Can We Make More Use of RAP? A Study of Extracted Binder Properties in NH, VT and Maine RAP Mixes

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Objective

- To determine what effect the increase of RAP/Millings in HMA has on the PG Binder
- Motivating Factors
 - Private customer mixes were using greater RAP percentages
 - DOT's are requiring the bumping of grades
 - Increasing cost of binders
 - Customers are looking for ways to reduce cost without jeopardizing quality

HMA Plant Protocol

- Choose a mix that was frequently produced (12.5 mm)
- Set cold feeds to produce Virgin mix and appropriate PGB content

PIKE- Hooksett NH



HMA Plant Protocol (con't)

- Produce mix and record temperatures and sample
 - 28 samples obtained for processing
- Increase RAP to 15% while maintaining temperature and PGB content
- Repeat this process for as many different percentages as required (20 %, 25%)

Pike Poland ME



Waterford VT



Other Sample Sources

- Brox Industries
 - Rochester, NH
 - Hooksett, NH
- Continental Paving Co.
 Londonderry, NH
 Litchfield, NH

Testing Procedures

- Samples were allowed to cool, boxed and transported to the Pike's Belmont Central Lab* where the samples were processed according to AASHTO's relevant procedures and according to relevant DOT methodology
 NHDOT tested companion samples for most
- mixtures

* AMRL Accredited Laboratory

Mixtures Tested

Producer	Plant	Virgin ac grade	% ac in mix	RAP percentages	RAP ac grade	% ac in RAP
Brox	Rochester, NH	PG 64-28	5.8	0, 15, 20, 25	PG 94-10	3.5
	Hooksett, NH	PG 70-22	6.0	0, 15, 20, 25	PG 88-10	3.9
CPI	Londonderry, NH	PG 64-28	6.0	0, 15, 20	PG 82-10	5.2
	Litchfield, NH	PG 64-28	6.1	15, 20	PG 88-10	4.6
Pike	Hooksett, NH	PG 64-28	5.1, 5.3, 5.4, 5.3	0, 15, 20, 25	PG 88-10	4.3
	Poland, ME*	PG 64-28	6.3, 5.8, 5.9, 6.0	0, 15, 20, 25	PG 76-22	5.0
	Hooksett, NH Mix 2	PG 58-28	5.1, 5.3, 5.4, 5.3	0, 15, 20, 25	PG 82-16	4.3
	Waterford, VT	PG 58-34	4.8, 5.2, 5.8	0, 15, 25	unknown	unknown

Effect of Plant Mixing

- Properties of virgin binder from tank
- Properties of extracted binder from virgin mix
- Compare:
 - High PG grade
 - Low PG grade/failure temperatures
 - Critical cracking temp

🔳 Liquid DOT 📲 Liquid Pike 🔳 Virgin Mix DOT 📲 Virgin Mix Pike



Producer - Plant

Increase of at least one grade after mixing



Not much change



🔳 Liquid DOT 📕 Liquid Pike 🔳 Virgin Mix DOT 📄 Virgin Mix Pike

Producer - Plant



Liquid DOT Virgin Mix DOT

Not much change

Comparison of RAP Mixtures

- Properties of extracted binder from virgin mix
- Properties of extracted binder from RAP mixes
- Compare:
 - High PG grade
 - Low PG grade/failure temperatures
 - Critical cracking temp



• One PG bump, mostly >20%



• One PG bump in some cases





Percent Binder Replacement

Normalizes with respect to

- Asphalt content in RAP
- Asphalt content in mix

% binder replacement = $\frac{\% ac in RAP * \% RAP in mix}{\% ac in mix}$

Change in High PG Grade



Change in Low PG Grade



Percent Binder Replacement

Change in T_{cr}



Conclusions

- > The high PG grade up to one grade increase
- The low PG grade stays same or only one grade increase
- Failure temps/T_{cr} only change a few degrees
- Change in high/low failure temp has decreasing trend with % binder replacement
- This data shows increasing trend of T_{cr} with % binder replacement

Future Work

- More batch & drum plants
- Various binder grades
- Higher RAP contents (% binder replacement)
- Performance testing on mixtures

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