

Technical sciences: Construction

DOI: <https://doi.org/10.63377/3005-4966.3-2026-01>

UDC: 625.061

IRSTI: 67.09.91

Investigation of the effect of SBS polymer concentration on the standard physical and mechanical properties of 70/100 grade bitumen***¹ Chernikov K. A., ¹ Bondar I.S., ² Bahia H.U.**¹ Kazakh Automobile and Road Institute named after L.B. Goncharov, Almaty, Republic of Kazakhstan, InDorTech LLP, Almaty, Republic of Kazakhstan² University of Wisconsin-Madison, Madison, Wisconsin, United States of America.*Corresponding author e-mail: kir.erehia@gmail.com

Received: February 02, 2026 Under review: March 05, 2026 Accepted for publication: September 15, 2026	Abstract This article presents the results of laboratory studies on the modification of road petroleum bitumen grade 70/100 produced by Kazakhstan using a styrene-butadiene-styrene (SBS) polymer of USA manufacture. The aim of the study is to assess the influence of different polymer concentrations on the standard quality indicators of the binder, which determine its operational reliability in road pavements. The testing program included the determination of needle penetration depth (penetration), softening point by Ring and Ball method, extensibility (ductility), and Fraass breaking point. Attention is paid to the analysis of the modified binder's resistance to technological aging (RTFOT), stimulating the process of asphalt concrete mixture preparation and paving. It has been established that the introduction of the SBS polymer significantly expands the plasticity range of the bitumen, increasing heat resistance and lowering the breaking point. The results of the elastic recovery test confirm the information of an elastic polymer network within the binder structure, contributing to increased durability of the road pavement. The obtained data allow for the determination of the optimal modified dosage based on regulatory requirements and the climatic conditions of Kazakhstan. Keywords: bitumen modification, SBS polymer, polymer bitumen, physical-mechanical properties, penetration, softening point (Ring and Ball)
Chernikov K.A.	Information about authors: Kazakh Automobile and Road Institute named after L.B. Goncharov, Almaty, Republic of Kazakhstan; ORCID ID: https://orcid.org/0009-0003-1776-9166 E-mail: kir.erehia@gmail.com
Bondar I.S.	Candidate of Technical Sciences (RF), PhD, Associate Professor, Kazakh Automobile and Road Institute named after L.B. Goncharov, Almaty, Republic of Kazakhstan. ORCID ID: https://orcid.org/0000-0001-7376-5643 E-mail: ivan_sergeevich_08@mail.ru
Bahia H.U.	PhD, Professor, University of Wisconsin-Madison, Madison, Wisconsin, United States of America. ORCID ID: https://orcid.org/0000-0002-0227-7009 E-mail: bahia@engr.wisc.edu

Техникалық ғылымдар. Құрылыс

DOI: <https://doi.org/10.63377/3005-4966.3-2026-01>

ӘОЖ: 625.061

FTAMP: 67.09.91

**70/100 маркалы битумның стандартты физика-механикалық көрсеткіштеріне
SBS полимері концентрациясының әсерін зерттеу*****¹Черников К.А., ¹Бондарь И.С., ²Бахиа Х.У.**¹ Л.Б. Гончаров атындағы Қазақ автомобиль-жол институты, Алматы қ., Қазақстан² Висконсин-Мэдисон университеті, Мэдисон, Висконсин, Америка Құрама Штаттары*Хат алмасу үшін автор (корреспондент-автор): Kir.Eremia@gmail.com

