1st NRRA TAP Meeting

Cold Asphalt Recycling Technologies using Rejuvenating Asphalt Emulsion: Impact; Implementation; Specification

Hassan A. Tabatabaee, Ph.D. Cargill Helping the world thrive

Dan Swiertz, P.E. bitumix solutions ASPHALT MIX DESIGN TECHNOLOGIES

Project Kickoff Meeting, 7/20/2020

Meeting Agenda

1. Introduction of the research team
   - Hassan Tabatabaee, Cargill and Dan Swiertz, Bitumix Solutions
2. Introduction of the TAP members

- Ben Worel, MNDOT
- Jerry Geib, MNDOT
- Pouya Teymourpour, WisDOT
- Daniel Oesch, MODOT
- Curt Dunn, NDDOT
- Kevin Kliethermes, FHWA
- Dan Staebell, APA
- Jo Sias, UNH
- Andy Cascione, FHR
- Guy Sisler, Husky Energy
- Mohammad Sabouri, Braun Intertec
- Dan Schellhammer, Midstate Co.
- Kiran Mohanraj, Transtec Group

3. Presentation of the proposed research plan
4. Review of specific discussion items on which TAP feedback is needed
5. Other questions and concerns

Cold In Place Recycling

- Cold Recycling, both in-place and central plant processed, broadly consists of methods to reincorporate the existing pavement millings into a new pavement layer using various stabilizing methods.

- The CIR/CCPR processes have traditionally relied on commodity asphalt emulsion products (CSS-1, CSS-1h, etc.) or foamed asphalt as the stabilizing additive. More recently “engineered” asphalt emulsions have become common in some areas of the Country.

