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Investigation of the Road Performance and Enhancement Mechanism of Biomass Fiber-Modified Asphalt Mixture

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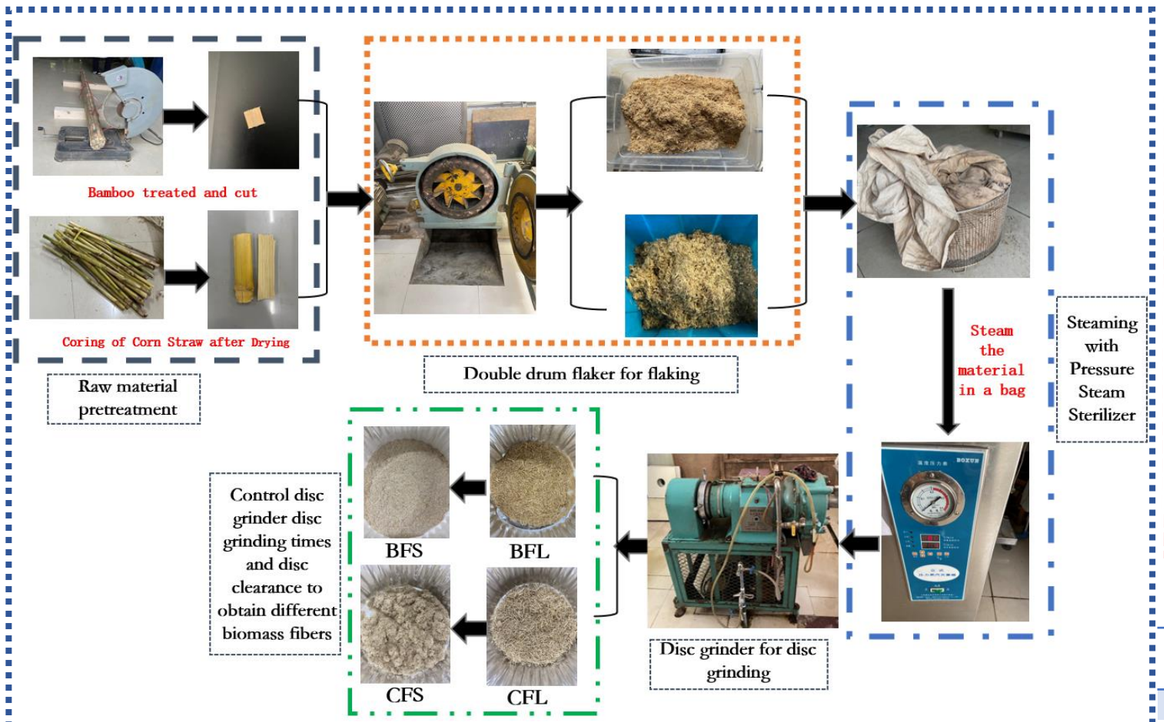
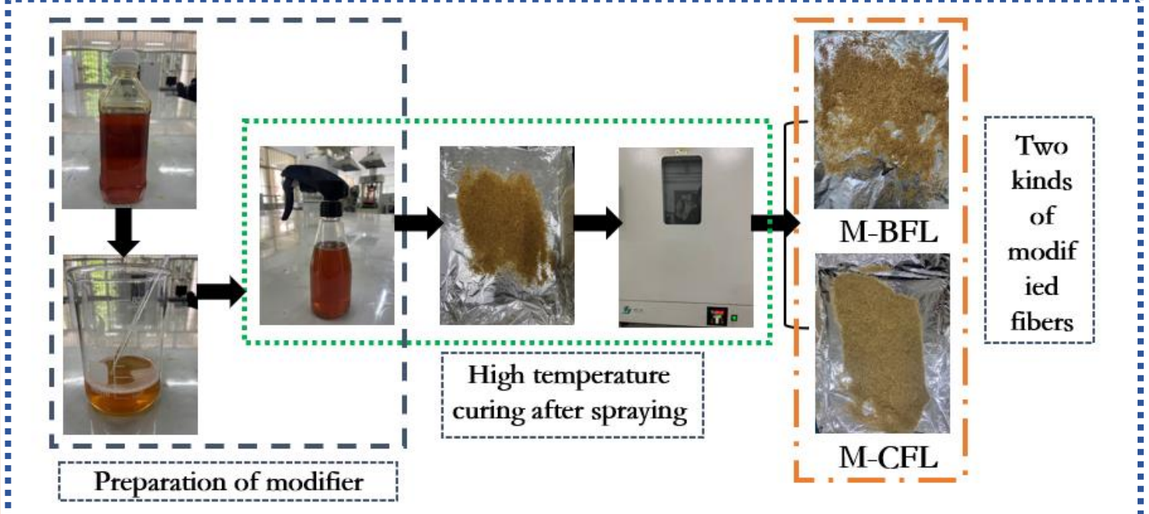
1. Introduction and objective

- To investigate the applicability of biomass fiber modifier in asphalt mixtures, corn straw fiber and bamboo fiber were produced and optimized with proper surface-treatment method.
- Four kinds of biomass fibers are obtained by proposed procedures, including long bamboo fiber (BFL), short bamboo fiber (BFS), long corn straw fiber (CFL), and short corn straw fiber (CFS). Two kinds of long fibers were modified with self-designed modifier to optimize the surface properties.
- The high-temperature and low-temperature performance, moisture damage stability, and fatigue behaviors of biomass fiber-modified asphalt mixtures were evaluated.
- The function mechanisms of biomass fiber modifier were analyzed based on the microscopic perspective by SEM test.