Мақала келді: Ақпан 02, 2026 Сараптамадан өтті: Наурыз 05, 2026 Қабылданды: Қыркүйек 15, 2026	Түйіндеме Бұл жұмыста Қазақстан өндірген 70/100 маркалы жол мұнай битумын америкалық өндірістегі стирол-бутадиен-стирол (SBS) типті полимермен модификациялау бойынша зертханалық зерттеулердің нәтижелері ұсынылған. Зерттеудің мақсаты – жол жабындарындағы пайдалану сенімділігін анықтайтын байланыстырғыштың стандартты сапалық көрсеткіштеріне полимердің әртүрлі концентрациясының әсерін бағалау. Сынақ бағдарламасы ине сұғу тереңдігін (пенетрацияны), «Сақина және Шар» әдісі бойынша жұмсару температурасын, созылмалылықты (дуктильдікті) және Фраас бойынша морттық температурасын анықтауды қамтыды. Асфальтбетон қоспасын дайындау және төсеу процестерін имитациялайтын технологиялық ескіруге (RTFOT) модификацияланған байланыстырғыштың тұрақтылығын талдауға ерекше назар аударылды. SBS полимерін енгізу битумның иілімділік аралығын айтарлықтай кеңейтіп, жылуға төзімділікті арттыратыны және морттық температурасын төмендететіні анықталды. Эластикалық қайтарым сынағының нәтижелері байланыстырғыш құрылымында серпімді полимерлік тордың қалыптасқанын растайды, бұл жол жабынының ұзақ мерзімділігін арттыруға септігін тигізеді. Алынған деректер нормативтік талаптар негізінде Қазақстанның климаттық жағдайларына сүйене отырып, модификатордың оңтайлы мөлшерін анықтауға мүмкіндік береді. Түйін сөздер битумды модификациялау, SBS полимері, физика-механикалық қасиеттер, пенетрация, жұмсару температурасы (СжШ)
Черников К. А.	Авторлар туралы ақпарат: Л.Б. Гончаров атындағы Қазақ автомобиль-жол институты Алматы қ., Қазақстан Республикасы. ORCID ID: https://orcid.org/0009-0003-1776-9166 E-mail: kir.eremia@gmail.com
Бондарь И. С.	Ресей Федерациясының Жоғары аттестаттау комиссиясы Т.ғ.к, ҚР БҒМ PhD докторы, Қазақстан Республикасы Білім және ғылым министрлігінің доценті (ассистент). Л.Б. Гончаров атындағы Қазақ автомобиль-жол институты Алматы қ., Қазақстан Республикасы. ORCID ID: https://orcid.org/0000-0001-7376-5643 E-mail: ivan_sergeevich_08@mail.ru
Бахиа Х. У.	PhD, Висконсин-Мэдисон университетінің профессоры, Мэдисон, Висконсин, Америка Құрама Штаттары. ORCID ID: https://orcid.org/0000-0002-0227-7009 E-mail: bahia@engr.wisc.edu

Технические науки. Строительство

DOI: <https://doi.org/10.63377/3005-4966.3-2026-01>

УДК: 625.061

МРНТИ: 67.09.91

Исследование влияния концентрации SBS - полимера на стандартные физико-механические показатели битума марки 70/100***¹Черников К.А., ¹Бондарь И.С., ²Бахиа Х.У.**¹ Казахский автомобильно-дорожный институт им Л.Б. Гончарова, г. Алматы, Казахстан, ТОО «ИнДорТех», г. Алматы, Казахстан² Университет Висконсин-Мэдисон, Мэдисон, Висконсин, Соединённые Штаты Америки*Автор-корреспондент e-mail: Kir.Eremia@gmail.com

Поступила: Февраль 02, 2026 Рецензирование: Март 05, 2026 Принята в печать: Сентябрь 15, 2026	Аннотация В данной статье представлены результаты лабораторных исследований, выполненных по по модификации битума нефтяного дорожного, марки 70/100 (производство Казахстан), полимером типа стирол-бутадиен-стирол (СБС, производство США). Целью исследования - является оценка опытным путём влияния различной концентрации полимера на стандартные качественные показатели вяжущего, определяющего его эксплуатационную надёжность в дорожных покрытиях. Программа лабораторных испытаний включала испытания, регламентируемые СТ РК, ГОСТ, такие, как: определение глубины проникания иглы (пенетрация), температура размягчения по кольцу и шару (КиШ), растяжимости (дуктильность), температура хрупкости по Фраасу. При проведении работы особое внимание было уделено анализу устойчивости модифицированного вяжущего к старению (RTFOT), имитирующему процесс старения при производстве асфальтобетонной смеси на асфальтобетонном заводе, и укладку готовой смеси. По результатам лабораторных испытаний установлено, что введение SBS полимера существенно расширяет интервал пластичности битума, повышая теплостойкость и снижая температуру хрупкости. Результаты теста на эластичный возврат подтверждают формирование упругой полимерной сетки в структуре вяжущего, что способствует повышению долговечности дорожного покрытия. Полученные данные позволяют определить оптимальную дозировку модификатора, опираясь на климатические условия Казахстана на основе нормативных требований. Ключевые слова: Модификация битума, СБС-полимер, полимер битум, физико-механические свойства, пенетрация, температура размягчения (КиШ)
Черников К.А.	Информация об авторах: Казахский автомобильно-дорожный институт им. Л.Б. Гончарова, г. Алматы, Казахстан. ORCID ID: https://orcid.org/0009-0003-1776-9166 E-mail: kir.eremia@gmail.com
Бондарь И.С.	К.т.н. ВАК РФ, PhD МОН РК, Ассоциированный профессор (Доцент) МНУВО РК. Казахский автомобильно-дорожный институт им. Л.Б Гончарова, г. Алматы, Казахстан. ORCID ID: https://orcid.org/0000-0001-7376-5643 E-mail: ivan_sergeevich_08@mail.ru
Бахиа Х.У.	PhD, Профессор, Университет Висконсин-Мэдисон, Мэдисон, Висконсин, Соединённые Штаты Америки. RCID ID: https://orcid.org/0000-0002-0227-7009 E-mail: bahia@engr.wisc.edu

1. Introduction

The durability and long-term performance of asphalt pavements are strongly influenced by the temperature susceptibility and mechanical behavior of bituminous binders [1,2]. This issue is particularly important in regions characterized by pronounced seasonal temperature variations, such as Kazakhstan, where pavement materials are exposed to both high summer temperatures and severe winter conditions. Conventional paving-grade bitumens may exhibit excessive softening at elevated temperatures, increasing susceptibility to permanent deformation, while at low temperatures they may become brittle and more prone to thermal cracking [3,4]. Therefore, improving the temperature stability and deformation resistance of bituminous binders remains an important task in modern road engineering.

