Federal Aviation
Administration

HMA Design for Airport Pavements: Current State of the Practice and Future Plans

Presented to: Illinois Bituminous Paving Conference
Champaign, IL

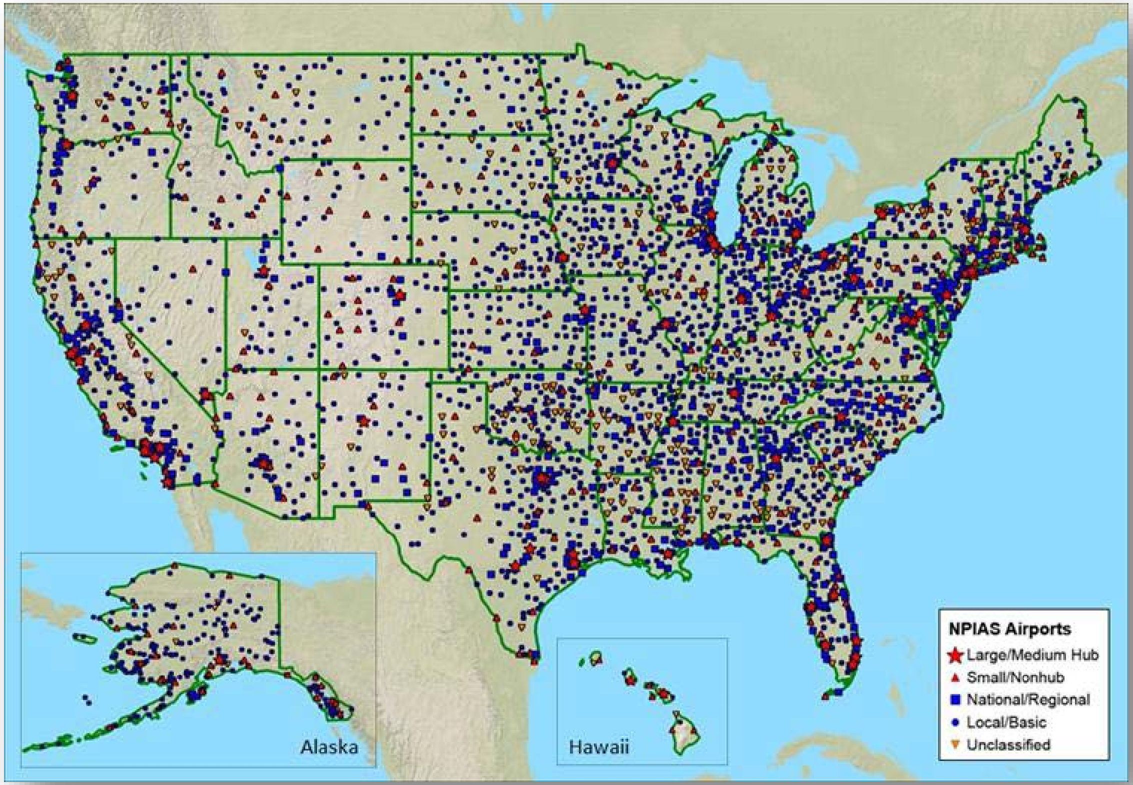
By: Navneet Garg, Ph.D.
Program Manager, NAPMRC
Federal Aviation Administration (FAA)

Date: December 12, 2017

Outline

- **Introduction**
- **FAA AC 150/5320-10G**
- **FAA AC 150/5320-10H DRAFT**
- **FAA's Research Program**
  - NAPTF National Airport Pavement Test Facility
  - NAPMRC National Airport Pavement & Materials Research Center
  - Field Instrumentation & Testing

United States Airport System

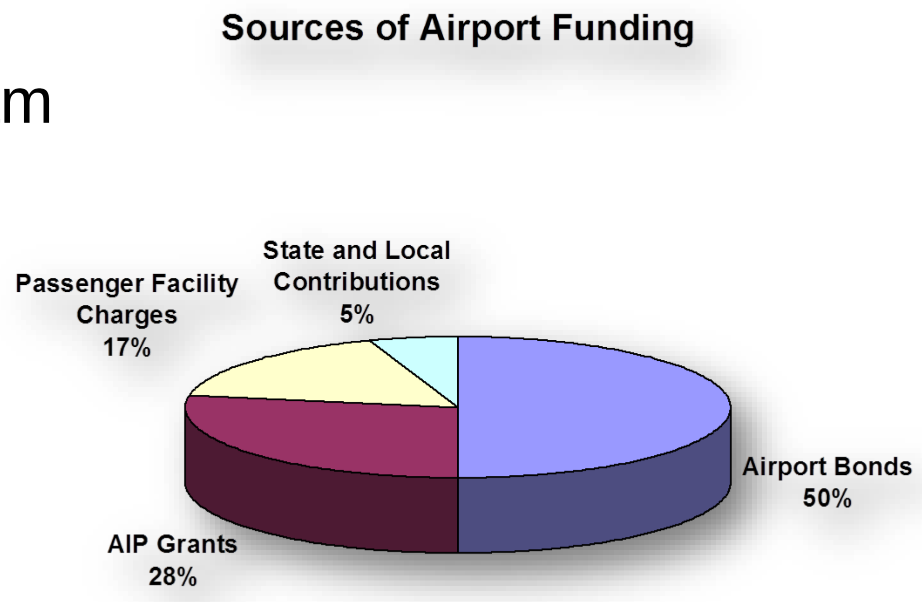


National Plan of Integrated Airport Systems (NPIAS)

- Over 600 million passenger enplanements annually at over 13,000 airports.
- 3,400 airports in the NPIAS (as of September 2014).

Airport Funding Sources

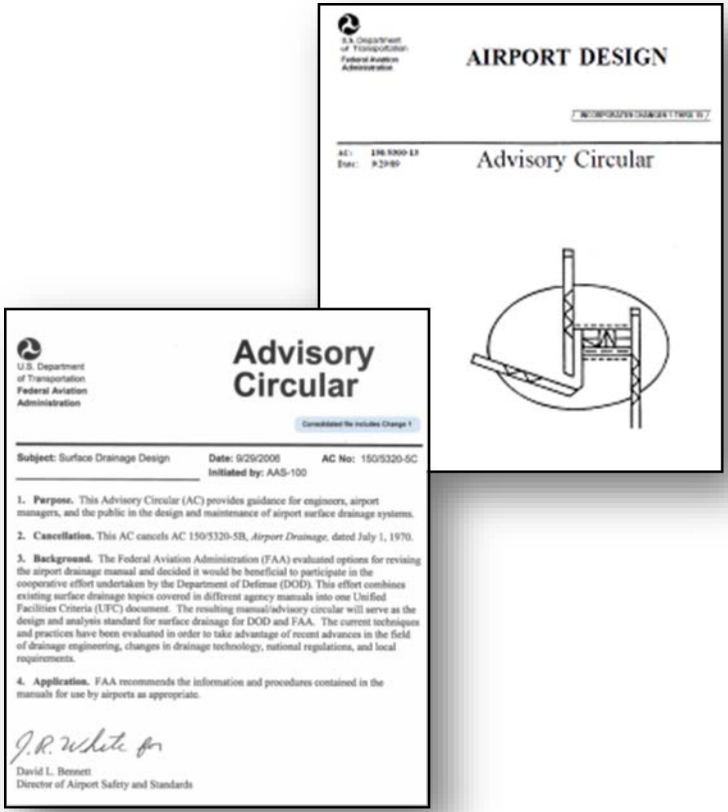
- Airport Improvement Program (AIP) Grants
  - $3 to 4 Billion per year
  - FAA Advisory Circulars (ACs)
  - Eligibility Requirements
- Passenger Facility Charges
- Airport bonds
- Airport revenue (pays off airport bonds)
- State & local government contributions



Source: GAO Report GAO-07-885 AIRPORT FINANCE Observations on Planned Airport Development and Funding Levels and the Administration's Proposed Changes in the Airport Improvement Program

Advisory Circulars

- FAA's Office of Airports (ARP-1) maintains more than 100 advisory circulars (ACs) that provide guidance on airport development.
- To be eligible to receive the AIP grant, all project work must meet standards set in these ACs.
- All areas of airport development:
  - Airport planning and design.
  - Airport lighting and marking.
  - Airport pavement design and construction.
  - Runway safety.
  - Aircraft rescue and fire fighting (ARFF).
  - Wildlife hazard mitigation.


AIRPORT DESIGN

Advisory Circular

U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: Surface Drainage Design

Date: 9/29/2006
Initiated by: AAS-100

AC No: 150/5320-5C

1. **Purpose.** This Advisory Circular (AC) provides guidance for engineers, airport managers, and the public in the design and maintenance of airport surface drainage systems.

2. **Cancellation.** This AC cancels AC 150/5320-5B, *Airport Drainage*, dated July 1, 1970.

3. **Background.** The Federal Aviation Administration (FAA) evaluated options for revising the airport drainage manual and decided it would be beneficial to participate in the cooperative effort undertaken by the Department of Defense (DOD). This effort combines existing surface drainage topics covered in different agency manuals into one Unified Facilities Criteria (UFC) document. The resulting manual/advisory circular will serve as the design and analysis standard for surface drainage for DOD and FAA. The current techniques and practices have been evaluated in order to take advantage of recent advances in the field of drainage engineering, changes in drainage technology, national regulations, and local requirements.

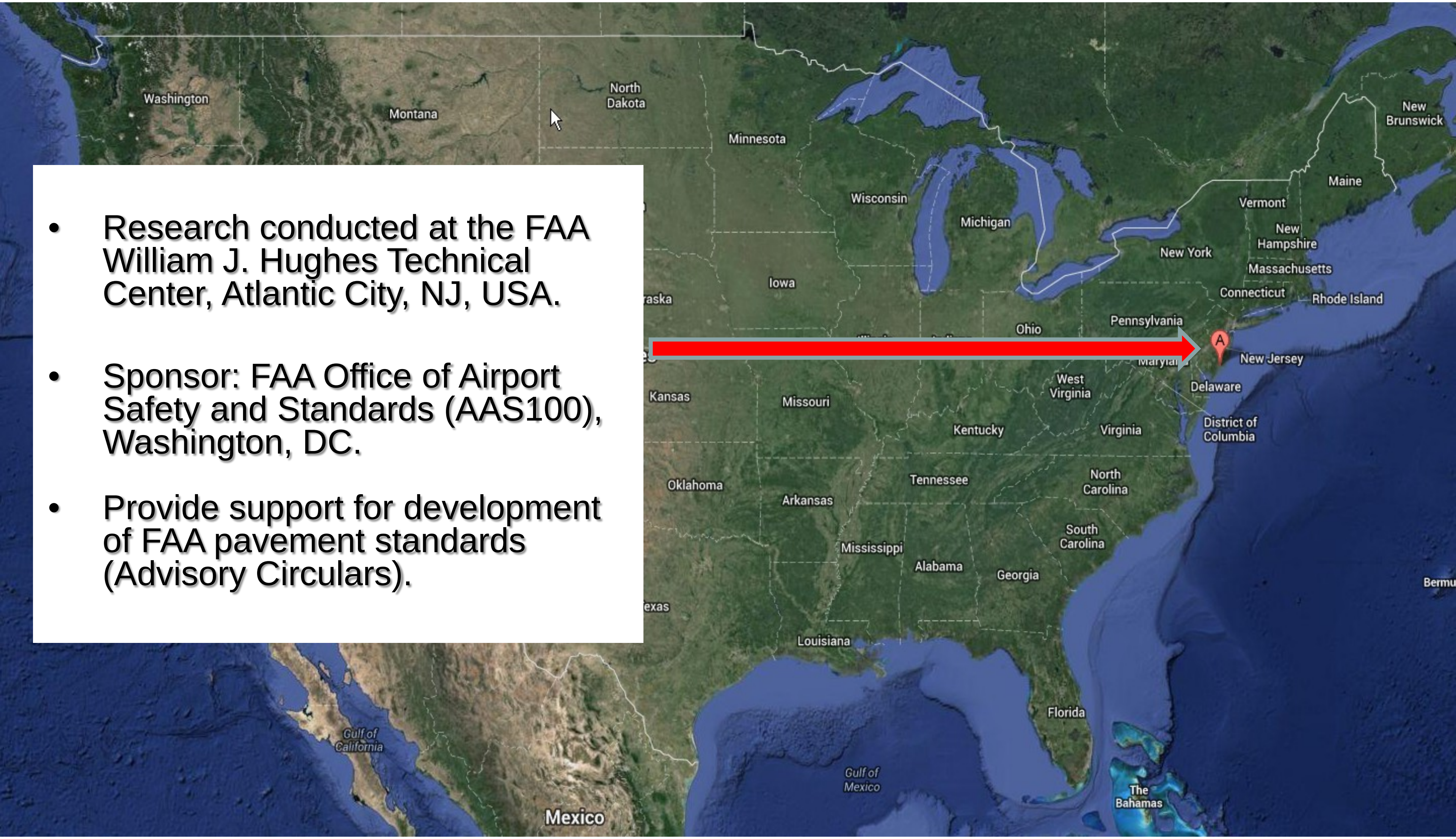
4. **Application.** FAA recommends the information and procedures contained in the manuals for use by airports as appropriate.

J.R. White for

David L. Bennett
Director of Airport Safety and Standards

FAA Airport Technology R&D Program

- Research conducted at the FAA William J. Hughes Technical Center, Atlantic City, NJ, USA.
- Sponsor: FAA Office of Airport Safety and Standards (AAS100), Washington, DC.
- Provide support for development of FAA pavement standards (Advisory Circulars).

