# Sustainable Use of Sasobit in Warm Mix Asphalt: A Review

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***Abstract*- Warm Mix Asphalt (WMA) is widely utilized in many parts of the globe due to its ability to combine the benefits of both hot mix and cold mix. Solidification is enhanced at lower temperatures when the adhesive's viscosity is decreased. On addition of additive, the asphalt mix is able to attain the properties of hot mix at the mixing temperature of a cold mix. To make the asphalt layer less vulnerable to low temperatures and have excellent permanent deformation qualities, the organic additives must be selected in such a manner that they melt at a lower temperature than predicted for the asphalt layer to reach the development site. Blends with the right qualities may be made in a more cost and environmentally-friendly way by using WMA expertise in asphalt. In recent years, there has been a rise in awareness of environmental and health risks in the construction industry. Various methods and additives have been developed by the industry to reduce the required assembly temperature of asphalt mixes, and this has resulted in the development of a new blend type known as Warm-mix-Asphalt (WMA). In this paper a review of contemporary practices of use of Sasobit in preparation of Warm mixes has been done.**

**Keywords-** Warm Mix Asphalt, Sasobit, Bituminous Mixes, Sustainability

## 1. INTRODUCTION

With 62,15,797 kilometers till 01st December 2021, India is having second highest road network in the world [1]. In India, flexible pavements are widely used. Aggregates and bitumen are major components of flexible pavement. Usually, flexible pavement is constructed without any reinforcement, in some cases geotextiles are used in the successive layers. The construction of flexible pavement requires the production of hot mix asphalt (HMA) which is produced at a very high temperature. The mixing temperature of HMA is 165 ℃ and the compaction temperature is 140 ℃. The transportation industry is always on the lookout for new ways to lessen its impact on the environment. Bitumen production and asphalt mixing processes release harmful pollutants into the air, including particulate matter, nitrogen oxides, and sulfur dioxide. Bitumen production and transportation are significant sources of greenhouse gas emissions. To move for sustainable construction practices, various waste materials have been utilized in pavement construction [2] [3].

Conventional hot mixes are produced at temperatures greater than 160 ℃ and compacted at temperatures between 120 – 160 ℃. Warm mix technology enables the manufacture of bituminous mixes at 10 – 40 ℃ lower than the conventional mix [4]. So, less energy is required to heat the bituminous mix. Throughout WMA manufacture, fuel consumption is often lowered by 20 – 35 % [5]. In addition, WMA reduces time in both manufacturing and road surfacing. Because WMA promotes compaction easier, the time and effort spent compacting the mix is reduced, resulting in cost savings. Lower temperatures enable additional asphalt mix to be transported over greater distances, lowering transportation costs. Using WMA technology, the viscosity of the binder can be reduced resulting in the coating of aggregates at lower temperatures. The warm mix technology results in a similar quality of asphalt mixture as the hot mix but with a reduced carbon footprint and improved workability, making it an environmentally friendly and cost-effective alternative to traditional hot mix asphalt.

Sasobit is a synthetic hard wax which is used worldwide in bituminous road construction. Because of its potential to reduce the viscosity of the binder, Sasobit is outlined as an "asphalt flow improver" both during the mixture procedure as well as during lay - down processes. Because of the lower viscosity, working temperatures can be reduced by 32 – 97 °F [6]. It is soluble in bitumen at temperature above 115 ℃ [7]. It subsequently forms a crystalline network model in the binder at temperatures less than its melting temperature, which leads to additional stability potential. The addition of Sasobit results in less energy requirement This results in a reduced need for high temperatures in the production process and can also lead to improvements in the quality and durability of the final asphalt product.

In this study, a review of various research conducted for production of WMA using Sasobit have been compiled and presented.

## 2. SCOPE OF THE STUDY

This study focusses on the performance of Sasobit in production of WMA. An organized literature study was done. Relevant literature was found using keyword-based search. Maximum data base was taken from Google Scholar and web of science. Attempt has been made to select latest research papers (After 2008). Emphasis is given to the effects on Marshall and durability properties of WMA after the addition of Sasobit. The results are also presented in tabular form for easy understanding. At the end, final conclusions are drafted.

