CP² Center News

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Differences between asphalt rubber and terminal blend modified asphalts

By R. Gary Hicks, CP2 Center

Based on some of the calls we get, there appears to be some confusion as to the difference between asphalt rubber (a field blended product) and terminal blends (blended at the refinery). Asphalt rubber has been in use since the 1960s and is currently widely used in California, Arizona, and Texas. The product consists of about 18-22% crumb rubber modifier (CRM), but may contain other additives including extender oils and polymers. The CRM has a maximum #8 or 10 mesh size depending on where it is used. In California, the rubber is mixed and reacted in the field at elevated temperatures (375° F) for a predetermined period of time (45 minutes) to allow a reaction to take place between the rubber particles and the asphalt. It has been a successful product when used in chip seals, interlayers and hot mixes. By ASTM definition, asphalt rubber must contain a minimum of 15% CRM from waste tires.

Terminal blends (or rubber-modified asphalts) have been used since the 1980's in Texas. They have been used in California, Florida, and Nevada in hot mixes and chip seals. In the beginning, the terminal blends contained less than 10% CRM in the binder which meant they did not meet the ASTM requirement for the minimum % CRM. The size of the CRM is much smaller as well with a maximum size of

Continued, next page

about 40 mesh size. In the 2000's, the producers of terminal blends increased the amount of CRM in the binder so now it can contain from 15% up to 25% CRM. They may also include some polymers making the terminal blends similar in production to polymer modified asphalts. The terminal blends now meet the ASTM definition for minimum CRM content. Some have expressed concern that there is no way to verify the amount of CRM used in this product. However, the process is a batch process like that used for asphalt rubber and a copy of the components can be provided to the agency on request. Furthermore, the suppliers of CRM must certify whether the rubber used in this process comes from California, just like it is done for the field blended asphalt rubber.

The CIWMB allows terminal blends for chip seals to be included in their grant program and, under contract to the CP2 Center, are evaluating the inclusion of terminal blends for hot mixes. Terminal blends have also been emulsified to produce slurry seals which are being used by local agencies in both Northern and Southern California. This product is different than the rubber emulsion asphalt slurry (REAS) in that the rubber is integrated into the asphalt. It is still too early to tell how they will perform in comparison to REAS where the rubber is basically a filler in the emulsion.

Figure 1. Asphalt rubber vs. terminal blend.

Figure 1 shows difference in appearance between asphalt rubber and a terminal blend. As can be seen, the asphalt rubber binder has clear evidence that the rubber is present in the binder. The terminal blend, because of the finer size of CRM, and the fact that the rubber is essentially dissolved and homogenized with the asphalt, does not show any rubber particles.

Asphalt rubber (high viscosity binders which require agitation) and terminal blends (lower viscosity with no agitation) are not the same product. Neither type should be directly substituted for the other without appropriate lab testing.

Caltrans evaluations

Caltrans undertook, or sponsored, a number of studies comparing terminal blends to asphalt rubber as discussed in the following sections. These include the following studies, all of which are inter-related.

Five-year warranty projects

Five projects were placed throughout the State during the 2002-2004 construction seasons and the contractor had to supply a five-year warranty for the project. Four of the five projects contained asphalt rubber, while one contained a terminal blend. Based on the most recent review of all projects (2005), they are all expected to reach the five-year warranty period and should reach their design life of 10 years. The next survey is expected to take place in the fall of 2009. More details on this study can be found at the Caltrans website: http://www.dot.ca.gov/hq/esc/Translab/ofpm/deliverables.htm.

University of California Partnered Research Center (UCPRC) HVS studies

This study was part of the Caltrans Sponsored Partnered Pavement Research Center program that was carried out at the UC Berkeley Richmond Field Station. The test consisted of six experimental overlay sections, including an HMA (DGAC) control, an RHMA-G control, and four terminal blend sections, two with 7% CRM and two with 15% CRM. The sections were placed over a cracked pavement and Heavy Vehicle Simulator (HVS) testing was used to assess rutting and reflective cracking performance of the thin overlays. Comprehensive laboratory testing was also used to assess the rutting and fatigue cracking performance of the mixes.

Severe fatigue cracking was observed on the 90 mm HMA and 45 mm RHMA-G sections after the equivalent of 16 million and 60 million equivalent standard axle loads (ESALs), respectively, had been applied with the HVS. No fatigue cracking was observed on any of the terminal blend sections after 60 million ESALS. The study results indicate that half-thickness gap-graded mixes with terminally blended rubber modified binders will provide superior performance in terms of reflective cracking compared to the full-thickness HMA or to the same half thickness of RHMA-G, when used in thin overlays on cracked asphalt pavements.

