ARC Research on RAP

Western Regional Superpave Center
UNIVERSITY OF NEVADA

CONSORTIUM MEMBERS

- Western Research Institute
- Texas A&M University
- University of Wisconsin – Madison
- University of Nevada Reno
- Advanced Asphalt Technology

PROGRAM AREAS

- Moisture Damage
- Fatigue Damage
- Engineered Materials
- Vehicle-Pavement Interaction
- R&D Validation
- Technology Development
- Technology Transfer

RAP Research

- **Objective: Work Element E2b**

  Develop testing and analysis procedures that can be effectively used to evaluate RAP materials and optimize the performance of HMA mixtures containing RAP materials

RAP Research

- Develop a System to Evaluate the Properties of RAP Materials
- Compatibility of RAP and Virgin Binders
- Develop a Mix Design Procedure
- Impact of RAP Materials on Performance of Mixtures
- Field Trials

RAP Research

- **Approach of ARC/FHWA**
  - **Work Plan is Flexible**
  - **Take input from Industry**
  - **Cooperate with other activities**
  - **Reduce Overlap**

Properties of RAP Aggregates

- As percent of RAP increases (30-50%) the properties of RAP aggregates become critical

- Evaluate the impact of: Centrifuge, Reflux, and ignition oven on the properties of RAP aggregates

Properties of RAP Aggregates

- **Four Aggregates:**

  - UNR: andesite and granite with one binder

  - NCAT: Hard limestone and soft limestone with one binder

Properties of RAP Aggregates

- **Properties before and after long-term lab simulated aging:**
  - **gradation**
  - **LA abrasion**
  - **Soundness**
  - **Absorption**
  - **Specific Gravity**
  - **FAA**
  - **CAA**
  - **SE**

Properties of RAP Binder

- **Extraction/recovery is unpractical**
- **Evaluating the properties of the RAP materials or the RAP mortar can reveal information about the properties of the RAP binder**

Properties of RAP Binder

- **RAP mortar: -#8 RAP materials**
- **Measure the properties of the RAP mortar using the BBR or DSR**
- **Measure the dynamic modulus of the RAP materials**

Properties of RAP Binder

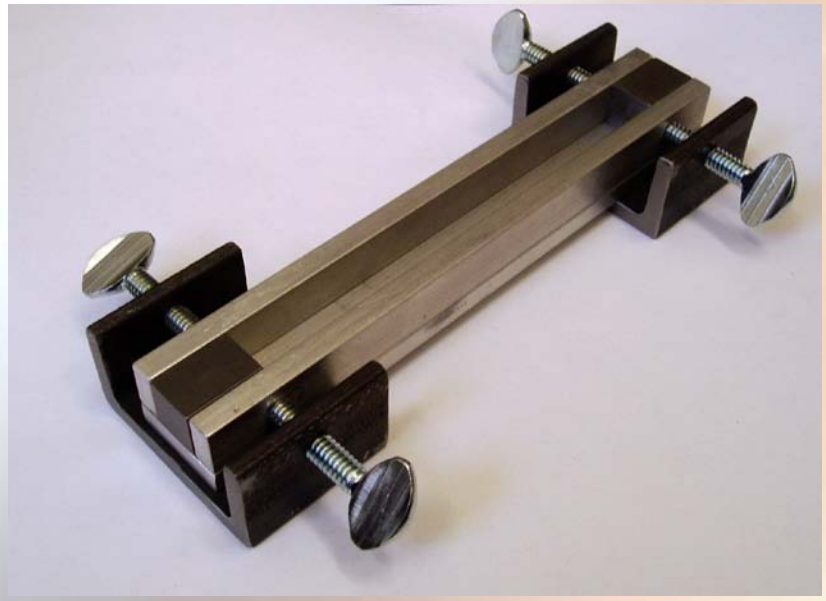
- **RAP Sources:**
  - **Modified-Stiff**
  - **Modified-Very Stiff**
  - **Un-modified-Stiff**
  - **Unmodified-Very Stiff**
- **Virgin Binders:**
  - **PG64-22**
  - **PG64-28**
  - **PG58-34**

Properties of RAP Binder

- **Testing RAP mortar in the BBR:**

  - The aggregates in the mortar were too large for the current BBR sample

  - Modified the BBR sample to: 12.7 x 12.7 mm cross section



DSR-Torsion Cylinder: Testing

- Stress-controlled Testing
- 100 kPa to 575 kPa
- Height used in test varies within a narrow range ± 0.5 mm

Field Trials

- **Can 40% RAP be used without changing the grade of the binder**
  - **section with 40% RAP+ same binder**
  - **section with 40% RAP+ diff binder**

