Gary L. Mitchell, P.E.
Chief of Engineering & Construction
American Concrete Pavement Association

ACPA

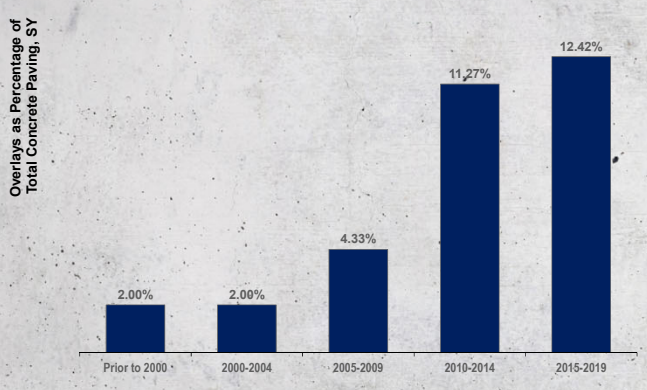
Learning Objectives:

- Understand the various type of concrete overlays
- Understand how to prepare the existing pavement for a concrete overlay
- Understand the timing during the pavement deterioration for when a concrete overlay is appropriate
- Understand how concrete overlay can be sustainable and resilient
- Understand FAA Life Cycle Cost Calculation Procedures
- Review and understand construction lessons learned from various concrete overlay case studies.

jectives

- Concrete Overlays – Why?
  - Can be great rehabilitation method
  - Sustainable and Resilient
- Performance of Concrete Overlays
  - Pavement Condition Index (PCI) Comparisons

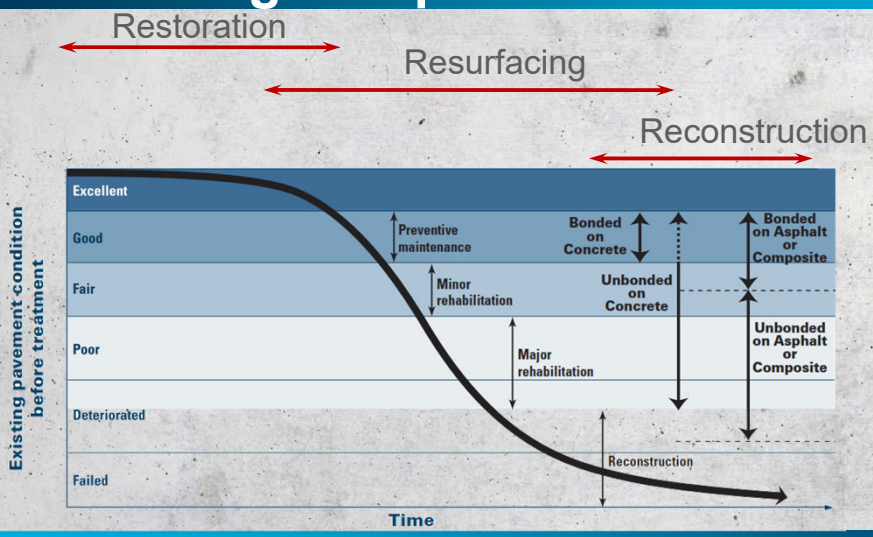
NATIONWIDE CONCRETE OVERLAY USAGE IS GROWING

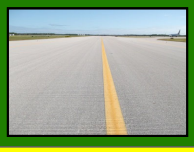


Source: From data submitted by ACPA chapters/state paving associations and other sources, including Oman Systems, Bid Express and DOT websites.

Overlay Examples

When should a concrete overlay be used? Timing is Important…



	PCI	PCI	REPRESENTATIVE PAVEMENT SURFACE	REHABILITATION ACTIVITIES
ROUTINE MAINTENANCE	86 - 100	90		Pavements with PCI indexes above 85, or 'Good' may require periodic joint/crack sealing and local patching.
PAVEMENT PRESERVATION	65 - 85	70		Pavements with PCI conditions ranging from 'Satisfactory' to 'Good' may require surface treatments (seal coat), **thin overlays**, and/or joint/crack sealing.
MAJOR REHABILITATION	40 - 64	40		Pavements that have deteriorated below a PCI 64, or within the range of 'Poor' to 'Fair' conditions may **require major rehabilitation** such as **pavement mill and overlay.**.
MAJOR RECONSTRUCTION	0 - 39	15		Pavements that have deteriorated below a PCI 40, or within the range of 'Failed' to 'Very Poor' conditions may require major reconstruction.

