Characterizing the Effectiveness of Recycling Agents and their Evolution with Aging in Binders and Mixtures with High RAP and/or RAS Contents

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NCHRP 9-58: The Effects of Recycling Agents on Asphalt Mixtures with High RAS and RAP Binder Ratios

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- Elie Hajj
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- Jo Daniel
- Gayle King

TTI
UNR
UNH
Consultant
Motivation – High Recycled Binder Ratio (RBR)
Mitigation – Recycling Agent (RA)

REMAINING ISSUES

**BENEFITS**

- Economic
- Environmental
- Engineering

**Engineering**

- Embrittlement
- Aging
- Blending
- Mixture Performance
WI DOT & Recycled with RA

DOT control Mix (0.22 RBR)
- RAP content: 27%
- Total Agg. 94.4%
- Total Binder 5.6%

Recycled with RA Mix (0.31 RBR)
- RAP content: 36%
- Total Agg. 94.6%
- Total Binder 5.4%

Virgin Agg. 68.7%
- RAP Agg. 25.7%
- Virgin binder 4.3%
- RAP binder 1.3%

Virgin Agg. 60.3%
- RAP Agg. 34.3%
- Virgin binder +RA 3.7%
- RAP binder 1.7%

Not to scale
NCHRP 9-58 Research Plan

**PHASE I**
Identification of Gaps in Knowledge on RA Use with High RBRs

- Task 1. Gather Information
- Task 2. Design Laboratory Experiment
- Task 3. Document Results in First Interim Report

**PHASE II**
Investigation of Effectiveness of RAs in Restoring Binder Rheology, Development of Blending Protocol, and Associated Mixture Performance

- Task 4. Conduct Laboratory Experiment
- Task 5. Design Field Experiment and Document Results in Second Interim Report

**PHASE III**
Validation of RA Use in Mixtures with High RBRs

- Task 6. Conduct Field Experiment
- Task 7. Propose Revisions to AASHTO Specifications and Test Methods
- Task 8. Develop Training Materials and Best Practices and Deliver Workshop
- Task 9. Document Results in Final Report
Phase II Laboratory Tests – BINDER & MORTAR

- **PG - BOTH**
  \[ \Delta T_c = (T_S - T_m) \]

- **Glover-Rowe**
  \[ G-R = \frac{G^*(\cos\delta)^2}{\sin\delta} \] @ 15 °C, 0.005 rad/sec

Rejuvenating Effectiveness

\[ RE = \frac{(\log G-R_{DOT\ Control} - \log G-R_{Recycled})}{\log G-R_{DOT\ Control}} \times 100 \]

- **Carbonyl Area Growth by FT-IR**
Phase II Laboratory Tests - MIXTURE

- **Stiffness**
  - $M_R @ 25 \, ^\circ C$
  - $E^*$

- **Cracking Resistance**
  - $FI$ by SCB
  - $N_f$ by S-VECD
  - $RI$ by UTSST
Phase II TX (Expanded) Materials

- TX: PG 64-22 + 0.28 RBR (0.1 RAP+0.18 MWAS) + 2.7% Tall Oil T1 (Target=PG 70-22)
- + 0.4 RBR w/RAP only, 0.5 RBR balanced RAP/RAS
- + Aromatic Extract A1
- + NH PG 64-28 & NV PG 64-28P
- + TX TOAS
RECYCLING AGENT (RA) DOSAGE SELECTION METHOD

1. Restore PGL/Check PGH
2. Restore $\Delta T_c$
3. Restore PGH
SELECT MATERIALS → PREP MATERIALS ← CONDUCT LAB TESTS → SELECT DOSAGE
SELECT MATERIALS

- Target and base binder PG grade
- RAP and/or RAS source(s)
- Recycling Agent (RA)
- RAP and/or RAS Recycled Binder Ratio (RAPBR/ RASBR)
Extract and recover binder from RAP and/or RAS source(s)

Prepare recycled binder blends:
- With no RA (control)
- With low RA dosage
- With high RA dosage
CONDUCT LAB TESTS

Obtain high PG grade (PGH) and low PG grade (PGL) per AASHTO M320:

• Target binder
• Recycled binder blend with no RA (control)
• Recycled binder blend with low RA dosage
• Recycled binder blend with high RA dosage
0.3 RBR (PG 64-22 | 0.1 TxRAP | 0.2 TxMWAS | T1)

- \( y = -1.8x + 81.8 \)
- \( y = -1.7x + 85.1 \)
- \( y = -1.3x - 16.0 \)
- \( y = -0.7x - 28.5 \)

Graph showing the relationship between high temperature PG grade and dosage. The graph includes points for original G*/sin(d) and RTFO G*/sin(d) with the respective regression lines.

