

Study on Environment-Friendly and Flame Retardant Asphalt Concrete

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Abstract: According to the relevant reports at home and abroad in recent years, when asphalt concrete pavement is used in tunnels, fire caused by traffic accidents is a problem that must be paid attention to in the using process. If the road surface is on fire due to traffic accidents in tunnels, the fire will spread rapidly. There is not enough time for the evacuation of relevant personnel, resulting in high casualty rate, which seriously threatens the safety of the life and property of the country and the people to a certain extent. Therefore, it is of great necessity to study the environment-friendly and flame retardant asphalt concrete.

1. Introduction

At present, China has the largest number of road tunnels and the longest road mileage in the world. For highways, especially highway tunnels, the number of traffic accidents is much higher than that outside the tunnel. Therefore, when asphalt pavement surface is paved, it is essential to add appropriate flame retardant in its base asphalt to increase the flame retardant capacity, and then meet the relevant requirements of flame retardant pavement.

2. A Brief Analysis of the Development of Flame Retardant Asphalt

In the middle of last century, the western countries had carried out the research work on flame retardant asphalt. At that time, the flame retardant methods used were mixing mineral fibers or inorganic mineral materials with very high ignition point in asphalt and diluting the amount of combustible materials in asphalt materials, which could not achieve ideal flame retardant effect in practical application. In the 1970s, foreign researchers put forward the following suggestions: Based on polymer materials, flame retardant products were developed and applied to asphalt flame retardant construction. In the early 21st century, Chen Huiqiang and other researchers applied inorganic metal compounds and organic halogens to develop flame retardants and simply discussed their flame retardant mechanism. Ding Qingjun and others carried out tests on oxygen content index and thermogravimetric properties of flame retardant asphalt mixed with ATH and MH in 2007. Experiments show that this compound formula can enhance the flame retardancy of asphalt to a certain extent. Until 2011, relevant scholars at home and abroad have further increased their attention to the study of new composite flame retardants, and have achieved some research results in the modification and compound use of asphalt flame retardants. Among them, rubber modified asphalt has outstanding performance in many aspects, such as high temperature resistance, aging resistance, etc. Moreover, it also reduces the production cost. Its process can also play a role in protecting the environment and reducing the waste of resources.

3. Main Problems Existing in Asphalt Concrete Pavement

With the rapid development of transportation infrastructure construction in China, a large number of large-scale highway tunnel projects have been built one after another. The inner space of the tunnel is narrow and closed, the noise pollution is serious, the vehicles are concentrated, and the traffic flow is large. The vehicles at the entrance frequently decelerate or accelerate, which may cause traffic accidents very easily. Once a vehicle accident occurs, the spread of flammable liquids such as gasoline will lead to the spread of the fire, which will pose a great threat to people's lives

and other vehicles.

Based on the above background, the asphalt concrete pavement in highway construction is its main form. However, with the passage of time, it will cause certain damage to the highway, and it is prone to some problems, which will seriously affect the safe and smooth operation of the highway, so it should be targeted exploration and problem resolving through modifying asphalt mixtures and other ways. At present, there are many common problems of highway asphalt pavement. Firstly, common highway asphalt pavement cracks. The main reason for the existence of load cracks is the driving load of vehicles. The non-load cracks are mainly affected by temperature, mainly caused by low temperature shrinkage and cracks caused by the use of materials without quality assurance. Secondly, pits and other phenomena in asphalt pavement. These problems are mainly due to the surface materials used in asphalt pavement, the distribution of particle size at all levels of aggregate and the unreasonable proportion of various raw materials, resulting in insufficient bonding strength of mixtures. Thirdly, the deformation of asphalt pavement, which is mainly manifested in pavement rutting disease. Due to high proportion of oil and stone in the asphalt mixture used, poor stability of the interlayer in the highway base, rain erosion suffered by the asphalt pavement, its bearing capacity and vehicle load conditions, the asphalt pavement suffers from a great potential for deformation, resulting in the rutting disease of the highway. Because of the relatively weak strength of highway roadbed, uneven settlement, high water content and overload of road traffic, the structure of roadbed will be destroyed to a certain extent, leading to the problem of asphalt pavement subsidence.

4. Design and Analysis of Environment-Friendly Asphalt Pavement Material

For asphalt mixture, it is a relatively complex system, mainly including coarse, fine aggregate, asphalt and many other components, so the formation structure of asphalt mixture has a certain degree of complexity.

4.1 Basic Structure of Asphalt Mixture

Asphalt mixtures with good quality and excellent formation are mainly composed of aggregates and residual pore, and have relatively dispersed systems with obvious spatial network characteristics. Because granular dispersion is an important component material, the internal friction of aggregate particles and the cohesion of asphalt cementation are the main factors affecting the mechanical strength of asphalt mixture. Because the gradation of asphalt mixture is different, its spatial composition pattern also differs. In addition, there are also different characteristics in mechanical properties. Therefore, the change of each system of asphalt mixture will have a certain impact on the stress characteristics of the mixture as a whole, resulting in the deformation feature of the mixture with their own characteristics. The main structural forms of commonly used asphalt mixtures include dense suspension and dense skeleton.