Polymer modification is widely used to enhance the performance characteristics of paving bitumen. Among the available modifiers, styrene–butadiene–styrene (SBS) block copolymers have received considerable attention because of their ability to improve the elastic response and temperature stability of bituminous binders. When appropriately dispersed within the bitumen, SBS can alter the binder structure and contribute to improved resistance to deformation at elevated temperatures while maintaining favorable behavior under low-temperature conditions [5,6]. The effectiveness of SBS modification, however, depends on several factors, including the properties of the base bitumen, polymer characteristics, polymer concentration, and preparation conditions.

The selection of an appropriate SBS dosage is therefore of practical importance. Insufficient polymer content may not provide the required improvement in binder properties, whereas excessive polymer addition may substantially increase binder stiffness and complicate processing and handling. Consequently, the influence of polymer concentration should be evaluated for the specific base bitumen being modified rather than assumed solely from previously published data or general recommendations.

In the present study, paving-grade bitumen 70/100 produced in Kazakhstan was modified with a linear SBS block copolymer containing approximately 31% styrene by mass. Polymer concentrations of 4%, 5%, and 6% were investigated, with 4% corresponding to the dosage recommended by the polymer manufacturer. The modified binders were evaluated using standard physical and mechanical tests, including penetration at 25°C, softening point by the Ring-and-Ball method, ductility, Fraass breaking point, and elastic recovery. Resistance to short-term thermal oxidative aging was additionally assessed using the Rolling Thin Film Oven Test (RTFOT).

The aim of this study was to evaluate the effect of SBS polymer concentration on the standard physical and mechanical properties of 70/100 grade bitumen and to compare the performance of the investigated polymer dosages before and after short-term aging. Particular attention was given to changes in high-temperature resistance, low-temperature behavior, consistency, and elastic recovery in order to identify a rational SBS concentration range for the investigated binder under the climatic and regulatory conditions relevant to Kazakhstan.

2. Materials and methods

The durability and long-term performance of asphalt pavements are strongly influenced by the temperature susceptibility and mechanical behavior of bituminous binders. This issue is particularly important in regions characterized by pronounced seasonal temperature variations, such as Kazakhstan, where pavement materials are exposed to both high summer temperatures and severe winter conditions. Conventional paving-grade bitumens may exhibit excessive softening at elevated temperatures, increasing susceptibility to permanent deformation, while at low temperatures they may become brittle and more prone to thermal cracking [3,7,8]. Therefore, improving the temperature stability and deformation resistance of bituminous binders remains an important task in modern road engineering.

Polymer modification is widely used to enhance the performance characteristics of paving bitumen. Among the available modifiers, styrene–butadiene–styrene (SBS) block copolymers have received considerable attention because of their ability to improve the elastic response and

temperature stability of bituminous binders. When appropriately dispersed within the bitumen, SBS can alter the binder structure and contribute to improved resistance to deformation at elevated temperatures while maintaining favorable behavior under low-temperature conditions [5,9,10]. The effectiveness of SBS modification, however, depends on several factors, including the properties of the base bitumen, polymer characteristics, polymer concentration, and preparation conditions.

The selection of an appropriate SBS dosage is therefore of practical importance. Insufficient polymer content may not provide the required improvement in binder properties, whereas excessive polymer addition may substantially increase binder stiffness and complicate processing and handling. Consequently, the influence of polymer concentration should be evaluated for the specific base bitumen being modified rather than assumed solely from previously published data or general recommendations.

In the present study, paving-grade bitumen 70/100 produced in Kazakhstan was modified with a linear SBS block copolymer containing approximately 31% styrene by mass. Polymer concentrations of 4%, 5%, and 6% were investigated, with 4% corresponding to the dosage recommended by the polymer manufacturer. The modified binders were evaluated using standard physical and mechanical tests, including penetration at 25°C, softening point by the Ring-and-Ball method, ductility, Fraass breaking point, and elastic recovery. Resistance to short-term thermal oxidative aging was additionally assessed using the Rolling Thin Film Oven Test (RTFOT) [5,11].

The aim of this study was to evaluate the effect of SBS polymer concentration on the standard physical and mechanical properties of 70/100 grade bitumen and to compare the performance of the investigated polymer dosages before and after short-term aging. Particular attention was given to changes in high-temperature resistance, low-temperature behavior, consistency, and elastic recovery in order to identify a rational SBS concentration range for the investigated binder under the climatic and regulatory conditions relevant to Kazakhstan.