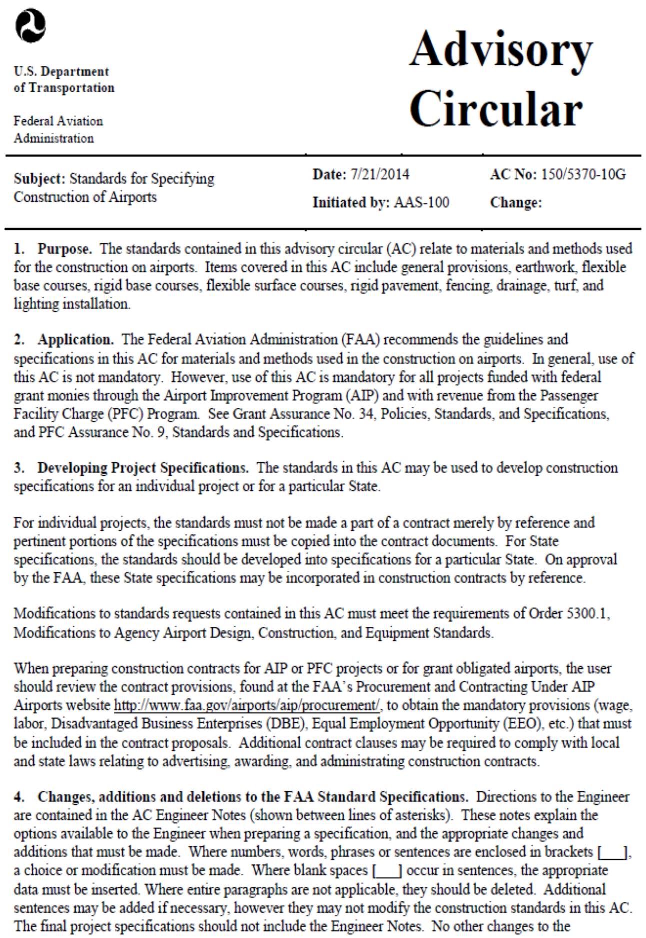


Outline

- Introduction
- **FAA AC 150/5320-10G**
- FAA AC 150/5320-10H DRAFT
- FAA's Research Program
  - NAPTF National Airport Pavement Test Facility
  - NAPMRC National Airport Pavement & Materials Research Center
  - Field Instrumentation & Testing

AC 150/5370-10G

- Standards for Specifying Construction of Airports.
- Most recent version – released July 21, 2014.
- Required to be used for all projects funded under an Airport Improvement Program (AIP) grant (U.S.).
- Available at: http://www.faa.gov/airports/resources/advisory_circulars/



U.S. Department of Transportation

Federal Aviation Administration

Advisory Circular

Subject: Standards for Specifying Construction of Airports	**Date:** 7/21/2014	**AC No:** 150/5370-10G
	Initiated by: AAS-100	**Change:**

1. Purpose. The standards contained in this advisory circular (AC) relate to materials and methods used for the construction on airports. Items covered in this AC include general provisions, earthwork, flexible base courses, rigid base courses, flexible surface courses, rigid pavement, fencing, drainage, turf, and lighting installation.

2. Application. The Federal Aviation Administration (FAA) recommends the guidelines and specifications in this AC for materials and methods used in the construction on airports. In general, use of this AC is not mandatory. However, use of this AC is mandatory for all projects funded with federal grant monies through the Airport Improvement Program (AIP) and with revenue from the Passenger Facility Charge (PFC) Program. See Grant Assurance No. 34, Policies, Standards, and Specifications, and PFC Assurance No. 9, Standards and Specifications.

3. Developing Project Specifications. The standards in this AC may be used to develop construction specifications for an individual project or for a particular State.

For individual projects, the standards must not be made a part of a contract merely by reference and pertinent portions of the specifications must be copied into the contract documents. For State specifications, the standards should be developed into specifications for a particular State. On approval by the FAA, these State specifications may be incorporated in construction contracts by reference.

Modifications to standards requests contained in this AC must meet the requirements of Order 5300.1, Modifications to Agency Airport Design, Construction, and Equipment Standards.

When preparing construction contracts for AIP or PFC projects or for grant obligated airports, the user should review the contract provisions, found at the FAA's Procurement and Contracting Under AIP Airports website http://www.faa.gov/airports/aip/procurement/, to obtain the mandatory provisions (wage, labor, Disadvantaged Business Enterprises (DBE), Equal Employment Opportunity (EEO), etc.) that must be included in the contract proposals. Additional contract clauses may be required to comply with local and state laws relating to advertising, awarding, and administrating construction contracts.

4. Changes, additions and deletions to the FAA Standard Specifications. Directions to the Engineer are contained in the AC Engineer Notes (shown between lines of asterisks). These notes explain the options available to the Engineer when preparing a specification, and the appropriate changes and additions that must be made. Where numbers, words, phrases or sentences are enclosed in brackets [___], a choice or modification must be made. Where blank spaces [___] occur in sentences, the appropriate data must be inserted. Where entire paragraphs are not applicable, they should be deleted. Additional sentences may be added if necessary, however they may not modify the construction standards in this AC. The final project specifications should not include the Engineer Notes. No other changes to the

AC 150/5370-10G

Principal Changes from 10F

- **Added new paragraphs to Section 90: Paragraph 90-10, Construction Warranty; and Paragraph 90-11, Project Closeout.**
- **Deleted Section 120 Nuclear Gauges and incorporated guidance in specifications.**
- **Gyratory Method has been added to Items P-401 and P-403.**
- **Added new sections and items:**
  - Section 105, Mobilization
  - Item P-601, Fuel-Resistant Hot Mix Asphalt (HMA) Pavement
  - Item P-608, Emulsified Asphalt Seal Coat
  - Item P-629, Thermoplastic Coal Tar Emulsion Surface Treatments
  - Item F-164, Wildlife Exclusion Fence
- **Deleted the following items:**
  - Item P-402, Porous Friction Course (Central Plant Hot Mix)
  - Item T-907, Tilling
  - Item L-102, Hazard Beacons

Standard Materials for Flexible Pavement Construction

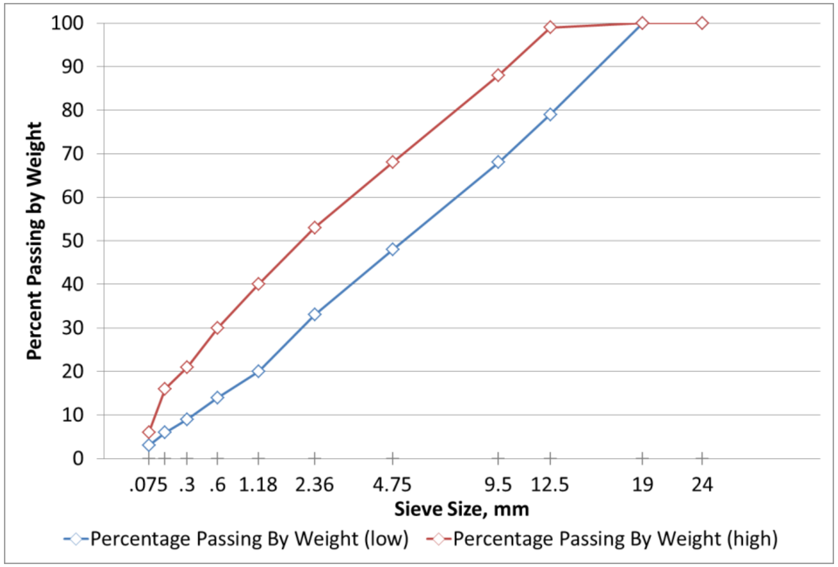
- **Flexible surface courses for pavements handling aircraft 12,500 lbs. (5670 kg) or above must conform to item P-401.**
- **Item P-403 can be used for:**
  - HMA stabilized base courses;
  - Leveling courses;
  - Surfaces of shoulders or pavements for aircraft less than 12,500 lbs. (5670 kg) gross weight.
- **Any material meeting P-401 will also meet P-403. (Reverse is not true.)**
- **Standard base course (unstabilized) is item P-209.**
- **Subbase courses conform to item P-154.**

Item P-401
Plant Mix Bituminous Pavements

- **P-401 specification covers:**
  - Material requirements;
  - Mix design (job mix formula);
  - Construction methods;
  - Acceptance requirements;
  - Contractor quality control (QC);
  - Method of payment and pay adjustment factors.
- **Note that the AC cannot be used “by reference.” The engineer must make appropriate insertions where indicated by brackets […] in the text.**

P-401 Mix Design

- **Mix design is based on Marshall criteria:**
  - Use 75 blows if aircraft gross weight is 60,000 lbs. or more.
  - 50 blows for < 60,000 lbs.
- **Aggregate gradation and minimum VMA are specified based on max. particle size.**
- **Alternate criteria based on Gyratory Compactor is included in 10G.**



Aggregate Gradation Limits for Item P-401 (3/4 inch/19 mm maximum stone size)

P-401 Mix Design

401-2.3 Asphalt cement binder. Asphalt cement binder shall conform to ASTM D6373 Performance Grade (PG) **[___]**. A certificate of compliance from the manufacturer shall be included with the mix design submittal.

Required Grade Bump

Aircraft Gross Weight	High Temperature Adjustment to Binder Grade
	All Pavement Types
≤ 12,500 lbs (5670 kg)	--
< 100,000 lbs (45360 kg)	1 Grade
≥ 100,000 lbs (45360 kg)	2 Grade

Typically, rutting is not a problem on airport pavements. However, at airports with a history of stacking on end of runways and taxiway areas, rutting has occurred due to the slow speed of loading on the pavement. If there has been rutting on the project or it is anticipated that stacking may occur during the design life of the project, then the following grade bumping should be applied for the top 5 inches (125 mm) of paving in the end of runway and taxiway areas: for aircraft tire pressure between 100 and 200 psi (0.7 and 1.4 MPa), increase the high temperature one grade; for aircraft tire pressure greater than 200 psi (1.4 MPa), increase the high temperature two grades. The low temperature grade should remain the same.

P-401 Mix Design

For Gyratory Method:

The Gyratory Design Criteria, applicable to the project shall be specified by the Engineer from the information shown below and inserted into Table 1 where asterisks (*) denote insert points.

Table 1. Gyratory Design Criteria

Test Property	Pavements Designed for Aircraft Gross Weights of 60,000 Lbs (27216 kg) or More or Tire Pressures of 100 psi or More	Pavements Designed for Aircraft Gross Weights Less Than 60,000 Lbs (27216 kg) or Tire Pressures Less Than 100 psi
Number of compactor gyrations	75	50
Target Air Voids (percent)	3.5	3.5
Percent Voids in Mineral Aggregate (minimum)	See Table 2	See Table 2

P-401 Mix Design

Table 2. Minimum Percent Voids In Mineral Aggregate (VMA)

Aggregate (See Table 3)	Minimum VMA
Gradation 3	16%
Gradation 2	15%
Gradation 1	14%

P-401 Mix Design

Table 3. Aggregate - HMA Pavements

Sieve Size	Percentage by Weight Passing Sieves		
	Gradation 1	**Gradation 2**	**Gradation 3**
1 inch (25 mm)	100	--	--
3/4 inch (19 mm)	76-98	100	--
1/2 inch (12 mm)	66-86	79-99	100
3/8 inch (9 mm)	57-77	68-88	79-99
No. 4 (4.75 mm)	40-60	48-68	58-78
No. 8 (2.36 mm)	26-46	33-53	39-59
No. 16 (1.18 mm)	17-37	20-40	26-46
No. 30 (0.600 mm)	11-27	14-30	19-35
No. 50 (0.300 mm)	7-19	9-21	12-24
No. 100 (0.150 mm)	6-16	6-16	7-17
No. 200 (0.075 mm)	3-6	3-6	3-6
Asphalt percent:			
Stone or gravel	4.5-7.0	5.0-7.5	5.5-8.0
Slag	5.0-7.5	6.5-9.5	7.0-10.5

P-401 Acceptance Criteria

Characteristic	Acceptance Criteria
Marshall Stability and Flow	PWL > 90%
Air Voids	PWL > 90%
Mat Density	PWL > 90%
Joint Density	PWL > 90%
Thickness	Max. deficiency on any sampled point = ¼ in. Average thickness > indicated for each lift.
Smoothness	Allow. variation on 16-foot straightedge = ¼ in.
Grade	Allow. variation = ½ in. from plan elevation.

Notes:
PWL = Percent within limits.
When P-401 Superpave is used, Marshall stability and flow are not evaluated for acceptance.

Item P-403
(Base and Leveling Course, Shoulders)

- **The P-403 specification is similar to Item P-401, except:**
  - Marshall design criteria for stability, flow and air voids are not as stringent.
  - Acceptance based on mat and joint density, thickness, smoothness and grade only (no evaluation of stability and flow from plant material).
  - Density is based on a straight acceptance limit (96% for mat density, 94% for joint density). PWL is not used.

Binder Selection:

- PG grades above a –22 on the low end (e.g., PG XX–16 or PG XX-10) are not recommended. Limited experience has shown an increase in block cracking with -16 or -10 grade asphalts.

- Typically, when the PG spread between the high and low temperature is 92 or more, the asphalt cement binder has been modified. A PG Plus Test will be required to determine if the asphalt cement binder has been properly modified. Use the PG Plus Test found in the Asphalt Institute's State Binder Specification Database for the project location. When a State does not specify a PG Plus Test, use ASTM D6084 with a minimum elastic recovery of 70%.

Outline

- Introduction
- FAA AC 150/5320-10G
- **FAA AC 150/5320-10H DRAFT**
- FAA's Research Program
  - NAPTF — National Airport Pavement Test Facility
  - NAPMRC — National Airport Pavement & Materials Research Center
  - Field Instrumentation & Testing

Part 6: Flexible Pavement

- **P401-2.3 Asphalt Binder**
  - Clarified how Grade Bumps applied

Required Grade Bump

Aircraft Gross Weight	High Temperature Adjustment to Binder Grade	
	All Pavement Types	Pavement area w/ slow or stationary aircraft and tire pressures greater than 100 psi (0.7 MPa)[1]
≤ 12,500 lbs (5670 kg)	--	--
< 100,000 lbs (45360 kg)	1 Grade	2 Grade
≥ 100,000 lbs (45360 kg)	2 Grade	4 Grade

[1]Grade bumping should be applied for the top 5 inches (125 mm) of paving. The low temperature grade will remain the same.

Part 6: Flexible Pavement

- **P401-3.3**
  - Certificate of Analysis (COA) for asphalt binder
  - COA for antistrip if used
- **P401-3.3**
  - Added Mix Performance Criteria
  - Asphalt Pavement Analyzer (APA)
    - 10 mm @ 4000 passes at 250 psi and 64 deg.C
    - 5 mm @ 8000 passes at 100 psi and 64 deg.C

Part 6: Flexible Pavement

- **P401-3.3**
  - Table 2 Aggregate Gradations Adjusted
    - Adjusted to assure gradations limited to one nMAX
    - Added VMA requirements
    - Added Minimum Construction Lift Thickness

Part 6: Flexible Pavement

Table 2. Aggregate - HMA Pavements

Sieve Size	Percentage by Weight Passing Sieves		
	Gradation 1	Gradation 2	Gradation 3[1]
1 inch (25.0 mm)	100	--	--
3/4 inch (19.0 mm)	90-100	100	--
1/2 inch (12.5 mm)	68-88	90-100	100
3/8 inch (9.5 mm)	60-82	72-88	90-100
No. 4 (4.75 mm)	45-67	53-73	58-78
No. 8 (2.36 mm)	32-54	38-60	40-60
No. 16 (1.18 mm)	22-44	26-48	28-48
No. 30 (600 µm)	15-35	18-38	18-38
No. 50 (300 µm)	9-25	11-27	11-27
No. 100 (150 µm)	6-18	6-18	6-18
No. 200 (75 µm)	3-6	3-6	3-6
Voids in Mineral Aggregate (VMA)	14	15	16
Asphalt percent by total weight of mixture:			
Stone or gravel	4.5-7.0	5.0-7.5	5.5-8.0
Slag	5.0-7.5	6.5-9.5	7.0-10.5
Minimum Construction Lift Thickness	3 inch	2 inch	1 ½ inch

[1] The Engineer is only to specify Gradation 3 for leveling course, airfield shoulders, and roadways.

