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Laboratory Investigation of the Low-temperature Crack Resistance of Wood Tar-based Rejuvenated Asphalt Mixture Based on the Semi-circular Bend and Trabecular Bending Test

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Introduction

Background

- Low-temperature crack resistance is the core issue affecting the promotion of rejuvenated asphalt.
- Wood tar has the characteristics of wide source, waste utilization, environmental protection and regeneration
- Studies have proved that wood tar as asphalt modifier can effectively improve the fatigue performance and low-temperature crack resistance of asphalt.

Objective

- Based on the creep relaxation characteristics of rejuvenated asphalt mixture at low temperature and the laboratory test results, establish damage creep model to describe the bending creep properties of rejuvenated asphalt mixture at low temperature.
- Evaluate the road performance of wood tar-based rejuvenated asphalt more comprehensively and promote the practical application of wood tar-based rejuvenated asphalt.

Materials & Method

- **Asphalt:** Styrene-butadiene-styrene **(SBS)** modified asphalt, RA-102 rejuvenated asphalt, Wood tar-based rejuvenated asphalt
- **Preparation process of rejuvenated asphalt**

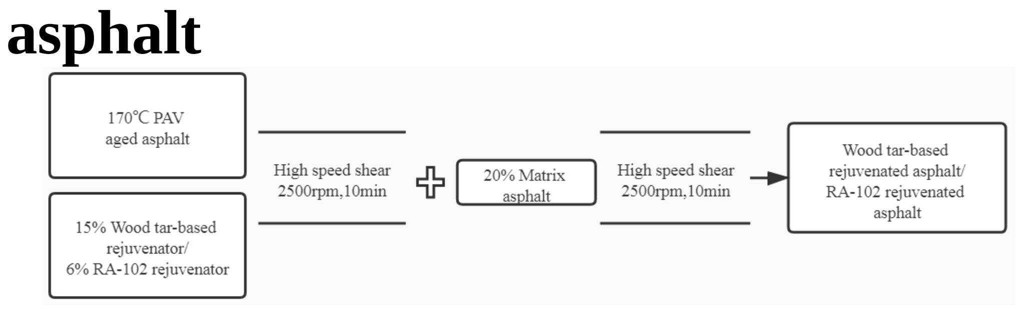


Figure 1. Preparation process of rejuvenated asphalt.

- **Mix design of asphalt mixture**

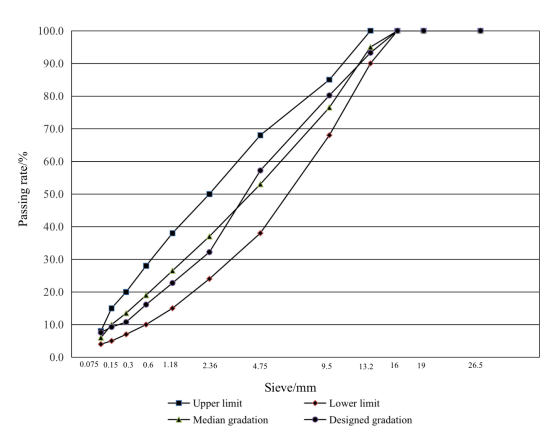


Figure 2. Synthesis gradation curve of AC-13

- **SCB test and BBR test**

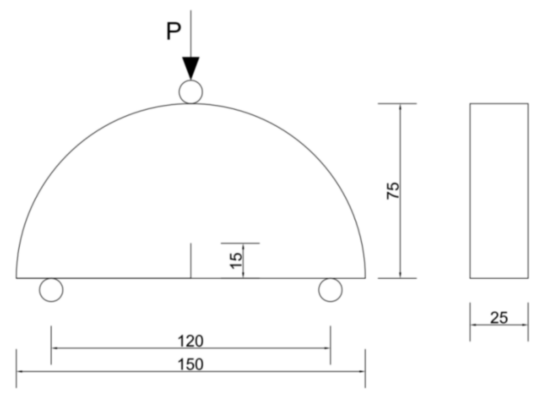


Figure 3. Semicircle bending test specimen (unit:mm). Figure 4. Low-temperature bending test device.

