Airfield Concrete Pavement Maintenance—Traditional Method & New Innovations

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ACPA

SWIFT
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Aviation Events Group

Performance Issues

- Airfield Functional Condition
  - FOD Potential
  - Friction/Hydroplaning
  - Profile

- Airfield Distress
  - Cracking (crack and joint sealing, repair)
  - Corner Breaks, shattered panels (full-depth repair)
  - Spalling (partial-depth repair)
  - Roughness/Polishing (diamond grinding)

Pavement Evaluation

- Collected as-built info, perform distress surveys, NDT (?), sampling (?)
- Determine distress / deterioration cause(s)
- Develop appropriate alternatives
- Also provide quantitative information for quantity estimates, LCCA

Maintenance versus Preservation

What is Preventive Maintenance?

- Planned strategy of cost effective treatments
- Applied to structurally sound pavements with significant remaining life
- Maintain or improve functional condition

What is Pavement Preservation?

- Long-term strategy for enhancing pavement performance
- Focus on extending pavement life and restoring functional condition
- Accomplished with a collection of preventive maintenance treatments and a few minor rehabilitation and routine maintenance treatments

Techniques

- Slab Stabilization and Slab Jacking
- Partial-Depth Repair
- Full-Depth Repair
- Dowel Retrofit and Cross-Stitching
- Diamond Grinding and (Re-)Grooving
- Joint (Re-)Sealing
- Concrete Overlays

Slab Stabilization: Purpose/Benefits

- Fills voids beneath slabs
- Restore supports
- Reduces pavement deflections
- Reduces progression of key distresses (pumping, faulting, corner breaks)

Concrete Slab Repairs

Depth of Repairs

- Partial Depth - Intent is to bond repair material to existing concrete and be compatible in characteristics
- Full Depth - Intent is to make the repair a functional part of the existing pavement.

Width-based Rule-of-Thumb Treatment Guidelines for Concrete Cracking

(Environmental/Non-load-related)

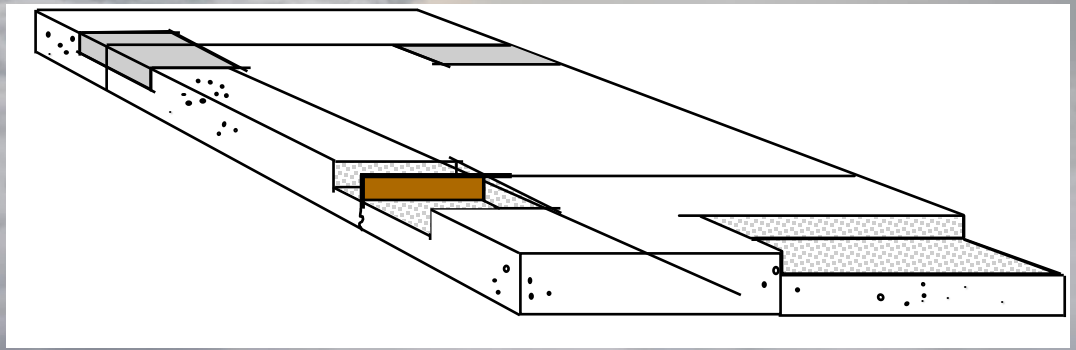
• Up to 1/4-inch	Do Nothing
• 1/4 to 1-1/2-inch (no spalls)	Rout (Saw) and Seal (+DBR?)
• 1/4 to 3/4-inch (spalled)	Partial-Depth Repair (+DBR?)
• 3/4 to 1-1/2 inch (spalled)	Full-Depth Repair
• More than 1-1/2 inches	Full-Depth Repair

Cracks and Causes

- Full Width of Panel (Slab Cracking)
  - Often a result of design, joint layout deficiencies
    - Load plus environmental (curl/warp, shrinkage) stresses
  - Rout-and-seal plus DBR may be cost-effective
- Corner Cracks (Diagonal Cracking)
  - Load-related distress
  - Full-depth repair or panel replacement is required
- Shattered Slabs - More than Four Pieces
  - Full-depth panel replacement is required

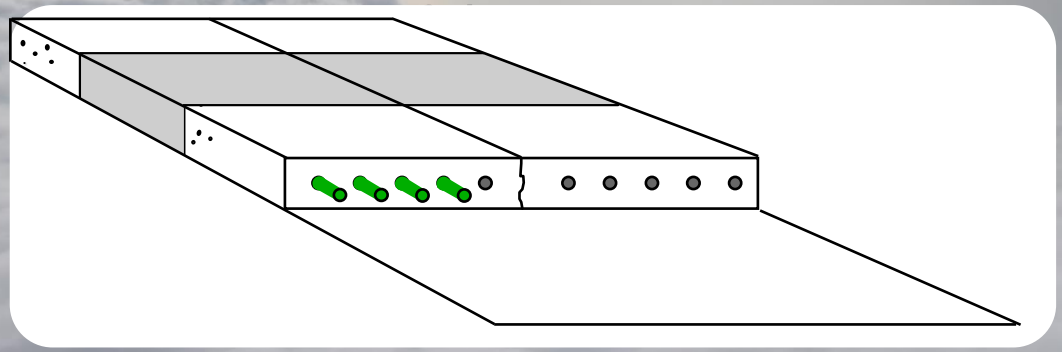
Partial-Depth Repairs

- Generally, spall repairs
- Repairs localized distress in the top 1/3 of the slab
- Generally located at joints, but can be placed anywhere surface defects occur