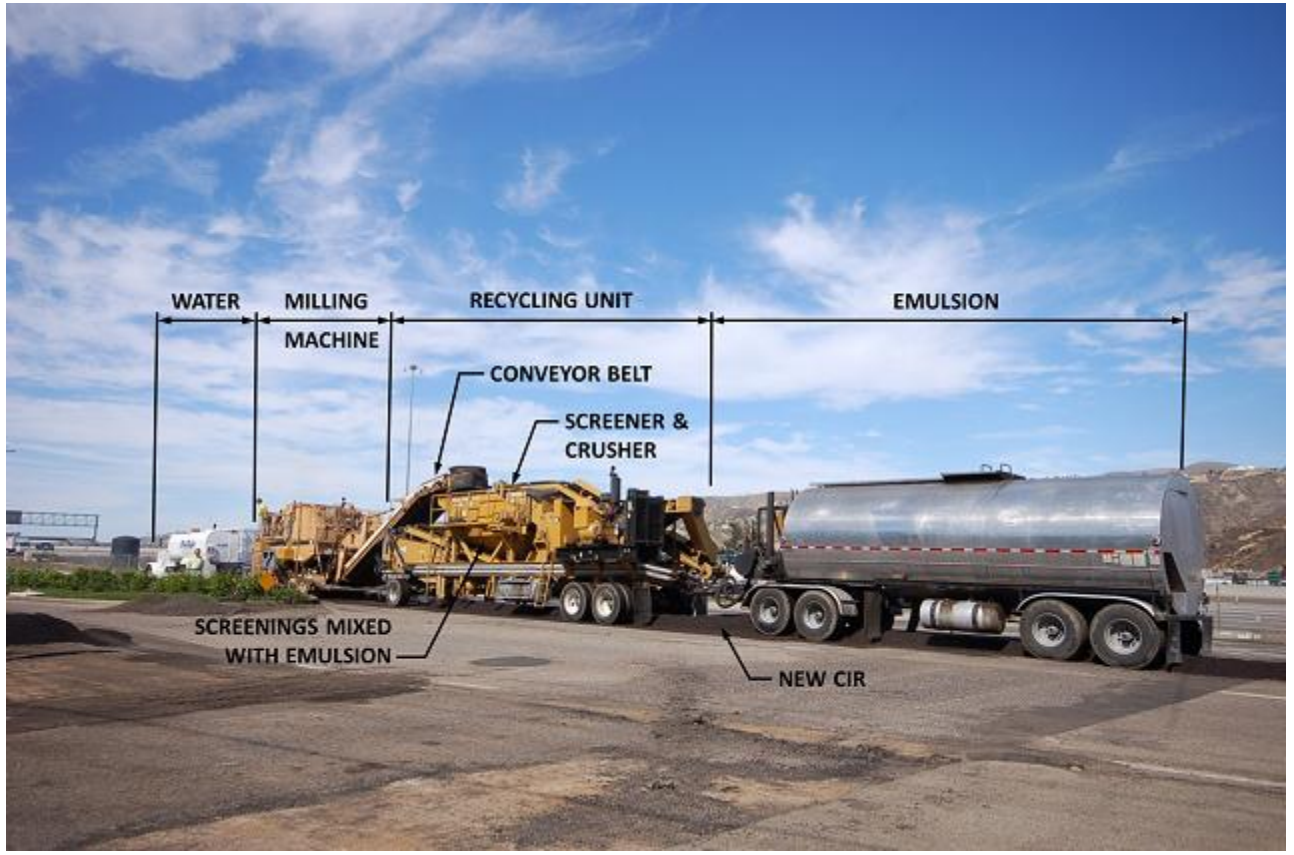


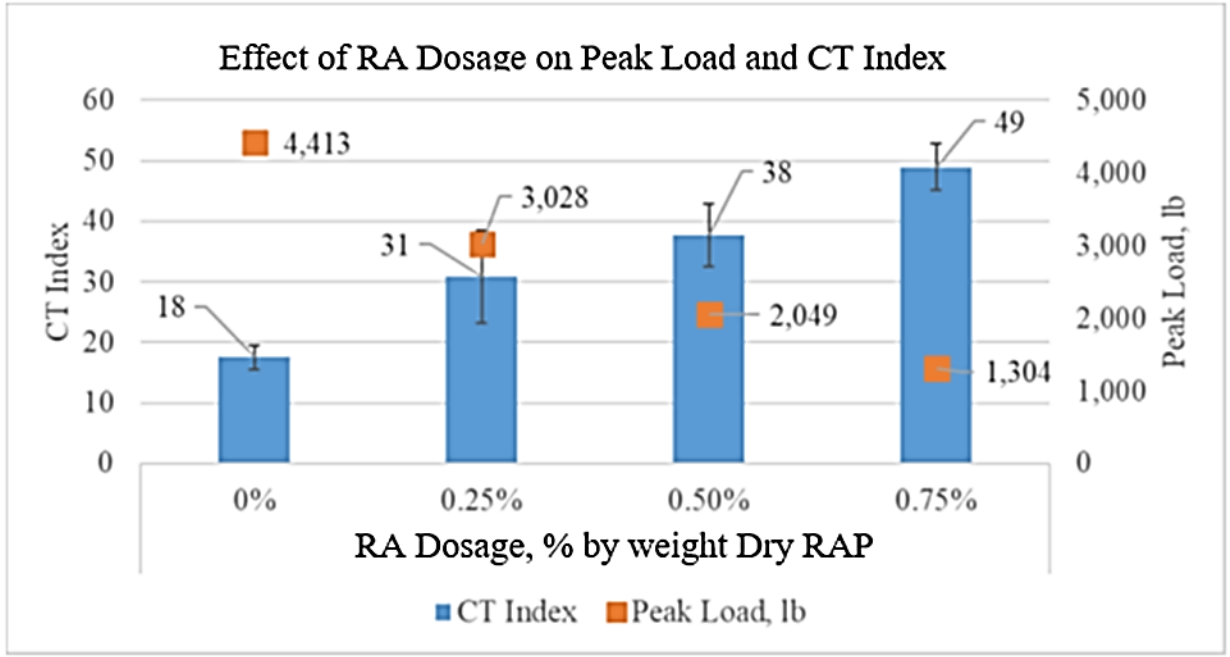
Image from LA County Public Works

Goals and Challenges

- The use of Recycling Agents (RAs) in high RAP HMA has demonstrated that through the proper selection and dosage, these mixtures can perform similarly or even better than control mixtures.
- RAs can be from petroleum-based sources or bio-based. Petroleum-based products have been used for many years in pavement preservation processes, while bio-based additives have become common as HMA recycling agents in recent years.
- In the current proposal it is hypothesized that the use of RAs in asphalt emulsion stabilized CIR and/or CCPR process can provide performance benefits.
- **Key practical questions need to be addressed:**
  - What performance properties need to be measured to ensure performance?
  - How can the dosage of RAs to be determined during the mix design phase?
  - Are the performance benefits of using RAs during cold recycling operations justified in terms of the potentially added mix design and raw material effort/costs?

Goals and Challenges

- Research conducted by the authors in developing a 100% RAP paving mixture suggests that the use of RAs applied directly to the RAP material may support the hypothesis.
  - *Note that this work was done for hot mix, and the mechanism observed for cold mixing applications may be different.*
- A “balance” between cracking and stability (peak load) must be achieved.



