ENVIRONMENTAL SUSTAINABILITY ISSUES IN PAVING INDUSTRY "WARM MIX ADDITIVES IN RECYCLING MIXES"

NABin Conference

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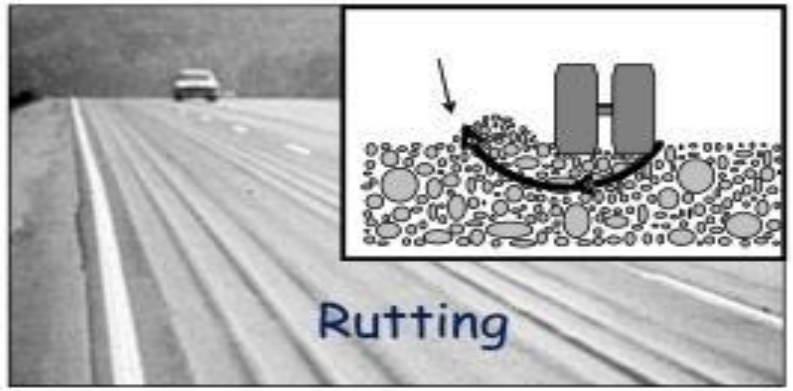
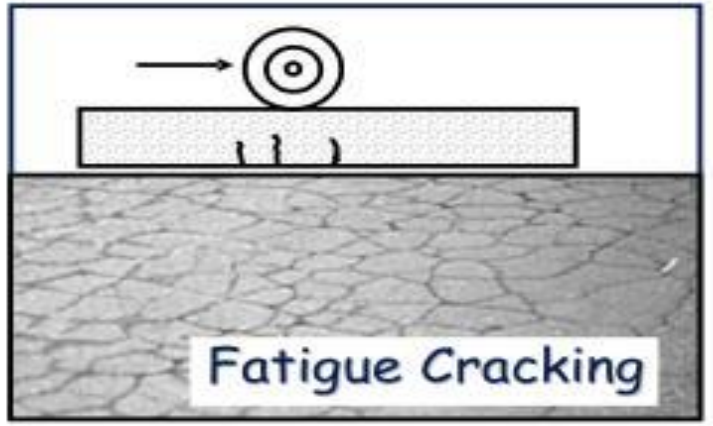
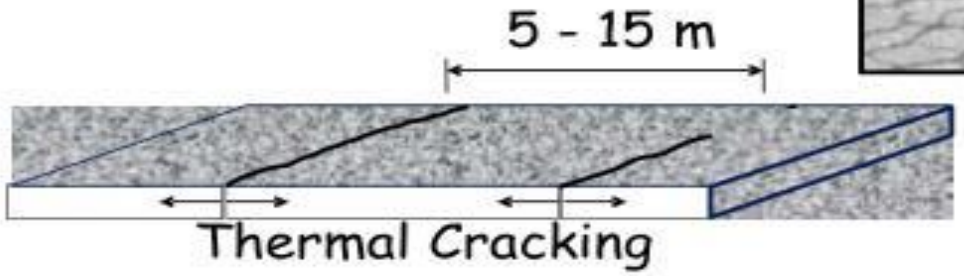
Primary Distress Modes HMA Pavements







Moisture Damage?

