DEVELOPMENT AND PERFORMANCE EVALUATION OF FUEL RESISTANT POLYMER MODIFIED ASPHALT

2017 NEC / AAAE Airports Conference
March 28, 2017
Hershey, PA

Ronald Corun
Specialty Products Manager
Associated Asphalt Partners, LLC

Background

- Airports experience fuel and hydraulic oil spills on aprons and taxiways
  - Fueling operations
  - Aircraft sitting in queues
  - Softens (weakens) asphalt
  - Causes permanent deformations and failures

Fuel Resistant Pavement Sealers

- Coal tar sealers are most commonly used to protect Hot Mix Asphalt pavements from fuel damage
- Different coefficient of expansion for coal tar causes substantial alligator cracking within 2-3 years
- Cracking allows fuel penetration - short service life

Fuel Resistant Pavement Sealers

- Coal tar sealers are carcinogenic
  - <u>MSDS – "Unusual Chronic Toxicity:</u> May cause cancer of the skin, lungs, kidney and bladder."
  - Adding carcinogenic material to pavement that may be recycled – future exposure
- Austin, TX and United States Geological Survey Report
  - 90% of PAHs in waterways may come from runoff from coal tar sealed pavements
  - Austin outlawed use
- Coal Tar sealers are also outlawed in California

Coal Tar Sealers

Article

PAHs Underfoot: Contaminated Dust from Coal-Tar Sealcoated Pavement Is Widespread in the United States

Peter C. Van Metre*, Barbara J. Mahler and Jennifer T. Wilson
U.S. Geological Survey, Austin, Texas

Environ. Sci. Technol., Article ASAP
Publication Date (Web): November 19, 2008
Copyright This article not subject to U.S. Copyright. Published 2008 by the American Chemical Society

Abstract

We reported in 2005 that runoff from parking lots treated with coal-tar-based sealcoat was a major source of polycyclic aromatic hydrocarbons (PAHs) to streams in Austin, Texas. Here we present new data from nine U.S. cities that show nationwide patterns in concentrations of PAHs associated with sealcoat. Dust was swept from parking lots in six cities in the central and eastern U.S., where coal-tar-based sealcoat dominates use, and three cities in the western U.S., where asphalt-based sealcoat dominates use. For six central and eastern cities, median ΣPAH concentrations in dust from sealcoated and unsealcoated pavement are 2200 and 27 mg/kg, respectively. For three western cities, median ΣPAH concentrations in dust from sealcoated and unsealcoated pavement are similar and very low (2.1 and 0.8 mg/kg, respectively). Lakes in the central and eastern cities where pavement was sampled have bottom sediments with higher PAH concentrations than do those in the western cities relative to degree of urbanization. Bottom-sediment PAH assemblages are similar to those of sealcoated pavement dust regionally, implicating coal-tar-based sealcoat as a PAH source to the central and eastern lakes. Concentrations of benzo[a]pyrene in dust from coal-tar sealcoated pavement and adjacent soils greatly exceed generic soil screening levels, suggesting that research on human-health risk is warranted.

View: Full Text HTML | Hi-Res PDF | PDF w/ Links

Development of Fuel-Resistant PMA

- Kuala Lumpur Airport specified jet fuel resistant asphalt pavements for new construction in 1995
- Objective – add fuel resistance to SBS modified asphalt without sacrificing performance
- Contains no Coal Tar

Development of Fuel-Resistant PMA

- Specifications required compacted mix samples to be immersed in jet fuel for 24 hours.
- Average weight loss of 4 Marshall specimens must be less than 2.0%

