Investigate the Effect of Using Reclaimed Asphalt Pavement RAP and Polymer-Modified Bitumen on the Moisture Damage of Hot Mix Asphalt

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Abstract. Asphalt additives, in general, aim to improve the performance of asphalt mixtures by enhancing their durability and resistance to cracking and other forms of damage. Asphalt additives can be natural or synthetic, and some are biodegradable. Natural asphalt additives, such as reclaimed asphalt pavement, are much more environmentally friendly than synthetic ones. Using environmentally friendly asphalt additives can help reduce the environmental impact of the asphalt mix while enhancing its performance. This study aims to evaluate the effects of using reclaimed asphalt paving (RAP) and styrene butadiene styrene (SBS) on the performance and moisture damage of asphalt mixture, and ordinary Portland cement (OPC) was used as mineral fillers. The research includes establishing a standard reference mix for comparison and two mixtures with different quantities of reclaimed asphalt paving at percentages (15, 30, and 45%) and polymer (SBS) at 4%. The Marshall test for stability and the indirect tensile strength test were among the tests used to evaluate the mechanical properties, and the results showed that the use of reclaimed asphalt pavers and polymer-prepared bitumen led to a significant improvement in the performance of the asphalt mixture and reduced moisture damage compared to the reference mixture.

Keywords: Moisture damage; reclaimed asphalt pavement; styrene–butadiene–styrene (SBS); Hot mix asphalt

1. INTRODUCTION

The early stages of paving often reveal significant issues and discomfort with the pavement. Due to various factors (high traffic density and climatic conditions represented by temperature and humidity) because of their ability to affect the hardness and deterioration of paving materials, these elements have long been considered in road design. Asphalt concrete pavement does not always meet acceptable quality standards under difficult climatic conditions and traffic loads, such as the impact of summer and winter temperature differences, load intensity, etc.. These elements all play a role in the declining service life of the pavement. The engineer in charge of creating the HMA must assess the external factors of the pavement location and choose materials and formulations that will guarantee optimal pavement performance. Road efficiency can also be improved through the development of asphalt-polymer mixtures and the use of various forms of fillers .[1] Asphalt concrete mixtures are widely used in pavement construction due to their advantages, such as improved smoothness, reduced traffic noise, ease of maintenance, and quick construction [2]. Because of the expected effects of traffic and climate, asphalt pavement has demonstrated various sorts of functional and structural deterioration. Increased axle loads, high temperatures, and moisture deterioration in asphalt pavement all play a role in developing such distress(Rutting, fatigue cracks, temperature cracks, and moisture damage). They are examples of distresses that significantly impact asphalt pavement performance [3].

Hot mix asphalt ingredient improvement (mixed design, analytical methodologies, and pavement design) requires additional research. This increases the useful life of the pavement and, as a result, reduces the expenses associated with fixing pavement problems. As a result, researchers and engineers are always working to improve the performance of asphalt pavements [4]. Asphalt binder makes up about (5-6) % of the total weight of the asphalt mix. It is a vital component that contributes to the performance of asphalt pavement layers. Three asphalt bond properties are critical to pavement performance in service. They are (temperature wettability, wettability, viscoelasticity, and aging) [5]. In construction, aggregates are the fundamental materials used, including sand, gravel, crushed stone, slag, and recycled concrete. Aggregates are required as an essential resource for any form of new construction. The aggregate in HMA plays a major role in resisting the compressive stresses that come from the traffic. It constitutes around 95% of the total mixture weight of HMA[6]. Mineral filler or dust is a fine material that passes through sieve No. 200 that is added to HMA to improve its performance and durability. It is typically made up of finely crushed rock, sand, or other mineral materials that are mixed with asphalt cement to create a smooth and consistent mixture. The behavior of the asphalt mixture is significantly affected by the type and content of mineral filler [7].

