Asphalt Institute Airfield Pavement Program

WAPA
WISCONSIN ASPHALT PAVEMENT ASSOCIATION

62nd Annual Conference and Business Meeting Kalahari Resort Nov. 30, 2021
Mark D Blow, P.E. – Sr. Reg. Engineer

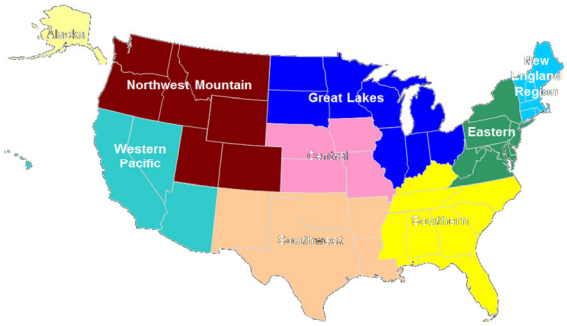
asphalt ACADEMY

Outline

- Size of Airfield Market
- Airfield Challenges
- 3-Day APTW Discussion
- 1 ½ Day APC Discussion
- Specs for Airfield Paving
- Recent Changes to P-401
- Cutting Back Longitudinal Joint

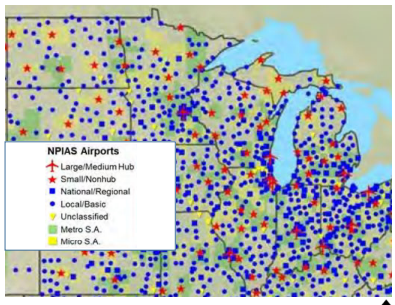
ARP Regional Divisions

There are **9** Airports Regional Offices, of which **6** larger offices also have field facilities called Airports District Offices (ADOs). The other **3** Regions are standalone and are structured to provide both Regional and ADO services.



Great Lakes Airports

- 8 States
- 636 airports
  - 12 hubs
  - 70 Commercial Service (passengers)
  - 800+ paved runways
- Region with most in the country



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FAA Airport Pavements in US

National Plan of Integrated Airport Systems (NPIAS)

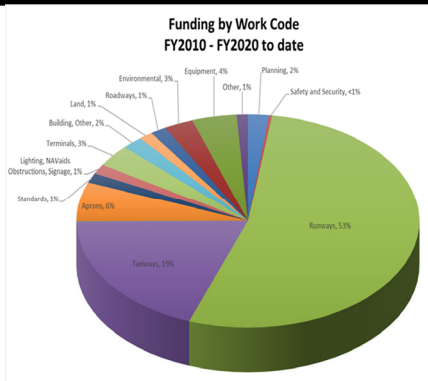
	AREA (million sy)	~14' wide Lane Mile	Overall %
RW	273	~33,000	59.4
TW	105	~13,000	22.8
Apron	81	~10,000	17.6
Total	460	~56,000	100.0

Credit Doug Johnson, FAA

***For Comparison: U.S. Interstate System has* 226,304 Lane Miles**
FHWA Table HM-60 - Highway Statistics 2017

Approximately 80% of RWs are asphalt
- General Aviation (50%): 7:1 HMA/PCC
- Primary (38%): 2:1 HMA/PCC

Most AIP $ is spent on Pavement



Example:

2017 Overall FAA Grants

- $3.2B Total AIP
- **>50%** Airside Pavements ~$1.7B

Two AI Courses Specific to FAA Standards

3 days on wide variety of topics, including pavement design/evaluation, materials, mix design, construction, preservation and rehab for airports.

- **Offered in Fall each year**

1.5 days focusing on P-401

- **Offered several times per year**
- **Next offering to be virtual in Spring of 2022**

AI / FAA Workshop Mission

Provide state of the art technical info. on airport asphalt pavements

- Necessary for:
  - Design
  - Construction
  - Maintenance /Preservation /Rehab

All presentations customized to airport pavements, and all reflect latest FAA guidance (ACs and errata)

3-Day Workshop Overview

APTW Background

- **Workshops started in 1999**
  - 2 offerings per year
- **AI and FAA have partnered throughout this time to conduct each offering**
  - Also reliant on regular contingent of outside experts as speakers
- **Locations rotated among FAA Regions**
- **One 3-day APTW per year, Oct-Nov**

AI Training in 2020 with COVID

- **Converted to all virtual offerings**
  - vAPTW in Oct 2020
  - vAPC in May 2020 and Mar 2021
  - Same content as in-person offering
  - 3 to 3.5 hours per day (typical)
- **Starting Fall 2021**
  - Offer some in-person and some virtual
  - vAPTW in Nov 2021
- **2022 plans**
  - One APC and one APTW

So why the need
for a special FAA Workshop?