-\( y = -1.7x + 85.1 \)
SELECT DOSAGE

Plot original & RTFO PGH, S- & m-controlled PGL vs. RA dosage for all blends

Establish linear regression equations

Select RA dosage in 0.5% increments to meet target binder PGL using warmer PGL regression line

Verify PGH of selected dosage vs. target binder PGH using colder PGH regression line

Meets target PGH?

YES

REPORT w/PG grade

NO

Δ dosage in 0.5% increments to meet PGH & maintain PGL

*For RAS mixtures, if dosage >5.5%, replace virgin binder with 50% RA and add other 50%.
0.5 RBR (64-22 | 0.25 TxRAP | 0.25 TxTOAS | T1)

- Original G*/sin(d): \( y = -2.2x + 100.5 \)
- RTFO G*/sin(d): \( y = -1.8x + 102.3 \)

High Temp. PG Grade (°C)

Dosage (%)

Target Grade: 70-22
Actual Grade: 74-25
Selected Dosage: 11.5%
PHASE II DOSAGE SELECTION RESULTS

- Restore PGL/ Check PGH
- Delta Tc

<table>
<thead>
<tr>
<th>Blends</th>
<th>Selected Dosage (%)</th>
<th>ΔTc</th>
</tr>
</thead>
<tbody>
<tr>
<td>TX 64-</td>
<td>22</td>
<td>-10</td>
</tr>
<tr>
<td>TX 64-</td>
<td>22</td>
<td>-8</td>
</tr>
<tr>
<td>TX 64-</td>
<td>22</td>
<td>-8</td>
</tr>
<tr>
<td>TX 64-</td>
<td>22</td>
<td>-7</td>
</tr>
<tr>
<td>TX 64-</td>
<td>22</td>
<td>-9</td>
</tr>
<tr>
<td>TX 64-</td>
<td>22</td>
<td>-10</td>
</tr>
<tr>
<td>NH 64-</td>
<td>22</td>
<td>-5</td>
</tr>
<tr>
<td>NH 64-</td>
<td>22</td>
<td>-11</td>
</tr>
<tr>
<td>NV 64-</td>
<td>28</td>
<td>-3</td>
</tr>
<tr>
<td>NV 64-</td>
<td>28</td>
<td>-7</td>
</tr>
<tr>
<td>NV 64-</td>
<td>28P</td>
<td>1.5</td>
</tr>
<tr>
<td>NV 64-</td>
<td>28P</td>
<td>2.0</td>
</tr>
<tr>
<td>IN 58-</td>
<td>28</td>
<td>3.5</td>
</tr>
</tbody>
</table>

Binder ΔTc:
-4.6, -4.6, -4.6, -4.6, -4.6, 1.4, 1.4, -3.6, -3.6, -3.6, -8
**G-R Binder Black Space Diagram**

**0.3 RBR (0.1 RAP & 0.2 RAS)**

- DOT Control, 64-22, NO RA
- Recycled Blend, 64-22, 4.5% T1
- Recycled Blend, 64-22, 5.5% A1
G-R Results w/Aging

0.3 RBR (0.1 RAP & 0.2 RAS)

- RTFO
- PAV 20
- PAV 40

<table>
<thead>
<tr>
<th>Blend Type</th>
<th>RTFO</th>
<th>PAV 20</th>
<th>PAV 40</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOT Control 64-22 NO RA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recycled Blend 64-22 4.5% T1</td>
<td>12%</td>
<td>50%</td>
<td>52%</td>
</tr>
<tr>
<td>Recycled Blend 64-22 5.5% A1</td>
<td>10%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

% improvement vs. the DOT control blend

Recycled Blends @ opt RA < DOT control Blend no RA
The "rejuvenating" effect of RA decreased with PAV aging.
Binder RE Evolution with PAV Aging

0.5 RBR (0.25 RAP & 0.25 RAS)
- Recycled Blend, 64-22, MWAS, 7.5% T1
- Control Blend, 64-22, MWAS, no RA

0.5 RBR (0.25 RAP & 0.25 RAS)
- Recycled Blend, 64-28, TOAS, 11.5% T1
- Control Blend, 64-28, TOAS, no RA
RA Dosage Selection – Mixture Validation - $M_R$

![Chart showing resilient modulus for different mixtures](chart.png)

- **DOT control**
- **Recycled w/ T1 @ FLD (2.65)**
- **Recycled w/ T1 @ (3.5%)**
- **Recycled w/ T1 @ OPT (4.5%)**
- **Recycled w/ A1 @ OPT (5.5%)**
RA Dosage Selection – Mixture Validation - SCB