Development of Fuel-Resistant PMA

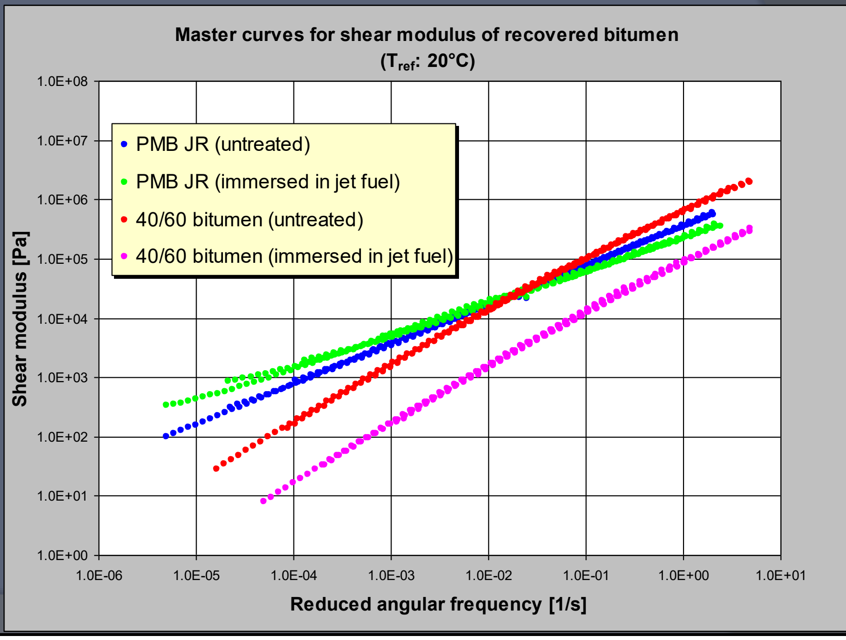
- Standard Hot Mix Asphalt mixture loses 10% weight from 24 hour soak in jet fuel
- Standard Polymer Modified Asphalt (PG 76-22) loses 4.5% weight after 24 soak in jet fuel
- Fuel Resistant PMA – ≈1.0% weight loss

Asphalt Binder Testing

- Compared original asphalt with asphalt submersed in jet fuel
  - Recovered asphalt soaked in jet fuel for 3 hours and dried for 5 days
- Compared unmodified 40/60 pen asphalt (PG 70-22) with PMA PG 76-22 and fuel resistant PMA

