Airport Pavement Design & Evaluation

Draft AC 150/5320-6F

FAARFIELD Software

ACC Summer Workshop

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Washington, DC

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Overview

- **Current Status AC 150/5320-6F**
  - Internal and Industry Comments Incorporated
  - Currently at Technical Editor
  - Next step Legal Review
  - Anticipate Issuing Late September / Early Oct

Principal Changes

- **FAARFIELD v 1.41 (ver 1.41.0010 latest)**
  - Revised failure curves + added compaction computation
  - Pavement Design Report saved as pdf
- **Reformatted to comply with Order 1320.46**
- **Text & Examples updated**
- **Define Regular Use**
- **Added discussion on Structural Life & Functional Life**
- **Tables for Minimum Layer Thickness as opposed to light & other**

Selection of Pavement Type
(Draft AC 5320-6F)

1.3.2 Selection of Pavement Type.

1.3.2.1 With proper design, materials, construction, and maintenance, any pavement type can provide the desired pavement service life. Historically, airport pavements have performed well for 20 years as shown in *Operational Life of Airport Pavements,* (DOT/FAA/AR-04/46). However, no pavement structure will perform for the desired service life without using quality materials installed and maintained with timely routine and preventative maintenance.

1.3.2.2 The selection of a pavement section requires the evaluation of multiple factors including cost and funding limitations, operational constraints, construction time-frame, cost and frequency of anticipated maintenance, environmental constraints, material availability, future airport expansion plans, and anticipated changes in traffic. The engineer must document the rationale for the selected pavement section and service life in the engineer's report.

It is your job as Engineer to document the rationale for the selection of pavement type, section and service life.

Selection of Pavement Type

- **Alternative Pavement Sections**
  - Assumed all will achieve desired result
- **Cost Effectiveness Analysis**
  - Lowest total cost over life of project
  - Challenge User Cost Impacts
  - Routine maintenance – marginal impact
  - Focus on Initial Construction, preventative maintenance and rehabilitation costs

It is your job as Engineer to document the rationale for the selection of pavement type, section and service life.

Selection of Pavement Type

- Reality –
  Funds Available is always a factor

- Just because LCCA supports section does not assure that funds available to support initial construction

Subgrade Support

- **Compaction Recommendations calculated by FAARFIELD (draft AC 5320-6F)**
  - Based upon Compaction Index (CI) concept
  - Minimum rework / re-compact top 12” in cuts plus any additional depth as calculated by FAARFIELD
  - Maximum depth of compaction 72” below finished subgrade
- **Aircraft < 60,000 lbs ASTM D 698**
- **Aircraft > 60,000 lbs ASTM D 1557**

Stabilized Base

- Stabilized Base Required
  - Aircraft > 100,000 lbs
  - Full Scale tests have proven superior performance with stabilized base
  - If less than 5% of traffic > 100K but less than 110k, may consider not using (still a good idea to use)
  - Crushed aggregate with CBR > 100 may be substituted…stabilized still better long term performance.
  - Subbase under Stabilized base CBR > 35

Pavement Life (6F)

- Design Life in FAARFIELD = Structural Life
- **Functional Life = Period of time** pavement able to provide acceptable service as measured by performance indicators such as foreign object debris (FOD), skid resistance or roughness.
- Typically design for 20 year structural life
- To achieve intended service life requires quality materials and construction combined with routine and preventative maintenance

Aircraft Traffic Considerations

- Load
  - Maximum anticipated Departure (Takeoff) Weights
  - If arrival and departure at same weight or if no parallel taxiway may need to adjust number of departures to match number of times pavement is loaded with each operation
- Volume
  - Annual Departures of Fleet
  - New in 6F ‘regular use = 250 departures)
  - New in 6F ‘occasional use and seasonal’ need to be documented

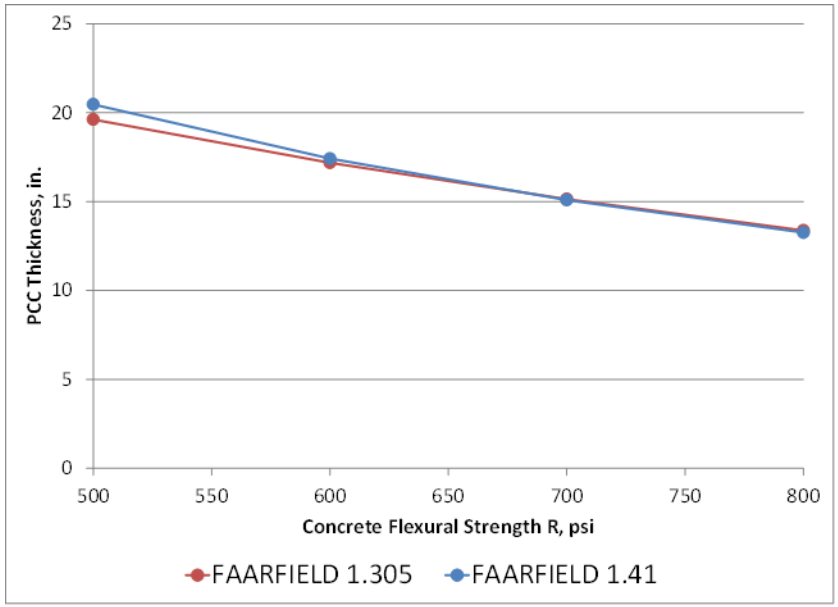
FAARFIELD 1.4 – What's New?