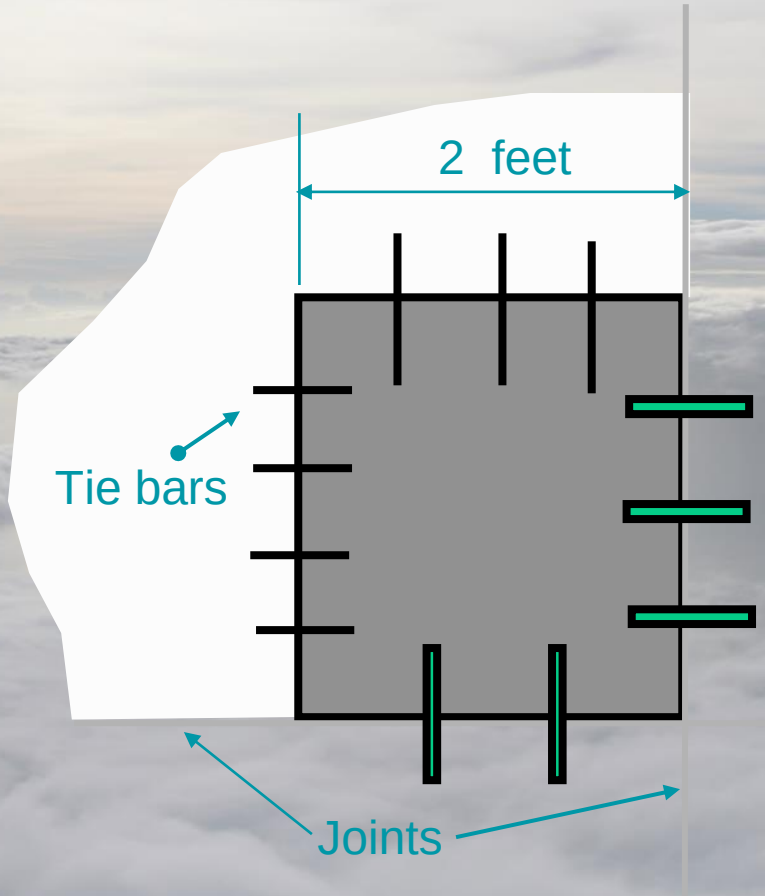
Full-Depth Repairs

- Repairs distresses greater than 1/3 the slab depth.
- Consists of removing and replacing at least a portion of the existing slab to the bottom

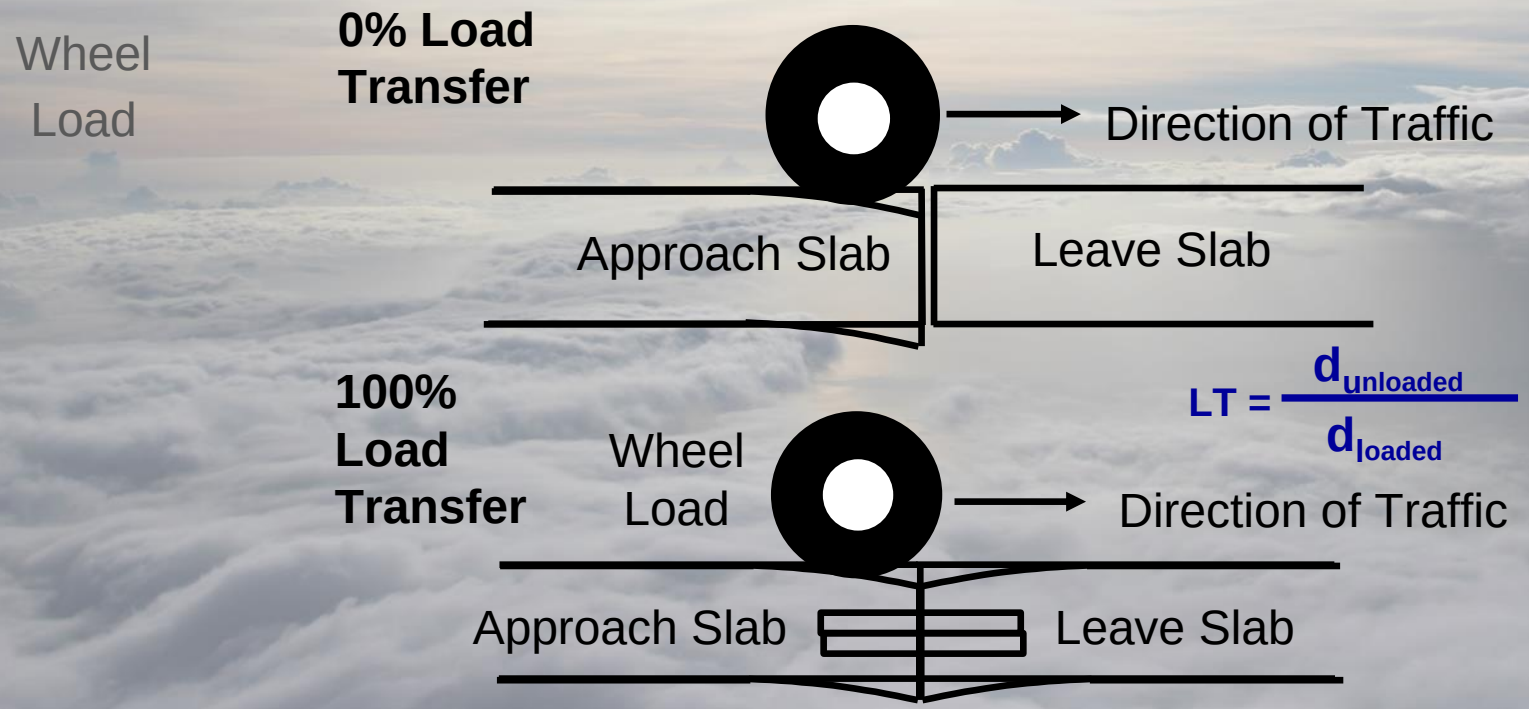


Full Depth Repairs

- Minimum repair dimension = 2 feet
- Full-depth cut at joints using diamond-segment saw blades
- Tie and dowel to existing panels

