RESEARCH ARTICLE OPEN ACCESS

Research on the relationship between water stability and aggregate gradation of asphalt pavement

Zhao Bing, Zhao Bo, Li Teng-fei, Zhai Yong-chao

(School of Civil Engineering and Architecture, Chongqing Jiaotong University, Chongqing 400074，China)

Abstract
In the early destruction of asphalt pavement, water damage is the most major form.In this paper, experimental study was conducted on the composition of asphalt concrete,Marshall specimens were made in different types of aggregate gradation with the same kind of asphalt. Water immersion tests were conducted in order to analysis the relationship between the water stability and aggregate gradation of asphalt pavement.
Keywords: Asphalt Pavement, Water Damage, Aggregate gradation,Water immersion test

I. Introduction

With the rapid development of China's highway, the asphalt pavement has been widely adopted. Early damage of asphalt pavement mainly contains : loose, pits, subsidence and pock, while all these diseases produce basically have a direct or indirect relationship with the water damage pavement. Water damage is produced when the asphalt pavement is affected by freeze-thaw.With the car wheels rolling, the gap is made in the continuous generation of hydrodynamic pressure water or repeated cycles of vacuum suction effect.Gradually water seep into the asphalt and aggregate interface,resulting in reduced adhesion of asphalt,and asphalt film stripped from the stone surface,all these form a variety of pavement diseases.So the research on the relationship between the water stability and aggregate gradation of asphalt pavement becomes more and more important.

II. Experimental study

This test is mainly for asphalt mixture consists of three asphalt and three aggregate gradation ,and the total is nine kinds of asphalt mixture.With these materials, we made Marshall specimens and water immersion test in order to analysis the effect of water damage under the same kind of asphalt and different aggregate gradation.The aggregate gradation of this test is the SMA-10 with gap-graded, the OGFC-10 with open-graded, the NovaChip®TypeB-10 with semi-open-graded.The specific grading design is in Table 1.

Gradation type		The percentage by mass in the following sieve（%）								
		13.2	9.5	4.75	2.36	1.18	0.6	0.3	0.15	0.075
SMA-10	Objective grading	100	90	28	20	14	12	10	9	8
	Median grading	100	95	44	26	20	17	14	12.5	10.5
	difference	0.0	-5.0	-16.0	-6.0	-6.0	-5.0	-4.0	-3.5	-2.5
OGFC-10	Objective grading	100	90	55	11	9	7	5	4	3
	Median grading	100	95	60	16	12	9.5	7.5	5.5	4
	difference	0.0	-5.0	-5.0	-5.0	-3.0	-2.5	-2.5	-1.5	-1.0
hNovaChip ® TypeB-10	Objective grading	100	90	28	25	14	10	8	6	4
	Median grading	100	92.5	33	28.5	19	14	10.5	8	5.5
	difference	0.0	-2.5	-5.0	-3.5	-5.0	-4.0	-2.5	-2.0	-1.5

Table1:Three types of aggregate gradation used in this article

During the test,We strictly in accordance with graded and asphalt that have identified in this article.we made Marshall specimens and water immersion test under the best amount of asphalt.During the test of not less than 4 for a group of specimens and it is divided into two groups.The first set of specimens cured in 60 ℃ thermostatic water tank 30min ~ 40min minutes,measuring its stable value MS1 and current value.The second set of specimens cured in 60 ℃ thermostatic water tank 48 hours,then Measuring its stable valueMS2 and current value.The measured results are shown in Table 2.