FAARFIELD 1.4 has:

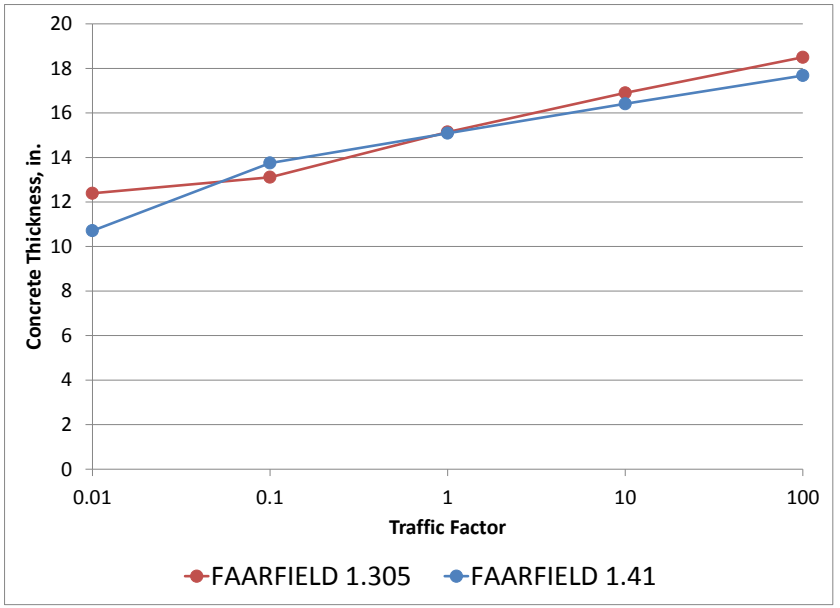
- Completely revised flexible and rigid failure models based on newest full-scale test data.
- Improved, more accurate 3D finite element model.
- Completely rewritten concrete overlay design procedure.
- Support for user-defined gear configurations.
- Updated aircraft library aligned with COMFAA 3.0.
- Automated, software-based compaction criteria.
- All data files now stored in document directories.
- Automatically generates PDF design report.

Improved Rigid Failure Model

- **Sensitivity to factors such as concrete strength, traffic level and subgrade support is similar to current version.**



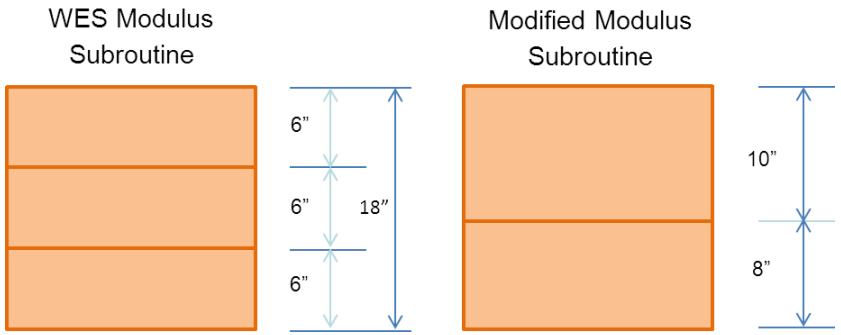
Effect of Concrete Flex Strength

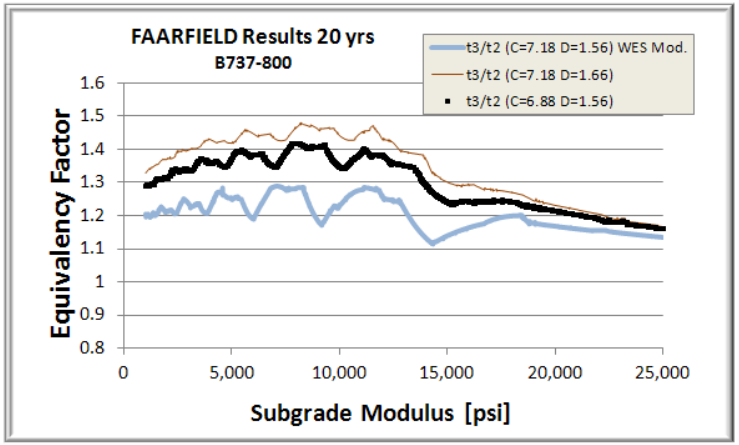


Effect of Traffic

New Aggregate Modulus Model

- **FAARFIELD 1.4 implements a new sublayering and modulus computation procedure for aggregate subbase (P-154 & P-209).**
- **Why?**
  - Previous procedure (WES Modulus subroutine) has gaps that can cause illogical results under some circumstances.
  - New model provides a continuous function of modulus with changes in P-154 thickness.
  - Better overall agreement with the P-209/P-154 equivalency factor used in PCN computations.





Automated Compaction Criteria

Computes compaction control points for rigid & flexible pavements.