Applying the Right Fix at the Right Time

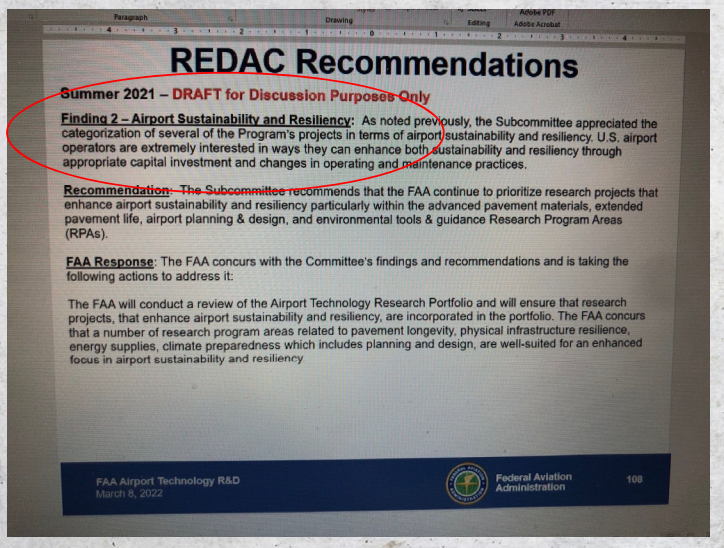
Effectiveness of Treatments

Treatment	Estimated Life Extension (years) Good PCI > 80	Fair PCI > 60	Poor PCI >40
Fog Seal/Rejuvenator	< 1	-	-
Spray Applied Seal	3-5	1-3	1-2
Chip Seal*	5-7	3-5	1-3
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 to date,
- For PCI < 60 typically do not recommend surface treatment but if can not do rehabilitation/reconstruction - will buy a little time.

* Typically not recommended on airports…FOD potential…Hard on tires

Federal Aviation Administration

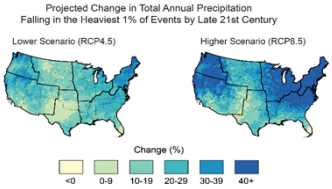


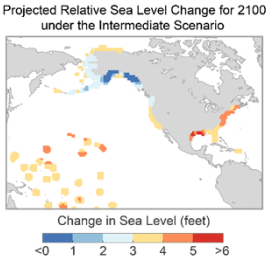
How are Concrete Overlays Sustainably?

- No demolition
- Raw Materials saving
- Long Life
- Use Phase
- Resilient

FUTURE CLIMATE CONDITIONS WILL NOT RESEMBLE THE PAST

U.S. severe storms, heavy precipitation events: Greater intensity *and* frequency Continued increases expected





Global mean sea level:
7–8 inches higher since 1900 - about half since 1993
Expected to rise by 1–4 feet by 2100

How will pavement layers be impacted?
Do certain pavement types / base layers perform better (than others) when exposed?

USGCRP, 2018: Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II: Report-in-Brief [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 186 pp.

