Effect of Warm Mix Agent on Performance of Asphalt Binder

Xiaoge Tian, Yantian Chu, Yichao Xu, Zhen Yang, Shaohua Zhen and Ren Zhang

ABSTRACT

To study the effect of warm mix agent on the performance of asphalt binder, different amount of warm mix agent EC-120 (0%, 1%, 2%, 3%, 4%, 5%) was added into two kinds of asphalt binders, A-70 and SBS I-D, to prepare 12 groups of warm mixed asphalt (WMA) samples. Then dynamic shear rheology (DSR) tests at high temperature and bending beam rheological (BBR) tests at low temperature were conducted on them respectively. The test results indicated that with the increase of EC-120 content, the rutting resistance of WMAs was increased and their low temperature performance were decreased. Considering the effects of EC-120 on the performance of WMAs, the content of EC-120 should not be higher than 4%. [1]

KEY WORD

Warm Mix Asphalt; Warm Mix Agent; High Temperature Performance; Low Temperature Performance.

INTRODUCTION

Hot Mixed Asphalt (HMA) has been widely used in asphalt pavement construction worldwide[1]. However, HMA also has many deficiencies: it will consume a lot of valuable energy during the mixing process to heat asphalt binder and aggregates to 1500C-1800C, and a large amount of toxic and harmful gases and
dust will be emitted, which not only threatens the safety and health of construction personnel, but also pollutes surrounding environment[1, 2].

Warm Mix Asphalt (WMA) is a solution to these problems[1, 2]. Compared to hot mix asphalt, WMA has its biggest advantage in energy saving and environmental protection. Researches on WMA showed that WMA can significantly reduce the generation of greenhouse gases, save fossil energy, reduce costs, protect the safety and health of construction personnel and surrounding environment. In the foreseeable future, WMA will be more widely used in asphalt pavement construction[1-4].

This paper studied the effect of warm mix agent EC-120 on the performance of asphalt binder at different high and low temperature.

1. Raw materials

1) Asphalt binder: Two kinds of asphalt binders were studied, matrix asphalt, A-70, and SBS modified asphalt, SBS I-D. Their technical indexes were shown in table 1[5].

<table>
<thead>
<tr>
<th>Technical Index</th>
<th>unit</th>
<th>A-70</th>
<th>SBS I-D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penetration @25°C, 5s, 100g</td>
<td>0.1mm</td>
<td>67</td>
<td>53.9</td>
</tr>
<tr>
<td>Soft point</td>
<td>°C</td>
<td>47.5</td>
<td>83.4</td>
</tr>
<tr>
<td>Ductility @15°C</td>
<td>cm</td>
<td>&gt;100</td>
<td>35.0</td>
</tr>
<tr>
<td>Relative density @25°C</td>
<td></td>
<td>1.043</td>
<td>1.027</td>
</tr>
<tr>
<td>Change of Mass</td>
<td>%</td>
<td>0.1</td>
<td>-0.422</td>
</tr>
<tr>
<td>Residual penetration ratio (25°C,5s,100g)</td>
<td>%</td>
<td>65.2</td>
<td>70.1</td>
</tr>
<tr>
<td>Residual ductility (5°C,5cm/min)</td>
<td>cm</td>
<td>6.8</td>
<td>28.4</td>
</tr>
</tbody>
</table>

2) Warm mix agent, EC-120: EC-120 is an organic viscosity-reducing asphalt modifier. Its technical index was shown in table 2[5].

<table>
<thead>
<tr>
<th>Items</th>
<th>Viscosity@15°C (cp)</th>
<th>Penetration@2°C (0.1 mm)</th>
<th>Density @25°C (g/cm³)</th>
<th>Freezing point (°C)</th>
<th>Flashing point (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical value</td>
<td>12</td>
<td>&lt;1</td>
<td>0.94</td>
<td>100</td>
<td>290</td>
</tr>
</tbody>
</table>

INFLUENCE OF EC-120 ON HIGH TEMPERATURE PERFORMANCE OF ASPHALT BINDER

Dynamic Shear Rheology (DSR) Test was used to evaluate rutting resistance of WMAs[6]. The index of rutting factor, $G^*/\sin\delta$, was introduced to evaluate the high-temperature performance of asphalt binder. And DSR tests were conducted on
WMAs samples at four different high temperature, i.e., 520 C, 580 C, 640 C and 700 C. The rutting factors of different WMAs calculated from measured complex modulus $G^*$ and phase angle $\delta$ were shown in figure 1.

![Graph showing rutting factors of different WMAs](image1)

(a) Warm mixed A-70 matrix asphalt  
(b) Warm mixed SBS modified asphalt

Figure 1. Diagram of $G^*/\sin \delta$ of WMA with EC-120 dosage.

It can be seen from Figure 1 that the rutting factors, $G^*/\sin \delta$, of each WMA under different temperature increase with increasing of EC-120 dosages, So, EC-120 can effectively improve the anti-rutting performance of asphalt binder at high temperature. This is consistent with others' [7, 8].

EFFECTS OF EC-120 ON THE LOW TEMPERATURE PERFORMANCE OF ASPHALT BINDER

WMAs Samples were subjected to BBR tests[6] at -120C, -180C, -240C respectively. The stiffness modulus $S$, and creep rate $m$, for different WMAs under different temperatures were obtained, as shown in figure 2.

![Graph showing stiffness modulus and creep rate](image2)

(a) Stiffness Module, $S$  
(b) Creep rate, $m$

Figure 2. Relationship of $S$ and $m$ to the contents of EC-120.
From Figure 2, it can be found that while the dosage of EC-120 increases, the stiffness modulus, S, of WMA gradually increase and the creep rate, m, gradually decrease. So, the low temperature performance of WMA is inferior to its original asphalt binder[9].

CONCLUSIONS

In this paper, DSR tests and BBR test were conducted on warm mixed A-70 and SBS I-D with different content of warm mix agent EC-120 to evaluate the effect of EC-120 on the performance of asphalt binder. The following conclusions were obtained.

(1) With the increase of EC-120 dosage, the rutting factor $G*/\sin\delta$ increased for both warm mixed A-70 and SBS I-D. So, the rutting resistance of asphalt binder were enhanced.

(2) With the increase of EC-120 dosage, stiffness modulus of WMA increases continuously, whereas its creep rate decreases. So, low temperature performance of WMAs will be decreased.

REFERENCES