Florida Department of
TRANSPORTATION

RAP/RAS Team Update

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TEAM MEMBERS

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ADDITIONAL SUPPORT

- Tom Bennert
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Two Main Issues

- How much of the RAS binder becomes effective asphalt binder?
  - Quantity of binder
- How to address the stiffness/brittleness of the RAS binder?
  - Quality of binder

Existing Approach (PP 78-14)

- Binder quantity:
  - Uses RAS Binder Availability Factor of 0.70 – 0.85
- Binder quality:
  - Uses Binder Grade Adjustment Guidelines:

Recommended Virgin Asphalt Binder Grade	RAS or RAS + RAP Binder Percentage
No change	<15
One grade softer	15 to 25
Use blending charts	>25

TASK TEAM RECOMMENDATIONS

Quantity of Binder

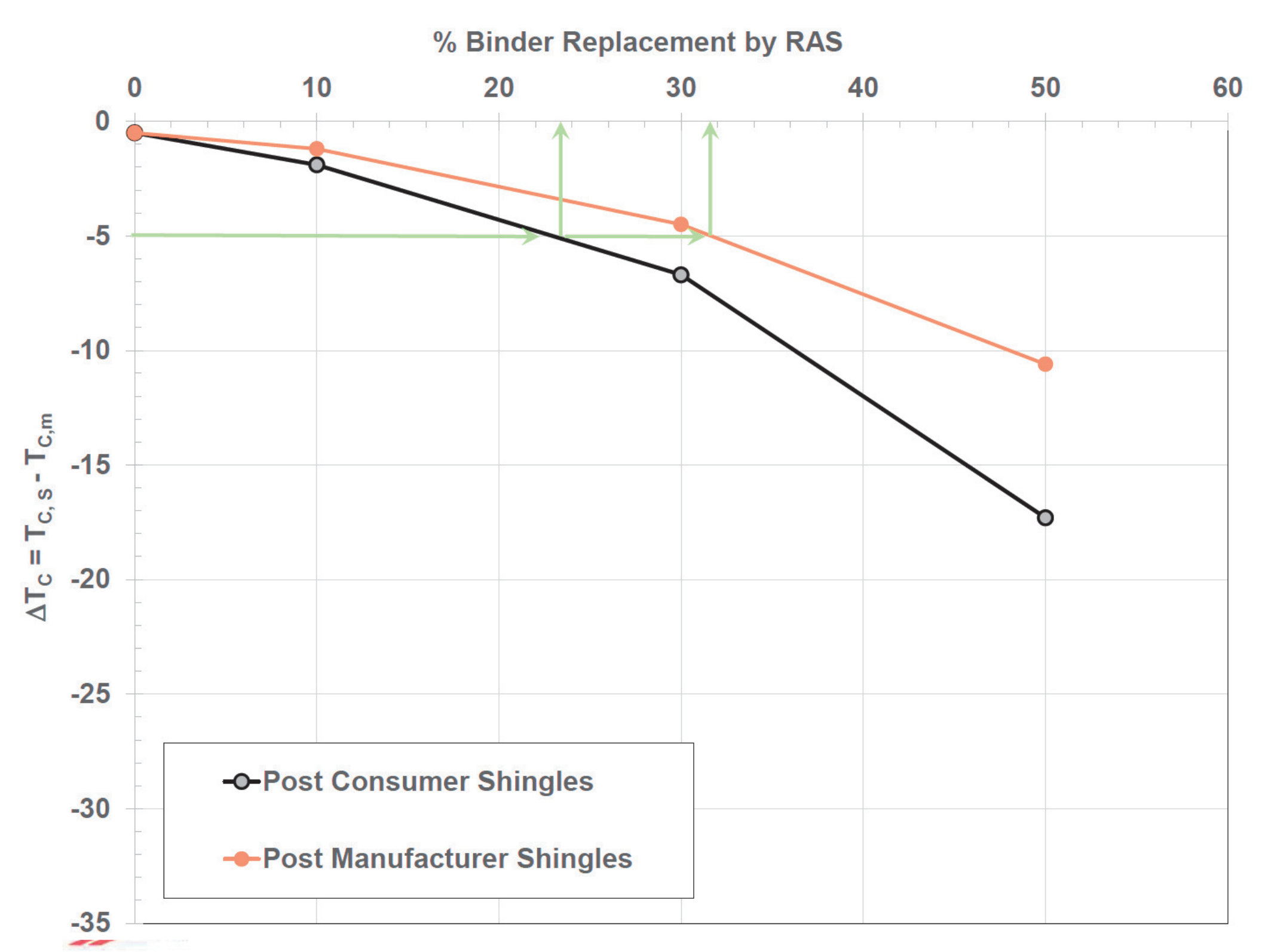
- Raise minimum VMA by 0.1% for every 1% RAS (by weight of total aggregate).
  - Based on assumption of 70% binder availability
  - Will increase effective binder in the mix to offset for the potential for non-effective binder on the RAS
- Simple way of addressing binder availability
  - More binder → Improved durability
  - Angular aggregate and stiffer binder in RAS → Minimal risk of rutting

