

TO COMPARE THE RELEVANT ENGINEERING PROPERTIES OF A MODIFIED BITUMEN MIX WITH CONVENTIONAL BITUMEN

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ABSTRACT

The study reveals that replacing a portion of bitumen with molasses in bituminous mixtures enhances the material's Marshall Characteristics, leading to improved strength and stability bitumen content and molasses content. This modified bitumen shows higher penetration and softening points, indicating increased durability and adaptability under varying temperatures. Notably, the specific gravity remains constant, but ductility decreases slightly with the addition of molasses. An environmental benefit of this substitution is the reduction in carbon dioxide emissions due to the decreased bitumen usage. The study concludes that an optimal composition for modified bitumen is at 10.5% molasses, making it a viable, sustainable alternative for partial bitumen replacement.

Keywords: Bitumen with molasses, specific gravity, carbon dioxide, modified bitumen, partial bitumen replacement

1. INTRODUCTION

Molasses in bituminous concrete can provide insights into its potential as an additive or modifier to enhance the performance of bituminous mixtures used in road construction. Sugarcane molasses is a by-product of the sugar industry, which contains organic compounds and sugars that can interact with bitumen, potentially improving the characteristics of the mixture. This research could lead to innovative, eco-friendly solutions for road construction by utilizing agricultural by-products like sugarcane molasses. Research focuses on exploring the use of molasses as an eco-friendly partial replacement for bitumen in bituminous concrete, a composite material used in road construction. The objective is to reduce pollution caused by the heating of bitumen, which releases harmful carbon dioxide emissions, while improving pavement quality. Molasses, a byproduct of sugar production, is identified as a potential alternative binder. To investigate the effects of partially replacing bitumen with molasses and to identify the optimum percentage that maximizes the pavement's mechanical properties while reducing environmental impact. Laboratory tests (penetration, ductility, softening point, and Marshall Stability) were performed on bitumen samples with varying bitumen and molasses content.

2. LITERATURE REVIEW

Bharath H M et al (2023) was a comprehensive study aimed at utilizing Reclaimed Asphalt Pavement (RAP) in combination with Crumb Rubber and Waste Engine Oil (WEO) for a bituminous concrete wearing course. This approach focuses on sustainable road construction by recycling existing materials, thereby reducing environmental impact and potentially improving the properties of asphalt mixtures. Involves determining an optimal mix design where RAP serves as a replacement for natural aggregate and binder. The challenge is to balance performance (e.g., durability, strength) with environmental and cost benefits. Should be processed to ensure consistent particle size (aggregate no larger than 14 mm) and quality. Derived from recycled tires, it can enhance flexibility and resistance to deformation. Acts as a rejuvenator, restoring the viscoelastic properties of aged asphalt in RAP and modifying the binder to improve its performance. Calculate the amount of RAP needed, considering the percentage of RAP in the mixture and the desired gradation. This step may require several trial mixes to achieve the required performance. Incorporate the Crumb Rubber and WEO into the mix, considering their effects on binder properties such as viscosity, elasticity, and temperature susceptibility. Highlight how using RAP reduces the need for virgin aggregates and binders, contributing to resource conservation. Crumb Rubber and WEO further reduce waste in the environment, promoting a circular economy by reusing materials that would otherwise be discarded. The success of your study will depend on optimizing the proportions of RAP, Crumb Rubber, and WEO to create a sustainable, cost-effective bituminous mixture that performs well under traffic loads.

Yassir Nashaat A.Kareem et al (2012) in bituminous mixtures, the mineral aggregate plays a crucial role in defining the mechanical and structural behavior of the pavement. Since aggregates make up a large proportion of the mix (approximately 95% by weight or 80% by volume), their gradation, or particle size distribution, can significantly affect the performance of the bituminous mixes. The study you're referring to likely aims to assess how different aggregate gradations influence key performance properties such as indirect tensile strength (ITS), shear strength, and

rutting behavior of bituminous mixes. The indirect tensile strength test is used to evaluate the tensile properties of bituminous mixtures, which relate to their cracking resistance. Gradation can influence the interlock and cohesion of aggregates, which in turn affects how the mixture resists tensile stresses. Shear strength is a critical parameter related to the stability of the mix under loading conditions, particularly for resisting shear-induced rutting. Rutting is a common form of pavement deformation caused by repeated wheel loads, which leads to permanent deformation in the wheel paths. The study would aim to establish relationships between these gradation parameters and the mechanical properties of the bituminous mixes.