## 3. EFFECT OF SASOBIT ON PROPERTIES OF WMA

**Table 1:** Review of Prominent Literature on Utilization of Sasobit in WMA

| Author/s | Year of Publication | Evaluated Parameters | Outlines/ Conclusion | Refs. |
|---|---|---|---|---|
| Herozi Morteza Rezaeizadeh et-al | 2022 | Indirect tensile strength (Water sensitivity), Modulus of elasticity, Fatigue and rutting resistance | - Addition of Sasobit resulted in improves softening point and decrease viscosity of bitumen.<br>- Improvement in modulus of elasticity, dynamic modulus, rutting resistance and reduction in tensile strength was observed on addition of Sasobit.<br>- Rutting resistance showed an improvement of 226 % in WMA with 6 % Sasobit content. | [8] |
| Almeida Arminda et-al**.** | 2021 | Wheel-tracking test, Marshall properties, Water sensitivity and Workability, Stiffness, Fatigue resistance | - Sasobit-Redux melts into bitumen at 85 °C, which is 15 °C lower than Sasobit.<br>- It was concluded that the WMA mix with plastic showed best performance against rutting and worst in uniaxial compression testing.<br>- Moisture resistance of WMA with plastic was lower than the conventional WMA.<br>- Addition of waste plastic resulted in improved stiffness and reduced fatigue resistance. | [9] |
| Ozturk and Pamuk. | 2021 | Image-based test system Temperature sensitive compatibility assessment method. | - Two different additives i.e., Sasobit as non-foaming and Advera as foaming additive were used in this study.<br>- It was concluded that the setting of WMA was significantly higher than that of the HMA blend, which increased its workability at any temperature.<br>- With the same pore content, the stability of the WMA mixture was slightly lower than that of the HMA mixture. | [10] |
| Liu Hengbin et-al. | 2021 | Viscosity of binder. Ageing resistance test. | - Develop a modified SBS asphalt binder to improve Warm mix asphalt technology.<br>- Sasobit was used as a Warm mix additive. Organic montmorillonite (OMMT) has also been used with Sasobit to increase UV aging resistance.<br>- The authors concluded that Sasobit and OMMT can improve the high temperature performance of SBS modified asphalt.<br>- Although the introduction of Sasobit resulted in a significant decrease in low-temperature performance, it could help restore OMMT moderately.<br>- Improvement in UV ageing resistance was observed with addition of OMMT additive. | [11] |
| Wang Riran al.et- | 2020 | XRD and FTIR | - Sasobit is does not significant chemical reaction with PMA, but it does affect how the polymer additives absorb chemicals, such as saturated fatty acids, from the asphalt.<br>- This resulted in reduction of the mixing temperature and therefore the viscosity of the asphalt. | [12] |
| Rochishnu Elchuri et-al. | 2020 | Marshall properties, bulk properties, stiffness, moisture sensitivity | - Sasobit has been shown to work best at a 3% concentration.<br>- Results showed that 70 % RAP blend improves the performance characteristics by approximately 25% over the standard blend.<br>- The performance of the RAP composite was enhanced by using additional reinforcement in the form of glass nanofibers.<br>- The addition of 0.3% glass nanofibers improves the performance properties of the recycled blend. | [13] |
| Rahman Taqia et-al. | 2020 | Rut resistance | - Sasobit and Rediset were used in airfield pavement.<br>- It was observed that addition of Sasobit resulted in better rutting resistance at the traffic opening temperature than conventional HMA.<br>- Sasobit may lead to reduction in overlay construction period by 4 % - 24 %. | [14] |
| Kushwaha and Swami | 2019 | Moisture susceptibility (ITS) | - Investigated the moisture susceptibility of bituminous mixes created with 84 % RAP and foamed bitumen.<br>- Based on moisture susceptibility test results, it was reported that the predefined RAP content can be incorporated in pavement construction with 2.5 % foam bitumen content. | [15] |

