Experimental Research on High Viscosity Emulsion Asphalt Sand Seal

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ABSTRACT

The mix design of high viscosity emulsion asphalt sand seal is carried out according to the test of 6 kinds of emulsified asphalt specimen with different solid content and Enge La viscosity ($E_v$). The road performance obtained according to the stone off rate test, skidding resistance performance test and shear performance test. The change law of road performance with different solid content and $E_v$ is obtained. The BPN of the specimen increases as the spray amount increases when $E_v = 7$, and first increases then decreases as the spray amount increases when $E_v = 10$, $E_v = 14$ or $E_v = 18$. The shear strength value between layers of emulsion asphalt sand seal increases as the solid content increases and reaches the maximum 2.14MPa when solid content is 70%.

INTRODUCTION

Seal is a new technology of pavement preventive maintenance, and the seal material is consisted by asphalt, other sealing agents or asphalt mixtures. The synchronous sand seal technology has some advantages including simple construction, high work efficiency and high performance-price ratio. The most outstanding advantages of high viscosity asphalt sand seal technology is synchronous spreading emulsified asphalt and sand, so the bound strength among interface reaches certain value before temperature drops. Safraz Ahmed et al. [1] put forward Thin-bonded studied the skidding resistance performance index for 5 kinds of asphalt mixtures specimen with overlays (TBOs). Arash Rezaei and Eyad Masad et al. [2] put forward a model of skidding resistance performance for asphalt pavement based on laboratory experiments. Zhao Zhangli [3] different maximum...
particle sizes and analyzed influencing factors by laboratory tests. The mix design of high viscosity emulsion asphalt sand seal is carried out according to the test of 6 kinds of emulsified asphalt specimen with different solid content and $E_v$. The road performance obtained according to the stone off rate test, skidding resistance performance test and shear performance test. The change law of road performance with different solid content and $E_v$ is obtained.

**MIX DESIGN OF HIGH VISCOSITY EMULSION ASPHALT SAND SEAL**

First, 6 specimens of emulsified asphalt are made up with different viscosities and solid content. Second, Meclod method [4-5] is used to calculate the theory spraying amount of emulsified asphalt and mechanism of sand, and then the single particle size grading mechanism of sand is determined according to the experiment [6]. On this basis, the theory spray amount is adjusted through the stone off rate test, anti-sliding performance test and sand sealing test.

Finally, the mix design of high viscosity emulsion asphalt sand seal is given through the test results and experience. The results of theory spray amount for different $E_v$ and different solid content are shown in table I.

| solid content % | 55   | 65   | 65   | 70   | 70   | 70   |
|-----------------|------|------|------|------|------|------|
| $E_v$           | 3    | 4    | 7    | 10   | 14   | 18   |
| spray amount(kg/m²) | 0.778| 0.597| 0.585| 0.568| 0.566| 0.549|

The spray amount of emulsion asphalt sand seal which has been obtained must multiply by 1.5 for the optimizing of design. Therefore, when the temperature is 25°C, the emulsified asphalt specimen is suitable for the mix design of high viscosity emulsion asphalt sand seal, whose solid content is 70%, $E_v=10$, spray amount of emulsified asphalt is 1.1kg/m², theory spray amount of the mechanism of sand is 6.7kg/m², single particle size grading mechanism of sand is 2.36mm~4.75mm.

**EXPERIMENTAL STUDY**

**Adhesive Properties**

In this paper, the adhesive properties of high emulsion asphalt sand seal was obtained through the stone off rate test[7-8] using single particle size grading mechanism of sand (2.36mm~4.75mm), the change law of optimal spray amount is analyzed with different $E_v$ and solid content as shown in the table II.
Table II. Summary table of the optimal spray amount of emulsion asphalt.

| Solid Content (%) | $E_V=3$ | $E_V=4$ | $E_V=7$ | $E_V=10$ | $E_V=14$ | $E_V=18$ |
|-------------------|---------|---------|---------|---------|---------|---------|
| 55%               | 7       | 8.8     | 5.6     | 10      | 9       | 27      |
| 65%               | 1.4     | 1.2     | 1.6     | 1.2     | 1.6     | 1.4     |
| 70%               | 1.089   | 0.836   | 0.936   | 0.682   | 0.906   | 0.769   |

The results show that: (1) When $E_V$ and solid content are different, the stone off rate for emulsified asphalt decreases as the spray amount increases. When the stone off rate is considered only, emulsified asphalt has the optimal spray amount. (2) The stone off rate is lower when $E_V=3$ and $E_V=4$, but the emulsified asphalt spreading amount of $E_V=3$ is higher than $E_V=4$. (3) The spray amount is 0.936kg/m$^2$ when the minimum stone off rate 5.6% and $E_V=7$. The spray amount is the lowest and the effect of preventing aggregate shedding is best compared with $E_V=10$, $E_V=14$, $E_V=18$. (4) The spray amount is 0.682kg/m$^2$ as the minimum stone off rate is 10% when $E_V=10$ and the economical efficiency is not better.