Researchers have developed mixtures for hot mix asphalt that contain additives to enhance the road performance of asphalt and to improve the service quality and lifespan of asphalt pavement [8]. One approach is using recycled materials, such as RAP, in the production process. This reduces the amount of virgin materials needed, conserves natural resources, and reduces waste. RAP can be used in various ways in road construction. It can be mixed with new asphalt to create a recycled mix, which can be used as a base or surface layer for roads. The use of RAP in asphalt mixes reduces the amount of new materials needed [9]. Asphalt pavements paved with recycled materials such as RAP are widely used in many countries, where they began to be used with hot mix asphalt in the mid-seventies due to the high cost of crude oil, where the Federal Highway Administration or government transportation departments in the United States of America found that asphalt paving Recycled is a good solution for restoring damaged road networks in many projects, due to the increase in new asphalt binder costs and the decrease in aggregate supply during the mid-2000s [10]. RAP was widespread in many countries in Europe, where its use rate reached 10% in mastic asphalt mixtures in the United Kingdom. In other countries such as New Zealand, Australia, and others, its use rate reached 15% in dense asphalt mixtures [11]. The effect of the physical properties of RAP on the mechanical properties of mixtures containing varying amounts of RAP was studied, as (the Marshall test, indirect tensile toughness modulus, indirect tensile stress, moisture sensitivity tests, and a circular wheel track) has also developed. It was observed that adding RAP to the investigated blends improved the mechanical properties of the mixture. The mixture containing up to 30% RAP has better fatigue strength than the control mixture [12].

Since the 1980s, the use of polymer-modified binders (PMB) has gained considerable interest in mitigating the damage (such as rutting, cracking, raveling, shoving, potholes, etc.) caused by factors like heavy traffic, overloading of commercial vehicles, and fluctuations in temperature throughout the day and season. The incorporation of polymers enhances the stiffness, cohesion, and elasticity of the binder to enhance its engineering characteristics. Polymers are frequently used to modify asphalt for this purpose[13]. Styrene-butadiene-styrene (SBS) is a thermoplastic elastomer commonly used in hot melt adhesives (HMA). SBS is a copolymer comprising three components: styrene, butadiene, and styrene. The styrene end blocks are rigid and provide strength and stability to the polymer, while the butadiene mid-blocks are flexible and provide elasticity. In HMA, SBS is typically used as a base polymer blended with other components, such as tackifiers, plasticizers, and antioxidants, to create a final adhesive product with specific properties. SBS-based HMA also has good thermal stability and can withstand high temperatures without losing its adhesive properties, and Enhance the mechanical characteristics and rheological behavior of traditional asphalt formulations [14]. This study aims to investigate the effect of using RAP and PMB on the moisture damage of HMA. Moisture damage is a significant concern in HMA as it can lead to premature failure of the pavement. RAP is a sustainable material that can be used in HMA to reduce the number of virgin materials needed, while PMB can improve the performance of HMA by enhancing its resistance to moisture damage. Therefore, this study aims to evaluate the effectiveness of using RAP and PMB in HMA to reduce moisture damage and improve its durability. The findings from this study can provide valuable insights into sustainable and effective practices for designing and constructing durable asphalt pavements.

2. MATERIALS

2.1 Asphalt Cement

A substance called bitumen, a thick and sticky liquid or semi-solid form of petroleum is commonly called black. It is the primary binding agent used in the production of asphalt concrete for road construction. Traditional asphalt cement was outfitted with a penetration grade (40–50). The necessary laboratory tests for this binder were carried out per the relevant standards. Table 1 and Figure 1 show these tests with results.

Table 1: Asphalt binder's physical characteristics.

No	Test type	Test Conditions	Units	Test value	Requirement	Reference standard
1	Penetration	100gm,25°C,5 sec.	0.1 mm	43	40-50	ASTM D5
2	Softening point	(4±1) °C/min	°C	52	30-80	ASTM D36
3	Flash point	-------	°C	291	≥ 232	ASTM D92
4	Ductility (cm)	25°C, 5cm/min	cm	122	>100	ASTMD113

Figure 1: Some tests on asphalt binder.

