



BLENDING CHARTS AND HIGH RAP MIXES

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Kansas Asphalt Forum
Topeka, Kansas
November 3, 2011

CONVENTIONAL WISDOM

- RAP contains old, hardened binder that will stiffen the mix
- This will help reduce rutting
- May increase cracking tendencies
- There is research and experience to support conventional wisdom
 - And some that doesn't.

POSSIBLE EFFECTS OF RAP BINDER



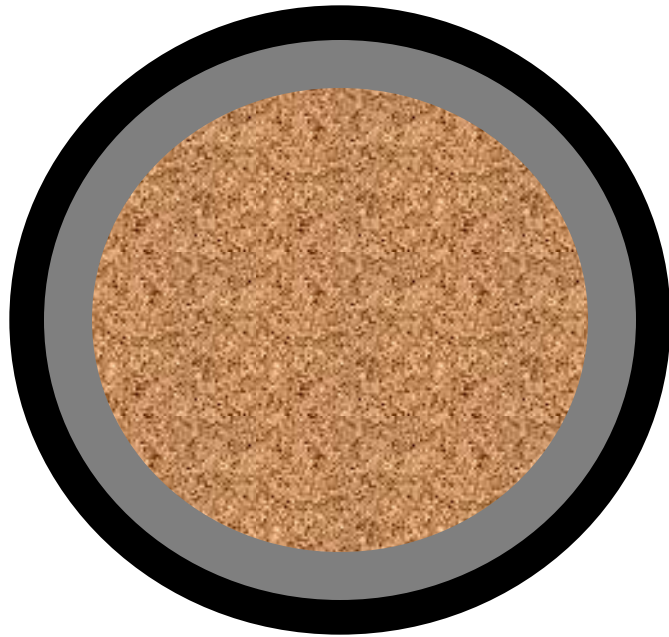
RAP aggregate
with oxidized
binder film

POSSIBLE EFFECTS OF RAP BINDER



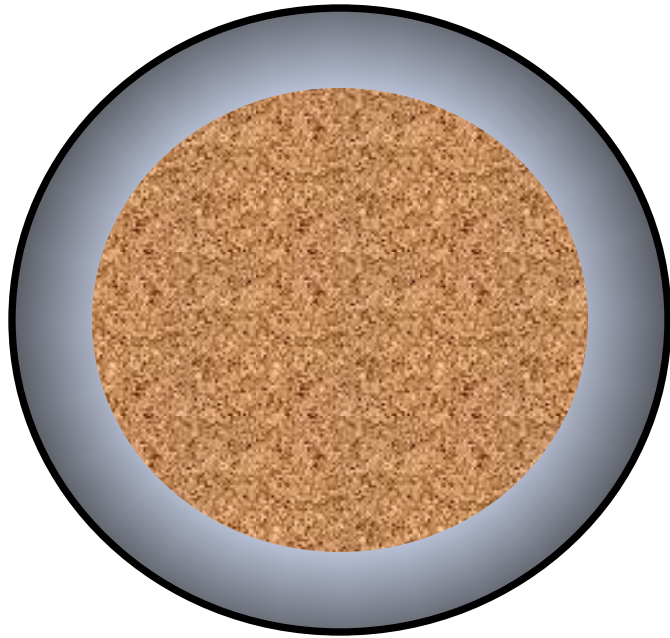
RAP aggregate with
oxidized binder film
plus virgin binder

POSSIBLE EFFECTS OF RAP BINDER



No blending –
Virgin binder properties
will dominate.

POSSIBLE EFFECTS OF RAP BINDER



Blending –
Effective binder
properties will be
determined by the
amount of blending
that occurs.

DOES BLENDING HAPPEN?