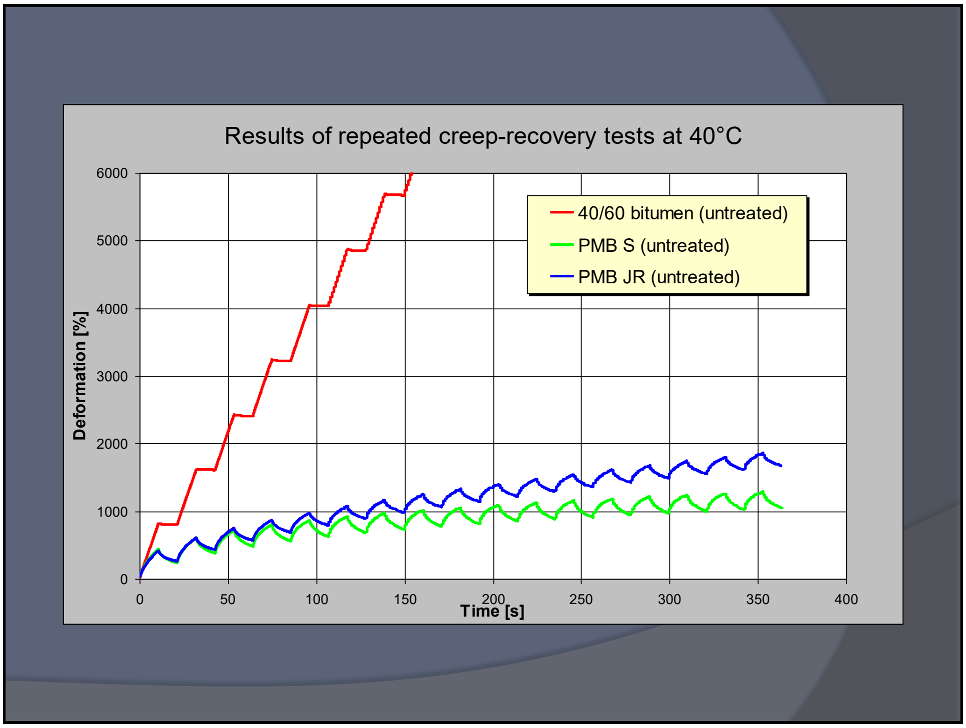
Asphalt Binder Testing

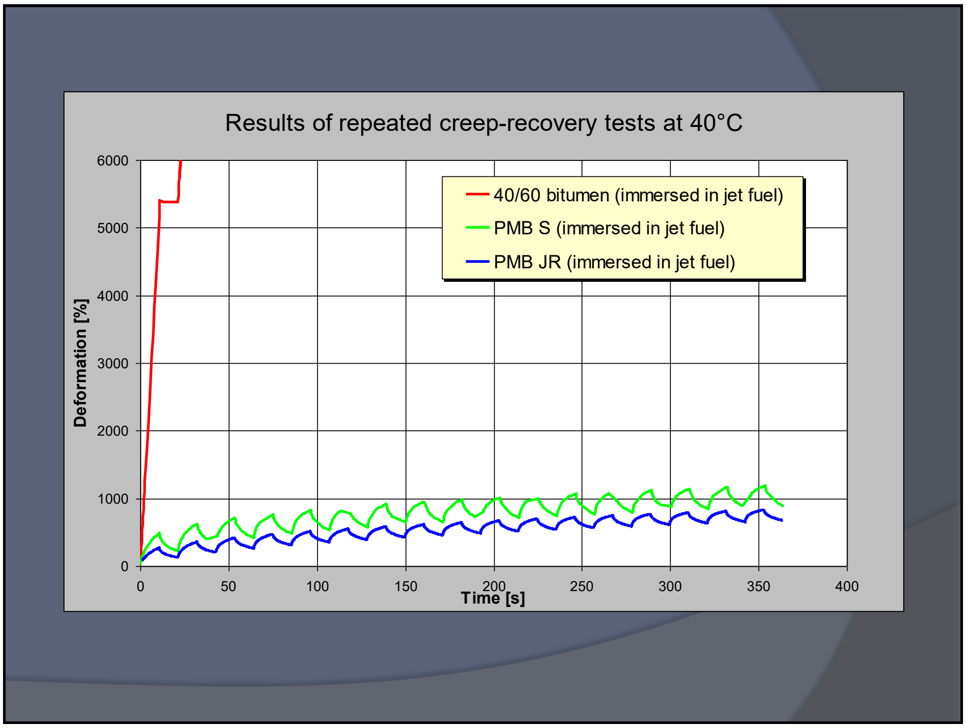
- Complex Shear Modulus (G*)
  - Measure of asphalt strength
  - Mastercurve shows effect of loading frequency
    - Low frequency – long loading times
    - High frequency – short loading times



Asphalt Binder Testing

- Repeated Creep-Recovery Test
  - Measures benefits of elastomer
  - Apply 10 kPa load for 11 seconds, followed by 11 second recovery period
  - 17 Creep-Recovery cycles were applied at 40˚C
  - Deformation was continuously recorded


Results of repeated creep-recovery tests at 40°C
40/60 bitumen (untreated)
PMB S (untreated)
PMB JR (untreated)
Deformation [%]
Time [s]
0
1000
2000
3000
4000
5000
6000
0
50
100
150
200
250
300
350
400


Results of repeated creep-recovery tests at 40°C
40/60 bitumen (immersed in jet fuel)
PMB S (immersed in jet fuel)
PMB JR (immersed in jet fuel)
Deformation [%]
Time [s]
0
1000
2000
3000
4000
5000
6000
0
50
100
150
200
250
300
350
400

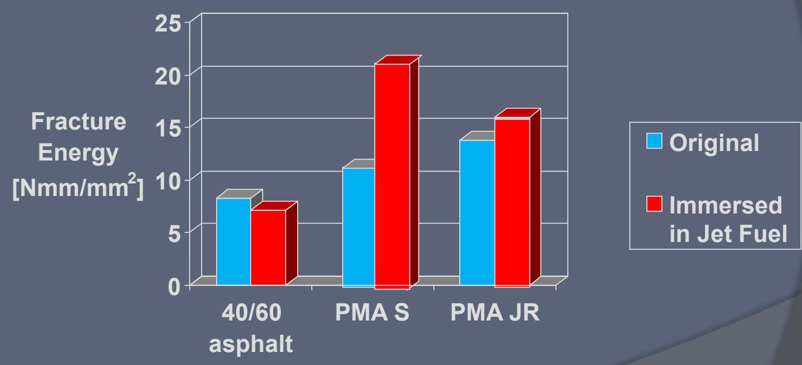
Laboratory Testing - Mixture

- Compared original hot mix asphalt (HMA) with mix submersed in jet fuel
- Compared unmodified PG 70-22 with PMA PG 76-22 and fuel resistant PMA
- Tested resistance to rutting and cracking

Laboratory Testing - Mixture

- Tested resistance of mixture to cracking with indirect tensile strength test
- Test temperature 0˚C
- Deformation rate of 0.85 mm/sec
- High fracture energy is desired to prevent cracking