Marshall immersion residual stability is determined by the following formula:

$$MS_0 = MS_2 / MS_1 \times 100$$

Among of the formula:

MS0 is tested for residual stability soaking pieces

MS1 is the stability of the specimen that has floodeed for 30min ~ 40min（KN）

MS2 is the stability of the specimen that has floodeed for 48h（KN）

Asphalt	Common asphalt			SBS modified asphalt			Rubber asphalt		
Grading	SMA-10	OGFC-10	Type B	SMA-10	OGFC-10	Type B	SMA-10	OGFC-10	Type B
OAC（%）	5.9	3.4	4.7	6.0	3.5	4.8	6.1	4.0	5.0
MS_1(KN)	9.62	7.02	10.49	9.35	7.02	10.59	8.89	6.97	11.04
MS_2(KN)	8.59	6.04	9.12	8.64	6.24	9.74	8.32	6.36	10.12
MS_0(%)	89.3	86.0	87.0	92.4	88.9	92.0	93.6	91.2	92.7

Table 2:Marshall immersion test measurement results

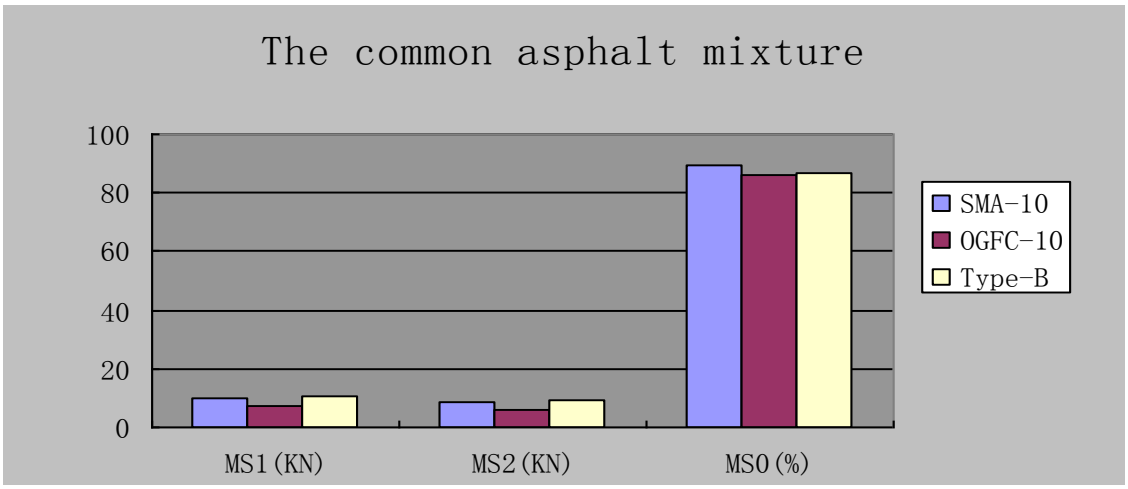

Chart 1:the ordinary asphalt mixture immersion Marshall parameters

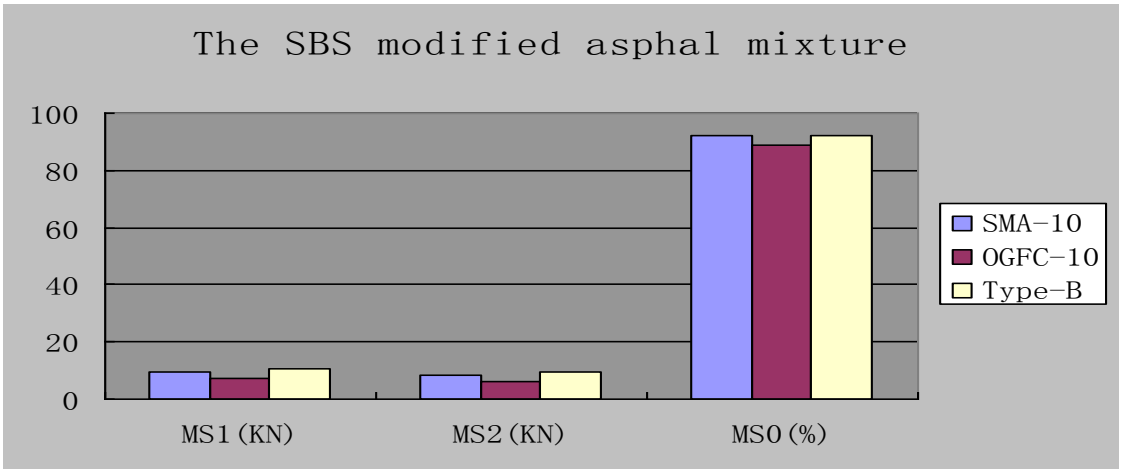

Chart 1-2:The SBS modified asphalt mixture immersion Marshall parameters

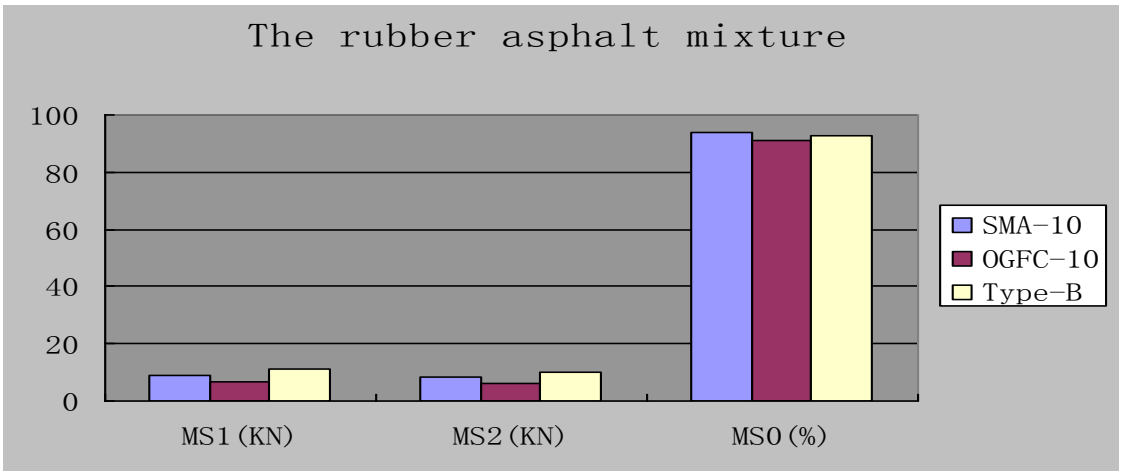

Chart 1-3:The rubber asphalt mixture immersion Marshall parameters

III. Conclusion

From Chart 1-1, Chart 1-2 and Chart 1-3 we can clearly come to the different degrees in different types of graded asphalt mixture water damage.The maximum nominal size of the same semi-dense gap-graded asphalt SMA-10, semi-open-graded asphalt Type B, open-graded OGFC-10 residual stability of these three different types of values grading gap-graded asphalt SMA-10>semi-open-graded asphalt NovaChip®TypeB-10>open-graded OGFC-10. The study shows that different type of aggregate gradation of asphalt mixture under the same conditions of the nominal maximum particle size and the asphalt, the denser of the residual stability is,the greater the residual stability of the immersion Marshall becomes.That is also to say:the denser