Study Objectives

The objectives of this study are:

- **Evaluate the efficacy of rejuvenating asphalt emulsions** in the CIR and/or CCPR process in terms of potential performance benefits relative to existing stabilization options (e.g., engineered emulsion) using concepts of balanced mixture design;

- **Provide preliminary usage and design guidelines** for the use of rejuvenating asphalt emulsion in CIR and/or CCPR processes;

- **Develop a "roadmap" for rapid implementation** of a test section utilizing rejuvenating asphalt emulsion stabilization.

  - Construction of the test section(s) is outside the scope of the current proposal, the research team and partners have declared their interest in participating in such a project if it were to be pursued by NRRA.

Research Approach

The research will consist of three major stages consisting of:

1. Literature review, material selection, and finalization of test plan
2. Material rheological and analytical characterization, for determination of the fundamental impact of rejuvenators on the CIR/CCPR material, and determination of proper design dosages.
3. CIR/CCPR Mix Design, performance testing, and comparison to conventional and innovative controls

- The results of these tasks will be used for creation of a protocol and roadmap for implementation of rejuvenation in CIR and/or CCPR

Project Tasks

- Task 1: Literature Review and Material Selection
- Task 2: Material Collection, Preparation, and Characterization
- Task 3: CIR/CCPR Mix Design and Performance
- Task 4 & 5: Draft and Final Deliverables and Communication of Results

Project Schedule

- Project to be carried out over 18 months (starting July 2020).

Month of Contract					1	2	3	4	5	6	7	8
Task 1: Lit. Review, Material Selection & Testing Plan					X	X	X	X				
Task 2a: Material Sampling & Preparation							X	X	X			
Task 2b: Material Characterization								X	X	X	X	X
Task 3a: CIR Mix Design								X	X	X		
Task 3b: Mixture Performance Assessment											X	X
Task 4: Draft Deliverables												
Task 5: Final Deliverables												
Month of Contract	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Task 1: Lit. Review, Material Selection & Testing Plan												
Task 2a: Material Sampling & Preparation												
Task 2b: Material Characterization	X	X	X	X	X							
Task 3a: CIR Mix Design												
Task 3b: Mixture Performance Assessment	X	X	X	X	X							
Task 4: Draft Deliverables					X	X	X					
Task 5: Final Deliverables								X	X	X		

Task 1: Literature Review and Material Selection

- RAP, rejuvenator, and bitumen materials will be selected from relevant sources of use within NRRA states.
- Literature review will result in a synthesis of prior and ongoing research including but not limited to the NCHRP 09-58 and MnDOT studies on CIR/CCPR.
- Based on the literature review the test plan will be refined and finalized at the end of this task.

Sample Type	Description
RAP	Two RAP sources will be selected, preferably from two different PG regions and from two planned/ongoing/completed CIR/CCPR projects.
Base Binder	A typical midwestern base binder will be used as the basis of the rejuvenating emulsion
Rejuvenator	One bio-based and one petroleum-based rejuvenator
Controls	A CSS-1H, and/or Foamed bitumen, and/or an engineered emulsion

Task 2: Material Collection, Preparation, and Characterization

- 2(a): Material collection
- 2(b): Material characterization
- The following table provides an overview of the proposed characterization tests to be conducted on the base asphalt, selected RAs, and RAP binder:

Test Method	Results	Significance
Differential Scanning Calorimeter (DSC)	Tg, Phase Miscibility	Results will be used to establish the existence of immiscible binder fractions, and impact of conditioning and rejuvenation
Dynamic Shear Rheometer	Mastercurve, PG	Determination of the performance grade, rheological performance, and mastercurves of the binder with aging and rejuvenation
Size Exclusion Chromatography	Molecular Size Distribution	Establish uniformity of molecular size distribution, and transition of polydispersity with conditioning and rejuvenation
Pressure DSC	Oxidation Induction Time	Establish impact of various fraction, conditioning, and/or rejuvenation on the oxidation potential.
Thermo-gravimetric Analysis (TGA)	Volatilization spectra	Complimentary method of assessment of various fractions within the bitumen in terms of volatility.
Iatroscan	SARA fractionation	Establish chemical fractions of various bitumen, calculate the Colloidal Instability Index

Task 3: CIR Mix Design and Performance

- Existing mix design(s) from NRRA states will be leveraged as control materials.
- Findings of Task 1 will be utilized to create a partial factorial design.
- Performance testing will then be carried out to identify impact of rejuvenation on the performance and properties of the CIR mix in support of validating or disproving the hypothesis.
  - Level 5 consists of a special innovative control in the form of a 100% rejuvenator + RAP CIR that does not incorporate additional bitumen.