Quality of Binder

- Focus on critical low temperature difference of the binder - ΔT_c
  - ΔT_c = Stiffness critical temp (S) – the Relaxation critical temp (m-value)
- Measured with the Bending Beam Rheometer (BBR)
- Criteria: ΔT_c for the blended binder should be greater than or equal to -5.0°C
  - Binder is PAV aged for 40 hours

Two Approaches

1. Binder Blending Procedure
   - Agency sets allowable RAS tiers;
   - Extract, recover, blend typical materials (RAS, RAP, base binder, etc.) at varying percentages
     - RASBR = 0.00, 0.15, 0.30
   - PAV age the blended binder for 40 hours
   - Test the blended binders to determine ΔT_c
   - Set the allowable tiers based on the criteria that ΔT_c must be greater than or equal to -5.0°C, and the appropriate PG grade is met.


% Binder Replacement by RAS
0
10
20
30
40
50
60
0
-5
-10
-15
-20
-25
-30
-35
ΔTC = TC, s - TC,m
Post Consumer Shingles
Post Manufacturer Shingles

Two Approaches

2. Mixture Extraction Procedure
   - Individual mixes are fabricated, extracted, the binder recovered and then PAV aged for 40 hours
   - The recovered binder is tested to determine ΔT_c
   - ΔT_c must be greater than or equal to -5.0°C, and the appropriate PG grade is met

Default Options

- A mixture performance test for cracking implemented by the State is acceptable in lieu of the binder testing for ΔT_c
- Default value option – a maximum RASBR can be used in lieu of testing
  - RASBR ≤ 0.10

Alternate Loose Mix Aging Procedure

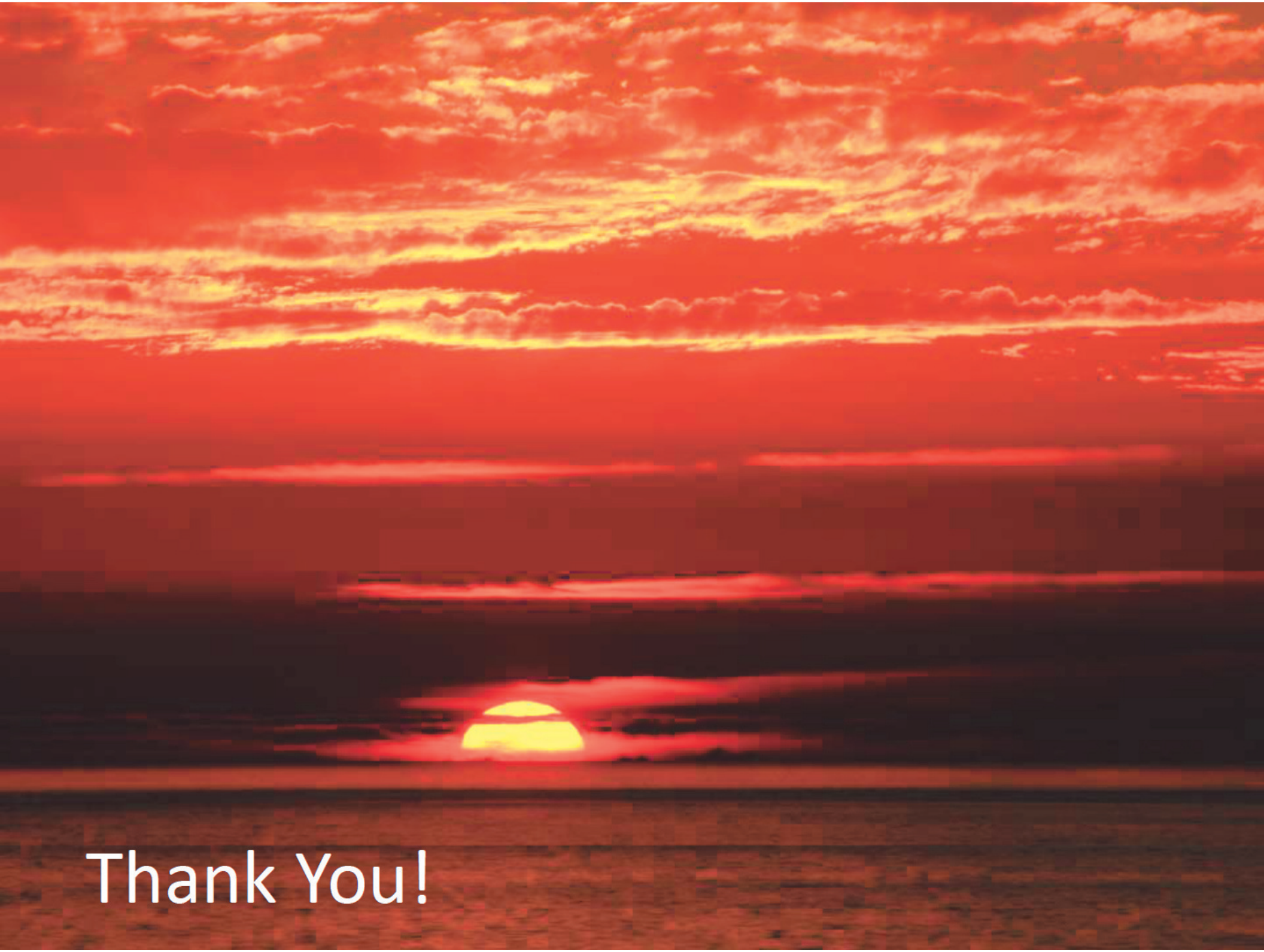
- Mixture Extraction Procedure
  - Individual mixes are fabricated
  - Loose mix is conditioned at 135°C for 24 hours
    - Uncovered pan at a depth of 25 to 50 mm placed in a forced-draft oven with no stirring
  - Mix is then extracted, the binder recovered
  - The recovered binder is tested to determine ΔT_c
  - ΔT_c must be greater than or equal to -5.0°C, and the appropriate PG grade must be met

