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Fatigue Performance Analysis and Life Prediction of Wood Tar-based Rejuvenated Asphalt

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Introduction

Background

- Biomass is widely used as a sustainable material for the production of aged asphalt rejuvenators.
- The fatigue performance decay of rejuvenated asphalt is different from that of the original asphalt, so more in-depth studies are needed.
- Wood tar-based rejuvenator can effectively restore the low temperature crack resistance and fatigue performance of aged asphalt.

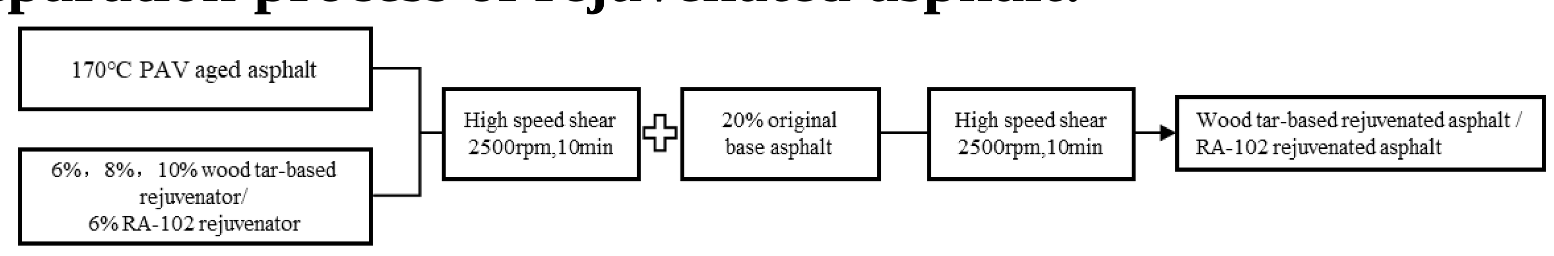
Objective

- Determine the evaluation index (N_{f50}, N_{P20}, N_{fm}) of fatigue performance of wood tar-based rejuvenated asphalt.
- Analysis of the effect of wood tar-based rejuvenator content on the fatigue performance of rejuvenated asphalt.
- Establishing a fatigue life prediction equation for wood tar-based rejuvenated asphalt considering the effect of temperature.

Materials & Methods

Raw materials

- **Rejuvenator:** Wood-tar based rejuvenator, RA-102 rejuvenator.
- **Asphalt:** 70# original asphalt (**OA**), Wood tar-based rejuvenated asphalt (**WA**) , RA-102 rejuvenated asphalt (**RA**).
- **Preparation process of rejuvenated asphalt:**