FAARFIELD v 1.41 - Notes and Information for Job REDAC

Section Names

- NewFlexible
- NewRigid

Design Information for Section NewRigid

Subgrade Compaction Requirements

NonCohesive Soil

Percent Maximum Dry Density(%)	Depth of compaction from pavement surface (in)	Depth of compaction from top of subgrade (in)	Critical Airplane for Compaction
100	0 - 16	--	B777-200 ER
95	16 - 70	0 - 43	B777-200 ER
90	70 - 183	43 - 156	B747-200B Combi Mixed

Cohesive Soil

Percent Maximum Dry Density(%)	Depth of compaction from pavement surface (in)	Depth of compaction from top of subgrade (in)	Critical Airplane for Compaction
95	0 - 16	--	B777-200 ER
90	16 - 28	0 - 1	B777-200 ER
85	28 - 96	1 - 69	B747-200B Combi Mixed
80	96 - 178	69 - 151	B747-200B Combi Mixed

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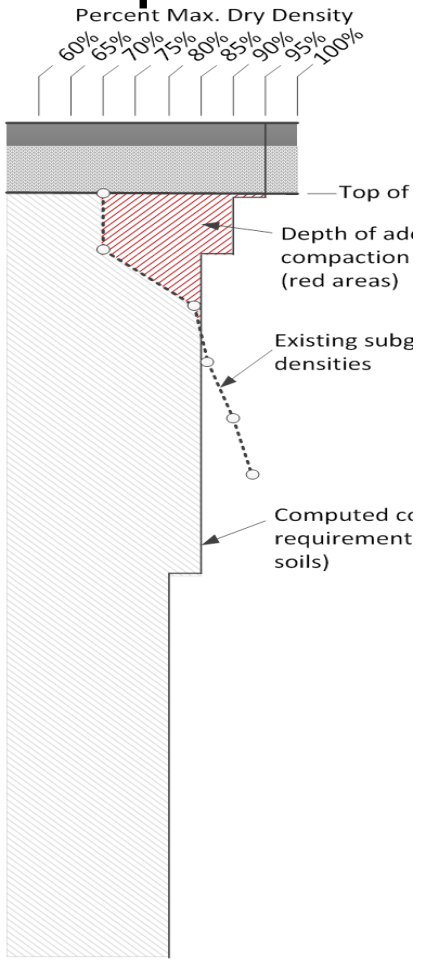
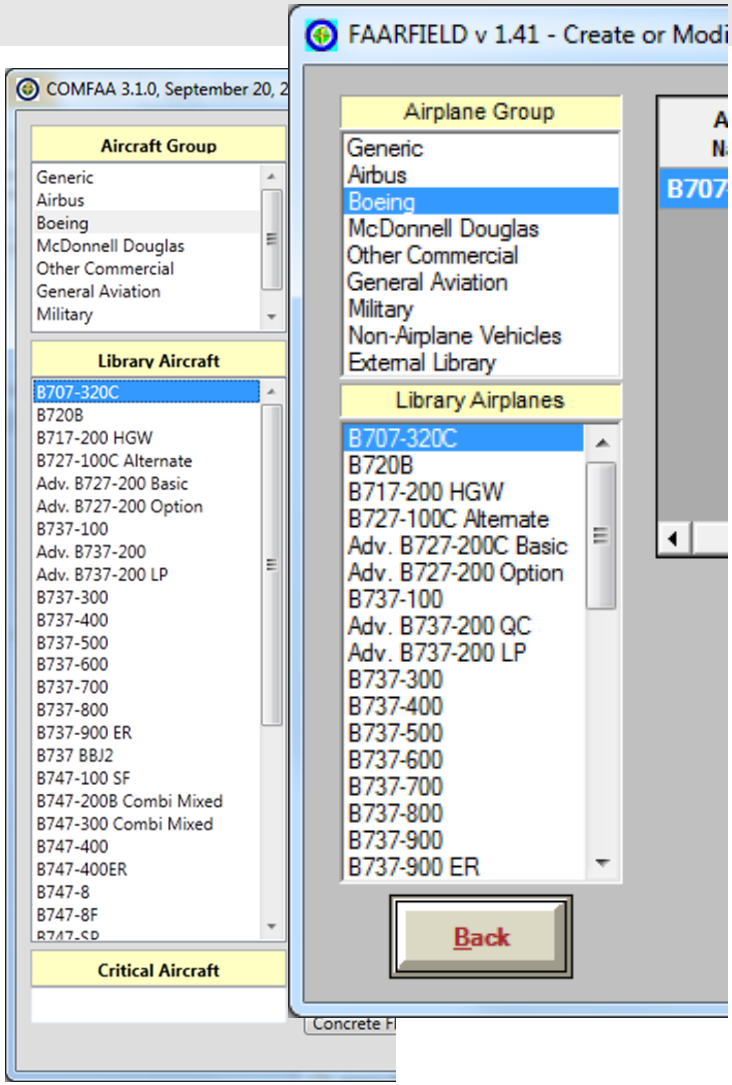


Aircraft Libraries

- **Aligned the aircraft libraries in COMFAA and FAARFIELD to the extent possible.**
- **Used the most current data from manufacturers.**
- **Multigear AC split into main & belly, but link AC**
- **Included new aircraft:**
  - A350-900 (Preliminary)
  - B747-8
  - B787-9
  - Embraer Fleet



