SPR 15680B Performance of High RAP Sections in NH: Phase II Field Sections on I-93

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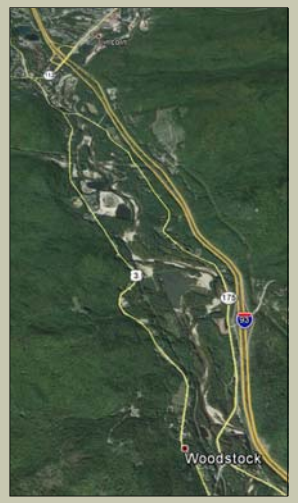
Research Objective:

- To evaluate the performance of plant produced RAP mixes in terms of low temperature cracking, stiffness, and permanent deformation
- To determine the impact of bumping binder grade at higher RAP percentages on material properties

Materials:

- Six plant produced RAP mixtures supplied by the Pike Industries Northfield NH Asphalt Plant with same target 12.5mm NMAS gradation and 5.8% ac
- Four specimen types:
  - Field Cores
  - Plant Produced, Plant Compacted (PMPC)
  - Plant Produced, Laboratory Compacted (PMLC)
  - Laboratory Produced, Laboratory Compacted (LMLC)



New RAP Field sections between Woodstock and Lincoln NH on I-93

Production Volumetrics

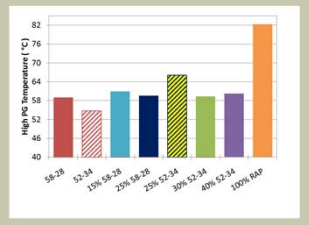
% RAP	0 %	15%	25%	25%	30%	40%
% Total AC	6.0	6.1	6.0	5.9	6.2	6.2
Virgin PG	58-28	58-28	58-28	52-34	52-34	52-34
VMA	16.9	15.6	15.2	15.8	16.4	16.7
VFA	79.5	84.2	85.9	84.1	77.7	79.7

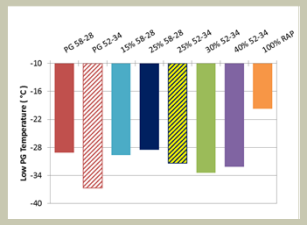
Testing and Analysis:

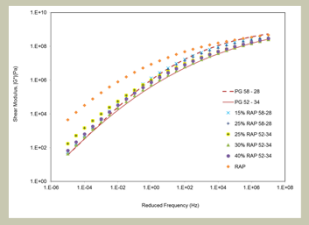
- Binder testing, dynamic modulus, and flow number testing on PMPC and LMLC specimens was completed by FHWA
- Dynamic modulus and fatigue testing on PMPC, PMLC, and field cores was completed by UNH
- Asphalt binder testing was conducted using a Dynamic Shear Rheometer:
  - Critical cracking temperature following AASHTO T314
  - Multiple Stress Creep Recovery (MSCR) testing following AASHTO TP 70-11
  - Continuous performance grade following AASHTO M320
  - Shear modulus following AASHTO T315
- Dynamic modulus and flow number testing was performed on the asphalt mixtures using an AMPT machine following AASHTO TP-79
- SVECD fatigue was performed following AASHTO TP 107

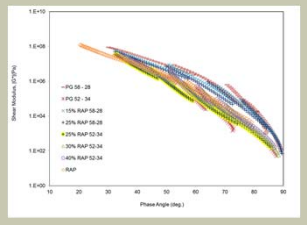
Binder Results:

- RAP increases both the high and low PG grades, but there is not a consistent trend with RAP content
- Binders generally show increase in shear modulus with increasing RAP content and the PG 58-28 base binder materials are stiffer than the PG 52-34 materials
- In Black space, the PG 52-34 materials show unexpected low phase angles that increase with RAP content.









Field Performance:

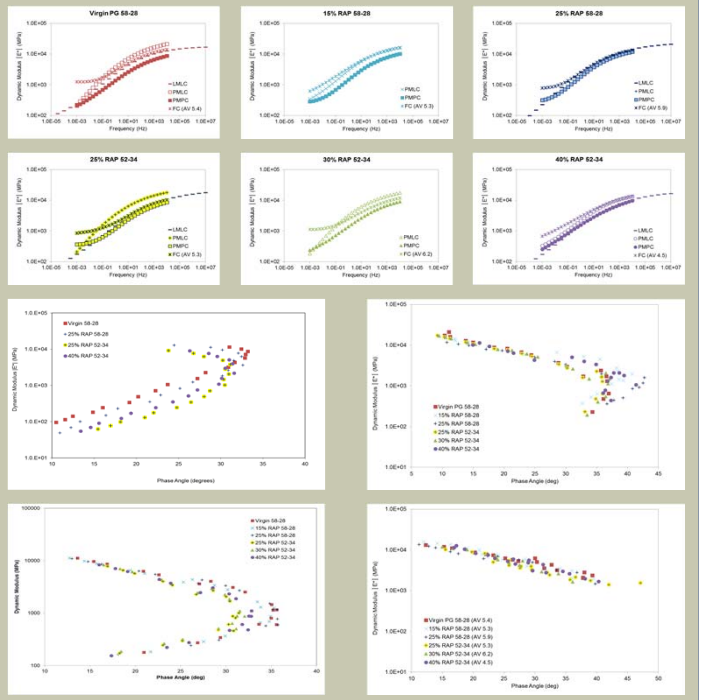
- Field performance was qualitatively assessed by NHDOT in December 2014, after approximately 3.5 years of service
- PG 58-28 mixtures are performing better than the PG 52-34 mixtures with respect to thermal and fatigue cracking. The amount of RAP does show performance differences.

Conclusions:

- Binder and mixture test results for the PG 58-28 materials showed expected trends with increasing RAP content.
- Use of PG 52-34 binder at the higher RAP contents did not help improve the performance of these materials, and in fact, appeared to make it worse, possibly due to REOB.
- PMLC specimens showed different trends due to the impact of additional aging that occurred during reheating of the material.
- Lab testing was able to identify the relative differences in the field performance of the mixtures
- The results support the practical limitation of 1.0% TRB in NH surface mixtures.
- Future work is needed to better understand the differences between binder and mixture test results and their relationship to field performance, the impact of aging, and the impact of various binder additives (such as REOB) on the long term performance of mixtures in NH.

Mixture Results:

- Dynamic modulus increases with RAP content, with larger increases observed with the PG 58-28 mixtures. The PG 52-34 mixtures all show softer response.
- PMPC dynamic modulus master curves measured by FHWA and UNH are statistically similar over most of the frequency range
- PMLC dynamic modulus curves show the impact of reheating; there is more stiffening with lower RAP contents and with the PG 52-34 mixtures
- LMLC dynamic modulus curves are stiffer than the plant produced materials and show larger differences at the lower RAP contents and with the PG 58-28 mixtures
- Field cores are stiffer than the PMPC specimens, likely due to air void differences
- Black space plots for the PMPC specimens show decreasing phase angle with increasing RAP for the PG 58-28 materials, but the opposite trend for the PG 52-34 materials. This is similar to the binder results. The PMLC results show the impact of reheating.



Acknowledgements:

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