Summary

- Revised PP 78
- Increased minimum VMA to address issue of binder quantity
- Used ΔT_c to address binder quality
  - Recovered binder is PAV aged for 40 hours
  - Criteria: $\Delta T_c \geq -5.0°C$
- Added loose mix aging (135°C for 24 hours) as an alternate in the appendix
  - Criteria: $\Delta T_c \geq -5.0°C$

Action Items

- Revised PP 78 sent out to ETG for review
  - A few typos need to be corrected
- Need ETG green light
  - Forward to AASHTO TS 2d
- Declare victory – for now…
- Need to get a new Task Team Chair


Thank You!

AASHTO PP 78 Proposed Revisions
FHWA Mixture ETG - RAS Taskforce
April 2016
Commentary to Changes

SCOPE: Nationally the use of reclaimed asphalt shingles (RAS) is increasing. The newly reissued provisional practice (PP 78-14) and provisional specification (MP 23-14) for RAS, while improved over previous versions, still had a number of issues that needed resolution. Consequently, the FHWA Mixture ETG formed a RAS Taskforce to evaluate PP 78 and MP 23 and prepare suggested changes for ETG consideration. The Taskforce included Jim Musselman (FDOT - Chair), Tim Aschenbrener (FHWA - Co-Chair), Lee Gallivan (Consultant), Audrey Copeland (NAPA), Danny Gierhart (AI), Gerry Huber (Heritage), John D'Angelo (Consultant), Randy West (NCAT), Ron Sines (Oldcastle), Richard Willis (NCAT), Tim Ramirez (PennDOT), and Hassan Tabatabaee (Cargill).

The goal of the taskforce was to review the two RAS provisional standards, identify areas in need of improvement, make subsequent recommendations to the Asphalt Mixture and Binder ETGs, and then move those recommendations forward to the AASHTO Subcommittee on Materials Technical Section for their consideration. Three specific areas that needed to be addressed included: binder availability factors, binder grade adjustments and a methodology to address both RAP and RAS.

ACTION: The RAS Taskforce reviewed available and emerging research, held multiple teleconferences (including teleconferences with representatives of the FHWA Asphalt Binder ETG), and then prepared an updated version of PP 78 based on the inclusion of new information. MP 23-14 did not require any changes. This document provides a commentary to changes proposed by the RAS Taskforce to the Asphalt Mixture and Binder ETGs.