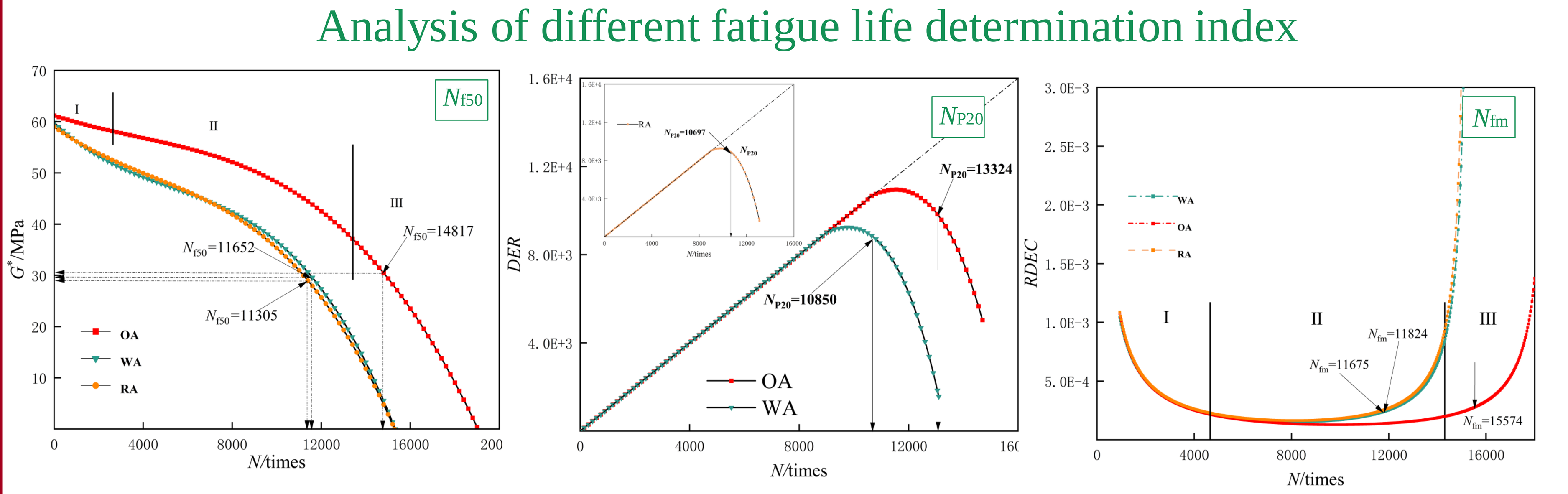


Repeated shear test

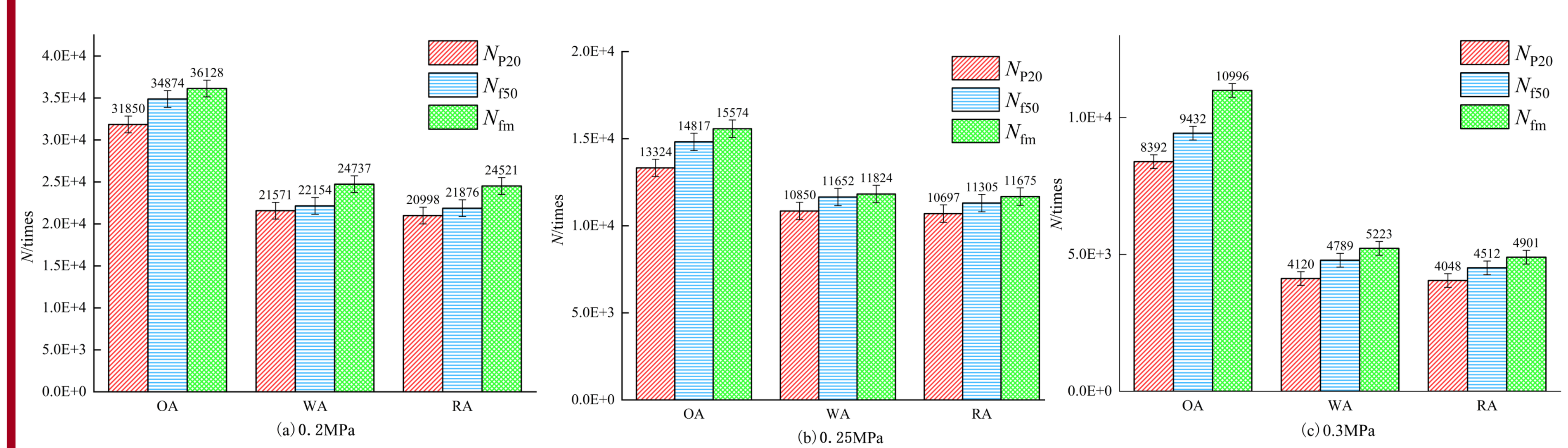
- DSR was used to conduct repeated loading test in stress control mode with a loading frequency of 10 Hz , and the test temperature were 15℃, 20 ℃ and 25 ℃, respectively. Different stress levels of 0.2～0.8 MPa were selected according to the test temperature to ensure that the asphalt was always within the viscoelastic range during the test.

