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Presented By Brian D. Prowell - NCAT

Evaluation of Warm Asphalt Technologies

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Why Warm Asphalt?

Research by Stroup-Gardiner and Lange at AU
Indicates increased emissions with increased temp.

Why Warm Asphalt?

- Reduce production and laydown temperatures
- Reduce emissions
- Reduce energy costs
- Reduce aging of binder
- Other Possible Benefits:
  - Cool weather paving (extend season)
  - Compaction aid for stiff mixes

What are Warm Asphalt Mixes?

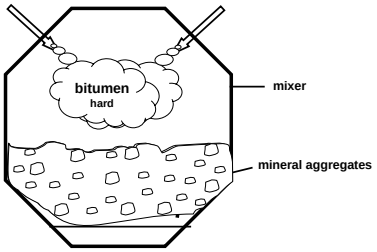
Several process have been developed to improve mixture workability allowing lower production and laydown temperatures

- WAM Foam – Shell/Kolo Veidekke
- Zeolite – Eurovia/Hubbard Construction
- Sasobit – Sasol Int./Moore and Munger

WAM-Foam

- Two Phase addition of asphalt
  - Aggregate coated with “soft” asphalt
  - Hard asphalt foamed to mix with pre-coated aggregate
  - Soft asphalt controls minimum placement temperature
  - Material placed as low as 80 C (176 F), 50 – 60 C (90 – 108 F) reduction
  - Requires plant modification for foaming, estimated at $50,000 - $70,000. No additional costs thereafter
  - Special asphalt feeds may be required

Two phase bitumen mixing method



Courtesy IFTA GmbH

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WAM Foam Installation in Hot Mix Asphalt Plant

Courtesy of Shell/Kolo Veidekke

Comparison of Visible Emissions

Courtesy of Shell/Kolo Veidekke

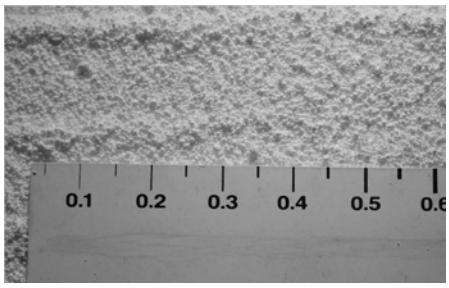
Zeolite

- Zeolites are crystalline hydrated aluminium silicates
- aspha-min®, is a special Zeolite added to the hot mix asphalt in the temperature range of 100 to 200 °C (212 to 392 °F)
- When the Zeolite is heated, it gives up its internal moisture, approximately 21% by weight, microscopically foaming the asphalt

Addition of aspha-min®

- Aspha-min is typically added at an addition rate of 0.3% by weight of mix
- Expected to increase mix cost by approximately $1.50 per ton
- Can be added to the mineral filler or fed separately
- Batch plants are more commonly used than drum plants in Europe
- Aspha-min has been added through the RAP collar into drum plants in France and using special feeder in U.S.

Granulated aspha-min®



Manual Addition

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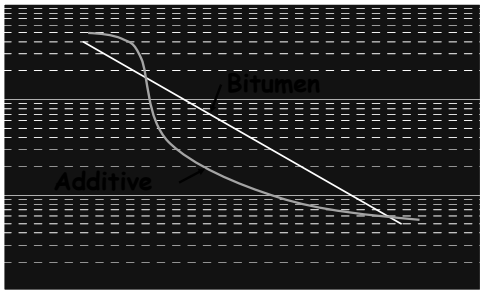
Weigh Bucket for aspha-min

Organic Additives

- Synthetic Fischer-Tropsch paraffin waxes – Sasobit
  - Added to binder
  - Can incorporate an SBS modifier (Sasoflex)
  - Does not require high-shear blending
  - May negatively impact low temperature properties
- Low molecular weight ester compounds (not included in the study at this time)

