Laboratory Evaluation: Wax Additives in Warm-Mix Asphalt Binder

ETG WARM MIX TASK GROUP:
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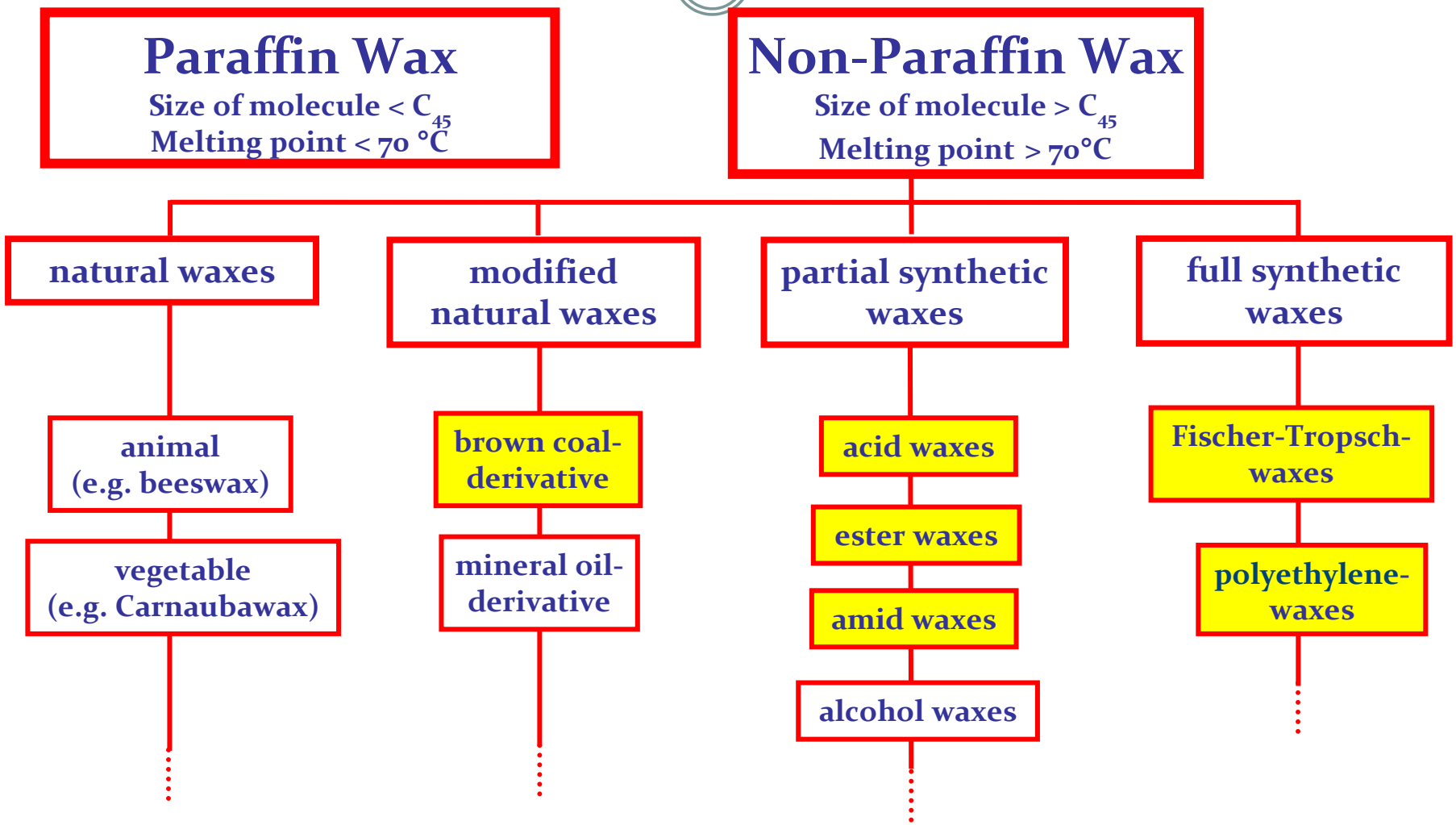
Objective

Evaluate the effect of wax additives on physical properties and characteristics of asphalt binders and their subsequent performance in mixtures.