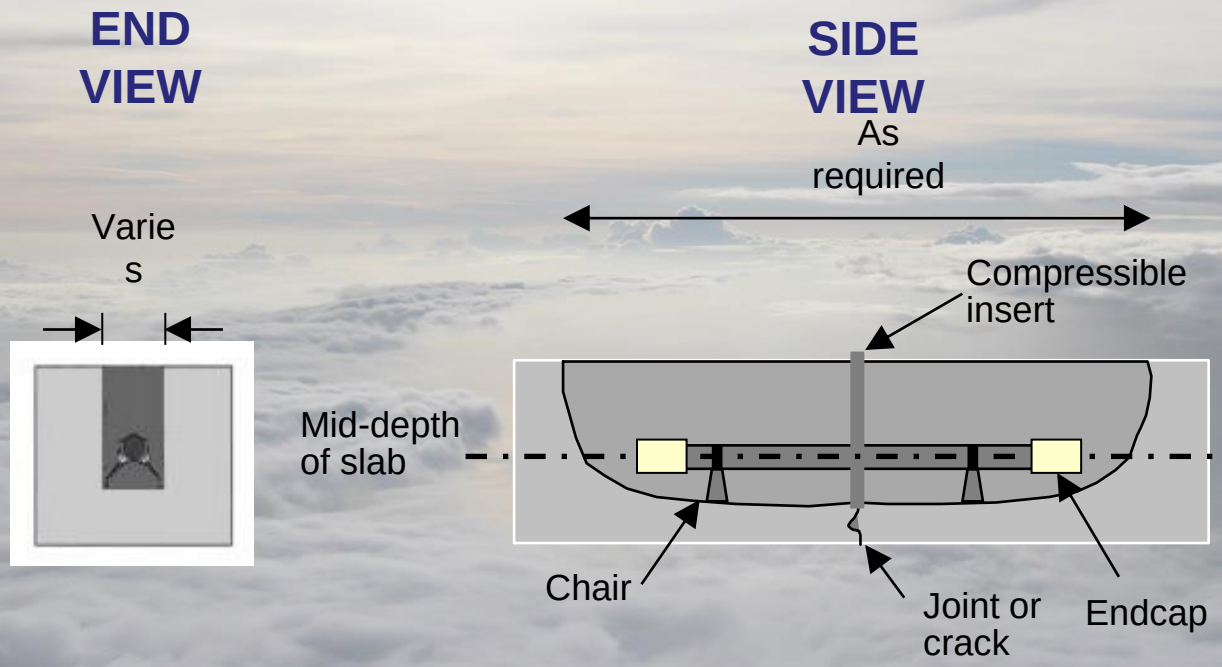


Load Transfer Efficiency



Load Transfer Restoration
(Dowel Bar Retrofit, Cross-Stitching, and Slot Stitching)

Schematic of Dowel Bar Retrofit Installation



Cross Stitching

- Definition

  Grouting of tiebars in holes drilled across nonworking longitudinal joints and cracks at an angle to the pavement surface

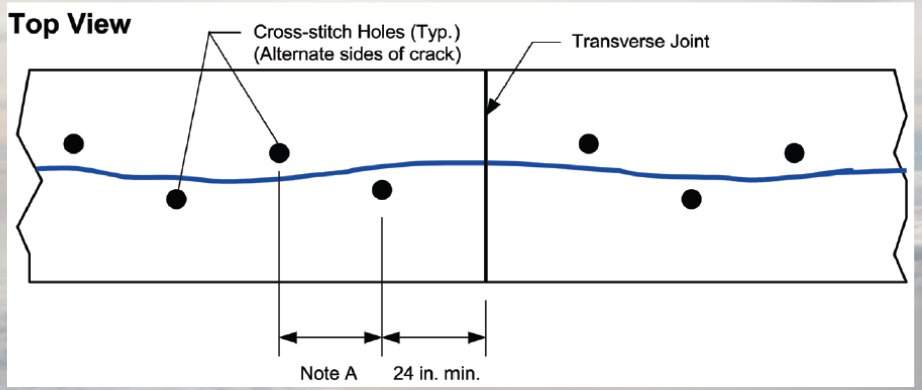
- Used to strengthen nonworking longitudinal joints and nonworking longitudinal cracks (in relatively good condition)

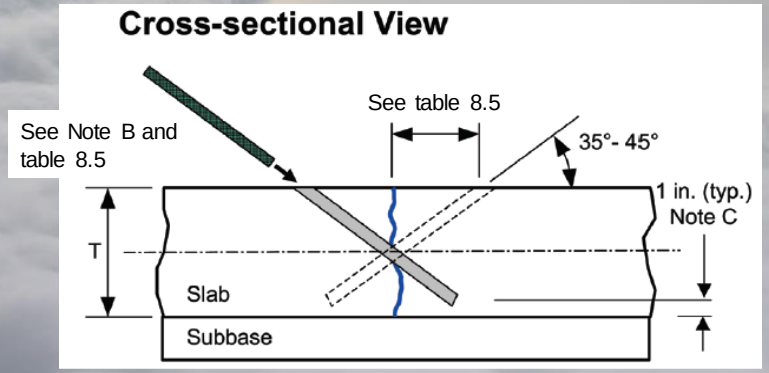
Cross Stitching

Applications and Benefits

- Prevent slab migration and to maintain aggregate interlock
- Mitigate the effects of tie bars omitted during construction
- Tying roadway lanes or shoulders that are separating
- Tying centerline longitudinal joints that are starting to fault

Cross Stitching Schematic





Diamond Grinding

- Improves safety by:
  - Smoothing the ride
  - Reestablishing the friction properties
  - Correcting the cross-slope
- Improves aesthetics

