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Experimental Study on Effect of Road Performance, Using Carbon Nano Materials/SBS as Modified Asphalt

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Abstract

The development and utilization of high-performance polymer modified asphalt is an important mean to improve the resistance ability of asphalt pavement, prolong the life of pavement by reducing the maintenance cost. The development of carbon nanomaterials provides more possibilities for modified asphalt technology. In order to explore the road performance of carbon nanomaterial modified asphalt mixture, five kinds of carbons were prepared under high speed shearing method: 0.1 Wt.%, 0.3 Wt.%, 0.6 Wt.%, 1 Wt.%, 2 Wt.%. The modified asphalt with nanomaterial content was studied by the comparative analysis of the basic performance indexes of base asphalt and five modified asphalts to study the compatibility between carbon nanomaterials and base asphalt. The modified asphalt with 0.3 Wt.%, 1 Wt.% and 2 Wt.% was used as the research object. The traditional carbon nanomaterials and optimized carbon nanomaterials were analyzed by macroscopic mechanics, microstructure and chemical composition. Based on the basic technical indicators and the macroscopic properties of the mixture, the formation mechanism of the microstructure and macroscopic properties of the carbon nanomaterial/SBS modified asphalt was explained by Scanning Electron Microscopy (SEM), fluorescence microscopy and infrared spectroscopy (FTIR). The results show that the optimum content of carbon nanomaterials is 1%, and the high and low temperature properties and storage stability of the modified asphalt are improved under the optimal dosage. The optimized carbon nanomaterials have become a bridge between SBS and asphalt due to their microscopic cyclic structure and conjugated bonds. The good microscopic compatibility with asphalt is the key to improving the modification performance.

Keywords: Carbon nanomaterial's; modified asphalt; compatibility; rutting and fatigue properties.

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1. Introduction

The thermoplastic elastomer SBS (styrene-butadiene-styrene block copolymer) can be used to improve the viscoelasticity, flexibility, ductility, adhesion, and aging resistance of the asphalt after shear mixing with the matrix asphalt in a heated and molten state. Based on this, SBS modified asphalt has become the main road bonding material for high-grade asphalt pavement [1]. Insufficient high temperature stability and anti-aging ability of modified asphalt is the main cause of rutting on asphalt pavement [1, 2].

Hardening of lightweight components is the main manifestation of asphalt aging, resulting hard and brittle asphalt, durability and decrease service life [3,4], and the aging of SBS modified asphalt is also related to the degradation of SBS[5]. Carbon nanomaterials, is a typical nanomaterial, not only have many dimensional effects unique to many nanomaterials, but also have excellent electrical and mechanical properties. Exploring carbon nanomaterials with different structures has become the direction of many researchers [6,7]

The temperature sensitivity, low temperature performance and aging resistance of the nano-ZnO modified asphalt prepared by the solvent method are obviously improved [8], and the Nano-material after surface modification can obtain better compatibility with asphalt [9]. Infrared spectroscopy can be used to detect the chemical bond evolution of polymer materials in asphalt. There are both physical and chemical interactions between Nano materials and base asphalt. Among them, physical effects are the main ones. Suitable nanomaterials can improve asphalt roads performance [10,11].

Carbon nanomaterials have begun to receive extensive attention in the field of asphalt modification. Some Researches have been carried out on the properties of asphalts and the properties of mixed materials after modification of different kinds of nanomaterials. However, the compatibility between nanomaterials and asphalt is the key factors for the modification effect are that there are no nanomaterial modifications in the existing research on the compatibility with asphalt. In this paper, the carbon nanomaterials were firstly oxidized-exfoliated-reduced. The SBS modified asphalt was used as the carrier, and the microstructure was characterized by X-ray diffractometer, modified asphalt fluorescence microscope and scanning electron microscopy. The effect and mechanism analysis of soil on the physical and aging properties of SBS modified asphalt.

2. Material and experimental method

Aggregates, bitumen and modifiers

The aggregate used is limestone produced by local crushing plant, The technical indicators are shown in Table 1. The asphalt used is SK asphalt with a penetration degree of 90, the technical indicators are shown in Table 2. The modifier type is Sinopec 1301 linear SBS polymer, and the technical indicators are shown in Table 3.

Carbon nanomaterials

There are two types of carbon nanomaterials used in the experiment. Physically exfoliated Nano graphene and chemically exfoliated Nano graphene are provided by Turing Evolution Technology Co., Ltd., and the oxidized modified Nano graphene is subjected to: oxidation (Oxidation) - Exfoliation - Reduction process, the graphene layer spacing is enlarged, and the graphene sp2 atomic sequence is purified. The technical specifications provided by the manufacturer are shown in Table 4.