**Skidding Resistance Performance**

In the skidding resistance performance test [9-11] for high viscosity emulsion asphalt sand seal, 4 specimens of emulsified asphalt whose $E_V=7$, $E_V=10$, $E_V=14$, $E_V=18$ and single particle size grading mechanism of sand is 2.36mm~4.75mm. The BPN is obtained when the theory spray amount is constant as shown in the table III.

| Solid Content (%) | $E_V=7$ | $E_V=10$ | $E_V=14$ | $E_V=18$ |
|-------------------|---------|---------|---------|---------|
| BPN (1.2 times)   | 76      | 99.8    | 99      | 95      |
| BPN (1.4 times)   | 87.6    | 89.8    | 98.2    | 99      |

The results show that: The BPN of the specimens first increases then decreases as $E_V$ increases at 1.2 times of the spray amount, and reaches the maximum value when $E_V=10$. The BPN of the specimens increases as $E_V$ increases at 1.4 times of the spray amount.

**Shear Performance**

To simulate the actual traffic load, the shear test temperature is 25℃, normal stress is 0.7MPa and loading rate is 10mm/min. The shear strength value of 6 specimens between layers of sand seal is obtained as shown in the table V.
The results show that: (1) The shear strength value between layers of emulsion asphalt sand seal increases as the solid content increases. (2) The value reached the maximum 2.14MPa when solid content 70% and reached 1.77MPa and 1.87MPa when solid content is 70% and 65% respectively. (3) The shear performance of emulsified asphalt sand seal with high viscosity and solid content is better than those with low viscosity and solid content. Therefore, the former is more suitable as the asphalt sand seal.

Table V. Summary table of combined specimen interlayer shear strength with $ev$.

| solid content (%) | 55 | 65 | 65 | 70 | 70 | 70 |
|-------------------|----|----|----|----|----|----|
| $Ev$              | 3  | 4  | 7  | 10 | 14 | 18 |
| $\tau_{\text{max1}}$ (MPa) | 1.77 | 1.85 | 1.88 | 2.15 | 2.18 | 2.08 |
| times of TDQ      | 1.2 | 1.2 | 1.4 | 1.0 | 1.4 | 1.0 |
| $\tau_{\text{max2}}$ (MPa) | 1.77 | 1.87 | 1.87 | 2.14 | 2.14 | 2.14 |

CONCLUSIONS

(1) At 25℃, the emulsified asphalt specimen is suitable for the mix design of high viscosity emulsion asphalt sand seal, whose solid content is 70%, viscosity content is 10 and the spray amount is 1.1kg/m², and the theory spray amount of the mechanism of sand is 6.7kg/m² and the single particle size grading mechanism of sand is 2.36mm~4.75mm.

(2) In the stone off rate test, at 1.2 times of the theory spray amount, the specimen with $Ev=10$ and solid content 70% reaches 10% of the minimum stone off rate and the spray amount of emulsified asphalt is the lowest.

(3) In the skidding resistance performance test, the BPN of the specimens first increases then decreases as $Ev$ increases at 1.2 times of the spray amount, and reaches the maximum value when $Ev=10$. The BPN of the specimens increases as $Ev$ increases at 1.4 times of the spray amount.

(4) In the shear performance test, the shear strength value between layers of emulsion asphalt sand seal increases as the solid content increases and reached the maximum 2.14MPa when solid content is 70%. The shear performance of emulsified asphalt sand seal with high viscosity and solid content is better than those with low viscosity and solid content. Therefore, the former is more suitable as the asphalt sand seal.

ACKNOWLEDGEMENTS

This work was financially supported by The National Natural Science Fund (51478276), The natural science foundation of Liaoning Province (2014020070), Liaoning Provincial Department of education project (L2014234), Shenyang City Highway Project Management Office (14-08-130), Ministry of housing and urban rural construction projects (2014-K5-024).
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