3. METHODOLOGY

To achieve these objectives, an experimental framework was developed to systematically assess the performance of bio-bitumen modified asphalt binders and mixtures. This framework involves comparing bio-bitumen modified asphalt with conventional asphalt binders and mixtures in terms of three key performance attributes:

Moisture Resistance: This attribute evaluates the asphalt's susceptibility to moisture-induced damage, which can affect its long-term durability. Standard tests, such as the Tensile Strength Ratio (TSR) test, are used to measure resistance to moisture damage.

Permanent Deformation Characteristics: Also known as rutting resistance, this property assesses the binder's ability to withstand heavy loads without significant deformation. Performance tests like the Dynamic Shear Remoter (DSR) and Hamburg Wheel Tracking test are commonly used to evaluate rutting resistance.

Fatigue Life: This attribute examines the material's capacity to endure repeated loading without cracking or failing. Fatigue life is typically measured through cyclic loading tests to simulate long-term traffic conditions.

The experimental design includes determining the optimum dosage of sugarcane molasses in bio-bitumen, aiming for an effective modification level that balances performance and cost. The collected data from these tests will enable a direct comparison with conventional asphalt, providing insights into the viability of bio-bitumen as a sustainable alternative for road construction.

4. RESULT AND DISCUSSION

To effectively compare the impact of adding molasses to bitumen, you could use bar graphs to showcase categorical data, like penetration grade, softening point, or ductility at different molasses percentages. For continuous data trends, such as viscosity or rheological behavior over a temperature range, line graphs would work best.

Marshall Stability Test

The Marshall Mix Design is a method used primarily for designing bituminous (asphalt) mixtures in road construction. It aims to determine the optimal asphalt content in the mix to provide sufficient strength, durability, and flexibility for pavement applications. Developed by Bruce Marshall in the 1930s, the method is popular due to its simplicity, reliability, and proven effectiveness. The selection includes coarse and fine aggregates and mineral fillers, meeting specific gradation requirements. The type and grade of bitumen (asphalt binder) should be suitable for the expected traffic and climate conditions. Aggregates are mixed with different bitumen contents (typically 3-6% by weight of total mix). Each bitumen content has a separate set of samples prepared and compacted using a Marshall Compactor, which applies a specified number of blows to each side of the sample. Using the plotted data, the optimum asphalt content is selected based on specifications, generally as the asphalt content that provides:

- ❖ Maximum stability
- ❖ Sufficient flow (within limits)
- ❖ Air voids around 4%
- ❖ VFA and VMA within specified ranges

The Marshall Mix Design method is especially suitable for hot mix asphalt (HMA) applications, although other methods like the Super pave mix design are often preferred for heavy traffic highways due to their adaptability to higher-stress conditions.

Table 1 Marshall Stability Test

Percentages of Molasses	Marshall Stability in KN	Flow Value mm	VFB %	Voids in %	Bulk unit weight g/cc
0	2.89	1.58	65.18	5.62	1.74
1.5	3.60	2.65	69.23	5.08	1.89
3	3.89	3.25	71.56	4.91	1.92

4.5	4.12	3.85	73.69	4.78	1.98
6	5.65	4.97	78.51	4.32	2.03
7.5	7.38	5.12	81.17	4.05	2.11
9	8.67	5.35	84.32	3.98	2.28
10.5	7.12	5.43	80.20	3.65	2.12
12	4.58	5.87	77.23	3.19	2.06