Table 1: Aggregate technical indicators

Technical Indicators/Units	Apparent relative density/g·cm3			Water absorption Rate/%			Los Angeles Wear Value/%
Test standard	ASTM C 128-88	ASTM 127-88					ASTM C 131
Aggregate specifications	0-4.75mm	4.75-9.5mm	9.5-16mm	0-4.75mm	4.75-9.5mm	9.5-16mm	9.5mm-13.2mm
Indicator values	2.716	2.761	2.785	1.35	0.87	1.03	19.40

Table 2: Technical indicators of base bitumen

Asphalt Type	25℃ Needle Entry / 0.1 mm	Needle degree index PI	15℃ Extension / cm	Softening Point / ℃	15℃ density /g /cm^3	Rotating film Heating (163℃，85min)		
						Loss of quality / %	Residual needle degree ratio / %	10 ° C residual extension/cm
SK90#	90.5	-1.07	105.2	47.0	1.030	0.10	64.0	16.0

Table 3: Technical indicators of SBS modifiers

Grade	Structure Type	Grey Component / %	Fixed Extension Stress / MPa	Tensile Strength /MPa	Elongation Rate/%	Shaw Hardness / A	Melting Flow Rate / Mm * S-1	Relative Density / (23℃, G*Cm^{-3})
Sinopec 1301	Linear	≤0.5	≥2.5	≥12	≥700	70	0.5~6	0.93

Table 4: Technical indicators of carbon nanomaterials

Product Type	Thickness / nm	Purity / wt.%	No. of floors	Particle size D50 / μm	Specific surface area / m2·g-1	Appearance / mm*s-1
Physical Stripping	7-15	98	≥12	7-12	50-200	Black powder
Chemical stripping	0.55-3.85	≥99	<10	2-10	50-100	Brown powder

Test Methods

Preparation of carbon nanomaterials/SBS composite modified Asphalt

The beaker containing the base asphalt is placed in the bath environment of the modified asphalt shearing machine at 175±2°C, adjust the shearing speed to 7000 r/min, and gradually add wt. 4% SBS modifier along the sidewall of the beaker. Carbon nanomaterials of wt. 0.1%, wt. 0.3% and wt. 0.5% were added and sheared for 1 h. The mixture was stirred in bath at 175 °C for 2 h to prepare a composite modified asphalt sample, which was poured into a container at room temperature for storage, and was heated in an oven when testing was required.

Dynamic Shear Rheological Test (DSR)

Dynamic shear rheometer (DSR) is a commonly used test method for evaluating the viscosity and elastic properties (rheology) of asphalt binder. The experimental equipment is a dynamic shear rheometer for SmartPave102 asphalt research produced by Anton Paar GmbH, Austria. The test standard is AASHTO T 315 ("SHRP-Test").

Scanning electron microscope (SEM)

Hitachi S4800 is used to launch scanning electron microscopy. The Hitachi S4800 cold field emission scanning electron microscope was used.

Fluorescence microscope

Using BML-400E modified asphalt fluorescence detection microscope, the slides and coverslips in the equipment were first washed with hydrochloric acid and washed with distilled water three times, and placed in a desiccator (dryer) for use. The asphalt which is evenly stirred and heated and melted is selected from the 2/5, 3/5, and 4/5 portions of the bottom of the beaker, and the asphalt is dripped on the glass slide, and the cover glass is gently pushed from one end to the other end.

Infrared spectroscopy (FTIR)

Infrared spectroscopy is used to characterize the molecular state changes of polymers before and after modification by capturing the characteristic functional groups in the bitumen composition to express the characteristics of modified bitumen [13]. The integral area of modified asphalt relative to matrix bitumen between 920cm-1 and 966cm-1 bands can be used as a characteristic index to characterize the distribution stability of asphalt modifiers [14].

3. Technical properties of carbon nanomaterials/SBS modified Asphalt

High Temperature performance

According to the "Testing Regulations for Asphalt and Asphalt Mixtures for Highway Engineering" JT E20-2011 for asphalt rheological properties test (T0629-2011) and softening point test (T0606-2011), SBS modified asphalt and five kinds of carbon nanomaterial under the SBS modified asphalt high temperature rutting factor G*/sinδ and softening point. The test results are shown in Figures 1 and 2.