Part 6: Flexible Pavement

- **P401-3.5 Test Section**
  - Greater of 250 Tons or ½ Sublot
  - Pay for ‘acceptable’ test section
  - Remove all test section that are not acceptable
- **P401-4.11**
  - Added what information should be in laydown plan
- **P401-4.13**
  - maximum cutback on longitudinal joints 3”

Part 6: Flexible Pavement

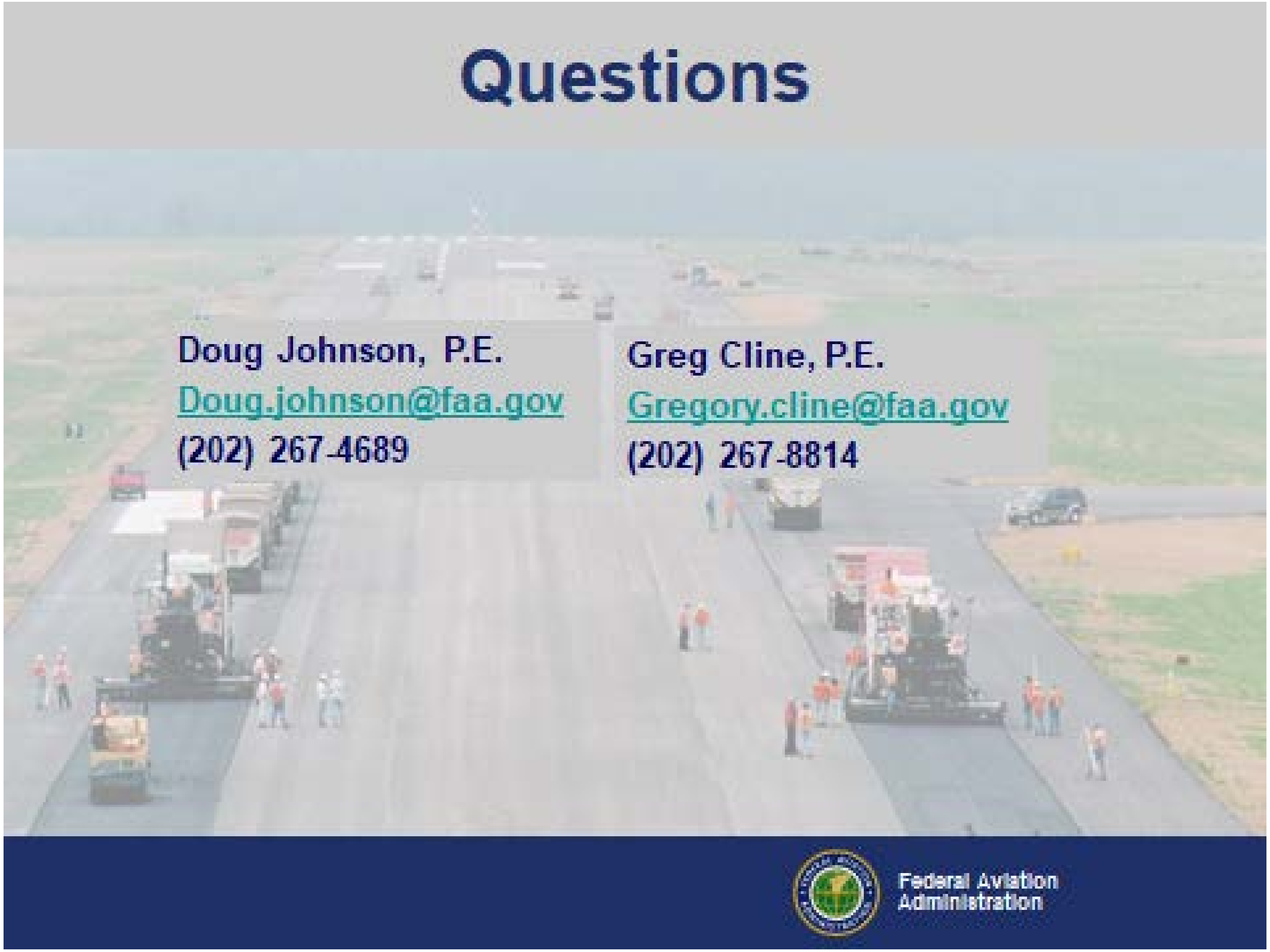
- **P401-6.2 Acceptance**
  - Air voids, Mat & Joint Density, Grade
  - Profilograph Smoothness only new or reconstructed Runway or Taxiway > 500’
  - Density relative to Theoretical Maximum Density (TMD)

Table 5. Acceptance Limits For Air Voids and Density

TEST PROPERTY	Pavements Specification Tolerance Limits	
	L	U
Air Voids Total Mix (%)	2	5
Surface Course Mat Density (%)	92.8	-
Base Course Mat Density (%)	91.8	-
Joint density (%)	90.5	--

Part 6: Flexible Pavement

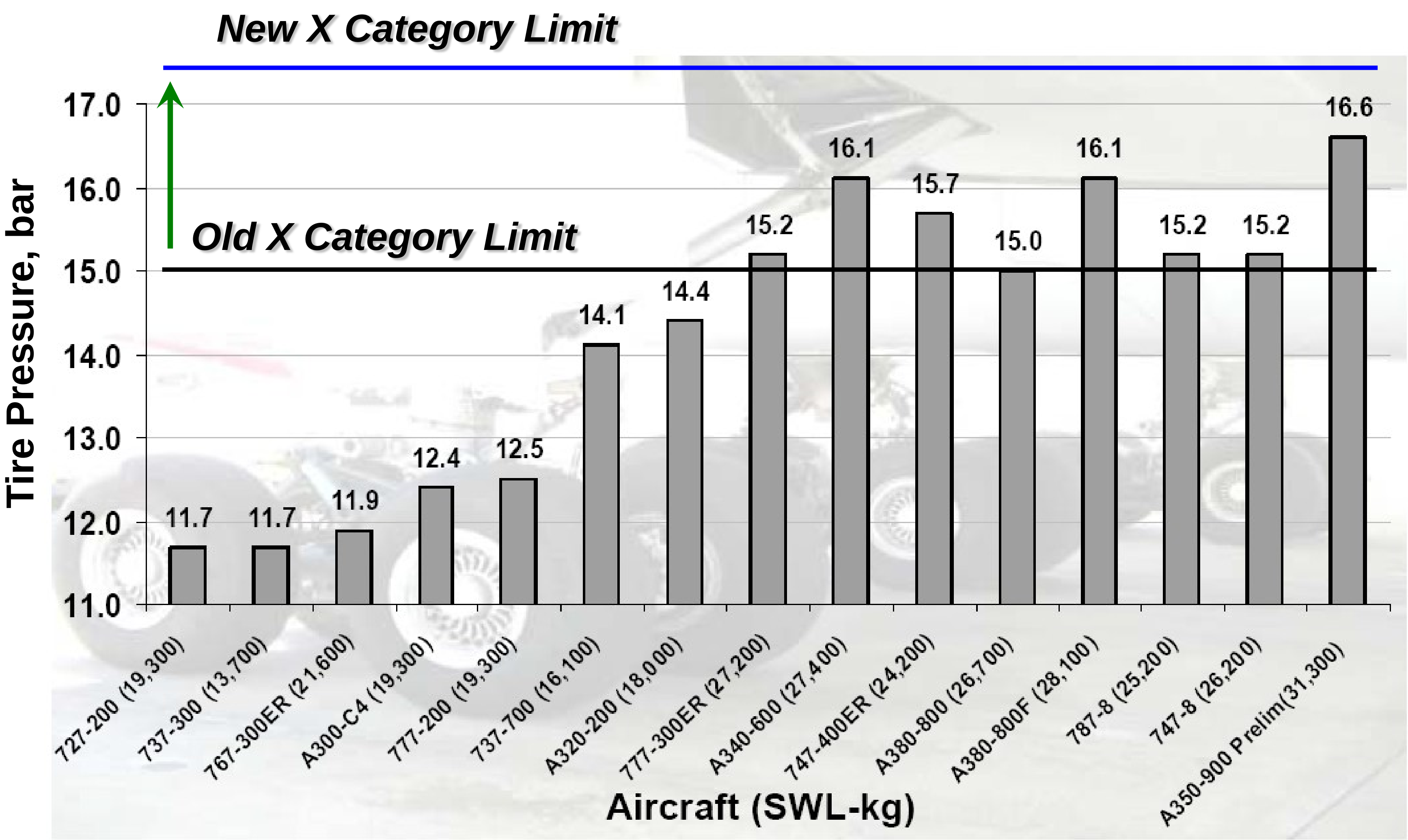
- **P403 Same changes as made to 401**
- **P403-6.2 Acceptance**
  - No PWL in 403
  - 96% TMD for Mat, 94% TMD for Joint


Questions
Doug Johnson, P.E.
Doug.johnson@faa.gov
(202) 267-4689
Greg Cline, P.E.
Gregory.cline@faa.gov
(202) 267-8814
Federal Aviation
Administration

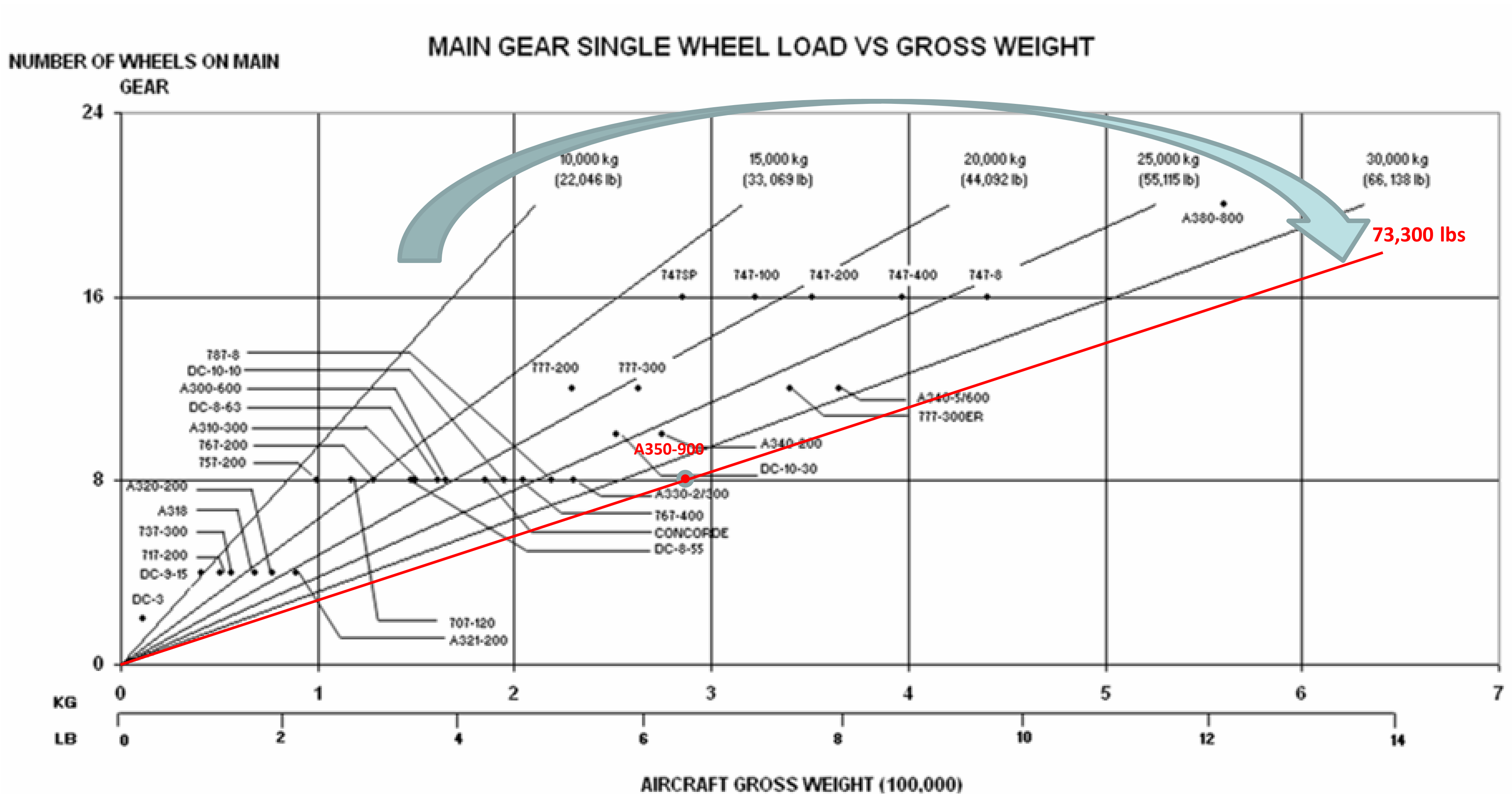
Outline

- Introduction
- FAA AC 150/5320-10G
- FAA AC 150/5320-10H DRAFT
- **FAA's Research Program**
  - NAPTF — National Airport Pavement Test Facility
  - NAPMRC — National Airport Pavement & Materials Research Center
  - Field Instrumentation & Testing

Aircraft Tire Pressure Trends



Aircraft Gross Weight Trends



[Published by the International Industry Working Group (IIWG), 2010]


Material Processing Facility
NAPMRC
NAPTF
Material Testing Laboratory
© 2016 Google
Google earth

National Airport Pavement Test Facility (NAPTF)