2.2 Aggregate

The aggregate used in HMA is a combination of coarse and fine aggregates. The coarse aggregate is typically crushed stone, gravel, or slag, while the fine aggregate is usually sand. The size and gradation of the aggregate are essential factors in determining the performance of the HMA. The aggregate must be clean, hard, durable, and free from dust, clay, and other deleterious materials. Properly selecting and proportioning the aggregate is critical to achieving a durable and long-lasting HMA pavement. The local sources provided the aggregate used in this project. The aggregate gradation for the mixes designed in this work followed the mid-of-Iraq specification from the State Corporation for Roads and Bridges (15), a Dense-graded surface layer (type A) with a mid-graduation of 12.5 mm. The gradation and physical properties of the coarse and fine aggregates were tested experimentally in the laboratories of Engineering College - University of Al- Qadisiyah, and the results are illustrated in Tables 2 and 3, respectively.

Table 2: Gradation of aggregate for surface course type A (SCRB, 2003).

Sieve size	mm	% Passing by weight	mid-range	100%Retained
¾	19	100	-	-
½	12.5	90 – 100	95	5
3/8	9.5	76 – 90	83	12
No. 4	4.75	44 – 74	59	24
No. 8	2.36	28 – 58	43	16
No. 50	0.3	5 – 21	13	30
No. 200	0.07	4 – 10	7	6
Pan	-	-	-	7

Table 3: The physical properties of course and fine aggregates.

Property	Course		Fine	
	Result	Reference standards	Result	Reference standards
Bulk Specific Gravity (gm/cm^3)	2.670	(ASTMC127, 2001)	2.496	C128 (ASTM,2015b)
Apparent Specific Gravity	2.810	(ASTMC127, 2001)	2.595	C128
Absorption (%)	1.7	(ASTMC127, 2001)	1.52	C128
% Crushed in coarse aggregate particles (%)	95	(ASTMD582113(2017)	-	-

2.3 Mineral Filler

Mineral filler is a fine powder material added to HMA to improve its performance and durability. Is a passing sieve No. 200 non-plastic material used to fill the gaps in paving mixtures and enhance mixture qualities? This work employs various mineral fillers (MF), including Common Portland Cement (OPC).

2.4 Reclaimed Asphalt Pavement (RAP)

Reclaimed asphalt pavement is a recycled material obtained from old pavements. It is typically generated during road reconstruction or resurfacing projects. RAP can be used as a substitute for virgin aggregate in producing hot-mix asphalt [16].

The use of RAP in HMA has several benefits, including:

- Cost savings: Using RAP reduces the need for virgin aggregate, which can be expensive to mine and transport.
- Environmental benefits: Recycling RAP reduces the amount of waste sent to landfills and conserves natural resources.
- Improved performance: Using RAP in HMA can enhance the performance of the pavement by increasing its durability and resistance to rutting.
- Energy savings: The production of HMA using RAP requires less energy than producing virgin asphalt.

The Reclaimed Asphalt Pavement (RAP) materials were obtained by removing a surface layer at a depth of (5cm) collected from an old pavement of the Al-Diwainyah-Najaf highway. After extraction tests, the percent of asphalt binder content was (3.19%) by weight of the total mix. See Tables 4 and 5 and Figure 2.

Table 4: Gradation of the recycled aggregate after centrifuge extraction test.

Sieve, mm	Gradation of Recycled Aggregate After Extraction	Iraq specification (SCRB/R9, 2003)
25	-------	---------
19	100	100
12.5	92	90-100
9.5	80	76-90
4.75	57	44-74
2.36	47	28-58
0.3	19	5-21
0.075	10	4-10

Table 5: Physical properties of RAP after extraction test.

Marital	Property	Test Results
Coarse aggregate	Bulk Specific Gravity(BSG),,	2.524
	Apparent Specific Gravity(ASG),,	2.572
	Percent Water Absorption%,,	1.2
Fine aggregate	Bulk Specific Gravity(BSG),,	2.472
	Apparent Specific Gravity(ASG),,	2.576
	Percent Water Absorption%,,	1.63
Asphalt cement	Asphalt content%	3.19

Figure 2: Centrifuge Extraction test: (A) Extraction machine, (B) before and (C) after testing.