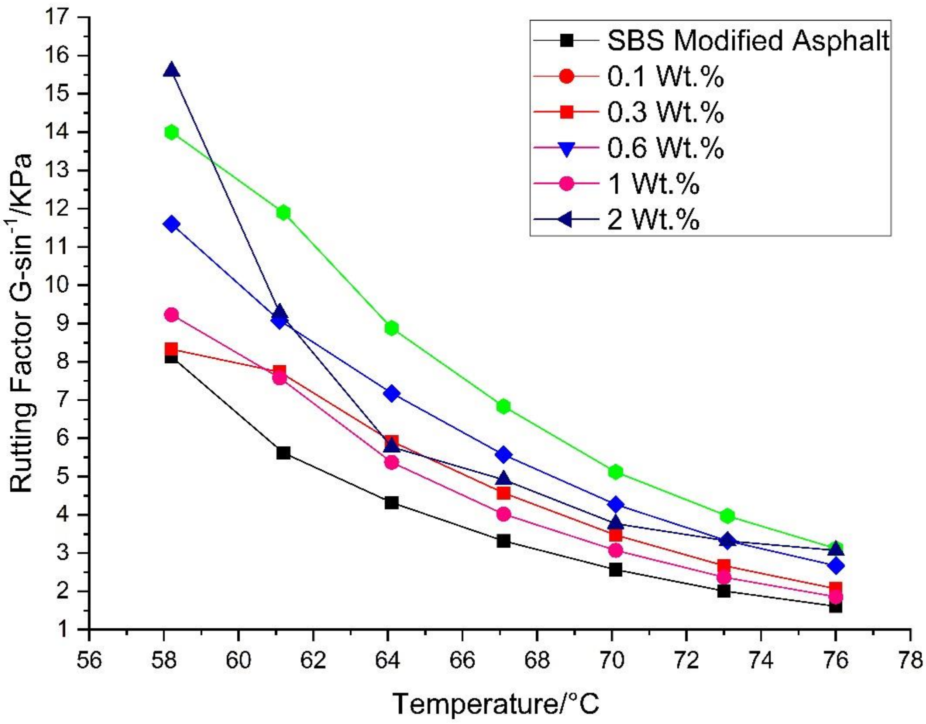


Figure 1: SBS Modified asphalt rutting factor

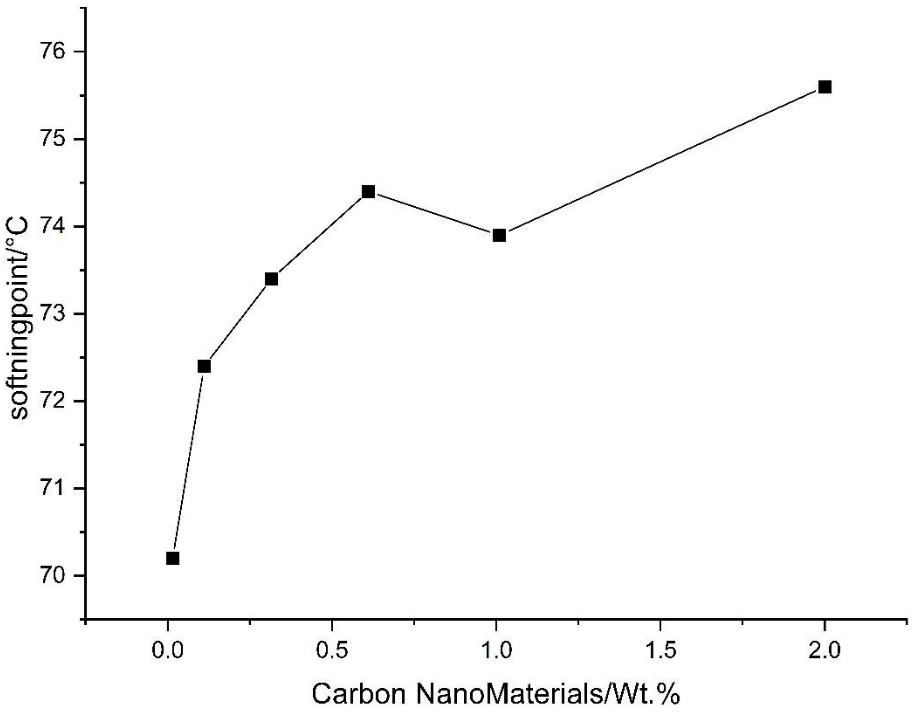


Figure 2: SBS Modified Asphalt softening point of carbon nanomaterials

It can be seen in Figure .1 that the incorporation of carbon nanomaterials generally improves the high temperature performance of asphalt. In the range of 0Wt.%~1Wt.%, the rutting factor increases with the increase of the carbon nanomaterial content. When the carbon nanomaterial content reaches 2Wt.%, the high temperature performance of the modified asphalt is 58 °C. Large, and the ruling factor is between 0.1 Wt.% and 0.3 Wt.% in subsequent temperature scans. The rutting factors of SBS modified asphalt, 0.3Wt.%, 0.6Wt.% and 1Wt.% were stable and regular under temperature gradient scanning. The two samples in 0.1Wt.% and 2Wt.% had the lowest There is a sudden change in the rutting factor at a temperature of 58 °C, which may be related to the accuracy of the test, or it may be caused by the instability of the modified asphalt under the two dosages.

It can be seen from Figure . 2 that the incorporation of carbon nanomaterials improves the softening point performance of the asphalt and increases as the amount of carbon nanomaterials increases.

Low temperature performance

The extension of SBS modified asphalt and five kinds of carbon nanomaterials/SBS modified asphalt under 5 ℃ was tested by reference to the asphalt extension test (T0605-2011) in JTG E20-2011 of "Highway engineering asphalt and asphalt mixture test regulations". The test results are shown in Figure 3.

Refer to the asphalt test for asphalt and asphalt mixture in JTG E20-2011 (T0605-2011), and test SBS modified asphalt and five kinds of carbon nanomaterials/SBS modified asphalt at 5 °C. The degree of delay. The test results are shown in Figure 3.