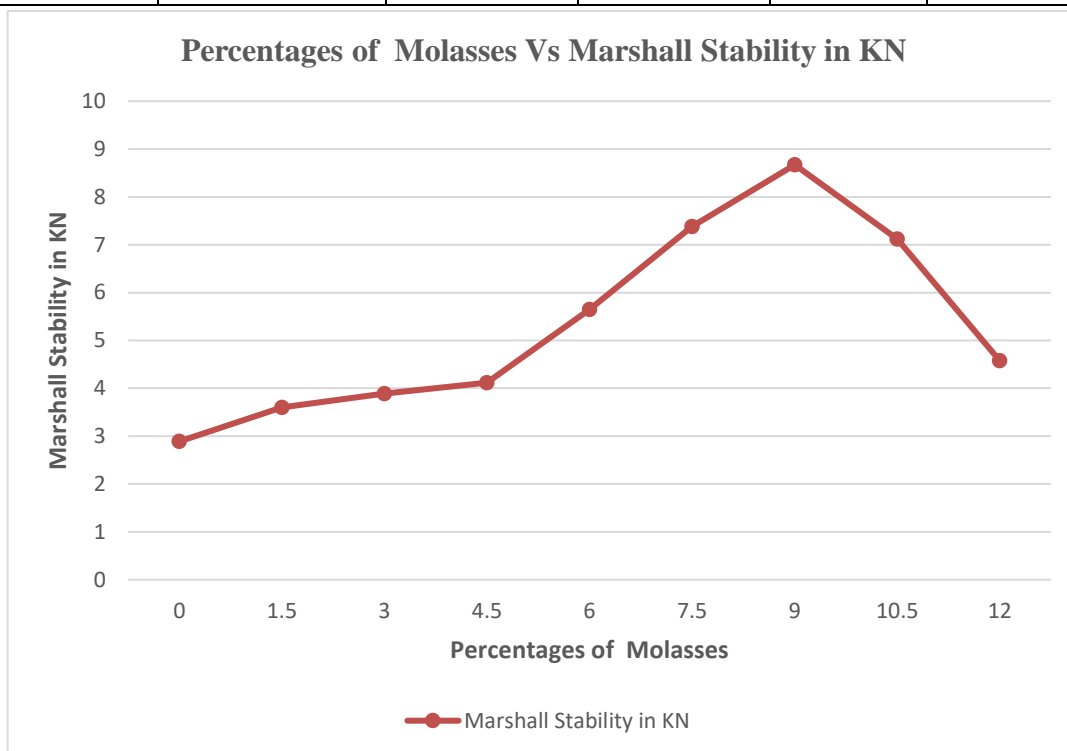


Figure 1 Marshall Stability test graph

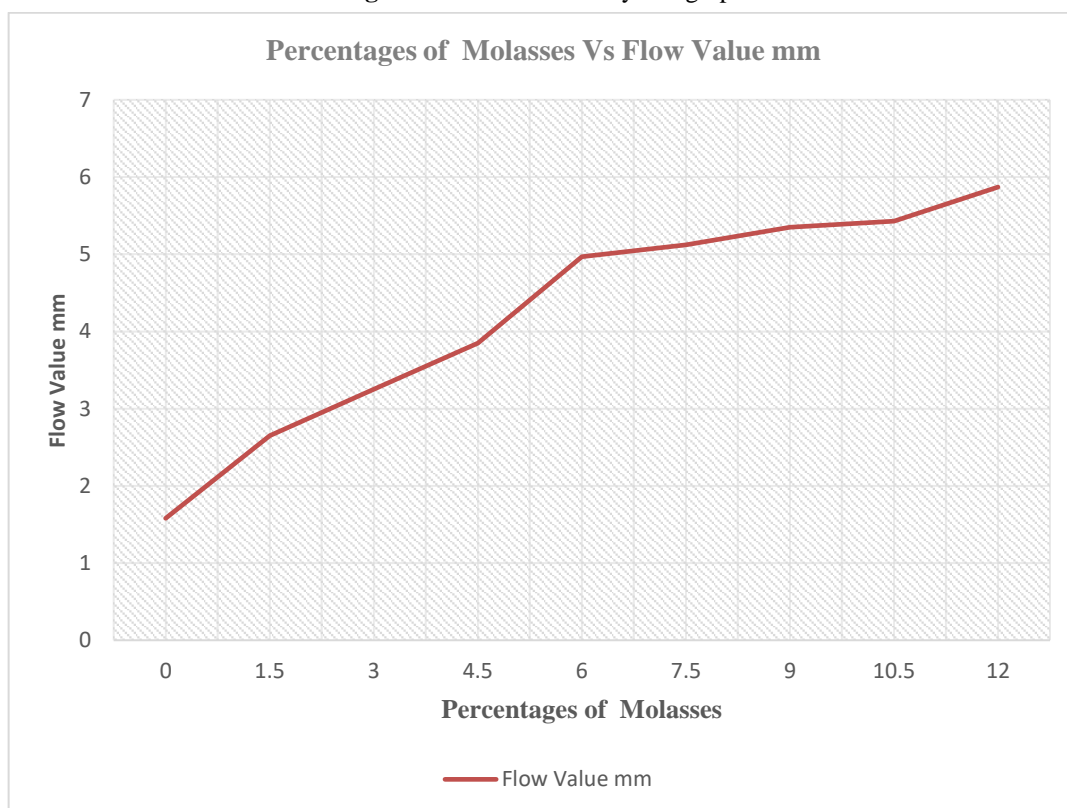


Figure 2 Flow Value test graph

5. CONCLUSION

Incorporating sugarcane molasses into bitumen offers significant improvements in several critical properties of asphalt. Enhancements in Marshall Stability, infiltration rate. These improvements contribute to the asphalt's strength, resilience to temperature fluctuations, and extended service life, while also providing a sustainable use for waste sugarcane molasses. To achieve an optimal molasses content in the bitumen mix, it's essential to consider factors like mixing time, temperature, molasses characteristics, and the bitumen type. Each of these factors influences the performance of the bitumen mix. For example, molasses with a high sugar content may affect the consistency of the bitumen, while the temperature and mixing time can influence the integration of molasses into the bitumen, affecting the final mix's stability and durability. Additionally, variations in the source and processing methods of sugarcane molasses can lead to differences in chemical composition, potentially impacting the physical properties of the asphalt.

6. REFERENCES

- [1] Bharat, A.s jans "The Use of Waste Polymers in Asphalt Mixtures: Bibliometric Analysis and Systematic Review" Submission received: 2 September 2023 / Revised: 23 September 2023 / Accepted: 3 October 2023 / Published: 5 October 2023 J. Compos. Sci. 2023, 7(10), 415; <https://doi.org/10.3390/jcs7100415>
- [2] Malek Anas Mohamed, Hassan Mahdy, Hamdi El-Sayed "Enhancement the performance of asphalt mixtures using polymers additives in dry process"