9 – AC's (FAA Advisory Circulars)

150_5320_6E Airport Pavement Design & Evaluation
150_5320_17A Surface Evaluation and Condition Rating
150_5335_5C PCN Reporting
150_5370_2F Operational Safety During Construction
150_5370_10G Standard for Specifying Construction of Airports
150_5370_10G Standard for Specifying Construction of Airports
150_5370_13A Offpeak Construction
150_5380_6C Guidelines & Procedures for Maintenance
150_5380-7B Airport Pavement Management Program (PMP)
FAA Advisory Circulars Required for Use in AIP Funded and PFC Approved Projects

22 – EB's (FAA Engineering Briefs)

EB_34A
EB_42
EB_56
EB_57
EB_57PWL
EB_63b
EB_64d
EB_65a
EB_66
EB_67d
EB_72a
EB_73
EB_74A
EB_75
EB_76
EB_78
EB_79
EB_83
EB_84_draft
EB_87
EB_89
EB_91
EB_92

Numerous Spreadsheets, Manuals and Supporting Doc's

AC1000-P401-PWL-5370-10G-9-18-2014
F806FAA
Flexible Pavement Design Example
Flexible Pavement Design Manual
old 5370-10F P-401 Payment Adjustment for Densities and Air Voids
PC1000_PCC Payment Factor for Strength and Thickness
R805FAA_Rigid Pavement Design
Rigid Pavement Design Manual

2001 Preventive Maintenance Guidelnes
Asphalt-Surfaced-Airfields-Distress-Manual
Concrete-Surfaced-Airfields-Distress-Manual
ISSA A105_Slurry Seal Guidelines_FEB2010
ISSA A143_Micro Surfacing Guidelines_FEB2010
Laboratory Accreditation
Mixture Selection Guide 2001
MOS Orlando IAP
MOS Rock County Airport
MOS Stevens Point Municipal, WI
Sawcut and Seal Details-LaDOTD
Selecting PM Treatment Jun 2000
TxDOT Pavement Mgmt Handbook

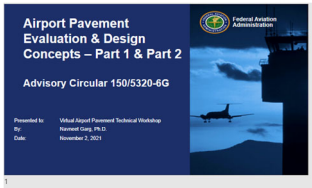
These items are all tied up into 31 Presentations

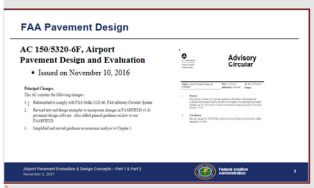
Ref No 1 - Workshop Overview and Introduction
Ref No 2 - FAA Overview.Regional Airport System
Ref No 3 - Airport Terminology
Ref No 4 - Overview FAA Update
Ref No 5 - Airport Pavement Evaluation & Design
Ref No 7 - Airport Pavement Thickness Design-FAARFIELD2
Ref No 8 - Class Exercise 1 - Flexible Pavement Design Using FAARFIELD2
Ref No 9 - Class Exercise 2 -HMA Overlay Design Using FAARFIELD2
Ref No 10 - ACR PCR Concepts
Ref No 11 - Asphalt Binder Selection
Ref No 12 - Aggregates
Ref No 13 - HMA Mix Design for Airport Pavements
Ref No 14 - Exercise - Review of Contractor Mix Design Submittal
Ref No 15 - Contractor Quality Control

