



**Road Science<sup>®</sup>**

Division of ArrMaz

**ArrMaz**

**REVIVE ASPHALT REJUVENATOR**

**USED FOR HIGH RAP MIXES**

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## RECYCLE AND REUSE



Using recycled materials to replace virgin aggregates, asphalt will reduce both the energy consumed and CO<sub>2</sub> produced during raw material extraction and processing,” says Dr. J. Richard Willis, NCAT associate research professor. “Additionally, using the combination of recycled materials and local materials reduces energy required to transport raw materials and the asphalt mixture.”

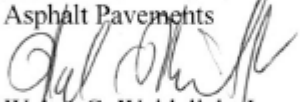
# FHWA MEMO



## Memorandum

Subject: **ACTION**: Recycled Materials in Asphalt Pavements

Date:

From:   
Walter C. Waidelech, Jr.  
Associate Administrator for Infrastructure

In Reply Refer To: HIAP-1

To: Directors of Field Services  
Division Administrators  
Resource Center

Recently there have been an increasing number of state highway agencies reporting pre-mature cracking in relatively new asphalt pavements. A similarity in many of these pavements is the high content of recycled asphalt binder.



## WITH THE USE OF A REJUVENATOR

- What is a Rejuvenator
- Rejuvenators
  - Oils that mix with the hard aged asphalt to soften it
- Pavement oxidation
  - The asphalt in the pavement continually get stiffer with age until it cracks excessively




## WHY USE A REJUVENATOR

- Economics
  - High return on utilization of RAP stockpiles
  - Reduces working capital needed for asphalt inventory
- Engineering
  - Restore properties of aged oxidized asphalt mixes
  - Improved mix flexibility
- Environmental benefits
  - Reduce consumption of raw materials (aggregate, asphalt binders and reduce or eliminate volatile organic compounds - VOCs)



## THREE MAIN TYPES OF REJUVENATORS

- Renewable Bio-based Rejuvenators 
  - REVIVE
  - No VOCs formula
- Aromatics
  - Hydrolene, Reclamite, etc.
- REOBs
  - refined engine oil bottoms, refined waste materials, refined waste fast food vegetable oils



## REJUVENATOR MIX DESIGN PROCESS

- Select rejuvenator type
- Select rejuvenator **dosage range** through balancing both PG and aging requirements of rejuvenated binder
- Finalize rejuvenator dosage through balancing rutting (HWT) and cracking (Ideal-CT) or (ITS) requirements of asphalt mixture



