

Typical diseases and prevention measures of asphalt pavement in Xinjiang region

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Abstract

Asphalt pavement, with its good mechanical properties, durability, driving comfort, and aesthetic environmental protection, is suitable for various vehicles to pass through, and has solid, durable, flat, and good anti-skid, anti-seepage, fatigue resistance, and high-temperature cracking resistance. However, due to various reasons, early damage to asphalt pavement often occurs, which has been listed as one of the common problems in highway engineering quality, demonstrating its universality and severity. This article investigates typical diseases of asphalt pavement in Xinjiang region and proposes corresponding prevention and control measures, providing reference for the maintenance of asphalt pavement.

Keywords

asphalt pavement; Cracks; Disease; Prevention and control.

1. Introduction

As the gateway connecting China, Central Asia and European countries and regions, Xinjiang is crucial to the "the Belt and Road". By the end of the "14th Five Year Plan", the total mileage of roads in the region has reached 220000 kilometers. Trunk roads have formed a ring network, and a comprehensive grid of expressways connecting east to west and unblocked north to south has been built. While developing rapidly, various diseases have gradually appeared on asphalt pavement, which has seriously affected the performance of high-grade highways[1]. The main types of asphalt pavement diseases identified in the survey are: transverse reflection cracks, longitudinal reflection cracks, ruts, potholes, etc. Longitudinal cracks are mainly distributed in the fast lane, overtaking lane, and slow lane areas, accounting for 23.67% of the total number of diseases. Horizontal cracks are mainly distributed in the slow lane and fast lane, accounting for 44.08% of the total number of diseases. Some sections have cracks, accounting for 15.92%. Pit and groove diseases are mainly distributed in the slow lane and fast lane, and the expansion joints at the bridge head are more obvious. Small passenger lanes have sporadic distribution, accounting for 5% of the total number of diseases. Part of the road sections have formed obvious rutting zones, accounting for 10.2%. These damages not only lead to a decrease in the service level of the road, but also significantly reduce the bearing capacity of the road structure, as shown in Table 1.

Table 1: Number and proportion of diseases

Disease type	Transverse crack	Longitudinal cracks	Cracking	Rutting	Pit groove
Number of diseases (m ²)	108	58	39	25	15
percentage (%)	44.08	23.67	15.92	10.20	6.12

2. Analysis of typical disease types and causes

The Xinjiang region has a vast territory and is generally divided into North Xinjiang, South Xinjiang, and East Xinjiang. The climate differences in each region are obvious. Therefore, investigations were conducted on asphalt pavement diseases in North Xinjiang, South Xinjiang, and East Xinjiang[2-4]. Typical diseases are as follows:

2.1. Cracks

After the opening of the expressway, with the increase of service life, various vehicles repeatedly roll over, and combined with natural factors such as groundwater and rainwater, the asphalt aging, foundation settlement, and asphalt surface layer will gradually produce cracks. After investigation, the typical cracks on highways are transverse cracks, longitudinal cracks, and cracking[5].

2.1.1 Horizontal cracks

Generally, highways use cement stabilized gravel with good stability and bearing capacity as the base layer. However, water stabilized base layers are prone to dry and thermal shrinkage deformation, which can expand towards the surface layer and produce reflective cracks. In addition, as a semi-rigid material, the stress in the internal gaps of water stable materials is concentrated in the low-temperature shrinkage area of asphalt, leading to the generation of comprehensive effects and the emergence of transverse cracks.

2.1.2 Longitudinal cracks

The bearing capacity of the foundation decreases, and the overall strength of the roadbed decreases. Under the repeated action of heavy vehicle loads, it is easy to cause longitudinal cracking of the road surface; When water enters the water stable base layer due to slight cracks or other reasons along the road surface, longitudinal cracks are generated under the rolling of driving loads; Improper treatment of asphalt pavement construction joints leads to longitudinal cracks; Heavy vehicles often drive along the same lane, resulting in longitudinal cracks.

2.1.3 Cracking

After the occurrence of transverse and longitudinal cracks, due to the lack of timely maintenance and treatment, the transverse and longitudinal cracks eventually connect together, forming mesh cracks and leading to the occurrence of cracking.

2.2. Pit and groove

As a common pavement disease in asphalt pavement[6], potholes refer to the pits caused by the aging of asphalt, decreased adhesion, and local aggregate detachment under the action of

vehicle load and external environment. They have the characteristics of high incidence and spread. After the appearance of potholes, they have a serious impact on the smoothness and safety of asphalt pavement. If not maintained in a timely manner, under the repeated effects of rain, snow, and driving loads, the use of the road will ultimately be greatly reduced.

2.3. Ruts

Asphalt concrete is a flexible material, and its modulus and strength decrease significantly with the increase of temperature. Therefore, under the influence of high temperature environment in summer, the strength cannot meet the repeated rolling of vehicle loads, and ultimately shear deformation occurs under the action of loads, resulting in lateral flow, road subsidence, and the formation of ruts.

