Concrete Overlays on General Aviation Airports

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Introduction to Concrete Overlays on Airports

JFK Runway 13R-31L: 18” Concrete Overlay

Conway-Horry County, SC
Runway 4-22: 5” Concrete Overlay

Southeastern Airports – Thinner Unbonded Overlays

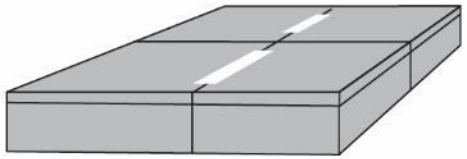
Thinner = Less than 9-inches of Concrete

State / Year	AIRPORT	RW / TW / Apron	Engineering Consultant
FL / 2004	Fernandina Beach	RW (6-in) and TW (5-in)	Passero & Associates
SC / 2004	Williamsburg County	Apron (5-in)	Wilbur Smith Assoc
FL / 2006	Williston	RW (4-inch, UBOC)	Passero & Associates
GA / Fall 2008	Cobb County	Runway (7-in)	Michael Baker Inc (LPA)
SC / 2009	Lancaster County	Runway (7.5-in)	Michael Baker Inc (LPA)
SC / 2011	Marion County	Apron (4-in)	SC Aeronautics Design
SC / 2012	Laurens County	Runway (5-in) & Taxiway	Michael Baker Inc (LPA)
SC / 2014 - 18	Greenwood County	Runway (5-in) & Taxiway	Michael Baker Inc
SC / Fall 2018	Grand Strand (N Myrtle Beach)	Runway (7.5-in)	Holt Inc
SC / 2019	Darlington County	Runway (7-in)	Michael Baker Inc
TN / 2020	Jamestown Municipal	Runway (5-in)	Neel-Schaffer
SC / 2024	Conway-Horry County	Runway (5-in)	Holt Inc
SC / 2025	Aiken County	Runway (6-in)	Michael Baker

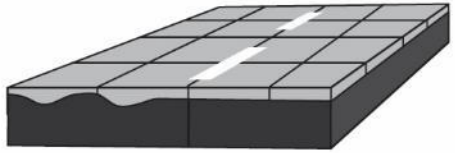
Types of Concrete Overlays

Bonded – Not Typical

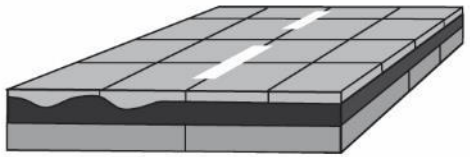
Bonded Concrete Overlays of Concrete Pavements
–previously called bonded overlays–



Bonded Concrete Overlays of Asphalt Pavements
–previously called ultra-thin whitetopping–

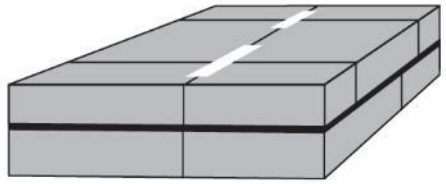


Bonded Concrete Overlays of Composite Pavements

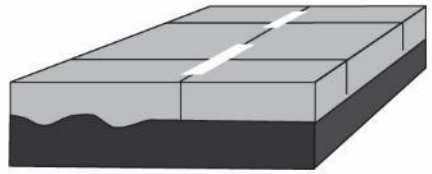


Unbonded – Typical

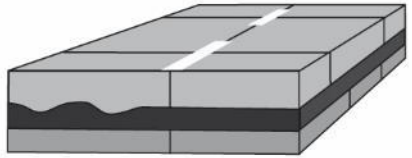
Unbonded Concrete Overlays of Concrete Pavements
–previously called unbonded overlays–



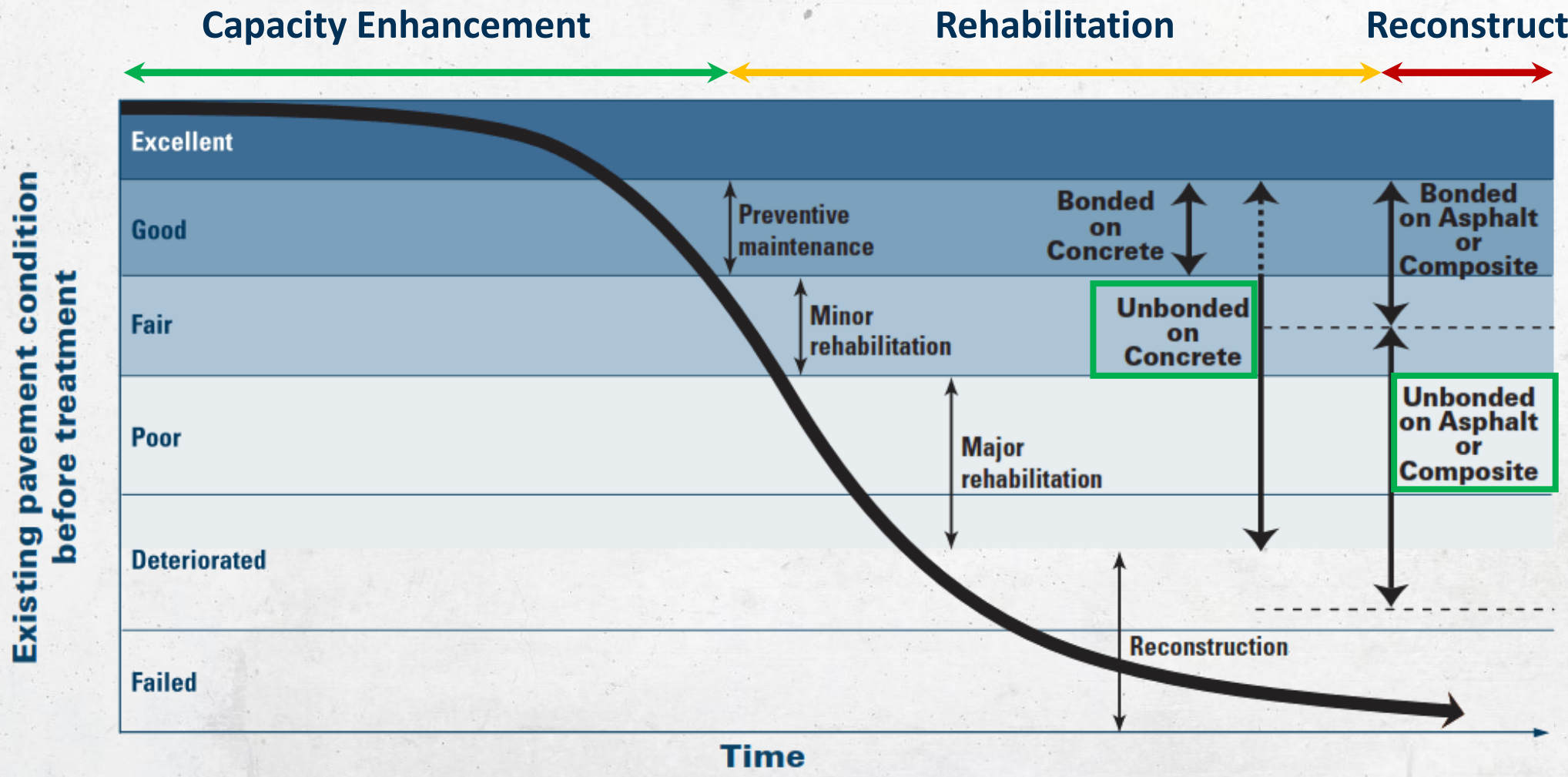
Unbonded Concrete Overlays of Asphalt Pavements
–previously called conventional whitetopping–



