

MAKING RAP WORK IN SUPERPAVE

By Mike Anderson, Pamela Turner, and Bob Peterson

Since the late 1970s, the use of reclaimed asphalt pavement (RAP) in asphalt mixes has become commonplace. The use of RAP has grown to the point that more than 70 million tons of RAP are reused every year. In fact, asphalt pavement has become the most recycled material in America.

Even with all the use of RAP, the Strategic Highway Research Program did not address its use in the Superpave system. As a result, many agencies were uncertain about its place in Superpave. Some agencies elected to allow RAP to be used under similar conditions applied to Marshall-designed mixes. Other agencies felt that Superpave was a very exclusive combination of materials that might be compromised by allowing the use of RAP, and thus, did not allow it in Superpave mixes.

Out of this need to evaluate the use of RAP, the National Cooperative Highway Research Program (NCHRP) 9-12 study, "Incorporation of Reclaimed Asphalt Pavement in the Superpave System," was established.

The contract was awarded to the North Central Superpave Center at Purdue University. Rebecca McDaniel was the Principal Investigator. The Asphalt Institute was the subcontractor. McDaniel and Purdue were responsible for managing the overall work, conducting the high-temperature shear-testing, and developing the overall report. The Asphalt Institute's efforts focused primarily on evaluating the "black-rock" issue.

When using RAP, there has long been a question regarding to what extent the reclaimed asphalt blends with the virgin binder. "Does it blend completely or does it act as a black rock?" This issue was considered a critical point in this study. If RAP were only black rock, then it would function

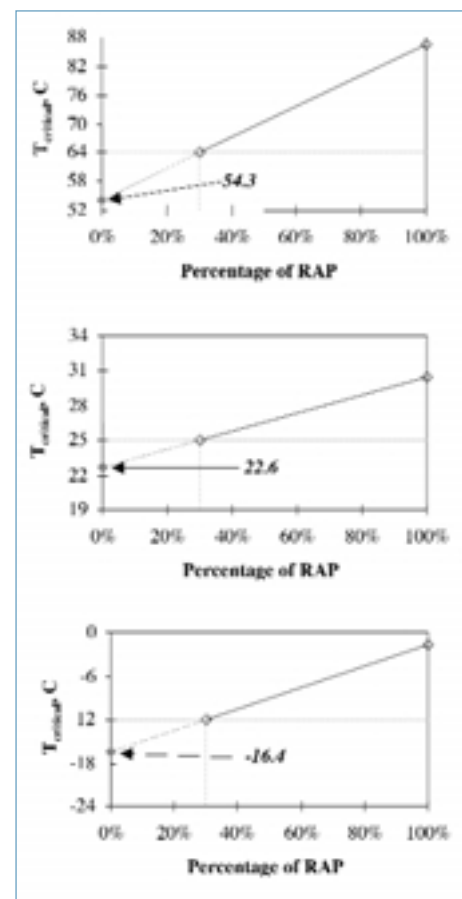


Figure 2: RAP Percentage is known (30%), RAP Binder Properties are known, What are the required properties of the virgin asphalt binder?

Using all three graphs, a PG 54-26 virgin asphalt binder would be needed. Rounding to a standard grade: PG 52-28.

as filler within the virgin mixture components, and there would be no need to account for the effects of the RAP binder.

In order to address the black-rock question, three potential cases were evaluated: *total-blending*, *black-rock*, and *real-world* cases. In the total-blending evaluation, the aggregate and binder were recovered from the RAP. The recovered aggregate was then blended with the virgin aggregate, and the reclaimed binder was physically mixed with the virgin binder. The combination of virgin and recovered aggregate and blended asphalt

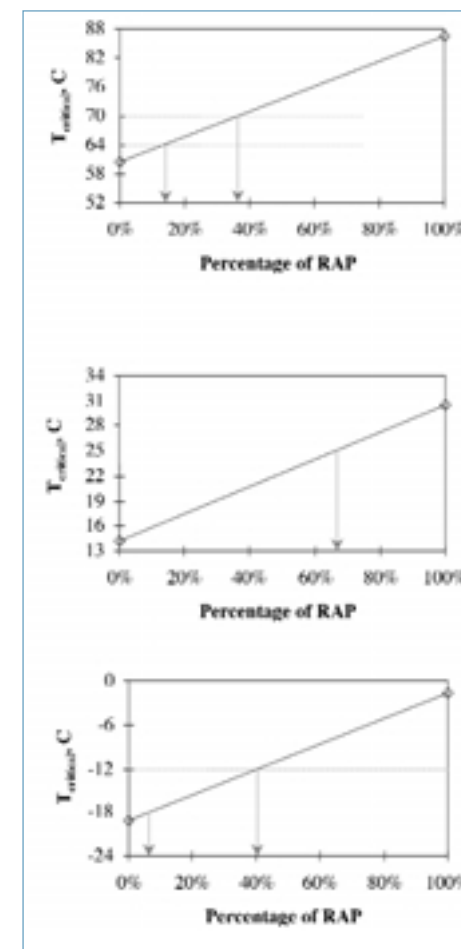


Figure 3: Virgin binder properties are known, RAP Binder Properties are known. How much RAP can be used and still have a final (blended) grade of PG 64-22?