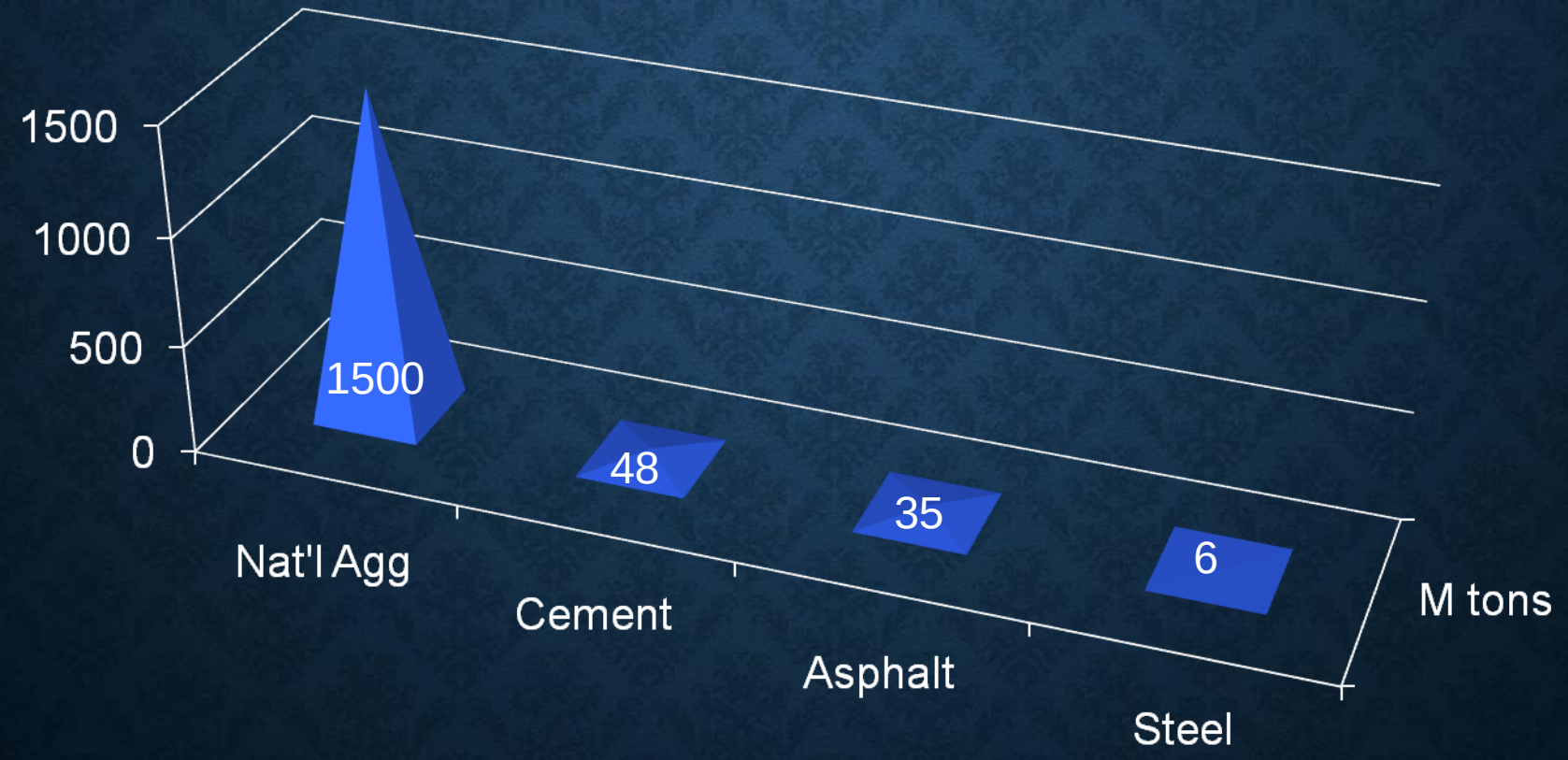
ISSUES TO CONSIDER

- Environmental Issues
- Cost Issues (Initial and LCCA)
- Compatibility Issues
- Recycling of the New Pavement
- Public Perceptions
- Acceptance by Governmental Agencies

U.S. INFRASTRUCTURE

- Over 5.9M Km of paved roads
- 94%: asphalt pvts
- 550 million tons of HMA used annually
- Spending billions in asphalt paving annually

MATERIALS ESTIMATED TO BE IN USE IN THE NATIONAL HIGHWAY SYSTEM



CONCRETE

- Concrete is used more than any other man-made material in the world.
- 8 cubic km of concrete made / year
- More than one cubic meter / person on Earth

WHY PICK ON CONCRETE?

- My oldest son, the main reason
- 5% of global emission is due to production of cement
- 20% use of fly ash: 0.7% reduction in CO_2
- What about 80% replacement??

RECYCLED MATERIALS

- Use of recycled materials in pavements can:
  - Improve pavement performance
  - Reduce initial costs
  - Reduce lifecycle costs
  - Provide useful disposal of waste without diminishing pavement performance
  - Any combination of these

TYPES OF RECYCLED MATERIALS

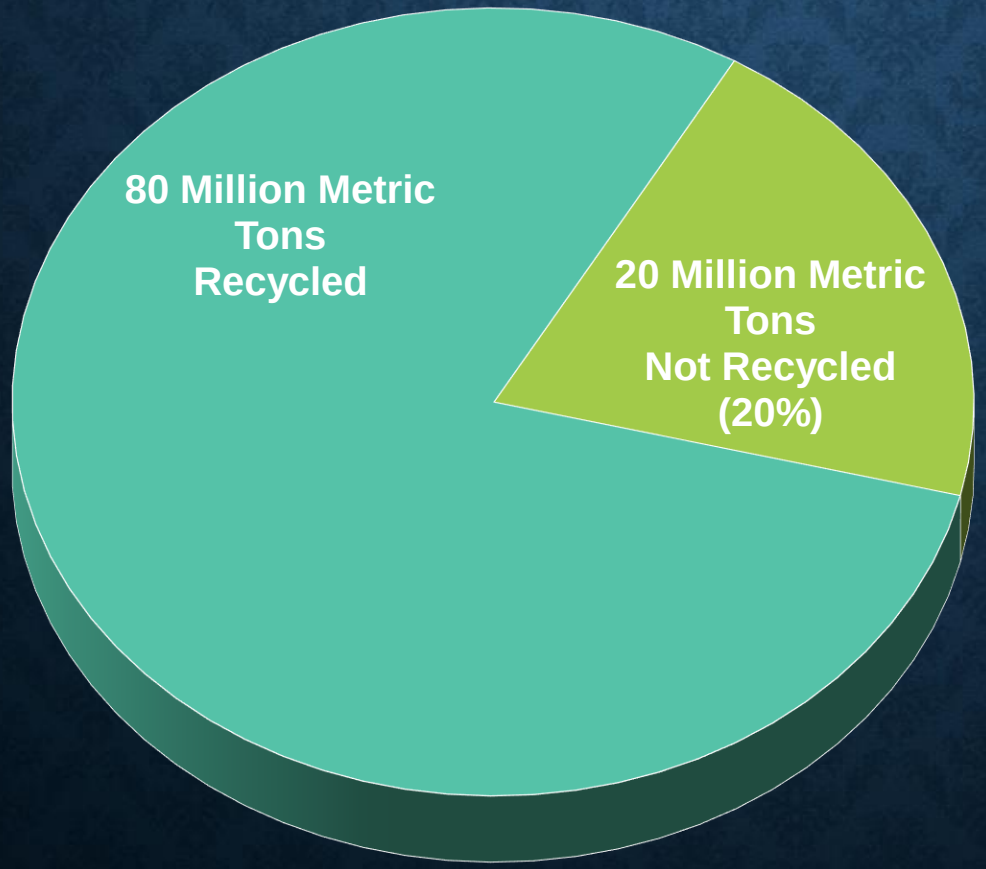
- Reclaimed asphalt pavement (RAP)
- Scrap tires (crumb rubber)
- Many others

RECLAIMED ASPHALT PAVEMENT (RAP)

