good skeleton dense structure, thus improve the mix of low temperature crack resistance and durability, but cannot use recycled dust, generally use the fine grinding of limestone powder.

Commonly used fiber stabilizers are wood fibers, mineral fibers and organic fibers. Now commonly used fiber is mainly lignin fibers, fiber content is generally 0.3% - 1.5% of the total mass of asphalt mixture. Fiber material with good dispersion properties, not only can act as a "reinforced" role in the asphalt, but also has some influence on the asphalt adhesion [11]. Fiber can also adsorb asphalt and mastic and prevent serious analysis of leakage occurred in asphalt and mastic, improve the mixture water stability and durability. But fiber can not be affected with damp and clusters, lest fiber additive on the road caused by oil stain, affect the road performance.

4. Technical Characteristics of SMA Mixture

Technical characteristics of stone mastic asphalt mix has been the focus of attention, how to ensure that the technical characteristics and performance of SMA has been and will continue to be the top priority of SMA research. SMA mixture commonly used for paving the road surface, impacted by traffic load and atmosphere, while its material physical and mechanical properties will be affected differently, so in order to guarantee service levels and capacity pavement, SMA mixture pavement must have certain technical characteristics and road performance.

1) Excellent high temperature stability, good flatness

Due to good embedded squeeze effect between coarse aggregate and asphalt mixture's ability to produce good resistance load deformation, even under the condition of high temperature, the viscosity of mastic asphalt, and to the effect of the resistance will be reduced, thus has the strong ability of high temperature rutting resistance. SMA asphalt mixture material in mineral aggregate gradation use the discontinuous gradation and relative to the resistance of plastic deformation and shear deformation, and to some extent, it can withstand heavy traffic, with strong ability to resist rutting and the longitudinal flat is good [12].

2) Good water stability

Compared with ordinary asphalt concrete, SMA asphalt mixture of void fraction is very small, almost impermeable, aggregate bond between asphalt and mineral powder

and the thickness is very good, can greatly improve the water stability of asphalt mixture;

3) Better anti sliding performance

SMA mixture of coarse aggregates, the stone is hard, rough, wear-resistant, the surface of the road to form a large pore, structural depth, so that the road mask has a good anti sliding performance.

4) Longer service life

In the sunlight, air and water and other atmospheric factors, the nature of the road slowly lose its stickiness, brittle, but SMA structure because effect of cellulose reinforced, dispersion, adsorption and absorption of asphalt and viscosity, which make package aggregate of asphalt film thickness, prolonging the service life of the pavement. Experiments show that, the mixture fatigue performance is much better than that of dense graded asphalt concrete, so it has good durability [13].

5) Good low temperature crack resistance

At low temperatures, the crack resistance is mainly determined by the binding material tensile properties. Since a considerable number of filling mastic asphalt between SMA aggregate, mastic toughness and flexibility is better able to resist deformation of the mixture at low temperatures, thereby increasing the low temperature crack resistance mixture.

These road performance requirements are often mutually contradictory or constraints so improve some performance, another performance may be affected. SMA mixture advantage is that these road performance requirements simultaneously taken into account. Using SMA pavement structure, it is important to carry out the mixture ratio design, and control the construction process strictly according to its characteristics, to ensure the quality of the project [14].

5. Effect of Asphalt and Fiber on Properties of SMA Mixture

There is a great relationship between Stone mastic asphalt mixture strength and the amount of asphalt and bitumen types, in the same material properties, the asphalt content is too high or too low will reduce strength of stone mastic asphalt mixture. The requirements of SMA pavement of asphalt binder are higher than ordinary asphalt concrete, but whether it need to use modified asphalt, there is no consistent affirmative conclusion on international, because of the various countries and regions of different climate conditions and traffic conditions, and also has a lot to do with economic strength. But from the general trend of development, the use of the modified asphalt is a direction [15]. Experimental studies have indicated that, compared with other types of asphalt concrete pavement, using a modified stone mastic asphalt mixture can significantly improve the performance and durability of the pavement, which can effectively reduce the incidence of road surface disease and prolong pave-

ment life and maintenance cycle, greatly reducing maintenance costs [16]. Hebei section of the Jingcheng highway is SMA modified asphalt pavement, it performs good pavement performance, and drives comfortably and safety during traffic for 3 years [17]. The study of Wang Rongqing, Zhang Yongxian [18] suggests that the use of 5% SBS modified asphalt in the asphalt mix material can improve the adhesion of asphalt and mix material and the ability of the mixture to resist water damage. But not using SMA SBS can improve all the performance, Hongxing shi [19] studies show that SBS modified asphalt can improve the rutting resistance mixture, and increase resistance to fatigue, while improving the low temperature cracking resistance but there is no significant improvement for mixes water stability. In the choice of materials has a great influence on the performance of SMA. To improve the performance of mixture, we should study more economic environmental protection raw materials, or use a variety of ways to improve the performance of mixtures and save raw material usage and reduce the cost of the SMA. George State Highway Administration study shows that use of modified asphalt SMA helps to improve fatigue performance and fine-grained SMA due to variability little so its resistance to fatigue is better than Coarse SMA [20].

Studies on mechanical properties of fiber asphalt mixture have also been of great concern. Lin Kueiyi, Bradley J. Ptu-nan [21-22] carried on the a lot of studies about polyester fibers and polypropylene fibers, and the results achieved with a certain practical significance and it believes that the polyester fiber and polypropylene fiber and polyacrylonitrile fiber has a certain impact on performance of asphalt mixture. Ding Zhiyong and others [11] conducted a test of the performance of fiber asphalt mixture, indicated that the polymer fiber can improve the performance of asphalt mixture significantly. Fiber material has improved asphalt mixture road performance, but its high temperature resistance and strength is insufficient, so finding a fiber can meet the asphalt mixture production conditions and the road performance has very important significance, so the research and development of fiber is very necessary.

The performance of SBS modified asphalt is excellent, but the cost is relatively high, which limits the popularization and application of SMA mixture. Some studies have indicated that the structure of SMA asphalt mixture is suitable for the swelling characteristics of rubber asphalt, while the cost of rubber asphalt is relatively low. Huifeng Huang [23] verifies the rubber modified asphalt can instead of SBS modified asphalt, the experiment shows that asphalt rubber SMA Mixture is slightly lower than that of SBS modified asphalt and SMA mixture in the high temperature performance and water stability, but value is similar, basically at the same level and meeting standard requirements; In the low temperature per-

formance, asphalt rubber SMA mixture is higher than that of SBS modified asphalt, and can also meet standard requirements.

6. Conclusions and Prospect

As can be seen from the above, SMA overcomes the shortcomings of AC, AM and AK, which are now widely used in the asphalt mixture, and the use of their advantages, so that the use of asphalt mixture can improve the performance. Therefore, SMA is excellent quality, comprehensive performance and adapt to modern traffic characteristics of ideal asphalt mixture pavement structure material. SMA mixture compared with other ordinary dense graded asphalt concrete in raw material composition, mechanical properties, performance evaluation are quite different. Although the study of SMA mixture has made a lot of achievements, but there are still some controversy, for example: Is it necessary to use modified asphalt or what circumstances can meet the maximum benefit for using modified asphalt, SMA mixture ratio design and SMA mixture high temperature stability and low temperature cracking and the like. Understanding the mechanical properties of SMA and optimization design, is conducive to the application and development of SMA mixture. Studying a new type of polymer modified asphalt, and controlling the best dosage of asphalt and mastering the variety and dosage of fiber can promote the development of application of SMA mixture. We should save the amount of raw materials and reduce the cost, and the extensive application of SMA mixture for economic and reasonable.

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