Variable	Level 1	Level 2	Level 3	Level 4	Level 5
RAP Source	PG 58-28 Region	PG 64-22 Region			
Base Binder	PG58-28				
Cement	No Cement	Added Cement			
Rejuvenator	None	Bio-based	Petro-based		
Liquid Type	Rejuvenating Emulsion	CSS-1H	Engineered Emulsion	Foamed Asphalt	Only Rejuvenator

Task 3: Cracking and Deformation Tests

- Team is considering 2 cracking and 2 rutting resistance test methods for use in this project based on experience and current understanding of literature.
- **Final selection** of tests to be used will be based upon Task 1 findings and **TAP feedback**.

Recommended Cracking Resistance Tests

Consideration	SCB-IFIT	IDEAL-CT
Standardization	AASHTO TP124	ASTM D8225
Current Usage	Up to 21 DOTs according to TRB survey and many research studies.	Unknown, recommended to at least 1 DOT; used extensively in research
Performance Limits in Literature (Y/N)	Yes	No, but recommendations have been made.
Precision and Bias Available (Y/N)	No, but estimates exist from published literature.	Yes, Conducted as part of ASTM Standardization
Equipment	Several manufacturers as well as retrofitting Marshall Load Frame available; 1-2 saws required	Use Marshall load frame; no saw required
Sample Preparation Effort	High Samples must be cut to “half-moon” and notched	Low Samples do NOT need to be cut
Testing Time	Low	Low

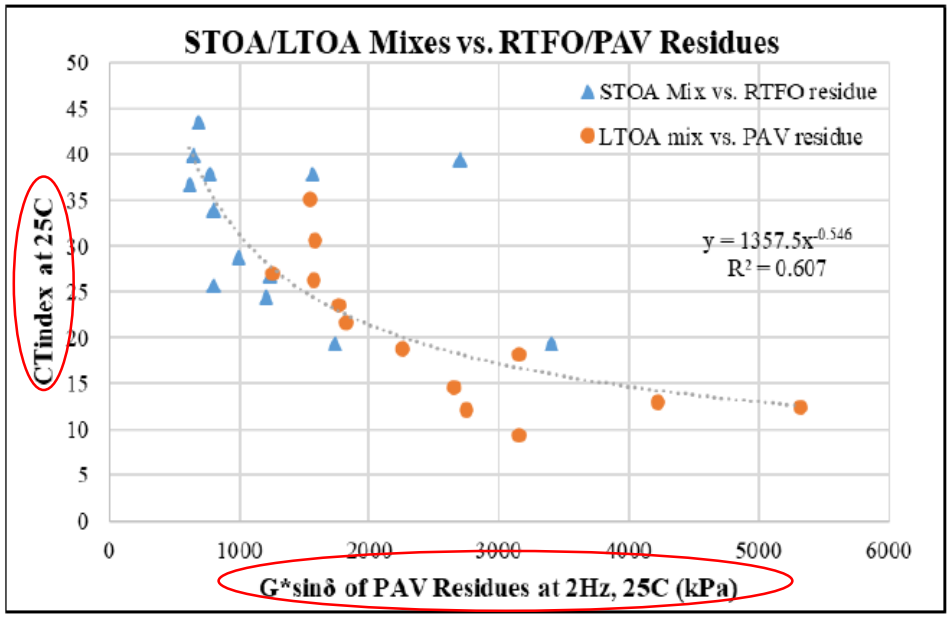
Recommended Deformation Resistance Tests