RECLAIMED ASPHALT PAVEMENT

U.S. RAP PRODUCTION

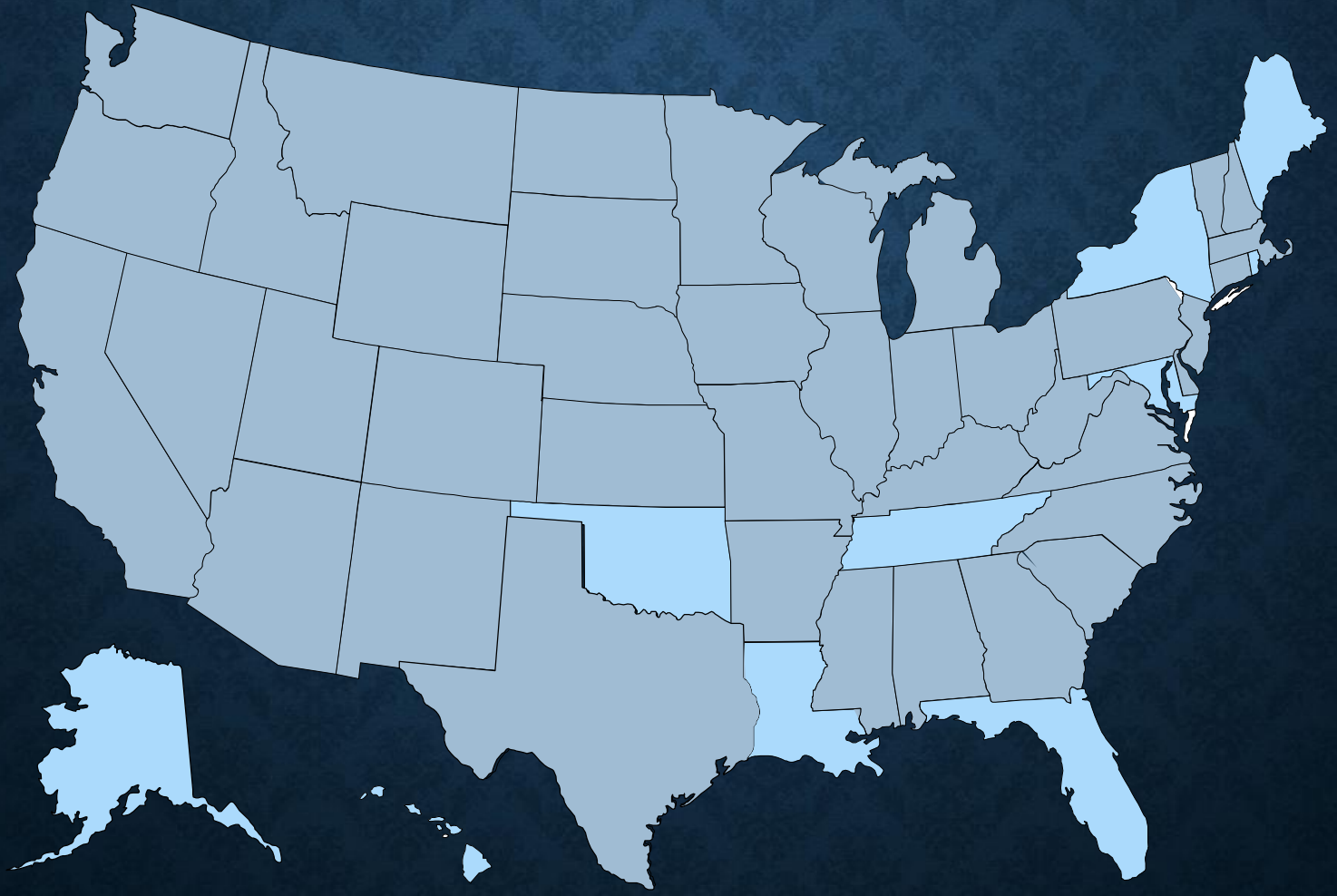
- ~100 million metric tons of RAP are produced in the U.S. each year



RECLAIMED ASPHALT PAVEMENT

- Most recycled product in U.S. in both percentage (80%) and tonnage (76 million)
- Used so frequently in highway construction, it's not considered a waste product
- saved nearly 38 million cubic meters of landfill space during 2017
- All 50 states regularly utilize RAP in flexible pavements
- 10 states only use RAP in base and intermediate course mixtures (not surface course)

STATES USING RAP IN ALL TYPES OF MIXTURES



TYPES OF PAVEMENT RECYCLING

- Surface recycling
  - In-place recycling to a depth of < 25 mm
- In-place surface and base recycling
  - In-place recycling to a depth of >25 mm
- Central plant recycling
  - Most common form of pavement recycling
  - Only form to remove material from roadway before reuse

MATERIAL CONSIDERATIONS

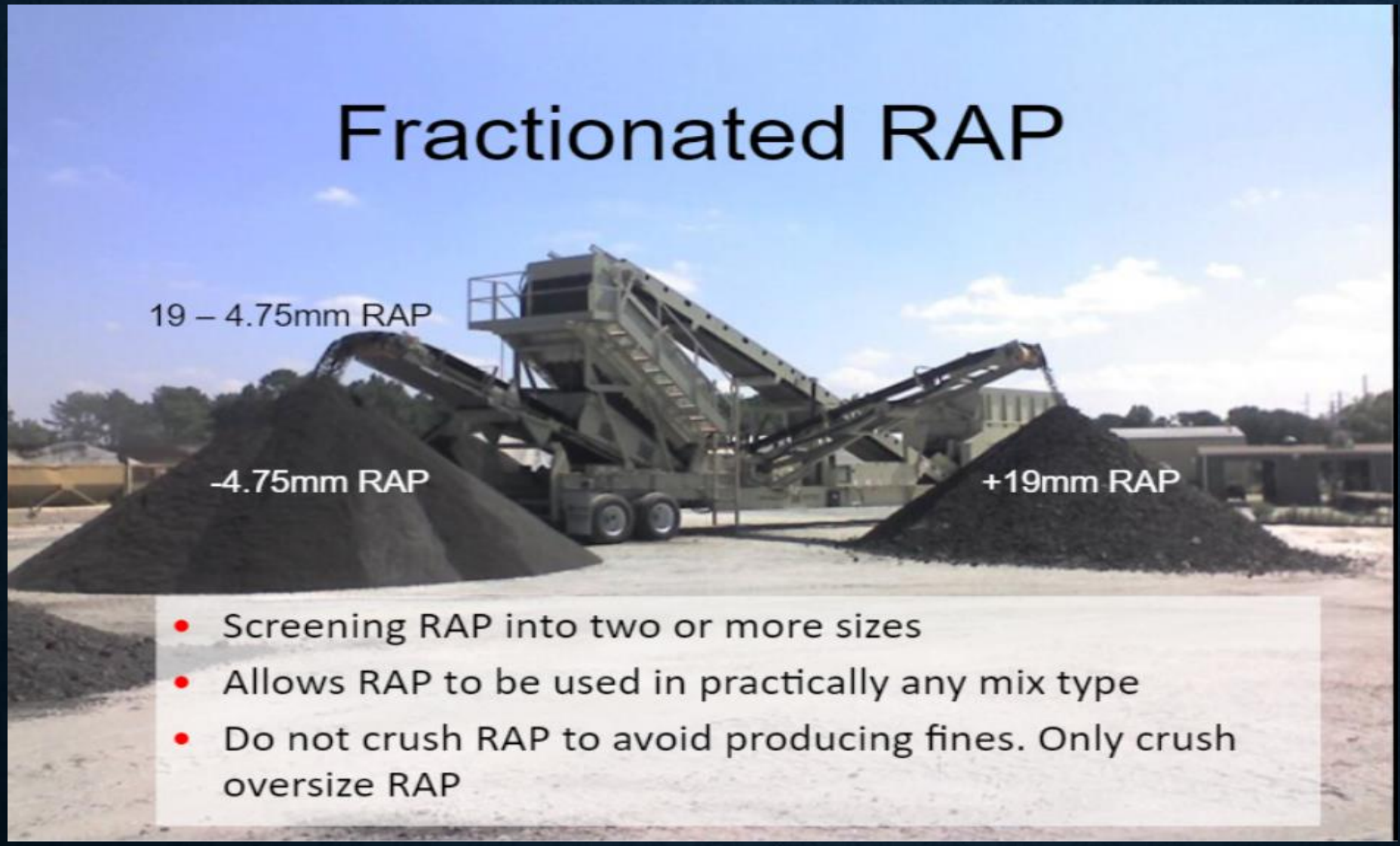
- Physical Aspects
- Chemical Compatibility
- Present & Future Environmental Issues
- Views of Public, Engineers, & Decision Makers
- Life-Cycle-Cost Issues
- NEED information to make the “right call”