Airport Pavement Design

Table 3-4. Minimum Layer Thickness for Rigid Pavement Structures

Layer Type	FAA Specification Item	Maximum Airplane Gross Weight Operating on Pavement, lbs (kg)		
		<12,500 (5 670)	< 100,000 (45 360)	≥ 100,000 (45 360)
PCC Surface	P-501, Portland Cement Concrete (PCC) Pavements	5 in. (125 mm)	6 in (150mm)[1]	6 in (150mm)[1]
Stabilized Base	P-401 or P-403; P-304; P-306	Not Required	Not Required	5 in. (125 mm)
Base	P-208, P-209, P-211, P-301	Not Required	6 in. (150 mm)[2]	6 in. (150 mm)
Subbase[3,4]	P-154, Subbase Course	4 in. (100 mm)	As needed for frost or to create working platform	As needed for frost or to create working platform

1. FAARFIELD thickness to be rounded to the nearest 0.5 inch (10 mm)
2. For pavements for Aircraft < 30,000 lbs(13,610 kg) base may be replaced with subbase.
3. Subbase layer is required for pavements designed for gross loads of 12,500 pounds (5 670 kg) or less only when the following soil types are present: OL, MH, CH, or OH..
4. The following specification items may also be used as subbase: P-208, Aggregate Base Course; P-209, Crushed Aggregate Base Course; P-211, Lime Rock Base Course; P-219 Recycled Concrete Aggregate Base Course; P-301, Soil-Cement Base Course. If more than one layer of subbase is used, each layer should meet the minimum thickness requirement in this table.

Airport Pavement Design

Table 3-3. Minimum Layer Thickness for Flexible Pavement Structures, Inches (mm)

Layer Type	FAA Specification Item	Maximum Airplane Gross Weight Operating on Pavement, lbs (kg)		
		<12,500 (5 670)	< 100,000 (45 360)	≥100,000 (45 360)
HMA Surface[1,2,3]	P-401, Hot Mix Asphalt (HMA) Pavements	3 in. (75 mm)	4 in. (100 mm)	4 in. (100 mm)
Stabilized Base	P-401 or P-403; P-304; P-306[4]	Not Required	Not Required	5 in. (125 mm)
Crushed Aggregate Base[5,6]	P-209, Crushed Aggregate Base Course	3in. (75 mm)	6 in. (150 mm)	6 in. (150 mm)
Aggregate Base[5,7,8]	P-208,Aggregate Base Course	3 in. (75 mm)	Not Used[3]	Not Used
Subbase[5,,8]	P-154, Subbase Course	4 in. (100 mm)	4 in. (100 mm) (If required)	4 in. (100 mm) (if required)

1. P-601-Fuel Resistant Hot Mix Asphalt may be used to replace the top 2 in (75mm) of P-401 where a fuel resistant surface is needed, structurally considered same as P-401
2. Additional HMA surface above minimum typically in 0.5 inch(10mm) increments
3. P-403 may be used as surface course < 12,500 pounds (5760 kg) or for HMA base or leveling course.
4. Use of P-306 requires FAA Approval on federally funded projects to assure adequate measures taken to control potential for reflective cracking.
5. Use the larger of the thickness in this table or the thickness calculated by FAARFIELD rounded to the nearest 0.5 inch (10 mm). Additional thickness may be required for frost protection above minimums.
6. P-209, Crushed Aggregate Base Course, when used as a stabilized base course, is limited to pavements designed for gross loads of 100,000 pounds (45 360 kg) or less, except as noted in paragraph 3.6, Stabilized Base Course.
7. P-208, Aggregate Base Course, when used as a base course, is limited to pavements designed for gross loads of 60,000 pounds (27 220 kg) or less.
8. P-219 Recycled Concrete Aggregate Base Course may be used as an aggregate base or subbase. How P-219 will perform is related to the quality of the material it is made from combined with the method used to process it into an aggregate base.

Allowable Modulus and Poisson Ratios

Layer Type	FAA Specified Layer	Rigid Pavement psi (MPa)	Flexible Pavement psi (MPa)	Poisson's Ratio
Surface	P-501 PCC	4,000,000 (30,000)	NA	0.15
	P-401/P-403 HMA	NA	200,000 (1,380)[1]	0.35
Stabilized Base and Subbase	P-401/P-403 HMA	400,000 (3,000)		0.35
	P-306 Lean Concrete	700,000 (5,000)		0.20
	P-304 cement treated base	500,000 (3,500)	NA	0.20
	P-301 soil cement	250,000 (1,700)		0.20
	Variable stabilized rigid	250,000 to 700,000 (1,700 to 5,000)	NA	0.20
	Variable stabilized flexible	NA	150,000 to 400,000 (1,000 to 3,000)	0.35
Granular Base and Subbase	P-209 crushed aggregate	Program Defined		0.35
	P-208, aggregate	Program Defined		0.35
	P-219, Recycled concrete aggregate	Program Defined		0.35
	P-211, Lime rock	Program Defined		0.35
	P-154 uncrushed aggregate	Program Defined		0.35
Subgrade	Subgrade	1,000 to 50,000 (7 to 350)		0.35
User-defined	User-defined layer	1,000 to 4,000,000 (7 to 30,000)		0.35

1. A fixed modulus value for hot mix surfacing is set in the program at 200,000 psi (1380 MPa). This modulus value was conservatively chosen and corresponds to a pavement temperature of approximately 90°F (32°C).