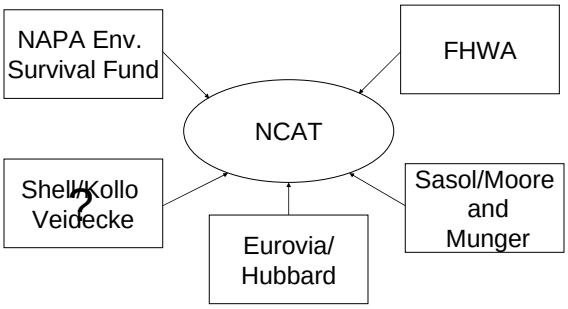
How organic additives work



Organic additives C/O Dr. Els

Sasobit

Project Partners



Study Objectives

- Evaluate Warm Asphalt Technologies for U.S. Paving Practices
  - High production
  - Rapid Turn-over to traffic
- Potential Concerns
  - "Curing" Time
  - Increased Potential for Moisture Damage
  - Binder effects

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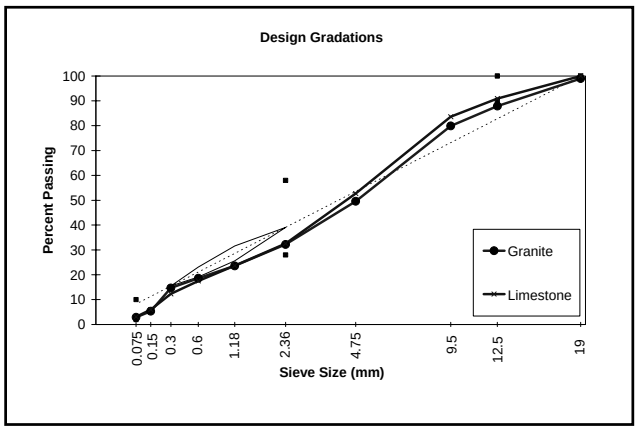
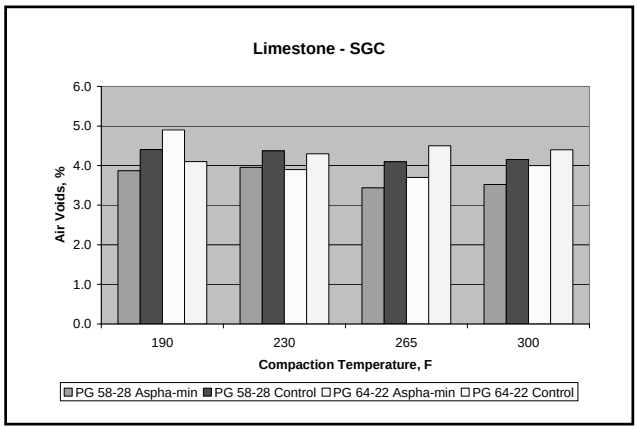
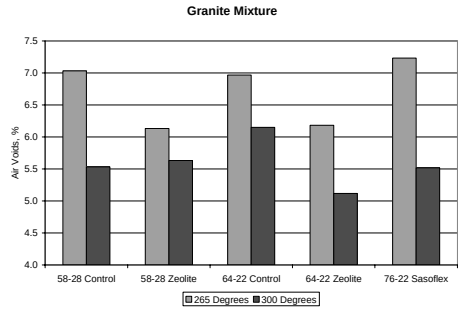


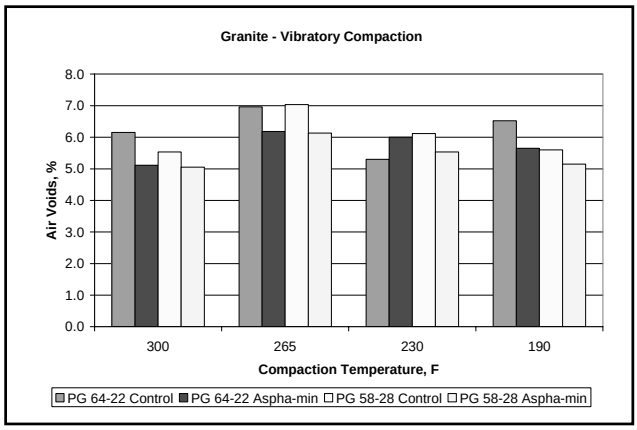
How Do You Measure Compaction in Lab?

