Application of Asphalt Pavement Concrete Flexible Base Course

Qiuyun Wang

Chongqing Vocational College of Transportation, Chongqing 402247, China

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Abstract: In this paper, a comparative study of Marshall compaction and rotational compaction molding, traditional Marshall design methods, and mechanical index methods is proposed to establish a molding method suitable for asphalt-stabilized macadam base. Construction technology and reasonable paving thickness.

1. Introduction

Asphalt treated base(for short ATB) ,different from semi-rigid base which is often used in our country, belongs to the category of flexible base. ATB has great shearing strength and good capability of fatigue resistance, and can control and reduce reflecting crack.Using ATB is economical and can bring fine pavement performances.

2. Characteristics of Asphalt Stabilized Macadam

Asphalt stabilized macadam base is a flexible structural layer material.It has higher shear strength and fatigue resistance.Compared with semi-rigid base, it is less likely to cause shrinkage cracking.It forms a full-thick asphalt pavement (thickness) with the asphalt surface layer. (Above 20cm), so that the entire asphalt surface layer has the advantages of short construction time, uniform pavement structure, less affected by water and freezing, low maintenance costs, pavement materials can be fully reused and the service life is extended. The following aspects:

(1) Asphalt stabilized macadam base structure type can open traffic earlier than semi-rigid base structure type, which can greatly shorten the construction period and realize economic benefits at an early date. Generally, the asphalt stabilized macadam base can be surfaced about one day after the completion of paving. Layer structure, while other types of grassroots require longer time to maintain in order to reach the age.

(2) Asphalt stabilized macadam base structure type has better long-term use performance than other types of base structure types. It can not only provide good flatness for the upper layer during construction, but also provide safe, comfortable and durable driving. Performance, it can greatly eliminate the adverse effects of early damage caused by semi-rigid base and lean concrete base types.

(3) Asphalt stabilized gravel base course structure type is more conducive to environmental protection. This full-thickness asphalt pavement structure is not only uniform and uniform, but also can be used in the course of repair and reconstruction at the end of its service life. This is not available in other types of structures.This not only saves resources and later construction costs, but also does not cause environmental pollution.It is an environmentally friendly grassroots type structure.

3. Basic Requirements for Asphalt Stabilized Macadam

The asphalt stabilized macadam base is generally located at a level of about 10 cm or less below the pavement. The stress levels and temperature conditions faced are far less severe than the surface layer. Some studies have shown that the stress level of the asphalt stabilized base is about 0.3 MPa. The average temperature of the asphalt stable base at higher temperatures can be approximated by the temperature.

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To study the strength, stability, and failure mode of asphalt mixtures, it is necessary to closely integrate the environment in which the mixture is used. For different asphalt mixtures, the failure modes in different temperature regions are very different.

Semi-rigid base is also called inorganic binder-stabilized base, which usually includes cement-stabilized base, lime-stabilized base and comprehensive stability-based base. Semi-rigid base has the following advantages:

(1) It has high strength, bearing capacity and distributed load capacity. Generally speaking, semi-rigid base materials have higher strength, and they have the characteristics of increasing with age. Therefore, semi-rigid base asphalt pavement usually has Small deflection and strong load distribution ability. From the perspective of deflection, most domestic highway pavement structures in different periods of time represent the deflection value generally within 0.2 mm, or even 0.1 mm The existing test road proves that the bearing capacity of semi-rigid asphalt pavement can be fully satisfied by the semi-rigid base layer, and the asphalt surface layer can only function as a functional layer, so the asphalt surface layer can be thinned and the construction cost can be reduced.

(2) Good stability. The semi-rigid base material has high water stability and freezing stability, so under the action of water and repeated freeze-thaw cycles, it will not affect the bearing capacity of the semi-rigid material base.

(3) The rigidity of the semi-rigid base layer is large, and the compressive rebound modulus of the semi-rigid base layer can be as high as 1800 MPa, so the flexural tensile stress of the asphalt surface layer is relatively reduced, thereby improving the asphalt surface layer's ability to resist driving fatigue damage. It is believed that the bearing capacity of semi-rigid base asphalt pavement can be satisfied by the semi-rigid base, and the thickness of the asphalt surface layer has no effect on the carrying capacity of the semi-rigid pavement, which encourages people to reduce the thickness of the surface layer.

