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The Research on Improvement of Low Temperature Stability for Diatomite Modified Asphalt Mixture with PE Particles

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Abstract

In light of the lake of low temperature stability for diatomaceous which used as asphalt modifier.Stat the research with the diatomite produced at Jilin Changbai, using the way of low temperature bending test to evaluate the PE and diatomite composite modified asphalt mixture's low temperature crack resistance performance. The results showed that after the diatomite and PE composite modified asphalt mixture has the best advantage of anti-cracking performance under low-temperature environment，which is better than PE modified asphalt mixture and the matrix asphalt mixture. As a result,asphalt mixture being composite modified by diatomite and PE could significantly improve asphalt mixture's low temperature stable performance.

Key words: Modified Asphalt Mixture；composite modified；low temperature stability ；PE; Diatomite

I. Introduction

Diatomaceous is used as one of the common asphalt mixture modifier, due to its special physical structure which could significantly improve asphalt pavement's high temperature stability to resist rutting, but generally diatomite modified asphalt mixture' stable low temperature performance is poor . PE is one of common asphalt modifier, however,its application in composite modified diatomite modified asphalt mixture is less common. Diatomite production in our country is huge, therefore, in order to make full use of diatomaceous earth resources, which means we must seek the appropriate modifier to be used with diatomite in the compound modified asphalt mixture ,for ensuring play the role of diatomite modifier's characteristic and significantly improve stability under low temperature environment at the same time. Therefore, this article aims tor the develop a new kind of composite modifier, which could improve the diatomite modified asphalt mixture's ability to resist low temperature crack as well as promote the further applications of diatomite in asphalt pavement field.

As the result, this paper used diatomite which produced at Jilin changbai to work with PE for researching the composite modified asphalt mixture' low temperature stable performance, respectively using low temperature bending test on matrix asphalt mixture, the diatomite modified asphalt mixture, as well as PE and diatomite composite modified asphalt mixture to evaluate the these three material's ability to anti low temperature crack and make further decision whether the composite modifier has good effect.

II. Raw materials

2.1 Aggregate and asphalt matrix

This paper chooses dry and clean limestone as aggregate and heavy traffic 90 matrix asphalt as basic raw materials .Matrix asphalt' technology indicators are shown in table 2.1.

Tab2.1 The technical indexes of matrix asphalt

Penetration/0.1mm	ductility/cm		Softening point/℃
25℃	5℃	15℃	
91	49.2	35	60

2.2 Diatomite modified asphalt

Diatomite modified asphalt of the paper is produced by the method of wet mixing matrix, which used 90 heavy traffic asphalt and diatomite from jilin changbai region.Through the dosage experiment proved that the optimum content of diatomite modifier that produced in this region for asphalt modifier is 14%, therefor,so the dosage of the diatomite in this experiment to is 14%. Adding diatomite into matrix asphalt while asphalt heating and continuously stirring with a glass rod, until the diatomite evenly dispersed in the asphalt.Finally,the paper take technology index test on modified asphalt .Test results are shown in table 2.1.

Tab2.1 The technical indexes of diatomite modified asphalt

Penetration/0.1mm	ductility/cm		Softening point/℃
25℃	5℃	15℃	
77	29.0	40.0	68

2.3 PE and diatomite composite modified asphalt

According to the index test of PE modified asphalt , this paper selected PE dosage which used as composite modifier was asphalt content's 4%. With this content to compound modified 90 # heavy traffic asphalt and the technology indicators for the composite asphalt are shown in table 2.3. PE and diatomite are show from figure 2.1 and figure 2.2.

Tab2.3 The technical indexes of PE modified asphalt

Penetration/0.1mm	ductility/cm		Softening point/℃
25℃	5℃	15℃	
63	48.1	68.3	79

Fig2.1 the modifier of PE particles

Fig2.2 the modifier of diatomite

III. Experiment of low temperature cracking resistance

Aiming at evaluate the performance of the asphalt mixture low temperature stability, according to the highway engineering asphalt and asphalt mixture experiment rules "(JTG E20-2011), low temperature bending test is adopted to judge the asphalt mixture' ability to resist low temperature crack . The experiment request forming asphalt mixture rutting plates and then using cutting machine to cut the plates into little beams; Through measured the maximum tensile strength and the maximum tensile strain when the the beam is failure .Low temperature crack resistance experiment is not evaluate low temperature stability only by maximum bending tensile strength or the maximum tensile strain under the low temperature environment, but the biggest strength combined with maximum tensile strain as judgment of low temperature crack resistance for asphalt mixture.

Low temperature bending test steps: firstly, according to the mixture ratio of the matrix asphal

mixture, diatomite modified asphal mixture, PE and diatomite composite modified asphalt mixture, then respectively forming rutting plate; When the rutting plates reaching health stipulated time, according to the test specification,the rutting plates will be cut into little beams which could satisfy regulation size (there kinds of asphalt mixture cut into three groups of little beams, respectively label with 1, 2, 3); Finally putting the beams on the experiment machine, adjust the machine to the specified test temperature and after reaching a certain time. With three-point loading experiments,we record the maximum tensile strain 、maximum tensile stress as well as the largest strain energy of the beams when the beams got broke .loading and broke figure of beam are show on figure 3.1 and figure 3.2.Mixture ratio used AC-25 and its ratio shows in table3.2.