The final summary report (UCPRC-SR-2007-03) plus the other supporting documents can be found at www.its.berkeley.edu/pavementresearch by clicking on "publications: and then "reports for client agencies".

Full scale demonstration project, SR 33, near Firebaugh

The Fresno Highway 33 experimental overlay project is located near the town of Firebaugh in the central valley of California. This project (constructed in 2004) consisted of nine pavement test sections with a variety of rubber-modified asphalt concrete mixes and a control section of a Type A dense-graded asphalt concrete (DGAC). The rubber-modified sections include a gap graded rubberized asphalt concrete (RHMA-G), a Rubber Modified Asphalt Concrete – Gap Graded (RUMAC) dry process, and two terminal blends, a gap graded G Modified Binder (MB-G), and a dense graded Modified Binder (MB-D) containing 15% CRM. All rubber-modified pavement test sections include two thicknesses: 45 mm and 90 mm. The DGAC control section was

Continued, next page

90 mm thick. Pre-construction, construction and performance information for the Highway 33 project is described in three separate volumes and can be found on the Caltrans website:http://www.dot.ca.gov/hq/esc/Translab/ofpm/deliverables.htm.

The results of the field monitoring and laboratory testing activities for the Fresno Highway 33 experiment indicate the following:

- The MB-D mix performed best, followed by MB-G and DGAC at about the same level of performance, followed by the RAC-G and RUMAC-GG sections.
- While the MB-D, MB-G and DGAC appear to meet or exceed the performance requirements for the projected 10-year design life, the RAC-G and RUMAC-GG sections are already in poor condition after only four years of service.

Based on the relative field performance of the MB-D and MB-G mixes, the results suggest the terminal blend binders are better suited for use in dense-graded mixes than in gap-graded mixes. Although highly modified, these terminal blends do not build viscosity like the high viscosity asphalt rubber binders and should not be used to try to mimic RAC-G mixes.

Asphalt rubber and terminal blend technologies will also be discussed in an article entitled *Rubber Roads: Waste Tires find a Home* in the October 2009 issue of Pavement Technology Update, a publication of the Technology Transfer Program at the University of California, Berkeley. Pavement Technology Update will be distributed as an insert in the fall issue of Tech Transfer, the Technology Transfer Program's quarterly newsletter.

Full scale demonstration project, SR 20

Mendocino Highway 20 was also an experimental overlay project located near the town of Ukiah, Calif. It consisted of three pavement test sections with a variety of rubber-modified asphalt concrete mixes and a control section of a Type A dense-graded asphalt concrete (DGAC). The rubber-modified sections include a rubberized asphalt concrete (RHMA-G), a Rubber Modified Asphalt Concrete – Gap Graded (RUMAC, dry process), and a dense graded terminal blend (MB-D). All rubberized asphalt concrete overlays are 60 mm thick. The DGAC overlay is 105 mm thick. The project was constructed in 2005.

The work plan, pre-construction, construction and performance reports for this project is described in several separate volumes, which can be found on the Caltrans website located at http://www.dot.ca.gov/hq/esc/Translab/ofpm/deliverables.htm. After three years of service, the rubberized asphalt concrete overlays, as well as the control DGAC overlay, are in very good condition and will likely meet the performance requirements for the projected 10-year design life.

Summary

Asphalt rubber and terminal blend are different products and should not be interchanged. However, both provide superior cracking performance at one-half thickness, when compared to conventional dense graded HMA. Only when there are construction issues will the products not be expected to perform in a superior manner.

With respect to chip seals, both the asphalt rubber and terminal blends have been used for a number of years. Again, the early terminal blend chip seals contained 10% or less of CRM. Currently, agencies are using this product with CRM contents of 15% or higher and are achieving good performance. The asphalt rubber chip seals have been used for a long time and are still known for their excellent performance. Studies currently underway in Caltrans District 11 show that both products can exhibit bleeding in hot climates and under heavy traffic. The results of these studies should help with mitigating this problem

Emulsions made from terminal blends rubber modified asphalts are being used in Southern California. Alternative processes of integrating the rubber into the emulsion are also being evaluated, including asphalt rubber oxidation shield (AROS). Field test sites have been placed with this process as well. They are integrated into the binder, but the added benefits have not yet been fully quantified in the field.