## Softened 2 Grades starting with 64-22

### REVIVE



<6% ADDITIVE NEEDED

- ORIGINAL AND RTFO DSR

in spec

- RTFO MASS LOSS

easily in spec

- BBR Slope

easily in spec

- BBR STIFFNESS

easily in spec

### Aromatics and REOBS

8.8% ADDITIVE NEEDED

- ORIGINAL AND RTFO DSR

in spec

- RTFO MASS LOSS

Out of spec **high**

BBR Slope

easily in spec

- BBR STIFFNESS

Out of spec **high**

- **CANNOT MEET PG 52-34 PG GRADE**

12.8% additive needed

- Original and RTFO DSR

in spec

- RTFO Mass Loss

easily In spec

- BBR Slope

easily in spec

- BBR stiffness

Out of spec **high**

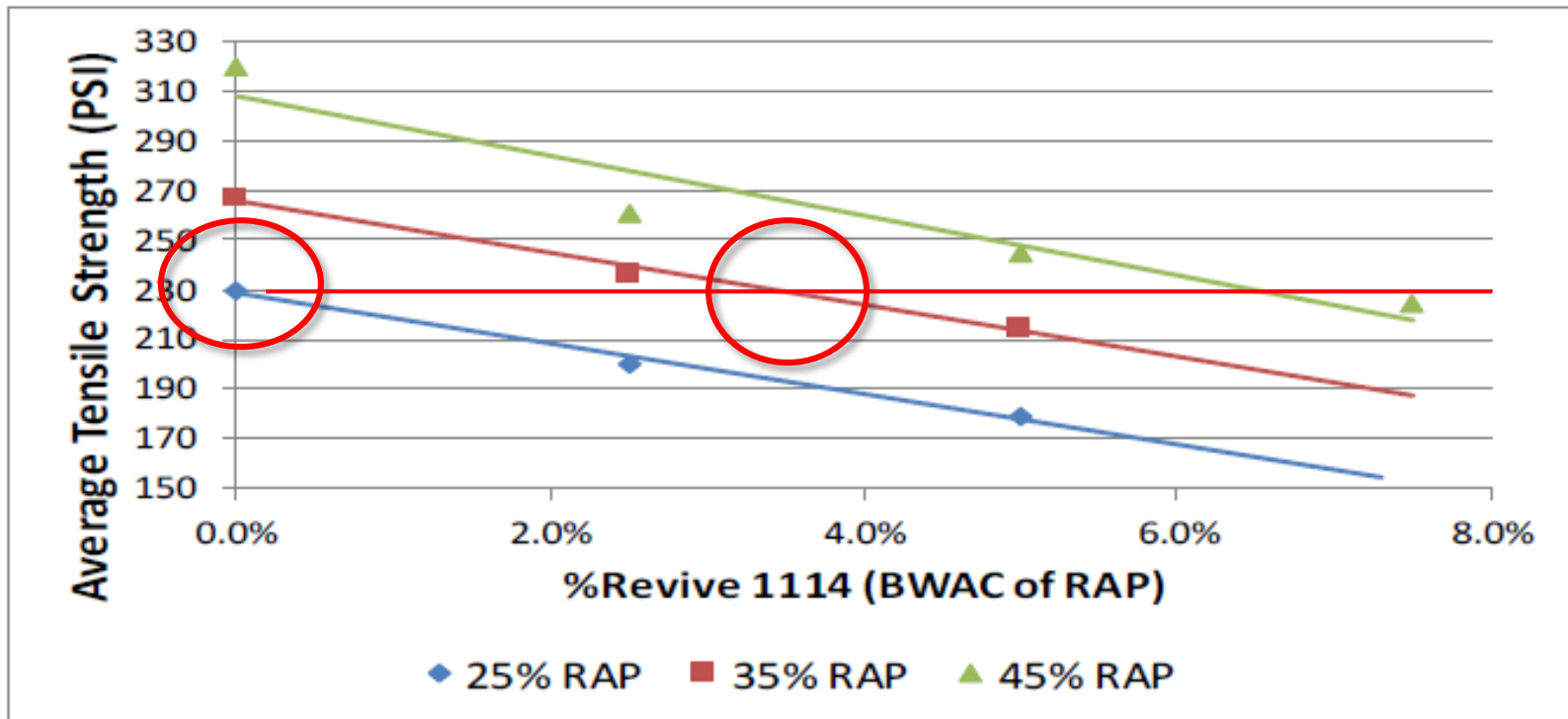
- **May meet PG 52-34 grade with more additive**





# MIX TESTING

## ITS – INDIRECT TENSILE STRENGTH



Stiffness indicator



# TENNESSEE DOT MIX PERFORMANCE EVALUATION

## PERFORMANCE OF A BITUMINOUS ASPHALT MIXTURE WITH THE AID OF REVIVE 1114 LIQUID ADDITIVE REJUVENATOR

- Performance evaluation methods
  - Ideal –CT for crack resistance (Generally a value of 70 has been recommended by NCAT and is currently in the VDOT Spec.)
  - Rutting – Hamburg Wheel Rut Test (HWT) less than 12mm @ 20k passes
  - Current TDOT Spec. 20%, Max Binder Replace

• Current TDOT 411D Asphalt Design

Replaced Asphalt Binder (14.9%)  
7% RAP 3% RAS  
TSR – 80.6

High Rap 411D Asphalt Design

Replaced Asphalt Binder (28.5%)  
22% RAP 3% RAS  
TSR - 82.4

Ideal –CT



The logo for the state of Tennessee, featuring the letters 'TN' in white on a red square background.

**TDOT**  
Department of  
Transportation

A photograph of a two-lane asphalt road with yellow double lines, curving through a landscape with snow-covered hills under a clear blue sky.