Results & Discussions

Analysis of different fatigue life determination index

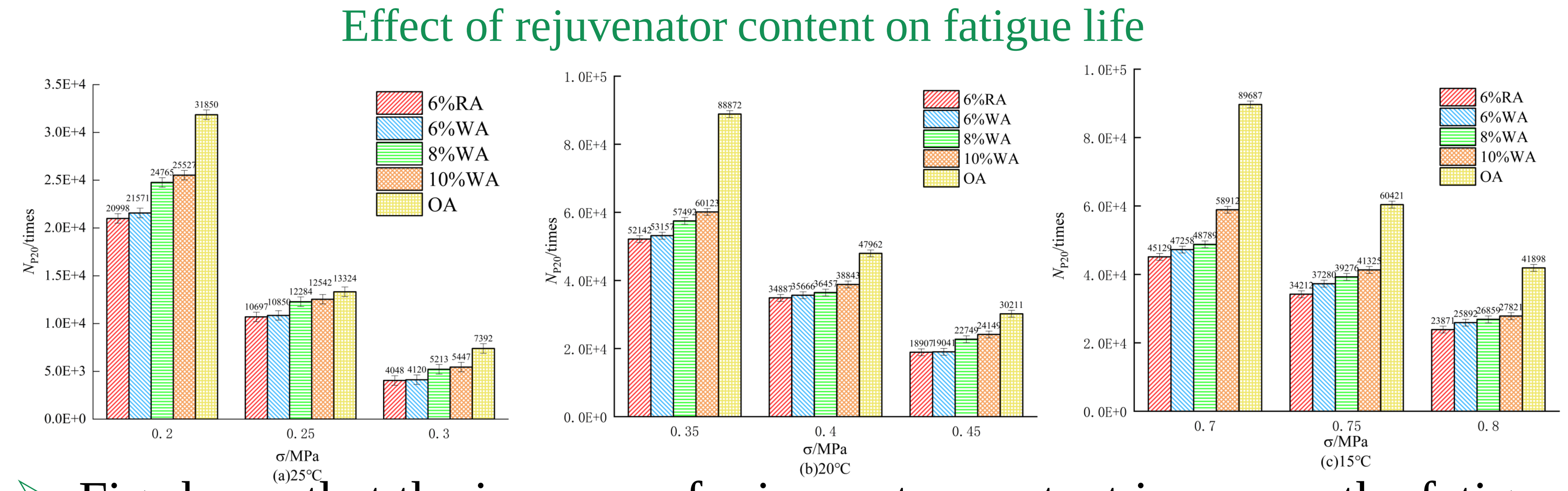


Comparative analysis of different fatigue life evaluation indexes



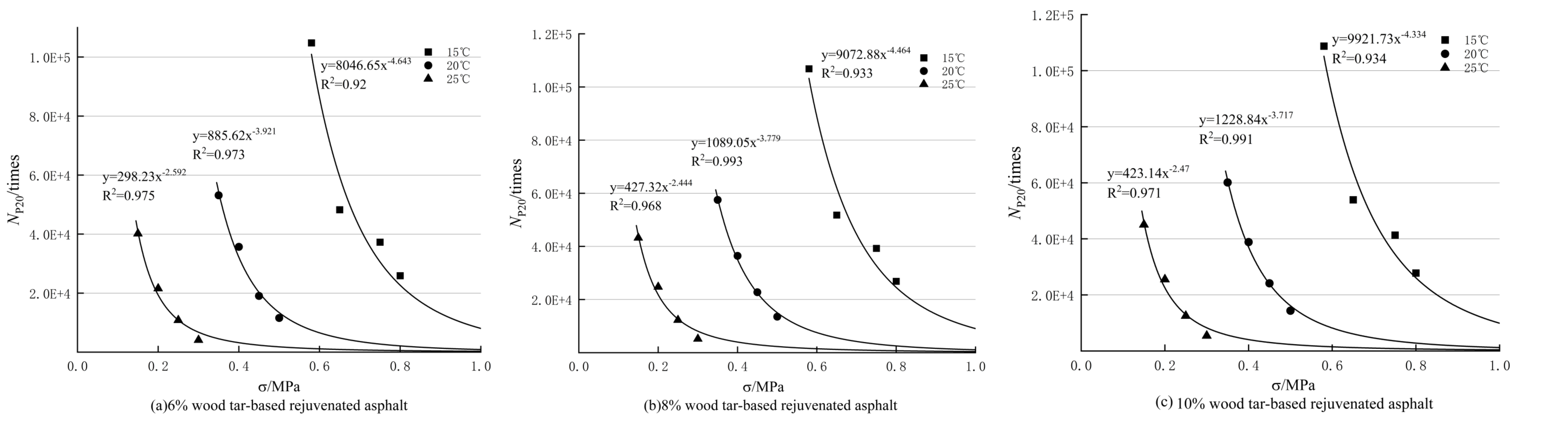
- Considering the meaning of each evaluation index and the determination of fatigue life, N_{P20} is chosen as the determination of fatigue performance of wood tar-based rejuvenated asphalt.

Effect of rejuvenator content on fatigue life



- Fig shows that the increase of rejuvenator content improves the fatigue performance of rejuvenated asphalt under the condition of certain temperature and loading stress.
- The main reason is that more wood tar-based rejuvenator can make the asphalt exhibit better toughness when fatigue cracking, which delays the process of fatigue cracking of asphalt.

Fatigue life prediction equation considering temperature effects



- $N_{P20} = (k_1 - k_2 t)\sigma^{(k_3 - k_4 t)}$ Where, k_1, k_2, k_3 and k_4 are fitting coefficients, t is temperature.

Rejuvenator content(%)	Fatigue life prediction equation	R^2
6%	N_{P20}=(17138.52 −633.86t)$\sigma^{(-6.598+0.198t)}$	0.8021
8%	N_{P20}=(22561.75 −807.98t)$\sigma^{(-7.848+0.285t}$	0.8346
10%	N_{P20}=(14705.73 −512.63t)$\sigma^{(-6.072+0.184t}$	0.8742

Conclusions

- N_{P20} can be used as evaluation index for the fatigue life of wood tar-based rejuvenated asphalt.
- Based on the selected evaluation index N_{P20}, the fatigue performance of aged asphalt can be restored after adding wood tar-based rejuvenator at different temperatures and content levels.
- The regeneration effect of the rejuvenator is influenced by the rejuvenator content and temperature.
- The fitted fatigue life prediction equation considering the effect of temperature can accurately predict the fatigue life of wood tar-based rejuvenated asphalt under different temperatures and stresses.