Unbonded Concrete Overlays of Composite Pavements



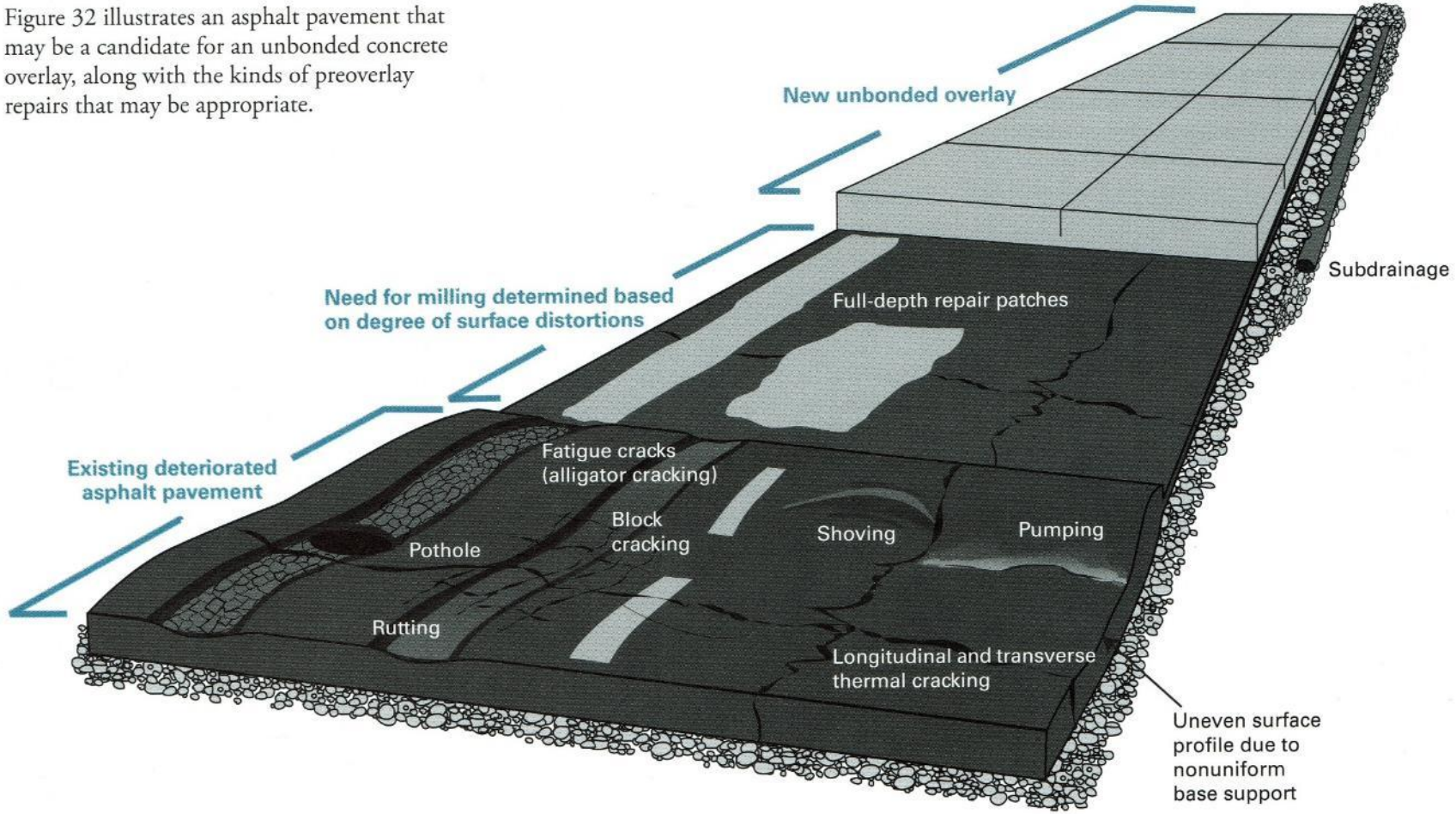
Rehabilitation Timing is Important



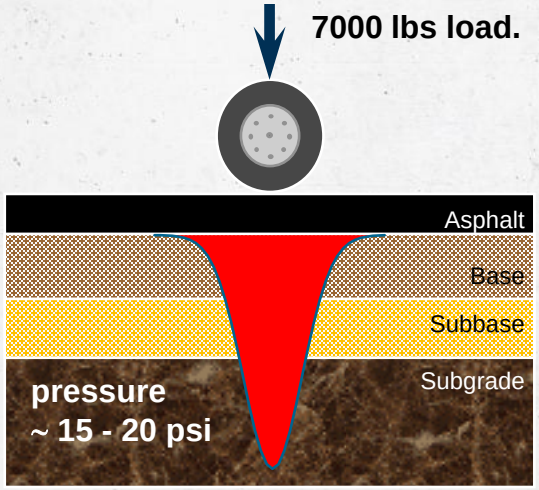
Concrete Overlays Bridge Distresses

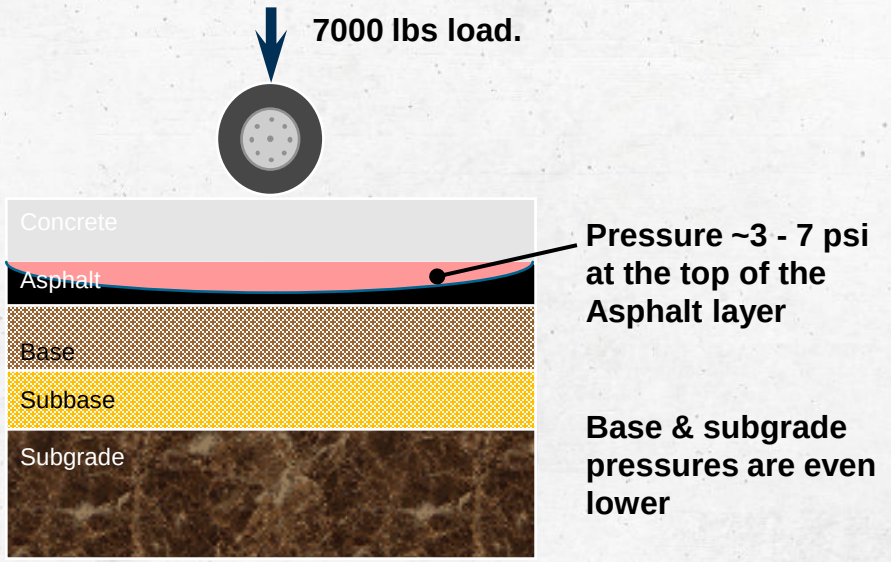
Unbonded Concrete Overlay on Asphalt Pavements

Figure 32 illustrates an asphalt pavement that may be a candidate for an unbonded concrete overlay, along