Diamond Grinding

Equipment Schematic

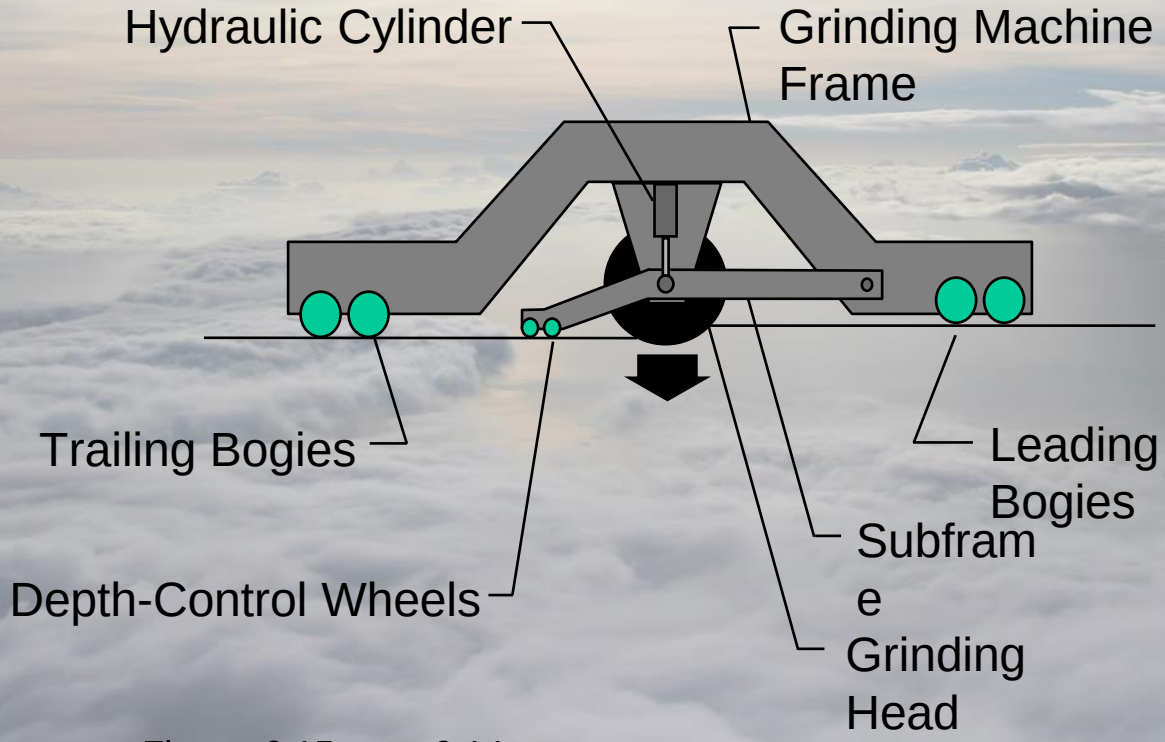


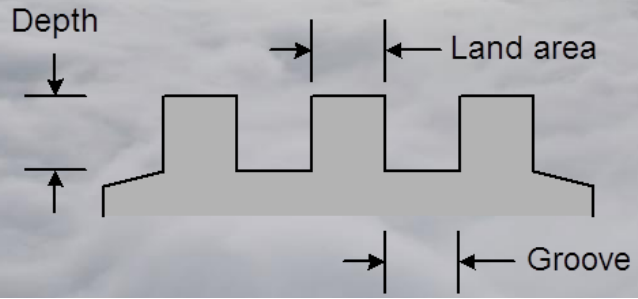
Figure 9.15 on p. 9.14

Diamond Grinding

Blade Spacing

Parameter	Range	Hard Agg	Soft Agg
Groove Width	0.09 – 0.15 in	0.09 – 0.15 in	0.09 – 0.15 in
Land Area	0.07 – 0.13 in	0.07 – 0.11 in	0.09 – 0.13 in
Depth	0.04 – 0.12 in	0.04 – 0.12 in	0.04 – 0.12 in
No. of Blades	50 – 60/ft	53 – 60/ ft	50 – 54/ft

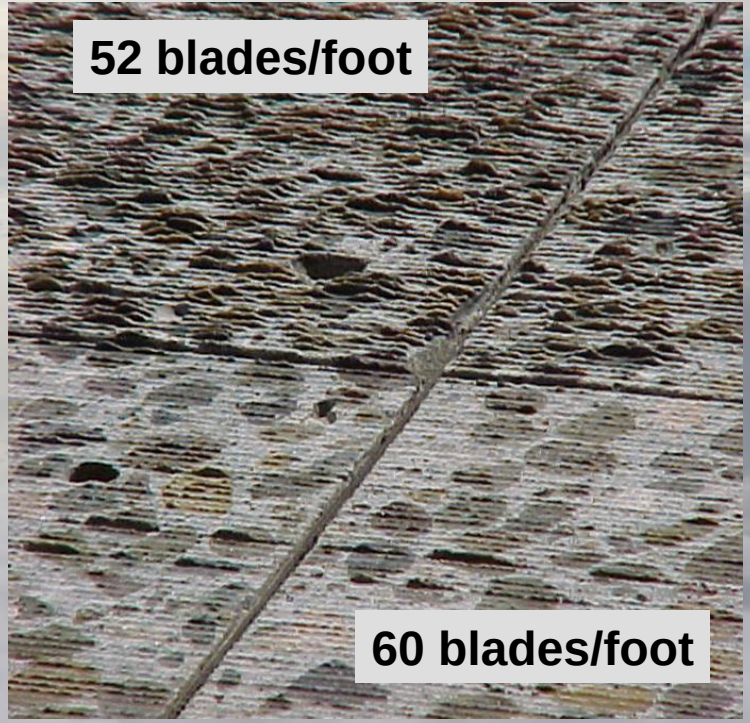
Table 9.1 on p. 9.3



Diamond Grinding

Blade Spacing Effects

- Correct spacing critical to achieving proper texture
- Hard and large size aggregates require tighter blade spacing



Diamond Grinding

Limitations

- Does not address structural or durability issues
- Hardness of aggregate affects costs, productivity, and performance life
- Roughness and deterioration will re-develop if causes are not addressed
    - Full- and partial-depth repairs
    - Dowel bar retrofit
    - Slab stabilization
    - Joint resealing?