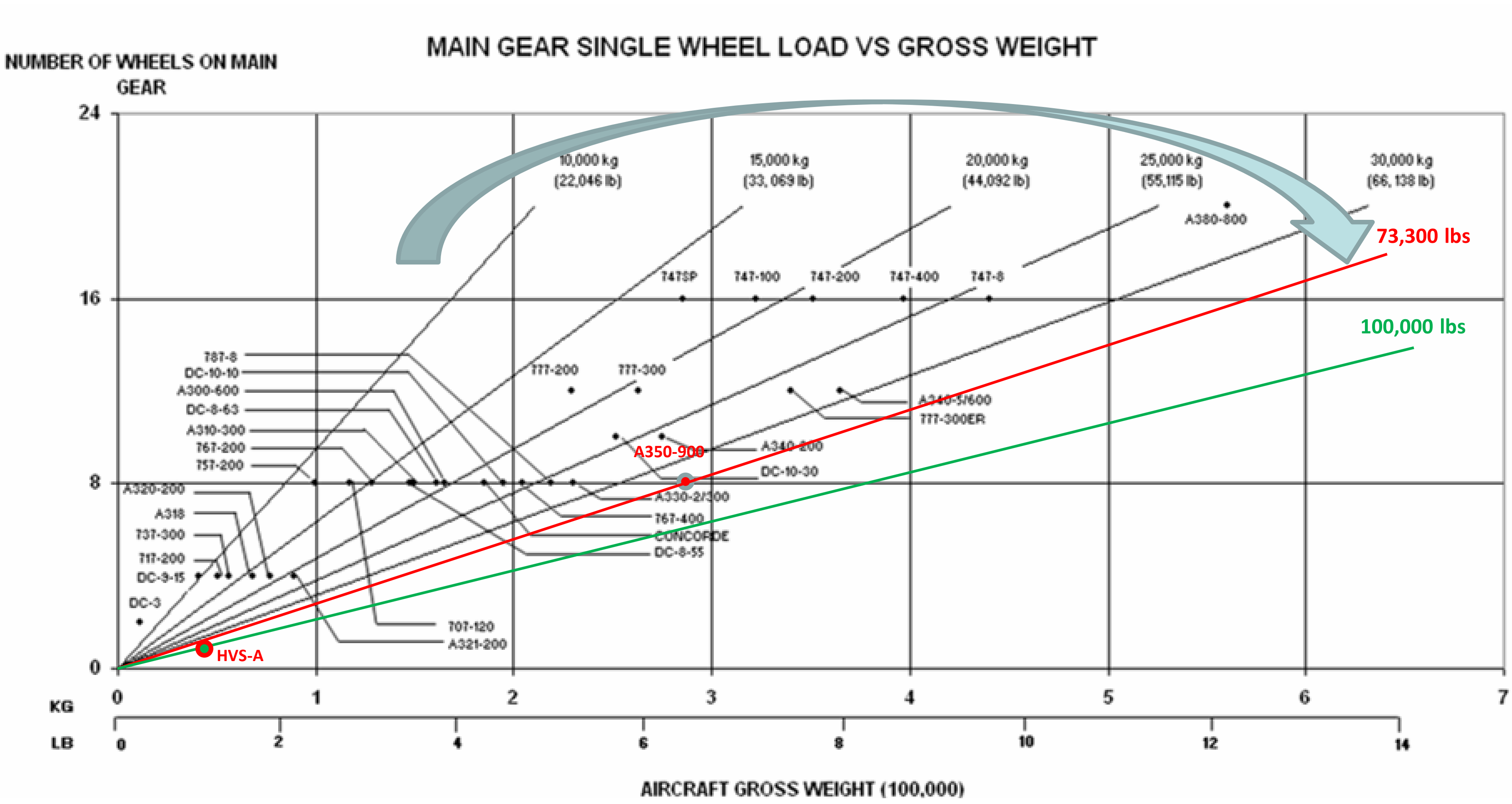
National Airport Pavement Test Facility (NAPTF)

- Located at the FAA's William J. Hughes Technical Center in Atlantic City, NJ, USA.
- 75,000 lbs (335 kN) max. load per wheel.
- 2.5 to 5 mph (4 to 8 km/h) traffic test speed.

Heavy Vehicle Simulator – Airport (HVS-A)

- Wheel loads - 10,000 to 100,000 lbs.
- Pavement temperatures up to 150°F
- Test speeds - 0.17 to 5 mph
- Single and Dual-Wheel configuration.
- Single wheel - radial aircraft tire size 52x21.0R22
- Dual wheel assembly (B-737-800)
- Wander Width – 6 feet

Aircraft Gross Weight Trends



Research at NAPMRC

EVALUATION OF NEW ASPHALT TECHNOLOGIES FOR AIRFIELD PAVEMENTS
Warm Mix Asphalt, Stone Matrix Asphalt, Polymer Modified Binders,
RAP Mixes, Full-Depth Rehabilitation

PROBLEM: Lack of Guidance/Standards/Specifications
Lack of Performance Data

Laboratory Performance Evaluation

Evaluate:
- Rutting
- Fatigue
- Moisture Susceptibility
- Durability
- Low Temperature Cracking

Full-Scale APT NAPMRC

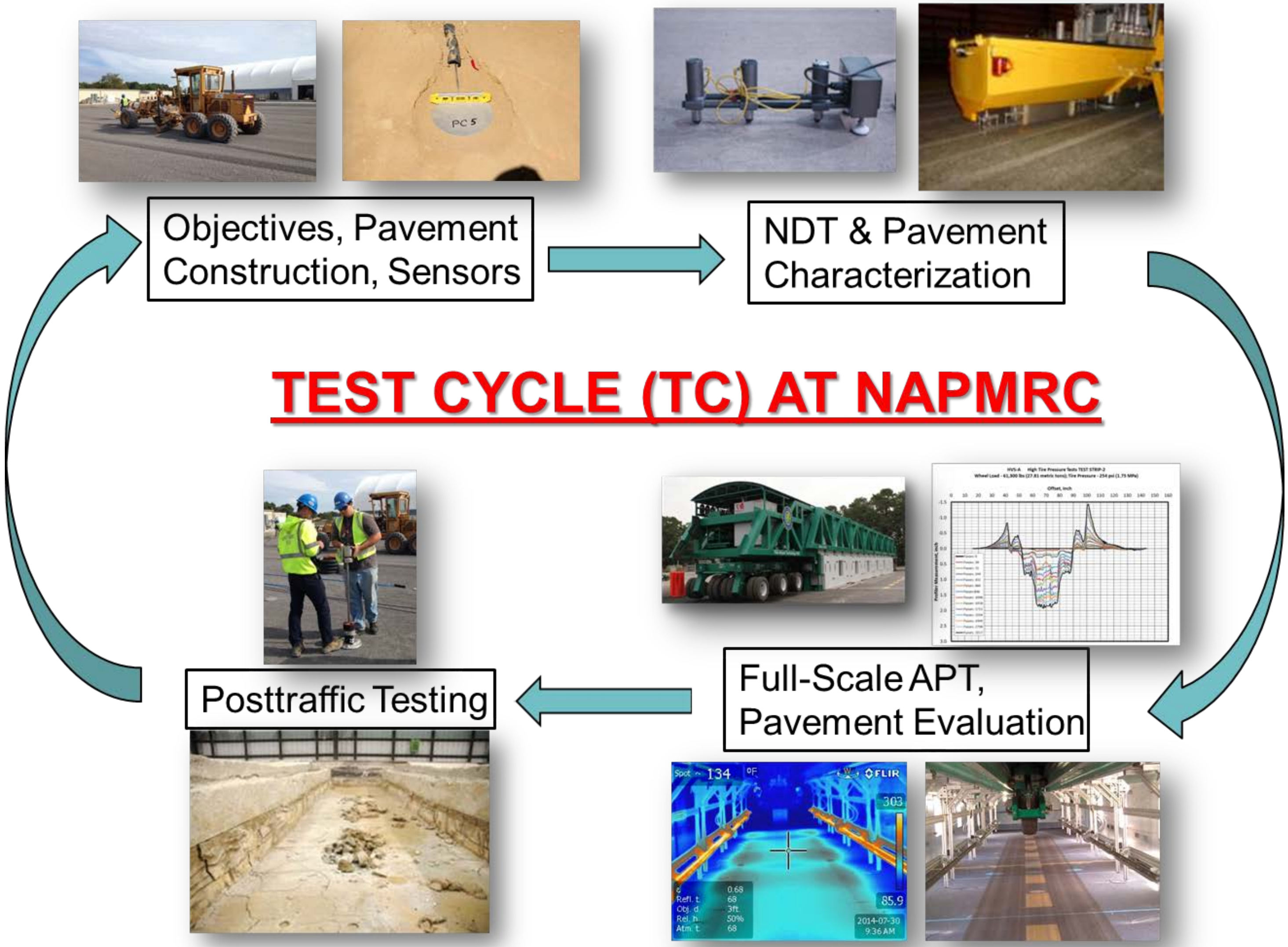
Full-Scale APT:
- Rutting
- Fatigue
- Tire Pressure Effects
- WMA
- RAP/RAS
- Full Depth Reclamation

Compare to P-401 HMA

Field Performance Evaluation

Field Projects:
- Lab Evaluation of Field Mixes
- Construction Evaluation
- Evaluate:
  - Mix Design
  - Production,
  - Construction
- Support from AAS-100, ADO

TEST CYCLE (TC) AT NAPMRC



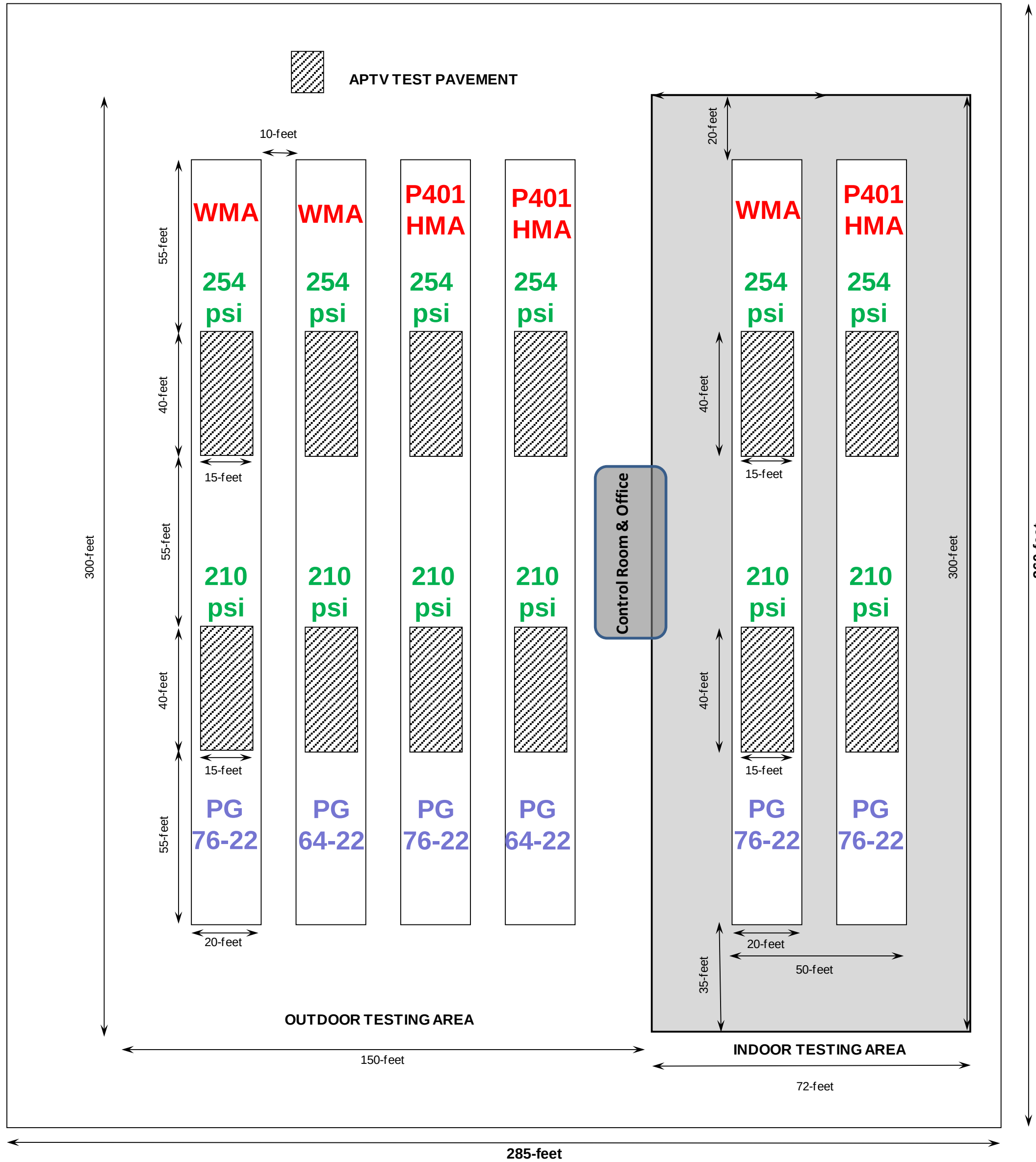
Test Cycle 1 (TC1) Objectives

- Compare Warm Mix Asphalt (WMA) performance with P401 Hot Mix Asphalt (HMA) performance (rutting);
- Effect of tire pressure on pavement rutting;
- Effect of polymer modified binder (PMA) on pavement rutting;
- Effect of temperature on pavement rutting.