In addition, the semi-rigid base material has good board properties, which is conducive to mechanized construction and low engineering cost. It can meet the needs of heavy traffic development. The semi-rigid base asphalt pavement structure is precisely because of its excellent engineering performance and significant economic benefits in China's highway construction. It has been widely used and has become the main structural form of high-grade highway pavement.

China has been using lime soil as the pavement base in road construction since the 1950s, and lime-stable semi-rigid materials have been the main base type of China's grade highways for decades. From the mid-1970s, China began to use Cement stabilizing materials are used as the base layer.Semi-rigid materials represented by cement stabilizing materials and lime and fly ash stabilizing materials have accounted for more than 95% of the base course materials of highways of all grades.

4. Gradation Composition of Asphalt Stabilized Crushed Stone Base Mixture

A group of good aggregates requires a minimum void ratio and a small sum of specific surface area. The former aims to make the aggregate itself the closest, and the latter aims to make the admixture the most economical. Traditional asphalt mixture The gradation composition is a continuous gradation based on the theory of interference.The gaps between the particles should be filled by the next-level particles, and the remaining gaps should be filled by the first-level particles, but the interstitial particles must not be larger than The distance of the gap. The mixture composed according to this principle has a certain cohesive force, not only has a large compressive strength, but also has a considerable tensile strength, so that under the cohesive effect of asphalt, it can meet the requirements of various aspects of pavement performance Therefore, this gradation is still mainly used in China's asphalt pavement. However, the strength of the asphalt mixture composed of this gradation is mainly due to the bonding of mineral and asphalt, so the performance of the mixture is affected by the weather. The environmental impact is large. At high temperatures, the softening of the asphalt leads to a decrease in the adhesive force, which is prone to high-temperature rutting. In addition, due to the severe overload, the mixture formed by the asphalt adhesive force cannot withstand increasingThe heavier the axle weight. On the basis of maintaining the characteristics of continuous grading, how to increase the squeezing capacity of the grading, thereby improving its deformation ability, is an important issue to be considered in the design of the gradation of the base of the asphalt stabilized macadam.

Relevant research shows that the contribution rate of asphalt performance to road rut resistance is only 29%, the contribution rate to fatigue resistance is 52%, and the contribution rate to low temperature crack resistance is 87%. Therefore, while continuously improving the asphalt performance To give full play to the positive effect of aggregates on the performance of asphalt mixtures, to design a good grading of minerals. As early as 1940, Hveem made a qualitative analysis of the relationship between grading and performance, and gave areas where problems might occur. Hint, these areas are mainly divided into four parts:

(1) 0.075mm-0.6mm, if the content of this part is too high, it belongs to the hump gradation, and a bit more asphalt content will cause the instability of the mixture;

(2) 0.15mm-2.36mm, if the content of this part is too low, the porosity of the mixture is too large, and the tensile strength is lacking;

(3) The content of the coarsest aggregate is too much, and the vicinity of the largest sieve hole of the gradation curve is too steep, so the mixture is easy to segregate;

(4) The gradation curve is too smooth near the largest sieve hole, the coarse aggregate is relatively thin, and the surface is uniform and easy to trim.

5. Design Theory of Grading of Mineral Materials

The current gradation design theory is based on two basic assumptions:

(1) the basic particles are assumed to be regular spheres;

(2) It is assumed that the particle sizes of the particles at all levels are equal. The theoretical basis is the stacking theory, which considers that the state of the aggregate arrangement has a large effect on the porosity, and the size of the porosity has no relationship with the size of the particle size.

The current grading of mineral mixtures can be divided into two categories: continuous grading and intermittent grading. The study of continuous grading, from the perspective of maximum density, is represented by Fuller, and the closer the particle gradation curve is to the parabola, , The greater the density, the commonly used calculation methods are:

(1) Method N-Taibo A. N method is proposed based on the principle of maximum density.

$$P_x = 100 \times (d / D)^n$$

In the formula: d-the particle size of a certain aggregate that you want to calculate, mm;

D-the maximum particle size of the mineral mixture, mm;

n ---- decreasing coefficient;

p x-the throughput of a certain level of aggregate that you want to calculate,%.