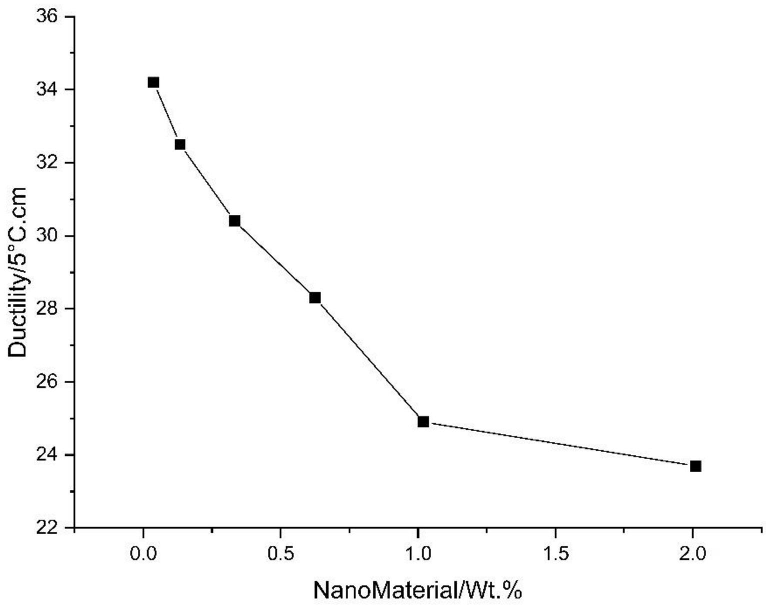


Figure 3: Carbon nanometer/SBS modified asphalt extension test

It can be seen in Figure . 3 that the incorporation of carbon nanomaterials generally reduces the low temperature performance of asphalt, and the ductility decreases with the increase of carbon nanomaterial content in the test range. When the carbon nanomaterial content exceeds 1Wt.%, the low temperature ductility of the modified asphalt is greatly reduced. Based on this, it is recommended that the carbon nanomaterials be less than 1Wt.% in the SBS modified asphalt.

Temperature sensitivity

The sensitivity of the asphalt to temperature is characterized by the penetration index PI. The PI calculation method used is shown in Equation 1. The penetration index PI reflects the degree of deviation of the asphalt from the Newtonian fluid. The penetration index of the SBS modified asphalt and the five kinds of carbon nanomaterial/SBS modified asphalt is shown in Figure . 4.

$$PI = \frac{1952 - 500 * \log(Pen_{25}) - 20 * SP}{50 * \log(Pen_{25}) - SP - 120} \qquad (1)$$

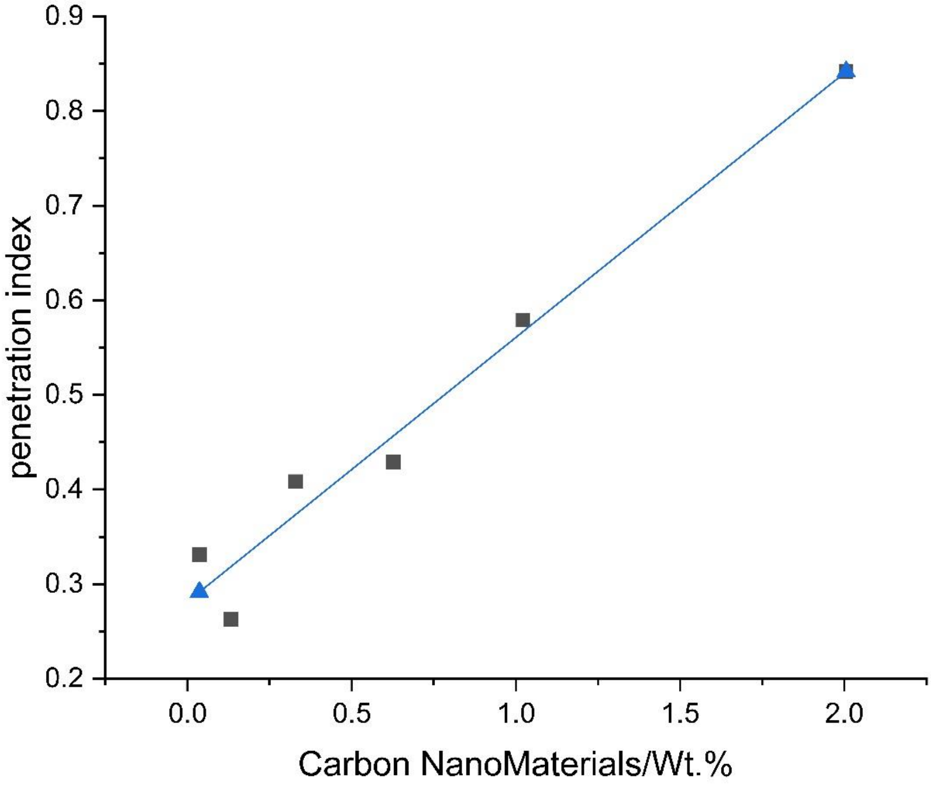


Figure 4: Carbon Nano/SBS modified Asphalt Softening Point

From the results of Figure . 4, the temperature index of the modified asphalt increases with the increase of the carbon nanomaterial content, indicating that the addition of carbon nanomaterials makes the modified asphalt exhibit gel characteristics, and Newtonian fluid the deviation is large, and the deformation increases under low temperature environmental load. However, the temperature-sensitivity index PI of the above test pieces is between -1.0 and +1.0, which are suitable for road engineering use.

Aging Performance

SBS modified asphalt and 0.3Wt.%, 0.6Wt.%, 1Wt.% three carbon nanomaterials/SBS modified asphalt were compared before and after aging for 75min. The results are shown in Table 5.