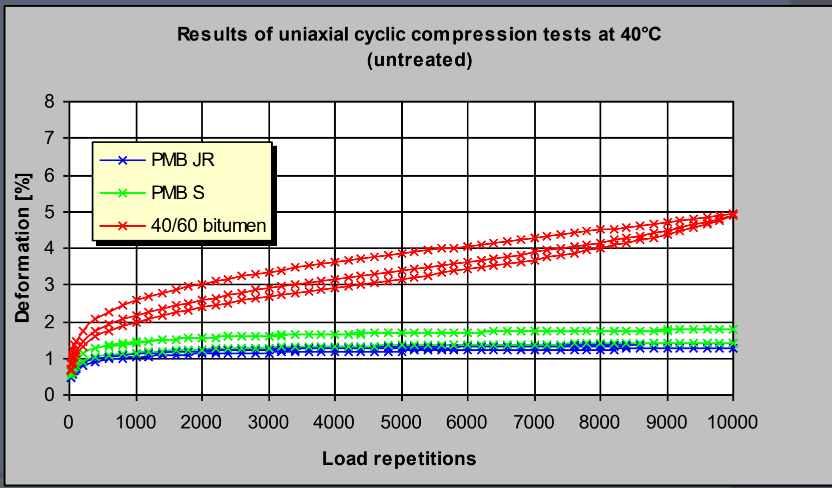
Indirect Tensile Strength Test



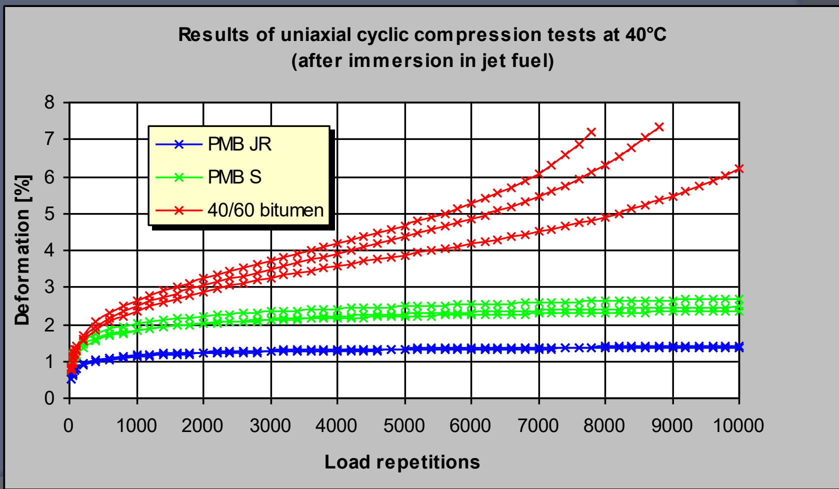
Laboratory Testing - Mixture

- Tested resistance of mixture to permanent deformation with uniaxial cyclic compression test
  - Test temperature 40˚C (60˚C for St Maarten)
  - 0.4 MPa load applied for 0.3 seconds
  - Rest period 0.7 seconds
  - Test stopped at 10,000 cycles or 7% permanent deformation

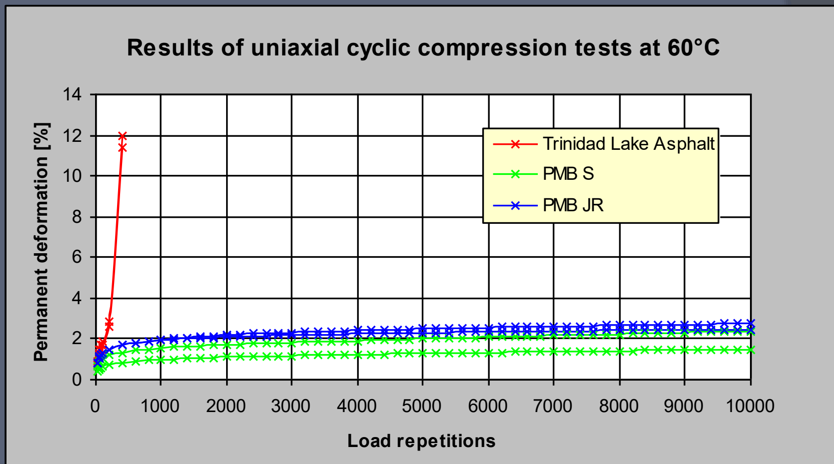
Uniaxial Cyclic Compression Test



Uniaxial Cyclic Compression Test



Uniaxial Cyclic Compression Test – St Maarten Airport



First Fuel-Resistant PMA Usage - Kuala Lumpur International Airport

Kuala Lumpur International Airport

- Constructed between 1996 and 1998
- 450mm cement treated base
- 100mm HMA base – conventional asphalt
- 150mm HMA base and surface containing jet fuel resistant PMA
  - 260,000 tons HMA