Joint Resealing

Basic Consideration for Joint Sealing

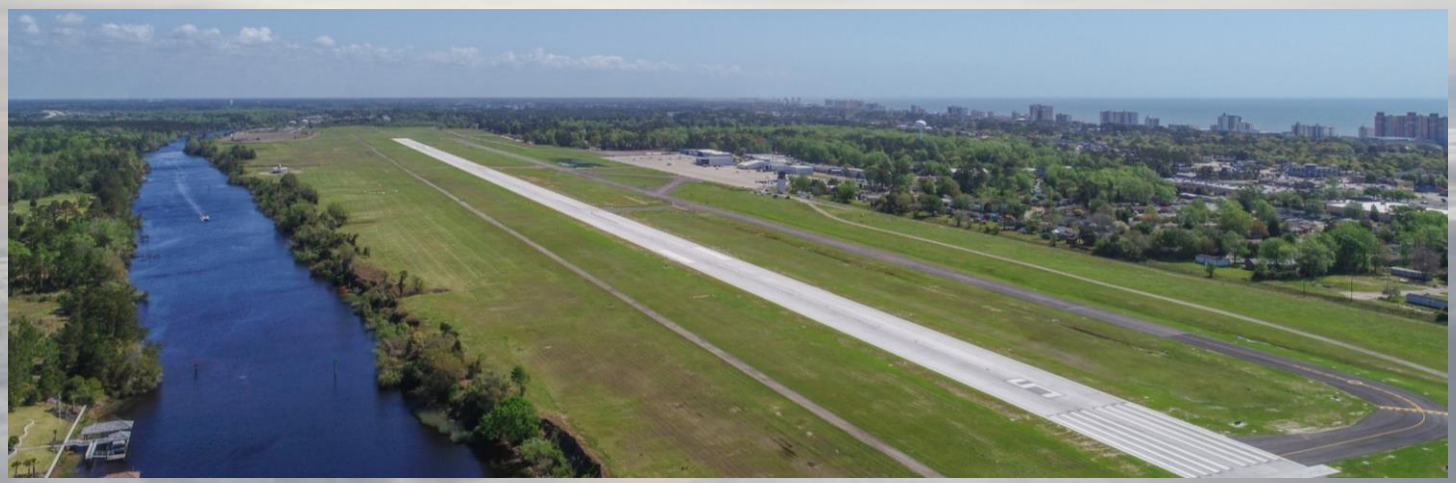
- Water-related pavement damage
  - Subgrade or subbase softening
  - Erosion
  - Pumping
  - Lost of support
- Joint seal minimizes the passage of water
  - Watertight pavement not practical to construct
- Incompressible Materials

Construction: Joint Resealing

Procedures

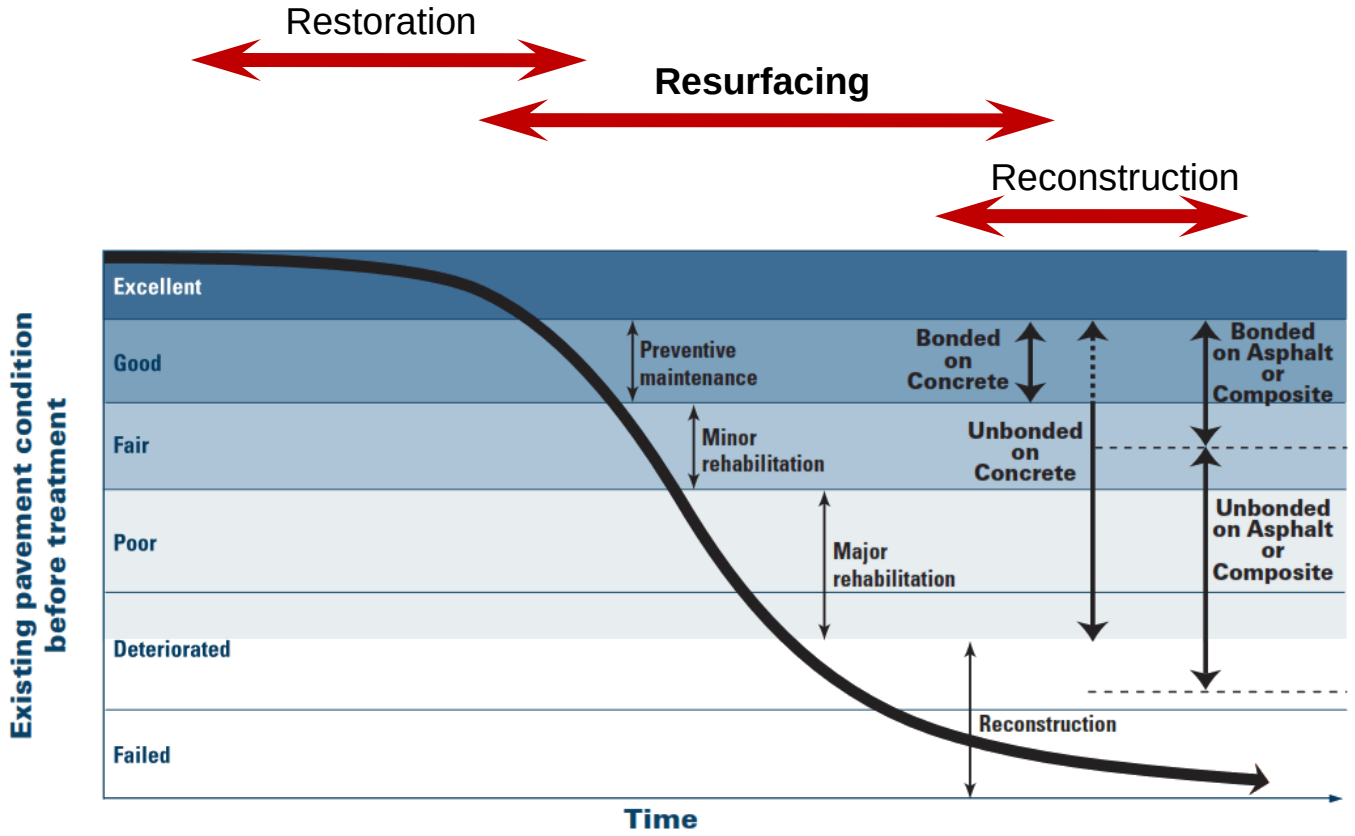
1. Old sealant removal
2. Joint refacing
3. Joint reservoir cleaning
4. Backer rod installation
5. New sealant installation

Concrete Overlays



Acknowledgement:
Greg Dean
Executive Director
CAROLINAS CONCRETE PAVING ASSOCIATION