Under normal circumstances, n = 0. 3-0. 6, when n = 0. 5, it is a Fuller curve, Japan considers n = 0. 35-0. 45, and the United States regards n = 0. 45 as the standard level. The basis for distribution.

(2) Method i--the method proposed earlier by Tongji University.

$$P=100(i)x$$

$$x=3.32lg(D/d)$$

In the formula: 1-the decreasing coefficient of passing percentage; the remaining parameters are the same as the above formula.

This method is basically the same as the n method, that is, i = 0.5, i = 0.7 ~ 0.8 is generally considered to be a reasonable range; 0.8 is too fine and not stable enough; i <0.7 is water permeable, so i = 0.75 is the best select.

(3) k-method-the method used by the former Soviet Union to control the decreasing coefficient of sieve residue.

y=3.32 lg(D / 0.004)

$$P_x = 100(\frac{k^x - 1}{k^y - 1})$$

x=3.32lg(D/d)

k--particle grading weight decrease factor;

d--the aggregate particle size of a grade that you want to calculate, mm;

x--number of bins.

Tongji University advocates that k = 0. 7 ~ 0.8 is more reasonable. It is better for k = 0. 7 in the south of China and k = 0.75 in the north. Rutting will occur when k> 0.8.

Bolomey method maximum theoretical density formula.

$$P_x = A + (100 - A) \times (\frac{d}{D})^{0.5}$$

In the formula:

A--the passing rate through the 35 # sieve,%

D--the maximum particle size of the aggregate, mm.

The study of the maximum compaction theory provides a theoretical basis for the gradation selection of continuous graded asphalt mixtures. Asphalt mixtures with the highest density can provide greater compactness by increasing the internal particle contact and reducing the aggregate pores. The maximum density of the asphalt mixture seems to be reasonable in the grading theory. However, because the gradation composition of the mineral material calculated by the maximum compaction theory is too dense, it usually contains excessive filler, so that the asphalt cement does not have sufficient volume change space. In order to meet the requirements of high temperature expansion of asphalt cement. In addition, in the most dense state of the mineral mixture, the coarser aggregate is usually suspended in the finer aggregate, which does not guarantee that the mineral mixture has a large internal friction resistance. It has been proven in practice that these gradation curves cannot usually be directly applied to engineering practice, because the mixture must leave a certain gap to ensure its durability and avoid the occurrence of oil flooding and rutting.

Intermittent gradation refers to a mineral mixture composed of small and large particles that do not exist continuously in a mineral composition, and there are no or only few mineral particles in a certain particle size range. Not only does the aggregate have enough coarse aggregate to form a space skeleton, but also the necessary amount of fine aggregate fills the gaps between the skeletons, so that the mixture has a high degree of compactness and forms a dense skeleton structure. Internal adhesion is high.

The discontinuous gradation is based on Weymouth's interference theory. Weiss theory believes that the gaps between particles should be filled by the next-level particles, and the remaining voids are filled by the second-level particles. It must not be larger than its gap distance, otherwise interference between particles of large and small size will inevitably occur.To avoid interference, particles of large and small size should be combined in a certain number of grades.

In practical applications, because the maximum particle size of the mineral mixture used for pavement does not exceed 40mm (or 35mm), generally only one or two gradations can be discontinued at most.Therefore, the usual intermittent gradation mixture is a continuous gradation The aggregate is a skeleton, which is formed by filling the gap with another continuous graded aggregate, which is also the theoretical basis of the volume design method. Although many countries have applied the intermittent graded theory to asphalt mixtures, they are only for specific The purpose of use is to design based on experience, but has not yet formed a mature design method.

6. Conclusion

Through the investigation and analysis of the test methods and design indicators of test pieces in different countries, it can be seen that the Marshall method is still one of the most commonly used methods in the world, and rotary compaction is also commonly used. Marshall design indicators and the performance of the road surface The correlation between them is not obvious, and the mixture that meets the Marshall index will still have problems such as shear failure on the road. By comparing the compaction effect and road surface of the four methods of Marshall compaction, kneading, rotary compaction and field compaction. The performance results: The test pieces formed by the rotary compaction method can make a good prediction of the performance of the pavement material.

References

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