Florida Department of Transportation Research

Enhanced Characterization of RAP for Cracking Performance

May 2020

Project Number
BDV31-977-70

Project Manager
Howard L Moseley
FDOT PMaterials Office

Principal Investigator
Reynaldo Roque
University of Florida

Current Situation

Road resurfacing produces millions of tons of used asphalt pavement. Some of this used asphalt can be recycled by adding it to asphalt mixes for new pavement. The use of recycled asphalt pavement (RAP) in asphalt mixtures offers a significant material cost savings and positive environmental benefits. However, improper use of RAP can negate these benefits by reducing the life of the new pavement. To assure long lasting pavements, the Florida Department of Transportation (FDOT) limits RAP to a maximum of 20% in its premium mixtures containing polymer-modified binders. Conversely, FDOT mixtures that contain unmodified binders have incorporated up to 50% RAP and use close to 30% RAP on average. Extensive research was needed to determine if more RAP could be used in FDOT mixtures containing polymer-modified binders without sacrificing pavement performance.

Using recycled asphalt pavement in new pavements saves money in road building and helps protect the environment.

Research Objectives

University of Florida researchers evaluated the effect of RAP binder stiffness, fineness, and gradation on cracking resistance to determine whether the current maximum RAP usage in polymer-modified asphalt (PMA) mixtures can be increased. They also examined the effect of RAP on asphalt mixtures made with high polymer (HP) binder. If more RAP could be effectively used, the researchers were also tasked with determining simple, but effective methods of characterizing the RAP for increased usage.

Project Activities

The researchers chose eight RAP sources from across the state. RAP was characterized primarily by its binder stiffness, fineness, and gradation. The RAP sources represented three gradations: two were coarse; three were intermediate; and two were fine. Asphalt mixes were designed using PMA binder with RAP at 0% RAP (control), 20% RAP (current maximum), 30% RAP, or 40% RAP. HP mixes were made with RAP at 0% RAP and 20% RAP. HP is a more expensive polymer binder that helps reduce cracking and minimize rutting.

Mixtures were evaluated using the interstitial component direct tension (ICDT) test and further evaluated with the Superpave indirect tensile (IDT) test. Binder stiffness and fineness of RAP were directly related to cracking reduction: coarser, less stiff RAP reduced cracking better than finer, stiffer RAP. But the relationship of cracking resistance to gradation was less clear. Three RAP sources had intermediate gradation and similar fineness levels, but two of these had higher binder stiffness and produced a more brittle mixture than less fine RAP. This indicated that it is important to characterize RAP binder stiffness and fineness before increasing the RAP content above the current maximum (20%) in PMA mixes.

A preliminary guideline based on RAP binder stiffness and fineness on the #16 sieve was developed for determining maximum RAP usage in PMA mixes and was validated by full mixture testing. Coarser and less stiff RAP allowed for greater maximum RAP content (up to 40%) in PMA mixes. It was also concluded that incorporation of 20% RAP in HP mixes would negate the benefits of using the more expensive high polymer binders.

Project Benefits

The possibility of using higher amounts of recycled asphalt pavement under the right conditions offers economic and environmental benefits.

For more information, please see fdot.gov/research