3. Disease prevention and treatment measures

3.1. Measures for crack treatment

3.1.1. Grouting

After cracks appear on the asphalt pavement, a large amount of rain and snow water enters the pavement structure layer through the cracks, and some even enter the roadbed. Under the action of road traffic loads, the pavement structure layer is washed away, ultimately leading to the loss of fine aggregates in the base layer, mud pumping phenomenon, and serious road potholes. One of the important methods for treating road surface cracks through grouting. The specific method is to use professional slotting tools to make rectangular small grooves of appropriate width and depth along the road surface cracks, and then use a seam filling machine to pour hot melt polymer into the rectangular small grooves, and fill them up. This sealing adhesive has strong elasticity within a certain temperature range, which can achieve deformation and expansion, thereby preventing rain and snow water from entering the pavement structure layer, suppressing the further development of cracks, and effectively extending the durability of the pavement[7].

3.1.2. Slurry sealing layer

Slurry sealing layer refers to a mixture of emulsified asphalt, well graded mineral materials, additives, and water mixed in a certain proportion under normal temperature conditions. After using steel brushes to clear the gaps and high-pressure blowing away road debris, professional machinery is used to spread it onto the original asphalt pavement, forming a uniform curing layer that is firmly bonded with the original pavement and has an anti-wear surface structure. Due to the characteristics of simple construction, rapid prototyping, and early development of transportation, this method is advantageous. Therefore, this method is particularly suitable for asphalt pavements with high traffic volume.

3.1.3. Mist sealing layer

Fog sealing layer is a direct, effective, and economical measure for preventing water seepage in asphalt pavement treatment. This method uses professional construction vehicles to sprinkle the fog sealing layer material onto the asphalt pavement, penetrating into small cracks and holes on the asphalt pavement, forming a tight waterproof layer, sealing the

pavement, playing a waterproof and anti-seepage function, avoiding water damage to the pavement, and thus extending the service life of the road. However, it is necessary to strictly control and master the spraying amount per unit area. Excessive spraying can form a thin film on the road surface, causing the road to lose friction resistance and opening up traffic later. Therefore, fog sealing layers are usually mainly used on low traffic flow, low-speed roads and parking lots.

3.2. Treatment measures for pits and grooves

3.2.1. Cold material cold repair process

This repair method is mainly used for acute repair, slotting and shaping, removing silt, pouring cold materials, ensuring sufficient material around the pit and spreading evenly, and then using vibration compaction. The pit with a depth of 6cm must be compacted layer by layer. To prevent sinking, the repaired surface is usually 5-10mm higher than the original road surface. At this time, after running for a period of time, the repaired surface will be level with the original road surface.

3.2.2. Hot material hot repair process

Compared with cold material repair, hot material repair technology is easier to meet quality requirements. Hot material repair technology uses radiation heating to heat the potholes on the road surface, melt the asphalt, regenerate it, supplement new materials, and compact it with a roller, thereby achieving better repair effects than cold material repair. However, this method has a longer cold repair cycle and a relatively higher cost. The equipment used in this technology is expensive and the original investment is relatively large. However, the repair materials used each time are relatively low and can achieve permanent repair. Therefore, this maintenance technology is suitable for highway maintenance units with independent maintenance functions and can fully leverage their advantages. Similarly, this method can also achieve a one-time repair result for cracks and ruts.

3.2.3. Hot material cold repair process

The hot material cold repair process is suitable for repairing the corresponding damaged road surface during the rainy season. If the asphalt road surface encounters the rainy season after being put into use, a large number of potholes will appear. If not repaired in time, these potholes will deteriorate and seriously affect the use of the road surface. The principle of the hot material cold repair process is to temporarily use cold repair materials to fill pits and grooves along the highway, compact them with a roller, and temporarily meet the requirements for traffic on the road surface. After the rain stops, the hot repair technology equipment - radiation heating - is used to apply the principle of hot repair technology to repair the pits and grooves on the asphalt road surface. This process combines the advantages of two repair techniques, making the repair of the road surface unrestricted by time and temperature.

3.3. Measures for handling ruts

3.3.1. Micro surface treatment

This method is formed by mixing appropriate graded stone chips or sand, modified emulsified

asphalt, water and external admixtures, and then evenly spreading them on the road surface to form a sealing layer. This method fully utilizes the value of old roads, protects the original road surface, and has the characteristics of minimal traffic interference and rapid construction.

3.3.2. Ultra thin wear layer

This method is a new technology for curing thin layer hot mix asphalt mixture using professional machinery. It is composed of coarse aggregates, and the filling frame is composed of materials formed by asphalt and fine aggregates in a certain proportion. These materials include cement, sand, lime, etc. Modified emulsified asphalt adhesive layer oil is sprayed between the ultra-thin wear layer and the old road surface. It can quickly improve road ruts and other diseases, enhance road performance, and quickly open up traffic.

4. Conclusion

This article analyzes the causes of typical road surface diseases in Xinjiang and proposes corresponding treatment measures. In addition, the occurrence and treatment of various diseases are not singular, and should be treated comprehensively. This can effectively delay the further development of early pavement diseases, maintain or improve the performance of the pavement, and extend the service life of the road, which has significant economic benefits.

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