Improved Resilience

Ocracoke Island, NC (Outer Banks)

Vicksburg, MS

- Pavement deterioration curves accelerate when flooding occurs
  - When flood waters recede, studies indicate subgrades remain moist
  - Pavements are often re-loaded before subgrades dry
- FAA Design Circular offers support of stabilized base & subgrade layers
  - *consider subgrade stabilization if any of the following conditions exist: poor drainage, adverse surface drainage, frost, periodic water inundation or the need to establish a stable working platform.*(AC 150/5320-6G, Section 2.4.3)

Improved Resilience

Henderson Field (Wallace, NC)

Offutt AFB (Omaha, NE)

- FAA Design Circular offers support of stabilized base & subgrade layers.
  - When saturated conditions are expected, use stabilization methods
- When a concrete overlay is used, **it takes the old pavement and turns it into a good stabilized base** for the new surface…It hardens the system!
  - It also RAISES the pavement surface off the possible high-water table

FLOODING CAUSES THE SUBGRADE TO BECOME SUPERSATURATED

Moisture infiltrates base, pushes the subgrade particles apart and weakens the system

Asphalt Pavements are Flexible

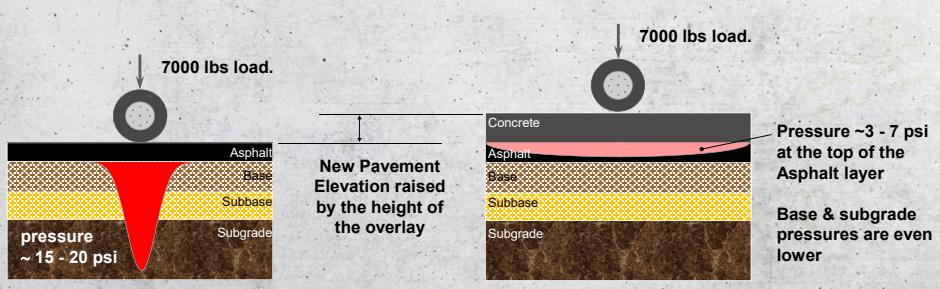
- Lowered subgrade strength & reduced modulus
  - Reduced load carrying capacity
  - Takes ~1 year to regain strength
- Loading during this times accelerates pavement damage / deterioration
  - Reduced pavement life

Concrete Pavements are Rigid

- Maintains high level of strength / stiffness
- Subgrade is weak, but still uniform
- Spreading of the load means subgrade is not overstressed
- Little impact on the serviceability / life

Flooding does not impact the concrete's load carrying capacity to the same degree as asphalt's

HOW DOES CONCRETE OVERLAYS IMPROVE ASPHALT PAVEMENT'S RESILIENCE TO FLOODING?

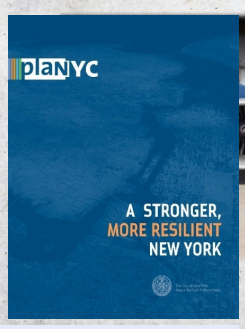


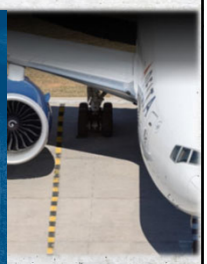
Concrete overlay increases both the height and the structural strength of the pavement

Resiliency of Concrete Recognized

Reconstruction of Runway 13L-31R at JFK
Port Authority of NY & NJ Press Release (April 2019)

*"The rehabilitation will provide aircraft a solid concrete runway that is more **RESILIENT** than asphalt and will increase the useful life of runway by four times"*





"Use of Concrete will extend runway's useful life to 40 years, rather than 8-12 years with asphalt."

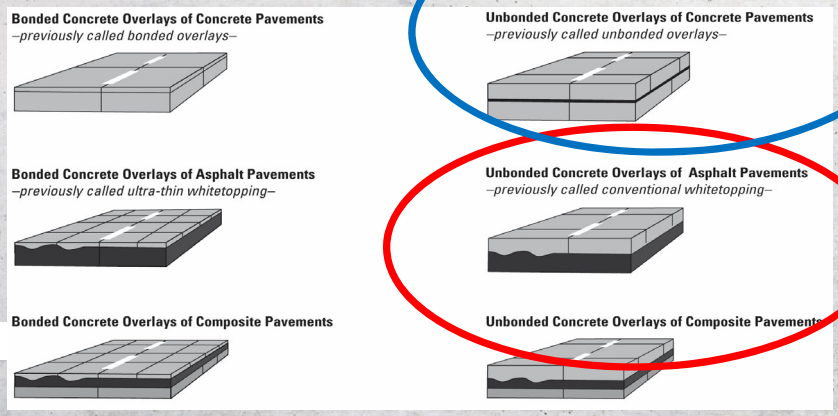
How Do We Decide an Overlay is Appropriate?