Timing is Important…



	PCI
ROUTINE MAINTENANCE	86 - 100
PAVEMENT PRESERVATION	65 - 85
MAJOR REHABILITATION	40 - 64
MAJOR RECONSTRUCTION	0 - 39

PCI	REPRESENTATIVE PAVEMENT SURFACE	REHABILITATION ACTIVITIES
90		Pavements with PCI indexes above 85, or 'Good' may require periodic joint/crack sealing and local patching.
70		Pavements with PCI conditions ranging from 'Satisfactory' to 'Good' may require surface treatments (seal coat), **thin overlays**, and/or joint/crack sealing.
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.**.
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

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
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

Concrete Overlay Performance

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**

Exceeds FAA 20-year Design Life

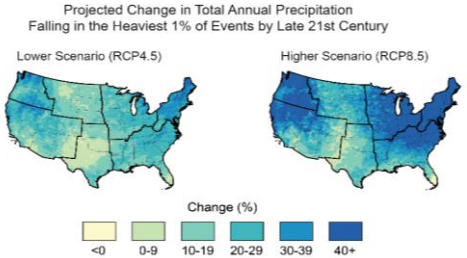
Columbus (IN) Municipal Airport

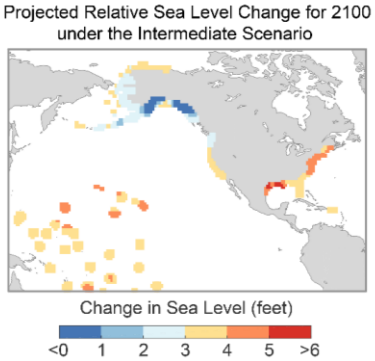
Concrete Overlays
Sustainable & Resilient

- 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
  - *Considering using subgrade stabilization when 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)

Flood Water Inundation

- 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 above the possible high water table

FLOODING CAUSES THE SUBGRADE TO BECOME SUPERSATURATED

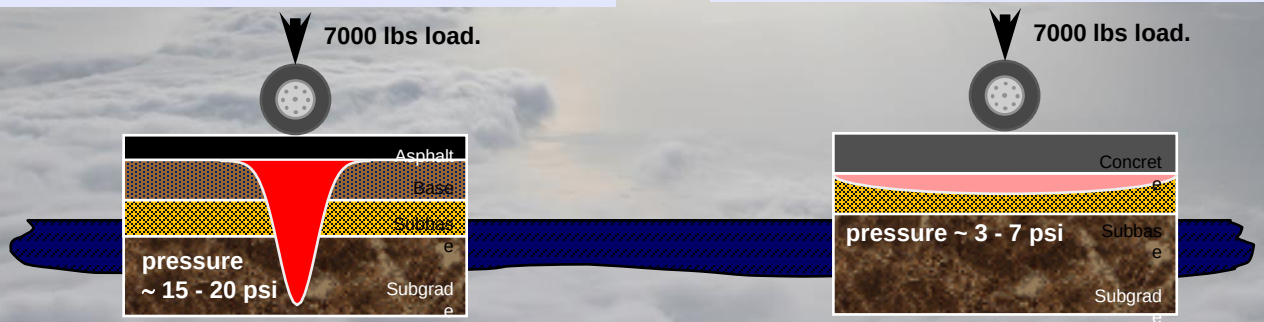
Moisture infiltrates base, pushes the subgrade particles apart and weakens the system

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**

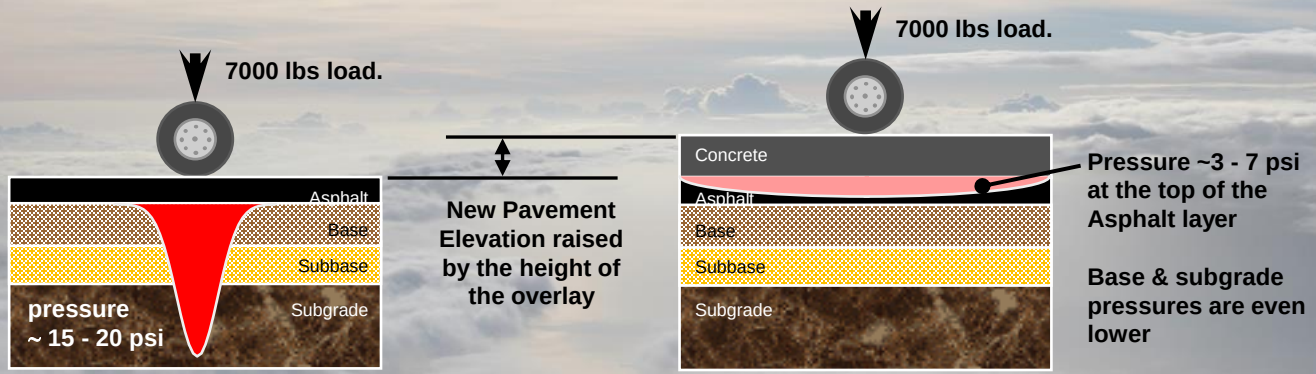
Concrete Pavements are Rigid

- **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 CONCRETE OVERLAYS IMPROVE ASPHALT PAVEMENT'S RESILIENCE TO FLOODING



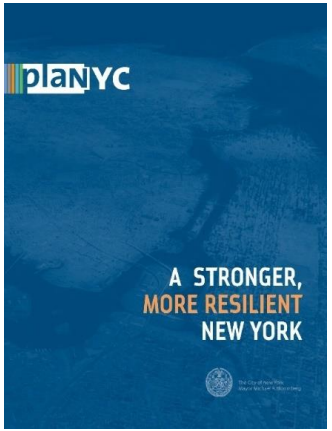
Concrete overlay increases both the height and the structural strength of the pavement

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"*



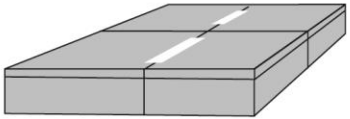
"Use of Concrete will extend runway's useful life to 40 years, rather than 8-12 years with asphalt."