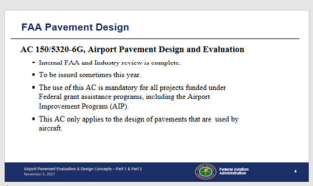
Ref No 16 - Owner Acceptance_PWL
Ref No 17 - Pay Factor Exercise
Ref No 18 - Prime Coat Milling Patching
Ref No 19 - Tack Coat
Ref No 20 - Paving Operations
Ref No 21 - Compaction
Ref No 22 - Longitudinal Joints
Ref No 23 - Void Reducing Asphalt Membrane
Ref No 24 - Runway Surface Considerations
Ref No 24a - Runway Surface Considerations
Ref No 25 - Airport Pavement Management Concepts
Ref No 26 - Decoding FAA Surface Treatments
Ref No 27 - Fog Slurry and Microsurfacing
Ref No 28 - Gilsonite and Coal Tar Surface Treatments
Ref No 29 - Fuel Resistant Asphalt Mixtures
Ref No 30 - Crack Sealing
Ref No 31 - Rehab of PCC with HMA

10 Presenters in our last APTW

Pavement Design Advisory circulars







Example: New FAARFIELD 2.0, 2021

- kwsv=2z z z 1dlusruwhfk1wfiddljry2Surqxfw2Dlusruw0Sdyhp hqw0 Vriwz duh0Surjudp v2Dlusruw0Vriwz duh0 Ghwdlo2DuwP IG26:3;2DuwfdnIG25;742IDDUIIHOG0535
- FAA's airport pavement thickness design software
- Accompanying AC 150/5320-6G, Airport Pavement Design and Evaluation.
- Redesigned graphical user interface (GUI) with improved screen flow and explorer-based navigation.
- New 3D finite element computational library, FAASR3D (FAA Structural Response – 3D), written in Visual Basic.NET™.
- Supports new ICAO ACR-PCR system (planned to replace ACN-PCN).
- New graphical vehicle editor provides the ability to add, save and edit user-defined vehicles.
- Updated aircraft library.
- Ability to work with multiple jobs/sections at once.

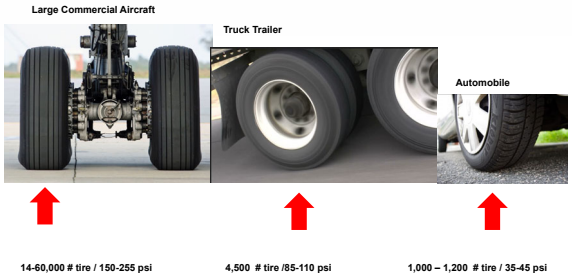
Aircraft Loads vs Highway Loads

- Aircraft and vehicle wheel loads differ significantly
- Aircraft tires are inflated to much higher pressures than vehicle tires
- The combination of higher aircraft wheel loads and tire pressures requires higher load design approach, materials and construction methods
- Aircraft engines sensitive to damage from pavement debris

We are Airports

FAA Office of Airports

Airplane vs Truck vs Car



We are Airports

FAA Office of Airports

Aircraft Loads vs Highway Loads

We are Airports

FAA Office of Airports

Keys to State Specs in lieu of P-403

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P-403

State highway department specs **may** be used in lieu of this specification for:

1. Access roads, perimeter roads and other pavements not subject to aircraft loading
2. Stabilized base courses under Item P-501
3. **Pavements designed for aircraft gross weight of 30,000 pounds or less**

- Must have a demonstrated satisfactory performance record under equivalent loadings and exposure.
- If density requirement is not specified, it shall be modified to include 403 requirements
- Include all applicable/approved state specifications

The use of state highway specifications for pavements subject to aircraft loading greater than 30,000 pounds and less than 60,000 pounds requires a MOS

A. P. Terminology and Distress ID

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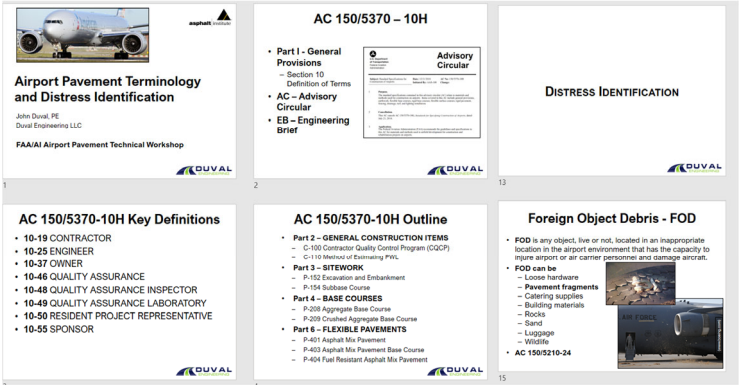