MATERIAL

TIRE PRESSURE

BINDER TYPE



TOTAL AREA = 102,600 sq. feet (2.36 acres)

NAPMRC
Test Cycle-1 (TC-1)

Pavement Cross Sections

NAPMRC TC-1 PAVEMENT CROSS SECTION

Test Parameters – Traffic Tests

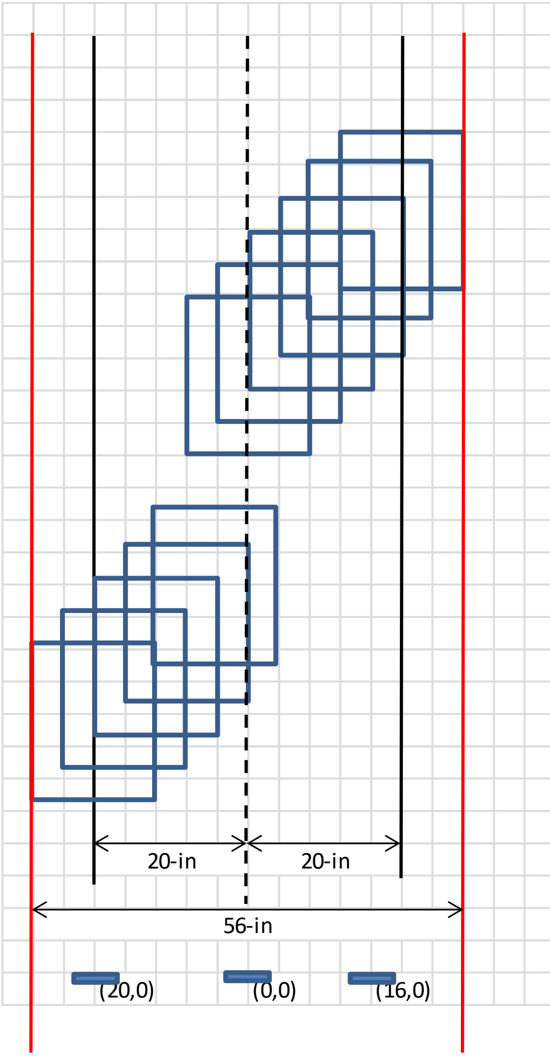
- Pavement Temperature: 120 deg. F measured at a depth of 2-inch below pavement surface.
- Test Speed: 3-mph
- Failure criteria: 1-inch surface rut

Test Area	Load Module	Wheel Load, lbs	Tire Pressure, psi
South	Single Wheel	61,300	210
North	Single Wheel	61,300	254

Pavement Performance

- Only RUTTING
- Cracking not considered (will be part of TC2)

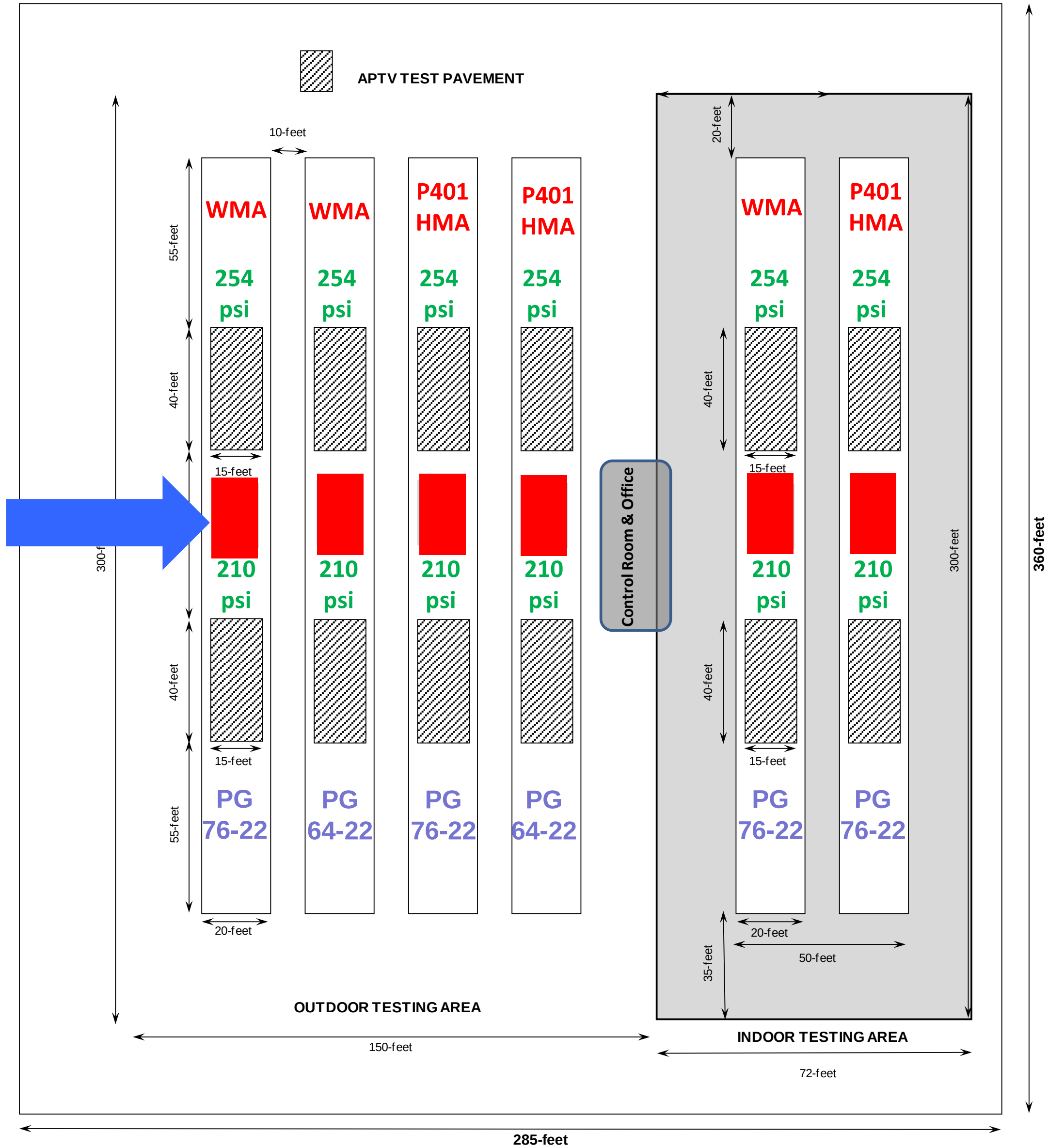
HVS-A TC1: Wander Pattern



Sequence No.	Wander Position, in
1	16
2	16
3	24
4	24
5	32
6	32
7	40
8	40
9	48
10	48
11	56
12	56
13	52
14	52
15	44
16	44
17	36
18	36
19	28
20	28
21	20
22	20
23	28
24	28
25	36
26	36
27	44
28	44
29	52
30	52
31	48
32	48

Sequence No.	Wander Position, in
33	40
34	40
35	32
36	32
37	24
38	24
39	32
40	32
41	40
42	40
43	48
44	48
45	44
46	44
47	36
48	36
49	28
50	28
51	32
52	32
53	40
54	40
55	36
56	36
57	20
58	20
59	24
60	24
61	36
62	36

CENTER SECTIONS
254-psi 90°F



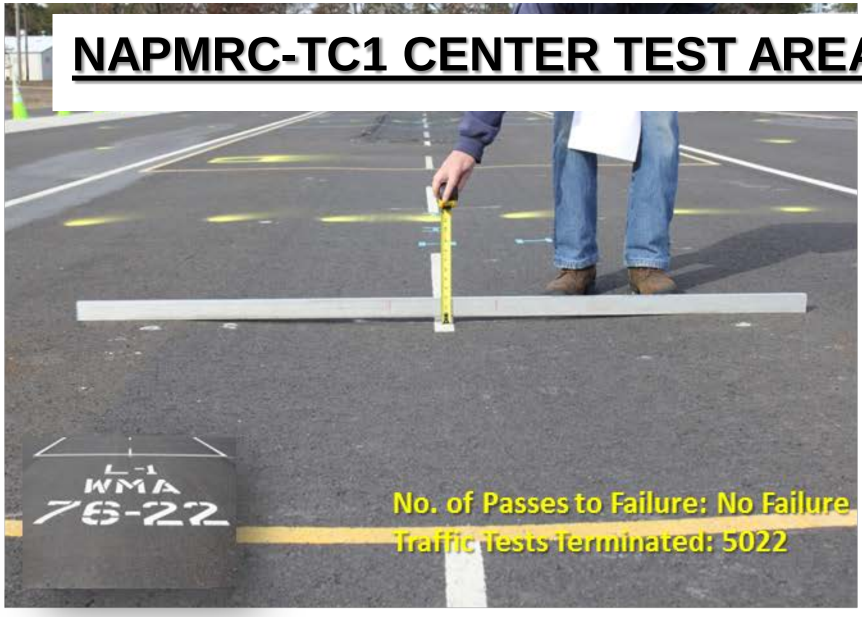
TOTAL AREA = 102,600 sq. feet (2.36 acres)

NAPMRC
Test Cycle-1 (TC-1)

NAPMRC-TC1 SOUTH TEST AREA (210-psi; 120°F)

NAPMRC-TC1 NORTH TEST AREA (254-psi; 120°F)

NAPMRC-TC1 CENTER TEST AREA (254-psi; 90°F)



Summary

- Compare Warm Mix Asphalt (WMA) performance with P401 Hot Mix Asphalt (HMA) performance (rutting);

  Comparable Performance in rutting.

  Cracking performance need to be evaluated (TC2)
- Effect of tire pressure on pavement rutting;

  Significant effects on mixes with unmodified binders.

  Insignificant effects on mixes with PMA.
- Effect of polymer modified binder (PMA) on pavement rutting;

  Improves rutting performance significantly.
- Effect of temperature on pavement rutting.

  Rutting performance of HMA/WMA is more sensitive to temperature than tire pressure.

TC1 Posttraffic Tests

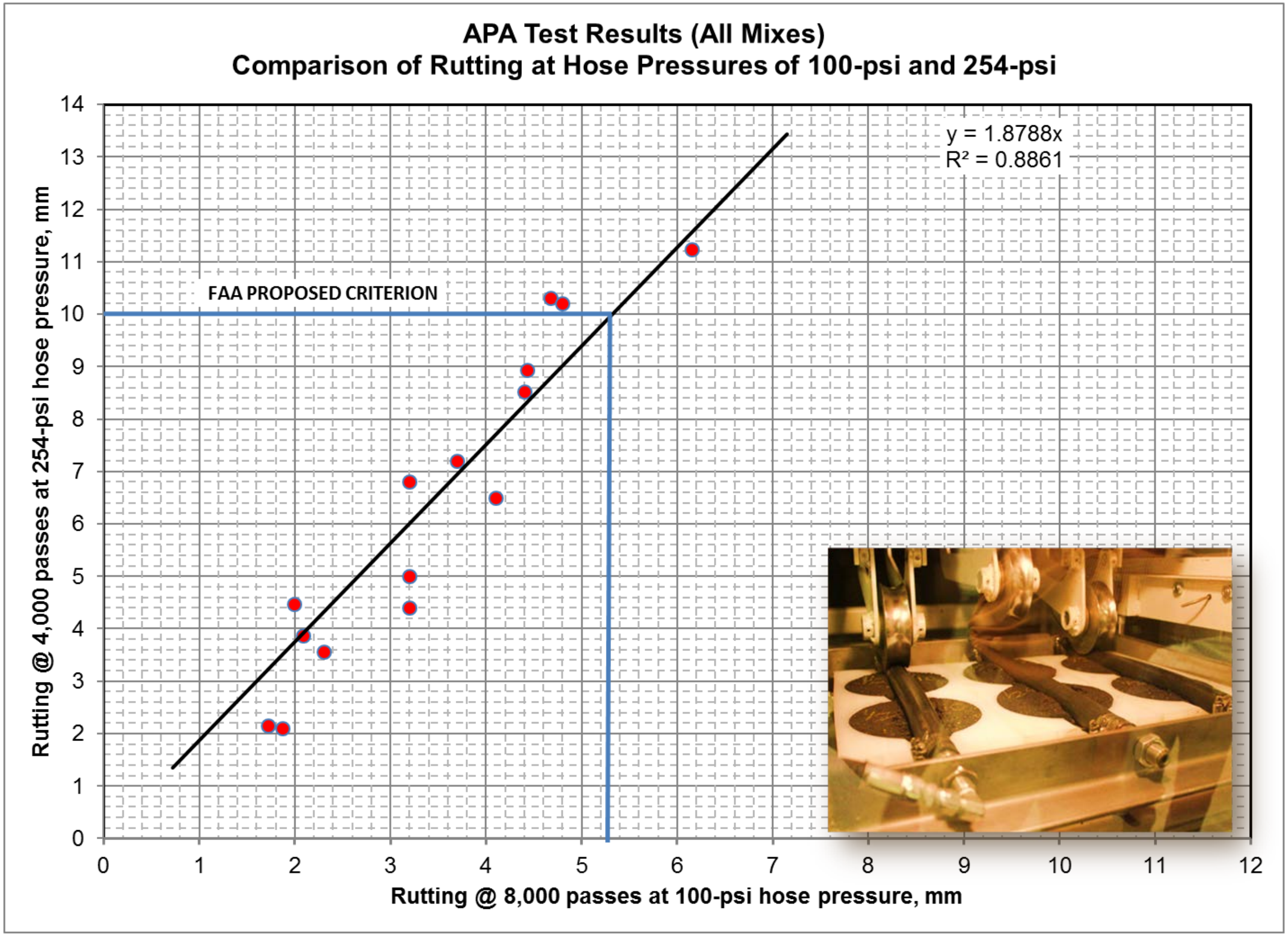
Loose Mix with Two Replicates								
Test Priority	**Schedule Priority**	**Test Objective**	**Test Type**	**Number of Reported Tests**			**Standard Specification**	**Performing Organization**
				No. of Mixes	*Replicates*	*Total*		
Primary	1	Quality Assurance	Bulk Specific Gravity, G_{mb}	All of prepared specimens			AASHTO T166	FAA Materials Lab
			Theoretical Maximum Specific Gravity, G_{mm}	4	2	8	AASHTO T209	
	2	Rutting Potential	Asphalt Pavement Analyzer	4	2	8	AASHTO T340	
			Indirect Tension (IDT- High Temp.)	4	2	8	ASTM D7369	
	3	Stiffness Characterization	Conventional Dynamic Modulus	4	2	8	AASHTO T342	
			Flow Number					
	5	Fracture Energy	Disk-Shape Compact Tension	4	2	8	ASTM D7313	
Secondary	6	Rutting Potential	Hamburg Wheel	4	2	8	AASHTO T324	Rutgers
	7	Stiffness	IDT Dynamic Modulus	4	2	8	LTPP	FAA Materials Lab
	8	Fatigue Performance	Semi-Circular Bend (Intermediate Temp)	4	2	8	AASHTO TP105	

Field Cores with Two Replicates								
Test Priority	**Schedule Priority**	**Test Objective**	**Test Type**	**Number of**			**Standard Specification**	**Performing Organization**
				No. of Lanes	*No. of Replicates*	*Total*		
Primary	1	Quality Assurance	Bulk Specific Gravity, G_{mb}	All of prepared specimens			AASHTO T166	FAA Materials Lab
	2	Rutting Potential	Asphalt Pavement Analyzer	6	2	12	AASHTO T340	
			Indirect Tension (IDT- High Temp.)	6	2	12	ASTM D7369	
	4	Fracture Energy	Disk-Shape Compact Tension	6	2	12	ASTM D7313	
	5	Fatigue Performance	Beam Fatigue	6	3	18	AASHTO T321	
Secondary	6	Rutting Potential	Hamburg Wheel	4	2	8	AASHTO T324	Rutgers
	7	Stiffness	IDT Dynamic Modulus	6	2	12	LTPP	FAA Materials Lab
	8	Fatigue Performance	Semi-Circular Bend (Intermediate Temp)	6	2	12	AASHTO TP105	