2.5 Styrene Butadiene Styrene (SBS)

SBS is a synthetic rubber commonly used as a modifier in hot mix asphalt (HMA) to improve its properties. It is added to the asphalt binder to enhance its elasticity, durability, and resistance to cracking and rutting. The asphalt was heated at a temperature of 160°C in an oven and put in a mechanical shear mixer. The mixing process continued for 2 hours at a temperature of 160°C. The SBS was added gradually from a small orifice with a tied cover as a percentage of asphalt binder. A use percentage of 4% by weight of asphalt was added to the study. The SBS powder, the chemical composition of SBS polymer, and its properties are shown in Figures 3 and 4 and Table 6.

Figure 3: The SBS powder.

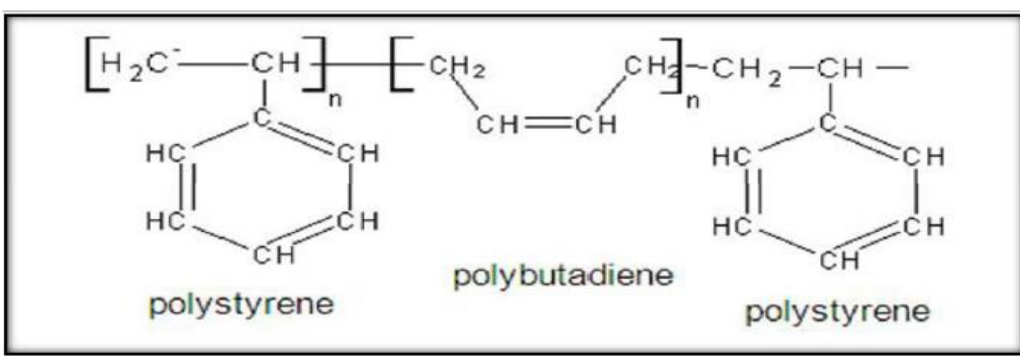

Figure 4: Typical composition of SBS Polymer [17].

Table 6: SBS properties.

SBS Polymer properties	Value
Density (gm/cm^3)	1247
Melting point ºC	180°

3. EXPERIMENTAL PLAN

Before using HMA in a transportation facility, performance testing of HMA mixes is carried out to assess novel materials and design strategies to improve the performance of HMA pavements. The sections that follow will go into greater detail on that.

3.1 Design of the Marshall Mix

Marshall Stability and Flow are two important properties of asphalt mixtures used in road construction. Marshall Stability is the resistance of an asphalt mixture to deformation or failure under applied loads. At the same time, Marshall Flow is the deformation or displacement of an asphalt mixture under the same applied loads. Three samples are prepared for five proportions of asphalt mortar (4, 4.5, 5, 5.5, and 6%) by the weight of the total mix with a different percentage of RAP (15, 30, and 45%) and (100% OPC), optimum asphalt content (OAC) was found (4.8%). Three mixtures were prepared as listed below:

- Control mixtures: This mixture was designed as a benchmark for comparison with other mixtures designed for this project. The design of this mixture employed only pure asphalt binder (40-50) and no fillers.
- Mixtures contained RAP and pure asphalt binder: To show the effect of using RAP on HMA, three percentages of RAP (15, 30, and 45%) were adopted as replacements for fine and coarse aggregate. At this stage, the effect of RAP particle size on the performance of HMA with a pure binder is investigated. The percent of asphalt cement in reclaimed asphalt pavement was determined as 3.19% from the extraction test.
- Mixtures contained RAP and modified asphalt binder (SBS): To select the optimum percentage of additives needed to be added to a pure binder, three trials were made with different percentages of SBS (4%) by weight of asphalt. The Marshall stability, flow, and ITS were also tested for samples of HMA prepared with a binder with the above percentage of additives, see Table 7 and Figure 5.
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Table 7: According to ASTM D6927, Marshall Test conditions.