Materials

- Asphalt – One (1)
  - Lion Oil PG64-22 Eldorado, AR Refinery (Saudi)
- Wax Additives – Nine (9)
  - Non-Paraffin Wax Additives
- Aggregates
  - Vulcan Barin Quarry Granite, Columbus, GA (Aggregate used on the NCAT Test Track)
- Mix Design
  - 12.5mm Dense Graded SuperPave™ Gyratory
    - ~5.5% Binder
    - ~7.0% Air Voids

Paraffin and Non-Paraffin Waxes



Selected Additives

- Paraffin Waxes:
  - Microcrystalline
    - Astra 3816 Refined Paraffin
- Non-Paraffin Waxes:
  - Modified Natural
    - Romonta Normal - Montan
    - Romonta Asphaltan A
    - Romonta Asphaltan B
  - Partial Synthetic
    - Clariant Licomont BS100 – N,N'-ethylenebisstearamide
    - Luxco Pitch – stearic acid pitch
    - Ester Wax - TBD
  - Synthetic
    - Sasobit – Fischer-Tropsch
    - Allied - Polyethylene

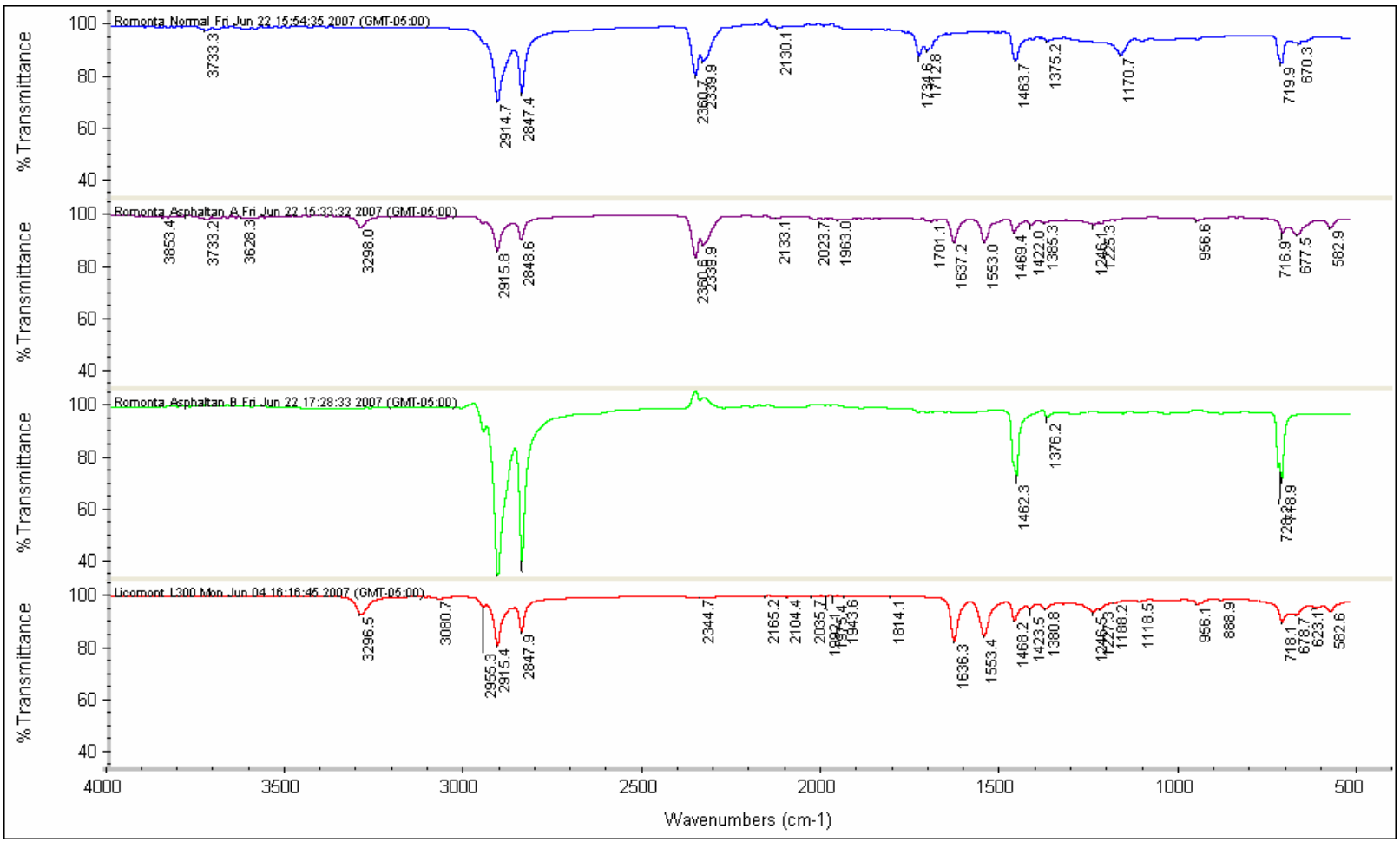
Experimental

- Proposed Testing Completed Cooperatively
  - Paragon Technical Services, Inc. (PTSi)
  - Mathy Technology and Engineering, Inc. (MTE)
  - Anderson Asphalt (Dr. Dave Anderson)
  - Western Research Institute (WRI)
