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Shingle Pavement Project

Portable Crushers

Tear-off Shingles

A Washington county provides the results of a paving demonstration project that used shingles

BY KRIS BEATTY, DAN KRIVIT AND MICHELLE CAULFIELD

King County overlay paving demonstration project using 3% RAS.

Editor's Note:

This is the second part of a two-part series about King County, Washington's Shingles in Paving demonstration. The first part was published in the July/August 2009 issue of C&D World. This article focuses on the implementation of the paving demonstration. Refer to the previous article for additional background and details about the development of the demonstration and the materials specification.

The use of asphalt shingles in paving is growing across the country. Currently 11 states have specifications or procedures in place for using recycled asphalt shingles (RAS) in hot mix asphalt (HMA). King County in Washington state recently published a report on its 2009 paving demonstration to test the use of RAS derived from tear-off roofing scrap in HMA on a public road.

King County Solid Waste Division's recycling market development program, LinkUp, initiated its "Shingles in Paving" effort in 2007, with a goal of establishing a strong local HMA end market for RAS that captures the resource value of tear-off shingles and diverts this material from landfills. The purpose of the paving demonstration is to show the addition of RAS in HMA has no significant impact on pavement performance. Additional outcomes from the paving demonstration include the development of technical standards to produce the RAS in HMA, as well as environmental, health and safety protocols for handling, processing and testing asphalt shingles.

Results from extensive initial materials engineering tests conducted by the King County Road Services Division (Road Services Division), with the support of the Washington State Department of Transportation (WSDOT), indicate using RAS as a part of the HMA mix has no negative effect on pavement performance. The first year of performance testing of the roadway was completed in September 2010 and annual testing will continue into 2012.

Designing the Project

To implement the paving demonstration, King County LinkUp and its project partners worked with a team of stakeholders to address the interests of key market players, ground the study in reality and provide technical and other resource contributions. An advisory group was assembled to provide technical input and to ensure the demonstration captured objective engineering data needed to gain wide acceptance of results. Road Services Division played a leadership role by dedicating a roadway in King County for the demonstration, conducting pre- and post-construction testing, and managing the paving contract. WSDOT provided valuable expertise and laboratory services related to the development of specifications and led the HMA mix design and testing. Advisory group members included regulatory agencies, HMA producers, recyclers, roofing contractors and local transportation agencies.

Selecting the right roadway helped lay a foundation for a successful demonstration. Road Services Division selected a two-mile stretch of roadway to be paved with 4,000 tons of 2-inch thick overlay, offering the right mix of HMA tonnage requirements and traffic volumes, as well as manageable surface and subsurface conditions. Based on extensive evaluation of pre-construction roadway conditions, Road Services Division designed the study with four HMA test sections: two experimental sections containing 3% RAS and 15% recycled asphalt pavement (RAP), and two control sections containing only 15% RAP, as illustrated in Table 1.

Designing the technical standards involved developing specifications for the RAS product and the RAS-modified HMA mix. The RAS specification included requirements for allowable materials, gradation, extraneous materials, moisture and asbestos containing materials (ACM), as well as health, safety and other environmental requirements associated with han-

dling asphalt shingles. The HMA mix design specified the amounts of RAS and RAP, as well as the estimated amount of virgin binder replacement from the RAS. The inclusion of RAP was not initially part of the study but because King County roads are traditionally paved with an average of 15% RAP, stakeholders strongly recommended the experimental mix design include RAP to best reflect typical asphalt mixes in production today.

Through a competitive bidding process, Road Services Division awarded the paving demonstration contract to Woodworth & Co. in July 2009. Woodworth is an HMA producer and paving contractor, as well as a recycler of tear-off and manufacturing scrap asphalt shingles. Woodworth proposed using an existing RAS stockpile (ground product) for the demonstration. While the RAS specifications called for specific quality assurance and quality control (QA/QC) procedures of incoming whole shingles, King County agreed to consider the proposed stockpile provided the material met asbestos and material engineering standards. Initial testing of 20 samples of the ground stockpile using the standard polarized light microscopy (PLM) test for ACM came back non-detect for all 20 samples. King County also tested additional samples using transmission electron microscopy (TEM), a more sensitive test for asbestos, which detected ACM—in low levels. King County worked closely with its asbestos-accredited laboratory and a consultant with extensive experience as a roofer and accredited asbestos inspector, to understand the test findings. Given the low level of ACM by weight in the samples, the expert consensus was the ACM came from non-shingle material. The team decided more aggressive inspection and sorting of incoming material was needed to identify and remove any potential ACM.

Finished RAS product stockpile at Woodworth & Company, Inc. in Lakewood, Wash.

Using a revised protocol and on-site training, the crew at Woodworth's facility hand-sorted and rejected any potential ACM roofing materials from new incoming roofing material. Two types of potential ACM roofing materials were identified: built-up roofing with an aluminum coating and a patching material found on a few of the shingles. Within several days, a new RAS stockpile was produced, tested and accepted for processing.