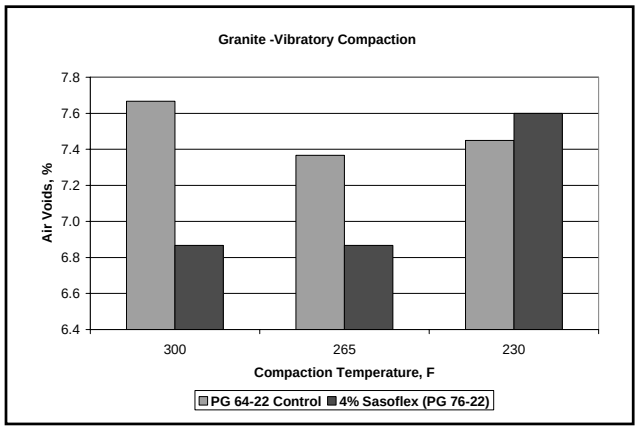
- Superpave gyratory compactor is not sensitive to reduced temperature – control mix produces the same voids
- Field Compaction, Marshall and Vibratory (PTI) Compaction sensitive to temperature/workability changes



Laboratory Testing for Reduced Compaction Temperature - AVC







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Summary of Laboratory Compaction

- Aspha-min improved compaction with both the SGC and vibratory compactor
  - Statistics indicated an average reduction of 0.65% air voids
  - Improvement seen as low as 190 F
- Sasoflex PG 76-22 indicated improved compaction over PG 64-22 down to 265 F
- Warm asphalt additive may reduce design asphalt content

German Autobahn Paving

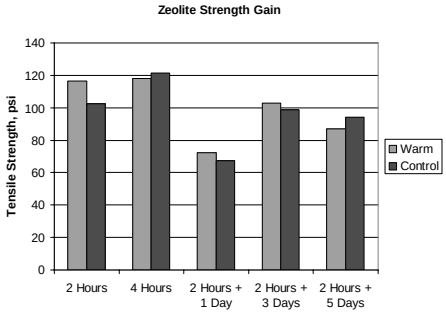
Cure Time – Early Concern

- In some cases, Europeans allow pavement to "cure" before allowing traffic on roadway
- Germans specify a minimum of 24 hours for SMA
- When does Warm asphalt's workability end?
- Will pavements rut if traffic allowed on an hour or so after placement?

European Cure Time Experience

- Sasobit being used for repaving Frankfurt Airport.
  - Placing 24 inches of HMA in 7.5 hour window (approx. 1,500 tons)
  - Opening to jet aircraft at 85 C (185 F)
- WAM Foam Paving SMA on ring road around Oslo Norway – Night work opened for rush hour traffic

Strength Gain Experiment



Resilient Modulus

Would the use of Warm Asphalt effect pavement thickness design?