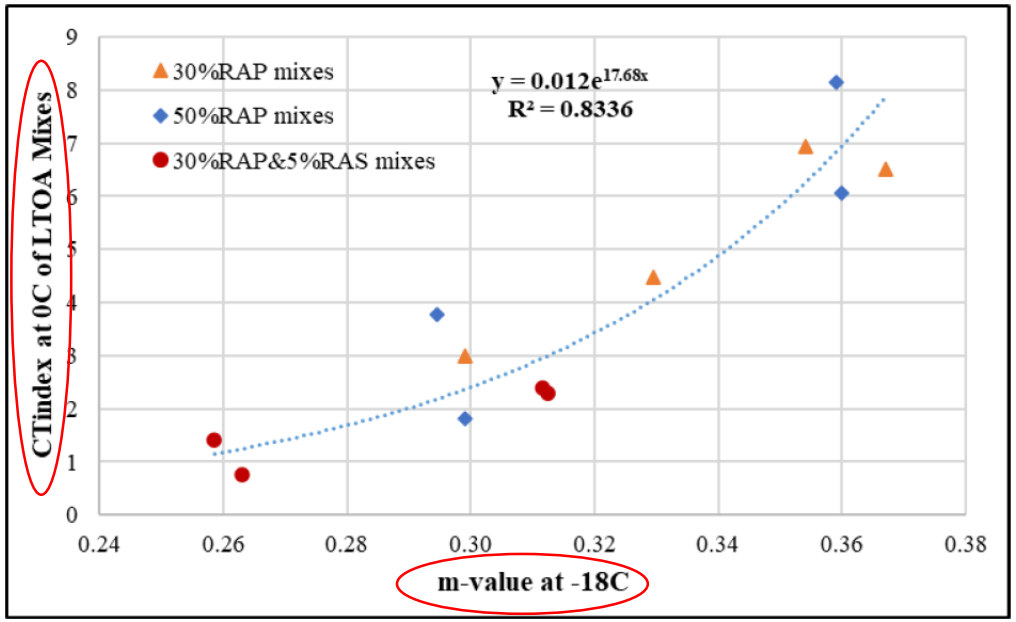
Consideration	Hamburg Wheel Tracking Test	Marshall Stability
Standardization	AASHTO T324	ASTM D1559
Current Usage	Up to 39 DOTs use test for HMA characterization	Common in cold mix industry; used worldwide
Performance Limits in Literature (Y/N)	Yes	Yes
Precision and Bias Available (Y/N)	N; Estimates from NCHRP 10-87 (*6*); Iowa DOT (*7*)	Yes
Moisture resistance (Y/N)	Yes	No, a moisture conditioned subset must be fabricated
Equipment	Separate device; at least four manufacturers	Same device as TSR load frame
Sample Preparation Effort	High Additional sample required; samples must be cut	Low
Testing Time	High	Low

Task 3: Other considerations

- Aging conditions will be considered and finalized during the literature review process.
  - Hypothesized that at least 2 levels of aging will be considered.
- Asphalt emulsions used in this study will be produced in the research team's laboratory using a controlled source of base asphalt, emulsification, and additive package.
- Discussion Point: A low temperature cracking test is not included in the initial selection of test methods for this proposal.
  - Recommend maintaining proper specification of low temperature binder PG (e.g. -28 or -34 in Northern regions) and/or including another binder parameter such as m-value or ΔTc to provide reliability against thermal cracking:

Results from:
Transportation Pooled Fund: TPF-5(352), WO 6 - 0092-19-13: Long-Term Performance of Asphalt Concrete Mixed with RAP and RAS – Draft Final Report – May 2020





Tasks 4 and 5

- The final deliverables of the project are anticipated to include the following:
  - **Final Report**, documenting findings, conclusions, and detailed results.
    - Proposed method for design and incorporation of rejuvenators in CIR,
  - **Presentation** summarizing the research and findings.
  - **A detailed plan and proposal for construction** of test sections at MnROAD or other locations as determined by NRRA members.
    - AASHTO Task Force 18-01 COC – COMP – COM Committee document “Developing Construction Guide Specifications for Pavement Preservation Treatments” as an outline for drafting such guidance, though not all sections may be applicable.

Tasks 4 and 5

- The research team will provide the Technical Advisory Panel with regular updates and solicitate input in accordance to the following schedule:
  1. **Kick-off meeting** at the initiation of the project to align on initial work plan.
  2. **Quarterly updates** in the form of around 5 power point slides.
  3. **Alignment meeting at the end of Task 1** to present and finalize work plan for Tasks 2 through 5. (expected to be Oct 2020, will be combined with Q1 update meeting)
  4. **Draft Report** provided to the TAP for review and solicitation of final input and recommendations (Task 4).
  5. **Final Report and Presentation**, incorporating TAP input (Task 5).
  6. **Presentation of findings to NRRA** and/or MAPA events, if possible.

What do we need from you?

- Extend invitation to join the TAP
- Materials and mix design(s) – we will be looking to source materials from projects from up to 2 different RAP locations OR known different RAP sources
  - This can happen immediately, and we want to take advantage of the paving season.
- Your input on the testing plan:
  - What does “Proof of Concept” look like to you?
  - Are there any test methods that are “must-haves” (critique of our selection)?
  - Are there any material combinations that are particularly relevant?
    - RA types?
    - Cement/No Cement?
    - Foam?

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Thank you for your attention!

Questions and concerns?

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