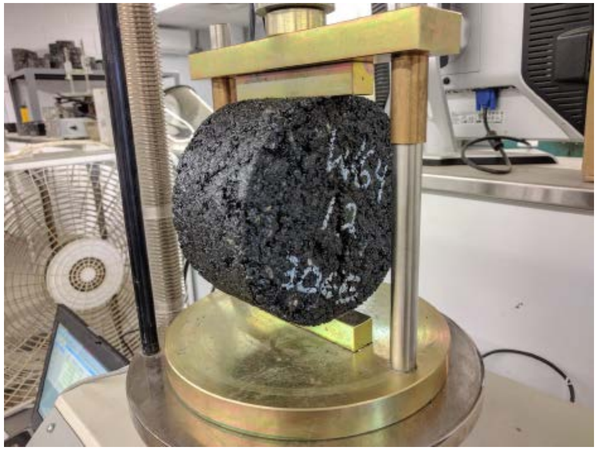
TC1: APA Test Results

		APA Rut Depth (mm)			
Hose Pressure/ # of Passes		100/8000		250/4000	
Sample Type	Mix Type	Average	Std Dev	Average	Std Dev
Lab Compacted	H64-22	3.2	0.2	6.8	0.7
	W64-22	4.4	0.5	8.9	0.2
	H76-22	1.9	0.6	2.1	0.2
	W76-22	2.0	0.2	4.5	0.0
Field Cores	L1(W76-22)	3.2	0.6	4.4	0.7
	L2(W64-22)	4.8	1.5	10.2	2.7
	L3(H76-22)	3.2	0.4	5	0.3
	L4(H64-22)	3.7	0.8	7.2	1.5
	L5(W76-22)	4.1	0.8	6.5	0.5
	L6(H76-22)	4.3	0.2	5.1	0.7

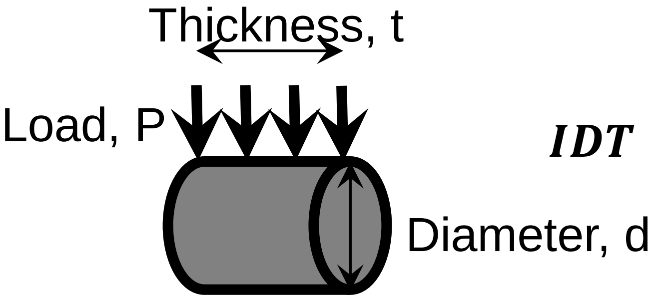
TC1: APA Test Results



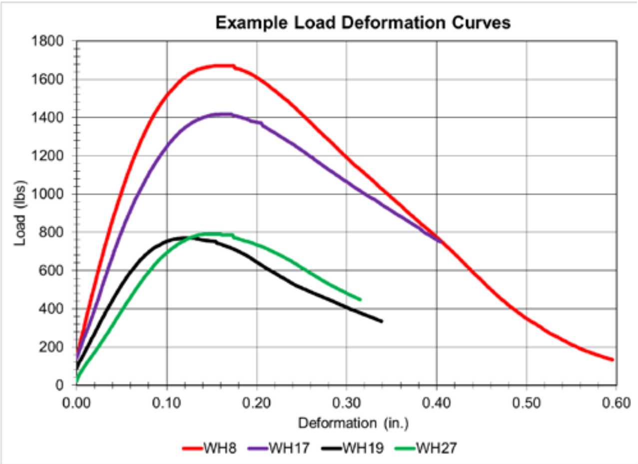
TC1: High Temperature IDT Test Results



High Temperature Indirect Tensile Strength Test



$$IDT = \frac{2P}{\pi d t}$$



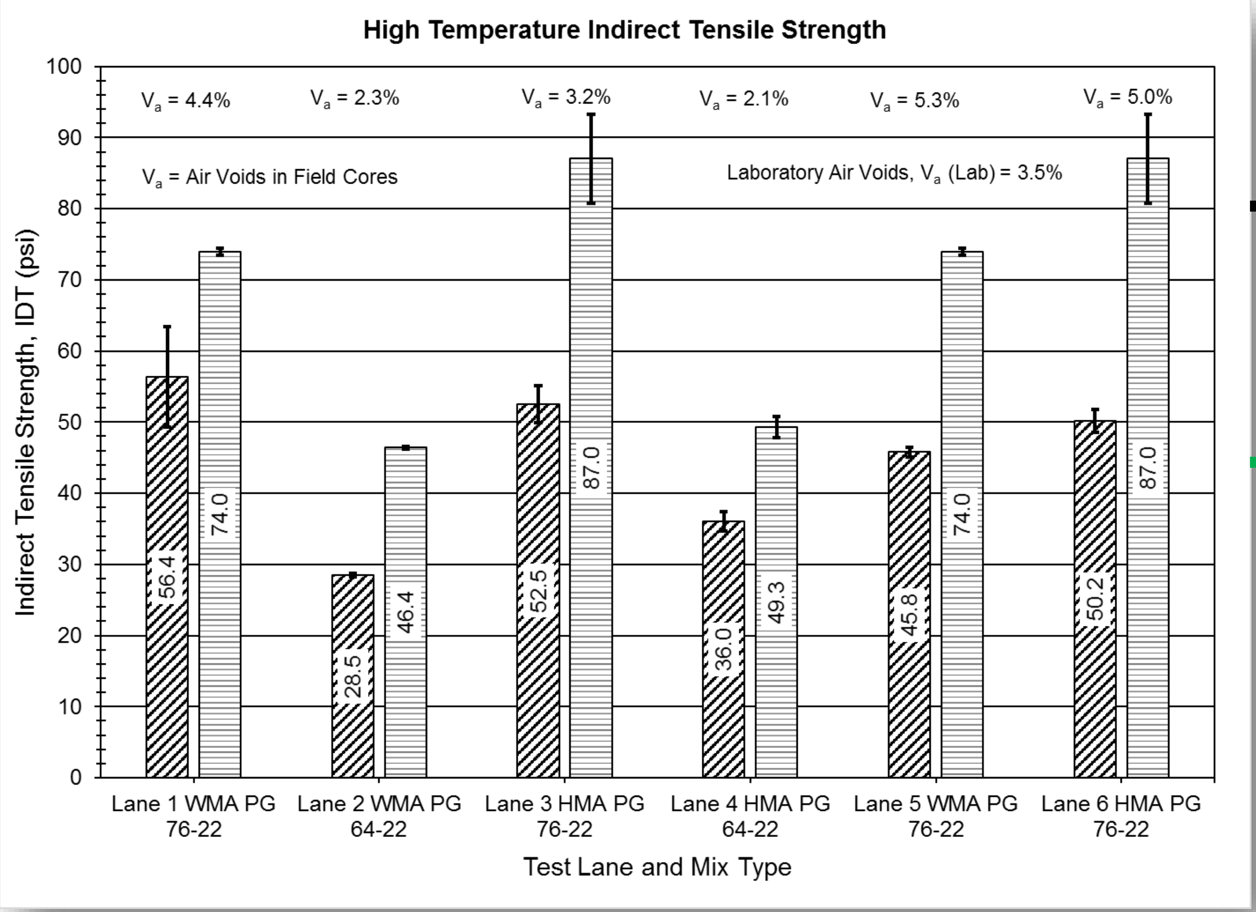
Conditioning:

Approximately 4-5hrs @ 104ºF (40ºC)

Rate of Loading:

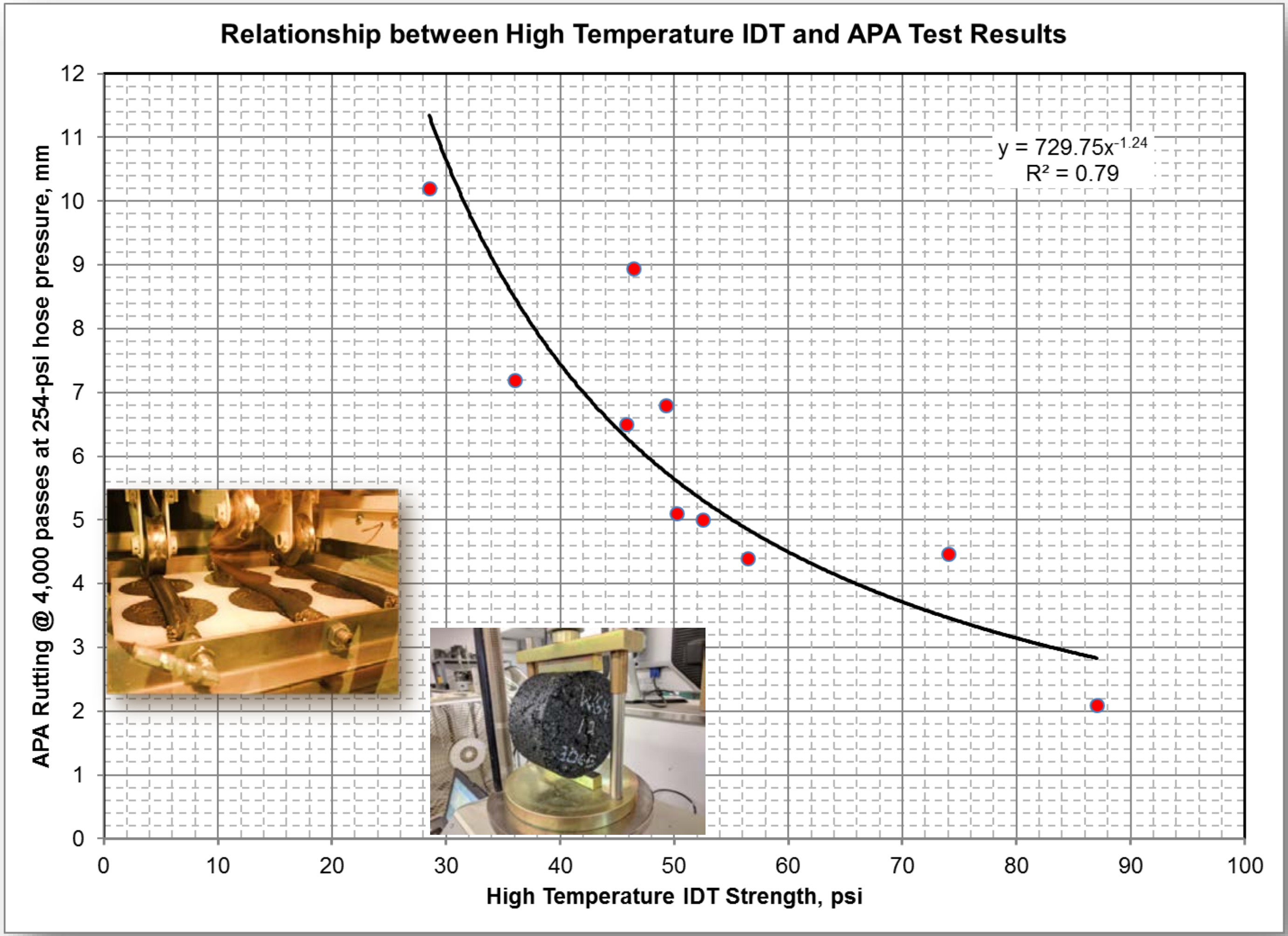
2.0 in./min (50mm/min)

TC1: High Temperature IDT Test Results

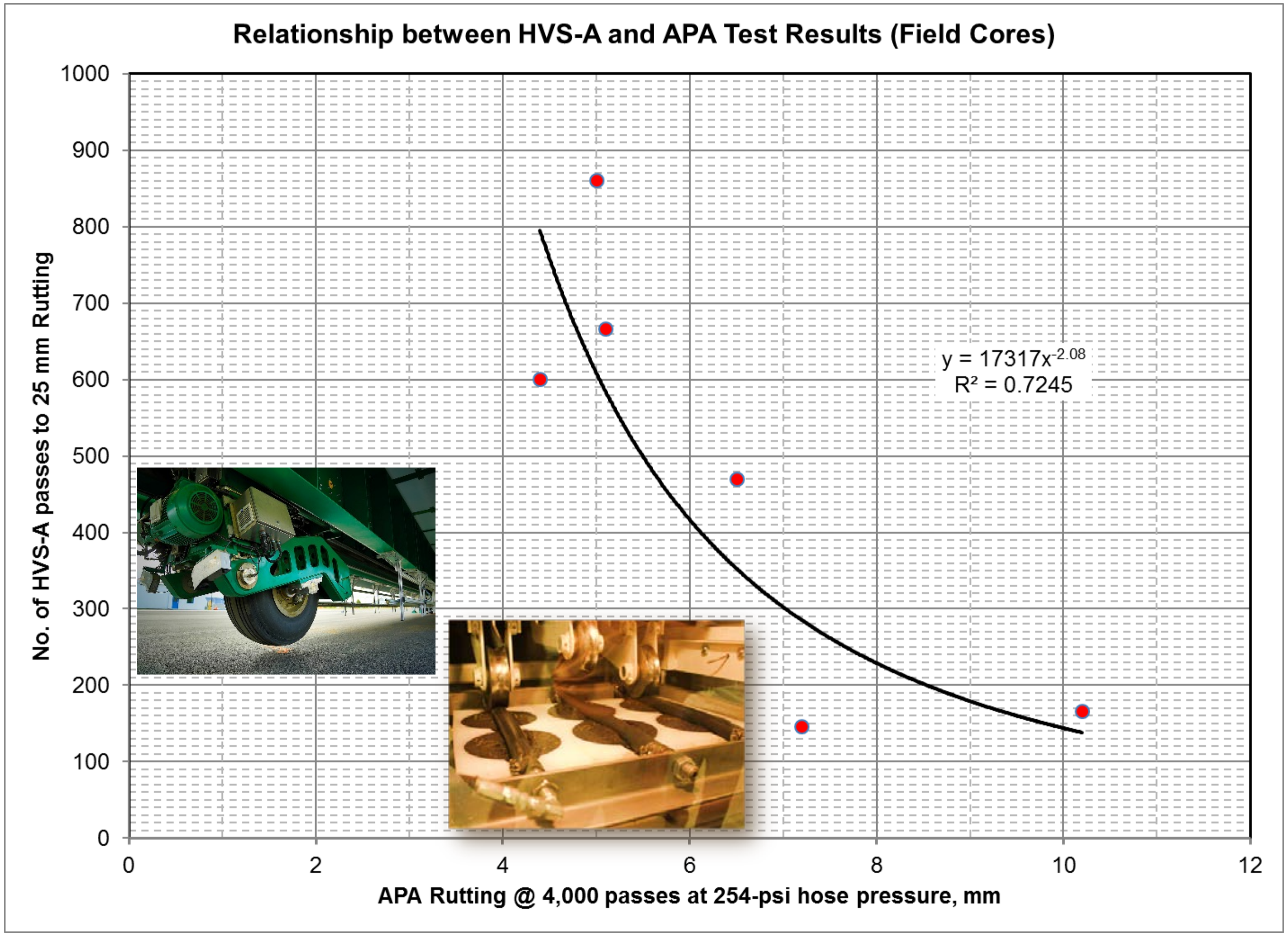


- Mixes with **polymer modified binder (PG 76-22)** consistently exhibited **higher strength** compared to **mixes with neat binder (PG 64-22);**
- **Field cores** exhibited considerably **lower strength** compared to the **laboratory compacted** specimens owing to **non-uniform air-voids**.