with the kinds of preoverlay repairs that may be appropriate.



Bridging Structural Failures

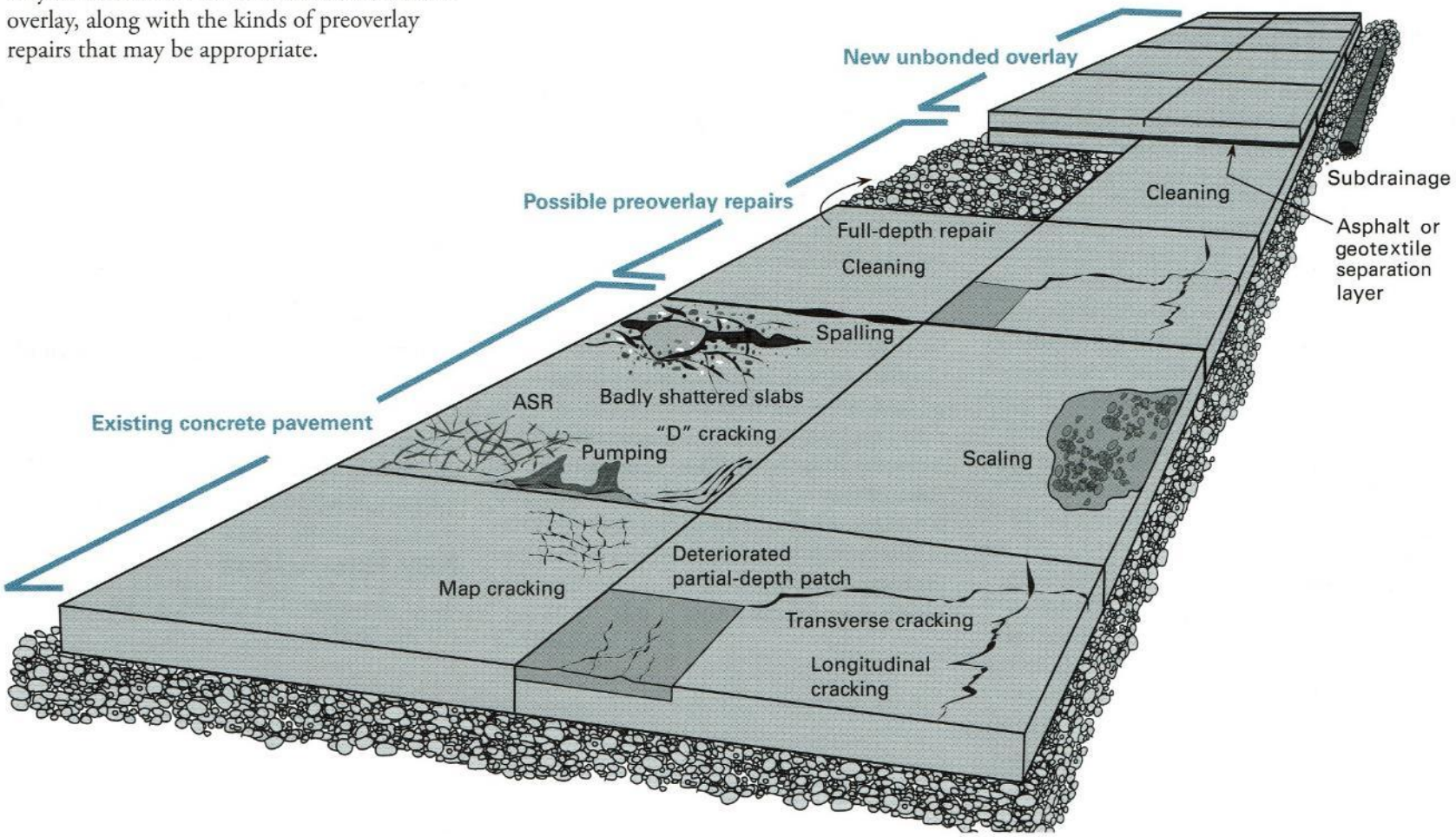




Concrete Overlays Bridge Distresses

Unbonded Concrete Overlay on Concrete Pavements

Figure 42 illustrates a concrete pavement that may be a candidate for an unbonded concrete overlay, along with the kinds of preoverlay repairs that may be appropriate.



