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Evaluation on Low Temperature Performance of Recycled Asphalt Mixture Using Warm Mix Asphalt Technology

Xiaolan Duan, Chunge Li, Congliang Wu，Xiaoye Yang
(Department of Civil Engineering, Chong Qing Jiao tong University, China)

ABSTRACT
In this paper, the basic idea is about the recycled technology of asphalt mixture, more in-depth study of the low-temperature performance of warm mix asphalt(WMA).First of all, Including the evaluation of low temperature performance of WMA made of reclaimed asphalt pavement (RAP) (passed and not passed 2.36mm screen), and the influence of WMA with RAP mixed of different dosage of dispersant. Then, using the SBS modified asphalt and base asphalt were test at low temperature, research on the influence of different type of asphalt to the low temperature performance of WMA.
Keywords **-** aging, recycled asphalt mixture, warm mix, low temperature performance

I. INTRODUCTION

The recycled technology of asphalt mixture is a green environmental technology of high energy-saving and low emission, It has a good application prospect. The topic chosen beam bending tests to evaluate the low temperature performance of WMA. This research can provide theoretical basis for actual construction application, And it has a certain theoretical significance and reference value.

II. RAW MATERIALS

1 Temperature mixing agent and dispersant

Warm Mix agents used in this project is provided by "US Mead West vac" company, In the premise of ensuring the performance of asphalt mixture under approximately constant, then, we put Warm Mix agents added to the asphalt mixture, and the purpose is to reduce the mixing forming temperature of the mixture.

In order to improve performance of WMA, then we introduce a dispersant. The main effect of dispersant is to improving the mixing effect of the old material. But experience has shown that excessive doping will have adverse effects on WMA, and from the direction of Saving the economic cost consideration, It is necessary to determine the optimal dosage of dispersant through the test.

2 Aggregate

The test uses limestone, the origin is Qij iang of Chongqing. According to "Highway Engineering aggregate testing procedures" (JTG E42-2005) [3] conducted performance tests to detect conventional stone, Its nature indicators shown in Table 1.

Table 1The physical properties of the old and new aggregate

technical Specifications	crush value（%）	Losangeles abrasion value（%）	apparent density（10 g/cm^3）	bibulous rate（%）	asphalt adhesion level
old aggregate	19.3	21.1	2.52	1.76	5
new aggregate	19.2	24	2.711	0.8	4.2
technical requirements	≤28	≤30	≥2.5	≤3.0	≥4

As can be seen from the data in the table, the performance indexes of new aggregate can meet the test requirements of regulation. Old aggregate such as sand, stone has certain wear and tear, this makes the mixture in reduced functionality. But speaking from the performance, sand, stone and other coarse aggregate is not failure.

3 Asphalt

The new asphalt of this topic is SK-70 # asphalt and SK - ID SBS modified asphalt, conduct a performance evaluation for old and new asphalt separately [2], the test results shown in Table 2.

Table 2 The performance index of the old and new asphalt

Index	penetration（25℃）/0.1mm	ductility（5℃）/cm	Softening point/℃
Old asphalt	31.2	14	65
new matrix asphalt	62	130	48
The new SBS modified asphalt	47	>100	56
SK-70# asphalt's technical requirements	61-80	≥40	44-54

From the table we can see that Various performance indexes of SK-70# asphalt and SBS modified asphalt meet the specification requirements. but the performance indexes of old asphalt are not meet the specification requirements, It has lost its road performance. So we need to join the new asphalt in order to ensure the road performance of the mixture.

III. Mix design of AC-13 asphalt mixture

This topic uses AC-13 type asphalt mixture, the old material with 2.36 mesh sieve. The old material content is 40% determined by mix design. The mixing temperature is 140℃.Compaction molding temperature is 130 ℃.Best whetstone ratio of Sieving is 4.98%, and the Whetstone ratio of not sieving is 4.65%.

Table 3 is the gradation composition of over 2.36 sieve, table 4 is the gradation composition of not over 2.36 sieve.

Table 3 gradation composition of over 2.36 sieve

Sieve size	Upper limit	lower limit	median	Design gradation	Old Gradation
0.075	8	4	6	5	5.4
0.2	15	5	10	9	7.7
0.3	20	7	13.5	12.8	10.6
0.6	28	10	19	18.7	14.5
1.18	38	15	26.5	24.3	19.6
2.36	50	24	37	37.2	27.2
4.75	68	38	53	52.3	46.5
9.5	85	68	75	75.8	77.8
13.2	100	90	95	94.2	98
16	100	100	100	100	100

