

# How to get Good Results using RAP in HMA



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County Engineers Workshop

February 4, 2026

Muskegon, MI

# Introduction



# Introduction

- What is RAP?
- Benefits/ Challenges of using RAP
- Key Performance factors
- Getting Good Results (Performance!)

# Why use RAP in HMA?



## Environmental impact

Resource conservation  
Landfill waste reduction



## Economic benefits

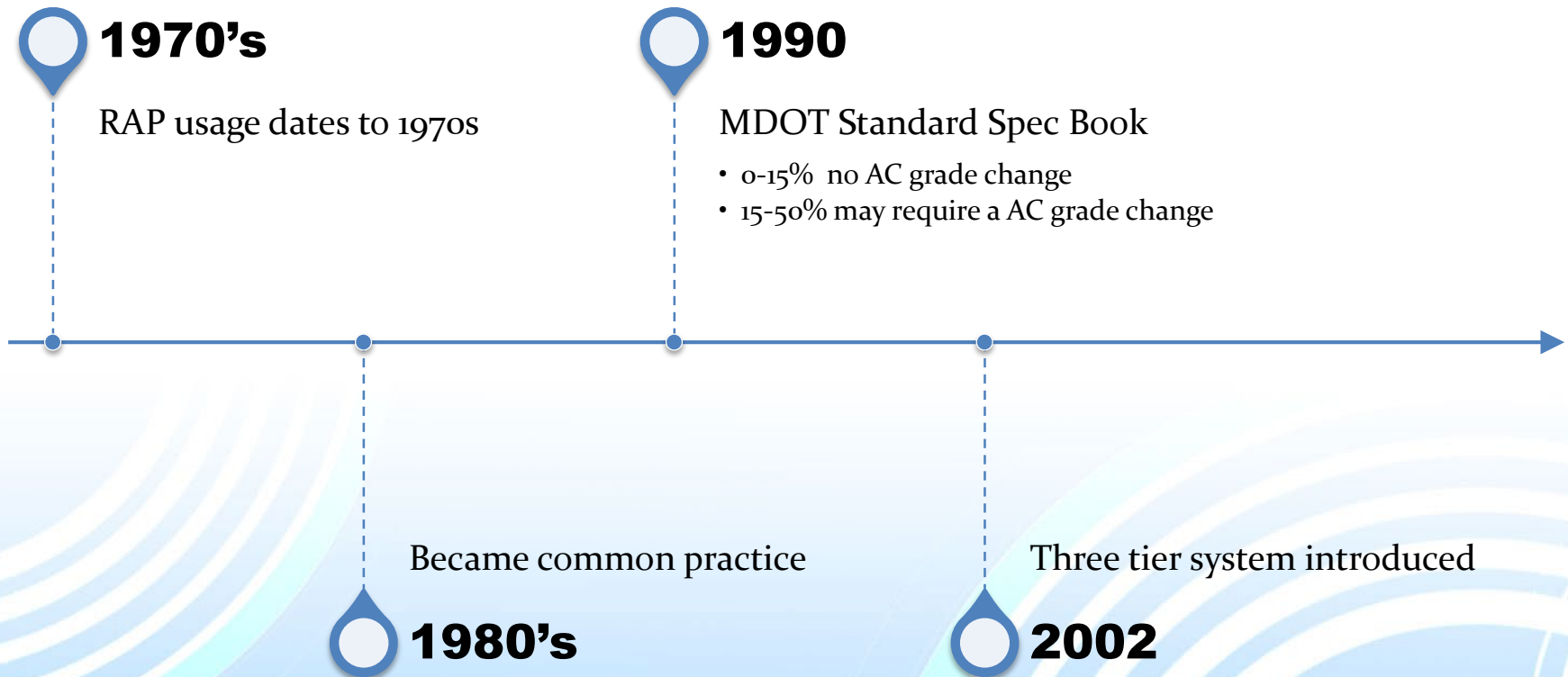
Cost savings  
Enhance competitiveness



## Performance benefits

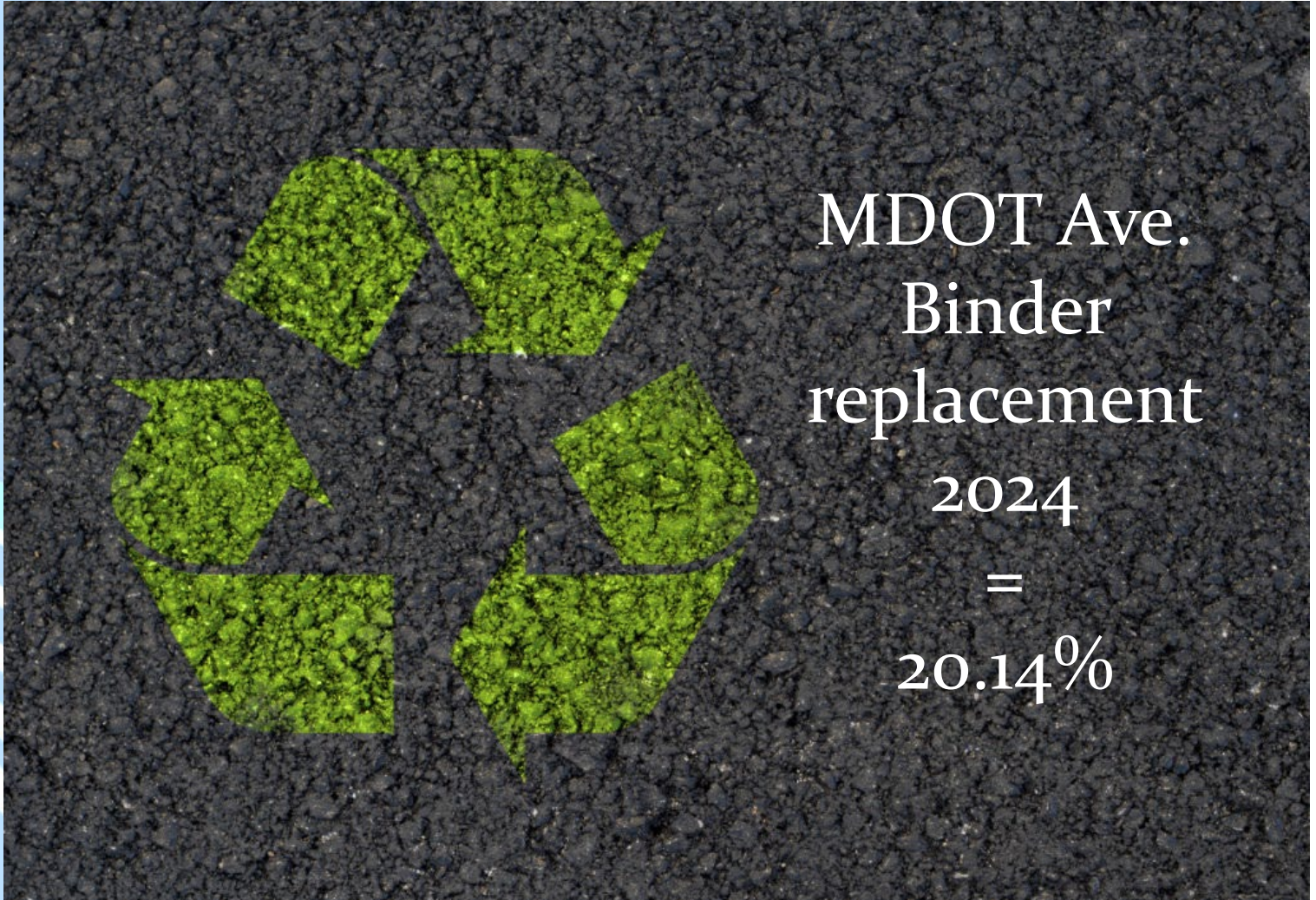
Consistency  
Rut resistance

# Starting Point





# RAP



# Question Break!

What factors contribute to limiting RAP use in your county?