Fuel-Resistant PMA Usage

- Fuel-Resistant PMA Airport Projects Around the World
  - Cairo, Egypt Airport – Reconstruction of main runway – 1997 (220,000 tons)
  - Aden, Yemen Airport – Reconstruction of main runway – 1999-2000 (40,000 tons)
  - St Maarten Airport – Reconstruction of apron – 2001 (12,000 tons)
- All projects report excellent performance to date

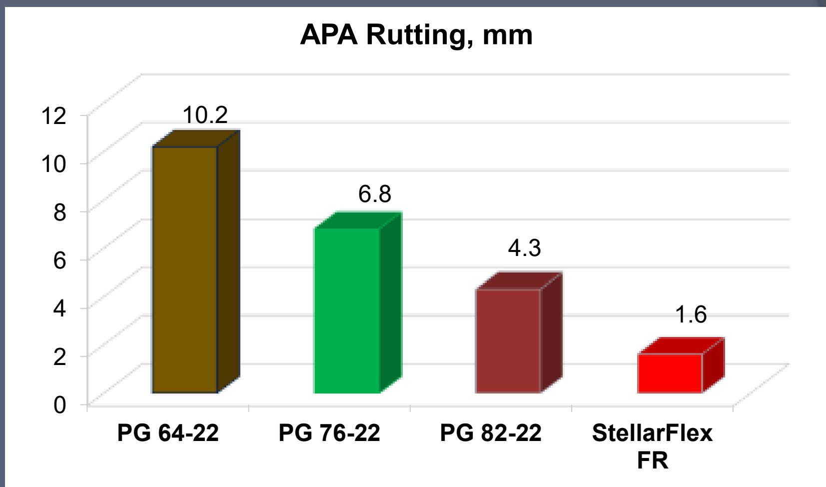
Fuel-Resistant PMA Usage

- Fuel-Resistant PMA Technology Brought to US Market in 2002
- First Construction Project in US – La Guardia Airport
  - Test section on taxiway – 450 tons

Asphalt Pavement Analyzer (APA) - Rutting Evaluation of HMA

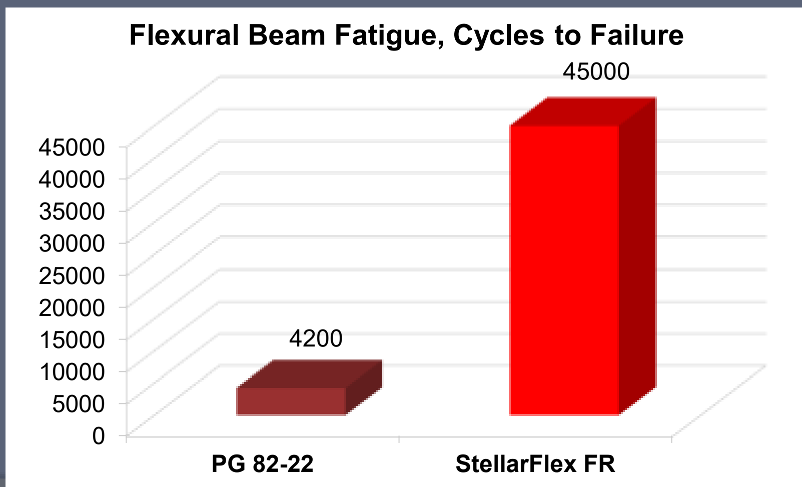
- Moving wheel load (100 lbs.) applied to a pressurized hose (100 psi) which lies on top of asphalt samples
- Tested at 64°C for 8,000 loading cycles
- Computer data acquisition system

Fuel Resistant PMA – Rut Resistance



Flexural Beam Fatigue Device

Fuel Resistant PMA – Crack Resistance



Fuel-Resistant PMA Usage – La Guardia

- Placed Fuel-Resistant PMA at La Guardia Airport August 2002
- Graded as PG 94-22
- Pumped into plant at 330°F
- Produced mix at 340°F
- Placed in silo for 4 hours

Fuel-Resistant PMA Usage – La Guardia

- Paved at 330°F
- No problems with placement
- Handwork and longitudinal joints look good
- Density achieved
- Paving crew could not see a difference in Fuel-Resistant PMA material from standard PMA