Concrete Overlays may improve Resilience

- Raises pavement elevation above flood plain
- Increases pavement structure above water table
- Rigid pavement can still support traffic when underlying materials are saturated
- Rigid pavement can be returned to service faster after flood event

Benefits of Concrete Overlays

Kenneth Urbaniak, Horry County Department of Airports describes the New (5-in) Concrete Runway Overlay - "It's as smooth as glass"

Grand Strand Airport

2018 Construction / Prior PCI = 48-56

TW used for limited operations

Traditional Flexible Pavement Rehab Strategies

Estimated Life Extension (years)			
Treatment	**Good PCI > 80**	**Fair PCI > 60**	**Poor PCI >40**
Fog Seal/Rejuvenator	< 1	-	-
Spray Applied Seal	3-5	1-3	1-2
Slurry Seal	5-7	3-5	1-3
Micro-surface	8-12	5-7	2-4
Thin HMA	10-12	5-7	2-4

NOTE:

- **Table is based on AAPTP Report 05-07 Table 4-1**
- **Not FAA Policy**
- **For PCI < 60 typically do not recommend surface treatment. But may be used to buy a few more years before rehab/reconstruction.**

Concrete Overlay Performance

Rigid Overlays of Asphalt				
Airport	**Thickness (in)**	**Year Constructed**	**Last PCI**	**Age at Last PCI**
Greenwood County, SC RW 9-27	5	2014	100	8
Lancaster Co, SC RW 6-24	7.5	2010	99	12
Cobb Co, GA RW 9-27	7	2008	98	16
Spencer Municipal, IA RW 12-30	6	1992	90	30
Fort Madison, IA RW 17-35	6	1991	81	32
Corning Municipal, IA RW 18-36	5	1988	74	36
Storm Lake, IA RW 13-31	5	1971	72	41

Let’s Look at Performance

- Storm Lake Iowa Runway 13-31
- 5” Overlay constructed in 1971

Condition History

Branch ID	Section ID	2015 Inspection	2019 Inspection	2022 Inspection
A01SL	01	86	88	83
A01SL	02	71	67	57
R13SL	01	89	82	72

Work History

R13SL	01	Slab Replacement - PCC	3/1/2014
R13SL	01	Patching - PCC Partial Depth	3/1/2014
R13SL	01	Joint Seal (Localized)	3/1/2014
R13SL	01	Crack Sealing - PCC	3/1/2014
R13SL	01	New Construction - PCC	5/1/1971

Extrapolated Distresses (722 slabs)

R13SL	01	11/18/2022	Shattered Slab (Medium)	5	slabs
R13SL	01	11/18/2022	Large Patch (Low)	40	slabs
R13SL	01	11/18/2022	Small Patch (Medium)	10	slabs
R13SL	01	11/18/2022	Joint Sealant Damage (High)	119	slabs
R13SL	01	11/18/2022	Corner Spalling (Low)	40	slabs
R13SL	01	11/18/2022	Joint Spalling (Medium)	35	slabs
R13SL	01	11/18/2022	LTD Cracking (Medium)	25	slabs
R13SL	01	11/18/2022	Small Patch (Low)	95	slabs
R13SL	01	11/18/2022	Joint Sealant Damage (Medium)	722	slabs
R13SL	01	11/18/2022	Corner Spalling (Medium)	80	slabs
R13SL	01	11/18/2022	Joint Spalling (Low)	15	slabs
R13SL	01	11/18/2022	Shrinkage Cracking (N/A)	15	slabs

Traditional Rigid Pavement Rehab Strategies

- **Diamond Grinding:**
  - May be used to remove surface distresses, correct minor grade deficiencies and restore surface friction
  - Requires sufficient pavement thickness to not lose structural capacity
  - Cannot fix structural issues

- **Selective Slab Replacement:**
  - May be used to replace isolated areas that have experienced structural failure
  - FAA limits to 30% replacement before project becomes reconstruction

- **Thin Asphalt Overlay:**
  - May be used to correct surface deficiencies or add structural capacity
  - FAA recommends minimum 3 inches of asphalt to avoid delamination
  - Joints, cracks and underlying distresses will reflect and must be maintained
  - Typically fail due to non-structural reasons

ACPA

Concrete Overlay Performance

Rigid Overlays of Rigid				
Airport	**Thickness (in)**	**Year Constructed**	**Last PCI**	**Age at Last PCI**
Charleston Executive, SC RW 9-27	11	2010	91	12
Columbus Municipal, IN RW 5-23	10	2010	98	12
Oskaloosa Municipal, IA RW 13-31	6	1998	75	26
Denison Municipal, IA RW 12-30	6	1997	78	27
Keokuk Municipal, IA RW 14-32	6	1995	84	28
Keokuk Municipal, IA RW 08-26	6	2013	94	10

Best Practices for Rigid Overlays

- Profile milling may be required to correct grade or reduce final elevation after overlay
- Designer must pay attention to tie-in to existing pavement and infields
- Closer joint spacings (smaller panels) improve performance of thinner overlays
- Paving directly over most cracks in asphalt is ok. But larger cracks may need to be filled
- Major distresses (panels rocking) may need to be repaired prior to overlay
- Saw timing is critical to prevent shrinkage cracking. Adequate curing too!
- Pay attention to construction loads!!!!
  - May need to reduce loads to prevent overloading pavement before full strength is achieved
  - Contractor may need to add more trucks, or slow paving to accomplish

FAA Policies for Rehabilitation and Reconstruction

Disclaimer: These policies may change…

FAA Policy on Rehabilitation vs. Reconstruction

- FAA Order 5100.38D change 1 – Airport Improvement Program Handbook

3-6. Eligibility of Maintenance, Rehabilitation, Reconstruction, and Replacement Projects.

These concepts cause much confusion. The goal for all of the actions above is to obtain a functioning unit as the final outcome. What differentiates these concepts is the level of effort and the resulting change in useful life. As the work effort for a category increases, the question of whether the work belongs in the category surfaces (for example, determining when timely maintenance is actually rehabilitation.) As a result, the conclusion of which category the project falls into rests with the specific circumstances. Table 3-2 explains the differences between these concepts and Table 3-3 provides eligibility examples.

FAA Policy on Rehabilitation vs. Reconstruction

- FAA Order 5100.38D change 1 – Airport Improvement Handbook

Table 3-2 Differences between Maintenance, Rehabilitation, Reconstruction, and Replacement Projects

Item	Explanation	Eligibility
b. Rehabilitation	Rehabilitation is a more comprehensive restoration of an original functionality that results in a piece of pavement, piece of equipment, or building with a useful life of at least 10 years, or half of the useful life per Table 3-7, whichever is less. This approach deals with the facility or item as a whole and is more far-reaching than the minor repair discussed under maintenance.	Rehabilitation is generally eligible (but must still be justified).
c. Reconstruction	Reconstruction is a complete restoration of an original functionality that results in a virtually new piece of pavement, piece of equipment, or building with a use life as listed in Table 3-7.	Reconstruction is generally eligible (but must still be justified).