Table 1: Test Section Layout

	Test Section #1	Test Section #2	Test Section #3	Test Section #4
1000 tons/day	½ mile	½ mile	½ mile	½ mile
Lane 1 (eastbound)	HMA Mix with 15% RAP	HMA Mix with 3% RAS and 15% RAP	HMA Mix with 3% RAS and 15% RAP	HMA Mix with 15% RAP
Lane 2 (westbound)	HMA Mix with 15% RAP	HMA Mix with 3% RAS and 15% RAP	HMA Mix with 3% RAS and 15% RAP	HMA Mix with 15% RAP

Table 2: Final RAS Stockpile Test Results

Test procedure	Requirement	Lab Sample KC-09-1122	Lab Sample KC-09-1123	Lab Sample KC-09-1124
Gradation, 1/2-inch sieve	100% Passing	99%	98%	98%
Gradation, 3/8-inch sieve	95% Minimum. Passing	94%	92%	93%
Lighter Extraneous Material	1.5% Maximum	0.06%	0.01%	0.03%
Total Extraneous Material	3.0% Maximum	0.06%	0.01%	0.03%
Moisture Content	5.0% Maximum	10.0%	9.3%	10.8%

Source: King County, final report: "Shingles in Paving Project: Paving Demonstration" (February 2010)

Employing Materials and Engineering Testing

Materials engineering testing of the RAS product after processing indicated the RAS product met the extraneous materials limit of the RAS specification, but did not meet the gradation and moisture content requirements. Key engineering properties of the finished RAS product are summarized in Table 2. Even though the materials exceeded the gradation and moisture limits, the Road Service Division determined the RAS product substantially met the engineering intent for the paving demonstration. This decision was in part based on the facts that Woodworth's process included further reducing the material in size when blended with RAP and that excessive moisture content was manageable given consistent readings.

Additional testing was conducted on the HMA mix during production and pavement construction. Testing verified all but one of the four test sections substantially met project specifications and materials standards. The test section in question was the first RAS-modified HMA mix, where higher oil and fines content led to significantly low air voids (an engineering parameter of pavement) in the job mix. In-place density tests

further verified air void loss. These results were below the WSDOT acceptance tolerance for air voids for field-produced HMA. However, the pavement looked perfect at lay down and initially performed as expected. Additionally, WSDOT's HMA mix design was slightly over-engineered in that it was for a roadway with more traffic than what is typical for the demonstration roadway. The engineering team decided to leave the questionable test section pavement in place but to modify the HMA to reduce the asphalt content and fines for the second RAS-modified test section, which proved successful.

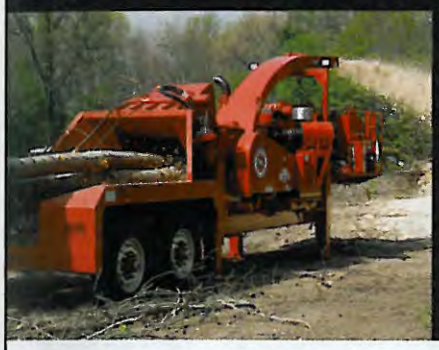
The high oil content in the first RAS-modified HMA mix indicate the RAS product introduced into the HMA mix contributed a greater amount of asphalt binder to the final HMA product than originally anticipated. Both Woodworth and WSDOT staff hypothesize double grinding RAS to meet the gradation requirements resulted in smaller particle sizes and may have enabled more of the RAS binder to be released and effectively used in the HMA than originally predicted. Future research and analysis is recommended to confirm this hypothesis.

Documenting Pavement Performance

In September 2009, a two mile stretch of SE 416th Street in South King County was successfully paved to test the use of 3% RAS and 15% RAP in HMA. After paving installation, a series of tests were conducted to evaluate pavement performance. Extensive initial materials engineering tests on the demonstration pavement indicate using RAS as a part of the HMA mix has had no negative effect on pavement performance. The finished roadway surface was installed to near perfect visual condition, comparable to a newly paved HMA roadway using traditional materials without RAS. Initial post-constructing testing for deterioration, skid resistance, roughness, structural condition and rutting indicate all test sections of the roadway are meeting performance standards. Long-term monitoring is scheduled and, provided performance standards continue to be met, the results will help the use of RAS-modified HMA gain wider acceptance.

Just as significant as these empirical engineering test results, the paving demonstration illustrated the critical importance of a multi-party partnership approach to such research and development efforts. Successful implementation of the paving demonstration was a direct result of the productive input and engagement of Road Services Division, WSDOT, Woodworth and stakeholders.

Built-up roofing with aluminum coating found to be ACM.



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Moving Forward

Since the paving demonstration, King County has continued to advance the development of infrastructure and end markets for RAS from tear-off roofing projects. King County and its partners are sharing paving demonstration results with key audiences including transportation agencies, recyclers and HMA producers—both locally and nationally.

King County recently completed a survey of more than 30 recyclers and HMA producers in Washington State to better understand awareness and use of shingles in paving in the region. Results indicate widespread interest in using RAS in HMA and general consensus that the key to market development is modifications to the state's road construction specification to allow for the use of RAS in HMA. To this end, King County is forging relationships with the paving industry, including the Washington Asphalt Pavement Association, to promote more research and development on the use of RAS in HMA.

With growing interest from local transportation agencies and municipal public works departments to use RAS in HMA, King County is revising the 2009 RAS specification to incorporate lessons learned from the paving demonstration and produce a 2010 RAS specification that can be used by agencies planning to use RAS in asphalt pavements. The revised specification calls for PLM testing for asbestos of whole shingles, prior to grinding. To start, the King County Solid Waste Division is planning to use this revised RAS specification for HMA paving associated with its own operations and facilities: the renovation and expansion of one of its key transfer stations and its maintenance paving contract (2011).

For the broader community of national interests working to develop HMA end markets for asphalt shingles, several questions for further consideration arose during the 2009 paving demonstration, including:

- How can the effective binder content of the RAS be more accurately predicted? Is there a measurable relationship between grind size (i.e., gradation) and the effectiveness of the RAS binder in the finished HMA product? Can this be modeled for mix design development?
- What training is available or needed to help shingles recyclers better identify potential ACM through visual inspections of tear-off asphalt shingle loads? Can these procedures be effectively implemented in the recycling facility setting? What are the most appropriate sampling and testing protocols for verifying ACM?

More information on King County's "Shingles in Paving" effort can be found at: http://your.kingcounty.gov/solidwaste/linkup/shingles/index.asp.

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