Study on Microcosmic Action Mechanism and Road Performance of Coal Gangue Powder Asphalt Mortar Depending on Computer

Rong Hu*, Yan Zhou

Chongqing Vocational College of Transportation, Chongqing, China, 404100

*E-mail: 986182987@qq.com

Abstract. As the largest amount of industrial waste, people have been unable to recognize the use value of coal gangue. In many industries, gangue has no main use. However, in the process of road construction, the use of coal gangue has been recognized by people. Because of its high hardness and good water stability, gangue can be used as a material for subgrade construction. In order to broaden the application prospect of coal gangue in road engineering, this paper analyzes the application performance of asphalt mortar with coal gangue powder as the main component in road engineering, and finally draws a conclusion.

Keywords: Computer, Gangue, Asphalt, Microcosmic, Performance

1. Introduction

China is a country with huge coal output. In the process of gradual progress of coal industry, we found that coal gangue was produced in the process of coal mining and coal washing. According to chemical analysis, the carbon content of coal gangue is very low. Its hardness is higher than ordinary coal. Generally, gangue is a kind of black gray rock. According to the statistics of industrial products in China, the existing gangue in China is about 4.5 billion tons[1].

The accumulation of coal gangue is still growing rapidly. It takes up a lot of land resources. It pollutes the atmosphere, soil and groundwater. People hate the production of coal gangue. However, it is gradually found that coal gangue can be used in the construction of Subgrade of road engineering. On this basis, domestic and foreign scholars have studied the coal gangue powder asphalt mixture. It is gradually found that the road performance of gangue powder, gangue lime and mineral powder made of different powder binder ratio (CWP, CWA and LS mentioned in this paper are abbreviated forms of gangue powder, gangue lime and mineral powder respectively). Researchers also gradually found a way to broaden the road value of coal gangue powder mixture.
2. Preparation of materials

In the selection of asphalt mortar, we suggest to choose alpha-A 70 ℃ petroleum asphalt. When choosing mineral powder, we can use limestone mineral powder. Coal gangue should be transformed into coal gangue powder by constant temperature heating and mechanical grinding at 60 ℃. According to chemical analysis, the ignition point of coal gangue powder is 750 ℃. The loss on ignition of gangue powder should be 30%\cite{2}. According to its physical characteristics, coal gangue powder appears black. After calcination, gangue lime appears brown (see Table 1).

| Index                  | Test result | Requirement |
|------------------------|-------------|-------------|
| Penetration            | 58.6        | 60-80       |
| Penetration index      | -1.21       | -1.5-1.0    |
| Ductility              | >100        | ≥ 100       |
| Softening point        | 48.5        | ≥ 46        |
| Mass change after RTFOT| -0.12       | -0.8-0.8    |
| Penetration ratio      | 68.4        | ≥ 61        |

3. Analysis of the conventional experimental results of asphalt mortar experiment

3.1. Preparation of experimental items

The laboratory should prepare five kinds of asphalt mortar with different powder binder ratio. In the preparation of asphalt mortar, with the increase of its powder to binder ratio, the mortar will become more viscous. In this case, we can use the method of increasing the temperature to ensure the uniformity of the glue. It should be noted that the preparation of articles for routine and unconventional experiments is the same\cite{3}.

3.2. Analysis of the results of the conventional performance experiment based on computer technology

According to the rules of asphalt mixture experiment, we need to carry out conventional performance test, dynamic shear rheological test, bending beam rheological test and micro experiment. According to the results of the conventional experiments, we can find that the softening point of the asphalt slurry with different fillers decreases with the decrease of the powder binder ratio. The softening point of CWA asphalt is the highest when the same powder binder ratio is used. In addition, we can also find that the flexibility of asphalt with different fillers increases with the decrease of powder binder ratio. Ls asphalt has the highest flexibility when the same powder binder ratio is used.

4. Analysis of experimental results of unconventional performance based on computer technology
According to the experimental results of dynamic shear rheology, we can find that the anti-rutting factor of asphalt mortar increases with the increase of powder binder ratio. Under the same temperature and powder binder ratio, CWA asphalt has the largest anti rut factor. Compared with LS asphalt, CWP asphalt and CWA asphalt have greatly improved their high temperature performance. According to the results of rheological experiments of curved beams, we can find that the creep stiffness modulus of different asphalt increases gradually with the increase of powder binder ratio, and the creep speed of different asphalt decreases with the increase of powder binder ratio. Under the same conditions, the creep stiffness modulus of LS asphalt is the smallest. According to the experimental results of Brinell viscosity, we can find that the viscosity of different asphalt increases with the increase of powder binder ratio. Under the same conditions, the viscosity of CWA asphalt is the largest. Based on the analysis of the above experimental results, we find that CWP asphalt is the most appropriate filler for asphalt mixture\(^4\).

5. Analysis of micro mechanism of asphalt mortar

According to the experimental analysis of the particle size, we found that the particle size of CWP asphalt mortar and CWA asphalt mortar is finer. They can absorb more bitumen. According to the chemical composition analysis, we found that CWA and CWP contain more active minerals than LS asphalt\(^5\).

According to the observation of high power SEM, we found that the surface of LS asphalt mortar is smooth, and the surface of CWP has a lot of void structure. Therefore, we conclude that CWP asphalt slurry can absorb more asphalt. Based on the above experimental analysis, we can conclude that the porous structure of CWP and CWA can absorb more light components. This situation can improve the high temperature property and temperature sensitivity of asphalt mortar\(^6\).

6. Conclusion

According to the analysis of the above experimental results, we found that the high temperature performance and temperature sensitivity of coal gangue powder and coal gangue lime have great room for improvement. Moreover, neither of them will react with asphalt. Their surfaces are very rough. This phenomenon can improve the adhesion of asphalt filler. However, unfortunately, the production process of gangue lime is not conducive to environmental protection. It costs a lot, too. Therefore, we think that coal gangue powder is more suitable to be used as filler of asphalt mixture.

References

[1] Rui X, Zi-Ming L, Xiao-Kai Y, et al. Research on Road Performance of Coal Gangue Powder and Brucite Fiber Modified Asphalt Mixture[J]. road machinery & construction mechanization, 2017.

[2] Xinjun F, Menglong Z, Wang C, et al. Research of Road Performances and Microcosmic Mechanisms of Coal Waste Powder Asphalt Mortar[J]. journal of building materials, 2019.

[3] Feng X, Zhao M, Chen W, et al. Research of Road Performances and Microcosmic Mechanisms of Coal Waste Powder Asphalt Mortar[J]. Jianzhu Cailiao Xuebao/Journal of Building Materials, 2019, 22(1):113-119.
[4] XIONG Rui, YANG Xiao-kai, YANG Fa. Laboratory Investigation of Performance of Coal Gangue Powder/Brucite Fiber Modified Asphalt Mortar[J]. Journal of Wuhan University of Technology, 2016.

[5] Wang C W, Wang F, Zhang W G. Research on Road Performance of Desulfurized Rubber Asphalt and Mixture[J]. Applied Mechanics and Materials, 2014, 525:546-551.

[6] Peng R S, Tian H, Liao L Q. Effect of Mineral Powder on Performance of Unaged and Aged Asphalt Mortar[J]. Advanced Materials Research, 2014, 1065-1069:1761-1765.