  - Lousiana State University (LSU)
  - Federal Highways (FHWA)
  - Kraton Polymers (KP)

Experimental – Additive Testing

- Fourier Transform Infra-Red Spectroscopy (FTIR) – WRI
- Gel Permeation Chromatography (GPC) – WRI/PTSi/KP
  - High Temp GPC – KP
- Glass Transition (Tg)
  - Modulated Differential Scanning Calirimetry (MDSC) – WRI/MTE
- Branching
  - Nuclear Magnetic Resonance (NMR) – WRI
  - Atomic Force Microscopy (AFM) - WRI
  - Mass Spectroscopy (MS) – WRI
  - X-Ray - LSU

Fourier Transform Infra-Red Spectroscopy (FTIR)



Experimental – Binder Testing

- Ten (10) Binders (Control PG64-22 and Nine (9) Wax Modified Binders

Note: Testing other than Tribo-Rheometry and Binder True Grade to be Performed on PAV Aged Binders

- Master Curve Development (DSR) – PTSi
- SuperPave™ True Grade (Through DTT) – PTSi
- Tribo-Rheometry – PTSi/MTE
- Physical Hardening (32 days saturation at -12°C) Bending Beam Rheometry (BBR) - PTSi
- Testing at 1,2,4,8,16 and 32 Days Concurrent with Binder
- Multi-Step Creep Recovery (MSCR) – FHWA
- Binder Stress Sweep Fatigue (Bahia UW Method) – PTSi/MTE

