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Research on Properties of Graphite Oxide Nano-fine Particles Modified Asphalt

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Abstract:
Nano graphite oxide fine particles contain an amount of graphene oxide. Through surface treatment of graphite oxide by Hexadecyl trimethyl ammonium Bromide, the compatibility between Asphalt and graphite oxide is improved, Through experiments, Penetration and softening point of Graphite oxide nano-fine particles modified asphalt decreased ; thaw splitting performance of asphalt mixture changed for the better, but poor water stability and high temperature stability.
Keywords: graphene oxide, Modified asphalt

Graphene as a new material with unique structure and excellent performance, has become a hot topic of scholars. However, it has a complete six-membered ring structure so that there is a strong inter-molecular forces between graphene molecules, each sheet layers can easily be stacked together. And the surface of the graphene is highly inert, it is difficult to dissolve in a solvent.To mix graphene and organic or inorganic material evenly is a more difficult thing. Graphene oxide (graphite oxide) is the predecessor of grapheme, as compared with graphene oxide, the graphene (graphite oxide) not only containing a hydroxyl group, an epoxy group, a carbonyl group, a carboxyl group and other functional groups, but being inserted or peeled by small molecules or polymers.For these reasons, Oxidized graphene (graphite oxide) can improve the properties of composite materials effectively.

I. Experimental material

Graphene oxide production cycle in the laboratory is very long and the yield is low, so we have chosen the graphite oxide nanoparticles as experimental material.Graphite oxide nanoparticles contain an amount of graphene oxide, Graphite oxide and graphite. Graphite oxide nano-fine particles were analyzed by laser particle size analyzer, the main resultswere as follows :

Table 1-1 BT-9300 Laser Particle Size Analyzer Test Results:

Number Average Particle Diameter	0.31μm	Average Length Particle size	0.52μm	Average Area Particle size	1.98μm
Average Weight Particle size	9.95μm	Median Particle size	5.58μm	Specific Surface area	605.76m2/Kg
Span	4.4	Average Particle size	1.37μm	Concentration	13.38

70# asphalt was chosen to experiment. Asphalt mixture gradation is AC-20, the aggregate is composed by limestone.

II. Graphite oxide nano-fine particles surfactant treatment

The surfactant can handle graphite oxide nanoparticles surface, and improve the compatibility of graphite oxide nanoparticles and asphalt. This makes Graphite oxide nano-fine particles can be dissolved asphalt, achieve the purpose of asphalt modified. Graphite oxide nano-fine particles contains epoxy groups and hydroxyl, carbonyl and carboxyl, and other functional groups. These functional groups are mainly negative charge, the anionic surfactant is more easily combined with Graphite oxide nano-fine particles.

We selected cetyl trimethyl ammonium bromide as the active agent to deal with the surface of Graphite oxide nano-fine particles. Cetyl trimethyl ammonium bromide will be coated on the surface of Graphite oxide nano-fine particles. Its hydrophilic groups point to Graphite oxide nano-fine particles and hydrophobic groups point to the asphalt. As a result, graphite oxide nano-fine particles can be uniformly dispersed in the asphalt.

We chose the 5% of graphite oxide nano-fine particles and 0.6% CTAB to modified asphalt. Compared with the original asphalt, penetration and softening point of Graphite oxide nano-fine particles modified asphalt decreased. Ductility is longer than 100:

Table 2-1 Comparison of Three Major Indexes

	25℃Penetration(mm)	Softening Point(℃)	Ductility（cm）
Matrix Asphalt	56	45	＞100
Modified Asphalt	57	48	＞100

III. Road performance of graphite oxide nano-fine particles modified asphalt

4.1 Water stability of graphite oxide nano-fine particles modified asphalt mixture

We used modified asphalt Marshall specimen to experiment As a comparison group with asphalt. Each of Marshall specimens were divided into two groups. Put one group into the 60 ℃ constant temperature water tank immersion 45min, then get Marshall stability MS_1, put the other set of specimens into 60 ℃ thermostatic water tank to soak 48 hours and got Marshall stability MS_2. Then according to $MS_0= MS_2/ MS_1\times100\%$ calculates the residual stability MS_0

Table 4-1 Immersion Marshall Test Data:

	Stability（kN）	48h stability(kN)	Residual Stability(%)
Matrix Asphalt	17.64	15.22	86.3
Modified Asphalt	11.25	9.52	84.6

From the experimental results can be seen that the residual stability of modified asphalt is more than 80%, water resistance qualified, but compared to the asphalt significantly lower. This shows that graphite oxide nano-fine particles makes asphalt water resistance decreased.

4.2 Thaw splitting performance of graphite oxide nano-fine particles modified asphalt mixture

Put one group of Marshall specimens into the water tank immersion 15min under vacuum, then placed in -18 ℃ refrigerator frozen 16 hours, then put into 60 ℃ thermostatic water tank to soak 24 hours, finally put into 25 ℃ thermostatic water tank to soak not less than 2 hours. Immersion split test got splitting strength R2. put the other set of specimens into 25 ℃ thermostatic water tank to soak not less than 2 hours. and got splitting strength R_1. Calculated residual strength ratio by the formula $R_0=R_2/R_1$

Table4-2 Freeze-thaw Splitting Test Data:

		Splitting Strength	Intensity Ratio
Matrix Asphalt	25℃	0.84	0.58
	-18℃	0.49	
Modified Asphalt	25℃	0.85	0.65
	-18℃	0.55	

As can be seen from the experimental data that both asphalt splitting strength has declined after freezing. However, the intensity ratio of modified asphalt was greater than the strength of asphalt ratio. So the ability to resist freezing and thawing of asphalt has increased after splitting graphite oxide nano-fine particles modified.

4.3 high temperature stability of graphite oxide nano-fine particles modified asphalt

Currently, asphalt mixture high temperature stability are usually evaluated by high temperature track test. The size of rutting test specimen is 3000mm×3000mm×50mm. Test temperature is 60 ℃. Wheel pressure is 0.7MPa. Rolling speed is 42 times / min. The following data were obtained by experiment.

Table4-3Asphalt Mixture Rutting test

	45Min Displacement(mm)	45Min Displacement(mm)	Dynamic Stability(times/mm)
Matrix Asphalt	5.29	5.66	1674
Modified Asphalt	4.23	4.67	1435

We can see from the data that although the modification of modified asphalt is less than matrix asphalt, its deformation increment is larger than matrix asphalt. This shows that the Dynamic Stability of modified asphalt is not as good as matrix asphalt.

IV. Conclusion

After the experiment we found that Graphite oxide nano-fine particles has a negative effect on asphalt in general. But we can see from the data that the performance of modified asphalt is better than matrix asphalt In the freeze-thaw splitting test. We only tested for three road performance of Graphite oxide nano-fine particles modified asphalt due to limited capacity. Further research is needed for other road performance and modified principle.

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