Study Suggests 70 Percent RAP for Minnesota Gravel Road Surfaces

What Was the Need?
Gravel roads offer a cost-effective option for road departments that wish to avoid the expense of asphalt and concrete roads in rural or low traffic areas. However, about an inch of gravel is lost from these roadways each year. Aggregate resources are diminishing, and gravel and crushed rock aggregate is growing increasingly expensive.

Gravel also generates dust that can reduce visibility, affect road performance and result in complaints from nearby homeowners.

Recycled asphalt pavement (RAP) can be an effective component of new asphalt pavement mixtures. Many aggregate producers stockpile RAP that has been broken into the size of aggregate. But not all RAP works well mixed in asphalt, and some aggregate yards are too far from pavement projects to economically use RAP in pavement.

Road agencies frequently use RAP in gravel roads. The asphalt content in RAP can bind with dust from crushed rock or gravel, helping manage fugitive dust. A recent study in Wyoming found that using RAP in new gravel surface applications at less than 50 percent of the aggregate resulted in good road performance and kept dust to a minimum.

What Was Our Goal?
In light of the findings from the Wyoming study, researchers sought to determine the optimal level of RAP in an aggregate mixture for Minnesota gravel road surfaces. These new applications would offer good driving stability while also controlling fugitive dust.

What Did We Do?
Research began with a review of the literature on RAP as an aggregate component of surface, base and subbase layers, as well as a survey of Minnesota counties on their experience with these mixtures.

In the lab, the research team tested three RAP materials and virgin aggregate from two Minnesota locations in various RAP content levels for strength and compression. Investigators then compared the economic feasibility of 100 percent virgin aggregate use to 50 percent virgin and 50 percent RAP aggregate mixtures on a 1-mile aggregate road, including annual grading and eventual regraveling in the estimations.

Research in the field focused primarily on six 1,000-foot gravel road test sections: four sections in Goodhue County using 15, 30, 45 and 60 percent RAP content, and two sections in Carlton County using 30 and 50 percent RAP. The studies entailed all-virgin aggregate control sections, and installations were made over roads with various subgrade soils that presented a variety of properties. Sites were tested for elasticity, bearing strength and fugitive dust generation.

A secondary field study focused on RAP contents of 50, 70 and 80 percent in 3-inch surface courses for three test sections and one control section in Goodhue County. Sites were tested for elasticity, strength, dust generation, ride quality and surface aggregate looseness over time, and some lab tests were conducted.

In lab and field testing, researchers examined mixtures of RAP and aggregate for new gravel road surface layers. Results suggested that mixtures with 70 percent RAP content can reduce dust generation and after a year of service can match all-aggregate gravel road performance with a smoother ride.
What Did We Learn?

Previous research indicated that RAP can help reduce fugitive dust, offers value as surface courses, and can reduce moisture susceptibility of gravel roads in cold or wet locations.

Lab mixtures with 30 percent RAP consistently produced high compressive strength values, and higher RAP levels generally correlated inversely with bearing strength. Improvements in dust reduction were limited until RAP levels exceeded 50 percent.

Economic analysis determined that a 50/50 percent mix of RAP and aggregate would cost 1.5 percent more than an all-virgin aggregate surface course in terms of construction and maintenance, but potential reductions in dust generation, surface aggregate loss and regraveling after three years of service may produce savings from RAP use.

Results from field testing defied clear recommendations on optimal RAP content. Generally, higher RAP content offered greater elasticity and lower levels of loose aggregate initially, but these benefits fell to equal or below non-RAP levels after a year. Higher RAP correlated with reduced dust generation, but again fell over the first year of service. In secondary testing, initial dust generation was lower with the 50 percent mixture than the others, but after a year was lowest with the 70 percent mixture.

Ultimately, researchers found that after a year, during which fugitive dust production was reduced, the performance of a 70 percent RAP content aggregate surface course was most like a virgin aggregate surface course and offered a smoother driving surface.

What’s Next?

While this research did not develop a definitive recommendation for an optimal RAP content in surface courses for aggregate roads, it did produce useful data on performance. The study did encourage a general sense that 70 percent RAP content for surface courses of approximately 2 inches may be effective and warrants systematic study for a three-year period.