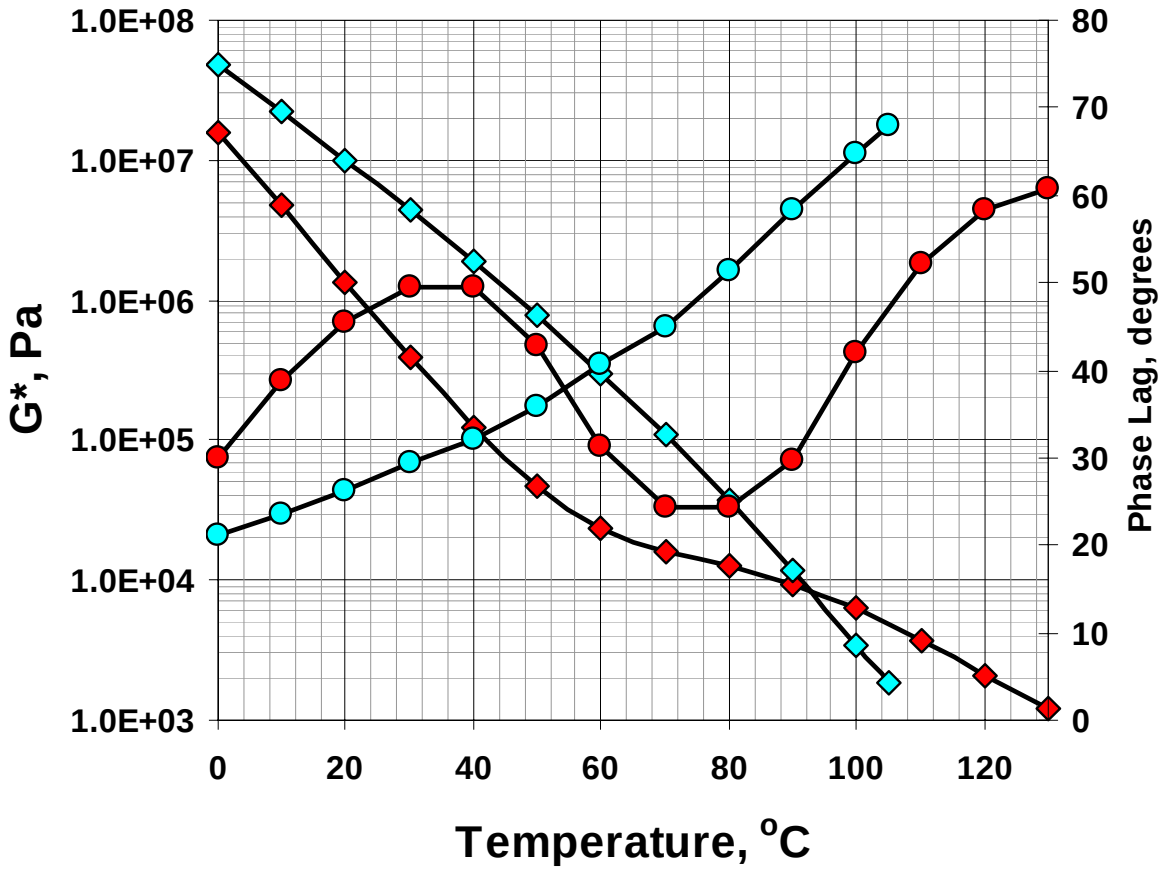
Experimental – Binder Testing (Contd.)