Fig3.1 the beam loading

Fig3.2 the beam broke

Tab 3.1The proportion of asphalt mixture

Sieve size（mm）	26.5	19	16.0	13.2	9.5	4.75	2.36	1.18	0.6	0.3	0.15	0.075
Synthetic grading	96.8	88.2	74.4	67.1	54.0	32.5	25.0	20.0	11.3	9.5	7.3	5.1
Asphalt ratio（%）	4.0											

IV. The result of the experiment and its analysis

According to the specification, low-temperature bending test of beam loading experiment under low temperature conditions, then measured beam's damage when the maximum tensile strain 、tensile strain damage when beam broke ； eventually ， calculate beam's strain energy density. As we all know ,the easier the material damage occurs, the greater the strain energy required for asphalt mixture under low temperature environment.

Through taking the low temperature bending test on the beams of matrix asphalt mixture, diatomite modified asphalt mixture, diatomite and PE composite modified asphalt mixture, the experimental results are shown in table 4.1

Tab4.2 The asphalt mixture test results of low temperature Bending Test

type of asphalt mixture	Specimen number	Tensile stress（Mpa）	average（Mpa）	Tensile strain（με）	average（με）	Strain energy（KJ/m^3）
matrix asphalt	1	9.1	8.4	889.0	887.8	3.147
	2	8.8		871.3		

	3	7.3		903.0		
diatomit	1	10.5	9.7	897.7	978.2	3.236
	2	9.9		992.1		
	3	8.8		1043.1		
PE and diatomite	1	12.3	12.0	1212.0	1248.6	4.534
	2	12.7		1329.4		
	3	11.1		1203.2		

Experimental results show that: (1) the matrix asphalt mixture, diatomite modified asphalt mixture, diatomite and PE composite modified asphalt mixture under test temperature of - 10 ℃, the strain energy respectively were 3.147 KJ/m3, 3.236 KJ/m3 and 4.534 KJ/m3.As the result shows,we use the strain energy density to evaluate low temperature's stability, that diatomite could improve low temperature stability of the asphalt mixture on a small degree. However,if we use diatomite and PE working together as asphalt modifier could significantly improve the low temperature crack resistance of asphalt mixture on the degree of 42.8%.

In light of three different kinds of asphalt mixture,considering low temperature bending test results, we could know that only use diatomite as asphalt modifier and ues diatomite working with PE as modifier has different effect .The tensile stress and tensile strain are respectively improved by 15.5%,10.2% ， 49.0%,40.6%.. Obviously, Jilin changbai produced diatomite modified asphalt mixture, compared with PE and diatomite composite modified asphalt mixture shows that composite modified asphalt mixture has best modifier effect and only using diatomite modifier modification shows little effects for low temperature crack resistance. The experimental results contrast is shown in figure 4.1.

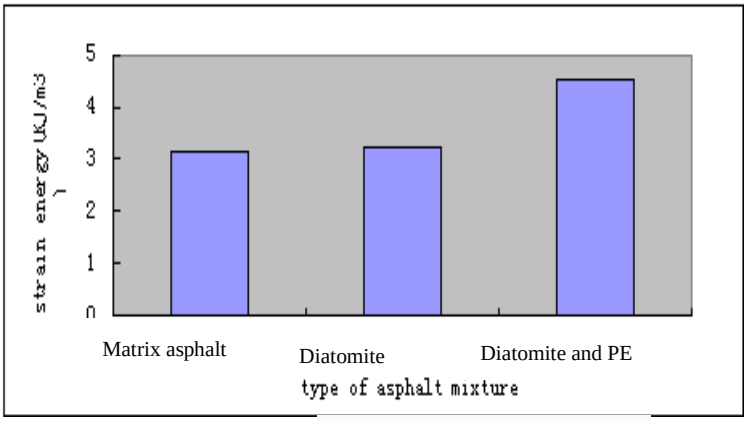

Fig 4.1 the comparison of low temperature bending test result

V. Conclusion

According to the highway engineering asphalt and asphalt mixture experiment rules "(JTG E20-2011), by adopting low temperature bend experiment to research PE and diatomite, produced in Jilin Changbai,composite modified asphalt mixture's ability of the low temperature crack resistance, according to the experimental results reached the following conclusions:

(1) The low temperature bending experiment results show that three different kinds of asphalt mixture, including matrix asphalt mixture, diatomite modified asphalt mixture, diatomite and PE composite modified asphalt mixture 's

low-temperature bending strain energy are respectively 3.147 KJ/m^3, 3.236 KJ/m^3 and 4.334 KJ/m^3 and low-temperature bending test strain energy could effectively evaluate asphalt mixture‘s stable performance under low temperature environment.

(2) Comparing those three different asphalt mixture’s low temperature bending test result, matrix asphalt mixture ,diatomite asphalt mixture， diatomite and PE composite modified asphalt mixture’s tensile stress are 8.4Mpa,9.7Mpa，12.0Mpa and tensile strain are 887.8με，978.2με，1248.6με which shows that diatomite could improve low temperature stability of the asphalt mixture on a small degree. However,if we use diatomite and PE working together as asphalt modifier could significantly improve the low temperature crack resistance of asphalt mixture on the degree of 42.8%.

(3) The PE could increase the flexibility of the asphalt mixture,in fact,PE is always used as asphalt flexibilizer in highway engineering. As the result shows composite modification asphalt mixture of diatomiteand PE could significantly improve low temperature performance and suggests to make further application research for PE and diatomite composite modification .

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