- Lots of evidence that significant blending does occur
 - Evaluation of blending by looking at mixture and binder stiffness
 - But, we may be able to go to higher RAP binder contents before changing grades
- There are still non-believers
 - Research will continue
 - More yet to learn

CURRENT GUIDELINES

- Current mix design recommendations assume that significant blending does occur
 - Strong evidence exists to support that
- But, they also assume there is a threshold level of RAP that can be added without affecting effective binder grade
 - 0 to 15% RAP, no binder grade change
 - 16–25% RAP, decrease virgin binder grade
 - Over 25% RAP, test RAP binder to determine appropriate virgin grade (or allowable RAP content)

THOSE GUIDELINES DEVELOPED UNDER NCHRP 9-12

Study by NCSC and Asphalt Institute found:

- RAP is not a black rock.
- At low RAP contents, there is not enough RAP to change binder or mix properties.
- As RAP content increases, effects become appreciable.
- Linear blending charts are valid for higher RAP contents.

OTHER FINDINGS OF NCHRP 9-12

- As RAP content increased, stiffness increased
 - Increased rut resistance
- Beam fatigue and low temperature testing showed similar stiffening.
 - Important – must account for this to avoid increased cracking (use softer virgin binder).

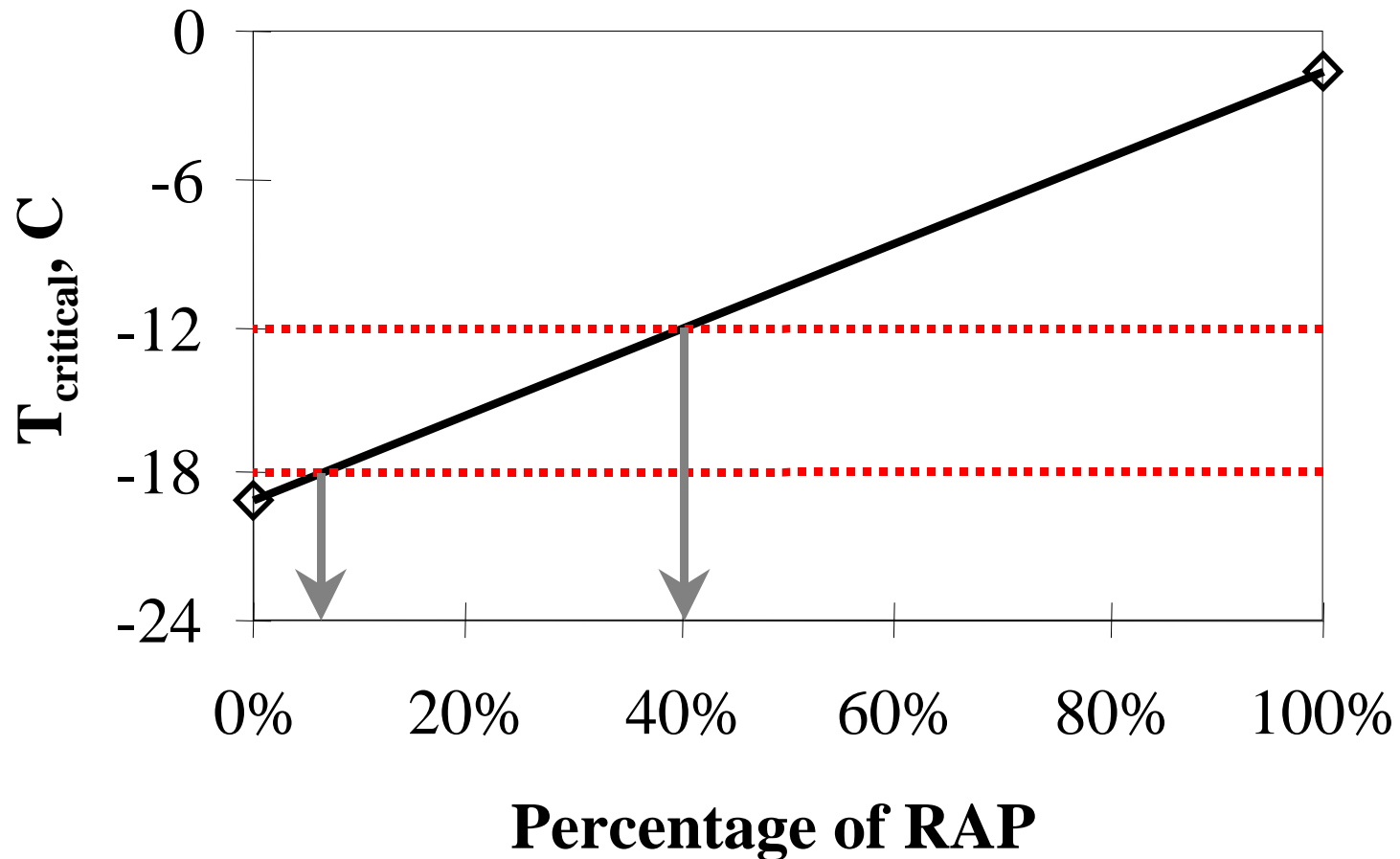
IMPACTS OF BLENDING ON PERFORMANCE

- If we assume there is blending and there isn't, virgin binder grade may be softer than desired.
 - Increased chance for rutting
 - Decreased chance for cracking
- If we assume there is no blending and there is, effective binder grade may be stiffer than desired.
 - Decreased chance for rutting
 - Increased chance for cracking