RAP STOCKPILE MANAGEMENT IS EVERYTHING!!

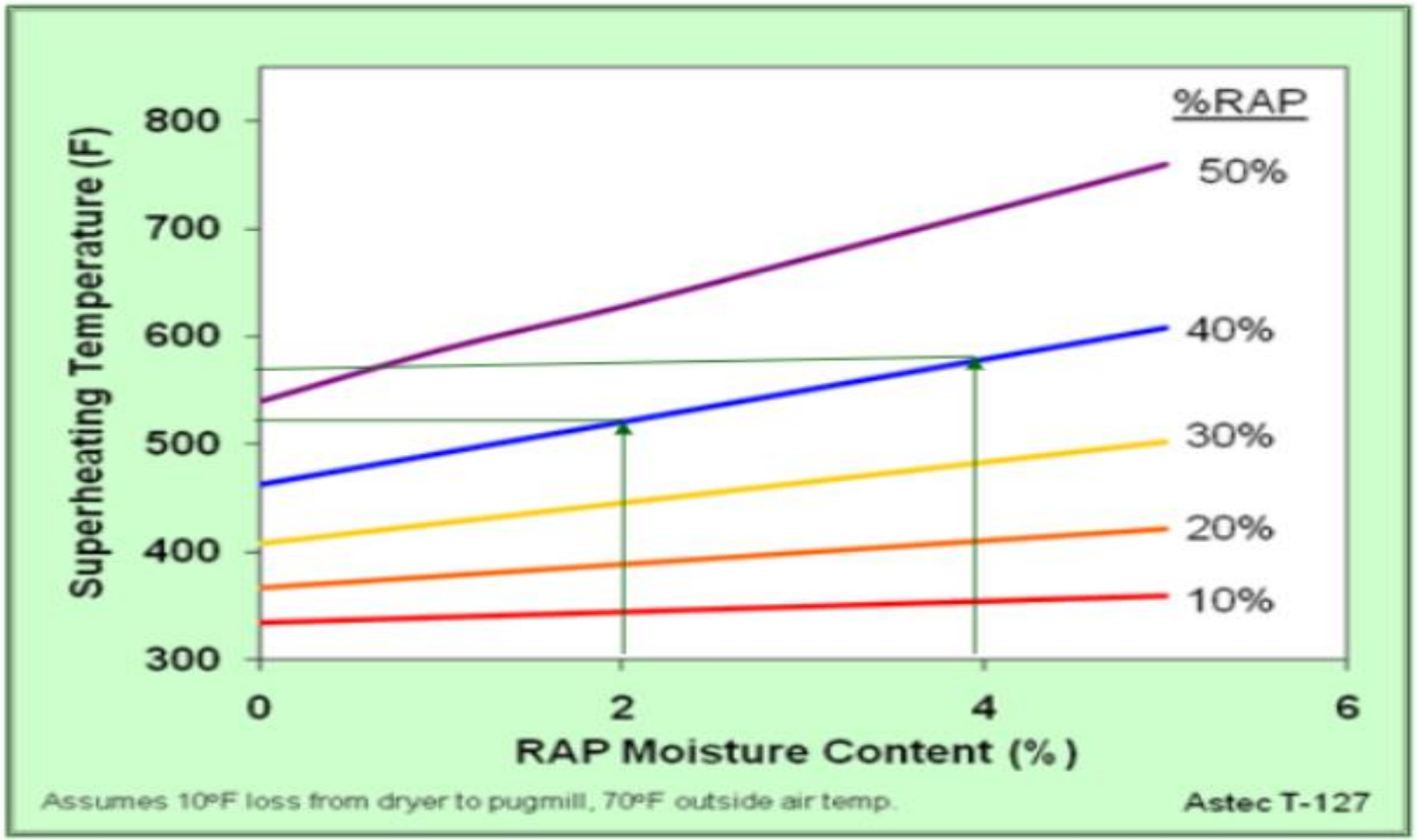
MILLED RAP


•Keep millings from different projects in separate stockpiles
•Milled RAP can typically be used “as is” in HMA without further crushing to save costs