Construction Safety

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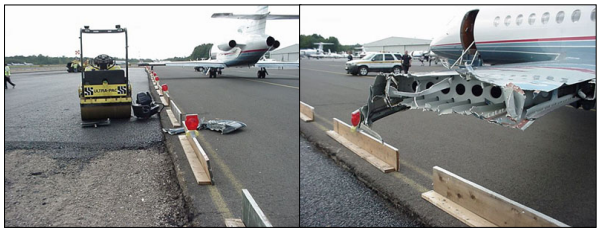

- See FAA Advisory Circular 5370-2 for help
- FAA $ - Construction Safety Phasing Plan required

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The Asphalt Institute | **Airfield Paving Clinic** *focusing on P-401*

Workshop Overview

APC - Started in 2019

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- **Offer new 1.5-day Airport Paving Clinic (APC)**
  - Deep-dive into just the P-401
  - Material specs, construction guidance, quality control and acceptance testing requirements
  - 1 or 2 offerings per year
  - All the APC content is part of APTW

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Airfields provide unique pavement challenges different from highways

Heavier Loadings
aircraft loads can exceed 1M# vs. 160,000# max load on hwys/bridges

Higher Tire Pressures
can exceed 300 psi vs. semi truck ≈ 100 psi

Foreign Object Debris (FOD)
must keep airfields at higher serviceability level

FOD is Real !!

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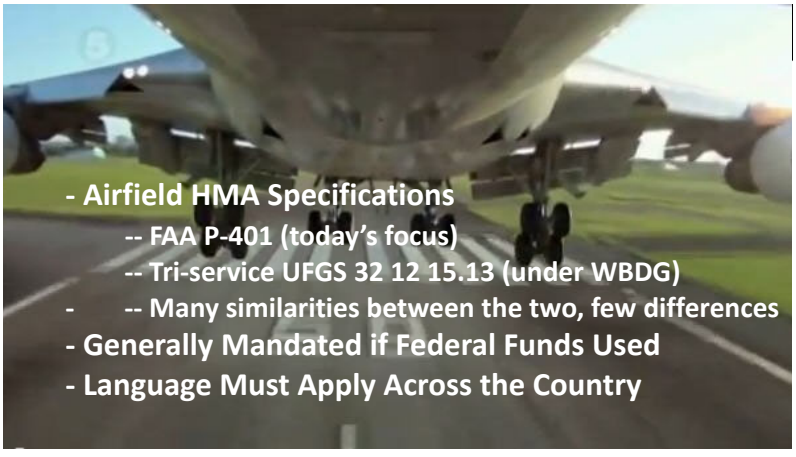
The GE-90 Engine used on Boeing 777's costs ???

$24M !!



- Airfield HMA Specifications
  - -- FAA P-401 (today's focus)
  - -- Tri-service UFGS 32 12 15.13 (under WBDG)
  - -- Many similarities between the two, few differences
- Generally Mandated if Federal Funds Used
- Language Must Apply Across the Country

APC – Example of Group Exercise

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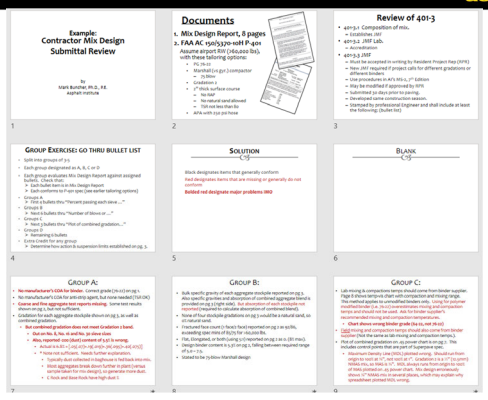
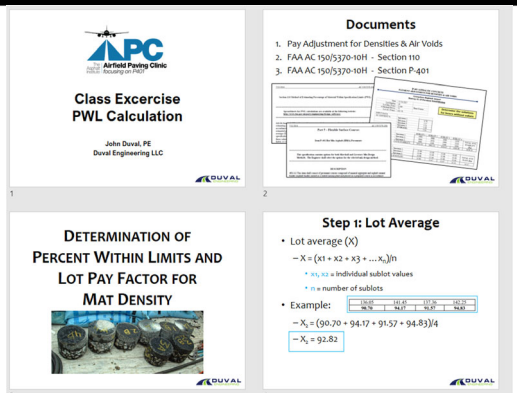
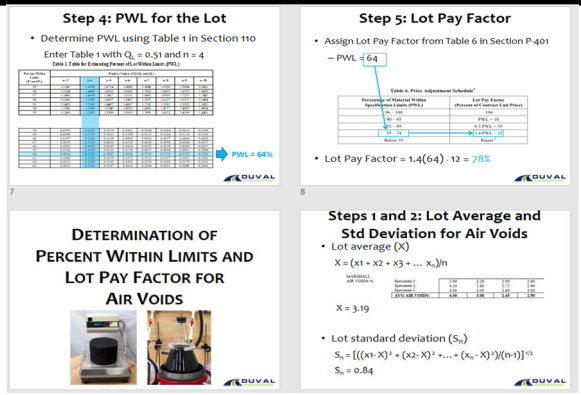