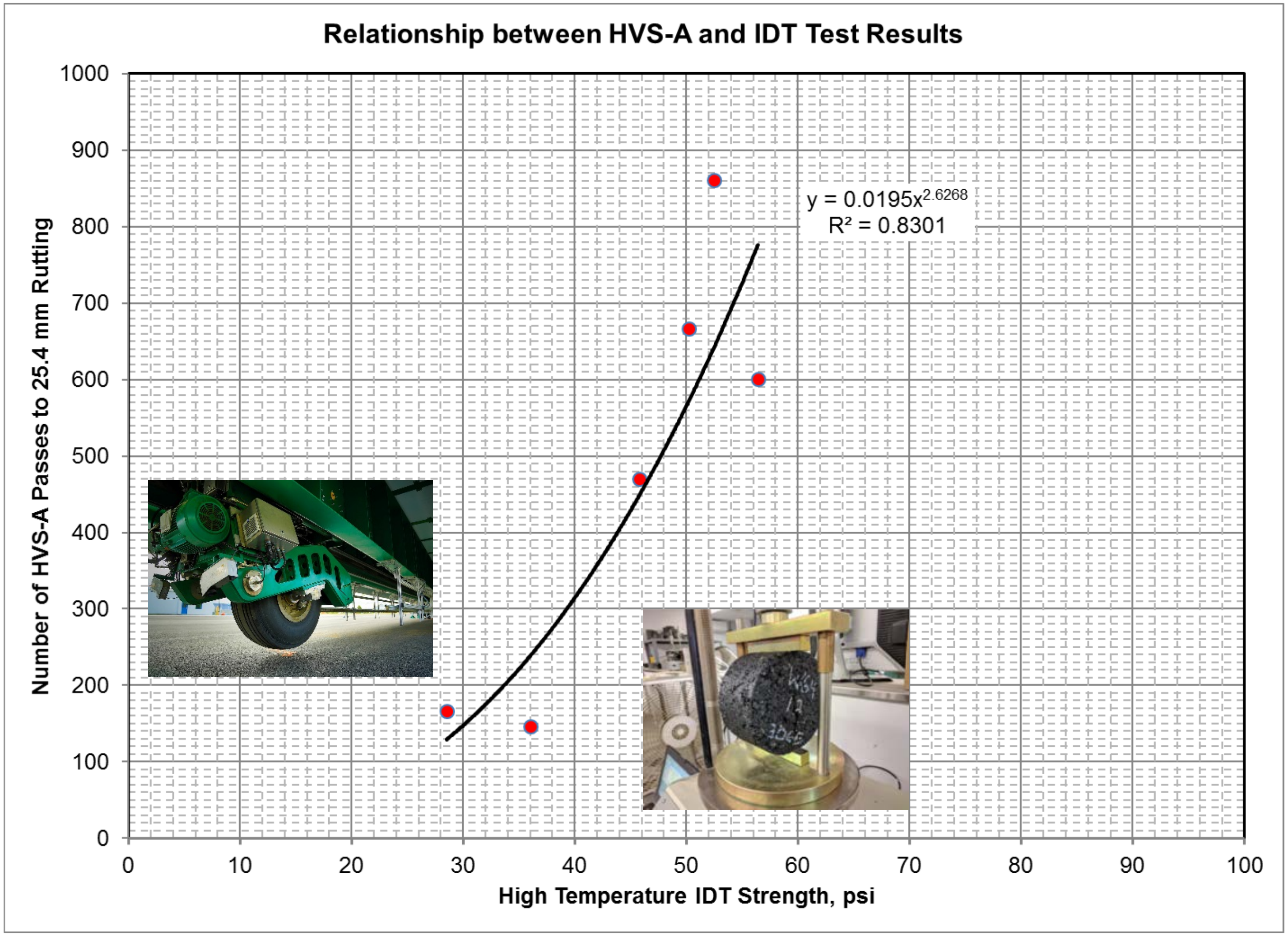
Relationship between IDT & APA Results



Relationship between HVS-A & APA Results



Relationship between HVS-A & IDT Results



HMA/WMA Characterization

- **Performance Testing**
  - Mixture Stiffness (Dynamic Modulus)
  - Fatigue Cracking (Flexural Beam Fatigue, Overlay Tester, SCB Flexibility Index)
  - Rutting Resistance (AMPT Flow Number)
  - Asphalt Pavement Analyzer (APA)




Mixture Conditioning

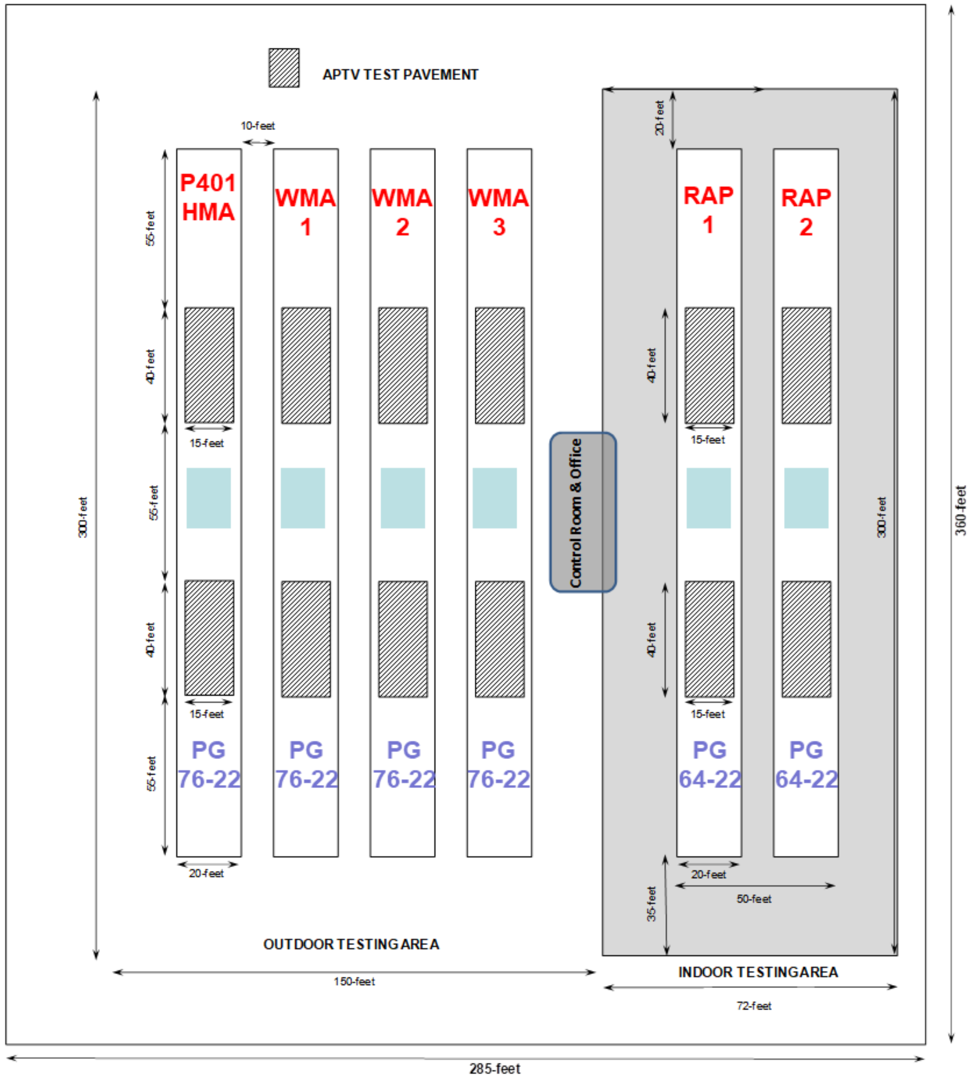
- **The sampled loose mix was “conditioned” in the laboratory to establish two different levels of “aging”**
- **Short-term Aged**
  - Loose mix reheated in laboratory for 2 hours at compaction temperature
  - Simulates early life aged condition (i.e. – 0 to 2 years)
- **Long-term Aged**
  - Loose mix reheated and conditioned in laboratory for 24 hours @ 135^{o}C
  - Research by Rutgers U. indicates this achieves similar rheological properties to asphalt of 12 to 14 years of age in the NY/NJ region

MATERIAL

RUTTING (test at high temperature)

CRACKING (test during winter)

Tire Pressure 254 psi



TOTAL AREA = 102,600 sq. feet (2.36 acres)

NAPMRC
Test Cycle-2 (TC-2)

Pavement Cross Sections

P-401 HMA/WMA SURFACE
9 inches

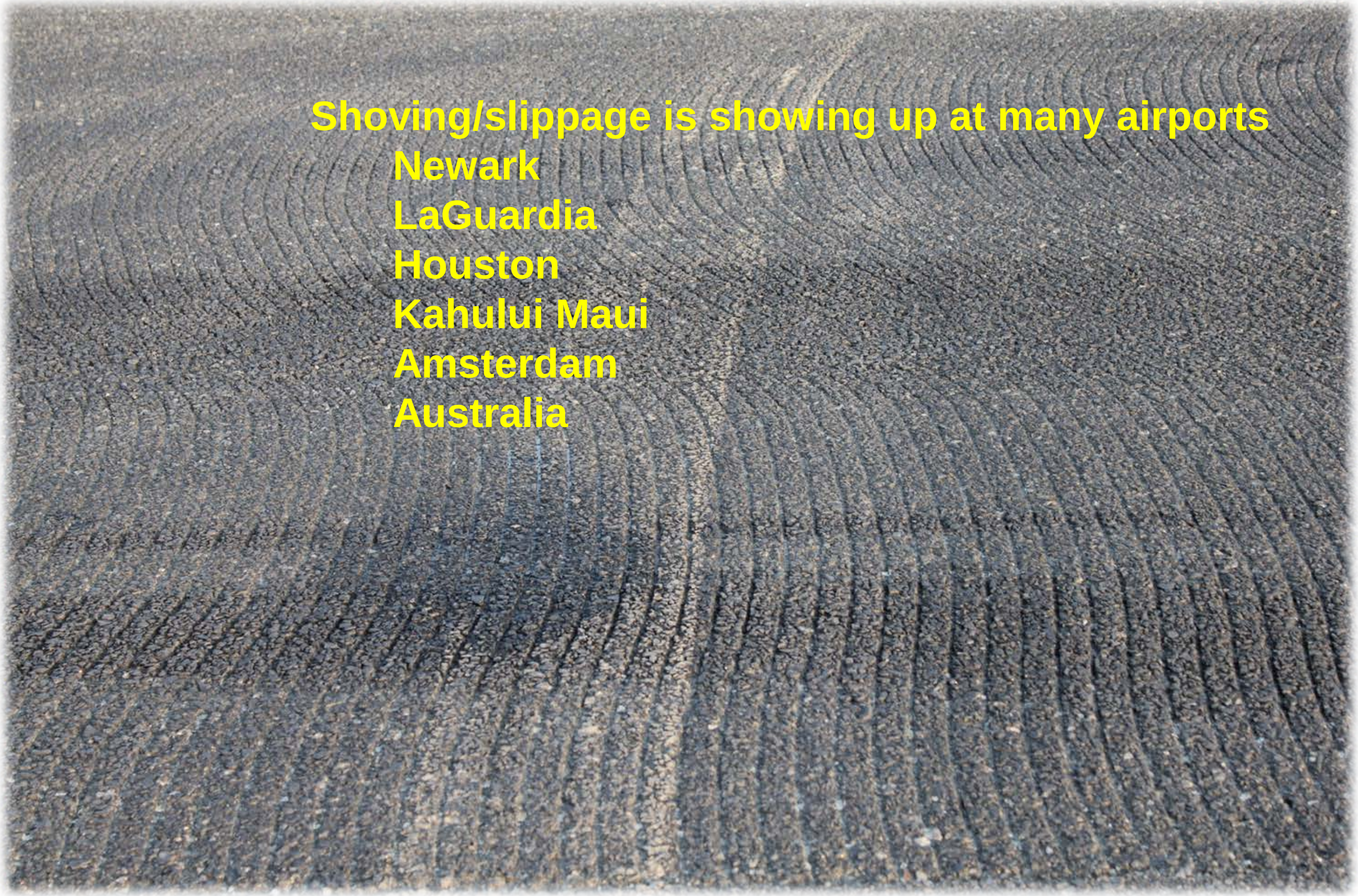
P-209 CRUSHED STONE BASE
8 inches

P-154 SUBBASE
12 inches

SANDY SUBGRADE
CBR 15

NAPMRC TC-2 PAVEMENT CROSS SECTION

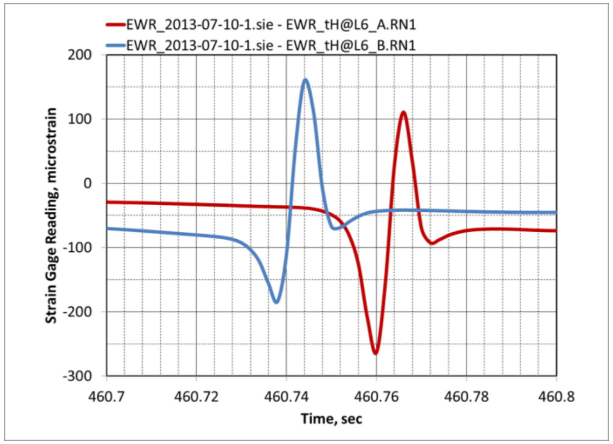
Field Instrumentation Projects



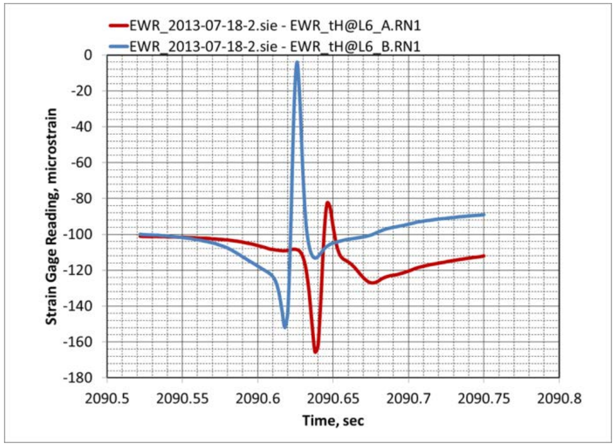
Newark Strain Gage Installation Location