PCI Requirements for Pavement Projects

G-3. Pavement Condition Index Requirements for Airfield Pavement Projects.

For an airfield pavement project, the ADO may justify pavement work based on the thresholds listed in Table G-2. The ADO has the option to fund pavement work outside of these thresholds if the ADO determines that the work is justified based on engineering analysis and the ADO obtains concurrence from AAS-100. The definitions (and eligibility restrictions by airport type) for reconstruction, rehabilitation, and maintenance are defined in Paragraph 3-6.

Table G-2 Pavement Condition Index Requirements for Airfield Pavement Projects

For the following type of airfield pavement project…	The pavement condition index (PCI) must be less than…
a. Reconstruction	55 (Poor)
b. Rehabilitation	70 (Fair)
c. Maintenance	N/A

FAA Standards for Concrete Overlays

Disclaimer: These standards may change…

FAA Standards for Pavement Rehabilitation

- AC 150/5320-6G Airport Pavement Design

4.3.1 Rehabilitation is defined as the replacement of a portion of the pavement structural layers. It is generally more cost effective to rehabilitate a pavement than to reconstruct it.

4.3.2 Pavements with a PCI less than 70 and greater than 55 are candidates for rehabilitation. There are times when a rehabilitation strategy is justified on pavements with PCI greater than 70 or less than 55.

4.3.3 Pavements require rehabilitation for a variety of reasons, for example, to correct surface conditions that affect aircraft performance (roughness, surface friction, and/or drainage) or material-related distresses or repair of localized structural damage.

Rehabilitation of Flexible Pavement

- AC 150/5320-6G Airport Pavement Design

4.3.4 Rehabilitation of flexible pavement consists of removal and replacement of a portion or all of the wearing surface. A mill and overlay of a flexible pavement will often provide a significant additional functional and structural life. Overlays can be accomplished with either flexible or rigid pavement. Timing of when to replace a flexible wearing surface is dependent upon many factors including: initial quality of materials and construction, environmental conditions, was routine maintenance performed and composition, nature of traffic as compared to design traffic as well as type and amount of existing pavement distress. Isolated full depth repairs of underlying structural layers in the flexible pavement may be required prior to overlay.

Rehabilitation of Rigid Pavement

- AC 150/5320-6G Airport Pavement Design

4.3.5 Rehabilitation of rigid pavement may include repairing or replacing up to 30 percent of isolated panels. Rehabilitation of rigid pavement may also include asphalt or concrete overlays, or diamond grinding of the surface to restore the wearing surface.

Overlay Structural Design – Life and Traffic

- AC 150/5320-6G Airport Pavement Design

4.7 **Overlay Structural Design.**

4.7.1 General.

An overlay consists of a new asphalt or concrete surface course placed on top of an existing pavement. FAARFIELD overlay design is based on layered elastic and three-dimensional finite element methods of analysis.

4.7.2 Design Life.

FAARFIELD designs the overlay thickness required to provide a 20-year (or other chosen) structural design life by meeting the limiting stress or strain criterion, subject to minimum thickness requirements. (Table 3-3). Design overlays for a 20-year structural life from the time of overlay. A design life less than 20 years (minimum of 10 years) may be considered if (a) the original pavement is more than 15 years old at the time of the overlay, and (b) the primary purpose of the overlay is functional rehabilitation of the pavement surface (i.e., where the underlying pavement retains considerable structural integrity). Document and support the design life used in the engineer's report.

4.7.3 Design Traffic.

Use the most recent traffic projections available to design overlays. Even for relatively new pavements actual aircraft traffic may differ from traffic used in the original design. Note that for non-structural flexible overlays where the original design traffic has not changed significantly, there is no need for FAARFIELD thickness calculations.

Concrete Overlay of an Existing Flexible Pavement

- AC 150/5320-6G Airport Pavement Design

4.7.4.2 **Concrete Overlay of an Existing Flexible Pavement.**

The design of a concrete overlay on an existing flexible pavement is essentially the same as designing a new rigid pavement. Characterize the existing flexible pavement by assigning the appropriate thicknesses and moduli of the existing layers. A trial overlay thickness is selected and FAARFIELD iterates on the thickness of the concrete overlay until a CDF = 1 is reached. The design thickness is the larger of the minimum concrete thickness or the overlay thickness required to achieve a CDF = 1. FAARFIELD assumes a frictionless (unbonded) interface between the concrete overlay and the existing flexible surface. Best practice is to use a fine stone bond breaker, ¼ inch (5 mm) or less 'choke stone'. It is not required to include the choke stone layer or other bond breaker material in the FAARFIELD structural design. Meet the joint spacing requirements of paragraph 3.16.3 for concrete overlays of existing flexible pavements. See Appendix H, paragraph H.5 for FAARFIELD example of concrete overlay.

Concrete Overlay of an Existing Rigid Pavement

- AC 150/5320-6G Airport Pavement Design

4.7.5.7.1 Fully Unbonded Concrete Overlays.

The design of fully unbonded concrete overlays of rigid pavements assumes no bond between the overlay and existing panel. A bond breaker may be either a thin layer of asphalt mixture, geosynthetic or a choke stone. FAARFIELD disregards the thickness of any asphalt interlayer or other bond-breaker in the design of the overlay. The design procedure assumes that the existing panel and overlay panel act independently of each other may have different moduli and deteriorate at different rates. During the design procedure, FAARFIELD iterates on the overlay thickness until it finds a design thickness that produces SCI = 80 for the overlay at the end of the 20-year design life. In contrast to asphalt-on-rigid overlay design, there is no defined terminal SCI condition for the existing concrete layer.