- Reason for Rehabilitation
  - Why is pavement ready for rehabilitation
  - Structural, material distress, other
- Start with condition assessment
  - Complete assessment of pavement materials and structural integrity
  - Thickness, condition, nature and strength of each layer
- Design must correct reason for rehabilitation

WHAT ARE THE VARIOUS TYPES OF CONCRETE OVERLAYS?

Bonded

Unbonded



Which method(s) are best for concrete overlays?

Concrete Overlay

Concrete Overlay of Flexible Pavement

- Essentially same as designing new pavement

Concrete Overlay of Rigid Pavement

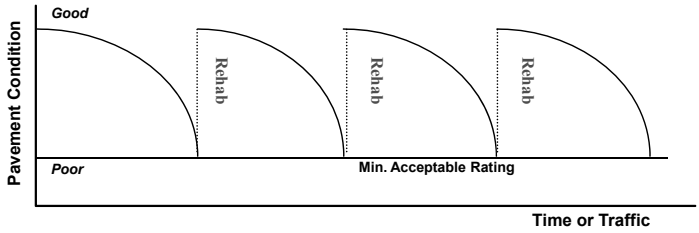
- Must consider the structural condition of existing
- CDFU How much of life prior to first crack (prior to SCI falling below 100)
- Either handled as fully bonded or fully unbonded overlay
- Fully unbonded—use interlayer or bond breaker (interlayer gets no structural value)

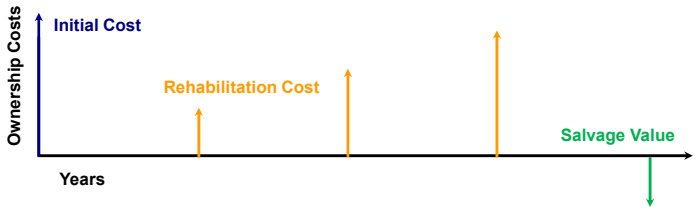
FAA AC 150/5320-6G – Chapter 4

LIFE CYCLE COST ANALYSIS IS PROJECT ANALYSIS TOOL THAT QUANTIFIES THE TOTAL "COSTS OF OWNERSHIP"

Accounts for initial costs and discounted future rehabilitation costs

Acknowledgement: Jim Mack, P.E., MBA





LCCA compares different options for a given project and determines which pavement design is most cost effective over the analysis period

$$NPV = \text{Initial Cost} + \sum Rehab\ cost \times \frac{1}{(1+d)^{n_k}} - Salvage\ Value \times \frac{1}{(1+d)^{n_k}}$$

Where
- NPV = Net Present Value
- d = real discount rate
- n_k = year of expenditure

