Florida Department of Transportation Research

Development of Mix Designs for RAP Concrete for Florida Concrete Test Road

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Current Situation

The resurfacing of asphalt roadways involves the removal, or milling, of the top pavement layer before retopping with fresh material. The milling process produces mountains of asphalt chips, and transportation agencies across the United States have worked to find appropriate uses for this material, referred to as recycled asphalt pavement, or RAP. One important use of RAP is as a replacement for part of the aggregate required to make concrete. In the right amounts, RAP improves the performance of concrete, but because the ingredients of concrete interact in complex ways, research is required to determine the correct proportions of the ingredients.

Research Objectives

University of Florida researchers used RAP as a replacement for up to 40% of the aggregate in concrete mixes. They used specially designed software to optimize these mixes.

Cross-sections through a series of samples show increasing RAP content, from no RAP at left to 40% RAP at right.

Project Activities

While it is possible to perform many tests on concrete in the laboratory, long-term testing must be performed on actual installations where the concrete will be exposed to the natural environment and to vehicle usage. To this end, the Florida Department of Transportation (FDOT) is constructing a 2.5-mile test road where concrete mixes can receive field testing. Because previous FDOT-sponsored research showed the value of adding RAP to concrete, in this project, concrete mixes containing RAP were tested for use on the test road.

The researchers used two FDOT-approved RAP sources in concrete mixes made with 0% to 40% RAP replacing aggregate and 0% and 20% fly ash replacing cement. Mixes were designed using the optimized aggregate gradation (OAG) technique, guided by the research team's OAG Tool software. Concrete specimens were subjected to critical stress analysis to evaluate their potential performance as concrete pavements.

The no-RAP control mix had a gap-graded aggregate which lacked intermediate-size particles. When 20% or 40% RAP was incorporated using the OAG procedure, the aggregate blend became significantly more well-graded and the concrete became more workable. The project showed that the OAG procedure is superior to the ACI procedure in proportioning aggregates to achieve a well-graded aggregate blend and a workable mix.

Critical stress analysis indicated that the RAP concrete using 20% fly ash and 20% to 40% RAP with a water-to-cement ratio of 0.50 could have better potential performance than a concrete mix made with no RAP, pure cement, and the same water-to-cement ratio. A cost analysis indicated 10% to 19% savings for the RAP concrete mixes.

Project Benefits

Research supports the use of RAP in concrete, which gives this plentiful waste material a useful new life, improves concrete performance, and reduces construction costs.

For more information, please see www.fdot.gov/research/.