

Outstanding Issues for RAP Best Practices

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Remaining Challenges (pg. 16)

The mix design process for HMA with RAP is similar to mix design for virgin HMA except in the case where high percentages of RAP (greater than 25%) are used. Despite similarities between producing virgin asphalt mixtures and RAP asphalt mixtures, there are still some remaining challenges for maximizing RAP use and routinely using high RAP. First, the current binder selection guidelines for RAP mixtures according to AASHTO M 323 *Standard Specification for Superpave Volumetric Mix Design*, shown in Table 4, were formulated based on the assumption that substantial mixing occurs between the virgin binder and RAP binder. **Unfortunately, there is no method available to accurately determine the amount of blending that occurs between virgin and RAP binder. However, ongoing research is developing methods to determine if proper blending has occurred by using mixture dynamic modulus properties to estimate blended binder properties and compare to measured binder properties.** [ii](#), [iii](#)

For high RAP mixtures, blending charts are specified to properly determine the virgin binder grade. The blending charts can also be used to optimize the amount of RAP to use if the virgin binder grade is known. **Blending charts require expensive, time-consuming binder extraction and recovery tests that use hazardous solvents. Many highway agencies are reluctant to specify amounts of RAP that require this additional testing and, further, many contractors are not equipped to perform binder extraction and recovery tests that involve hazardous solvents.**

Minimize solvent extractions

- Ways to reduce number of extractions?
- Regional RAP binder studies?

Major Obstacles – 2009 Survey

- i) regarding the blended virgin and RAP binder qualities especially for high RAP mixes and polymer modified binders and
- ii) stiffening of the mix from high RAP quantities and resulting cracking performance.

Correction Factors for Ignition Oven (pg. 19 & 29)

- How to choose correction factor?
- How reliable is asphalt content?

Specifying RAP from State DOT Projects

- Should we mention it under “Best Practices” chapter? Pg. 23

Mention LTPPBind Protocols (pg. 27)

Through years of experience balancing the material quality requirements for the specific application with the market availability and cost, many agencies have standardized the PG binder grade for HMA on a regional, project type, and/or program basis in lieu of determining the project binder grade quality for the specific location and application. **It is recommended that agencies reassess the binder quality requirement for the specific application utilizing the LTPPBind protocols [i] to assess quality needs based on local environmental conditions and design reliability of the application to gain more insight into the required binder quality.**

RAP amounts based on binder replacement (pg. 27)

The primary volumetric issue in the use of RAP in asphalt mixes is the amount of binder replacement available since the use of RAP can reduce the need for virgin binder. Thus, RAP may also be specified according to percent binder replacement.

The percentage of RAP used in the mix may be selected by determining the contribution of the RAP binder toward the total binder in the mix, by weight (i.e. so much percentage of the binder may come from RAP). In fact, several State DOTs have specified a minimum percentage virgin binder content requirement (e.g. 70% of the binder content must be virgin binder).

The amount of total binder replaced by binder in RAP is computed as follows:

$$\text{Binder Replacement, \%} = (A*B)/C$$

where: A = RAP, % Binder Content

B = RAP, % in Mixture

C = Total, % Binder Content in Mixture

Estimating RAP Gsb (pg. 30)

The bulk specific gravity of the RAP aggregate after the ignition oven, burnt aggregate, is too low of an estimate, and the effective specific gravity of the RAP aggregate (unburnt) is too high.

The bulk specific gravity of the RAP aggregate, , can be estimated by determining the maximum theoretical specific gravity of the RAP mixtur , and using an assumed asphalt absorption (if the asphalt absorption can be estimated with confidence) for the RAP aggregate to calculate . However this may cause an error into the combined aggregate bulk specific gravity and VMA calculations.

VMA requirements may be adjusted based on experience with local or commonly used aggregates.

When the RAP contains highly absorptive materials (i.e. absorptions above 2%), the amount of absorbed asphalt should be estimated based on experience and used to back calculate the bulk specific gravity of the aggregate. With the use of highly absorptive materials combined with higher RAP percentages (e.g. 40%), there is a potential impact ranging from 0.2 – 0.4% difference on the required asphalt content.

NCAT Long-term Performance Study (pg. 35)

- Most recently, NCAT completed a study comparing virgin and recycled asphalt pavement using data from the Long Term Pavement Performance (LTPP) program. [ii](#) Data from eighteen projects across the US was analyzed in order to compare overlay type, thickness, and surface preparation (milled versus nonmilled). The overlay types were virgin asphalt mix and recycled asphalt mix containing 30% RAP. According to an Analysis of Variance (ANOVA) analysis, the overlay type (virgin versus RAP mixes) was only significant for fatigue, longitudinal, and transverse cracking where the virgin performed better than the RAP mixes. Statistical analyses using paired t-tests showed the RAP mixes performed better than or equal to virgin mixes for the majority of the data for each distress parameter. NCAT concluded that in most cases using 30% RAP in an asphalt pavement can provide the same overall performance as a virgin asphalt pavement.

Pavement Management Systems

- Should we recommend including RAP in PMS?
- What data is important to capture?

Thanks for your feedback!