TYPES OF CONCRETE OVERLAYS

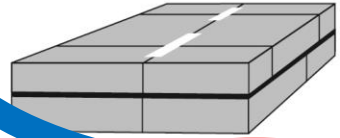
Bonded

Unbonded

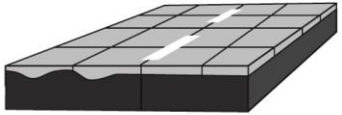
Bonded Concrete Overlays of Concrete Pavements
–previously called bonded overlays–



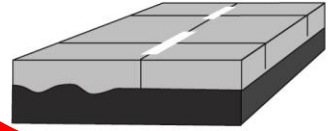
Unbonded Concrete Overlays of Concrete Pavements
–previously called unbonded overlays–



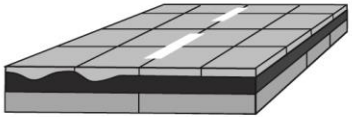
Bonded Concrete Overlays of Asphalt Pavements
–previously called ultra-thin whitetopping–



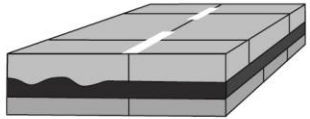
Unbonded Concrete Overlays of Asphalt Pavements
–previously called conventional whitetopping–



Bonded Concrete Overlays of Composite Pavements



Unbonded Concrete Overlays of Composite Pavements



Concrete Overlay

- Concrete Overlay
  - Essentially same as designing new pavement
- Overlay of Rigid Pavement
  - Must consider the structural condition of existing pavement
  - FAARFIELD does not consider address reflection cracking as a failure mode
  - CDFU—How much of life prior to first crack (prior to SCI falling below 100)

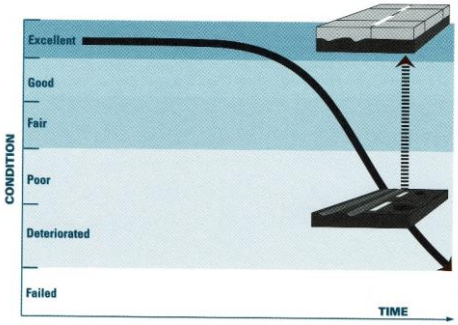
Preparation for Overlay

- 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: Repair?
  - Grooves: ok unless exhibiting signs of distress,
  - PFC: remove
  - Paint & Surface contaminants: Remove ?