3. Results

The data analysis reveals significant changes in the binder characteristics within the high-temperature range. The results of the heat resistance evaluation for the base and modified bitumen, both before and after aging, are presented in Figure 1.

The softening point, determined by the Ring and Ball (R&B) method, serves as an indicator of heat resistance and demonstrated a direct correlation with polymer concentration [12]. While the base bitumen recorded a value of 48°C, the introduction of 4% SBS polymer shifted the phase transition point to 69.6°C. Further increasing the polymer content to 5% and 6% raised this indicator to 73.7°C and 76.6°C, respectively. Following short-term aging via the RTFOT method, the softening point increased to 74.5°C for the 4% polymer content and to 80.3°C for the 6% polymer content.

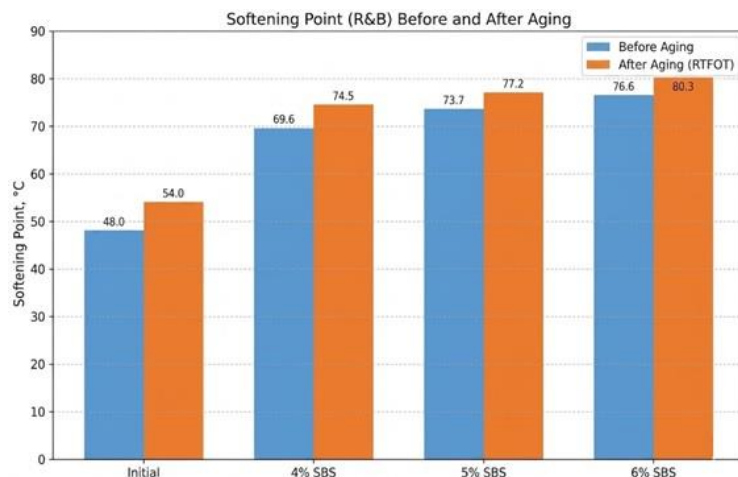


Figure 1. Comparative histogram of softening points for base and polymer-modified bitumen before and after aging [author's material]

Further evaluation of physical and mechanical properties included the determination of the needle penetration depth at 25°C. The dynamics of this parameter are illustrated in Figure 2.

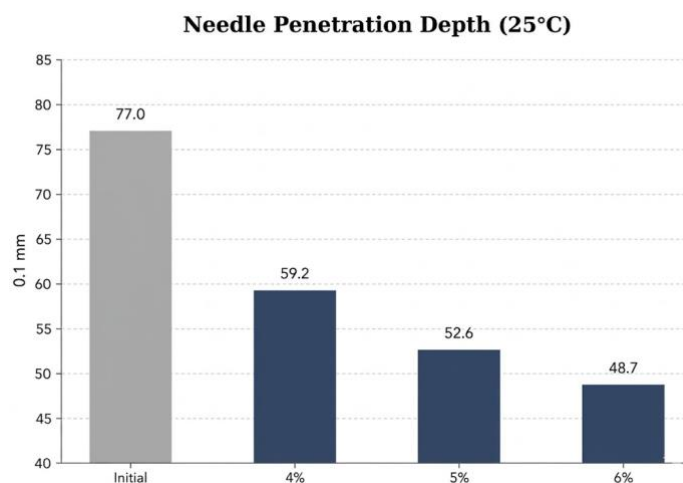


Figure 2. Comparative histogram of penetration depth for base and polymer-modified bitumen [author's material]

Regarding the penetration depth at 25°C, a consistent densification of the structure was observed: penetration values decreased from 77.0 (0.1 mm) for the base bitumen to 59.2 (0.1 mm) at 4% polymer content, and further to 48.7 (0.1 mm) at the maximum dosage of 6%. This reduction in permeability is attributed not to the oxidation of oils, but to the physical interaction between the polymer chains and the maltene fraction of the bitumen. The binder becomes denser, which enhances its cohesive strength—the ability to resist internal rupture [13].

The influence of polymer concentration on the visco-plastic properties of the binder is shown in Figure 3.

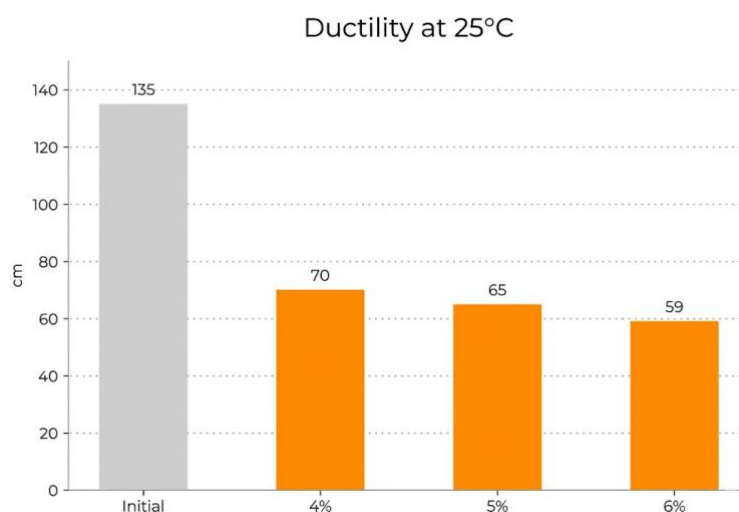


Figure 3. Comparative histogram of bitumen ductility [author's material]