FRACTIONATED RAP



CONTROLLING MOISTURE IN RAP



ADVANTAGES OF RAP

- Saves landfill space
- Conserves virgin materials
- Lower cost without compromising performance
  - The use of RAP and RAS: cost savings of more than $2.2 billion
- Decreased rate of aging
- Increased resistance to water damage

HOW CONTRACTORS LOOK AT WMA

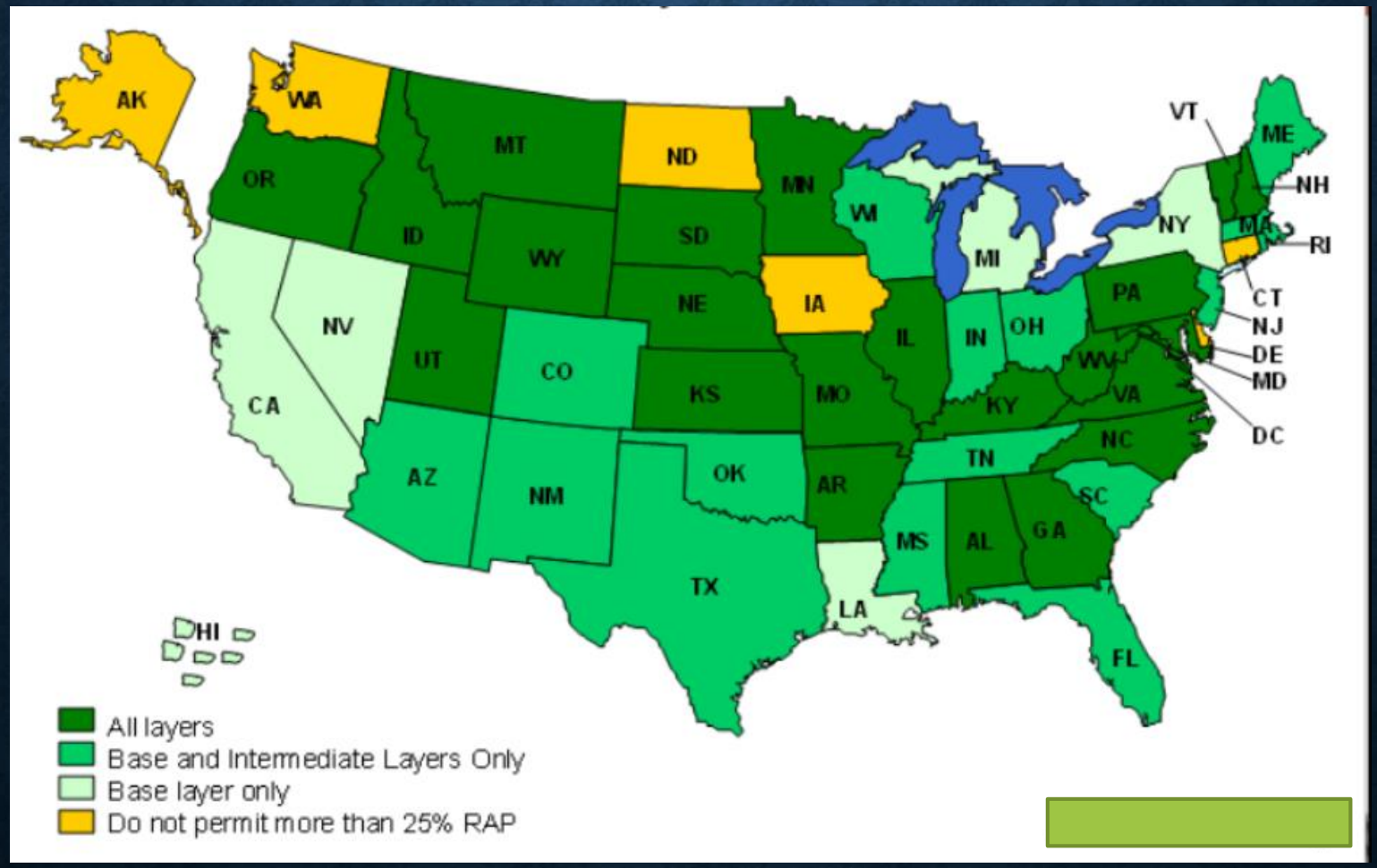
- Less time is needed for production
- Compaction is easier and faster
- The mix can be hauled longer distances

USE OF RAP IN USA

- USA produces @100Mt of RAP annually
  - average of 17% RAP is recycled in HMA
  - 23 States have experience with >25% RAP
  - aim is to increase RAP in all mixes >25%
  - still some perceptions that asphalt with RAP is inferior to all virgin material
- Main driver for using RAP is economics and sustainability has become the new driver
  - NAPA reported that 25% RAP usage neutralises the carbon foot print of a HMA plant

'Trade in your old pavement for a new one'