Minimum Layer Thickness for Rigid Overlay

- AC 150/5320-6G Airport Pavement Design

Table 3-4. Minimum Layer Thickness for Rigid Pavement Structures[1]

Layer Type	FAA Specification Item	Maximum Aircraft Gross Weight Operating on Pavement, lbs (kg)		
		<60,000 (27,215)	< 100,000 (45,360)	≥ 100,000 (45,360)
Rigid Surface[2]	P-501, Cement Concrete Pavement	6 in (150 mm)[2]	6 in (150 mm)[2]	6 in (150 mm)[2]

Note 2: Use greater of FAARFIELD thickness to nearest 0.5 inch or minimum layer thickness. **If all aircraft < 30,000 lbs 5-inch minimum thickness.**

Design Example

- GA Runway
  - Initial Construction: 1985
  - Last Major Work: 2010 (structural overlay)
  - 2023 PCI: 53
  - Distresses:
    - L&T Cracking (L, M, H)
    - Weathering (M)
    - Raveling (L)
    - Alligator Cracking (L, M)

Inputs

Structure

Job Name: Rigid Overlay | Thickness Design | Run

Structure Name: Overlay 1 | ☑ Include in Summary Report | ☐ Add To Batch

Pavement Layers

Pavement Type: PCC Overlay on Flexible

	Material	Thickness (in.)	E (psi)	k (pci)	R (psi)
-->	P-501 PCC Overlay on Flexible	5.0	4,000,000		650
	P-401/P-403 HMA Surface	3.0	200,000		
	P-208 Crushed Aggregate	12.0	50,093		
	Subgrade		15,000	172.4	

Select As The Design Layer | Delete Selected Layer

Design Life (Years): 10

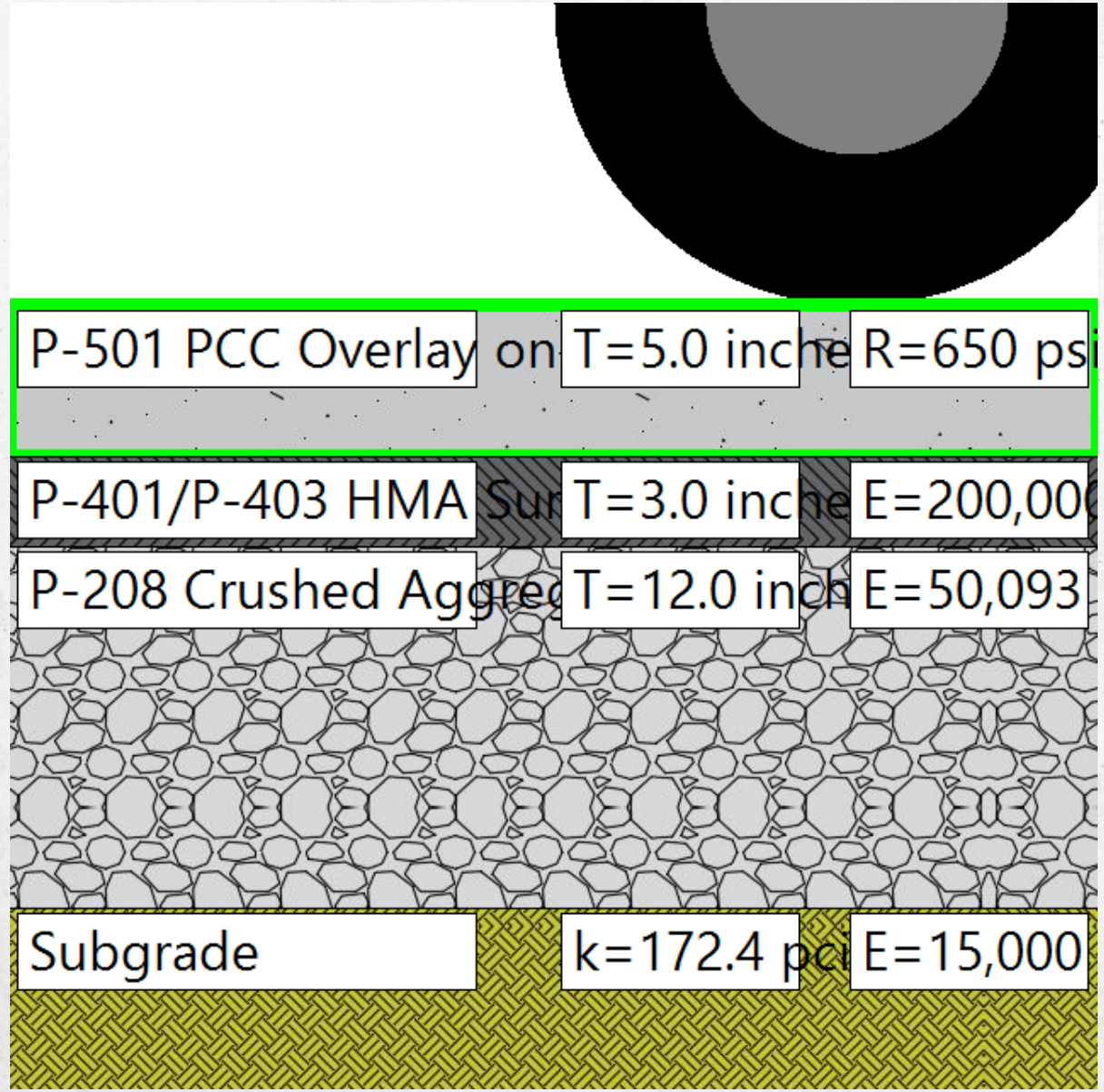
The standard design life for pavement structure is 20 years (1 to 50 allowed).

