

Determining Percentage of Recycled Asphalt Pavement in Asphalt Mixtures

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Introduction

Drum mix plants, the primary hot-mix asphalt (HMA) production plants for most Kansas Department of Transportation (KDOT) projects, use belts to feed virgin aggregates and reclaimed asphalt pavement (RAP) into a drum for HMA production. At the beginning of each project, the belts are calibrated to control the aggregate and RAP quantities during mixing. Based on the totalizer input, a specific amount of virgin binder is then pumped from a storage tank (NAPA & APWA, 2000). Although current specifications require the use of a totalizer to determine the percentage of RAP in HMA, an asphalt cement mass-balance method identified discrepancies in amount of RAP fed into the drum for various projects when compared to the totalizer method. KDOT conducted a detailed analysis of one project and found that the amount of RAP backcalculated from the total mass of mixture and virgin binder content was higher than the designated RAP content, highlighting the need for data investigation and verification of multiple projects.

Project Description

Drum mix plants are the primary hot-mix asphalt (HMA) production plants for most Kansas Department of Transportation (KDOT) projects. In drum mix plants, a totalizer controls the input rate of virgin aggregates and recycled asphalt pavement (RAP). In current practice, the RAP percentage is determined by the input rate shown on the totalizer. However, KDOT conducted a detailed analysis of data from one project and found that the estimated amount of RAP based on the asphalt cement mass-balance method was higher than the designed/Job Mix Formula RAP content. The study for this report included visits to several plants and the collection of plant operation and total production data to calculate the RAP percentage. Furthermore, a Monte-Carlo approach was followed to estimate RAP quantity based on RAP binder content, and actual plant input and output data verified the calculations. This report proposes test guidelines for RAP and reclaimed asphalt shingle percentages.

The objective of this study was to investigate the discrepancies between calculated and actual rap contents in HMA produced in the drum mix plants. The study collected actual feed/input data from plant production and then compared the data to the calculated results.

Project Results

This study investigated RAP percentage using the totalizer method in the HMA plant and the AC mass-balance method after production. The RAP percentage determined by the totalizer method was steady and did not exceed the designed percentage of RAP. However, a significant difference was observed between the AC mass-balance method results and the totalizer results. For example, the burn-off test results of binder content in RAP from the contractor and KDOT differed, which resulted in varying RAP percentages; a high RAP AC content resulted in a decreased percentage of RAP. Follow up investigations were made at two more plants to determine the effect of RAP asphalt content and burn-off tests were conducted on RAP and HMA mixtures collected from the projects. The burn-off test results from multiple labs showed significant differences, indicating that RAP AC content significantly influences the RAP content calculated based on the AC mass-balance method. The Monte Carlo analysis also supported this observation.

In current QC practices for RAP in Kansas, the contractor determines RAP AC content once during the first lot and then once per 1,000 tons of RAP. For QA, KDOT conducts one test during the first lot and one test per 4,000 tons of RAP (KDOT, 2015b; KDOT, 2022). However, the percentage of RAP usage in the projects (20%–25%) and the volume of HMA production on each project limits the testing frequency for the RAP AC content. Small sample sizes may increase variability and decrease precision in the RAP percentage analysis. Therefore, a higher frequency for testing the binder content of RAP is recommended to enlarge the population to reduce variability.

Project Information

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