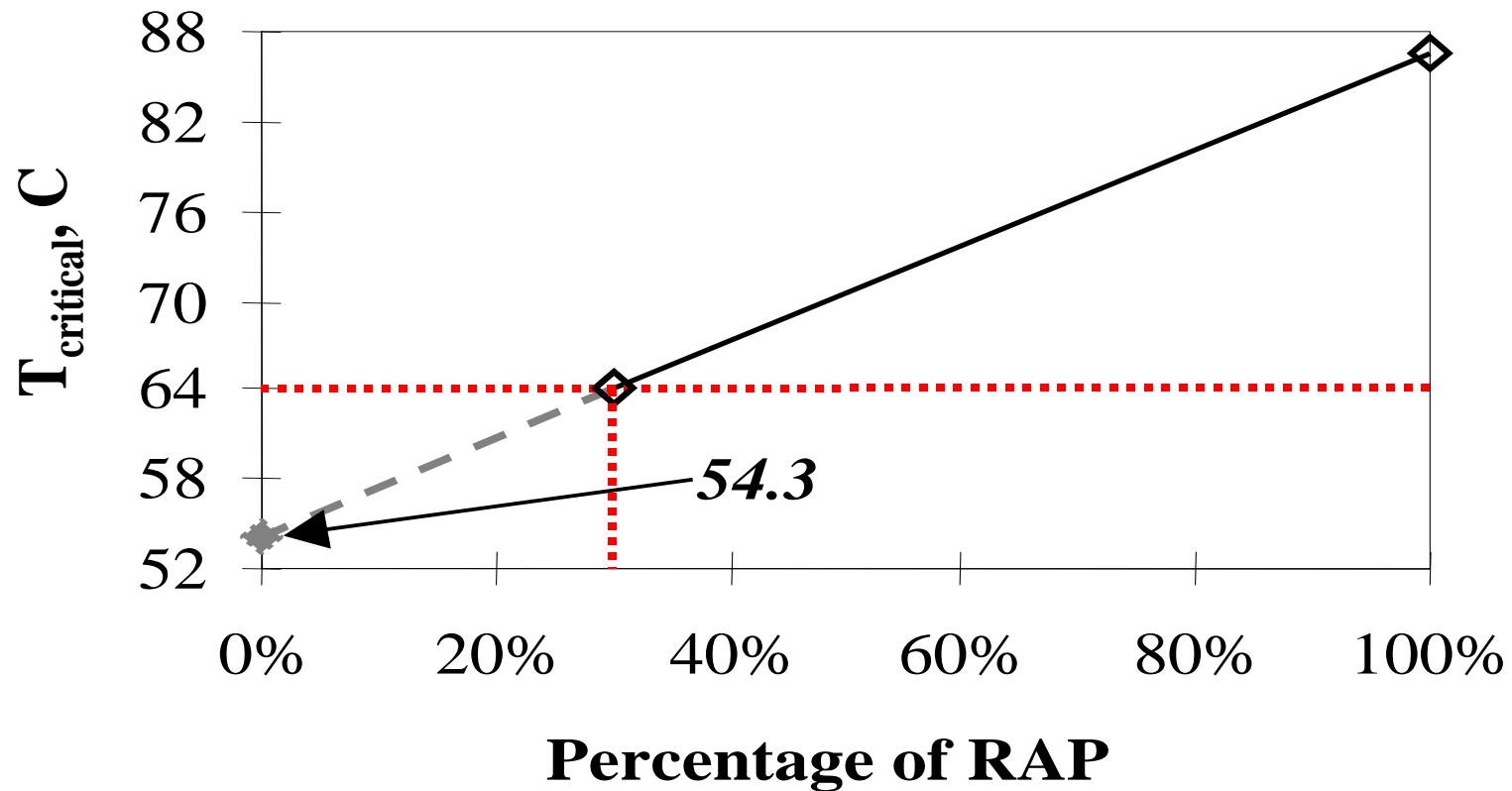
RISKS OF FALSE ASSUMPTIONS

- Assuming there is blending may be more conservative.
 - Shouldn't rely on binder to control rutting
 - Increased cracking can have performance and economic impacts
- Current guidelines are a starting point, but not the definitive answer

LOW TEMPERATURE BLENDING CHART, KNOWN VIRGIN BINDER



HIGH TEMPERATURE BLENDING CHART, KNOWN RAP CONTENT



Also check at intermediate temperature.

HIGHER RAP CONTENTS

- Current guidelines and blending charts based on non-fractionated mixes with about 5% binder in both the RAP and new mix.
- Now we are fractionating more RAP
 - Higher RAP binder content in fine fraction
 - More binder ⇒ reduced cost
- Higher RAP contents are being used
- Better to consider binder replacement
 - Or specify minimum percent virgin binder

FHWA STUDY AT NCSC

- Evaluated five plant produced mixes from Indiana and Michigan
- RAP was crushed/screened; fine fractions used
- No change in virgin binder grade needed at up to 25% RAP
- Based in part on this study, INDOT changed specs to allow up to 25% binder replacement without grade change
 - Drop one grade for up to 40%
 - Blending chart for higher RAP contents
- Report in publication; out soon

WILL THIS HOLD FOR ALL MIXES EVERYWHERE?

- Probably not, but maybe in areas with similar materials and climates
