The influence of the warm-mixed agent on the performance of Gussasphalt after superheated aging

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Abstract. Gussasphalt has been widely used in steel bridge deck and pavement in China, but it will lead to the pyrolysis aging of gussasphalt binder in the mixing process due to the high temperature and longtime mixing. The effect of improving the aging performance of Gussasphalt was studied by adding warm-mixed agent after superheat aging, and the aging performance between the matrix asphalt and the gussasphalt modified with Sasobit and RH were compared and analyzed. The results show that: RH warm-mixed agent has little effect on the penetration of Gussasphalt binder, while Sasobit warm-mixed agent has more influence on the penetration of Gussasphalt binder. Gussasphalt binder with of 2% RH warm-mixed agent or 1% Sasobit warm-mixed agent is the optimum mix dosage. The adding of 2% RH warm-mixed agent or 1% Sasobit warm-mixed agent can effectively decrease the mixing temperature of the mixture, and Sasobit's effect is better.

1. Introduction
With the improvement of bridge construction technology in China, in the channel form design of crossing the river, sea and Yellow River, from the 100-meter cable-stayed bridge in the 1990s to the single-span suspension bridge of double-tower at the kilometer level and even the multi-tower double-span suspension bridge (such as Taizhou bridge and Maanshan Yangtze river bridge) more than two kilometers level has been developed[1]. Meanwhile, the higher technical requirements are put forward for pavement layer to keep good compatibility with steel bridge deck with the continuous record of main span for steel box bridge[2]. Under this background, gussasphalt concrete paving materials are widely used for their excellent synergetic deformation ability, low temperature cracking resistance and water tightness[3].

However, during the process of molding and transportation, gussasphalt mixture need to undergo superheat temperature from 220℃ to 240℃ and mixing in the special equipment named Cooker car for about 4–6 hours. The molding environment is more severe than the common polymer modified asphalt mixture for the 170℃ to 185℃ level of mixing temperature and seconds of mixing time. Such superheated temperature and longtime molding conditions will lead to the pyrolysis aging of the gussasphalt[4].

According to the problem of severe performance degradation for gussasphalt after superheat aging, this paper attempts to study the influence of warm-mixed agents on the performance of gussasphalt after superheat aging by a series tests.
2. Study on performance improvement of Gussasphalt by warm-mixed agents

2.1 Warm-mixed agent
Two kinds of warm-mixed agents Sasobit and RH commonly used on the market were selected in this study: The basic characteristics are shown in Table 1, and the appearance is shown in Figure 1.

| Project | Melting point (℃) | Flash point (℃) | Density of 25℃ (g/cm³) | Appearance |
|---------|-------------------|-----------------|------------------------|------------|
| Sasobit | 76                | 280             | 0.94                   | White spherical, granule about 3mm |
| RH      | >100              | 310             | <1.15                  | White or light yellow solid granule/powder |

![Figure 1](image1.png)  
(a) Sasobit (b) RH  
Figure 1 The appearance of warm-mixed agents

2.2 The influence of the dosage of warm-mixing modifier on asphalt performance
The gussasphalt binder was blended by TLA: 70# matrix asphalt = 60:40, and the dosage of warm-mixed agent was 0%, 1%, 2%, 3% and 4% of the mixed asphalt, respectively. The test results of three major indexes modified by RH and Sasobit warm-mixed agents are shown in Figures 2 and 3.

![Figure 2](image2.png)  
Figure 2 Test results of three major indexes of gussasphalt modified with RH
The test results in Figure 2 show that the RH has little effect on the penetration of gussasphalt binder, and the penetration of asphalt with different proportions of RH is maintained at about 22mm. The softening point showed a relatively obvious upward trend with the increase of RH content. For every 1% increase of the content, the softening point increased by about 10°C. The RH has a great influence on the ductility of the gussasphalt binder. After the addition of the RH modifier, the ductility of the binder decreases to half of that before the mixing; and with the increase of the dosage, the ductility shows a tendency to increase first and then decreases.

The test results in Figure 3 show that the Sasobit has more influence on the penetration of the gussasphalt binder, but the Sasobit with different proportion has little change in the penetration of the asphalt. In terms of softening point, mixed with 1% Sasobit warm-mixing modifier, the softening point of asphalt increased by about 10°C, and Sasobit was mixed with more than 2%, the softening point of asphalt was 99°C. The Sasobit has great influence on the ductility of the gussasphalt binder. After the modifier is added, the ductility of the binder decreases to half of that before the blending; and with the increase of the dosage, the degree of ductility shows a decreasing trend.

Based on the test results of Fig. 2 and Fig. 3, the gussasphalt binder is mixed with 2% RH and 1% Sasobit.

### 2.3 Study on the effect of warm-mixed agent on the viscosity of gussasphalt

In order to verify the cooling effect of the RH and Sasobit under the optimal dosage obtained in the above test, the viscosity characteristics of the gussasphalt before aging were studied by the asphalt rotational viscosity test (Brookfield viscometer method). The original gussasphalt is TLA: 70#:60:40, the RH is 2%, and the Sasobit is 1%.

The test results are shown in Figure 4.
Looking at Figure 4, it can be found that at all the test temperatures, the viscosity of the two warm-mixed agents is about half of that of the original asphalt, indicating that both modifiers can effectively decrease the viscosity of the cast asphalt, and the effect of 1% Sasobit is slightly better than that of 2% RH. Compared with the original asphalt without warm-mixed agents, the test temperature of the two modifiers should be decreased by about 15°C under the same viscosity, which indicates that the mixing temperature of the mixture can be decreased under the premise of ensuring the fluidity of the mixed construction about 15°C.

3. Conclusion
In this chapter, according to the problem of severe degraded performance of cast asphalt after aging, from the perspective of warm-mixed agent, the effect of the warm-mixed agent on the performance of gussasphalt was discussed, and the optimal dosage was quantitatively analyzed. The cooling effect was verified by the asphalt rotational viscosity test. The main conclusions are as follows:

The RH warm-mixed agent has little effect on the penetration of cast asphalt binder; the softening point shows a clear upward trend with the increase of RH content. The softening point increases by about 10°C for every 1% increase; the overall degree of ductility shows a downward trend, and as the dosage of addition increases, the ductility first increases and then decreases.

The Sasobit warm-mixed agent has more influence on the penetration of the cast asphalt binder. The penetration of the asphalt mixture has little change under different dosages; when the content is 1%, the softening point is increased by about 10°C. When the dosage is more than 2%, the softening point of the asphalt is 99°C; the ductility shows a decreasing trend with the increase of the dosage.

Comprehensive economy and improvement of asphalt performance, gussasphalt binder with of 2% RH or 1% Sasobit is the optimum mix dosage.
Under the premise of ensuring the fluidity of the mixture construction, the adding of 2% RH or 1% Sasobit can effectively decrease the mixing temperature of the mixture, and Sasobit's effect is better.

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