4.2 Mix Ratio of Asphalt Mixture

In the process of designing the gradation of asphalt mixture, the following three problems should be clearly defined. Firstly, how to reasonably compose filling aggregate. Secondly, how to reasonably form the structure skeleton. Lastly, how to reasonably proportionate the aggregates.

5. Key Performance Indicators of Environment-Friendly and Flame Retardant Asphalt Concrete

First, the penetration of environment-friendly and flame retardant asphalt concrete. But according to the relevant standard conditions, the penetration value can only reflect the degree of viscosity of asphalt itself under special conditions, which will change when the test conditions change. The so-called rheological property of asphalt mainly refers to the liquidity and deformation performance of asphalt at different temperatures and shear rates, which has a direct relationship with the pavement performance of asphalt. At present, the penetration test is one of the key ways for

relevant testers to evaluate the consistency of viscous asphalt in the world. The main principle is to add a qualified needle of certain quality into the depth of the sample vertically within the prescribed temperature and time range. In general, the penetration value of asphalt with better consistency is relatively small. The harder the asphalt is, the lower its consistency is. In other words, the penetration value is proportional to the asphalt softness and hardness. When a penetration test is conducted, it should be noted that the test is a conditional test, so environmental conditions should be paid special attention to in the process. Test temperature, test time and needle quality are important conditions for penetration test. The corresponding test results will be obtained under each test condition. Therefore, the test conditions must be strictly controlled and the type of standard needle must be checked in detail. The damaged standard needle should never be used. After the test, it is necessary to wipe the standard needle repeatedly with appropriate concentration of trichloroethylene. On this basis, the temperature should also be strictly controlled to meet the relevant requirements of accuracy. One of the key operations affecting the penetration value of asphalt is its contact with the sample surface. Therefore, in the process of testing, the standard needle must be placed in the place where the light condition is better when it contacts the surface of the sample, so as to be able to observe its reflection on the surface of the sample. Meanwhile, it is of importance to adjust the lifting distance of the standard needle so that the standard needle can touch the reflection of the sample surface. In the process of pushing asphalt samples into experimental containers, bubbles should be avoided as far as possible. If bubbles occur, an open flame can be used to extinguish them, thereby preventing them from affecting the accuracy of the results.

Secondly, the softening point of environment-friendly and flame retardant asphalt concrete. In fact, asphalt materials belong to a class of amorphous macromolecule materials. They can be condensed from liquid to solid or melted to liquid. They do not have relatively stable solidification point or liquefaction point. In most cases, their hardening point is equal to solidification point while drop point is equal to liquefaction point. When the asphalt material is in the temperature range from hardening point to dropping point, the state of asphalt material is viscous but still can flow. Global ignition point method is the main method adopted in current standard test in China. A small steel ball of certain size and quality is placed above the softening point of the asphalt pattern in the metal ring of the relevant specified size. It is put into water or glycerol and heated at a relatively stable temperature rising speed until the steel ball sinks to the temperature at the specified distance. The temperature is in Celsius. The following points should be noticed in the course of the test. (1) The heating speed should be strictly controlled in the range of 4.5 to 5.5 degrees Celsius per minute. If the heating speed exceeds the prescribed value, the measured results will be significantly higher than the actual value. If the heating speed is lower than the prescribed value, the measured results will be fixed at the actual value. Therefore, if the temperature rises faster than the prescribed range in the heating process, it needs to be tested again. (2) The distance between the plates at the bottom of the laminate should be about 25 centimeters. (3) If the heating medium is pure water, distilled water that has just boiled and cooled to the test temperature should be used. On this basis, bubbles should be avoided in the heating process, since they will seriously affect the test results.

Thirdly, the extensibility of environment-friendly and flame retardant asphalt. The so-called ductility of asphalt mainly refers to that asphalt can bear the total amount of plastic deformation when it is under external tension. In most cases, the conditional ductility index is expressed by ductility. For asphalt ductility, in centimeter, it is the length of a specimen with a certain shape that is stretched at a certain temperature and at a certain speed until it breaks. During the test, the following points should be paid attention to (1) when the specimens are poured, a certain quality of isolating agent should be allocated to avoid the failure to remove the specimens. If the specimens are bonded to the glass, they need to be replaced again. It should be noted that too much isolating agent can not be applied at the bottom of the test mould to avoid the influence of the test results. It is because the isolating agent occupies a certain volume of the sample and causes the cross section of the sample, falling short of the standard after cooling. (2) When filling the mould, the sample needs to be higher than the test model, in order to prevent the sample from undermodelling after cooling and make its thickness not up to the standard. (3) In the process of scraping die treatment,

bitumen and test die should be scraped equally, especially in the middle of the test die. No low concave can appear. If the asphalt filament floats on the water surface or sinks into the bottom of the tank in the test, it is necessary to add appropriate amount of alcohol in the water and adjust the density of the water until it is close to the sample before the test.

6. Conclusion

With regard to asphalt concrete pavement, the improvement of its environmental protection and flame retardancy as well as certain technical maintenance can, on the one hand effectively reduce road fire caused by traffic accidents, and on the other hand, further prolong the service time of asphalt pavement, thereby providing better protection for the daily travel safety of vehicles. Our country's environment-friendly and flame retardant asphalt concrete production technology also has a certain space for progress, so we should continue to conduct in-depth research, in order to better improve the performance of environment-friendly and flame retardant asphalt pavement.

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