Based on the presented data, the ductility of the base bitumen was 135 cm, which is characteristic of viscous liquid media. However, a slight decrease in ductility was noted, ranging from 70 cm at 4% polymer content to 59 cm at 6%.

The most critical result is the assessment of the modified binder at low temperatures. Generally, modifying bitumen to make it stiffer can impair its frost resistance. However, SBS polymer, as a thermoplastic elastomer, demonstrated a different trend in laboratory tests, as shown in Figure 4.

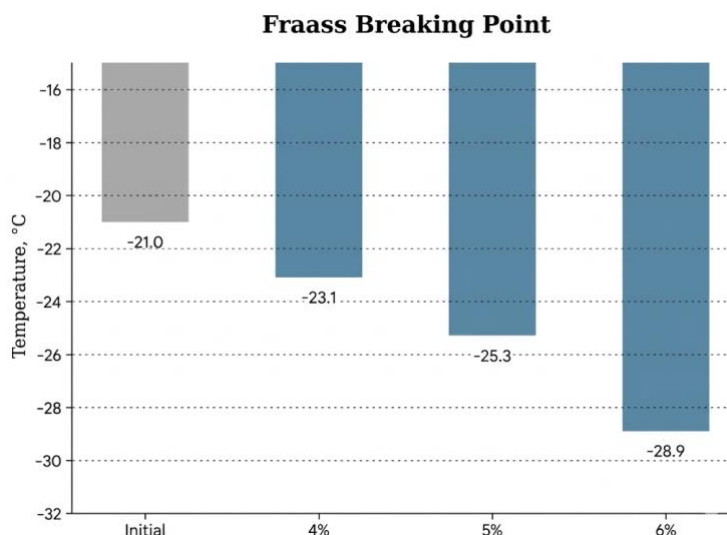


Figure 4. Comparative histogram of Fraass breaking points for base and polymer-modified bitumen [author's material]

The test data show an inverse correlation: as the binder stiffness increases, the Fraass breaking point does not rise but instead decreases. At a 4% polymer concentration, the temperature is -23.1°C, and at 6%, it reaches -28.9°C. This difference of nearly 6°C demonstrates a substantial safety margin for the winter operation of highways [13].

The ability of the binder to recover after deformation was evaluated using the elastic recovery index, the results of which are shown in Figure 5. This laboratory test is conducted exclusively for polymer-modified bitumen (PMB).

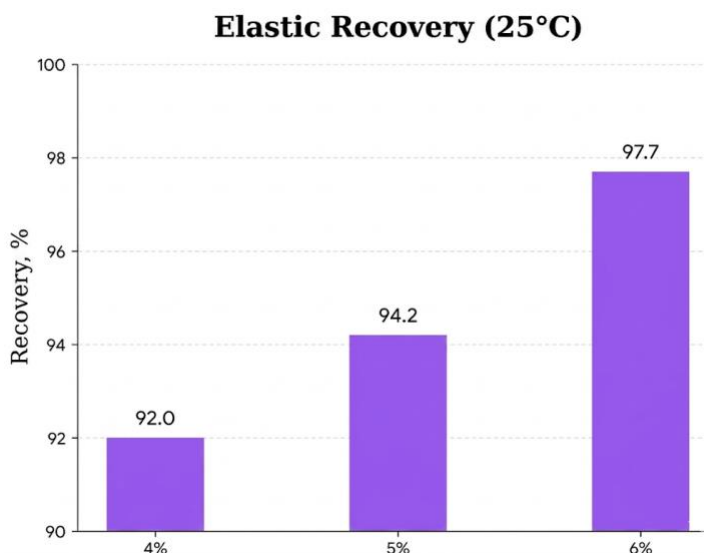


Figure 5. Comparative histogram of elastic recovery for polymer-modified bitumen [author's material]

According to the experimental results, values exceeding 90% elastic recovery (92%, 94.2%, and 97.7% for 4%, 5%, and 6% polymer content, respectively) classify the resulting material as a high-performance polymer-modified binder (PMB). An elastic recovery rate close to 100% indicates that the deformations within the material are reversible.