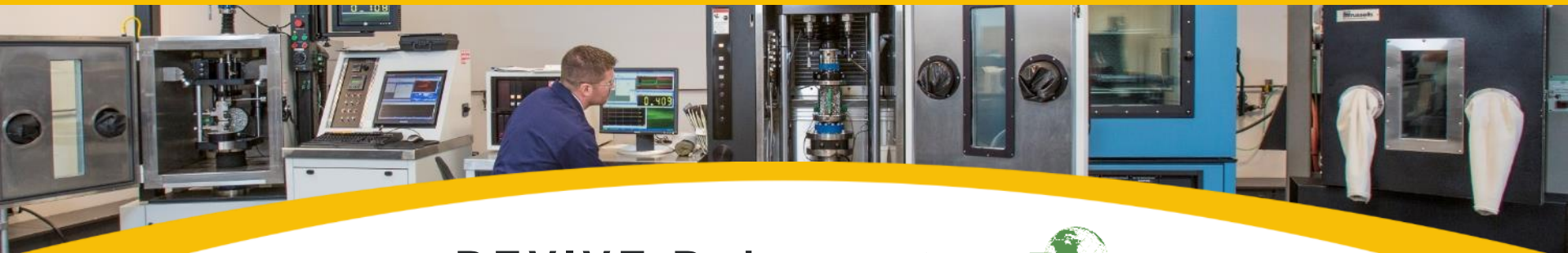
## RESEARCH CONCLUSIONS

- **HIGH RAP MIX DESIGN OUT PERFORMED CURRENT TDOT 411-D MIXES**
- **IMPROVED IDEAL CT CRACKING TEST AND PERFORMED WELL IN THE RUTTING TEST.**
- **THE LONGITUDINAL JOINTS PERFORMED BETTER USING REJUVENATOR**
- **GIVEN THESE RESULTS MAKES WAY FOR TDOT DISCUSSION OF A MORE BALANCED MIX DESIGN.**
- **2017 TDOT HAD 1,081,220.02 TONS OF MIXES, PUT IN PLACE, CONTAINING ANTI-SKID MATERIAL WITH AN INDUSTRY AVERAGE RAP USAGE OF APPROXIMATELY 9%.**
- **IF INDUSTRY COULD INCREASE THE RAP USAGE BY AN AVERAGE OF 20% MORE, IT WOULD AID A DEPLETING RESOURCE OF ANTI-SKID MATERIAL BY STRETCH IT ANOTHER 110,000 TONS THRU THE USE OF MORE RAP, EACH YEAR.**
- **IN TERMS OF \$, IT WOULD GIVE TDOT ANOTHER \$2.5 - \$3 MILLION TO WORK WITH EVERY YEAR, JUST BY REPLACING STONE WITH RAP. PLUS ANOTHER \$4.3M IN BINDER SAVINGS.**
- **WITH THE MAIN IDEA OF GETTING QUALITY ROADS IN RETURN.**



## WASHINGTON STATE GREAT NORTHWEST CONTRACTORS RECOGNIZE BENEFITS OF REVIVE 1114

- Binder replacement increased to 30% in most cases and up to 40%
- Revive reduces the stiffness of the binder preventing premature cracking
- Increased mix workability in the field with the benefits of density improvements
- With the addition of Revive the ODSR's a lines with the original desired binder grade ODSR
- Revive dosage ranges from 1.0% to 4.8% (bwvb) by weight of virgin binder
- Rap usage increased 10 to 20%
- 40% binder replacement currently limited by state DOT
- Reduction in overall mix cost
- Contractors plan to increase product usage for increased profitability



# REVIVE Rejuvenator



## ENVIRONMENTAL

**REDUCED EMISSIONS @ HMA PLANT  
AND PAVER**

**REDUCED CONSUMPTION OF RAW  
MATERIALS, ASPHALT CEMENT,  
AGGREGATES, ENERGY  
CONSUMPTION, TRUCKING**

**FOR EVERY 150,000 TONS OF HMA  
PRODUCED WITH AN INCREASE IN 15%  
RAP**

**Reduce consumption of Virgin Asphalt  
Binder by 2,700 Tons or 108 TL Delivered  
from Terminal To HMA Plant**

## PERFORMANCE

**OXIDIZES AT LOWER RATE THAN VIRGIN  
BINDER**

**ORIGINAL AND RTFO DSR IN SPEC**

**RTFO MASS LOSS EASILY IN SPEC**

**BBR SLOPE AND BBR STIFFNESS EASILY IN  
SPEC**

**REDUCED EXCESSIVE AGING AS A RESULT OF  
INCREASED USE OF OXIDIZED ASPHALT**

**INCREASED WORKABILITY**

**LONGER TRANSPORT TIMES**

**COLD WEATHER PAVING (NIGHT WORK)**

**HIGHER PRODUCTION RATE**



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**THANK YOU**

**QUESTIONS?**

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