High-Speed Taxiway N of Newark Liberty International Airport

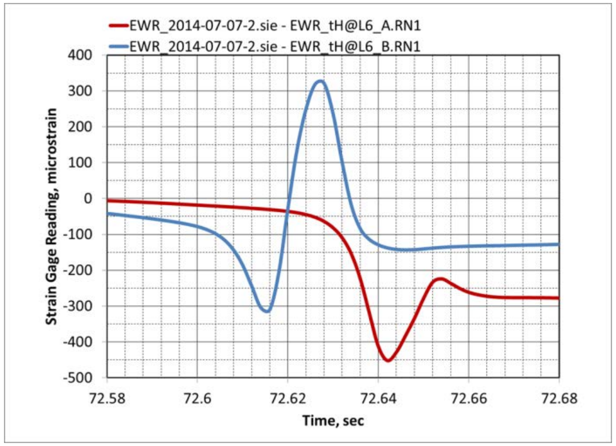
HMA Delamination and Slippage at EWR Airport



2013-07-10



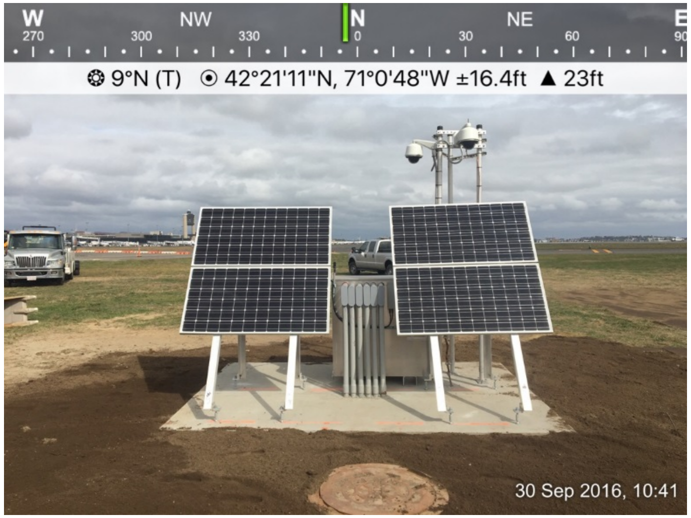
2013-07-18



2014-07-07

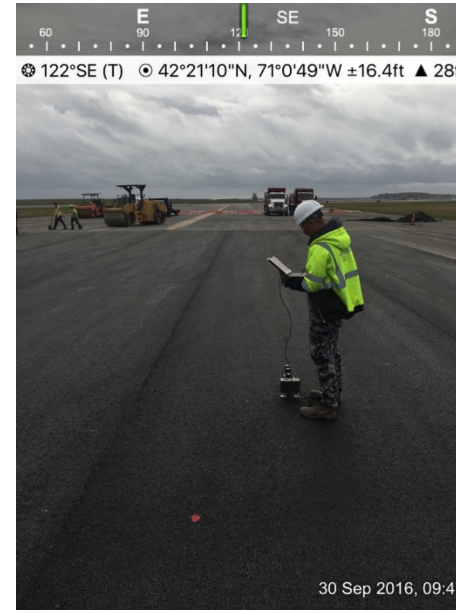
Boston Logan International Airport (BOS)

Boston Logan International Airport (BOS)

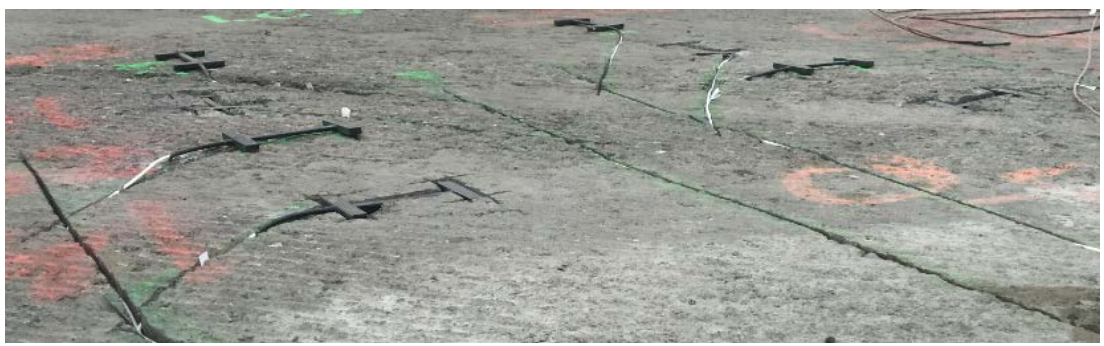


Data Acquisition Unit

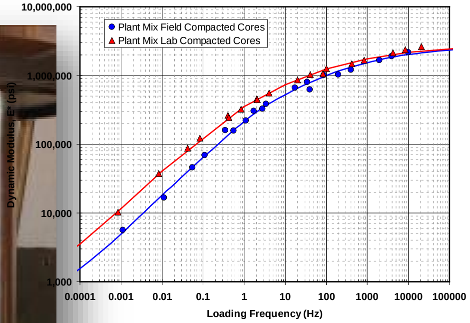
LWD

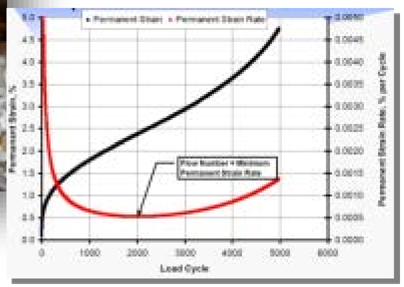


PSPA

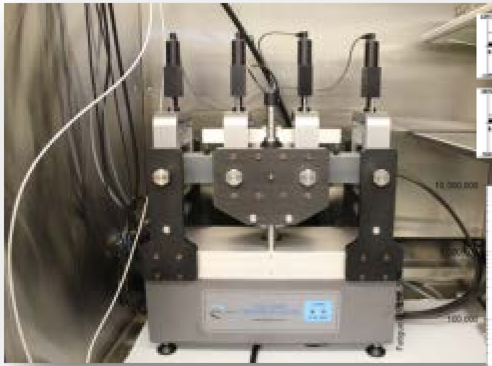


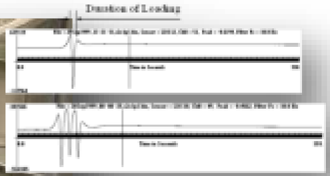
Example Strain Gauge Installation at Taxiway M-Taxiway B Intersection

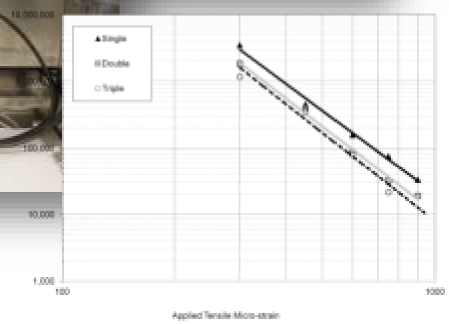


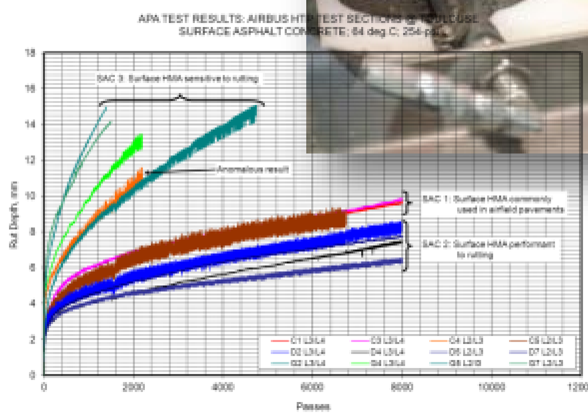


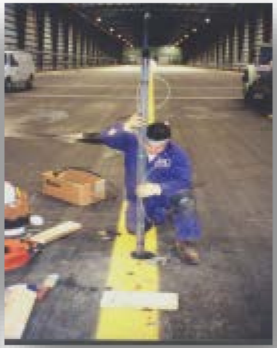
LABORATORY CHARACTERIZATION



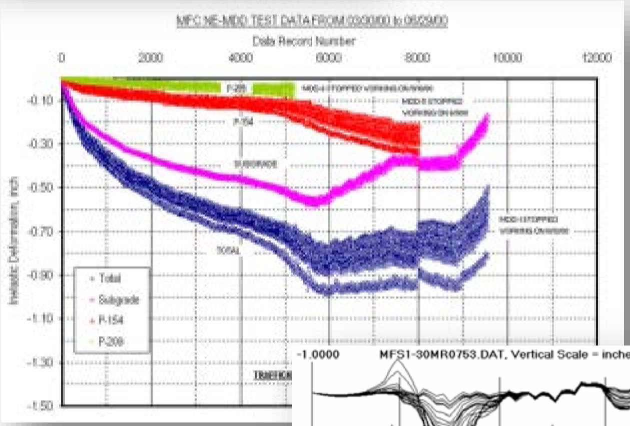


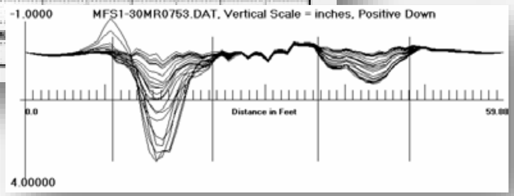


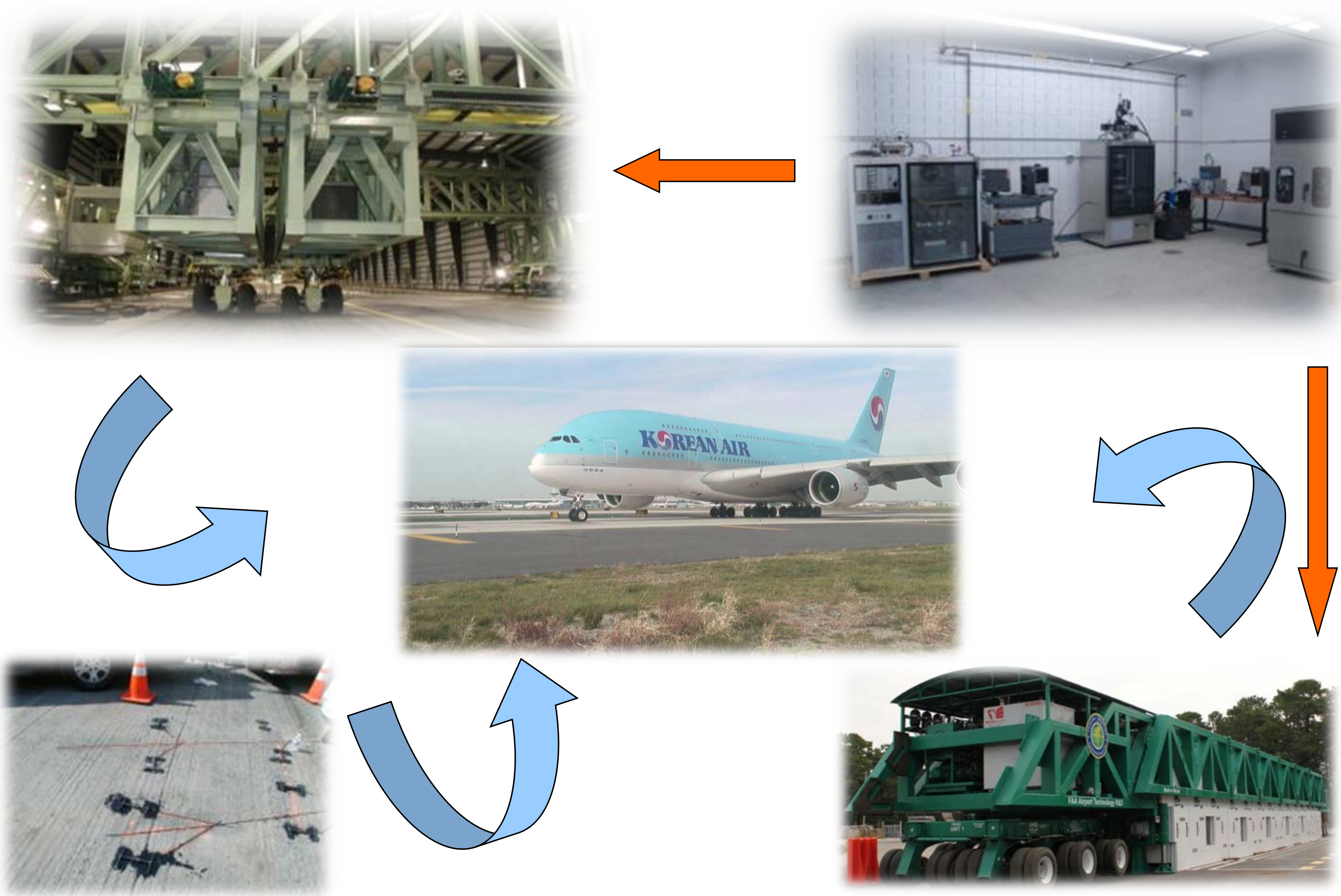




FULL SCALE APT






KOREAN AIR

Navneet Garg, Ph.D.
Program Manager, NAPMRC
(609)485-4483
Navneet.Garg@faa.gov
http://www.airporttech.tc.faa.gov

ACKNOWLEDGEMENTS

- **FAA**
  Jeff Gagnon
  Murphy Flynn
  Benjamin Mahaffay
  Wilfredo Villafane
  Stephen Murphy

- **Dynatest Consulting**
  Peter Millar

- **ARA**
  Scott Murrell
  Lia Ricalde
  Tim Parsons
  Hasan Kazmee
  Sam Guy
  Chris Tomlinson
  Russel Kniereim
  John Gerke

- **CSRA**
  Dennis Bataille
  Monir Haggag
  David Traverzo