- Ten (10) Binders (Control PG64-22 and Nine (9) Wax Modified Binders

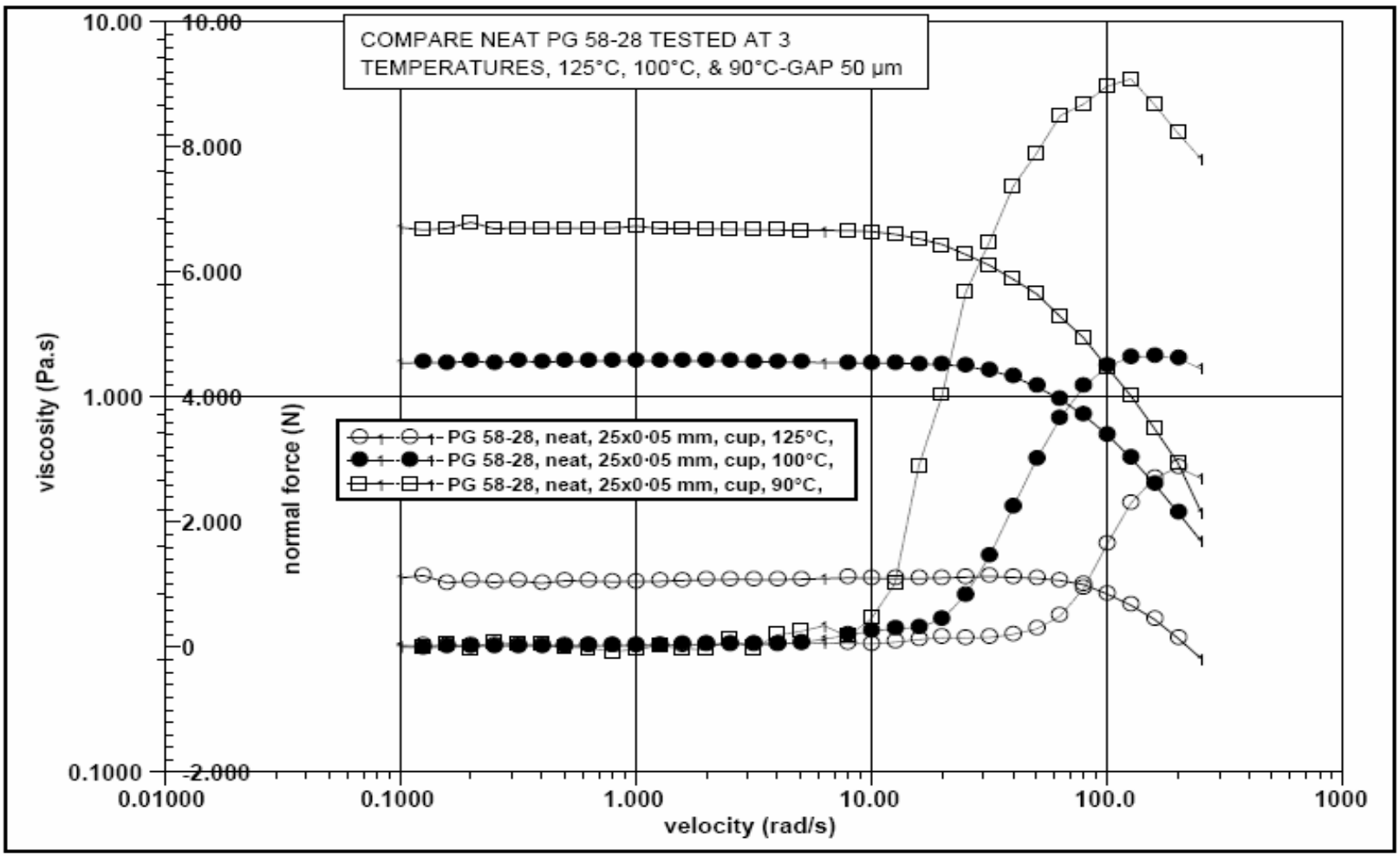
Note: Testing other than Tribo-Rheometry and Binder True Grade to be Performed on PAV Aged Binders

- Glass Transition Tg
- Modulated DSC (MDSC) – WRI/MTE/Anderson Asphalt
- Dilatometric Analysis - Anderson Asphalt
- Fracture Testing – Anderson Asphalt
- Atomic Force Microscopy (AFM) - WRI
- Solid State NMR –(WRI
- X-Ray – LSU
- High Pressure Liquid Chromatography/Gel Permeation Chromatography/Mass Spectroscopy – (HPLC/GPC/MS) – WRI/LSU