Table 5: Technical index before and after aging of/SBS modified asphalt of carbon nanomaterials

Test projects	SBS Asphalt	Modified	0.3Wt.% Nano	Carbon	0.6Wt.% Nano	Carbon	1Wt.% Carbon Nano	
	Before aging	After aging	Before aging	After aging	Before aging	After aging	Before aging	After aging
25℃ penetration Entry/0.1mm	58.5	58	56.3	56	55.7	55	52.2	52
5℃ extension/cm	29.4	17.2	26.5	13.4	24.1	11.0	23.0	9.5
Softening Point/℃	68.3	72.2	73.5	76.3	76.8	77.6	83.7	84.7
Quality Change/%	0.2	0.2	0.2	0.1	0.2	0.1	0.1	0.2

It can be seen from Table 5:

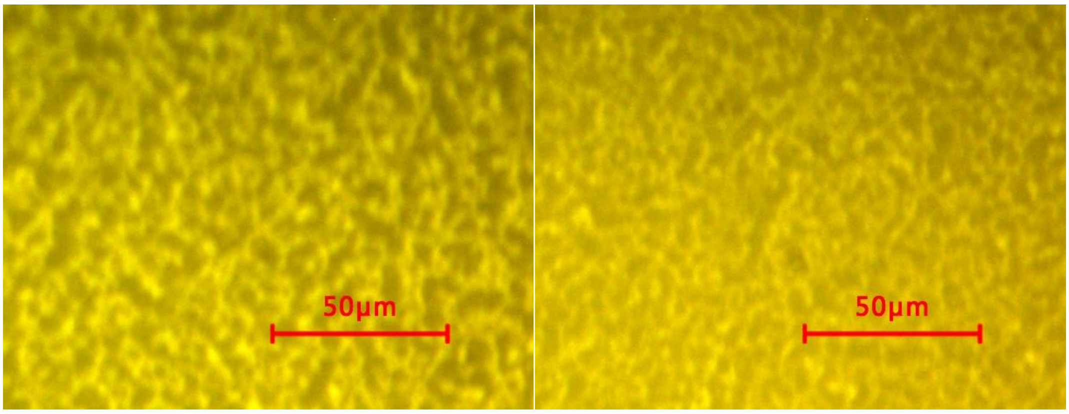
The penetration degree becomes smaller, and 0.3Wt.% carbon nanomaterial is added to reduce the penetration degree after aging by 3.45%. The greater the residual penetration ratio, the better the asphalt's anti-aging performance is to some extent. Compared with SBS modified asphalt, carbon nanomaterial/SBS modified asphalt has less change in penetration before and after aging, indicating that carbon nanomaterial/SBS modified asphalt has better thermal stability. The softening point is increased, and the softening point is increased after the aging of the 0.3 Wt.% carbon nanomaterial. Compared with SBS modified asphalt, the reduction of softening point of carbon nanomaterial/SBS modified asphalt is reduced, indicating that the effect of aging on the rheological properties of SBS modified asphalt is different from that of carbon nanomaterial/SBS modified asphalt. Compared with the softening point index, carbon nanomaterial/SBS modified asphalt has certain advantages in performance. The ductility becomes smaller, and the ductility is reduced by 22.1% after aging with 0.3 Wt.% carbon nanomaterial. It can be seen from Table 5 that even a short period of aging can greatly reduce the ductility of the asphalt. The residual ductility of the SBS modified asphalt is only 58.5% before aging, while the amount of 1Wt.% carbon nanomaterials is The residual ductility of carbon nanomaterial/SBS modified asphalt is only 45.6% before aging, which indicates that the low temperature performance of carbon nanomaterial/SBS modified asphalt after aging is worse than that of SBS modified asphalt.

Analysis of blending mechanism

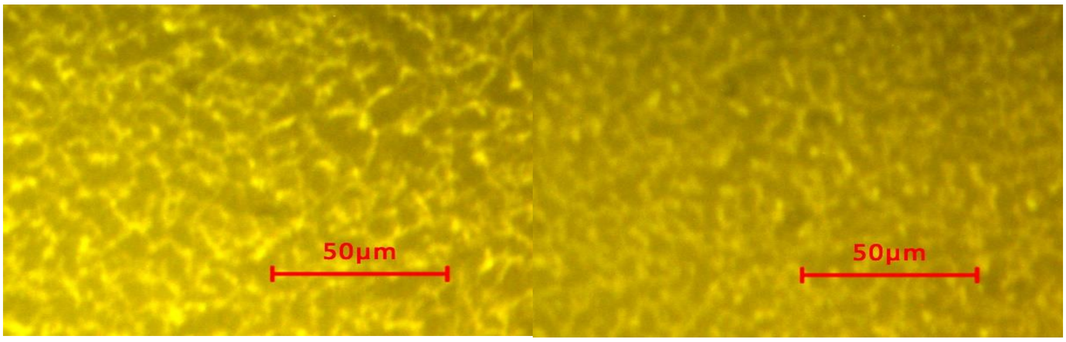
The incorporation of nanomaterials into asphalt can be divided into three forms of existence, one is agglomeration, the asphalt component is absorbed, and the intermolecular force interacts; the other is compatible with the asphalt, and the asphalt is modified at the nanometer scale. The third is dispersed between the asphalt and the modifier to act as a bridge between the SBS polymer and the matrix asphalt. The following experiments were carried out by fluorescence microscopy, scanning electron microscopy and infrared spectroscopy. The mechanism of blending carbon nanomaterials with SBS modified asphalt was studied from the perspective of microstructure, morphology and functional group evolution.