FAARFIELD Design Report

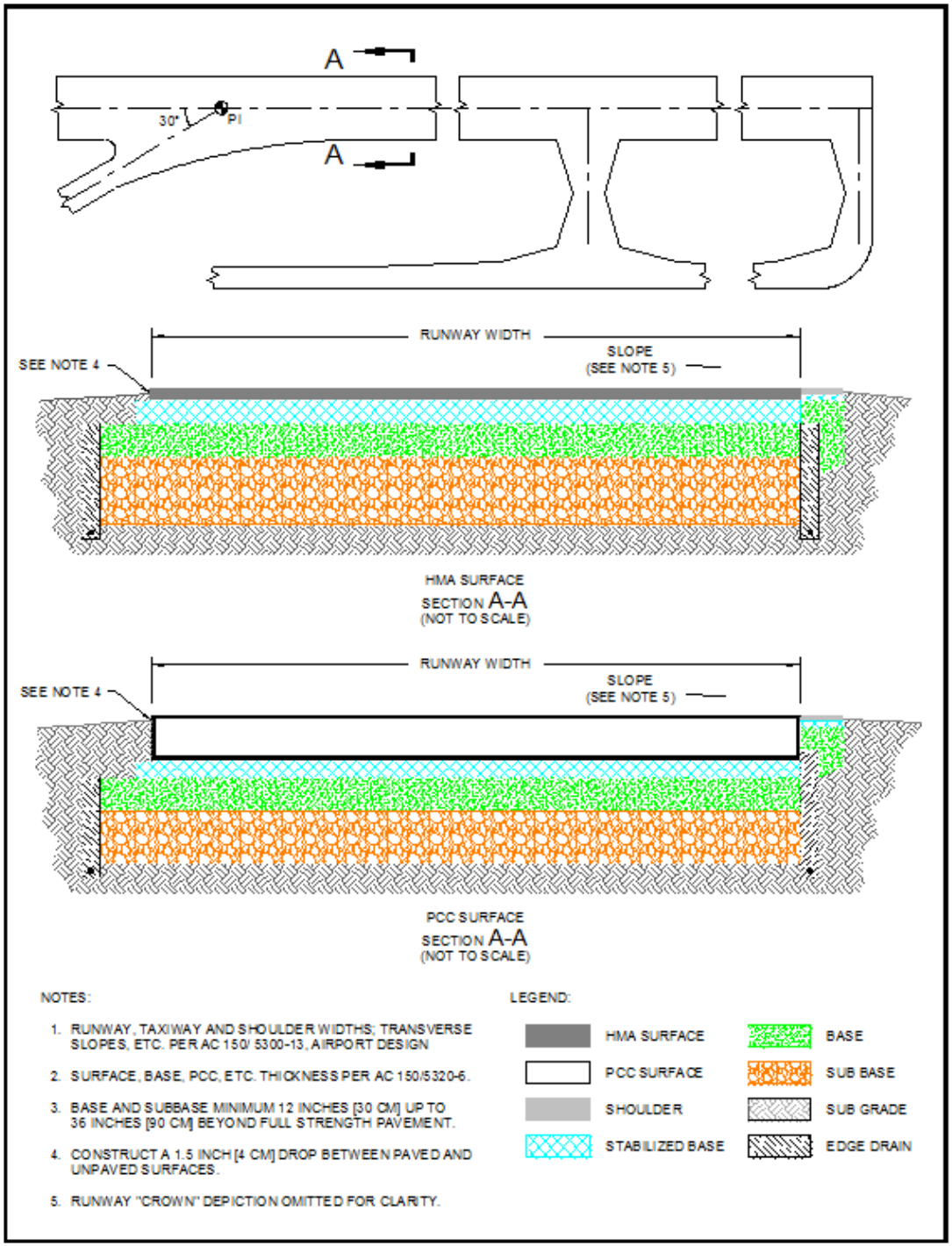
- **Include copy of FAARFIELD Design Report in Engineers Report**
- **Pavement Design Form no longer needed**
- **Still need to run COMFAA to determine PCN and use COMFAA support spreadsheet to get weight information for 5010**

(Future plans include FAARFIELD computing PCN, but this f(ICAO) adopting changes to ACN/PCN process. FAA is currently working with ICAO on these changes)

Typical Section

Note Variable thickness surface still an option, i.e exit TW just arrival weight, keel full strength transitioning to 1% traffic on outer for middle of RW