- **Trabecular bending creep test**

Results & Discussion

Creep stiffness and creep rate

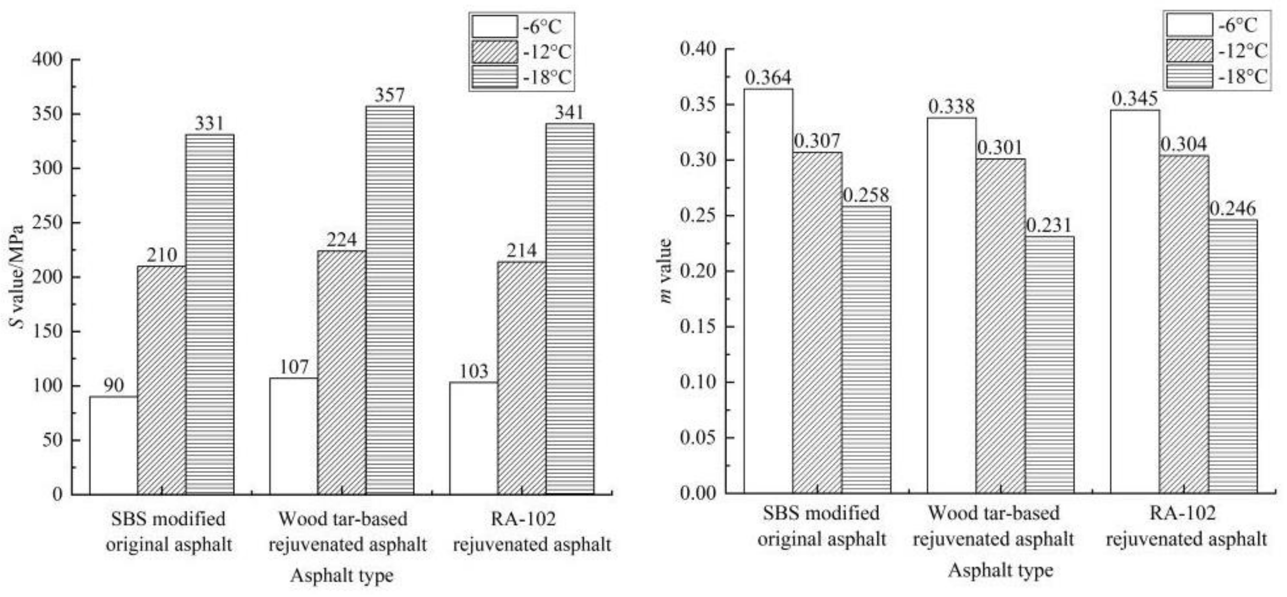


Figure 5. Calculation results of continuous low-temperature classification temperature of each asphalt.

SCB test results

Table 1. SCB test results of each asphalt mixture.

Test index	SBS modified original asphalt	Wood tar-based rejuvenated asphalt	RA-102 rejuvenated asphalt
Flexural tensile stress σ_B /MPa	3.142	2.946	2.565
Flexural tensile strain ε_B /με	2143.7	2018.4	1733.6
Fracture energy density	0.038	0.041	0.034