Parameter	Test standard	Used value
Mix temperature; ℃	(150-190)	157
No of samples	3	3
The load; mm/min	(50 ± 5)	50
Test temperature; ºC	(60 ± 1)	60 ± 1
Time of test; min	(30-40) min	30 min
Compaction	75 blows each Face	75
Sample diameters; mm	(101.6-101.7)	101.6
Sample thickness; mm	(63.5 ± 2.5)	63.5 ±2.5
Curing; hr	24hr at Lab	24hr at Lab

Figure 5: Prepare samples for Marshall Test.

3.2 Indirect Tensile Strength Test (ITS)

This test is commonly used in the hot mix asphalt industry to determine the tensile strength of asphalt mixtures. This test is performed by applying a compressive load to a cylindrical specimen of the asphalt mixture, which is placed between two platens. The load is applied at a constant rate until the specimen fractures [1]. Table 8 conditions for ITS tests per T283 (AASHTO, 2007a). This maximal tensile strength was estimated using the formula in Equation (1):

$$\mathrm{ITS} = \frac{2000\mathrm{P}}{\mathrm{D.t.\pi}} \quad (1)$$

Where; ITS (kPa), P is maximum Load (N), D is diameter (mm), and Tis thickness (mm).

Tensile Strength Ratio (TSR), which is calculated using Equation (2) below, is used to find compacted samples' moisture susceptibility.

$$\text{TSR} = \frac{\text{S tm}}{\text{S tc}} \quad (2)$$

Where; S tm: average moisture-conditioned sample tensile strength, S tc: average of the control sample's tensile strength.

Table 8: According to ASTM D4867 (indirect tensile strength test conditions).

Parameter	**Test standard**	**Value for testing**
Rate of loading, mm/min	50 ± 5	50
No. of specimens	6	6
Test temperature, ºC	25 ± 2	25 ± 2
Specimen thickness, mm	63.5±2, 95±5	63.5 ± 2.5
Specimen diameters, mm	100, 150	101.6
Compaction	Compacted to 7 ± 0.5% AV	7%
Curing for moisture-conditioned samples	Placed in a water bath for 24 hr at 60 °C then 25°C for 1 hr	The same specification was used
Curing for unconditioned samples	Placed in a water bath for 20 min at 25°C	The same specification was used

3.3 Vacuum Saturation Equipment

According to AASHTO T283, specimen conditioning was done by submerging the samples in water and subjecting them to a vacuum for varying treatment times to reach 70% and 80% saturation. The specimens used in this study were conditioned using the following method:

- In the vacuum container, place the specimen on the perforated spacer.
- Pour enough potable, room-temperature water into the vacuum container to cover the specimen with at least 1 inch (25 millimeters) of water.
- Delay stopping the vacuum pump until the gauge pressure exceeds 25 in Hg (check the vacuum gauge). Close the pressure release valve on the lid after opening it gradually to the partial pressure of 20 in Hg. For five minutes, maintain this pressure.
- Open the pressure release valve to gradually release the suction.
- Submerge the specimen in water for an additional five minutes.

After the partial vacuum saturation, remove the cover and measure the mass of the saturated, surface-dry specimen. Samples are conditioned once again in the vacuum chamber by adjusting either the duration or the pressure until the appropriate saturation level is obtained if they are unable to reach saturation levels between 70% and 80%. However, samples are eliminated if they reach a more than 80% saturation level. Before the IDT test, the vacuum-conditioned samples were incubated for two hours at 60°C in a water bath [19]. The vacuum conditioning equipment utilized in this work is depicted in Figure 6. The percentage of saturation was calculated using Equation (3) below.

$$\text{S} = \frac{\text{J}}{\text{Va}} \quad (3)$$

Where: S is % saturation J is the mass of absorbed water, and Va is specimen air voids.

Figure 6: Vacuum conditioning device.