Laboratory Trial 1

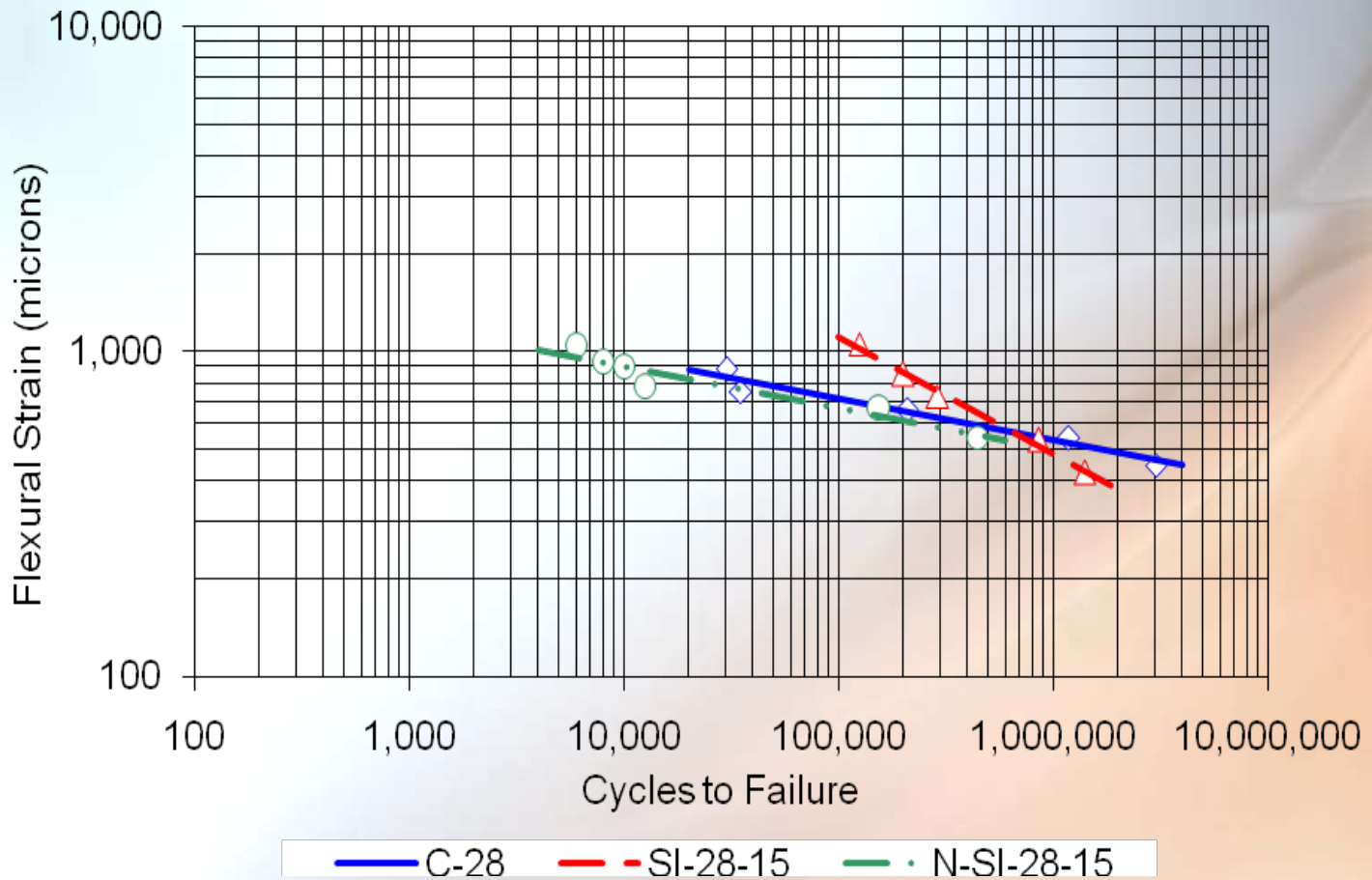
- **Plant Waste RAP**
- **15% RAP**
- **Target Binder Grade PG64-28**
  - **PG64-28 virgin binder**
  - **PG64-34 virgin binder**

Laboratory Trail 1

- **T-283 TSR**
  - **0% RAP + PG64-28: 82%**
  - **15% RAP + PG64-28: 90%**
  - **15% RAP + PG64-34: 66%**
- **APA at 140F**
  - - **0% RAP + PG64-28: 2.1 mm**
  - **15% RAP + PG64-28: 1.4 mm**
  - **15% RAP + PG64-34: 2.1 mm**

Laboratory Trial 1

- **TSRST**
  - **0% RAP + PG64-28: -24C**
  - **15% RAP + PG64-28: -31C**
  - **15% RAP + PG64-34: -39C**


10,000
1,000
100
Flexural Strain (microns)
100
1,000
10,000
100,000
1,000,000
10,000,000
Cycles to Failure
C-28
SI-28-15
N-SI-28-15

Laboratory Trial 2

- Virgin binder: PG58-28
- Mixtures: 0, 20%, and 40% RAP
- TSR: all the same at 97%
- Low Temp (0°C) TS:
  - 0% RAP: 168 psi
  - 20%RAP: 178 psi
  - 40% RAP: 188 psi
- 40% RAP with the same binder: no detrimental effect – Wisconsin Conditions