2. Material preparation



Preparation process of biomass fiber



Modification process of biomass fiber

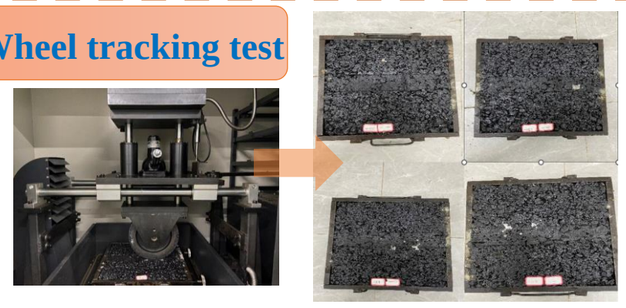
Preparation of experimental materials:

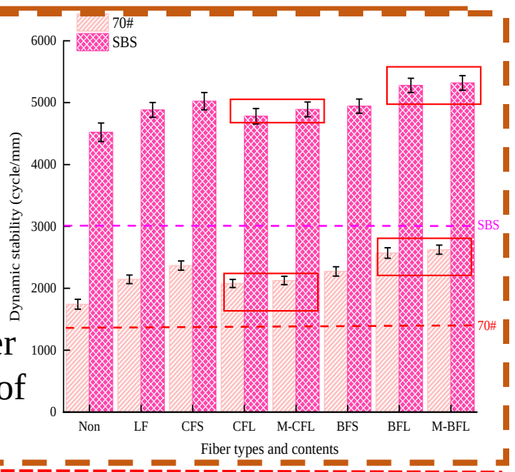
- The gradation of asphalt mixture is SMA-13. The asphalt used is styrene-butadiene-styrene (SBS) modified asphalt and 70# asphalt.
- The fiber content in asphalt mixture is the same, and the best asphalt aggregate ratio is determined through tests.
- The modifier is a resin polymer made in the laboratory.

3. Test methods and results

- The main tests in this paper are Rutting test, Moisture damage resistance test and SCB test