4. Discussion

The experimental results demonstrate a systematic influence of SBS concentration on the conventional physical and mechanical properties of 70/100 grade bitumen. Increasing the SBS

content from 4% to 6% resulted in a progressive increase in softening point, a reduction in penetration, a decrease in ductility, an improvement in low-temperature resistance according to the Fraass test, and an increase in elastic recovery. Taken together, these changes indicate that SBS modification alters the balance between stiffness and elasticity of the binder rather than simply increasing its hardness. The observed trends are consistent with the general behavior of SBS-modified bituminous binders reported in previous studies [1–4,14,15].

The softening point increased markedly from 48.0°C for the unmodified binder to 69.6°C, 73.7°C, and 76.6°C for the binders containing 4%, 5%, and 6% SBS, respectively. This trend indicates a substantial improvement in the resistance of the binder to softening at elevated temperatures. The greatest absolute increase occurred after the initial addition of 4% SBS, whereas further increases from 4% to 5% and from 5% to 6% produced progressively smaller increments in softening point. This suggests that the relationship between SBS concentration and the conventional high-temperature indicator is not proportional over the investigated range. Similar improvements in high-temperature behavior after SBS modification have been attributed in the literature to the development of a polymer-rich structure within the bituminous matrix and to the elastic contribution of the SBS phase [5,16]. However, the present study did not include microscopic or spectroscopic characterization; therefore, the formation and morphology of such a polymer network cannot be directly confirmed from the current data.

A corresponding change was observed in penetration at 25°C, which decreased from 77.0×0.1 mm for the base bitumen to 59.2, 52.6, and 48.7×0.1 mm as the SBS content increased from 4% to 6%. The decrease in penetration reflects an increase in binder consistency and reduced susceptibility to deformation under the conditions of the penetration test. This result is consistent with the simultaneous increase in softening point and confirms that higher SBS concentrations lead to a stiffer binder response at intermediate and elevated temperatures. Nevertheless, penetration is an empirical consistency parameter and does not by itself provide a direct measure of shear resistance, rutting resistance, or the molecular interaction between SBS and the bitumen fractions. Such mechanisms would require additional rheological or physicochemical characterization.

The ductility results show a different trend. The base bitumen exhibited a ductility of 135 cm, whereas the values decreased to 70 cm, 65 cm, and 59 cm at SBS concentrations of 4%, 5%, and 6%, respectively. This represents a substantial reduction in conventional elongation capacity as measured by the ductility test. For polymer-modified binders, however, lower conventional ductility should not necessarily be interpreted as deterioration in deformation performance, because SBS introduces an elastic response that is not adequately characterized by elongation to rupture alone. In this respect, elastic recovery provides a more relevant complementary indicator of the response of the modified binder after deformation. The results obtained in this study therefore illustrate the limitation of relying on ductility as a single indicator when evaluating polymer-modified bitumen.

The low-temperature results are particularly important because increasing binder stiffness can potentially reduce resistance to thermal cracking. In the present study, however, the Fraass breaking point decreased from –21.0°C for the unmodified bitumen to –23.1°C, –25.3°C, and –28.9°C for the 4%, 5%, and 6% SBS-modified binders, respectively. Thus, the increase in conventional high-temperature stiffness was accompanied by an improvement rather than a deterioration in the Fraass low-temperature indicator. This behavior is consistent with the thermoplastic elastomeric nature of SBS and with previous studies reporting that SBS modification may improve the balance between high-temperature resistance and low-temperature flexibility [2,117]. At the same time, the Fraass test remains an empirical method; therefore, the present results should not be interpreted as a complete assessment of low-temperature cracking resistance. Further investigation using rheological low-temperature methods, such as the Bending Beam Rheometer, would provide a more comprehensive evaluation.

Elastic recovery increased consistently with polymer concentration, reaching 92.0%, 94.2%, and 97.7% for binders containing 4%, 5%, and 6% SBS, respectively. This is one of the clearest indications of the effect of polymer modification observed in the study. The high recovery values show that the modified binders were able to recover a substantial portion of the imposed deformation, and the trend indicates that this elastic response became more pronounced as SBS content increased. These results are consistent with published studies describing the transition of SBS-modified binders toward more pronounced viscoelastic behavior due to the contribution of the polymer phase [13–15]. Nevertheless, elastic recovery should be considered together with other rheological indicators rather than used as an independent measure of overall pavement performance.

Short-term aging also affected the binders, as indicated by the increase in softening point after RTFOT. For example, the softening point of the 4% SBS binder increased from 69.6°C to 74.5°C, while that of the 6% SBS binder increased from 76.6°C to 80.3°C. The increase in softening point after aging is consistent with the hardening typically associated with thermal oxidative exposure during asphalt production and placement. Previous studies have shown that SBS-modified binders may undergo complex changes during aging, including both oxidation of the bituminous phase and degradation or restructuring of the polymer phase [18–20]. The present results confirm that the binders undergo measurable hardening after RTFOT, but the available data are insufficient to characterize the aging mechanism in detail. A more complete assessment would require additional parameters such as penetration retention, mass change, rheological indices before and after aging, or chemical analysis.