Traffic

Stored Aircraft Mix: GA 30K | Save Aircraft Mix to File

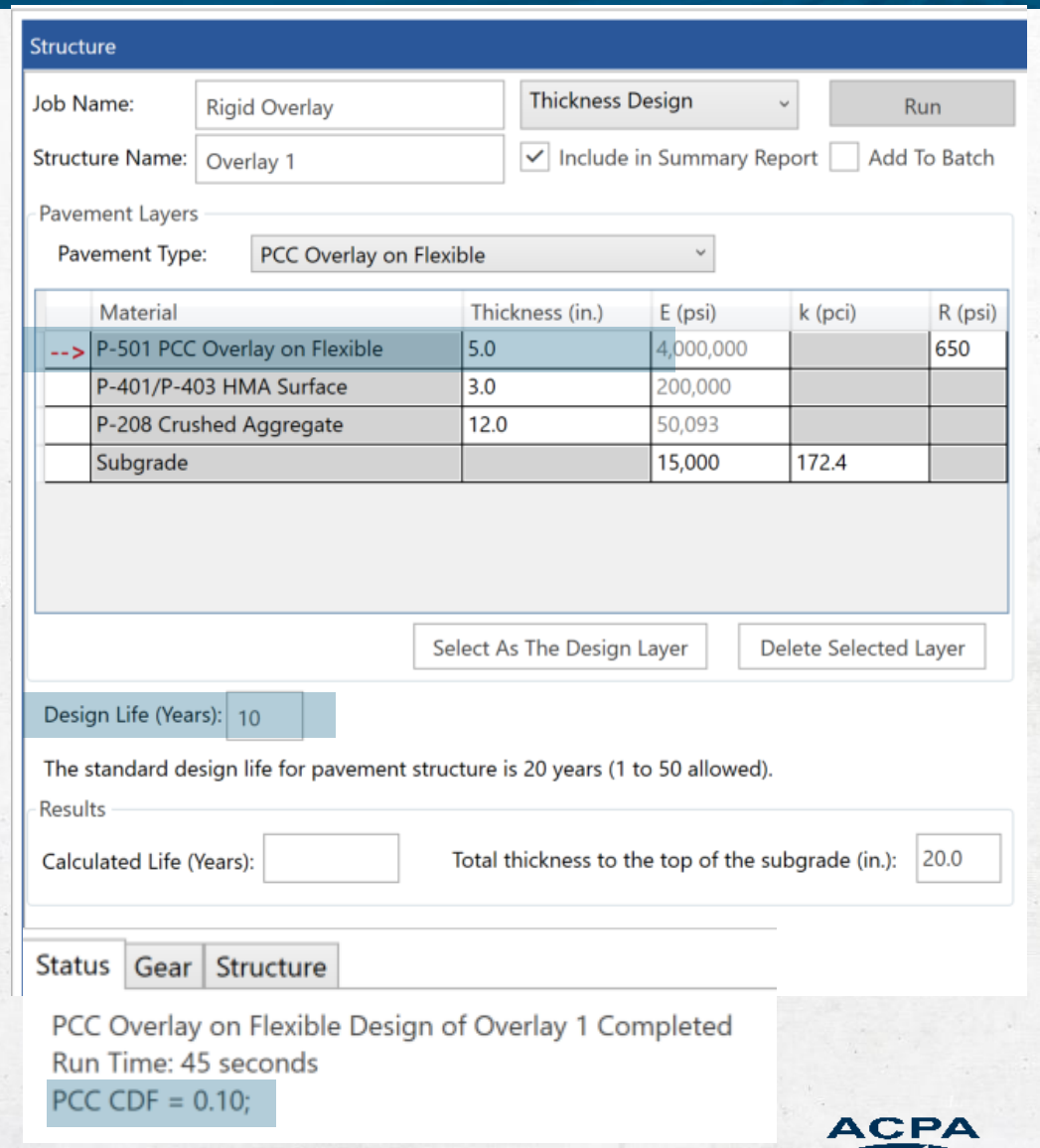
Airplane Name	Gross Taxi Weight (lbs)	Annual Departures	Annual Growth (%)	Total Departures
SWL-5	5,000	1,200	0	12,000
SWL-10	10,000	1,200	0	12,000
S-25	25,000	1,200	0	12,000
S-30	30,000	1,200	0	12,000
D-20	20,000	1,200	0	12,000

Overlay Design Results



When does an Overlay become Reconstruction?

- **FAA grants are based on Rehabilitation vs. Reconstruction**
  - Rehabilitation provide more flexibility to maintain non-standard conditions
  - Reconstruction may require significant updates to meet FAA standards
- **When is an overlay rehabilitation?**
  - Restoring surface condition
  - 10-year structural life; **or**
  - If structural capacity is met with less than minimum layer thickness
- **If overlay is designed for more than 10-year service life it may be designated reconstruction**



Joint Spacing for Concrete Overlays

- AC 150/5320-6G Airport Pavement Design

Table 3-7. Recommended Maximum Joint Spacing - Rigid Pavement[1,2]

a. Without Stabilized base

Panel Thickness	Joint Spacing
6 inches or less (152 mm)	12.5 feet (3.8 m)
6.5-9 inches (165-229 mm)	15 feet (4.6 m)
>9 inches (>229 mm)	20 feet (6.1 m)[2]

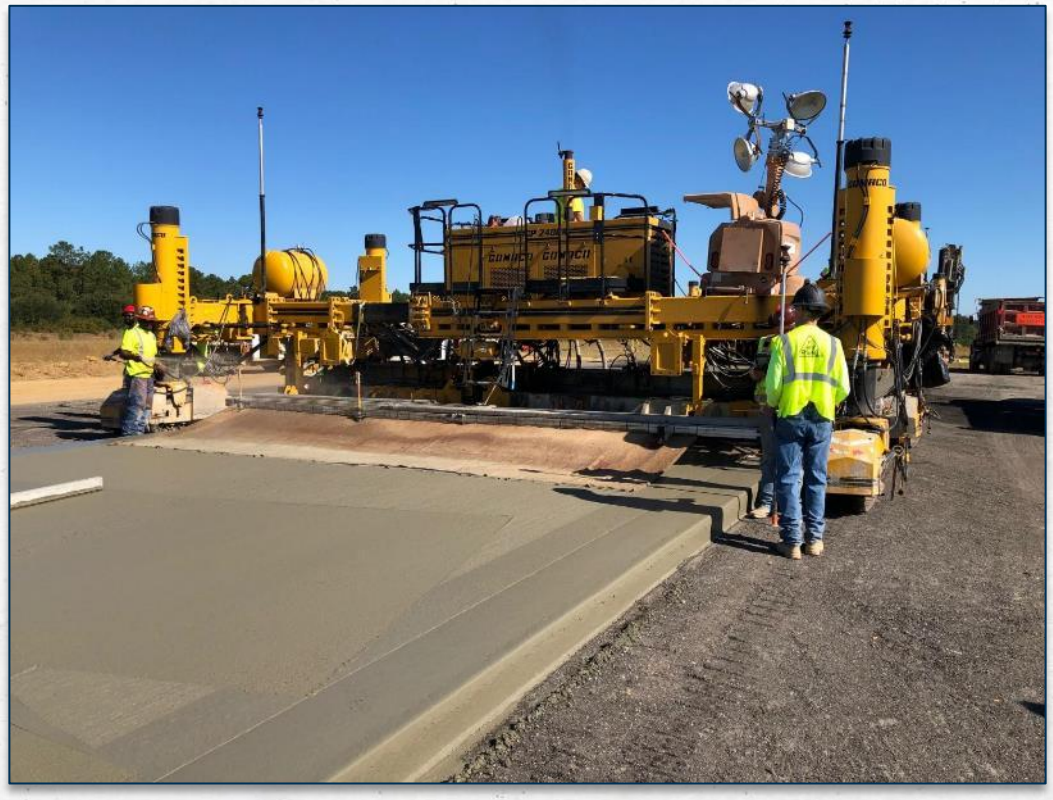
b. With Stabilized base

Panel Thickness	Joint Spacing
8–10 inches (203-254 mm)	12.5 feet (3.8 m)
10.5-13 inches (267-330 mm)	15 feet (4.6 m)
13.5-16 inches (343-406 mm)	17.5 feet (5.3 m)
>16 inches (>406 mm)	20 feet (6.1 m)[2,3]