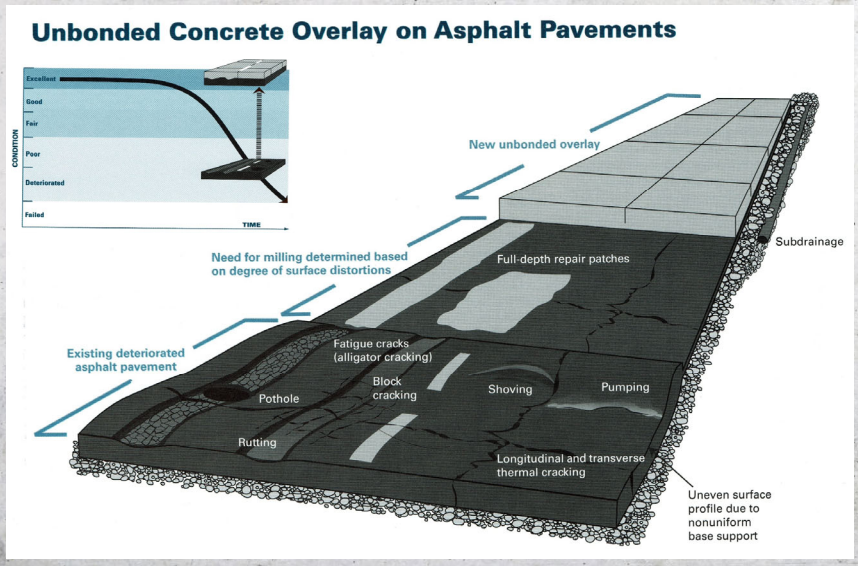
CEMEX

How do you prepare for a concrete overlay?

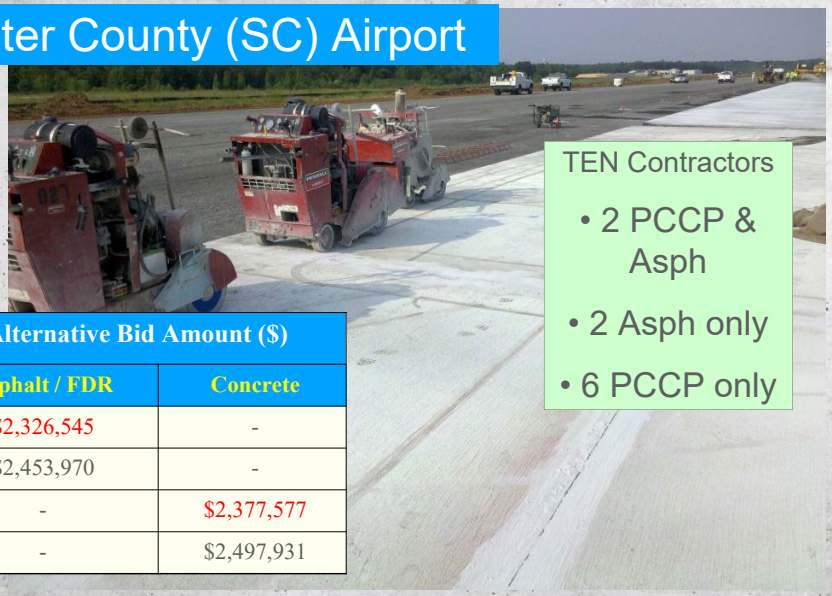
- Defective areas in base, subbase and subgrade must be corrected
- Flexible Pavements
  - Patching: Remove localized distressed pavement and fix reason that led to distress
  - Milling: Remove surface irregularities
  - Cracks & Joints (maybe depending on how bad)
  - Grooves: ok unless exhibiting signs of distress,
  - PFC: remove
  - Paint & Surface contaminants

Preparation for Overlay

- Rigid Pavements
  - Broken & Unstable Slabs: Localized replacement may be required or may be able to break and seat
  - Leveling Course: Depending upon extent of surface condition
  - Cracks & Joints:
  - Surface Cleaning: Clean of dirt and other foreign material, remove excessive joint sealant, (do not need to remove paint)