APC – PWL Class Excercises





Beware FAA $, strict standards!

- P-403 Density

403-5.2(b)(1) Mat density. Acceptance of each lot of plant produced material for mat density shall be based on the average of all of the densities taken from the sublots. If the average mat density of the lot so established equals or exceeds 96%, the lot shall be acceptable. If the average mat density of the lot is below 96%, the lot shall be removed and replaced at the Contractor's expense.

- P-401 PWL (% within limits)

Significant Changes to P-401, Dec 2018

- **Adjusted gradation bands**
  - matching military airfield specs
- **Improved minimum lift thickness guidance**
- **Tack coat as a separate pay item**
- **Contractor quality control**
  - greater emphasis, new requirements, separate pay item
- **New loaded wheel test requirement for mix design**
  - APA with 250 psi hose pressure at 64C
- **New guidance on PG grade selection**
  - additional grade bump
- **Compaction now % of TMD (vs lab bulk density)**
  - matches highway industry
- **Greater use of State highway standards**

On December 21, 2018, FAA released a new version of their Airport Construction Standards
AC 150/5370-10G (released 2014)
~~**AC 150/5370-10H**~~

- P-401 just one of many specs in this AC (700+ pgs).

- Revision process includes extensive internal, industry and legal reviews (16 months, 2200+ comments). Thus, these ACs don't get updated frequently. Errata changes do occur.

Typical FAA Pavement Layers (for Flexible Pavements) and Their Specs in AC 150/5370-10H

- Surface Course
  - P-401 (asphalt mix)
  - P-403 (similar to P-401 but no PWL)
    - For pavements supporting aircraft <30,000 lbs, or shoulders, roads, blast pads, or small maintenance projects
  - P-404 (fuel-resistant asphalt mix)
- Stabilized Base Course (typically required for aircraft > 100,000 lbs)
  - P-403 (when used as bond-breaker)
  - P-304, P-306, P307 (various cement treated aggregate bases)
- Base Course
  - P-209 (crushed aggregate)
  - P-208 (aggregate, less crushed)
  - P-207 (full depth reclamation - New)
- Subbase
  - P-154 (coarse sand)

Significant Changes to P-401 (Dec 2018)

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Covered in next Slides. Changes noted in red.

Slide 38

GD1 Gierhart, Danny, 3/28/2019

GD1

Changes to P-401 Mix Gradations (Table 2)

Sieve	Gradation 1	Gradation 2	Gradation 3
1 inch	100	- -	- -
3/4 inch	90 - 100	100	- -
1/2 inch	68 - 88	90 - 100	100
3/8 inch	60 - 82	72 - 88	90 - 100
No. 4	45 - 67	53 - 73	58 - 78
No. 8	32 - 54	38 - 60	40 - 60
No. 16	22 - 44	26 - 48	28 - 48
No. 30	15 - 35	18 - 38	18 - 38
No. 50	9 - 25	11 - 27	11 - 27
No. 100	6 - 18	6 - 18	6 - 18
No. 200	3 - 6	3 - 6	3 - 6

P-401-3.3

Gradation bands adjusted to match UFGS 32 12 15.13, and be consistent with NMAS definition.

Gradation 2 is typical surface mix. Gradation 3 intended for leveling courses. Gradation 1 generally for non-surface mixes.