Flexibility Index (FI)

- DOT Control
- Recycled w/ T1 @ FLD (2.65%)
- Recycled w/ T1 @ 3.5%
- Recycled w/ T1 @ OPT (4.5%)
- Recycled w/ A1 @ OPT (5.5%)
Phase IIB Materials

- **TX**: PG 64-22 + 0.28 RBR (0.1 RAP+0.18 MWAS) + 2.7% Tall Oil T1 (Target=PG 70-22)
- + Better Base Binder (less negative $\Delta T_c$)
- + Softer Base Binder
- + Vegetable Oil V1, + Bio-Based Oil B
- + **0.5 RBR** balanced RAP/RAS w/ TX TOAS
- Related Phase IIA results
Phase II
B

- RA Dosage Selection beyond restoring PGL/checking PGH by restoring $\Delta T_c$ to -5, restoring PGH
- + HWTT to preclude over-softening
- + BBR Sliver (AASHTO TP 125) for mixture Black Space
- + DSC (& UTSST) for onset of brittle behavior
SELECT DOSAGE

Plot original & RTFO PGH, S- & m-controlled PGL vs. RA dosage for all blends

Establish linear regression equations

Select RA dosage in 0.5% increments to meet target binder PGL using warmer PGL regression line

Verify PGH of selected dosage vs. target binder PGH using colder PGH regression line

*For RAS mixtures, if dosage >5.5%, replace virgin binder with 50% RA and add other 50%.

2 Restore ΔT_с

Meets target PGH?

Δ dosage in 0.5% increments to reduce ΔT_с to -5 & REPORT w/PG grade

NO

Δ dosage in 0.5% increments to meet PGH & maintain PGL

YES
PHASE IIIB DOSAGE SELECTION RESULTS
0.28 RBR (0.1 TX RAP + 0.18 TX MWAS)

- Restore Delta Tc
- Restore PGL/Check PGH
- Delta Tc

Selected Dosage [%]

Blends

Binder $\Delta T_c$

TX 64-22

T1 -4.6

V1 -4.6

B -4.6

IN 64-22

T1 -1.2

A1 -1.2

V1 -1.2

B -1.2

$\Delta T_c$

-12

-10

-8

-6

-4

-2

0
G-R Results @ 21°C – (0.28 RBR) Blends w/ IN PG 64-22

Restore PGL/Check PGH and Restore $\Delta T_c$

<table>
<thead>
<tr>
<th>Blend Description</th>
<th>Results</th>
<th>G-R @ T= 21°C, same thresholds RAs may not be needed with 0.3 RBR and a better binder</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOT Control IN 64-22 NO RA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recycled Blend IN 64-22 2% T1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recycled Blend IN 64-22 2% A1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recycled Blend IN 64-22 1% V1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recycled Blend IN 64-22 1% B</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Diagram showing log of $|G^*|$ (Pa) vs. Phase Angle (degrees) for different blends.
G-R Results @ 21°C – (0.28 RBR) Blends w/ TX PG 64-22

Restore PGL/Check PGH

G-R @ T= 21°C, same thresholds
Control blend ages beyond the thresholds
RAs improve the blends
G-R Results @ 21°C – (0.28 RBR) Blends w/ TX PG 64-22

Restore $\Delta T_c$

- DOT Control
  - TX 64-22
  - NO RA
- Recycled Blend
  - TX 64-22
  - 12.5% T1
  - 9.5% A1
- Recycled Blend
  - TX 64-22
  - 8.5% V1
  - 7% B

Glover-Rowe Parameter (kPa)

<table>
<thead>
<tr>
<th>DOT Control</th>
<th>Recycled Blend</th>
<th>Recycled Blend</th>
<th>Recycled Blend</th>
<th>Recycled Blend</th>
<th>Recycled Blend</th>
</tr>
</thead>
<tbody>
<tr>
<td>TX 64-22</td>
<td>TX 64-22</td>
<td>TX 64-22</td>
<td>TX 64-22</td>
<td>TX 64-22</td>
<td>TX 64-22</td>
</tr>
<tr>
<td>NO RA</td>
<td>12.5% T1</td>
<td>9.5% A1</td>
<td>8.5% V1</td>
<td>7% B</td>
<td></td>
</tr>
</tbody>
</table>

Phase Angle (degrees)

Log $|G^*|$ (Pa)

RTFO | PAV 20 | PAV 40

Rutting!!!
PHASE IIB DOSAGE SELECTION RESULTS
0.5 RBR (0.25 TX RAP + 0.25 TX TOAS)

