Study on the performance of the investigation and repair material of asphalt pavement crack diseases

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Abstract. Rutting and cracks are the main diseases of asphalt pavement at home and abroad. Based on the investigation of a highway, the author studies the degree of cracks on the highway and the main causes. According to the characteristics of pavement diseases, the corresponding treatment measures are put forward. Through laboratory tests, it is determined that the fibre repairing materials have a good effect on improving the low temperature anti cracking performance of asphalt mixture, and can be preferentially considered as pavement repairing materials.

1. Background

The construction of Expressway reflects the level of transportation development and the overall level of economic development of a country or region. With the rapid development of Expressway construction, the problem of premature destruction of large areas of roads has also attracted attention from all walks of life. Many newly built or newly overhauled national and provincial roads have suffered serious early damage, which is far from the design service life. There are many reasons for these problems, such as traffic overload, heavy load, design reasons, construction reasons and so on. Based on the investigation of a highway, this paper studies the severity and causes of pavement crack disease, and puts forward corresponding treatment materials according to the characteristics of pavement disease.

2. Analysis of Pavement Performance in Section with Crack Disease

2.1. Pavement crevice degree along the mileage

Because the evaluation index and evaluation standard of the current standard are not sensitive enough to evaluate the pavement condition of expressway. According to the field investigation, the overall condition of this section of highway is very poor, and the indicators and evaluation in accordance with the existing norms and standards are still in a good or even excellent state. Therefore, according to the actual situation of the pavement and the characteristics of the disease, the evaluation of crevice degree
was selected. The calculation formula of crevice degree is as follows:

\[
\text{crevice degree} = \frac{\text{the length of the crack}}{\text{the road surface area of this section}} \times 1000 \left(\frac{m}{1000 m^2}\right)
\]

The crevice degree of double-lane varies with the mileage are shown in Figure 1~2.

![Figure 1. The crevice degree of up lines varies with the mileage](image1)

![Figure 2. The crevice degree of down lines varies with the mileage](image2)

Survey results show that, Some sections crevice degree more than 20, Transverse cracks are denser, Some sections are more than 30 cracks. So Relatively Speaking, the highway upward’s crack is more than the highway downward.

2.2. The overall condition of the core sample with dense cracks

Field coring was carried out in three crack-intensive sections of the investigated section.
Figure 3. Longitudinal crack core sample 1
Longitudinal cracks develop from top to bottom to mid-surface

Figure 4. Longitudinal crack core sample 2

Figure 5. Core sample at network crack 3

Figure 6. Core sample at network crack 4

The above layer and the upper layer of the intermediate layer are loose, the lower and the lower layer of the intermediate layer are complete.

Comprehensive analysis of coring in crack dense section

1) Transverse crack: From the coring results, the transverse cracks in the coring section are mainly reflection cracks. Most of the cracks are wider in the lower part and narrower in the upper part. At the same time, the core samples of the whole surface layer can be taken out at the filling joint, and the base is loose. After rainwater seepage in the later stage, under the action of driving load, rainwater erodes the bonding layer between the surface and the base layer, which causes the surface layer and the base layer to fall off. At the same time, hydrodynamic pressure causes the first loosening of the base material.

2) Longitudinal cracks: Coring found that the main longitudinal cracks are fatigue damage caused by insufficient shear resistance of surface mixtures. The edge of longitudinal cracks has obvious edge gnawing phenomenon, but mainly stay in the upper layer, part of the position develops to the upper layer, the lower layer and the base layer are relatively complete, and the bond between the surface and the base layer is also good.

3) Reticulated cracks: Coring found that some of the cracks are caused by fatigue cracks in the surface layer. The depth of crack development is mainly in the upper layer, partly the upper layer, partly in the intermediate layer, the lower layer and the base layer are in good condition; a small
number of cracks have developed to the base layer, and both the surface layer and the base layer appear serious looseness.

3. Study on properties of fibre repairing materials

Fiber material is a structured material formed by the textile processing technology of fibrous material. Fiber is a material form with a large aspect ratio, which is prone to bending deformation and has very good adaptability to soft shape. Its addition has the function of reinforcing and preventing cracks in the mixture. A large number of experiments show that the type, length, fineness and content of fibers have a significant impact on the fiber asphalt mixture. This part investigates the changes of Marshall index under different fiber dosage and the influence of fiber blending on the results of low temperature crack resistance. It provides a basis for selecting fibers and guiding the design and construction of fiber mixtures.

3.1. Effect of Fiber Dose

When the dosage of fibers is different, the dispersion degree, effective specific surface area and strengthening effect of fibers in the mixture are different. In order to analyze the effect of fiber dosage, Dolanit AS fibers were used for comparative experiments. Fiber dosage was 0%, 0.20%, 0.35% and 0.50% respectively.