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| Gong Jie et-al. | 2019 | Marshall stability test,<br>Dynamic mechanical properties,<br>Warm-mix epoxy asphalt binder (WEAB), Thermal, mechanical, morphological, characterization**.** | - Warm mix epoxy asphalt binder (WEAB) was prepared by mixing curing agent and epoxy oligomer in binder.<br>- Sasobit has been shown to significantly reduce the viscosity of pure WEAB and extend the life of mixed tires.<br>- Sasobit lowers the glass transition temperature of pure WEAB.<br>- Sasobit slightly reduces the thermal stability and moisture properties of pure WEAB and increased its WEAB frictional power.<br>- As the amount of WMA additive increased, the crystal structure of the Sasobit-coated crystals changed into a circular, band-like, gelatinous structure. | [16] |
| Almeida and Sergio. | 2019 | Marshall stability test,<br>compatibility test. | - Conducted a study to check the effect of Sasobit REDUX on the properties of WMA.<br>- Sasobit REDUX is soluble in bitumen at 85 °C which is 30 °C lower than Sasobit.<br>- For this study, three temperature range of 90, 100 and 110 °C were considered.<br>- It was resulted that satisfactory results of Marshall parameters were obtained using Sasobit REDUX as admixture.<br>- It was also observed that the workability of Sasobit REDUX was better than the conventional HMA.<br>- It was concluded that Sasobit REDUX can reduce the mixing temperature by 20 °C. | [17] |
| Carlina Serli et-al. | 2019 | Marshall Stability, Resilient modulus and fatigue resistance | - Sasobit was used in the range of 1 %, 2 % and 3 % by weight of bitumen.<br>- It was reported that addition of 3 % Sasobit resulted in improved stability values, resilient modulus and fatigue resistance.<br>- It was concluded that addition of Sasobit resulted in reduction in compaction temperature by 7 °C. | [18] |
| Jamshidi Ali et-al. | 2012 | Rheological properties using Dynamic shear rheometer and rotational viscometer | - Rheological properties of different grades of binders incorporated with Sasobit additive were investigated.<br>- The rheological properties were determined at different age conditions with Dynamic shear rheometer and rotational viscometer.<br>- Sasobit can be added in the proportion of 1.6 % to binder without effecting fatigue resistance of binder. | [19] |
| Hamzah Meor Othman et-al. | 2010 | Required heat energy, $CO_2$ emissions, fatigue resistance | - 1 % Sasobit was successful in reducing the heat energy and $CO_2$ by 2.8 % and 3 %.<br>- Based on fatigue resistance test results, the optimum dosage of Sasobit was obtained as 1.6 %. | [20] |
| Tao and Mallick | 2009 | Bulk Specific Gravity, Seismic Modulus, Indirect Tensile strength | - Studied the impact of 100 % RAP on the properties of HMA.<br>- Sasobit H8 was used in proportion of 1.5 %, 3 % and 5 % and Advera Zeolite were used in proportions of 0.3 %, 0.5 % and 0.7 % by weight of bitumen.<br>- It was resulted that at both the additives, the workability of 100 % RAP HMA improved at 110 °C.<br>- At temperature below 80 °C, the mixture becomes stiff resulting in reduced workability, increased seismic moduli and ITS.<br>- Sasobit H8 performed well in improving the bulk specific gravity of the mix. | [21] |

## 4. CONCLUSION

Following conclusions are drafted from the above research work:

- Warm mix asphalt (WMA) is the need of the hour as it can result in saving comprehensive amount of energy resources.
- Sasobit can reduce the mixing and compaction temperature of HMA.
- Addition of Sasobit improves ductility and softening point of bitumen while reduces the viscosity of bitumen.
- Sasobit in the range of 1 % - 5 % by weight of binder have been used in many research.
- There is another material Sasobit REDUX which is soluble in bitumen at temperature less than Sasobit.
- Addition of Sasobit resulted in reduction of compaction temperature by 7 °C - 30 °C.
- Incorporation of RAP in bituminous mixes results in preparation of stiff mixture. Sasobit reduces the workability of the binder resulting in making the mix more workable and easier to use for pavement construction.
- By using Sasobit, 84 % - 100 % RAP can be used in pavement construction.

## 5. REFERENCES

[1] https://en.wikipedia.org/wiki/Roads_in_India
[2] Sachdeva, N., Kushwaha, P., & Sharma, D. K. (2022). Impact of clay brick dust on durability parameters of bituminous concrete. Materials Today: Proceedings.

[3] Sharma, D., Kushwaha, P., & Sachdeva, N. (2021). Use of Demolished Recycled Aggregate for Pavement Construction: A Review.