Note 3: Base and subbase minimum 12” up to 36” beyond full strength



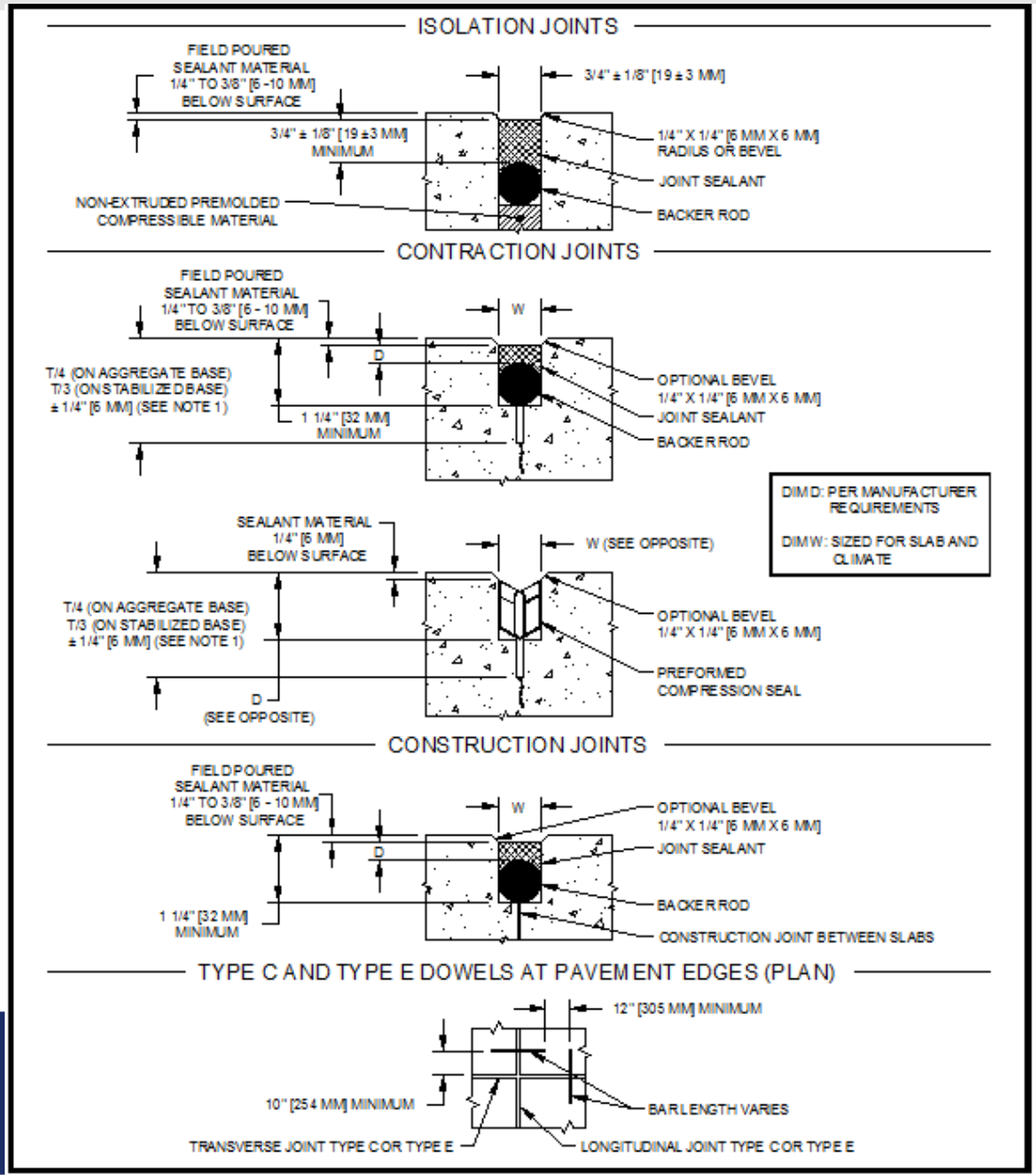
Joints

Saw cut depth recommendations added on joint detail:

