Study on indoor pavement performance of diatomite-modified asphalt mixture

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Abstract. In order to improve the pavement performance of asphalt material, diatomite was used as a modifier to prepare diatomite-modified asphalt with 70# asphalt ,and selected the AC-20 gradation and asphalt-aggregate ratio of 4.2% to mix and make the diatomite-modified asphalt mixture in this article, then compared different content diatomite-modified asphalt mixture through marshall, freeze-thaw splitting and rutting test. The results show that the strength, water stability and high temperature stability of asphalt mixture are greatly improved after modification, and its indoor pavement performance is relatively better when the content is 13%.

Keywords: diatomite, indoor pavement performance, content.

1 Introduction

The growing traffic, heavy load, large vehicles and other povement issues appear constantly, the highway level must be improved to solve these problems. Although the use of asphalt materials meets the requirements of heavy traffic, the damage of pavement structure is still frequent for its self-defects. So it need to modify asphalt to improve the povement performance of asphalt and its mixture.Diatomite is a modifier with excellent characteristics such as stable chemical property, thermal stability and strong adsorption ability, added to improve the performance of asphalt and asphalt mixture, and the modification cost is low, the modified method and construction process is simple[1-5]. In this paper, introduce the modification method firstly, then in view of the diatomite-modified asphalt mixture, carry out a comparison study of indoor pavement performance.

2 Experimental

2.1 Asphalt modification method

The experiment chooses the 70# asphalt and diatomite which have been mineral purifying as raw materials [6]. Modified method: weigh quantitative asphalt and heat to freely flow; then according to the content of diatomite, weigh accurate quality and dry it at high temperature; finally keep asphalt at

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appropriate temperature and add diatomite into asphalt, modification process will finish after stiring them well for nearly half an hour.

2.2 Preparation of mixture

Preparation method: take the corresponding quality of limestone aggregates according to AC-20 gradation(Tab.1)and weigh 50.4g mineral powder according to the proportion of 4.2%; Put them into the oven, heat to 155~175℃ and keep the temperature for four hours. Then take diatomite-modified asphalt as same quality as mineral powder and mix it with the limestone aggregates for 1.5 minutes in the asphalt mixture blender[7]; After that, add mineral powder into them and still stir for 1.5 minutes, the temperature of asphalt mixture blender must stay at 165~185℃ in the hole stirring process[8]. Diatomite-modified Asphalt mixture can be obtained.

Table 1. AC-20 gradation.

Gradation type	Quality percentage through the following screen mesh(%)											
AC -20	26.5	19	16	13.2	9.5	4.75	2.36	1.18	0.6	0.3	0.15	0.075
	100	97.5	86	74.5	58.5	42.5	29	18	13	10	8	6

2.3 Test sample

The test samples were divided into 9%, 11%, 13%, 15% by the content of diatomite, and the content 0% is the sample of 70# asphalt mixture for contrast. The marshall test sample must be strictly satisfied with the standard that the quality is 1200 ± 20 g and the height is 63.5 ± 1.5 mm, and its each sides need to be impacted 75 times for shape[9]; Freeze-thaw splitting test sample is the same with the marshall test , the difference is that it's shaped by impacting 50 times; The length, width and height of rutting test sample is 300mm, 300mm, 50mm; It must be paved and impacted in rutting mode[10].

3 Performance tests

3.1 Marshall test

Table 2. Marshall test results of different content diatomite-modified asphalt mixture.

Content(%)	VA(%)	VFA(%)	VMA(%)	MS (KN)
0%	3.4	72.8	12.6	8.870
9%	3.535	72.316	12.761	12.033
11%	3.964	69.533	13.012	12.360
13%	3.980	69.122	12.888	13.025
15%	3.965	68.876	12.738	12.208

Using marshall test to evaluate the strength of the diatomite-modified asphalt mixture, as shown in Tab.2, the marshall stability of different content diatomite-modified asphalt mixture increased 3.163~4.155KN compared with 70# asphalt mixture, the strength of the diatomite-modified asphalt mixture is improved than 70# asphalt mixture. The marshall stability is the largest one when the content is 13%, the strength is the best one in these five contents.The voidage of diatomite-modified asphalt mixture was increased compared with 70# asphalt mixture, its anti fatigue, anti aging performance will be weakened after modification [11-13].

3.2 Freeze-thaw splitting test

Table 3. Freeze-thaw splitting test results of different content diatomite-modified asphalt mixture.

Content(%)	P_{T1}(KN)	h_1(mm)	R_{T1}(MPa)	P_{T2}(KN)	h_2(mm)	R_{T2}(MPa)	TSR
0	34.71	63.38	3.4430	27.21	64.24	2.6630	77.35%
9	37.71	63.38	3.7407	33.16	64.24	3.2453	86.76%
11	38.21	63.82	3.7641	33.77	64.18	3.3081	87.88%
13	38.33	64.52	3.7350	34.25	63.84	3.3730	90.31%
15	37.89	64.22	3.7093	33.24	64.13	3.2587	87.85%

Freeze-thaw splitting test is used to assess the water stability of mixture, It is mainly through the comparison of the Splitting strength ratio before and after the water damage[14]. From Tab.3, it shows that the splitting strength ratio of different content diatomite-modified asphalt mixture improved 9.41%~12.96% than 70# asphalt mixture,their water stability performance are all better than 70# asphalt mixture. The splitting strength ratio is 90.31% when the content is 13%, its water stability performance is also the best one in these five contents. The splitting strength ratio reduced after the content of 13%, its water stability weakened, the content of diatomite is not the more, the better.

3.3 Rutting test

Table 4. Rut test results of different content diatomite-modified asphalt mixture.

Content(%)	Sample number	Dynamic stability /(time·mm^{-1})	Average dynamic stability /(time·mm^{-1})
	1	995	
0	2	1071	1027
	3	1014	
	1	2128	
9	2	2039	2075
	3	2059	
	1	2571	
11	2	2540	2496
	3	2377	
	1	2825	
13	2	2813	2865
	3	2958	
	1	2647	
15	2	2692	2633
	3	2561	

The ability of asphalt mixture resist the plastic deformation of asphalt at high temperature, which is commonly known as high temperature stability, rut test is a common method to detect high temperature stability of asphalt mixture [15]. As seen from the Tab.4, the rut dynamic stability of different content diatomite-modified asphalt mixture are 2~2.8 times of 70# asphalt mixture, their high temperature stability are greatly improved than 70# asphalt mixture. For diatomite-modified asphalt mixture, rut dynamic stability was 2865 time•mm-1 when the content of 13%, its high temperature stability is relatively better than others.

4 Conclusions

As can be seen from the indoor povement performance tests, compared with 70# asphalt mixture, the marshall stability of different content diatomite-modified asphalt mixture increased 3.163~4.155KN,

freeze-thaw splitting strength ratio improved 9.41%~12.96%, their rut dynamic stability are 2~2.8 times of 70# asphalt mixture, and the strength, water stability and high temperature stability of diatomite-modified asphalt mixture are all better than that of $70^{\#}$ asphalt mixture; When the content of diatomite is 13%, the marshall stability of diatomite-modified asphalt was 13.025KN, freeze-thaw splitting strength ratio was 90.31%,rut dynamic stability was 2865 time•mm-1,its indoor pavement performance is relatively better.

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