Trabecular bending test

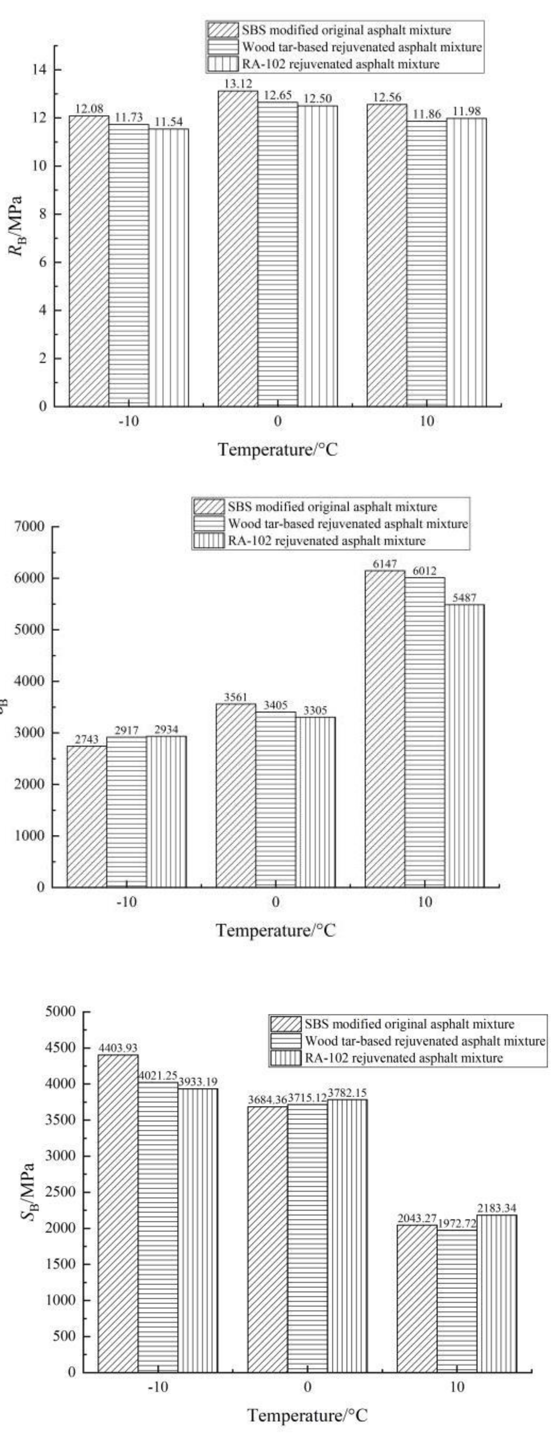
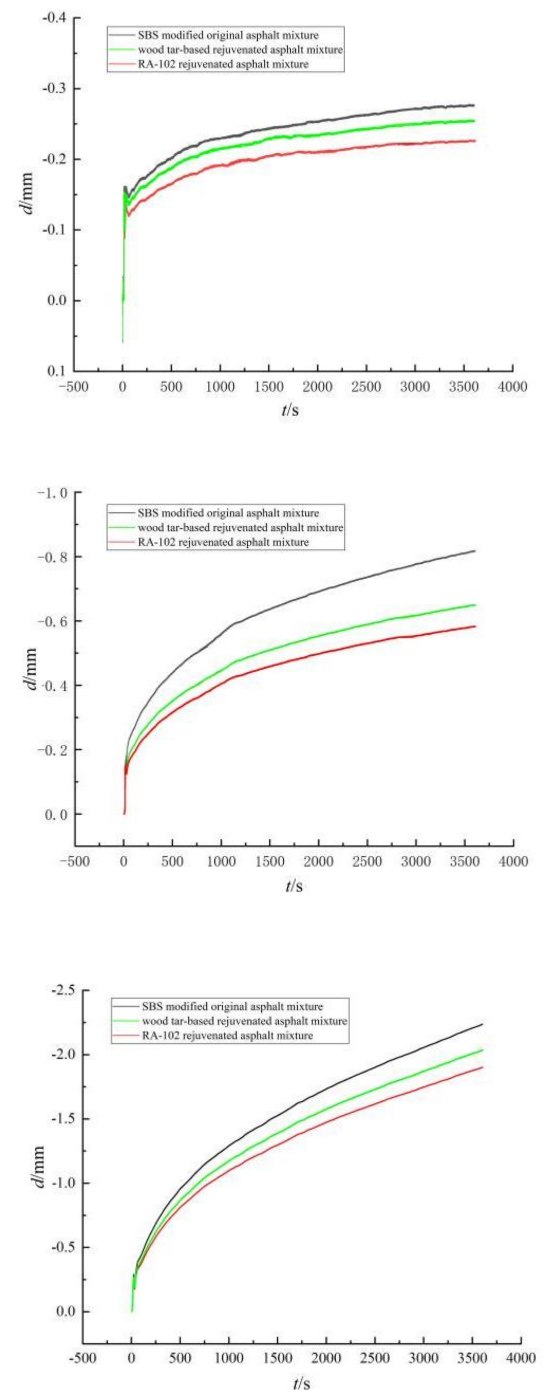


Figure 6. Trabecular bending test results of each asphalt mixture.

Trabecular bending creep test



Fiure 7. Creep curves of each asphalt mixture(10,20,30℃).

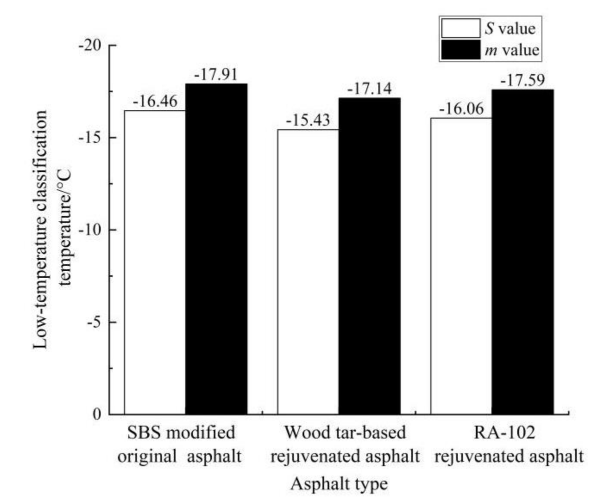


Figure 9. Calculation results of continuous low-temperature classification temperature of each asphalt.