Lancaster County (SC) Airport



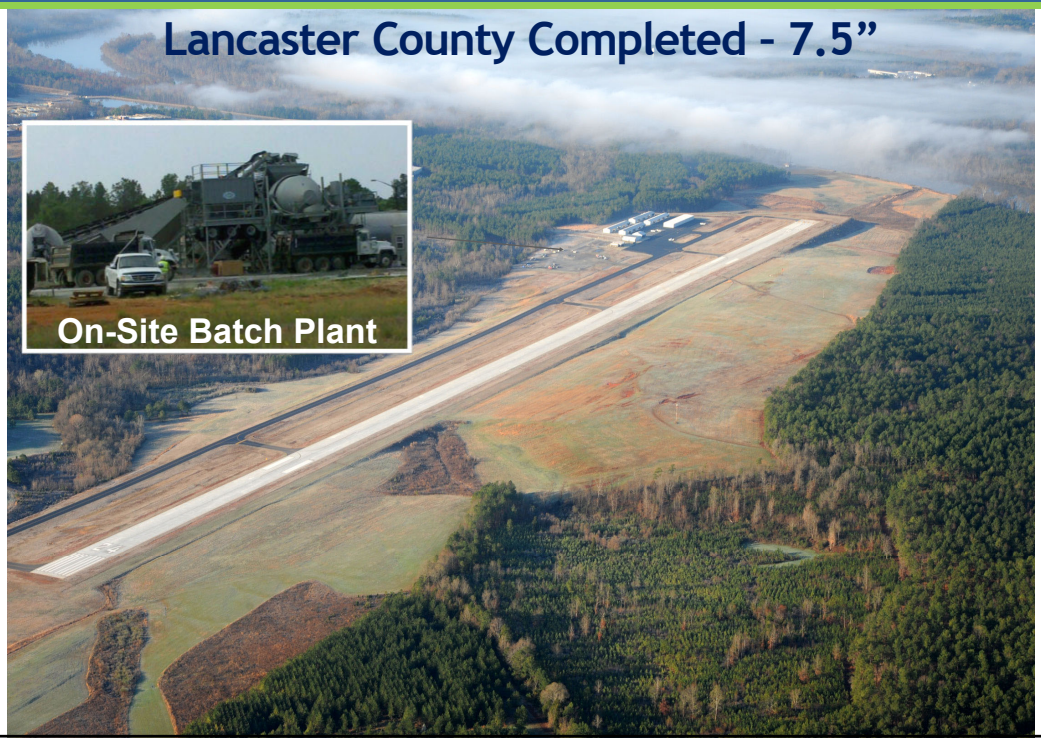
April 2009 Bid

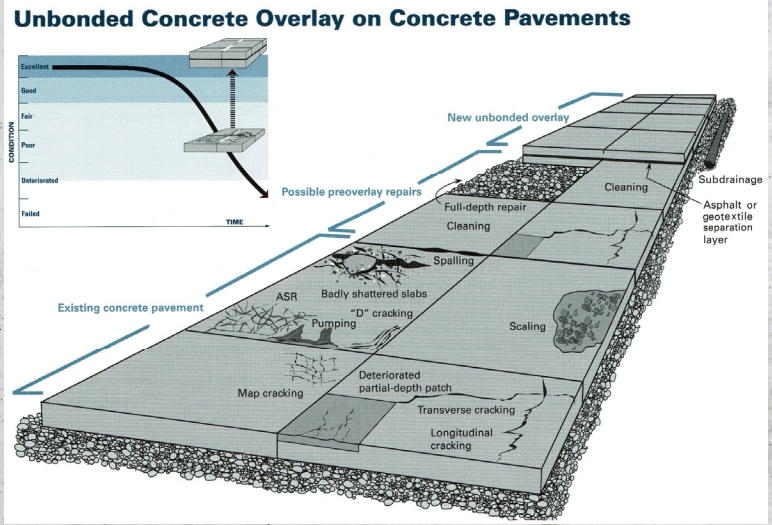
Contractor	Alternative Bid Amount ($)	
	Asphalt / FDR	Concrete
A	$2,326,545	-
B	$2,453,970	-
C	-	$2,377,577
D	-	$2,497,931