STATES PERMITTING >25% RAP



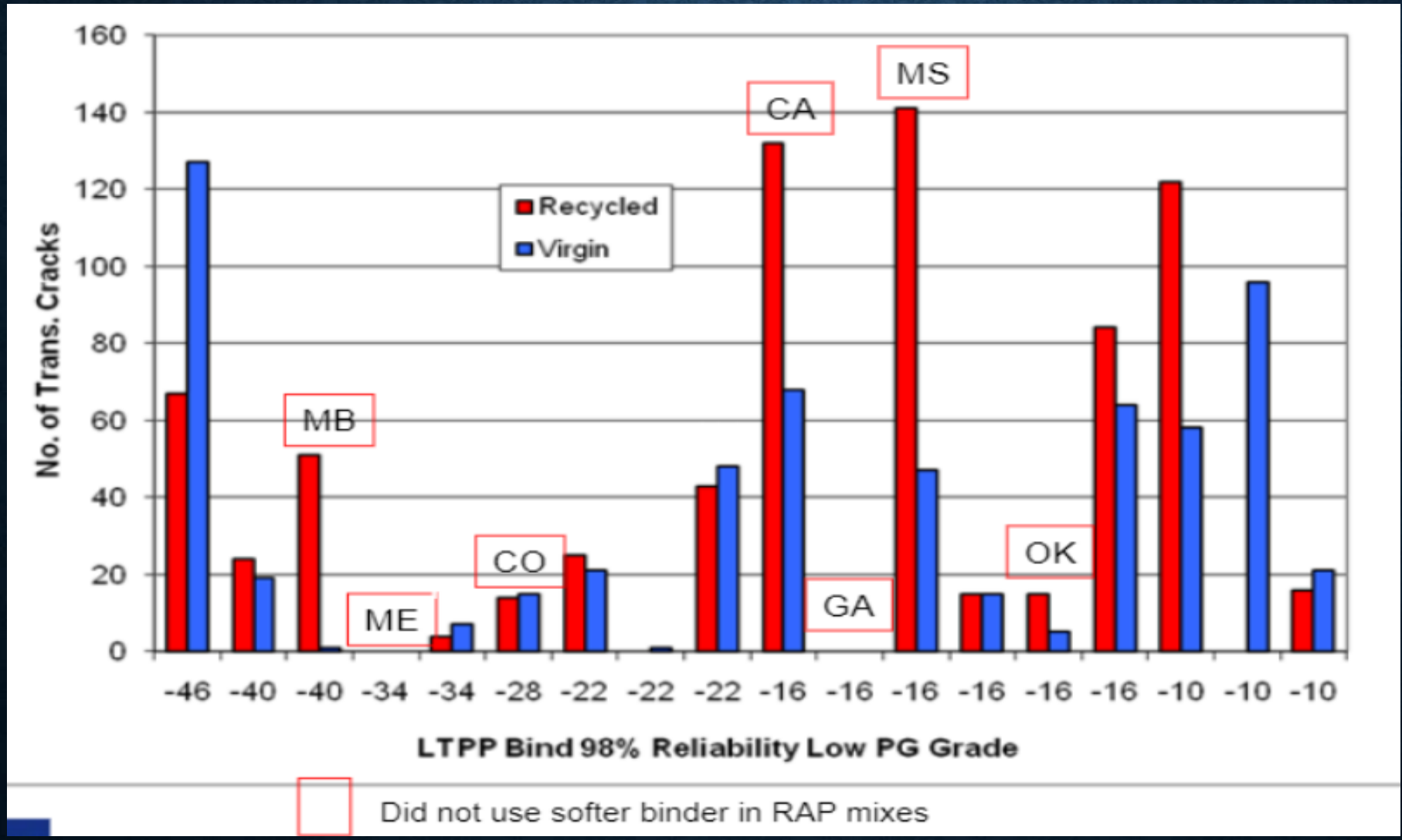
CONCERNS OVER USING >20% RAP

- Concern over **comingled binder properties**
  - Stiffening of binder could lead to early cracking
  - Use of high % RAP may negate the benefit of using PMB's i.e. dilution of the PMB
- **Durability of surface layers** could lead to raveling
- **Variability/consistency** of RAP
  - Lack of QC by contractor
- Meeting **skid resistance** requirements
- Two biggest obstacles in **mix design**:
  - Binder characteristics
  - Percent passing 75µm i.e. excessive fines

WHAT DO CONTRACTORS/DOTS SAY?

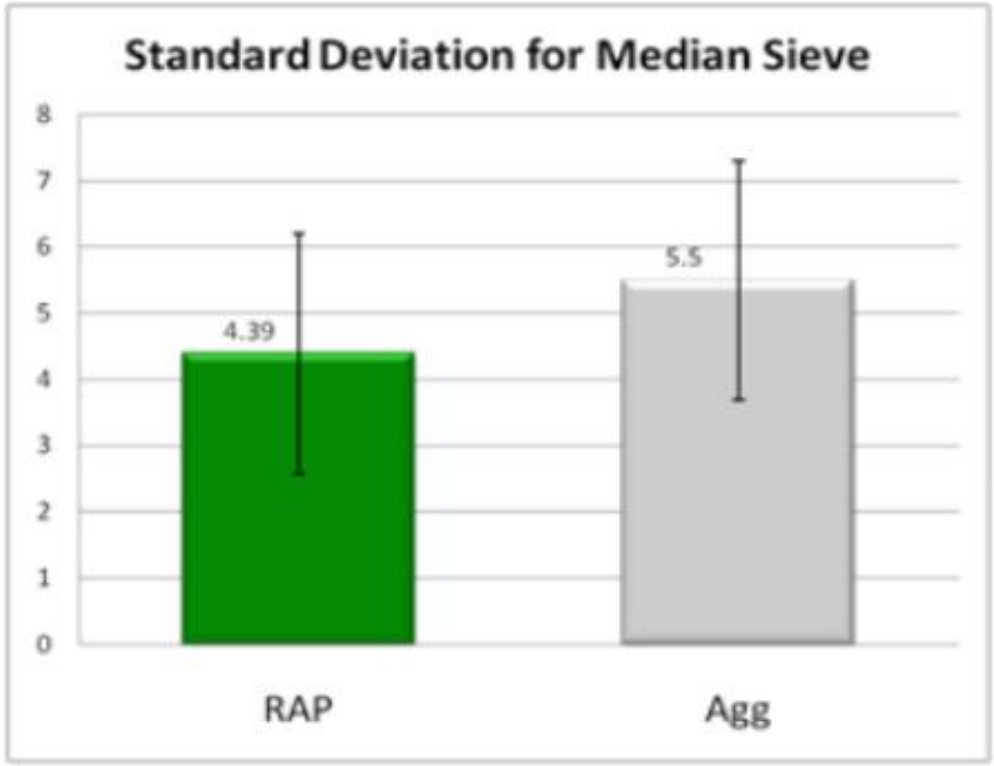
- RAP reduces potential of mix to rut
- Adding RAP stiffens the binder to a higher performance grade
  - Substituting RAP for PMB was found to render similar deformation resistance i.e. rutting performance
- Monitoring on 18 test sections up to 17 years with RAP showed pavements using >30% RAP are performing well
- Up to 40% RAP does not increase CV of HMA
  - In some cases contractors found less variability in RAP than virgin aggregates