-T/4 on aggregate

-T/3 on stabilized
-T/5 or T/6 early entry

-Preformed Detail



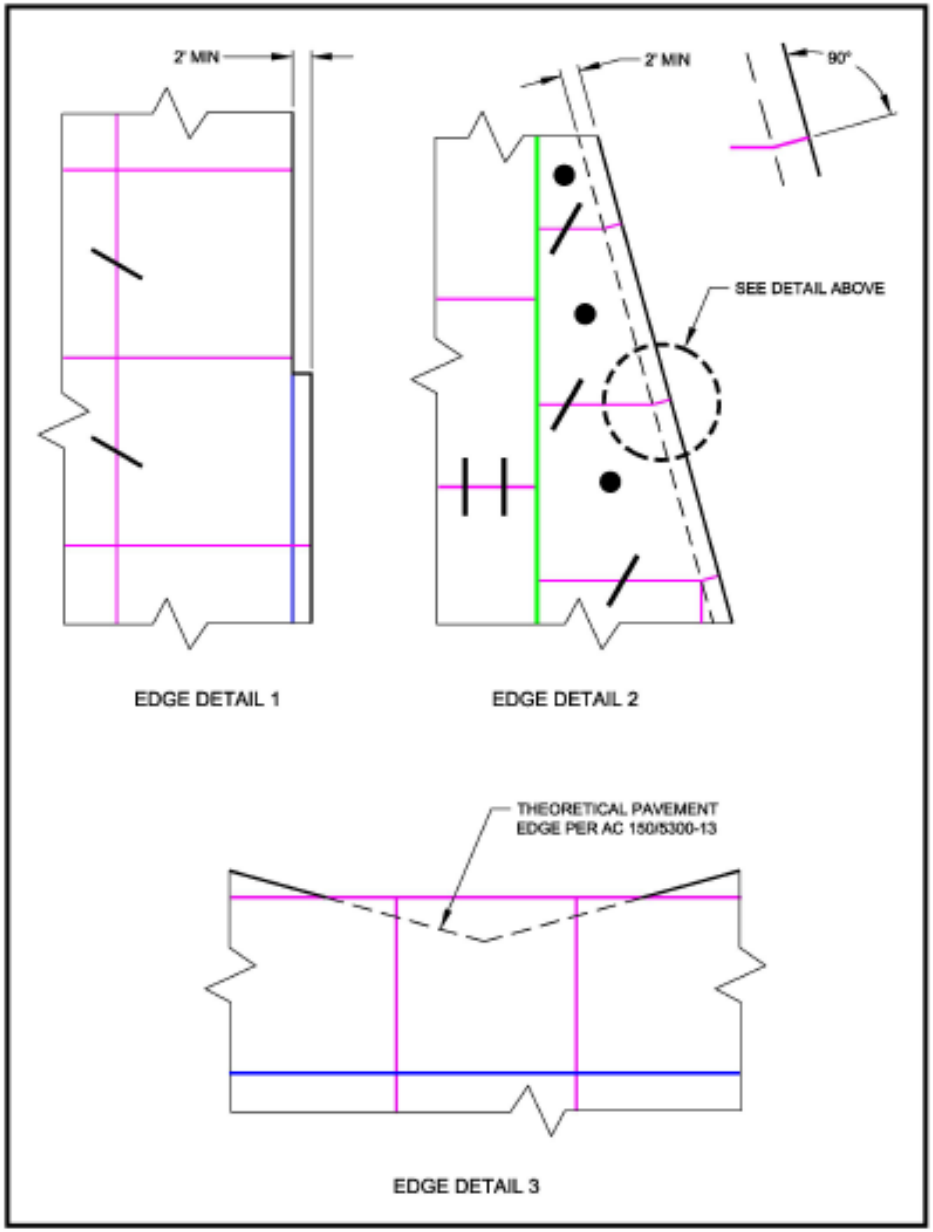
Joints

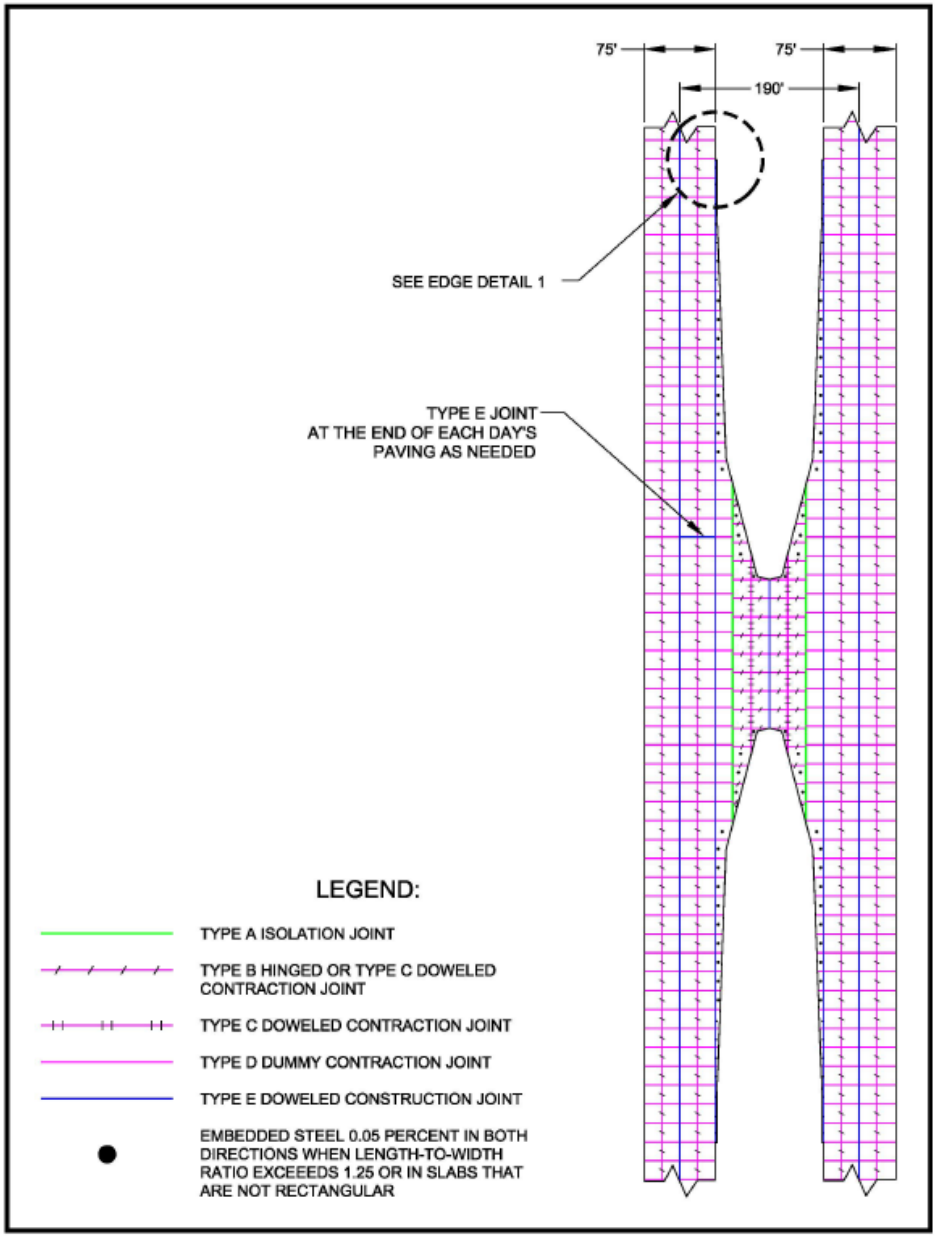
- **Sample PCC Joint Plans pdf or dxf @https://www.faa.gov/airports/engineering/pavement_design/**

