Draft CP2 article

Title: Understanding RAP and its effect on local government asphalt mixes

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The following is a summary of a presentation given by John Harvey of the City and County Pavement Improvement Center on July 25th at the 39th Annual Northern California Bedroll Conference which was held at Camp Tehama, Mineral CA.

RAP is the acronym for recycled (or reclaimed) asphalt pavement, which are collected when an existing asphalt pavement is milled (also called cold planing in Caltrans specifications). Milling is done to allow matching of grade when overlaying asphalt pavement, and often done to remove the more heavily aged surface of asphalt pavements. Aging of asphalt pavement occurs from the top down and is caused by exposure of the hyrdrocarbon chains in the asphalt binder to hot air. The hot air causes oxygen cross links to form between the chains and that increasingly makes the asphalt stiffer, which increases the stresses that occur when the asphalt contracts when it cools at night and in the winter (the coldest night in the winter causes the highest stresses). The oxygen cross links (referred to as "oxidation") also make the asphalt less able to "relax" those stresses that occur during cooling.

The amount of aging in asphalt pavement depends on several factors and is not the same throughout the asphalt layers. Oxidation only occurs to the depth to which hot air can penetrate, and maximum temperatures are less with depth, and air penetrates less with depth. Air penetration can be limited shallower depths and there is less oxidation when there is good compaction of the asphalt mix during construction.

The properties of RAP that affect new asphalt mix performance when RAP is included depend on the quantity of the RAP, the amount of asphalt binder in the RAP, and how oxidized the RAP binder is, which is largely depends on how old it was, how hot the climate region is, how deep it was in the pavement, and how well compacted it was. In other words, the properties vary!

Some common questions about RAP are:

- Why would I want my specifications to allow my suppliers to include RAP in the asphalt mix my agency purchases?
    - Inclusion of RAP reduces the cost of producing the mix and reduces the global gas emissions and other emissions that come from production of asphalt mix., provided the mix with RAP gets same or better performance.
    - Inclusion of RAP helps extend the life of virgin aggregate quarries, which is a major issue in many parts of the state where existing quarries are reaching the end of their life, and there is a long process with uncertain outcomes to permit new quarries.
    - California law (AB 2193, 2022) requires that local governments use RAP in mixes matching Caltrans specifications or hold a public hearing explaining why they don't (The bill exempts small cities with populations of 25,000 or less and counties with 100,000 residents or less.)
- How do I get same or better performance?

- Asphalt mixes can be engineered to have same or better performance by measuring the properties of the virgin binder and the RAP binder that together will form the new blended binder, and understanding how the asphalt mix will be used in the new pavement.
- RAP will often improve rutting performance, and will generally improve fatigue cracking (cracking in the whelepaths under heavy trucks and buses) when the new asphalt layer is 3 inches or thicker. The issue is age related cracking (the oxidation discussed at the beginning of this article). Those blended binder properties, critical at low and intermediate temperatures when contraction is occurring, can be engineered by using the blended binder properties and information about the climate region through the PG specification. A new test, the IDEAL-CT cracking test is also being evaluated as a simple method to evaluate the effects of the blended binder on the mix (the binder mixed with the aggregate).
- Stay tuned to future CCPIC information on use of RAP as Caltrans, industry and the University of California Pavement Research Center work together (along with colleagues across the country and globally) to complete developments of mix design for high RAP content mixes.