Fuel-Resistant PMA Usage – La Guardia

- Inspected fuel resistant pavement in October 2003
- Excellent condition
  - No rutting
  - No cracking
  - No surface deterioration

Fuel Resistant Mix Design

- At major airports, coarse mixes used to prevent rutting
  - Low AC %
  - Prone to segregate
  - Durability
- Recommend 2" surface containing fuel resistant PMA to provide fuel resistance to entire pavement structure
  - Use ½" P-401 mix
  - Design at 2.5% air voids

Fuel Resistant Specification

- Developed generic specification for fuel resistant HMA
  - Minimum PG 82-22 polymer modified asphalt
    - Pass fuel resistance test
    - Minimum 85% Elastic Recovery
  - Standard test method for fuel resistance
  - ½" P-401 mix
    - 50 blow Marshall design
    - Design at 2.5% air voids

Fuel-Resistant Usage – Logan Airport

- Placed 1300 tons of fuel resistant mix on Taxiway N and Runway 4L-22R at Logan Airport in June 2004

Fuel-Resistant Usage – Logan Airport

- FR Asphalt graded as PG 94-22
- 1/2” P-401 mix designed at 2.5% air voids
- 7% asphalt content design target
- APA testing at WPI showed 0.70mm rutting on this mix

Fuel-Resistant Usage – Logan Airport

- Mix produced in drum plant at 340˚F
- Placed at 325˚F without difficulty
- Met density specification
- Excellent surface appearance

Fuel Resistant PMA at Logan Airport

Fuel-Resistant Usage – New Projects

- **Boston, MA - Logan Airport**
  - **Alleyway Project – 2005**
- **Charlotte, NC - Douglas International Airport**
  - **Runway Project – Summer 2006**
- **Florida DOT**
  - **Truck Inspection Station – Summer 2006**
- **Boston, MA - Logan Airport**
  - **Alleyway Project – 2006**
- **Boston, MA - Logan Airport**
  - **Alleyway Project – 2007**
- **Williston, FL – GA Airport**
  - **Apron project - 2015**

Fuel-Resistant Usage – Charlotte Airport

- Charlotte, NC - Douglas International Airport
  - Runway 18L – 36R
  - August 2006
  - Night work – Runway available from 11:00 pm until 6:00 am
  - Mill 2”
  - Pave with 2” FR Mix

Fuel-Resistant Usage – Logan Airport

Fuel-Resistant Usage – Logan Airport

Fuel-Resistant Usage – Logan Airport

Logan Airport - 2014

10 year old FR Pavement

Logan Airport - 2014

Logan Airport - 2014

Logan Airport - 2014

Fuel Resistant PMA at Logan Airport 2014

10 year old P-601

10 year old P-401

Logan Airport - 2014

Logan Airport - 2014

Logan Airport - 2014

Logan Airport - 2014

- De-icing at Logan Airport is done at the gates
- Alleyway P-601 pavement in picture has been exposed to de-icing chemicals for 9 winters – no visible damage to date

P-601 Project – Williston, FL Airport

P-601 Project – Williston, FL Airport

P-601 Project – Williston, FL Airport

P-601 for Bus Lanes

- Bus lanes have heavy, channelized traffic – rutting may be an issue
- Oil and fuel leaks are also present
- Logan Airport has used P-601 pavement in bus lanes to solve the problem

FAA P-601 Specification

- FAA has adopted advisory Circular # 150 / 5370-10G , dated 07/21/2014
- Contains specification item P-601 Fuel Resistant Hot Mix Asphalt (HMA) pavement

FAA P-601 Specification

- Asphalt Binder Specification
  - ASTM D6373 Minimum grade of PG 82-22
  - ASTM D6084 Elastic Recovery at 25°C ≥ 85%
  - ASTM D7173 Maximum temperature difference of 40°F (4°C) when using ASTM D36 Ring and Ball apparatus
- Mix Specification
  - P-401 ½” mix
  - Target air voids = 2.5%
  - 50 blow or 50 gyration mix compaction regardless of aircraft type
  - Maximum Weight loss by fuel immersion 2.5% as measured by test procedure in FAA P-601 Specification Section 601-3.3

P-601 Summary

- Polymer-Modified Asphalt developed specifically to resist jet fuel damage
- Eliminate need for coal-tar sealers
- Polymer modification provides excellent resistance to permanent deformation and cracking in addition to fuel resistance

P-601 Summary

- Workability allows contractors to use standard construction practices
- Cost effective product
- Proven product – 20 year history

Questions?