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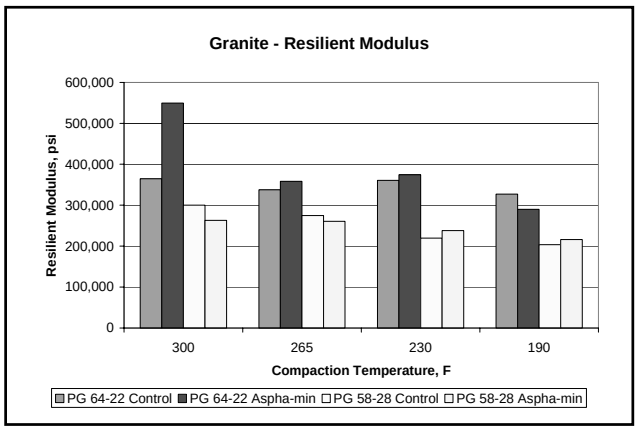
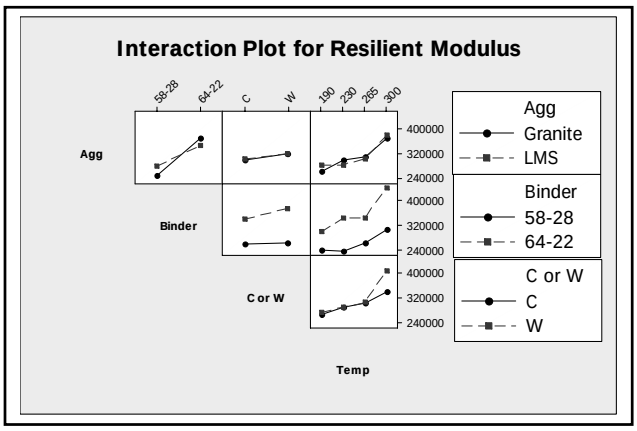
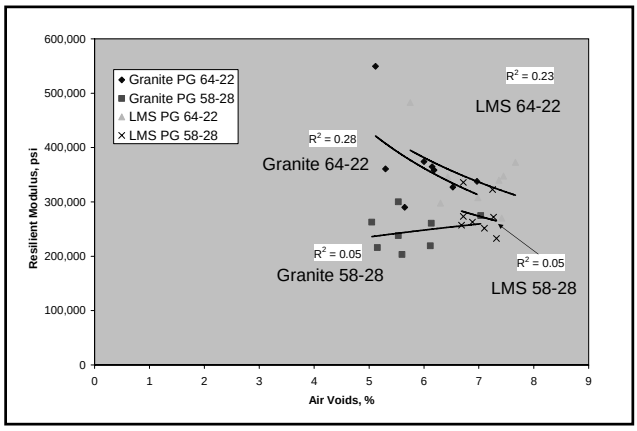
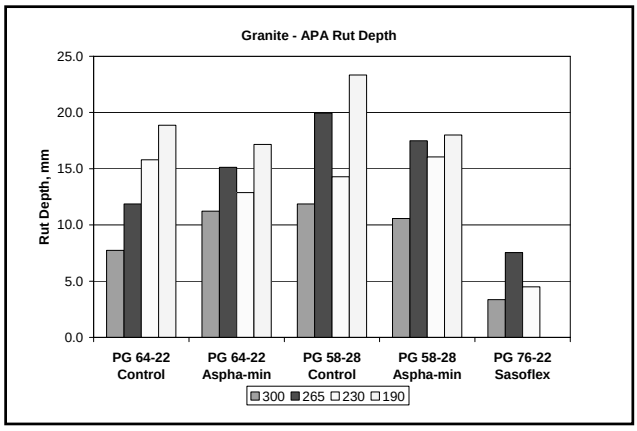
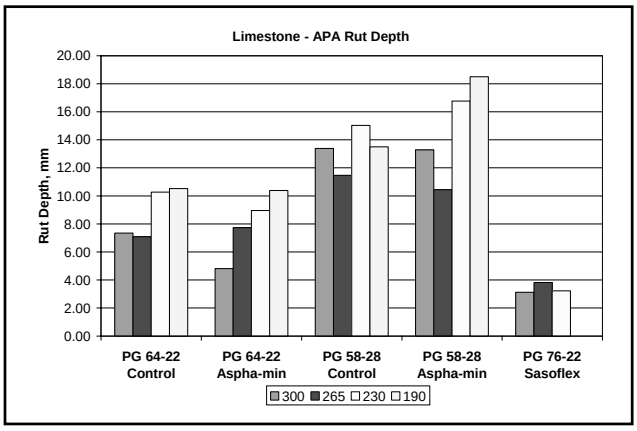






APA Rut Testing





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Summary of Stiffness and Permanent Deformation

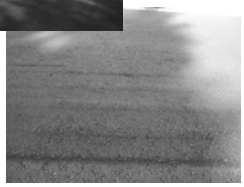
- No evidence of required "cure time" based on indirect tensile strength after various aging periods
- Statistical Analysis indicated that the inclusion of zeolite did not effect modulus or APA rut depth
  - Decreased temperature did decrease modulus and increase rut depth. This may be related to decreased aging of the binder
  - Higher density generally resulted in higher modulus

Aspha-min Field Sections

- Paving project in Germany – Fall 2003
- Orlando Paving Company – First U.S. trial February 2004
- World of Asphalt – March 2004
- Charlotte, NC – Blythe Construction – September 2004

Laydown of Polymer Modified Warm Asphalt with Zeolite at 250 F

94% Gmm
55 F Air Temp.



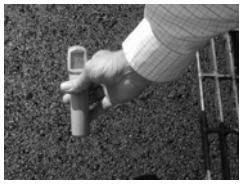
4 passes of Rubber Tire,

followed by 4 vibratory passes, followed by static finish roller

U.S. Drum Plant Addition

Seeing is Believing!

Hot Mix 314 F



138.1 pcf

Warm Mix 254 F

138.5 pcf

Summary

- Three warm asphalt processes used in Europe for up to 5 years
- Allows compaction at lower temperatures
- Concerns about U.S. production rates and turn over to traffic – initial results very promising (no problem)
- A Tool for the Tool Box!

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