Changes to P-401 Mix Gradations

Table 2. Aggregate - Asphalt Pavements

	Gradation 1	Gradation 2	Gradation 3
Min. VMA	14.0	15.0	16.0
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
Recommended Minimum Construction Lift Thickness	3 inch	2 inch	1-1/2 inch

P-401-3.3

VMA now listed in Table 2. Criteria unchanged (1% higher than SP)

Min. Lift Thickness recommendation also added.

In Both P 401 and UFGS 32 12 15.13

Designer's option to choose between Marshall Hammer or Superpave Gyratory Compactor as Lab Compactor

New Loaded Wheel Test Requirement as Part of Mix Design - Designer Options

- **Primary Method—APA @ 250 psi**
  - AASHTO T340, 64ºC, 250 psi hose pressure
  - Rutting must be < 10 mm @ 4,000 passes
- **Alternative Method—APA @ 100 psi**
  - AASHTO T340, 64ºC, 100 psi hose pressure
  - Rutting must be < 5 mm @ 8,000 passes
- **Alternative Method—Hamburg Device**
  - AASHTO T324
  - Rutting must be < 10 mm @ 20,000 passes

➢**Only Required on Projects for > 60,000# aircraft**

- Per Errata published on 11/12/19

Reference: AC 150/5370-10H

P-401 Calls for PG Grade (ASTM D 6373) and possible PG-plus test

Guidance in engineering note

- Determine "base grade" (based on climate only, no bumping for traffic), then bump per table:

Aircraft Gross Weight	High Temperature Adjustment to Asphalt binder Grade	
	All Pavement Types	Pavement area with slow or stationary aircraft
≤ 12,500 lbs	--	1 Grade
< 100,000 lbs	1 Grade	2 Grade
≥ 100,000 lbs	2 Grade	3 Grade

- Add PG Plus test if UTI is 92 or greater
  - Default is ER (ASTM D6084) 75% min*.
    - -- Errata note (Sep 2019): *Follow procedure B on RTFO aged binder
  - Engineer may replace ER with the local state DOT's PG-Plus test (and criteria).
    - -- Reference AI's binder spec database to see what each state uses

What about RAP or RAS?

- No RAP for surface mixes, except shoulders
- Max RAP is 30% for non-surface layers & shoulders.
- When using RAP:
  - 0-20% RAP, no change in binder grade
  - 20-30% RAP, adjust to one grade softer (HT and LT)
    - PG 64-22 adjusted to 58-28.
- No Recycled Asphalt Shingles (RAS)

Expanded Opportunities to Use State Paving Specs

- **Airfields with aircraft ≤ 30,000 lbs - NO FAA-approved MOS required**
  - Used to be ≤ 12,500 lbs (under …-10G)
  - About 30% of RWs in NPIAS rated below 30,000 lbs
- **Non-primary airports > 30,000 and < 60,000 lbs**
  - Allowed with FAA-approved MOS
  - Due to FAA Reauthorization Act 2018
  - Current FAA sponsored research looking at performance of airfield projects built using state highway specs
- **Other pavements not for aircraft loading: shoulders, perimeter roads, blast pads, vehicle roads and parking. Also stabilized base under PCC**

P-404 Fuel-Resistant Mixture

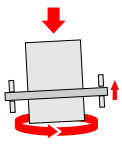
- **Per FAA, use only as surface course (1.5" - 3" thick) where fuel resistance needed**
  - On aprons to replace PCC or coal tar sealers
  - Some airports have used P-404 on RWs and TWs prone to rutting
- **Properties**
  - 50-blow Marshall
  - Design air Voids: 2.5%
  - 9.5mm gradation
  - Weight loss from fuel immersion test < 1.5%
- **Binder**
  - PG 88-22 or 92-28
  - ER > 85%
  - Separation test: max. temp diff. of 4 deg C (w/ ring and ball)

Tri-services just released (Nov 2020) similar FR mix spec for airfields: UFGS 32 12 17.19

Preparation of Gyratory Test Specimens

- **Gyratory Compactor**
  - **600 kPa**
  - **30 RPM**
  - **1.25º Angle**
- **Compact with 50 or 75 gyrations**
  - **<60,000 lbs = N_{des} = 50**
  - **≥60,000 lbs = N_{des} = 75**

6" Diameter Mold



Airfield specs require cutting back the longitudinal joint.

