Performance Evaluation of Aspha-min Modified Warm Mix Asphalt

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Abstract

Hot Mix Asphalt (HMA) has long been the main material for flexible pavement, and it is mixed and compacted at high temperatures, usually between 150 and 170 degrees Celsius. HMA has been valued for its durability and strength for a long time, but its production process leads to high fuel consumption and emissions of greenhouse gases. Additionally, Short-term aging of the materials is a major concern linked to HMA. Over the past few years, countries around the world have been moving towards making construction more sustainable, which has led to the creation of Warm Mix Asphalt (WMA) technologies. WMA can be produced and compacted at temperatures that are 20–40 degrees lower than those used for HMA which saves energy and reduces emissions without affecting the quality of the pavement. Adding Aspha-min, a synthetic zeolite, is a key technology used to help bitumen foam during WMA production. As a result, aggregates are more easily coated and become more compactable at lower temperatures, which also helps to reduce the amount of energy used. While several studies have examined the performance of Aspha-min modified WMA, no study has evaluated its behavior under Sri Lankan environmental and operational conditions. Moreover, the existing literature does not present a consistent trend regarding the performance impact of Aspha-min. This study focuses on evaluating the performance of Aspha-min modified WMA under local environmental and operational conditions. The primary objective is to determine the optimal dosage of Aspha-min and mixing temperature that would provide performance comparable to conventional HMA while offering environmental benefits. For this purpose, the study tested three Aspha-min dosages, which are 0.25%, 0.30%, and 0.35% by weight of asphalt mix at three mixing temperatures: 125 °C, 130 °C, and 135 °C. A control HMA sample was also made at 150 °C of mixing temperature for comparison. Specimens were prepared and evaluated using the Marshall mix design method, following the requirements of ASTM standard specifications. The main performance parameters analyzed were Marshall stability, bulk specific gravity (G_{mb}), and air void content. The results were checked against the SSCM guidelines for wearing course applications in Sri Lanka to assess the suitability of each Aspha-min dose and mixing temperature. The results showed that a mix with 0.30% Aspha-min and a mixing temperature of 130 °C gave the best combination of workability, stability and void structure. This mix achieved a high Marshall stability value, acceptable density values, and air voids within the recommended range. Furthermore, the compaction properties of the Aspha-min mix were similar to those of the standard HMA mix which means that Aspha-min did not negatively impact density or durability. The research shows that using Aspha-min modified WMA is a possible and lasting choice for constructing flexible pavements in Sri Lanka. Because it reduces the production temperature by up to 20 °C, it helps save fuel and cut emissions, making construction more environmentally friendly. In addition, the optimized mix guarantees the structure's strength, making it suitable for use in local roads. Future efforts may consist of long-term testing in the field and cost analysis to confirm that large-scale adoption is feasible.

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