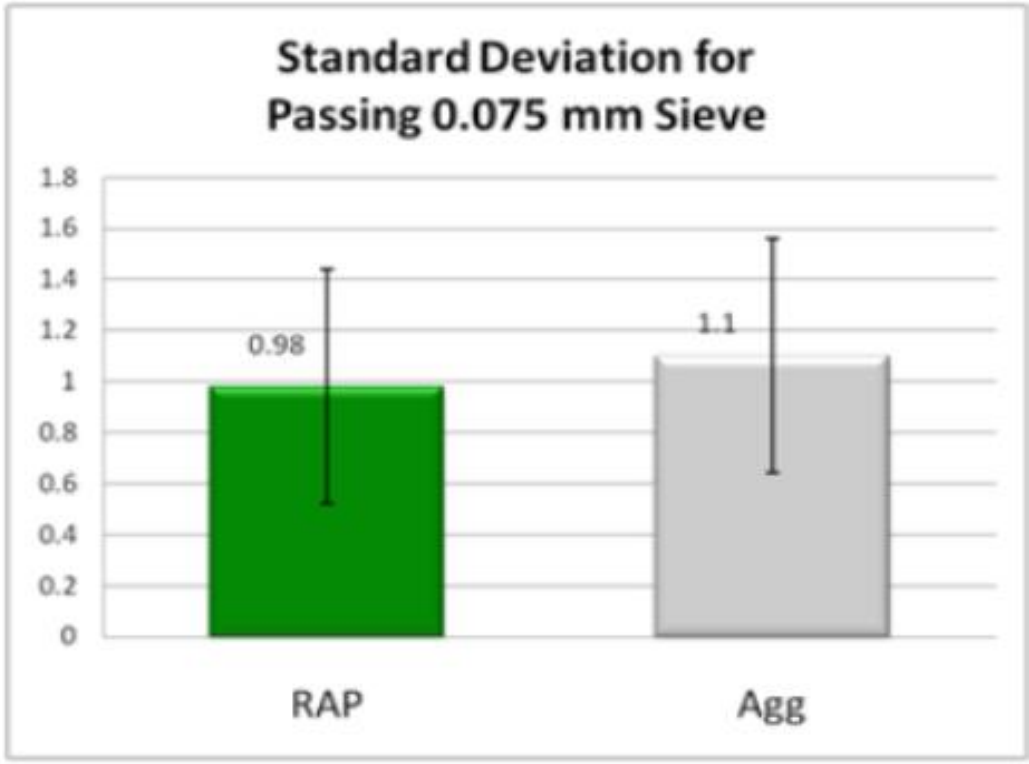
WHAT ABOUT CRACKING?



WHAT ABOUT VARIABILITY?

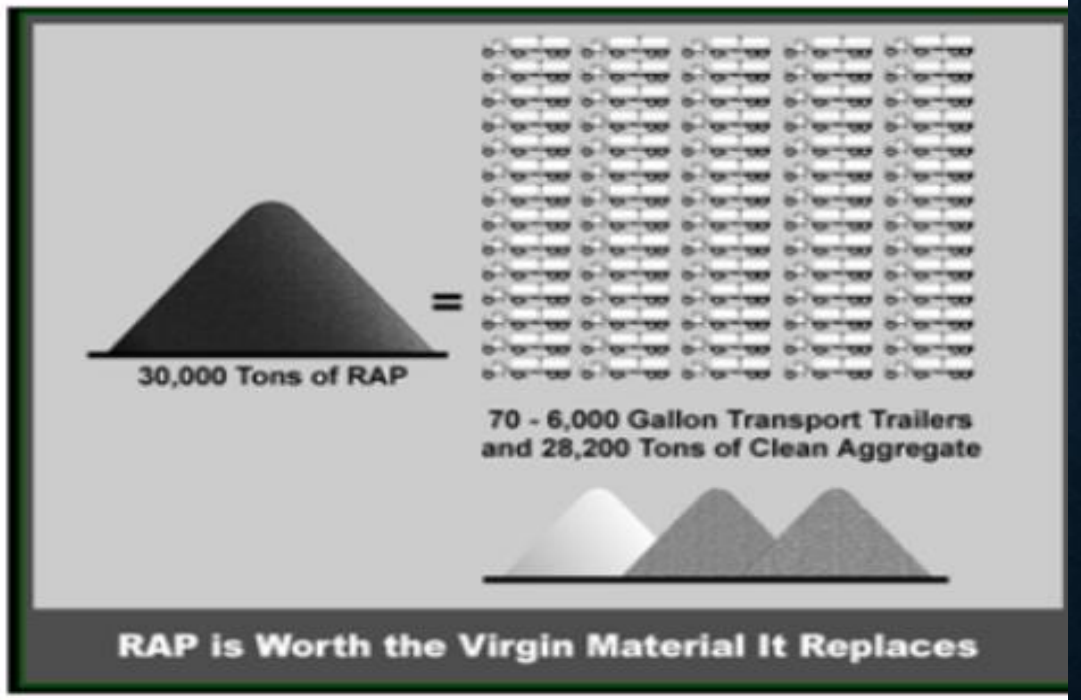
Based on 74 RAP stockpiles in 14 states, and 60 Aggregate stockpiles in 6 states





CONTRACTOR'S POINT OF VIEW

- **Reduction in energy** requirements to heat virgin agg & binders
- Hedge against **rising bitumen prices** & global uncertainty which can effect supply
- Reduces amount of virgin aggs & bitumen which **reduces material costs**



DIFFERENCES IN VARIOUS STATES

- Caltrans
  - Can use up to 15% in WC without additional testing otherwise can increase to 30%
  - No RAP allowed in OGA & BRA
- VDoT
  - < 30% allowed in WC except SMA <20%
  - < 35% in base
- South Carolina
  - non fractionated RAP: <20% in WC & <30% in base
  - Fractionated RAP: <25% in WC
- North Carolina
  - <50% base
  - <30% in WC if RAP screened through 25 mm sieve