From a practical perspective, the results indicate that even the lowest investigated SBS dosage of 4% produced a pronounced improvement in softening point, Fraass breaking point, and elastic recovery compared with the unmodified binder. Increasing the SBS content to 5% and 6% provided further improvements in these indicators, but the magnitude of the additional benefit was smaller for some properties, particularly the softening point. At the same time, penetration and ductility continued to decrease as polymer concentration increased. Therefore, the selection of an appropriate SBS dosage should be based on a balance between high-temperature resistance, low-temperature behavior, elastic response, and technological requirements rather than on maximizing a single property.

The present study is limited to conventional physical and mechanical indicators and short-term aging assessment. It does not include direct measurements of viscosity, storage stability, dynamic shear rheology, MSCR response, BBR behavior, mixture-level rutting or cracking performance, or field compaction. Consequently, conclusions regarding production temperature, workability, compaction behavior, long-term pavement performance, or economic efficiency cannot be established solely from the current experimental results. Future research should combine the standard tests used in this study with rheological characterization and asphalt-mixture performance testing to determine more precisely the SBS concentration that provides the most appropriate balance of properties for the climatic and operating conditions of Kazakhstan.

5. Conclusion

Summarizing the comprehensive physical and mechanical characteristics obtained, it can be stated that the introduction of the SBS polymer (produced in the USA) allows for the expansion of the binder's operational temperature range (plasticity interval) to impressive values exceeding 100°C (from -28.9°C to +76.6°C).

From the perspective of technical and economic feasibility, and based on the laboratory research results, the following conclusions can be drawn:

4% Polymer Content: This concentration provides an optimal balance between performance properties and processability. The recorded indicators (Softening Point, ductility, elastic recovery) fully comply with the regulatory requirements of the ST RK (Standards of the Republic of Kazakhstan) and are suitable for use on high-category highways. Furthermore, the

laying and compaction of the asphalt mix remain standard, with no significant risk of under-compaction, provided that temperature regimes and technological protocols are followed. This is recommended as the baseline solution for enhancing the performance of high-traffic roads.

5% Polymer Content: A binder with 5% polymer content demonstrates maximum physical and mechanical performance in terms of heat and crack resistance. However, its application requires enhanced quality control during the production and transportation of the mix. Due to the higher polymer percentage, the bitumen viscosity increases, which leads to a rapid loss of workability as the material cools. The use of this composition is justified only with strict adherence to temperature regimes, short transport distances, and the availability of high-efficiency compaction equipment.

6% Polymer Content: At a 6% dosage, the formation of a continuous polymer network is observed, leading to the maximization of elastic properties. The viscosity of the binder becomes even higher compared to the 5% concentration, creating critical risks during construction: the mix becomes overly stiff, requiring a significant increase in production temperature at the asphalt plant (which leads to premature bitumen aging), and field compaction becomes difficult. The use of this polymer concentration in road construction is considered inexpedient for both technological and economic reasons.

Conflict of Interest. The corresponding author declares that there is no conflict of interest.

Cite this article as: Chernikov K. A., Bondar I.S., Bahia H.U. Investigation of the effect of SBS polymer concentration on the standard physical and mechanical properties of 70/100 grade bitumen. *Vestnik Kazahskogo avtomobil'no-dorozhnogo instituta* = *Bulletin of Kazakh Automobile and Road Institute* = *Kazakh avtomobil-zhol institutynyn Khabarshysy*. 2026; 3 (15), 3-13. <https://doi.org/10.63377/3005-4966.3-2026-01>

References

1. Taheri, A., Khodaii, A., & Hajikarimi, P. (2026). Correlations among chemical and rheological aging indices/indicators of asphalt binder at high temperatures. *Scientific Reports*, 16. <https://doi.org/10.1038/s41598-026-40007-6>
2. Roy, S., Ali, A., & Bharath, G. (2026). Performance Study of Polymer Modified Asphalt for Durable Pavements. *International Journal For Multidisciplinary Research*. <https://doi.org/10.36948/ijfmr.2026.v08i01.67553>
3. Imanbayev, Y., Ongarbayev, Y. K., Zhambolova, A., Kanzharkan, Y., Kenzhagaliyeva, A., Myltykbayeva, Z. K., Yensegenova, U., Bussurmanova, A., & Akkenzheyeva, A. (2026). Rheological and Mechanical Characterization of Asphalt Binder Modified with Plastic Waste Polymers. *Polymers*, 18. <https://doi.org/10.3390/polym18131574>
4. Teltayev, B., & Suppes, E. (2019). Temperature and moisture distribution in a highway in south-eastern Kazakhstan. *MATEC Web of Conferences*. <https://doi.org/10.1051/mateconf/201926502005>
5. Pipintakos, G., Škulteckė, J., Vaitkus, A., Šernas, O., & Soenen, H. (2025). Optimising bitumen modification: how styrene-butadiene-styrene (SBS) characteristics and content affect bitumen behaviour. *Road Materials and Pavement Design*, 26, 443 - 463. <https://doi.org/10.1080/14680629.2025.2482842>
6. Yan, C., Xi, J., Ai, C., & Leng, Z. (2023). Investigating the unique entropy-elasticity of polymer modified asphalt. *Cleaner Materials*. <https://doi.org/10.1016/j.clema.2023.100216>
7. Teltayev, B., & Radovskiy, B. (2016). Low Temperature Cracking Problem for Asphalt Pavements in Kazakhstan. 139-144. https://doi.org/10.1007/978-94-024-0867-6_20
8. Shambilova, G., Iskakov, R., Shazhdekeyeva, N., Kuanbayeva, B., Kuzin, M. S., Skvortsov, I., & Makarov, I. S. (2025). Environmentally Sustainable and Climate-Adapted Bitumen-Composite Materials for Road Construction in Central Asia. *Infrastructures*. <https://doi.org/10.3390/infrastructures10120345>