4. RESULTS AND DISCUSSION

4.1 Marshall Stability Test (MST)

These results are shown in Tables 9 and 10, and samples of these results are presented graphically. Figure 7 shows the characteristics of mixes containing RAP and OPC. The replacement ratios for RAP were calculated using OPC at 15, 30, and 45% of the weight of the mixture. According to the results, the optimal value for the RAP ratios that achieved the highest stability is (15%) RAP, and 100% OPC of filler rate showed the best Marshall stability (14.26 kN) when compared to mixtures with different replacement percentages and control mix, where added to the mixture, Improved Stability because RAP contains aged asphalt binder that has undergone oxidative hardening, making it stiffer and more brittle than fresh asphalt binder. When RAP is added to the HMA, it can improve the overall stability of the mix by increasing its stiffness and reducing its susceptibility to rutting and deformation [20]. Figure 8 shows the characteristics of mixes containing RAP+4%SBS and OPC. The replacement ratios for RAP were calculated using OPC at 15%, 30%, and 45% of the weight of the mixture. When added(reclaimed asphalt pavement (RAP) and modified asphalt binder (SBS) to the mixture can have a positive effect on the stability and flow of the hot asphalt mix, According to the results, the combinations with (15%, 30%, and 45%) RAP+4%SBS and 100% OPC of filler rate showed the best Marshall stability at (15%RAP+4%SBS) is (16.43 kN), when compared to mixtures with other replacement percentages and control mix and The addition of RAP can improve the stability of the mix by increasing the amount of aggregate in the mix, which can lead to better interlocking between particles and improved resistance to deformation. Using an SBS-modified binder can also improve stability by increasing the viscosity and elasticity of the binder, which can help prevent rutting and cracking. High stability values indicate a high stiffness mix with a remarkable ability to spread the applied load and resist creep deformation. Observations indicate that the presence of SBS leads to an augmentation in Marshall Stability. This suggests that the inclusion of SBS causes a rise in the rigidity of binders, resulting in mixtures containing SBS exhibiting more excellent stability compared to control mixtures [21].

Table 9: The results of the test of the control mix design.

Properties	Property	Result	Standard
Mechanical properties	OPC%	4.8	
	Marshall Stability	13.50 kN	Min 8 kN (SCRB, 2003)
Volumetric Properties	Marshall Flow	3 mm	2 - 4, 1/10mm (SCRB,2003)
	AV%	4	3-5(SCRB, 2003)
	V.M.A%	16.1	>14 (SCRB,2003) >15 MS2(Institute, 2014)
	VFA%	70.5	70-75% MS2 (Institute, 2014)

Table 10: Properties of mixtures with different ratios of RAP.

Parameter	Stability (kN)			Flow		
RAP%	15%	30%	45%	15%	30%	45%
RAP	14.26	13.81	12.64	2.1	2.7	2.6
RAP+4%SBS	16.43	16.12	15.16	2.9	3.2	3.5

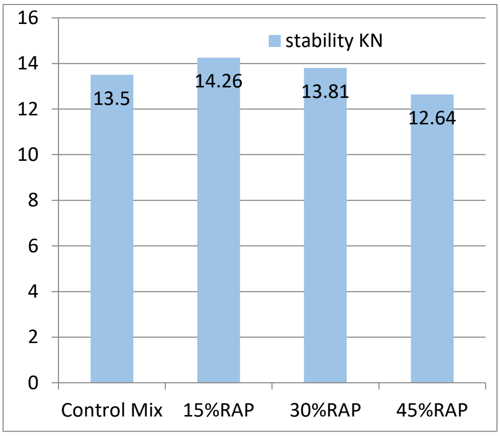

Figure 7: The impact of RAP % on the MST of HMA.

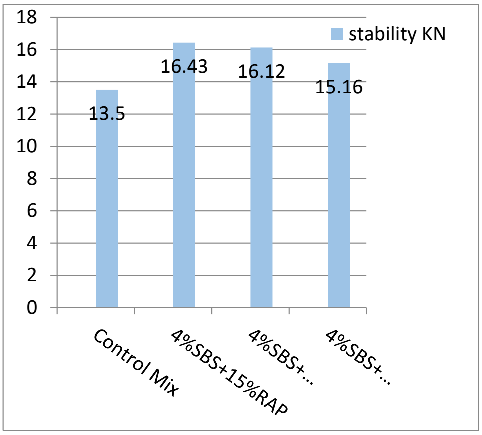

Figure 8: The impact of RAP+4%SBS on the MST of HMA.