- a. RAP inconsistency (gradation / binder)
- b. RAP binder properties (stiffness)
- c. RAP aggregate properties (friction/ toughness)
- d. None



# Challenges when using RAP

- Aged Binder stiffness
- Consistency of properties
- Heating & blending RAP
- Availability
- Additional mix design considerations



# Key Performance Factors

- Binder grade selection
- RAP percentage
- aggregate quality

# Michigan's Problem

**Superpave = Dry Mixes**



**Dry Mixes = Poor Durability**



**Does  
Superpave = Poor Durability?**

# MDOT Strategy to address Cracking

## 1. Binder Quality

- Tier System

## 2. Increase Binder Quantity

- Decrease air voids
- Increase VMA

## 3. Proportions

- Increase  $V_{be}$  via gradation

# Binder Quality

- Current Special Provisions
  - 501H RAP & RAS in Superpave
  - 501F RAP on Local Agency Projects





# Binder Quality - MDOT RAP Tiers



## Tier 1:

0-17% RAP binder  
No adjustment for RAP binder



## Tier 2:

18-27% RAP binder  
lower the low end of PG (some exceptions)



## Tier 3:

28% + RAP binder  
Use blending chart

# Tier 3 Opportunity

		Mix Size		
		Base	Leveling	Top
ESAL	Low	✓	✓	✓
	Med-Low	✓	X	X
	Med-High	✓	X	X
	High	✓	X	X

# Question Break!

In my experience, mixes are  
(\_\_\_\_\_) produced at the maximum  
RAP allowed by specification?

- a. *Always-Often*
- b. *Sometimes*
- c. *Rarely-Never*

# Question Results

- MDOT's Answer: **B. Often**
  - Tier 1: Always
  - Tier 2: Always to Often
    - Easy to binder bump
    - Lack of RAP in one region prevents maximization
  - Tier 3: Sometimes
    - Blend chart testing can be cost prohibitive
    - Lack of softer binder for base mixes



# Increasing Binder Quantity



**Reduced air  
voids from 4.0%  
to 3.5%**

Resulted in +0.2% binder  
increase



**Air Voids  
reduced to 3.0%**

Another 0.2% binder  
increase



**Fine graded  
mixtures  
required**

Applied to top and leveling



**VMA production  
target**

**1% higher than  
design**

# Mix Design Strategies

- Superpave considerations by RAP content
  - Low, intermediate, high
- blending charts
- rejuvenators

# Blending Charts

Pavement Recycling and Reclaiming Center  
Review of High Percentage RAP Usage in Asphalt Concrete