9. Hong, Z., Yan, K., Ge, D., Wang, M., Li, G., & Li, H. (2022). Effect of styrene-butadiene-styrene (SBS) on laboratory properties of low-density polyethylene (LDPE)/ethylene-vinyl acetate (EVA) compound modified asphalt. *Journal of Cleaner Production*. <https://doi.org/10.1016/j.jclepro.2022.130677>
10. Hong, Z., Yan, K., Ge, D., Wang, M., Li, G., & Li, H. (2022). Effect of styrene-butadiene-styrene (SBS) on laboratory properties of low-density polyethylene (LDPE)/ethylene-vinyl acetate (EVA) compound modified asphalt. *Journal of Cleaner Production*. <https://doi.org/10.1016/j.jclepro.2022.130677>
11. Shah, S. K., Almansour, A. I., Gao, Y., & Zubair, M. (2026). Comparative Evaluation of Short-Term PAV and Conventional Short-Term Aging Protocols for Thermoplastic-Modified Asphalt Binders. *Materials*, 19. <https://doi.org/10.3390/ma19102061>
12. Shakhmov, Z., Zhumagulova, A., Kosparmakova, S., Kozhahmet, A., & Kabdrashit, J. (2023). Properties of modified bitumen in road construction. *Technobius*. <https://doi.org/10.54355/tbus/3.2.2023.0040>
13. Hetemoğlu, Y. O., Çubuk, M. K., & Gürü, M. (2025). Improvement in Performance Characteristics of Bitumen and Bituminous Mixtures by Means of Polyvinyl Acetate. *Construction Materials*. <https://doi.org/10.3390/constrmater5010009>
14. Bahia, H. U., Hanson, D. I., Zeng, M., Zhai, H., Khatri, M. A., & Anderson, R. M. (2001). *Characterization of modified asphalt binders in Superpave mix design* (NCHRP Report No. 459). Transportation Research Board, National Research Council. http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_459-a.pdf
15. Liu, D., Li, J., Guo, H., Yang, K., Cao, Q., Guo, F., & Yao, T. (2025). Chemical composition-driven performance evaluation model for sbs-modified asphalt using multivariate statistical. *Scientific Reports*, 15. <https://doi.org/10.1038/s41598-025-27348-4>
16. Bansal, S., Gupta, V., Chopra, T., & Mehta, R. (2024). Styrene-Butadiene-Styrene polymer modified bitumen: A review on compatibility and physico-chemical properties. *Physica Scripta*, 99. <https://doi.org/10.1088/1402-4896/ad9113>
17. Khan, I., Bilal, M., Khaliq, W., Khan, N., Khahro, S., Memon, Z., & Malik, M. A. (2024). Evaluating the dynamic response and phase angle behavior of SBS-modified asphalt mixtures for enhanced pavement performance. *Scientific Reports*, 14. <https://doi.org/10.1038/s41598-024-79869-z>
18. Wang, F., R., Li, Y., Sun, M., Wang, Y., Sun, Y., & Cheng, P. (2025). Weathering aging resistance in seasonal frozen regions: A comparative study of SBS- and SBR-modified asphalt binders through rheological and morphological characterization. *Scientific Reports*, 15. <https://doi.org/10.1038/s41598-025-98396-z>
19. Shah, S. K., Almansour, A. I., Gao, Y., & Zubair, M. (2026). Comparative Evaluation of Short-Term PAV and Conventional Short-Term Aging Protocols for Thermoplastic-Modified Asphalt Binders. *Materials*, 19. <https://doi.org/10.3390/ma19102061>
20. Nie, Y., Bai, Y., Liu, F., Li, P., & Zhou, Z. (2025). Molecular Insights into the Kinetic Aging Mechanisms of SBS-Modified Asphalt. *Materials*, 18. <https://doi.org/10.3390/ma18214821>