4.2 Indirect Tensile Strength (ITS)Test

These results are shown in Figures 9 to 12, and samples of these results are presented graphically. Using asphalt mixtures containing RAP and modified asphalt binder (SBS) positively affects the hot asphalt mix in terms of the Indirect Tensile Strength (ITS) test. The addition of RAP can improve the overall strength and durability of the mix. At the same time, the use of an SBS-modified binder can enhance its resistance to cracking and deformation, and the result show incorporating RAP into asphalt mixes can increase their ITS values by up to 30%, depending on the percentage of RAP used. This is because RAP contains aged asphalt binder that has undergone some degree of hardening, which can contribute to the stiffness and strength of the new mix. Meanwhile, SBS-modified binders are known for improving the performance properties of asphalt mixes, particularly regarding rutting and cracking resistance. Adding SBS to the binder makes it more elastic and flexible, allowing it to withstand traffic loads and temperature fluctuations better.

The mixtures with RAP positively affect the hot asphalt mix in terms of moisture damage. This is through the clear results of TSR in Figure 11, where all the ratios of the RAP increased compared to the reference mix, and they were all higher than the specification, which is 80%, where the highest rate in the asphalt mixture with 15% RAP was 88.3%. This is due to using RAP in asphalt mixtures that reduce moisture damage by providing a more porous surface that allows for better drainage. This reduces the amount of water trapped within the pavement structure [18]. Based on Figure 12, it can be inferred that the combination of SBS and RAP in mixtures enhances the binding and sticking properties of the binder. This makes it difficult for water to displace asphalt components from the aggregate surface, resulting in more optimal mixtures compared to those treated with only RAP and give result to the mixture (stronger, more durable pavement that is less prone to cracking, rutting, and other forms of distress) [21-23]. This is through the clear results of TSR in Figure 12. The highest rate in the asphalt mixture with (15% RAP+4%SBS) was 95.7%, which was a high value, indicating good resistance to moisture damage.

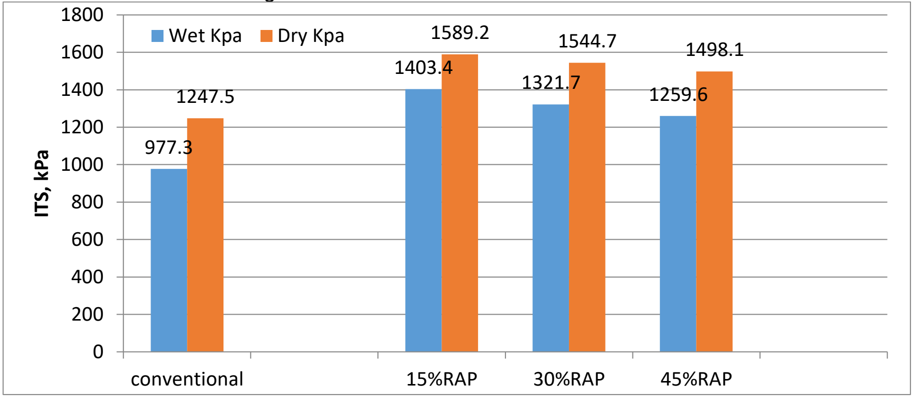

Figure 9: The impact of various RAP % on the ITS of HMA.