401-4.14 Joints

- LJs shall be cutback if exposed >4 hrs, or if surface <175 deg F, or if irregular, damaged, uncompacted, etc.
- With cutting wheel (typical) or pavement saw (not typical)
- Cut back max of 3" for clean, sound, uniform vertical face full depth
- Remove cutback material
- Tack LJ face per P-603

Cutting Back Joint

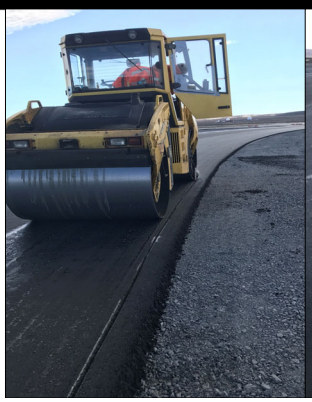
- Why: Eliminates low density material
- Avoid tearing
  - must cut when mix still warm (temperature sweet spot)
  - watering cutting wheel may help
- Critical to cut straight (use stringline)
  - easier with long wheel base vehicle

Cutting Wheel

Equipment for cutting back joint

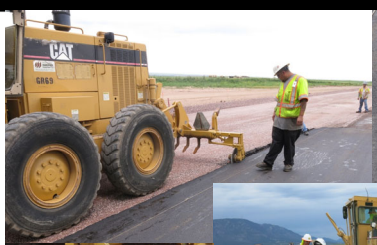
- Roller with cutting wheel attached to drum
  - operates on newly paved surface while mix is warm
- Grader
  - Operates on adjacent paving lane
    - Potential to cause rutting if on new mat that has not cooled
  - Some have cited easier to cut straight when cutting wheel attached to rear ripper versus blade between wheels
- Not recommended: short wheel base vehicles (i.e. skid steer)

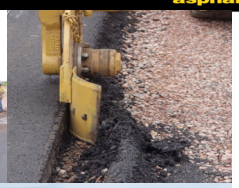
Thule AFB, Greenland

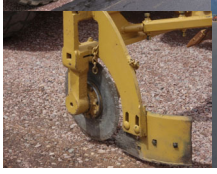


Thule AFB, Greenland (video)

Fort Carson, CO







Fort Carson, CO (video)

P-401 Joint Density

- 401-6.1 Acceptance sampling and testing
  d. (5) In-place Joint density
  - **One core centered over LJ for each sublot**
  - Joint density = bulk density divided by avg. TMD for lot
    - "For joints between two lots, use lower avg. TMD"
- 401-6.2 c. Acceptance criteria for joint density
  - **PWL of lot >90: acceptable**
  - **PWL <90%: evaluate reason**
  - **PWL <80%: cease operations until figure out why**
  - **PWL <71%: lot pay factor reduced by 5%**
- 401-6.3 PWL Acceptance limit for joint density
  - **Lower limit: 90.5% (Table 5)**
  - **90 PWL achieved when consistently producing average joint density of at least 92.5% with 1.55% or less variability**

More on Longitudinal Joints

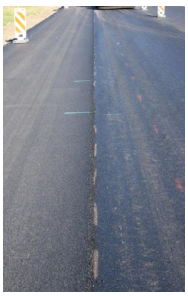
Not Airfield Specific

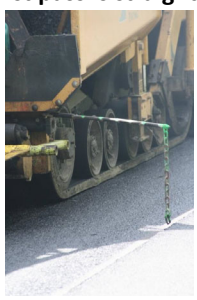
Resource: AI's "L.J. Info" Webpage

- **Based on workshop developed for FHWA and delivered to 45 State DOTs (2011 -2014)**
  - **Recommendations for roads, not airfields**
- **http://www.asphaltinstitute.org/engineering/longitudinal-joint-info/**
  - **Available for download:**
    - **Handout of workshop slides (180+)**
    - **Video of entire 4-hr Workshop in OH**
    - **Webinars**
    - **Project report**
    - **5-page "Summary of Recommendations"**
    - **Magazine articles on project and findings**

First Pass Must Be Straight!