Creep damage model

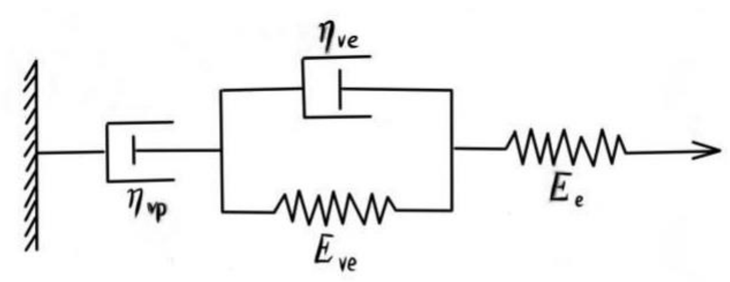
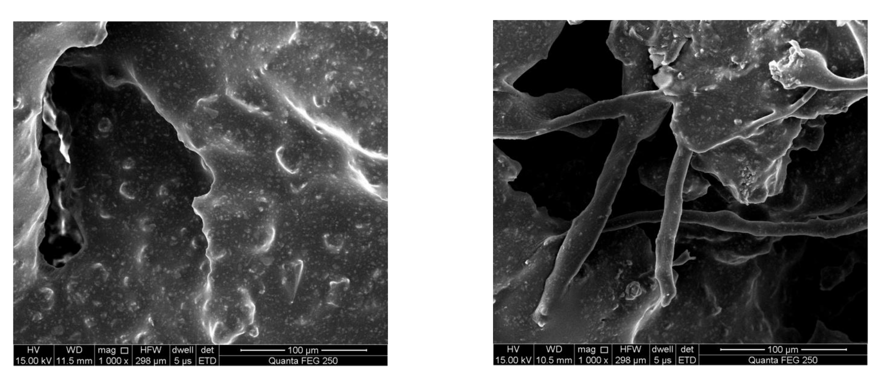


Figure 10. Improved Burgers model.



(a)Non-fiber (×1000) (b) Biomass fiber reinforced (×1000)

Figure 8 Failure interface of SCB test of different asphalt mixture

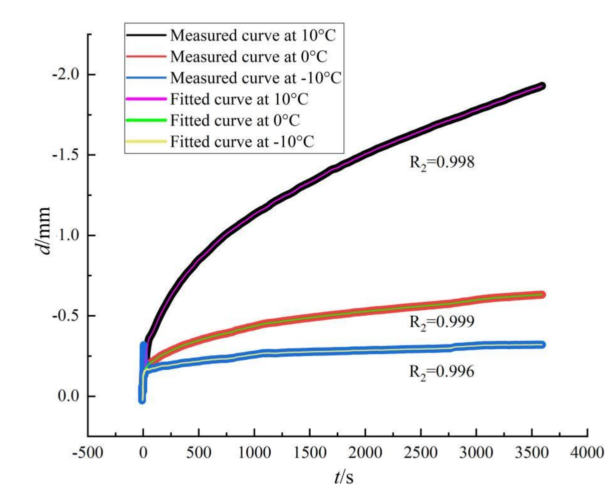


Figure 11. Measured displacement and fitted curve of wood tar-based rejuvenated asphalt mixture.

Conclusions

- The low temperature classification of wood tar-based rejuvenated asphalt is basically in the same grade with original asphalt and RA-102 rejuvenated asphalt.
- The synergistic effect of wood tar and biomass fiber can effectively alleviate the bond failure between asphalt and aggregate, improve the stiffness of the mixture, and make the toughness and crack resistance of the rejuvenated asphalt mixture at low temperatures significantly improved.
- The established creep damage model can better describe the flexural creep performance of rejuvenated asphalt mixtures at low temperature, and can be used to infer the deformation characteristics of other temperature.
- The creep damage model established in this study can be effectively extended to the study of low temperature crack resistance of other types of rejuvenated asphalt mixtures.