Fluorescence Microscopic structure analysis

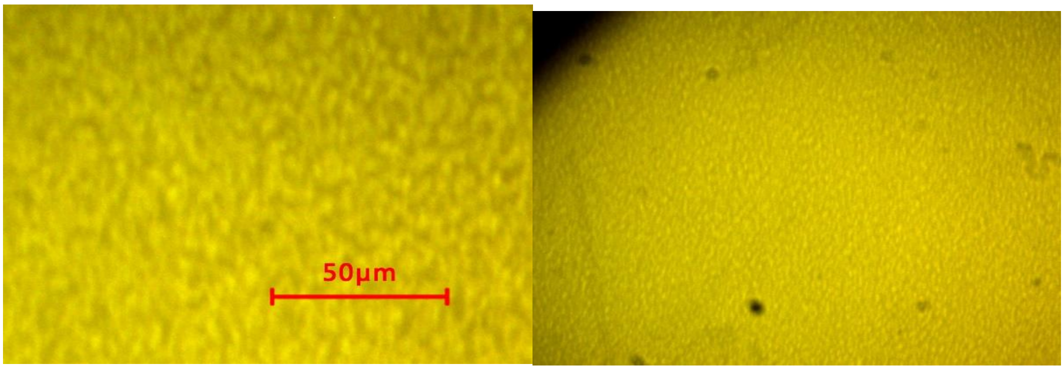
The modified asphalt samples of SBS modified asphalt and carbon nanomaterials were observed and sampled under a fluorescence microscope, and six groups of samples with microscopic structure were selected, as shown in Figure 7, where bright yellow was SBS polymer. The dark color is matrix asphalt, which is magnified 400 times; the carbon nanomaterials (graphene), SBS modified asphalt and the two sets of carbon nanomaterials/SBS modified asphalt are scanned under the image shown in Figure . 8



(A)SBS modified asphalt fluorescent Images (B) 0.1Wt.% Fluorescent pictures



(C) 0.3Wt.% fluorescent pictures (D) 0.6Wt.% fluorescent pictures

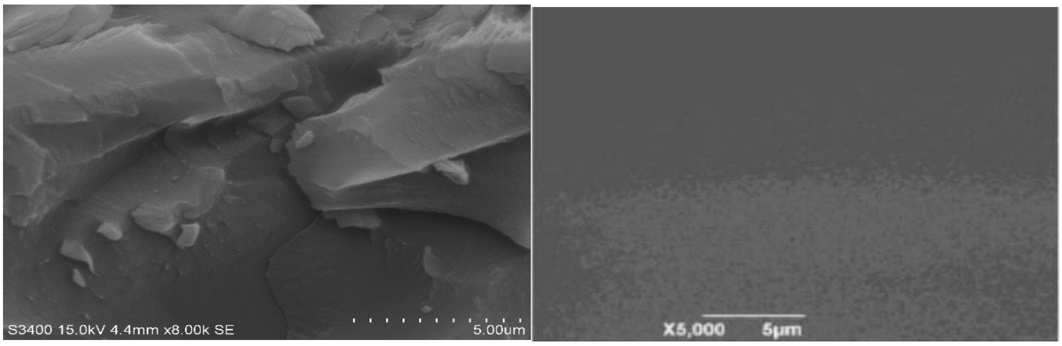


(E) 1Wt.% fluorescent pictures (F) 2Wt.% fluorescent pictures

Figure 5: Carbon Nano/SBS modified asphalt fluorescence microscopic images

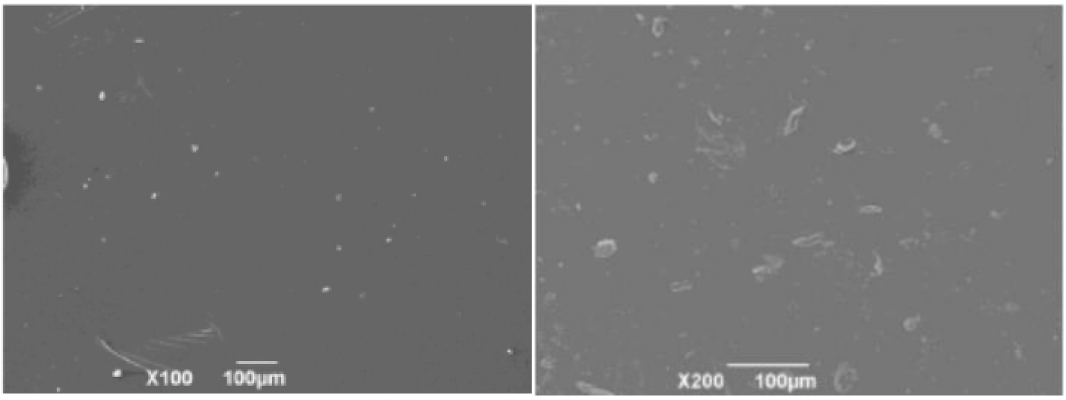
From Figure 5, it can be analyzed that for the modified bitumen of 4Wt.% SBS polymer content (Figure . a), the polymer and the matrix asphalt exhibit a continuous network structure, and the polymer is in the absorption matrix asphalt. A polymer modified asphalt phase of about 5-10 μm is formed after the light weight composition. Figure b, Figure c, Figure d, Figure f are fluorescence micrographs of carbon nanomaterials at 0.1Wt.%, 0.3Wt.%, 0.6Wt.%, 1Wt.%, 2Wt.%, respectively. There is no significant difference between the microstructure of the modified asphalt after carbon nanomaterials and the incorporation. From the analysis of Figure . b to Figure . e, it can be seen that as the amount of carbon nanomaterials increases, the interval between SBS modifiers becomes larger, and the mesh is gradually opened until the microstructure of 1Wt.% content begins to lose continuous network. The agglomeration effect of SBS polymer particles is gradually weakened, and the length distribution of SBS polymer is mainly reduced from 10~15μm to 5~10μm.