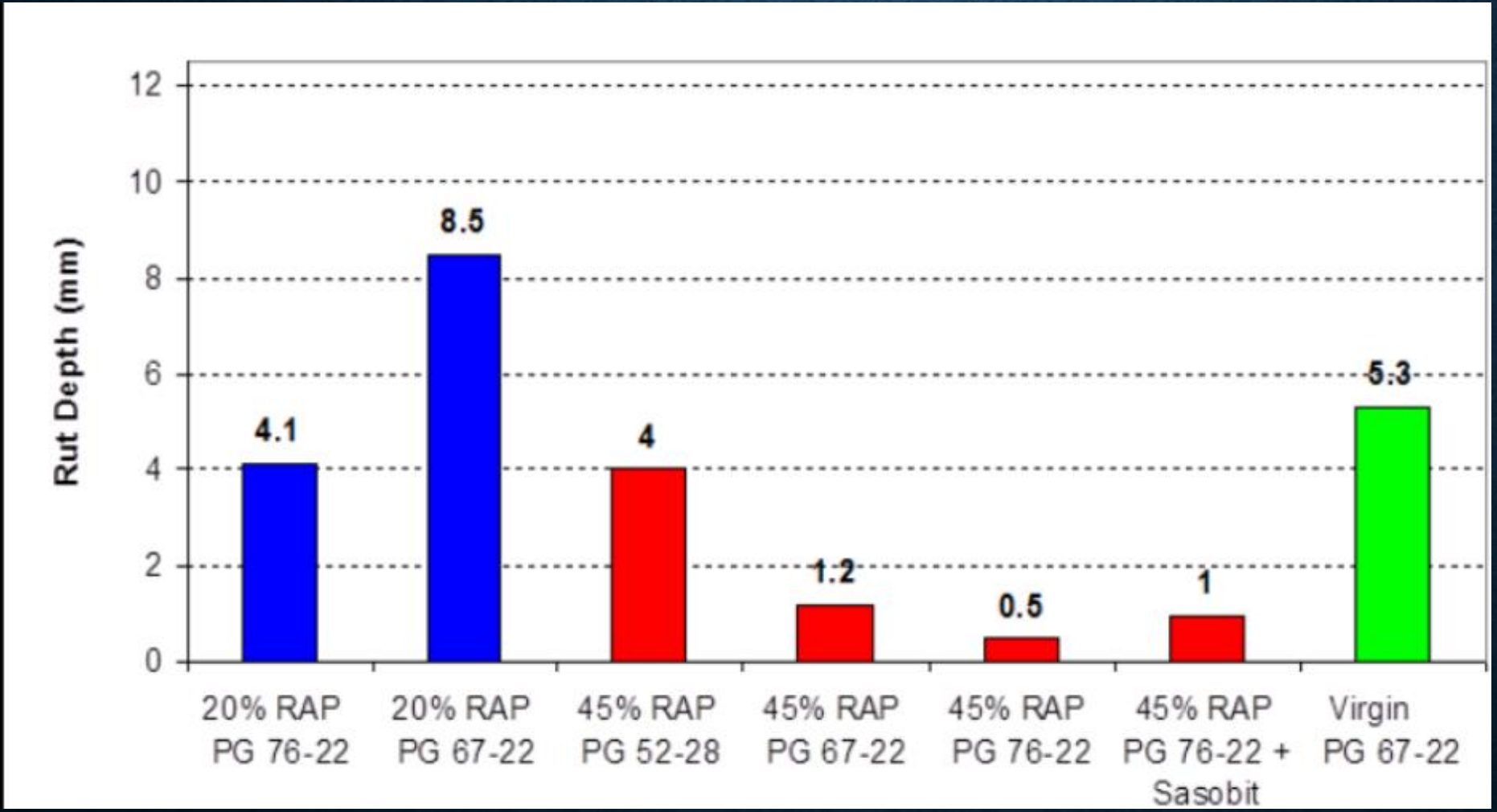
A DIFFERENT APPROACH

- Base maximum % RAP on net effect that RAP binder has on the properties of new mix
- Limiting factor will be determined by:
  - recovered aged binder properties
  - % binder in RAP i.e. 4% vs 7% depending on grading (fine or coarse)
- This means that you can use double the amount of coarse RAP vs fine RAP for same aged binder properties
- Typically 70% of binder must be virgin

GRADE OF THE VIRGIN BINDER?

- FHWA recommendations:
  - <15% RAP: no change in binder grade
  - <15 < 25%: use one binder grade lower i.e. softer
  - >25%: use blending charts
- However studies have shown that:
  - 20% RAP can be used without changing binder grade
  - NCAT test sections indicate that the performance of up to 45% RAP there is no evidence to adopt a lower grade

RUTTING ISSUES?



OTHER ISSUES

- Where skid resistance is a concern use small sized RAP < 7mm
- Reduced mix temperature allows more RAP to be used
- Using higher % RAP in WMA helped increase temperature of bag house
- Aged binder on RAP works as an “anti-stripping” agent & improves TSR values

OTHER OBSERVATIONS

- Consensus was that you could increase the FHWA recommended addition rates of RAP for WMA (by 10%) before changing the binder grade:
  - < 25%: no change
  - >25 < 35%: bump to softer grade
  - > 35%: use blending charts
- Lower mixing temperature resulted in less oxidation & light oil remaining in virgin bitumen
- Steam produced from drying RAP creates inert atmosphere
- Recovered binder from WMA with 25% RAP has the same rheological properties as recovered binder from HMA with virgin bitumen

CONCLUSIONS/RECOMMENDATIONS

- Optimise the use of RAP in asphalt mixes without compromising mix performance
  - Valuable resource
  - Engineered product
  - Reduce demand for non-renewable raw materials

CONCLUSIONS

- Develop guidelines for the inclusion of various % RAP into different application i.e. mixes and layers
  - Procedures for processing & stockpiling RAP
- Developed simplified procedures for evaluating RAP and binder properties for >30% RAP
  - Determine effect of the properties of the aged binder and binder content of RAP on performance of mix specifications e.g. blending charts

THANK YOU