TEN Contractors

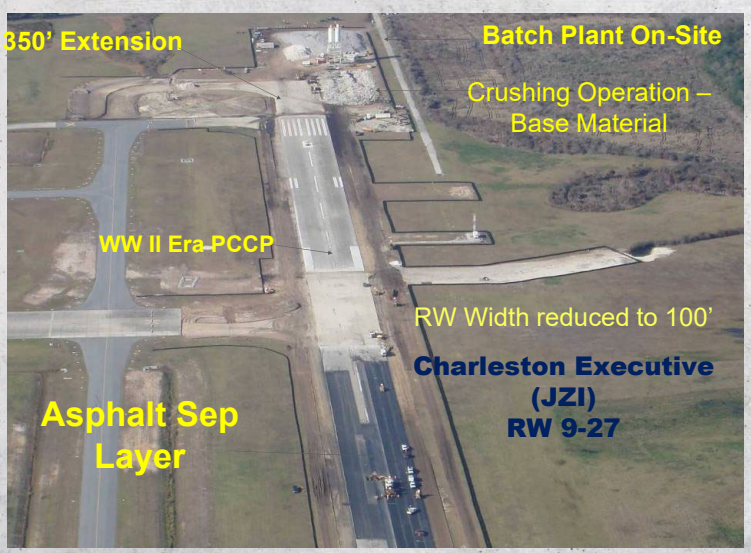
- 2 PCCP & Asph
- 2 Asph only
- 6 PCCP only

Lancaster County Completed - 7.5”





Asphalt or Fabric can be used as Sep Layer between distressed concrete and new concrete overlay



CONCRETE OVERLAY COMPLETED

59,700 SY of 11-inch P-501

Laurens County (SC) Airport
½ Width Paving - 37.5'

5-Inch, SCDOT 501 Spec (substituted for P-501), Min of 4400 psi

Greenwood County RW 9-27

- Asphalt was nearly one foot thick!
- PCCP Paving completed in 10 days!

Greenwood County RW 9-27
55,500 SY of 5-inch PCCP

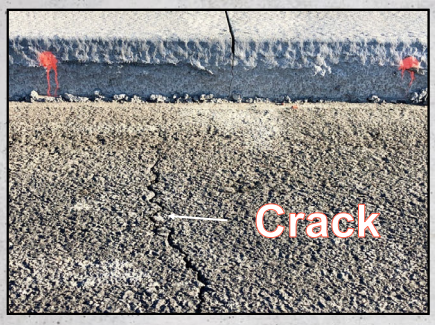
Grand Strand Airport

2018 Construction / Prior PCI = 48-56

Grand Strand Airport

7.5-inch RW 5-23 Overlay

What are the Construction Lessons Learned?



- ✓ Paving directly over (most) asphalt cracks are OK
- ✓ Curing is extremely important with thinner overlays (pavement edges too)
- ✓ Remember to "block out" working joints that have opened wide (pilot lanes)
- ✓ There are more joints on thinner overlays…saw timing is critical

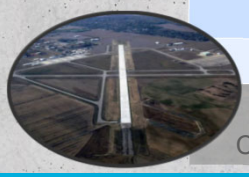
Concrete Overlay Performance
Rigid over Asphalt (WT)

AIRPORT	Thickness	Last PCI	Year C
South Carolina			
Lancaster Co RW	7.5	99	2010
Berkeley Co RW	9	99	2010
Laurens Co RW	5	99	2013
Greenwood Co RW	5	100	2014
Iowa			
Storm Lake RW	5	89	**1971**
Corning RW	5	75	**1987**
Carroll RW	5	85	**1988**
Ft. Madison RW	6	94	**1991**
Spencer (RW 12 / RW 18)	5 / 6	91 / 100	**1992 / 1994**

Exceeds FAA 20-year Design Life

Concrete Overlay Performance
Rigid over Rigid (with Sep Layer)

AIRPORT	Thickness	Last PCI	Year C
South Carolina			
Charleston Exec RW	11	93	2010
Indiana			
Columbus Municipal	10	98	2010
Iowa			
Keokuk RW	6	94	**1996**
Denison RW	6	90	**1997**
Oskaloosa RW	6	87	**1998**



Columbus (IN) Municipal Airport

Exceeds FAA 20-year Design Life

O · nfl‡v£ ¡ fl¼0 vflj · flflv£ ¡

8 afl‰ A1B vtjun}}‡M121
. uvns£s2¡tv¡nnfiv¡t å . £¡flffi·j‡v£¡
%~ nfivja¡ . £¡jfin‡n Ma"n~ n¡‡%flfl£jva‡v£¡
t~ vtjun}}Ó aj«a1£ft
» » » 1aj«a1£ft