After incorporating 2Wt.% of carbon nanomaterials, the network structure of SBS polymer phase has been completely lost, the agglomeration effect of SBS particle size is sharply weakened, black agglomerated particles appear in the microstructure, and the carbon nanomaterials are too large. Carbon nanomaterials agglomerate each other, and the state of the microstructure is detrimental to the performance of the modified asphalt.



(A) Scanning electron microscopy images of carbon nanomaterials

(B) SBS modified asphalt scanning electron microscope photo



(C) 0.3Wt.% scanning electron microscope photos (D) 1Wt.% scanning electron microscope photos

Figure 6: Carbon Nano/SBS modified Asphalt scanning electron microscope image

Figure 6 (a) and (b) show the microscopic morphology of carbon nanomaterials (graphene) and SBS modified asphalt under scanning electron microscopy. The microscopic morphology shows that SBS can be uniformly dispersed to asphalt after stirring and shearing. The modification process is completed well. However, from the photos we can still see the larger banded SBS, which may be due to the partial swelling of the SBS molecules, which are dispersed in the asphalt to form local aggregate flocculation and cross-linking. The appearance is uniform. From the (c)0.3Wt.% scanning electron micrograph analysis, the modified asphalt after the carbon nanomaterials were mixed, the micro-morphology of the modified asphalt was relatively uniform, indicating that the carbon nanomaterials have good compatibility with SBS modified asphalt in the microscopic field. After incorporating 1Wt.% of carbon nanomaterials, compared with 0.3Wt.% of SBS modified asphalt and low nanomaterials added, carbon nanomaterials showed a certain degree of polymerization, and carbon particles of 10μm or more appeared. Polymerization, which has a considerable degree of polymerization for carbon particles in nanometer size.

4. Analysis of the evolution of functional groups

The wavelength of infrared light is between 0.5 and 1000 μm between visible light and microwave wavelength. The most commonly used infrared spectral region is 2.5~25μm in the mid-infrared region, and the wavenumber range corresponds to 4000~400cm-1. Infrared light of a certain wavelength illuminates the molecules of the substance being studied, and the infrared light is extracted, which causes the intensity of the light to change when the substance is irradiated. At this time, the absorption spectrum of the infrared light can be recorded, and the wave number (cm-1) or the wavelength (μm) is the most applied. As the plane abscissa, the ordinate is absorbance (A) or percent transmittance (T%). T% decreases as the absorbance increases, and the band intensity increases. The FTIR test results of carbon nanomaterials in six dosages are shown in Figure 7.

FTIR analysis of the distribution of the group in the material, to determine whether the chemical group can be generated inside the mixture after the carbon nanomaterials and the original group transformation, the absorption peak characterizes the conjugated double bond C=C stretching vibration; 1390cm-1 It is a characteristic peak of in-plane bending vibration of aliphatic CH; 1082cm-1 represents CO stretching vibration; 791cm-1 and 693cm-1 belong to the benzene ring substitution zone, which is the fingerprint zone in infrared spectrum, of which 791cm-1 is aromatic hydrocarbon CH The out-of-plane bending vibration, 693 cm-1 is the characteristic absorption peak of the olefin CH outside the bending vibration. The 2849cm-1 absorption peak in the infrared spectrum is the characteristic peak of the asymmetry stretching vibration of the alkane CH, and the 2922cm-1 is the asymmetric stretching vibration of the alkane CH. The above two absorption peaks indicate that the asphalt contains saturated hydrocarbons; 1106cm-1 represents CO stretching vibration; 724cm-1 and 682cm-1 belong to the benzene ring substitution zone, which is the fingerprint zone in the infrared spectrum, where 724cm-1 is the out-of-plane bending vibration of the alkane CH and 682cm-1 is the out-of-plane bending vibration of the olefin CH. The absorption peak, carbon nanomaterials increase the CO conjugate bond. For the blended materials, if they have good compatibility or strong chemical interaction, the characteristic peak wave number and width may appear in the infrared spectrum. Or the change of intensity, the appearance or disappearance of new characteristic peaks, etc., indicating the chemical changes in the blend system, which proves that a chemical interaction occurs between the SBS modified asphalt and the carbon nanomaterial. From the chemical point of view, the conjugate bond can be generated. The bonding strength of the groups between the internal mixtures is further enhanced.

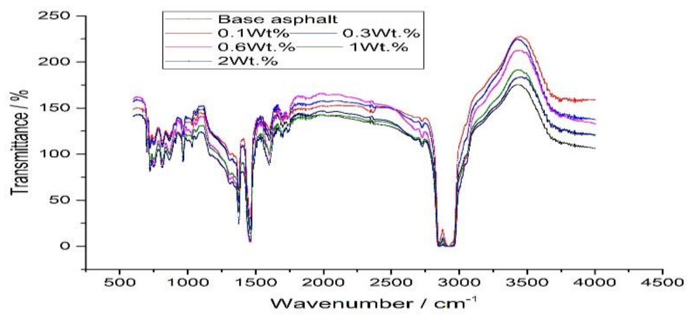


Figure 7: infrared spectroscopy of/SBS modified asphalt for carbon nanomaterials

Study on the effect of carbon nanomaterials on aging properties

Table 6: Effect of different carbon nano material dosage on physical performance index of SBS modified asphalt