Using all three graphs, 14% to 36% RAP would ensure that the final (blended) asphalt binder would be a PG 64-22.

binder were then proportioned to produce asphalt mixture specimens.

This process ensured that blending actually occurred. In the black-rock case, the RAP aggregate was recovered and blended with virgin aggregate and virgin binder. Because this case assumed that the RAP binder had no effect, the reclaimed asphalt was not used in the black-rock mixture specimens. Finally, in the real-world situation, the RAP was blended directly with virgin aggregate and virgin binder without direct separation of RAP components.

This scenario approximated what happens in the mixing plant. Mixture specimens were made for each of the three cases, and the physical properties of the specimens were compared.

These properties included high-temperature mixture stiffness or rutting potential, intermediate-temperature fatigue, and low-temperature cracking or brittleness. These specimens allowed a determination of whether the real-world results more nearly matched the complete-blending or the black-rock results.

As shown in Figure 1, the mixture tests indicated that the real-world results more closely match the total-blending scenario at cold temperatures.

Having shown that blending does, at least partially take place, then developing a blending-chart for selection of virgin binder grade became meaningful. New blending-charts were developed that advanced earlier work by the Asphalt Institute (under the direction of Dr. Hussain Bahia) and the National Center for Asphalt technology (under the direction of Mr. Ken Kandhal.)

The Asphalt Institute's approach to developing these new blending-charts used Critical Temperature (T_c) as the limiting factor. Critical temperatures are defined as the temperatures at which a binder meets certain specification (AASHTO MP-1) requirements. For example, the temperature at which the Rolling Thin Film Oven aged material meets the $G^*/\sin\delta$ requirement of 2.20kPa is the T_c . It was found that increasing the RAP binder content of a blend created a linear relationship that

readily lent itself to a blending-chart approach. See Figures 2 and 3.

Unlike earlier efforts, the NCHRP 9-12 blending-charts also include cold-temperature effects—which gives a more comprehensive characterization of RAP's influence on a virgin binder.

In addition to the black-rock study, AI conducted two other evaluations: a binder-effects study and a mixture-effects study. The binder research measured the effects of blending varying amounts of recovered RAP binder with virgin binders. It was found that blending 15 percent or less RAP binder with a given PG-grade, typically, caused no change in binder grade. Similar results were found for the mixture-effects comparison. Incorporating 15 percent or less RAP had little effects on mixture properties.

Essentially, the NCHRP 9-12 research validated the position earlier adopted by the Federal Highway Administration's Mixture Expert Task Group (ETG) and implemented by many agencies. (See Table 1.)

This effort should remove any remaining fears among user agencies regarding the use of RAP in Superpave mixtures. The recycling of asphalt can continue to be a good choice in terms of favorable economics, protecting the environment, and providing an ingredient with proven performance. ▲

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Stiffness @ 60 sec, 40% CT RAP + PG 52-34

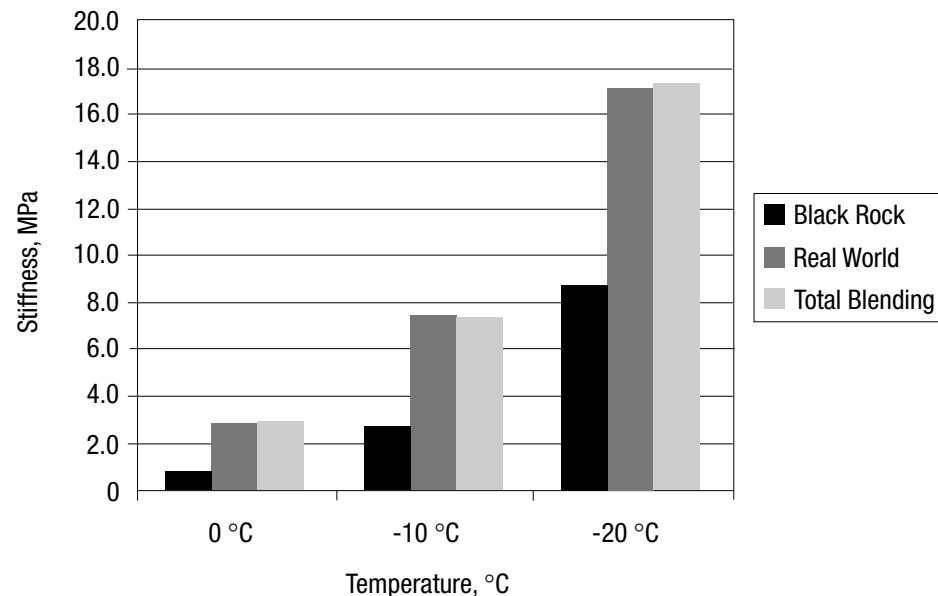


Figure 1: Comparison of Cold Temperature Binder Stiffness

Table 1: Mixtures ETG Guidelines for Utilizing RAP

RAP Percentage	Recommended Virgin Asphalt Binder Grade
Less than 15%	No change in binder selection
15 – 25%	Select virgin binder one grade softer than normal (i.e., select a PG 58-28 if a PG 64-22 would normally be used)
Greater than 25%	Following recommendations from blending charts