Smaller joint spacing is common for thin overlays (8 - 10 ft)

Bond Breakers

- **Rigid Overlay of Flexible –** Recommended best practice is to use a choke stone bond breaker
- **Rigid Overlay of Rigid**
  - Traditional bond breaker is 1” asphalt interlayer
  - Geosynthetics maybe be used
  - Choke stone may be used



Darlington County Jetport, SC
RW 5-23 7” Overlay

Consider Alternatives

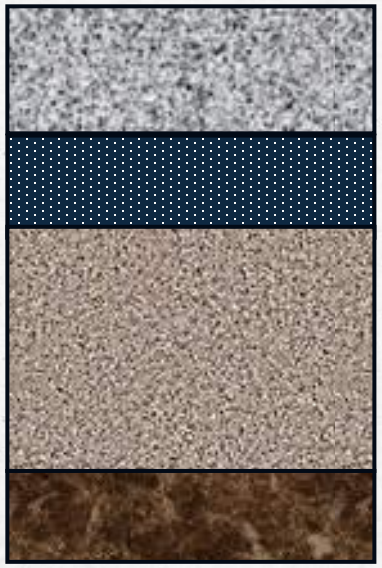
Grand Strand, SC
RW 5-23 7” overlay

Alternatives Analysis

Alternative 1: 2” mill and fill

- Fixes surface distresses
- Does not fix structural distresses
- Achieves min 10-year structural life
- Functional life could be less than 10 years

Alternative 2: 2” mill 5” Rigid Overlay



- Bridges structural distresses
- Achieves minimum 10-year structural life
- Functional life could be 30+ years with proper maintenance

Alternative 3: Full Depth Reclamation

- Creates “new” pavement section
- FAA policy defines as reconstruction
- Must design for 20-year structural life
- Must bring runway up to FAA standards

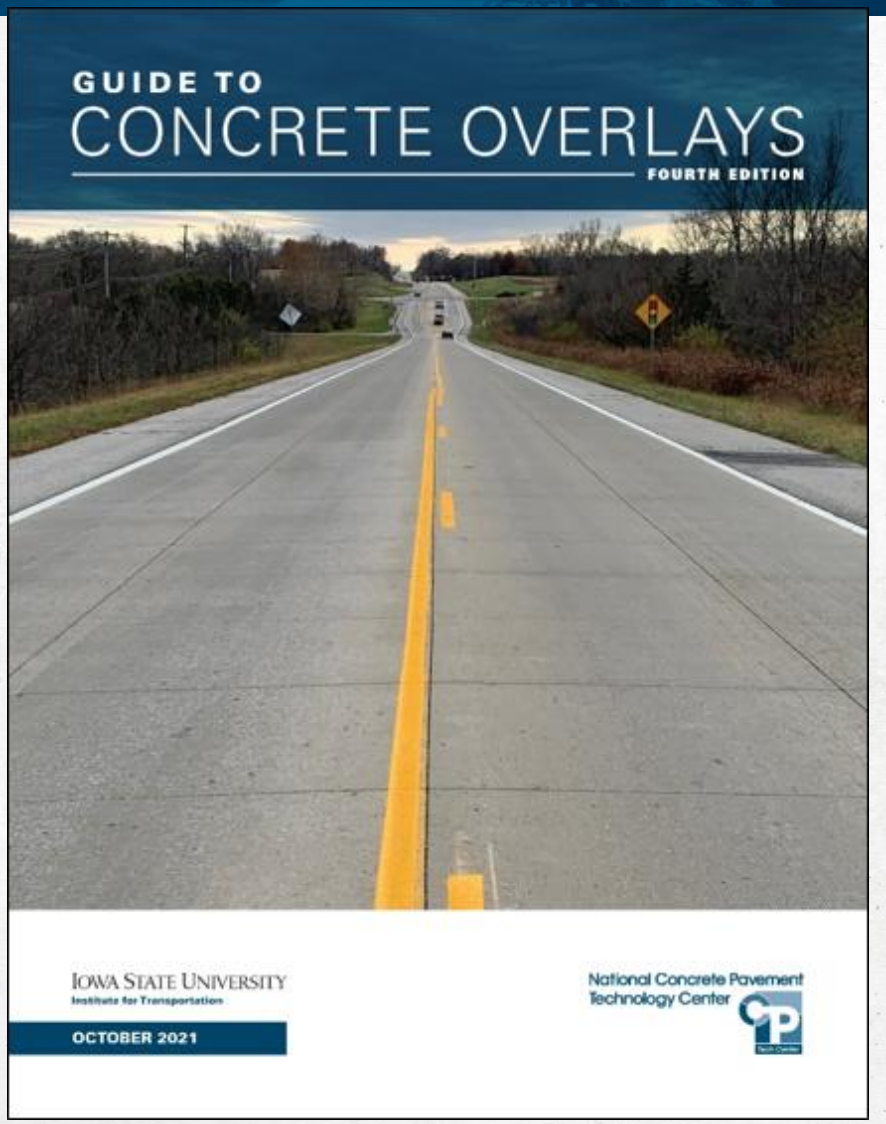
What about costs? Construction Schedule?

Summary

- Rigid Overlays can be an effective rehabilitation alternative for airfield pavement
  - May allow for rehabilitation later in the pavement life-cycle
  - Typically requires minimal pre-overlay preparation
  - Functional life may be significantly longer than other rehabilitation methods
- Proper evaluation of existing conditions is critical to analysis of rehab alternatives
- Perform a detailed alternatives analysis of all rehabilitation options
  - Consider life-cycle costs along with other pros and cons of all alternatives
  - Start considering early in the process to get best chance at FAA funding
- Thin rigid overlays on GA airports have a proven record of long functional lives with low maintenance costs.
- Rigid Overlays can be used on large airports too!

Guide to Concrete Overlays (4th Edition)

- FHWA Sponsored guide
- Discusses best practices for evaluation, design and construction
- Highway focused guide but many of the concepts are similar
- ACPTP is finishing up study on thin concrete airfield pavements including overlays



ACPA

Thank You

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