- States should know a reasonable threshold level for typical materials.
- Above threshold, know if blending is occurring or not.
- Contractors should know and manage RAP stockpiles to control the assumptions.

THRESHOLD VALUES

- Test and know your typical RAP materials (recommended at state level)
 - What kinds of binder did you use?
 - How much aging is typical?
 - How stiff are typical RAP binders?
 - Extract and grade RAP binders, mixes
- Based on testing and experience, some states had changed the tiers
 - Say, up to 20% RAP without changing grade
 - Now going further in some cases

OTHER WORK

- Review of LTPP sections with 30% RAP for FWHA RAP ETG showed they performed as well as virgin
- NCHRP 9-46, *Improved Mix Design, Evaluation and Materials Management of High RAP Content HMA (NCAT)* – completion 3/2012
- FHWA HMA Recycling ETG – continuing to develop and disseminate guidance
- NAPA also issuing documents
- Other state studies ongoing
- All will offer more guidance.

NCAUPG TECHNICAL CONFERENCE

- Topics: RAP, RAS, WMA, Construction Operations, Intelligent Compaction and more
- Downtown Indianapolis
- February 15–16 or February 22–23 (awaiting proposals from hotels)
- Details will be on the web -- Link from NCSC page or <http://cobweb.ecn.purdue.edu/~spave/NCAUPG/Index.html>



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