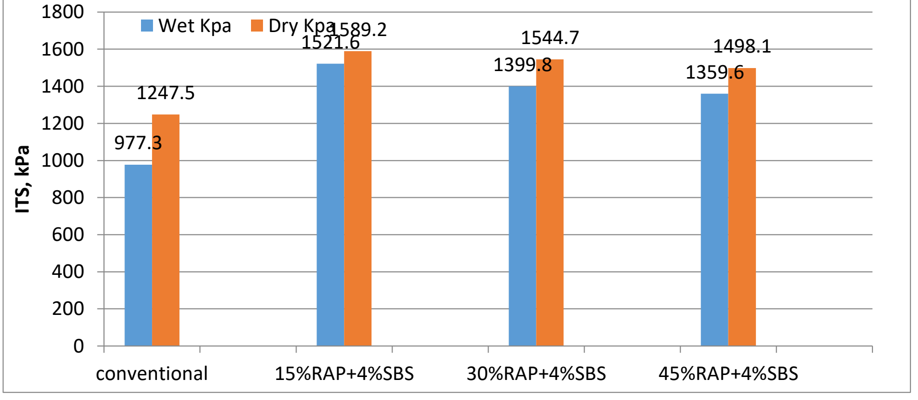

Figure 10: The impact of various RAP %+4%SBS on the ITS of HMA.

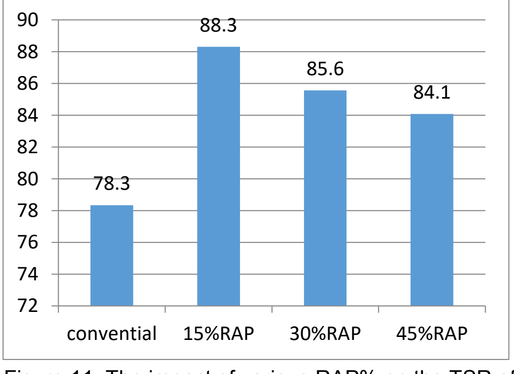

Figure 11: The impact of various RAP% on the TSR of HMA.

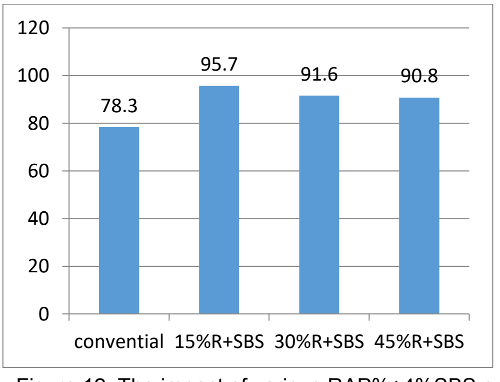

Figure 12: The impact of various RAP%+4%SBS on the TSR of HMA.

5. CONCLUSIONS

The study aims to address moisture damage, a common problem in asphalt pavements, by exploring the potential benefits of incorporating RAP and polymer-modified bitumen into the mix. The study seeks to determine whether these materials can improve the resistance of hot mix asphalt to moisture damage. In this study, the effect of using asphalt mixtures containing RAP and modified asphalt binder (SBS) on the hot asphalt mixture's properties and the mixture's ability to resist moisture damage that occurs on the pavement was studied. The asphalt binder was used in addition to the coarse and fine aggregates. Examinations (Marshall's stability test and Indirect Tensile Strength Test (ITS))

Using asphalt mixtures containing RAP and modified asphalt binder (SBS) can positively affect the hot asphalt mix in terms of moisture damage.

- The addition of RAP can improve the overall sustainability of the mix by reducing the number of virgin materials needed. At the same time, using an SBS-modified binder can enhance durability and resistance to moisture damage. The highest rate for marshal stability is (14.26 kN), and TSR was 88.3% for 15%RAP.
- SBS-modified binders have been shown to improve the adhesion between asphalt binder and aggregate, which can reduce stripping and increase resistance to moisture damage. Additionally, SBS-modified binders have improved elastic recovery properties, which can help prevent cracking due to thermal cycling and traffic loading. The highest rate for marshal stability is (16.43 kN), and TSR was 95.7% for 15%RAP+4%SBS.
- Using RAP in asphalt mixtures can also help reduce moisture damage by providing a more porous surface that allows for better drainage. This reduces the amount of water that is trapped within the pavement structure, which can lead to premature deterioration.

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