AASHTO PP 078 - Standard Practice for Design Considerations When Using Reclaimed Asphalt Shingles (RAS) in Asphalt Mixtures

- Editorial Updates
  - Included "by weight of aggregate" when referencing typical agency limitations on allowable amounts of RAS.
- Binder Availability Factor – The binder availability factor was originally included to assure that if not all of the asphalt binder in the RAS was effective (or available), that there would still be enough total binder in the asphalt mixture to provide good performance. In order to address this issue of binder quantity, the minimum VMA requirement for mixtures containing RAS (as specified in AASHTO M 323) should be increased by +0.1% for every 1% RAS by weight of total aggregate. This change will

result in additional asphalt binder being added to the mixture, which will help to improve the mixture's durability. The risk of rutting due to the additional binder will be minimized due to the increased stiffness of the RAS binder and angularity of the RAS aggregate.

- Binder Grade Adjustments – In order to address the issue of binder quality in mixtures that contain RAS, PP 78-14 recommended binder grade adjustments based on the total amount of RAS binder in the mixture. Rather than take this approach, the embrittlement of the blended binder should be evaluated. An estimation of the brittleness can be determined from the Bending Beam Rheometer (BBR) binder test that measures both stiffness and relaxation. The binder stiffness (S) is calculated from the measured beam deflection at 60 seconds, and the relaxation (m-value) is measured as the slope of the deflection curve at 60 seconds. The m-value reflects the ability of the binder to relax stress to prevent cracking as the load is applied. Several studies have related the combination of stiffness and m-value properties to cracking performance. As a binder ages its stiffness (S) increases and its ability to relax (m-value) decreases. Studies have shown the relaxation (m-value) will deteriorate at a faster rate than the stiffness (S) will increase. The impact of this differential aging can be seen as a spread in the failure grade for stiffness (temperature at which the stiffness reaches 300 MPa) and the failure grade for relaxation (temperature at which m-value reaches 0.300). This differential aging is typically expressed as ΔT_c, which is determined as follows:

  $$\Delta T_c = \text{Stiffness critical temp (S)} - \text{the Relaxation critical temp (m-value)}$$

  Separate research done by Mike Anderson and Tom Bennert have indicated that when ΔT_c is less than or equal to -5.0°C there is a significant loss of cracking resistance. Additional work has indicated that when determining ΔT_c, use material that has been PAV aged per AASHTO R 28, with the exception that the temperature and air pressure inside the pressure vessel is maintained for 40 h ± 10 min.

  Using the ΔT_c approach, there are two methods of determining the maximum amount of RAS material that can be used in an asphalt mixture:

  1. The agency develops tiers for RAS use on a regional or statewide basis based on the "Binder Blending Procedure" where they extract and recover typical RAS binders and blend them with typical softer asphalts and/or rejuvenating agents, and then test the blended binders to determine ΔT_c and set the allowable tiers based on the criteria that ΔT_c must be greater than or equal to -5.0°C.
  2. The agency evaluates individual mixtures and limits RAS use based on the "Mixture Extraction Procedure" where the agency extracts and recovers the binder from each mixture that contains RAS and then determines ΔT_c and uses the criteria that ΔT_c must be greater than or equal to -5.0°C.

A default value is provided in a Note for agencies that do not desire to conduct the testing. Additionally, it is noted that mixture performance tests would be acceptable in lieu of testing for ΔT_c.

- Methodology to address a blend of RAP and RAS – For cases where both RAP and RAS are used in a mixture, ΔT_c should be evaluated along with the Performance Grade of the binder, either by following the Binder Blending Procedure or the Mixture Extraction Procedure as described above.

  Guidance is provided in a Note for combining RAP and RAS binder ratios for agencies that do not desire to conduct the testing.

- Appendix X1 Alternative Loose Mix Aging Procedure - An alternative to the binder aging in the PAV as described above is to age the mixture prior to recovering the binder. Data from several researchers has shown that 24 hours of loose mix aging equates to approximately 40 hours of PAV aging.

Summary:

- The binder availability factor is deleted from PP 78 and replaced by an increase in the minimum VMA by 0.1% for each 1% addition of RAS. This will address the issue of binder quantity in the mixture.
- Binder grade adjustments based on a table are deleted from PP 78 and replaced by either 1) setting allowable RAS tiers based on extracting, recovering, blending and testing typical RAS binders to determine ΔT_c, or 2) by extracting, recovering, and testing binders from mixes containing RAS to determine ΔT_c. ΔT_c must be greater than or equal to -5.0°C and the binder must meet the required Performance Grade. This will address the issue of binder quality in mixtures that contain RAS.
- For cases where both RAP and RAS are used in a mixture, ΔT_c should be evaluated for the complete blend, either by following the Binder Blending Procedure or the Mixture Extraction Procedure.
- Notes are provided for guidance for those states that do not desire to conduct this testing. Further, mixture performance tests would be acceptable in lieu of testing for ΔT_c.