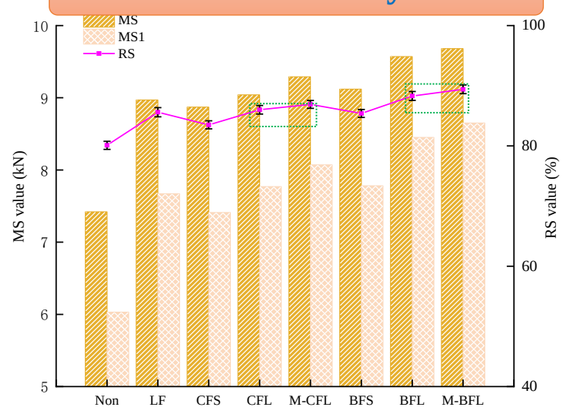
Wheel tracking test

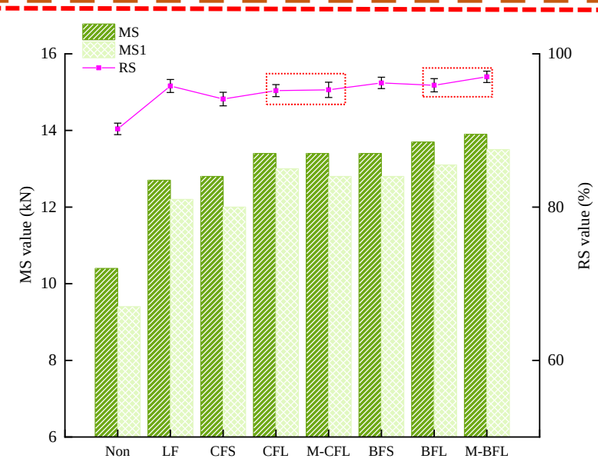


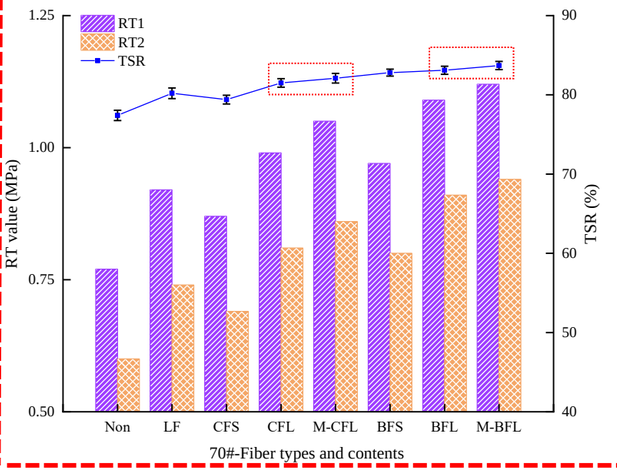


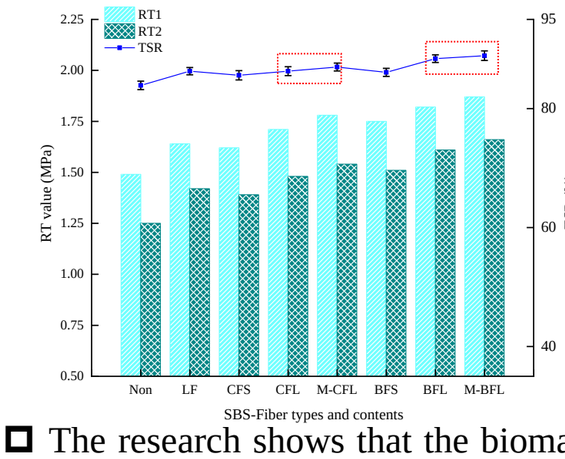
- The research shows that the addition of fiber can improve the high-temperature stability of the mixture

Moisture Stability Test







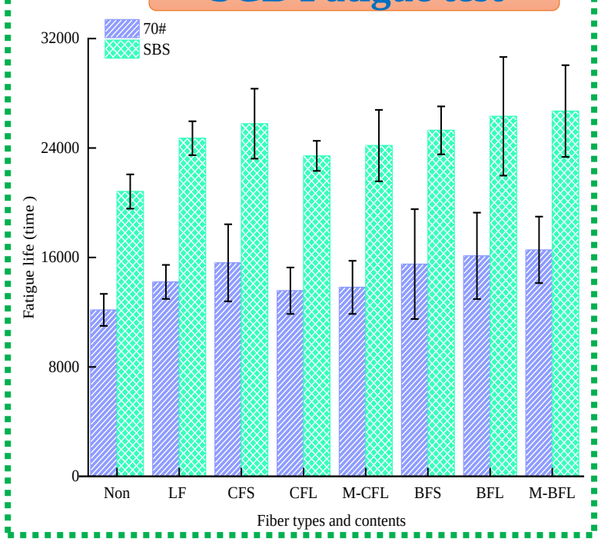


- The research shows that the biomass fiber contributes to the moisture stability of the mixture

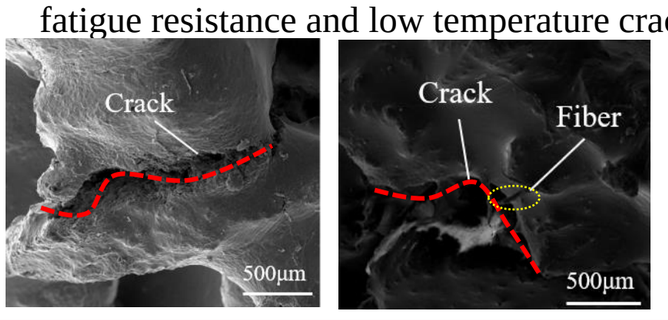
Low temperature SCB test

Type of asphalt mixture	Bending tensile strength/MPa	Stiffness modulus/MPa	Failure strain/με
70#-Non	4.98	205	17801
70#-LF	5.58	236	19120
70#-CFS	5.34	223	18477
70#-CFL	5.69	254	19291
70#-BFS	5.92	264	20104
70#-BFL	6.09	276	21645
70#-M-CFL	5.79	252	19872
70#-M-BFL	6.18	282	22087
SBS-Non	8.18	444	22301
SBS-LF	8.87	481	23480
SBS-CFS	8.78	455	23098
SBS-CFL	8.94	467	23841
SBS-BFS	9.12	490	24093
SBS-BFL	9.30	505	24487
SBS-M-CFL	9.02	476	24009
SBS-M-BFL	9.46	523	24874

SCB Fatigue test



- The test results show that the addition of biomass fiber can improve the fatigue resistance and low temperature crack resistance of asphalt mixture



- The microscopic pictures show that the fiber plays a certain tensile role when the asphalt mixture is damaged by force.

5. Conclusions

- The road performance of the modified asphalt mixture was improved by adding the biomass fiber modifier.
- The surface modified fibers have excellent low temperature performance and fatigue performance in asphalt mixture.
- The micro-morphology of biomass fiber showed obvious influences on the microstructure of asphalt mixtures.