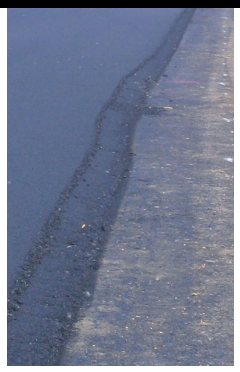
String-line should be used to assure first pass is straight



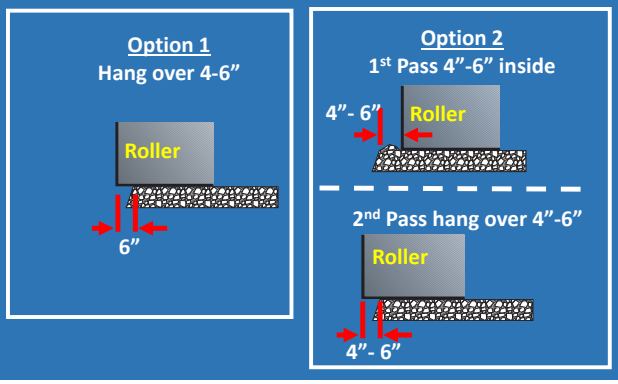


Stringline for reference, and/or Skip Paint, Guide for following

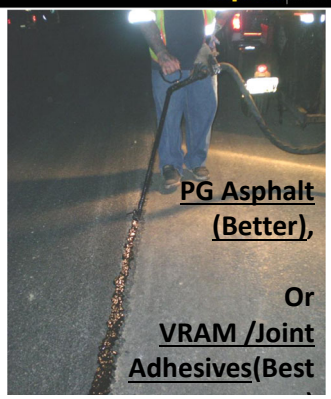
If not straight, impossible to get proper overlap (1") with next pass



Rolling Unconfined Side? 50-50 on Where to Put 1st Pass

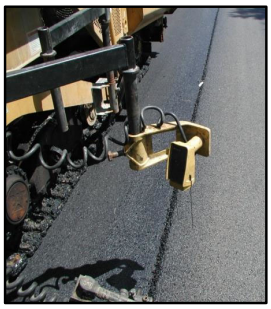


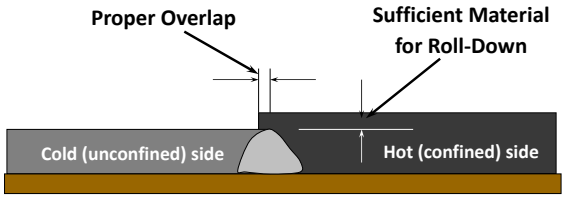
Paint the Side of Joint (Butt or Wedge)



When Closing Joint, Set Paver Automation to Never Starve the Joint of Material

- Target final height difference of +0.1" on hot-side versus cold side
  - NH spec requires 1/8" higher
- Joint Matcher (versus Ski) is best option to ensure placing exact amount of material needed
- If hot-side is starved, roller drum will "bridge" onto cold mat and no further densification occurs at joint





Proper Overlap:

- 1.0 ± 0.5 inches
- Exception: Milled or sawed joint should be 0.5 inches

Bumping the Joint?

Rolling Confined Side

1st pass entire drum on hot mat with roller edge off joint approx. 6-12”

2nd pass overlaps on cold mat 3-6”

Consider Pneumatic Rubber Tired Rollers

- Kneading action helps provide tighter surface that is more dense and less permeable compared to drum rollers.
- Keep away from unconfined edge to avoid excessive lateral mat movement
- Use during intermediate rolling of confined edge (not finish rolling)

Other Options / New Products

- Mill & Pave One Lane at a Time
- Echelon Paving
- Wider Paving Lanes
- Cut Back Joint
- Joint Heaters
- Intelligent Compaction
- Joint Adhesives (hot rubberized asphalt)
- Rubber Tire Rollers
- Surface Sealers Over Joint
- VRAM/ Longitudinal Joint Seal (LJS)

And Lastly, we all know

- Repairing RW or TW is Major Disruption to Ops
  - Can’t just close a lane and “keep traffic open”

A.I. Airfield Training Opportunities

Asphalt Airfields

Seminar	Date	Location	PDHs
Airfield Asphalt Certification Program	JAN 25-28, 2022	Lexington, KY	24
Airfield Paving Clinic	TBA	ONLINE!	12
Airport Pavement Technical Workshop	TBA	ONLINE!	23

Our Fall 2021 APTW workshop just concluded on Nov 12

Our First offering of our brand new AACP will be offered in-person in Lexington, KY

Our next APC and APTW workshops have not yet been scheduled for 2022. Look for an APC clinic coming later next spring.

Thanks to AI Members. Questions?