Selected Dosage [%]

<table>
<thead>
<tr>
<th>Blends</th>
<th>Selected Dosage</th>
<th>ΔTc</th>
</tr>
</thead>
<tbody>
<tr>
<td>TX 64-22</td>
<td>14.5</td>
<td>-9</td>
</tr>
<tr>
<td>T1</td>
<td>13.5</td>
<td>-7</td>
</tr>
<tr>
<td>NV 64-28P</td>
<td>12.5</td>
<td>-5</td>
</tr>
<tr>
<td>NH 64-28</td>
<td>13.5</td>
<td>-5</td>
</tr>
<tr>
<td>MN 58-28</td>
<td>16.5</td>
<td>-8</td>
</tr>
<tr>
<td>MN 58-28 A1</td>
<td>13.5</td>
<td>-10</td>
</tr>
<tr>
<td>MN 58-28 V1</td>
<td>13.5</td>
<td>-6</td>
</tr>
<tr>
<td>MN 58-28 B</td>
<td>16.0</td>
<td>-6</td>
</tr>
<tr>
<td>Binder ΔTc</td>
<td>-4.6</td>
<td></td>
</tr>
<tr>
<td>T1</td>
<td>-3.6</td>
<td></td>
</tr>
<tr>
<td>T1</td>
<td>1.4</td>
<td></td>
</tr>
<tr>
<td>T1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>A1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>V1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>
SELECT DOSAGE

Plot original & RTFO PGH, S- & m-controlled PGL vs. RA dosage for all blends

Establish linear regression equations

Select RA dosage in 0.5% increments to restore PGH to minimum that meets target using colder PGH regression line

*For RAS mixtures, if dosage >5.5%, replace virgin binder with 50% RA and add other 50%.

REPORT w/ PG grade & $\Delta T_c$
PHASE IIB DOSAGE SELECTION RESULTS
0.28 RBR (0.1 TX RAP + .18 TX MWAS)

<table>
<thead>
<tr>
<th>Blends</th>
<th>Selected Dosage (%)</th>
<th>Binder $\Delta T_c$</th>
</tr>
</thead>
<tbody>
<tr>
<td>TX 64-22 T1</td>
<td>6.0</td>
<td>-4.6</td>
</tr>
<tr>
<td>TX 64-22 A1</td>
<td>6.5</td>
<td>-4.6</td>
</tr>
<tr>
<td>TX 64-22 V1</td>
<td>5.5</td>
<td>-4.6</td>
</tr>
<tr>
<td>TX 64-22 B</td>
<td>6.5</td>
<td>-4.6</td>
</tr>
<tr>
<td>IN 64-22 T1</td>
<td>5.0</td>
<td>-1.2</td>
</tr>
<tr>
<td>IN 64-22 A1</td>
<td>6.5</td>
<td>-1.2</td>
</tr>
<tr>
<td>IN 64-22 V1</td>
<td>3.5</td>
<td>-1.2</td>
</tr>
<tr>
<td>IN 64-22 B</td>
<td>-3</td>
<td>-1.2</td>
</tr>
</tbody>
</table>

$\Delta T_c$ represents the change in temperature coefficient.
Estimated G-R @ 21°C
(0.28 RBR) Blends w/ TX PG 64-22

Restore PGH

- DOT Control
- Recycled Blend
- Recycled Blend

<table>
<thead>
<tr>
<th>Blend Type</th>
<th>DOT Control</th>
<th>Recycled Blend</th>
</tr>
</thead>
<tbody>
<tr>
<td>TX 64-22 NO RA</td>
<td>5.5% V1</td>
<td>6% T1</td>
</tr>
<tr>
<td>TX 64-22 6.5% B</td>
<td>6.5% A1</td>
<td></td>
</tr>
</tbody>
</table>

Glover-Rowe Parameter (kPa)

<table>
<thead>
<tr>
<th>Condition</th>
<th>RTFO</th>
<th>PAV 20</th>
<th>PAV 40</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOT Control TX 64-22 NO RA</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Recycled Blend TX 64-22 6% T1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recycled Blend TX 64-22 6.5% A1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recycled Blend TX 64-22 5.5% V1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recycled Blend TX 64-22 6.5% B</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
PHASE IIB DOSAGE SELECTION RESULTS
0.5 RBR (0.25 TX RAP + 0.25 TX TOAS)