[4] Vaitkus, A., Čygas, D., Laurinavičius, A., Vorobjovas, V., & Perveneckas, Z. (2016). Influence of warm mix asphalt technology on asphalt physical and mechanical properties. Construction and Building Materials, 112, 800-806.

[5] Zaumanis, M. (2014). Warm mix asphalt. Climate Change, Energy, Sustainability and Pavements, 309-334.

[6] Hurley, G. C., & Prowell, B. D. (2005). Evaluation of Sasobit for use in warm mix asphalt. NCAT report, 5(6), 1-27.

[7] Wasiuddin, N. M., Selvamohan, S., Zaman, M. M., & Guegan, M. L. T. A. (2007). Comparative laboratory study of sasobit and aspha-min additives in warm-mix asphalt. Transportation Research Record, 1998(1), 82-88.

[8] Rezaeizadeh Herozi, M., Valenzuela, W., Rezagholilou, A., Rigabadi, A., & Nikraz, H. (2022). New Models for the Properties of Warm Mix Asphalt with Sasobit. CivilEng, 3(2), 347-364.

[9] Almeida, A., Capitão, S., Estanqueiro, C., & Picado-Santosc, L. (2021). Possibility of incorporating waste plastic film flakes into warm-mix asphalt as a bitumen extender. Construction and Building Materials, 291, 123384.

[10] Ozturk, H. I., & Pamuk, O. C. (2022). Evaluation of Warm Mix Asphalt compactability indices using laboratory compactors from a temperature perspective. International Journal of Pavement Engineering, 23(10), 3621-3632.

[11] Liu, H., Zhang, Z., Xie, J., Gui, Z., Li, N., & Xu, Y. (2021). Analysis of OMMT strengthened UV aging-resistance of Sasobit/SBS modified asphalt: Its preparation, characterization and mechanism. Journal of Cleaner Production, 315, 128139.

[12] Wang, R., Yue, M., Xiong, Y., & Yue, J. (2021). Experimental study on mechanism, aging, rheology and fatigue performance of carbon nanomaterial/SBS-modified asphalt binders. Construction and Building Materials, 268, 121189.

[13] Rochishnu, E., Ramesh, A., & Ramayya, V. V. (2021). Sustainable pavement technologies-performance of high RAP in WMA surface mixture containing nano glass fibers. Materials Today: Proceedings, 43, 1009-1017.

[14] Rahman, T., Dawson, A., & Thom, N. (2020). Warm mix asphalt (WMA) for rapid construction in airfield pavement. Construction and Building Materials, 246, 118411.

[15] Kushwaha, P., & Swami, B. L. (2019). A study on moisture susceptibility of foamed bitumen mix containing reclaimed asphalt pavement. Transportation Infrastructure Geotechnology, 6, 89-104.

[16] Gong, J., Liu, Y., Jiang, Y., Wang, Q., Xi, Z., Cai, J., & Xie, H. (2021). Performance of epoxy asphalt binder containing warm-mix asphalt additive. International Journal of Pavement Engineering, 22(2), 223-232.

[17] Almeida, A., & Sergio, M. (2019). Evaluation of the potential of Sasobit REDUX additive to lower warm-mix asphalt production temperature. Materials, 12(8), 1285.

[18] Carlina, S., Subagio, B. S., & Kusumawati, A. (2019). The Performance of Warm Mix for the Asphalt Concrete-Wearing Course (AC-WC) Using the Asphalt Pen 60/70 and the Sasobit® Additives. Civil Engineering Journal ITB, 26(1), 11-16.

[19] Jamshidi, A., Hamzah, M. O., & Aman, M. Y. (2012). Effects of Sasobit® content on the rheological characteristics of unaged and aged asphalt binders at high and intermediate temperatures. Materials Research, 15, 628-638.

[20] Hamzah, M. O., Jamshidi, A., & Shahadan, Z. (2010). Evaluation of the potential of Sasobit® to reduce required heat energy and CO2 emission in the asphalt industry. Journal of Cleaner Production, 18(18), 1859-1865.

[21] Tao, M., & Mallick, R. B. (2009). Effects of warm-mix asphalt additives on workability and mechanical properties of reclaimed asphalt pavement material. Transportation Research Record, 2126(1), 151-160.