Master Curve Development



Tribo-Rheometry



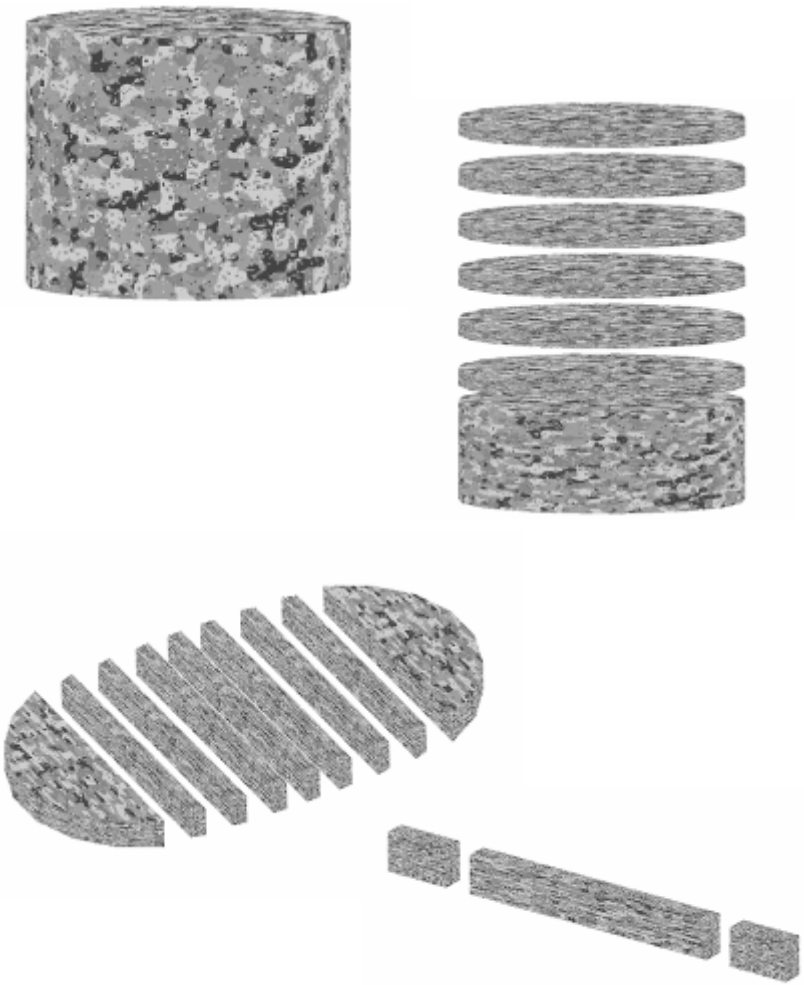
Experimental – Mixture Testing

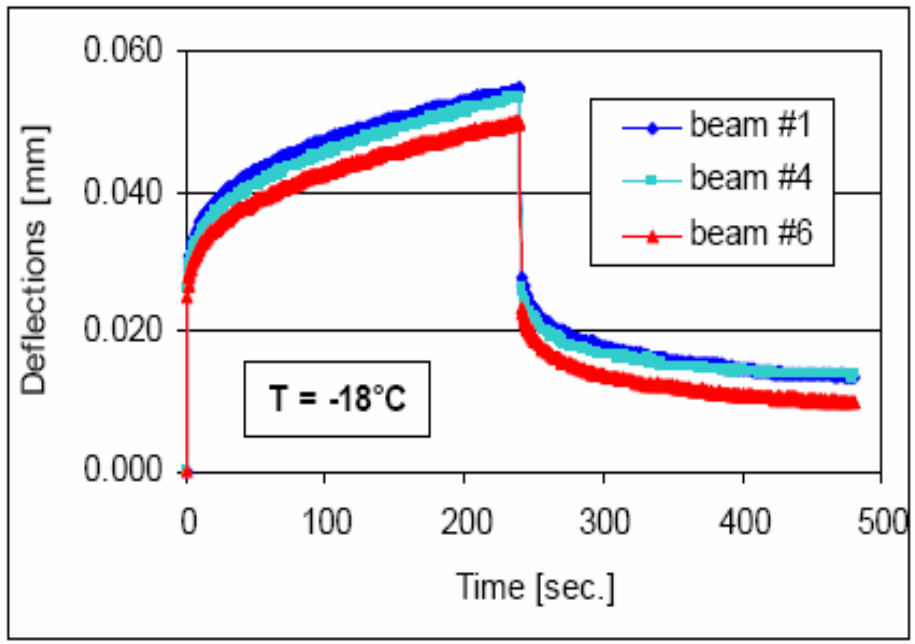
- Ten (10) Mixtures (Control and Nine (9) Modified)

  Dense Graded SuperPave™ Gyratory Specimens

- Physical Hardening (32 days saturation at -12°C) Bending Beam Rheometry (Marasteanu UM Method)(BBR) - PTSi
  - Testing at 1,2,4,8,16 and 32 Days Concurrent with Binder
- Sand Cylinder Fatigue (SCF) – MTE
- Glass Transition (Tg) (MTE Method) – MTE
- Fracture Testing – Anderson Asphalt

Physical Hardening - BBR





Questions?