Test projects / Diatomite Content	25℃ penetration/0.1mm	Softening Point/℃	5℃ extension/cm
SBS Modified Asphalt	58.5	68.3	29.4
1%	56.3	73.5	26.5
2%	55.7	76.8	24.1
3%	52.2	83.7	23.0

Table 7: Technical index of SBS modified asphalt and carbon nanomaterials after aging of modified asphalt/SBS

Test projects	SBS Modified Asphalt		0.3Wt.% Carbon Nanomaterials		0.6Wt.% Carbon Nanomaterials		3% Diatomite	
	Before aging	After aging	Before aging	After aging	Before aging	After aging	Before aging	After aging
25℃ penetration /0.1mm	58.5	58	56.3	56	55.7	55	52.2	52
5℃ extension/cm	29.4	17.2	26.5	13.4	24.1	11.0	23.0	9.5
Softening Point/℃	68.3	72.2	73.5	76.3	76.8	77.6	83.7	84.7
Quality Change/%	0.2	0.2	0.2	0.1	0.2	0.1	0.1	0.2

The SBS modified asphalt and 1%, 2%, 3% three carbon nanomaterials/SBS modified asphalt were compared before and after aging for 75min. The results are shown in Tables 6 and 7. The results are as follows:

The penetration degree becomes smaller, and 0.3Wt.% carbon nanomaterial is added to reduce the penetration degree after aging by 3.45%. The greater the residual penetration ratio, the better the asphalt's anti-aging performance is to some extent. Compared with SBS modified asphalt, carbon nanomaterial/SBS modified asphalt has less change in penetration before and after aging, indicating that carbon nanomaterial/SBS modified asphalt has better thermal stability.

The softening point is increased, and the softening point is increased after the aging of the 0.3 Wt.% carbon nanomaterial. Compared with SBS modified asphalt, the reduction of softening point of carbon nanomaterial/SBS modified asphalt is reduced, indicating that the effect of aging on the rheological properties of SBS modified asphalt is different from that of carbon nanomaterial/SBS modified asphalt. Compared with the softening point index, carbon nanomaterial/SBS modified asphalt has certain advantages in performance.

The ductility becomes smaller, and the ductility is reduced by 22.1% after aging with 0.3 Wt.% carbon nanomaterial. It can be seen from Table 7 that even a short period of aging can greatly reduce the ductility of the asphalt. The residual ductility of the SBS modified asphalt is only 58.5% before aging, while the 0.6Wt.% carbon nanomaterial is blended. The residual ductility of the carbon nanomaterial/SBS modified asphalt is only 45.6% before aging, which indicates that the low temperature performance of the carbon nanomaterial/SBS modified asphalt after aging is worse than that of the SBS modified asphalt.

5. Analysis of modification and aging performance mechanism

The internal appearance of matrix asphalt aging is the conversion and aggregation of polar substances, light components and the chemical reaction of condensation, oxidation and dehydrogenation [13]. The aging of SBS modified asphalt also includes degradation aging and performance loss of SBS modifier [14]. Carbon nanomaterials have excellent microscopic pores, uniform pore distribution and strong adsorption capacity. After optimization, the impurity components are eliminated, the purity is improved, and the surface charge distribution of carbon nanomaterials is improved. The carbon nanomaterial particles in the particle size range of about 0.5 to 5 μm are cut by the cutting device under strong shearing action. Carbon nanomaterials adsorb a large number of light components with its strong oil adsorption capacity. The carbon nanomaterial itself has higher anti-aging properties than asphalt and has a higher softening point, thus slowing the volatilization of light components. At the same time, the adsorption of lightweight components. The fraction of carbon nanomaterials in turn inhibits the penetration of oxygen and reduces the degree of aging of the asphalt. On the other hand, the addition of carbon nanomaterials makes the resistance of the SBS modifier and the asphalt phase relatively large, which reduces the ability of the molecules to move freely after aging, so that the low temperature plasticity of the asphalt after aging is reduced.

6. Conclusions

The carbon nanomaterials optimized for asphalt properties can effectively improve the high temperature performance and aging performance of asphalt after being mixed with asphalt; the carbon nanomaterials are mixed with SBS by doping process and prepared by doping with asphalt. Carbon nanomaterial/SBS composite modified asphalt can improve the high and low temperature performance and aging resistance of SBS modified asphalt to a certain extent;

The optimized carbon nanomaterial and SBS modified asphalt show good compatibility characteristics, and the generated conjugate bond can increase the bonding strength between the internal groups of the asphalt mixture, but the polymerization of carbon nanoparticles is more significant after the content of carbon nanomaterials reaches 1Wt.%. After surface modification, it can improve the compatibility in asphalt, but it also directly affects the Nano-effects. It can find the surface treatment which can improve the compatibility of Nano-materials with asphalt and cannot hinder the performance of Nano-materials. The method is crucial.

The microstructure and blending mechanism of the modified asphalt were characterized by over-fluorescence microscopy, infrared spectroscopy and scanning electron microscopy. It is concluded that the carbon nanomaterials added to the asphalt are modified from the nanometer scale on the asphalt. Adsorption in the form of agglomeration in the asphalt plays a role in modification, which is the cause of the change in the macroscopic physical properties of the asphalt.

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