the gradation type is,the better the water stability of asphalt mixture becomes. We know that the factors that affect water stability of asphalt pavement are multifaceted, for example,if the shapes of mineral aggregate are different, the gap will change a lot, thereby affecting the porosity of asphalt,the porosity of asphalt road is the main factor that affects the texture depth.As we all know, the texture depth refers to the average depth of open porosity in the uneven road surface in a certain area, and it is mainly used to assess the pavement surface macro-roughness, the drainage performance and slip resistance.When the water is into the pavement layer,in the role of vehicle load repeated cycles, it will produce a high water pressure,thus causing the asphalt membrane and aggregate premature peeling , on this way the road will damage.So it is a direct response to the water stability of the road surface.

IV. Epilogue

Through the above experiments we know that the effect of the stone-grade used in the asphalt pavement cannot be ignored. Therefore, in order to make the life of the new road in accordance with the design requirements, we should guarantee that the stone shape meet the design requirements and strictly control the stone grading, sampling in each batch of material and resolutely eliminate substandard materials approach, all these is to fully guarantee the bonding properties of asphalt mixture. At the same time, the temperature of the asphalt paving, the rolled several times should meet the design requirements. what's more, we must strengthen the drainage facilities of the asphalt pavement, crack down load transportation. Only in this way, can the highways have a rapid development and create more convenience for people.

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