4/5/2013

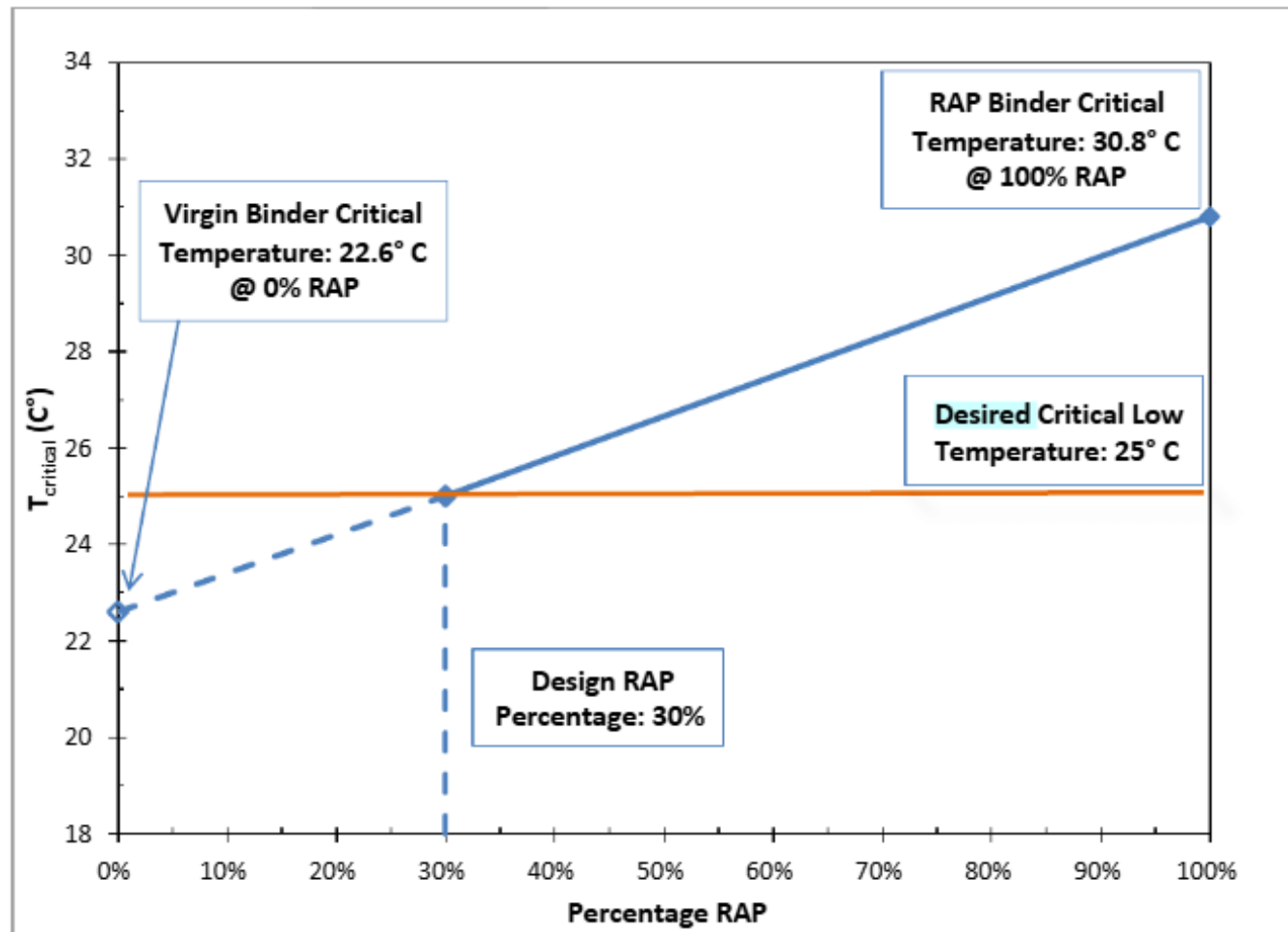
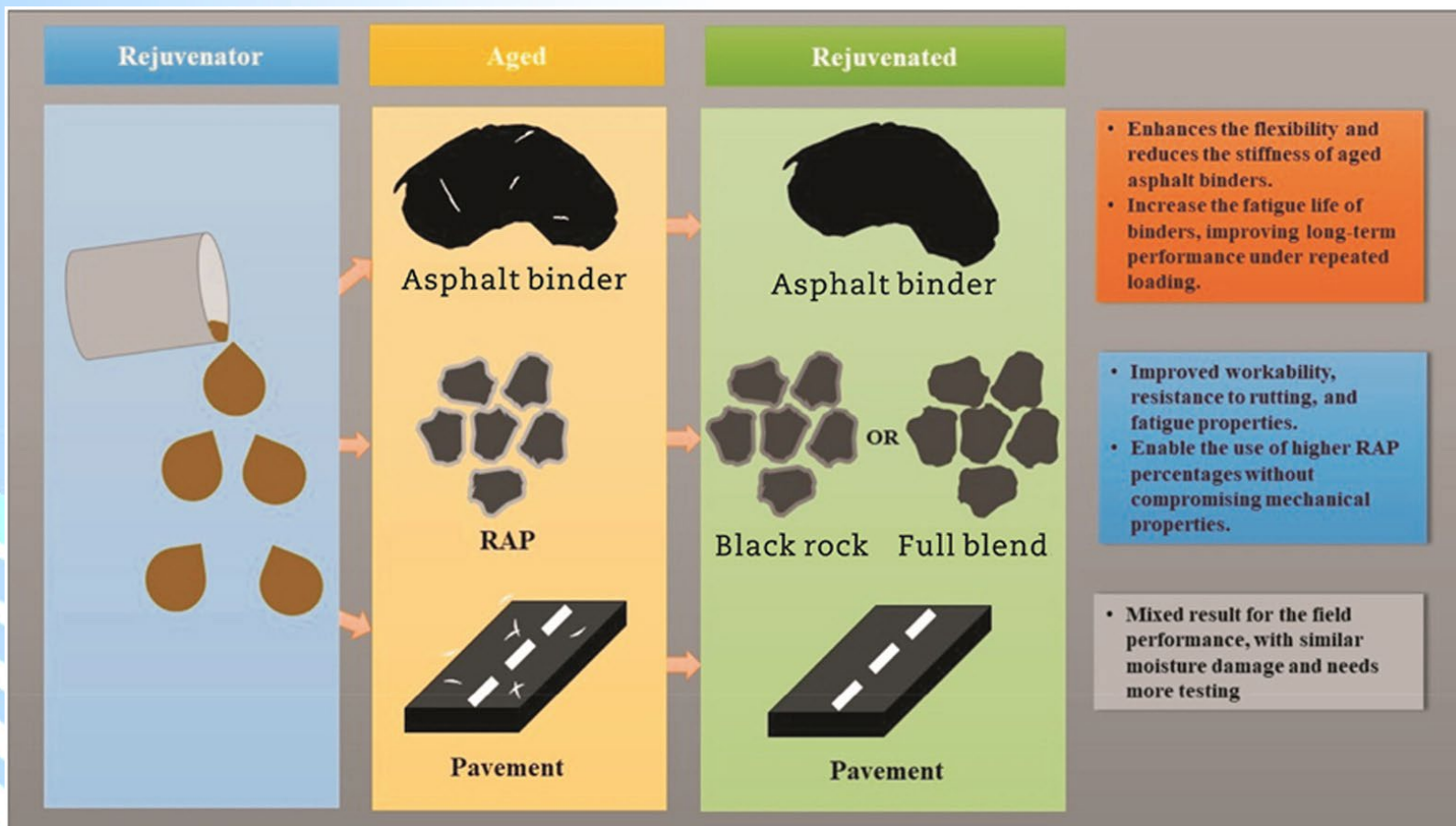


Figure 4-1. Blending chart example

# Rejuvenator





# Production Best Practices

- RAP management plan
  - Processing
  - Testing frequency  
1/1000 ton (min. 3 tests)
  - Moisture control



# Production Best Practices

- Plant
  - RAP feed consistency
  - Mixing time
  - temperature control



# Performance Expectation

The Expectation:  
equivalent (or better) pavement  
performance with RAP

# Performance Enhancements



ADDITIVES



POLYMERS



BALANCED MIX  
DESIGN APPROACH



# Outcomes

- Opportunity to increase RAP exists!
  - 25% of surface designs are 30%+ RAP by weight
- RAP levels achieved are lower than specification limits
- Design specific RAP limitations
- Plateau of RAP use

# Do I recommend adopting this approach?

This is a Pre-BMD strategy

Rutting –  
addressed with  
Superpave

Cracking –  
addressed with  
more/ softer binder

Moisture –  
addressed with TSR



Don't need to wait to  
implement

# Considerations

- Not comprehensive, study-based strategy
- Does not include additives options
- Cost
- Not a replacement for mixture performance testing

# Summary & Takeaways

Sustainability benefits

Best practices

QC importance

Performance follows





# Q & A





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Thank  
You!