- [3] Yassir Nashaat A.Kareem, Haider Habeeb Aodah, Satish Chandra "Performance of Bituminous Mixes with Different Aggregate Gradations and Binders" International Journal of Engineering and Technology (IJET) – Volume 2 No. 11, November, 2012.
- [4] Prakash, K. S., Phanindra M., Surya S. R., and Naresh J. .(2014). "Percentage replacement of bitumen with sugarcane Waste molasses.", IJCIET, 5(7), 188-197.
- [5] Mose, G. Y., and Ponnurangam, P., (2018). "Investigating the Effect of Cane Molasses on the Performance of Base Bitumen.", IJRIAS, 3(4), 54-58.
- [6] Jayanthi, Mahalaksmi, M., Meiyarasu. ,Abhirami., and Shankar, K., (2014). "Experimental study on ecofriendly tar", IJIAREC, 5(1), 895-898.
- [7] Boomika, A., Naveen, M. A., Richard, J. D., and Mythili, A.,(2017). "Experimental study on partial replacement of bitumen with lignin and plastic" IJCESR, 5(4), 35-41.
- [8] Tiwari, V. A., and Rao, Y. M. A.,(2017). "Study of Plastic Waste Mixed Bituminous Concrete Using LDPE and HDPE." TARCE, 6(2), 1-6.
- [9] Kumar, G. R., Bharani S., and Kumar, R. S. S.,(2017). "Partial Replacement of bitumen by waste plastic and polypropylene in road construction." TARCE, 6(2), 1-6.
- [10] Gandhimathi , A., and Abinaya, S.,(2017). "An experimental study on behavior of modified bitumen using recycled plant." IJCIET, 8(8), 1707-1715.
- [11] Prasad, A. R., and J, S. N.,(2015). "Bitumen Modification with Waste Plastic and Crumb Rubber." IJERT 4(5), 1586-1591.
- [12] Ghalayan, P., Rana, S., (2017). "Partial replacement of bitumen by using plastic- waste in bitumen concrete", IJLREC, 5(2), 2347-6540