Florida Department of Transportation Research

Use of Reclaimed Asphalt Pavement in Concrete Pavement Slabs
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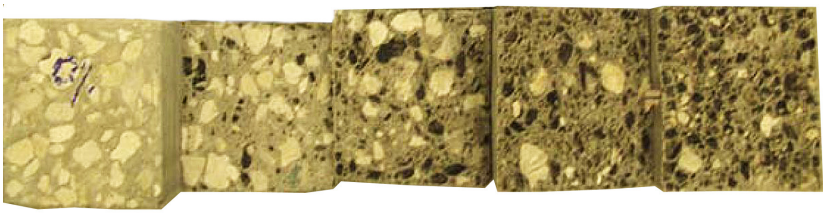
Reclaimed asphalt pavement (RAP) recycled into new asphalt pavements has saved Florida substantial dollars while conserving virgin aggregates and asphalt. However, the Superpave mix design adopted in Florida in recent years has stricter specifications, reducing RAP use and leaving more for other uses. If RAP could be used in concrete pavement, growing stockpiles of excess RAP could be well used, demand for decreasing supplies of high-quality virgin aggregate reduced, and performance and cost effectiveness of concrete pavements improved.



Concrete samples containing various percentages of recycled asphalt pavement, from left to right 0%, 20%, 40%, 70%, and 100%.

To determine the feasibility of replacing aggregate in concrete pavements with RAP, University of Florida researchers formulated concrete-RAP mixes, replacing from zero to 100 percent of aggregate with RAP. Four different RAPs were tested for both coarse portion and fine portion replacement. Mechanical properties were determined at four different curing periods ranging from seven to 90 days.

Comprehensive testing was performed on hardened concrete samples. Generally, compressive strength, modulus of elasticity, flexural strength, and splitting tensile strength decreased as the RAP percentage increased, whereas drying shrinkage, coefficient of thermal expansion, and Poisson's ratio increased with RAP percentage. RAP-4, a mixture of limestone, granite, and polymer-modified binder, produced concrete mixtures with lower coefficient of thermal expansion and much higher flexural strength than mixes with other RAPs. A promising characteristic of RAP-concrete mixes was an increase in failure strain and concrete toughness with increasing RAP percentage.

The researchers found that the ACI equation relating flexural strength to compressive strength underestimated flexural strength of RAP-concrete mixes used in this study throughout the entire range of compressive strength. Conversely, the ACI equation that relates modulus of elasticity to compressive strength overestimated the modulus of elasticity up to 2500 psi and cannot be used to estimate the modulus of elasticity of concrete mixtures containing RAP.

Measured properties of concrete containing RAP were subjected to computer analyses to determine how the various RAP-concrete mixtures might perform in typical concrete pavement. Software, including FEACONS IV, ADINA, and the mechanistic empirical design guide program (MEPDG), were used to study critical loading condition, stress-strain, and failure load. Critical stress analysis showed that maximum stress in pavement decreases as RAP content increases. Though flexural strength of concrete with RAP was lower than for conventional concrete, the computed stress-to-strength ratio for some RAP mixtures was lower than for conventional concrete. Analyses showed that, on average, pavement slabs containing RAP had higher ultimate failure loads than controls, indicating a potential for RAP concrete to outperform conventional concrete in pavement slabs.

This project showed that recycled asphalt can produce better pavement slabs than conventional concrete, when the right RAP is used in the right proportions. Development of this promising new application can continue with full-scale testing using mix design procedures recommended by the researchers.

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For more information, visit http://www.dot.state.fl.us/research-center