The experimental results are shown in Table1.

| Fiber Dose | optimum bituminous dosage (%) | density (g/cm³) | Stability (KN) | flow values (0.1mm) | void volume (%) | VMA (%) |
|------------|-------------------------------|----------------|---------------|-------------------|----------------|---------|
| 0.000      | 4.71                          | 2.564          | 10.41         | 32.97             | 3.26           | 14.74   |
| 0.200      | 4.78                          | 2.555          | 10.74         | 34.41             | 3.62           | 15.23   |
| 0.350      | 4.88                          | 2.549          | 10.94         | 37.34             | 3.83           | 15.67   |
| 0.500      | 4.87                          | 2.540          | 10.46         | 38.67             | 4.01           | 15.77   |

From the above analysis, with the increase of asphalt content the density decreases, the void fraction and VMA increase with the addition of fibers. The Marshall stability should depend on the reinforcement of fibers and the dispersibility of fibers, and the flow value has an increasing trend.

(1) Fiber dosage and optimum asphalt dosage

With the increase of fiber dosage, improving the optimum asphalt content of asphalt mixture. This is because adding fibers, like adding fillers, requires more asphalt to be wrapped on the surface of the fibers. The finer the fibers, the more the fibers content, the larger the specific surface of the fibers, the more asphalt adsorbed. The optimum asphalt content increases accordingly. However, when the fibers continue to increase, because of the dispersion of the fibers, they will cluster among the fibers, so that total specific surface area of fibers will not increase or increase slightly, and then the optimal asphalt content will not increase. It can be seen from this that the addition of fibers will have an impact on the asphalt content, and when the addition of fibers is too much, the effect will be reduced, so the amount of fibers should be reasonably selected in use.

(2) Fiber dosage and density

The relative density and volume of fibers are relatively small. When the fibers are added to the
mixture, they occupy some space. Therefore, in compaction under the same, the asphalt mixture density decrease. The larger the dosage of fibers, the more the density will decrease. Therefore, in the construction of fiber asphalt mixture, if we want to further improve the compaction effect of fiber asphalt mixture, Therefore, the dosage of fibers should be reasonably selected in use..

(3) The fiber dosage and the stability and flow value
The experimental results show that the stability and damage resistance of the mixture increase with the increase of fiber dosage when excellent fibers are added and the dispersion of the fibers is uniform, but the stability decreases when the fiber dosage is large, because the dispersion of the fibers is limited. Therefore, the Marshall stability value increases with the increase of fiber dosage, but decreases when it reaches a certain value.

The flow value tends to increase with the increase of fiber dosage, which shows that with the increase of fiber dosage, asphalt in the mixture is more. At the same time, the addition of fiber can effectively enhance the anti-deformation ability of the mixture.

(4) Fiber dosage and void ratio and VMA
When the dosage of the fibers is small and the mixing is uniform, the addition of the fibers takes up a certain space. Under the elastic effect of the fibers, the compaction process is hindered by the same compacting function. Therefore, the void fraction of the fibers increases with the increase of the dosage of the fibers.

The void fraction of mineral aggregate increases with the increase of fiber dosage. Although VMA increases, VFA does not change much. This indicates that the effective thin thickness of asphalt increases with the addition of fiber, which is beneficial to the low temperature and durability of mixtures.

3.2. Study on Low Temperature Crack Resistance of Fiber Asphalt Mixture
The low temperature crack resistance is ability of asphalt concrete pavement to resist low temperature shrinkage cracks. As the temperature of asphalt pavement decreases, the stiffness increases and the deformability decreases, under the action of external loads, part of the stress can not relax, and the stress gradually accumulates. When the tensile strength of the material exceeds, cracks will occur, leading to pavement damage.

The ultimate deformation ability of asphalt mixture at low temperature reflects the viscous and plastic properties of materials at low temperature and the ability of materials to resist deformation. The higher the ultimate failure strain of asphalt mixture is, the better the crack resistance at low temperature is.

| types     | Fiber type   | Maximum breaking load (KN) | Maximum bending (mm) | Flexural tensile strength | Maximum bending strain (%) | Bending stiffness modulus (Mpa) |
|-----------|--------------|----------------------------|----------------------|--------------------------|---------------------------|---------------------------------|
| AC-16     | Dolanit AS   | 1.206                      | 0.205                | 9.845                    | 0.108                     | 9147                            |
|           | polyester fibre | 1.226                      | 0.209                | 10.008                   | 0.110                     | 9098                            |
|           | Lignin fiber | 1.266                      | 0.211                | 10.335                   | 0.111                     | 9311                            |
|           | No fiber     | 1.133                      | 0.201                | 9.249                    | 0.105                     | 8809                            |
From the above analysis, it can be seen that as long as fiber material is added, the flexural and tensile strength of concrete is higher than that of ordinary mixture, and the failure strain and stiffness modulus of concrete increase correspondingly. That is to say, the low temperature cracking resistance of asphalt mixture can be improved by adding fiber materials.

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