<table>
<thead>
<tr>
<th>Blends</th>
<th>Binder ΔT&lt;sub&gt;c&lt;/sub&gt;</th>
<th>Selected Dosage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TX 64-22 T1</td>
<td>-4.6</td>
<td>13.5</td>
</tr>
<tr>
<td>NV 64-28P T1</td>
<td>-3.6</td>
<td>16.0</td>
</tr>
<tr>
<td>NH 64-28 T1</td>
<td>1.4</td>
<td>15.5</td>
</tr>
<tr>
<td>MN 58-28 T1</td>
<td>0</td>
<td>16.5</td>
</tr>
<tr>
<td>MN 58-28 A1</td>
<td>0</td>
<td>20.0</td>
</tr>
<tr>
<td>MN 58-28 V1</td>
<td>0</td>
<td>16.5</td>
</tr>
<tr>
<td>MN 58-28 B</td>
<td>0</td>
<td>13.0</td>
</tr>
</tbody>
</table>
Cumulative G-R

- Virgin (64-22)
- DOT Control NO RA
- Recycled 4.5% T1
- Recycled 4.5% A1
- Recycled 4.5% V1
- Recycled 4.5% B

PAV aging (hours)

log Com. G-R

100000
10000
1000
100
10
1
- Finalize **RA Dosage Selection Method**
- Consider **Incompatibility** by Chemical or Rheological Properties
- Complete **Aging Analysis** to explore oven vs PAV aging, chemical vs rheological properties
- Characterize **Mixtures**
  - **Cracking Resistance** – FI by SCB, $N_f$ by S-VECD, RI by UTSST
  - **Embrittlement** - UTSST Viscous-Glassy Transition, Mixture Black Space with BBR Sliver and $E^*$, $\phi$
- Evaluate **Phase III Field Projects** to set thresholds for Rejuvenating Effectiveness w/Aging
Phase III Field Projects

NV 9/15: 0.3 RAPBR
RA: T2 + A2

IN 9/15: 0.4, 0.5 RBR
RA: T2

WI 9/16: 0.3 RBR
RA: V2

TX 6/14: 0.3 RBR
RA: T1

?? DE 2016: PG 64-28
RA: ??
# NV Field Project

**Laboratory Mixtures (LMLC) & Field Mixtures (RPMLC, Cores)**

<table>
<thead>
<tr>
<th>Binder</th>
<th>Dosage Selection</th>
<th>RE &amp; Evolution</th>
<th>HWTT</th>
<th>$M_R$ &amp; SCB (STOA &amp; LTOA)</th>
<th>E* &amp; UTSST (LTOA)</th>
<th>S-VECD (LTOA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target 64-28P</td>
<td>Mod Binder</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Recycled (R) 64-28P (0.3 RAPBR)</td>
<td>–</td>
<td>–</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>(R) +T2@FLD (2%)</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>(R) +A2@FLD (2%)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>DOT Control 64-28P (0.15 RAPBR)</td>
<td>–</td>
<td>–</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
## IN Field Project

### Laboratory Mixtures (LMLC) & Field Mixtures (RPMLC, Cores)

<table>
<thead>
<tr>
<th>Binder Mixture</th>
<th>Dosage Selection</th>
<th>RE &amp; Evolution</th>
<th>HWTT</th>
<th>(M_R) &amp; SCB (STOA &amp; LTOA)</th>
<th>E* &amp; UTSST (LTOA)</th>
<th>S-VECD (LTOA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target 64-22</td>
<td>-</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>DOT Control (58-28)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>(0.32 RBR)</td>
<td></td>
<td>-</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>(0.25 RAP &amp; 0.07 MWAS)</td>
<td></td>
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<tr>
<td>Recycled (58-28)</td>
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<tr>
<td>(0.42 RBR)</td>
<td></td>
<td>High RAS</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>(0.14 RAP &amp; 0.28 MWAS + T2 FLD (3%))</td>
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</table>
# WI Field Project

Laboratory Mixtures (LMLC) & Field Mixtures (RPMLLC, Cores)

<table>
<thead>
<tr>
<th>Binder Mixture</th>
<th>Dosage Selection</th>
<th>RE &amp; Evolution</th>
<th>HWTT</th>
<th>(M_R) &amp; SCB (STOA &amp; LTOA)</th>
<th>(E^*) &amp; UTSST (LTOA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOT Control 58-28S (0.22 RAPBR)</td>
<td>–</td>
<td>–</td>
<td>√</td>
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<tr>
<td>Recycled 58-28S (0.3 RAPBR)</td>
<td>–</td>
<td>–</td>
<td>√</td>
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<td>Mod Binders</td>
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<tr>
<td>Recycled 52-34S (0.3 RAPBR)</td>
<td>–</td>
<td>√</td>
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<td>V Type</td>
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<tr>
<td>Recycled 58-28S (0.3 RAPBR) + V2@FLD</td>
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