Table 4 the gradation composition of not over 2.36 sieve

Sieve size	Upper limit	lower limit	median	Design gradation	Old Gradation
0.075	8	4	6	5	10.74
0.2	15	5	10	9	11.68
0.3	20	7	13.5	12.8	13.61
0.6	28	10	19	18.7	17.34
1.18	38	15	26.5	24.3	20.22
2.36	50	24	37	37.2	28.68
4.75	68	38	53	52.3	44.14
9.5	85	68	75	75.8	75.44
13.2	100	90	95	94.2	96.1
16	100	100	100	100	100

IV. low temperature performance of recycled asphalt mixture using warm mix asphalt technology

There are three aspects influencing asphalt mixture performance:

①types of asphalt.
②The old material whether over 2.36 sieve.
③dispersant content

1 Trabecular bending test of matrix asphalt

Forming eight pieces of rutting specimens, divide them into two groups, The composition of the two groups is:①Four of them are over 2.36 sieve+matrix asphalt+Warm mix agent+dispersant, whetstone ratio is 4.98%,set the four group number are 0, 1, 2, 3.②The other four pieces are not over 2.36 sieve+matrix asphalt+Warm mix agent+dispersant, whetstone ratio is 4.65%,Set the four group number were 5, 6, 7, 8.Content of the dispersant is 0,1%, 2%, 3% respectively.

After rutting specimens are molded, left to cool a certain time, Cut trabecular specimens with a cutter .Finally we get the matrix asphalt beam bending test results as shown in table 5.

Table 5 trabecular bending test of matrix asphalt data

old material sieving condition	No.	breaking strength/MPa	breaking strain/με	modulus of damage stiffness/MPa	The dosage of dispersant/%
sieving	0	11.66	1579.91	7431.300	0
	1	11.25	1570.46	7164.19	1
	2	11.94	1727.60	6915.98	2
	3	12.30	1648.71	7453.12	3
not Sieving	5	8.71	1555.18	5636.69	0
	6	11.34	1559.37	7322.69	1
	7	11.06	1651.41	7619.39	2
	8	10.39	1683.78	6222.95	3

This paper mainly put the destroy the bending tensile strain as the main index.

①The old material whether over 2.36 sieve to influence mixture low temperature performance.

In ensuring the dispersant content is certain as can be seen from table 5, the low temperature performance of old material over 2.36 sieve is better than the old material not over 2.36 sieve.

②The influence of dispersant content on the mixture performance at low temperature.

As can be seen from table 5,the right amount of dispersant helps to improve the low temperature performance of asphalt mixture, but pay attention to the content of the dispersant is not too high.

2 Trabecular bending test of SBS modified asphalt

Forming tow pieces of rutting specimens, the composition of the specimens is:①over 2.36 sieve+SBS modified asphalt+warm mix agent, whetstone ratio is 4.98%.②not over 2.36 sieve+SBS modified asphalt+warm mix agent, whetstone ratio is 4.65%.Forming method is same with matrix asphalt. Old material content is still 40%,but not to mix with dispersant.

After rutting specimens are molded, Cut trabecular specimens with a cutter .Finally we get the SBS modified asphalt beam bending test results as shown in table 6.

Table 6 trabecular bending test of SBS modified asphalt data

old material sieving condition	breaking strength/MPa	breaking strain/με	modulus of damage stiffness/MPa
sieving	11.13	2269.97	4900.93
not Sieving	12.19	2171.14	5490.683

①The old material whether over 2.36 sieve.

It can be seen from above table, when the asphalt is SBS modified asphalt, the low temperature performance of old material over 2.36 sieve is better than the old material not over 2.36 sieve. This is consistent with the situation of when it is matrix asphalt.

②The influence of types of asphalt.

We can see from table 5 and table 6, the low temperature performance of SBS modified asphalt is better than that of the matrix asphalt.

V. Conclusion

Through Trabecular bending test can draw the following conclusions:

①Warm mix recycled technology can ensure the pavement performance of asphalt mixture, and there is a certain degree of improvement. The test to determine the mixing temperature is about 140℃, compaction molding temperature of 130 ℃.

②types of asphalt, dispersant content and The old material whether over 2.36 sieve all influence the performance of asphalt mixture.

③It is better to ensure the uniformity of the old material, when the old material over 2.36 sieve. The low temperature performance of old material over 2.36 sieve is better than the old material not over 2.36 sieve. So in the later test, we will be the best use of the old material after sieving.

④The right amount of dispersant helps to improve the low temperature performance of asphalt mixture, but the content of the dispersant is not too high.

⑤The low temperature performance of SBS modified asphalt is better than that of the matrix asphalt.

This paper mainly studied the low-temperature performance of WMA by laboratory test, but failed to make corresponding research on mechanism

caused the performance change .In the future, we can pin the above issues in-depth study.

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