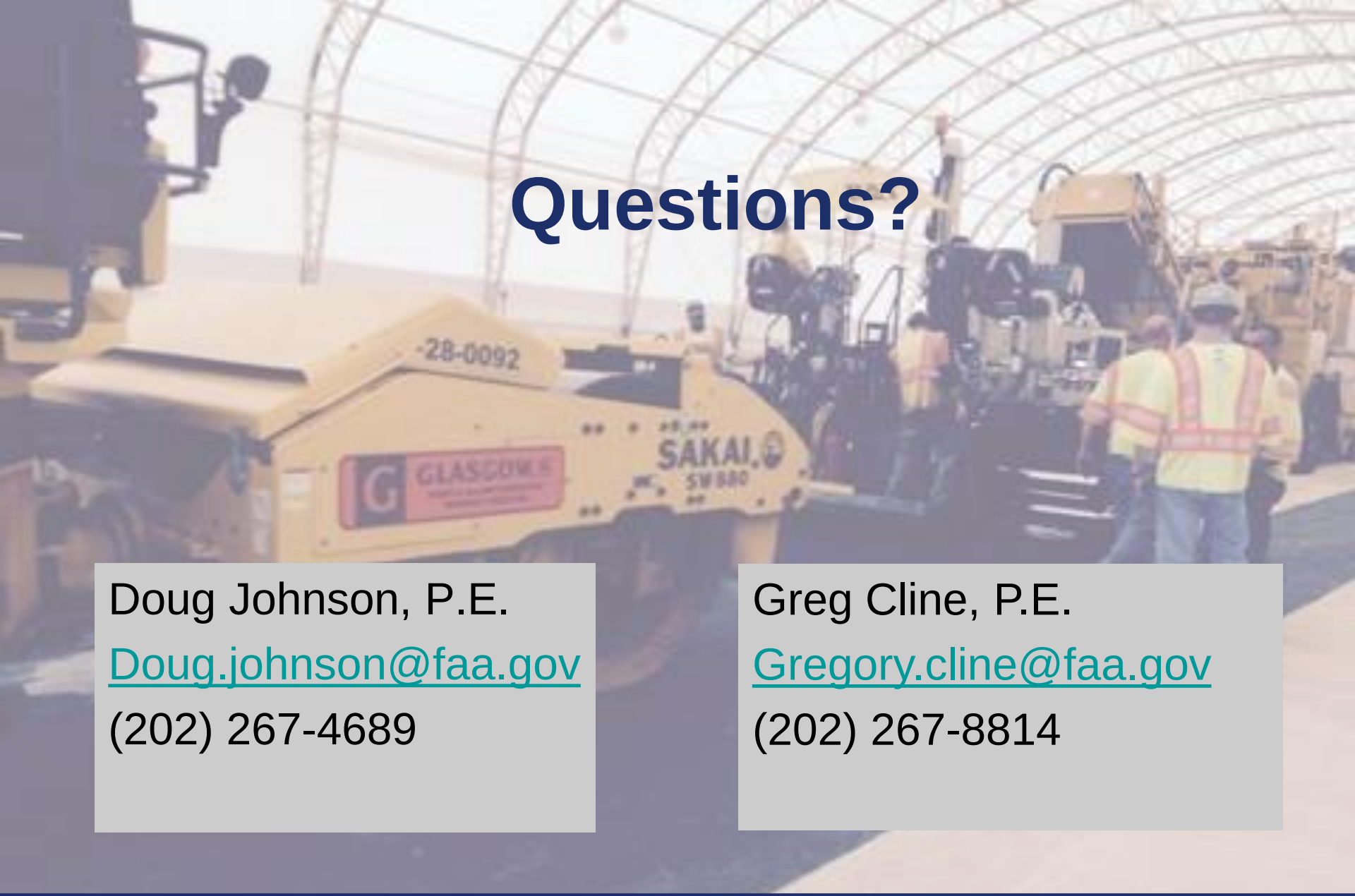
Sample PCC Joint Plans

- PCC Joint Detail - Crossover TW: PDF, DXF
- PCC Joint Detail - Entrance TW: PDF, DXF
- PCC Joint Detail - Tee TW: PDF, DXF
- PCC Joint Detail - High Speed TW: PDF, DXF
- PCC Joint Detail - Sections: PDF, DXF
- PCC Joint Detail - Details: PDF, DXF

Joints


2' MIN
2' MIN
90°
SEE DETAIL ABOVE
EDGE DETAIL 1
EDGE DETAIL 2
THEORETICAL PAVEMENT EDGE PER AC 150/5300-13
EDGE DETAIL 3


75'
75'
190'
SEE EDGE DETAIL 1
TYPE E JOINT AT THE END OF EACH DAY'S PAVING AS NEEDED
LEGEND:
TYPE A ISOLATION JOINT
TYPE B HINGED OR TYPE C DOWELED CONTRACTION JOINT
TYPE C DOWELED CONTRACTION JOINT
TYPE D DUMMY CONTRACTION JOINT
TYPE E DOWELED CONSTRUCTION JOINT
EMBEDDED STEEL 0.05 PERCENT IN BOTH DIRECTIONS WHEN LENGTH-TO-WIDTH RATIO EXCEEEDS 1.25 OR IN SLABS THAT ARE NOT RECTANGULAR



Questions?

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