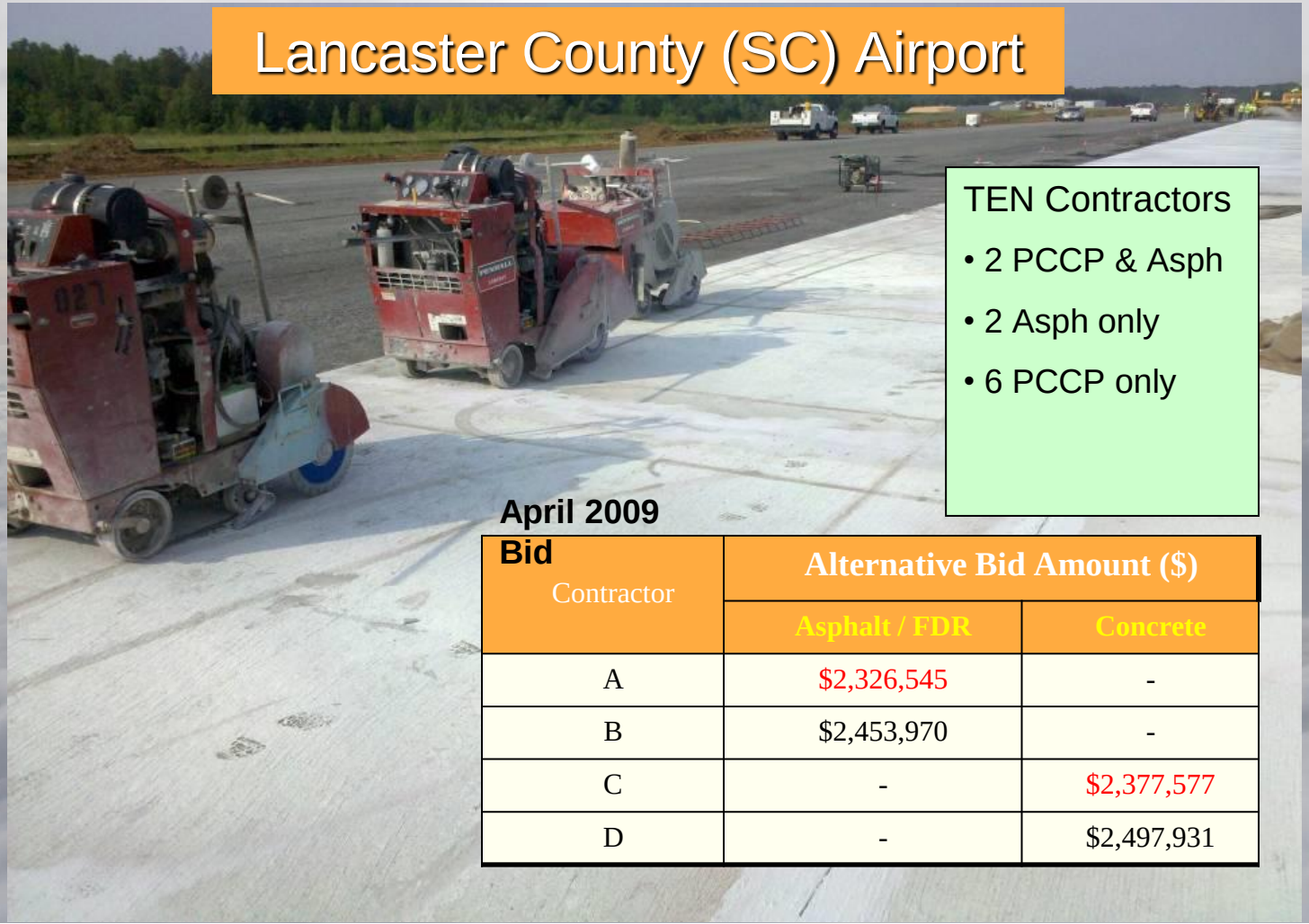
Preparation for Overlay

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

Unbonded Concrete Overlay on Asphalt Pavements



Lancaster County (SC) Airport



TEN Contractors

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

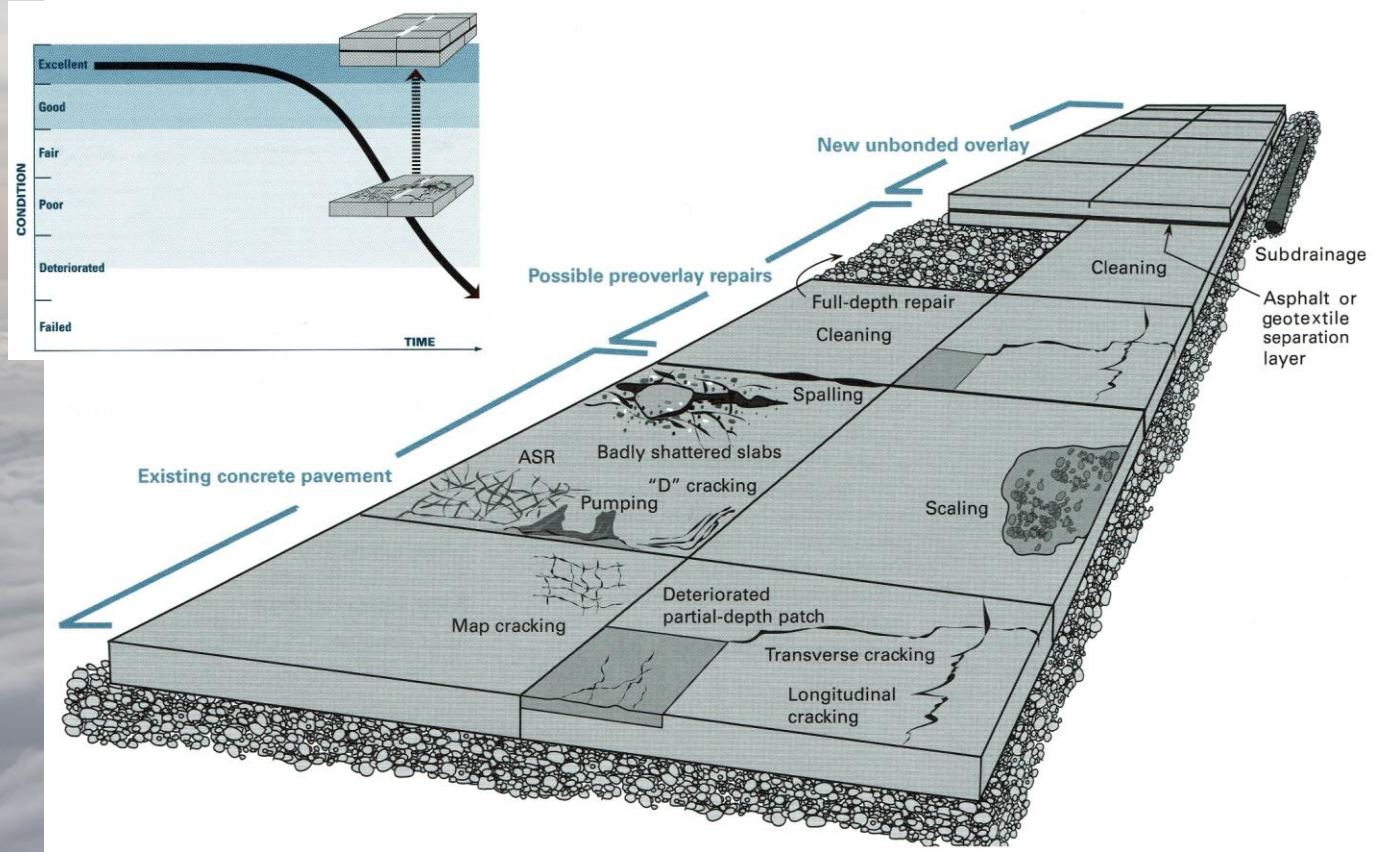
April 2009 Bid

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

Lancaster County Completed – 7.5”

On-Site Batch Plant

Unbonded Concrete Overlay on Concrete Pavements



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


350’
Extension
Batch Plant On-Site
Crushing Operation – Base Material
RW Width reduced to 100’
WW II Era PCCP
Asphalt Sep Layer
Charleston Executive (JZI)
RW 9-27

CONCRETE OVERLAY COMPLETED

59,700 SY of 11-inch P-501

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

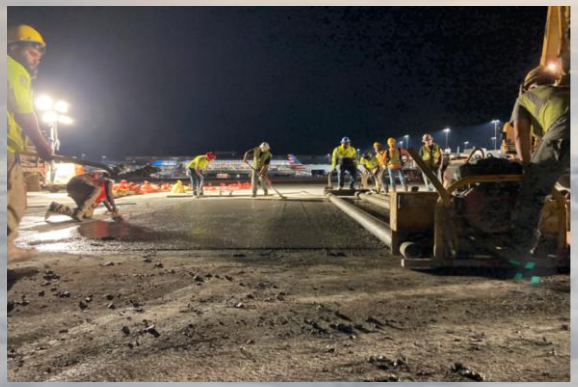
Grand Strand Airport

2018 Construction / Prior PCI = 48-56

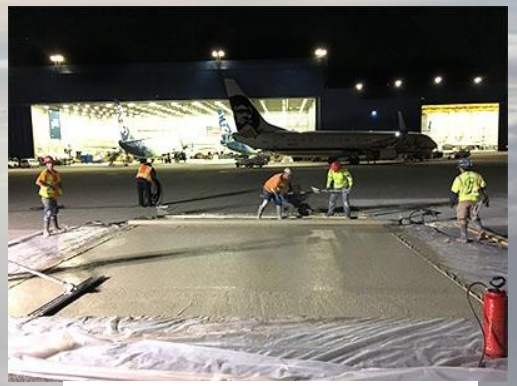
Grand Strand Airport

7.5-inch RW 5-23 Overlay

New Products



concretum
the fastest concrete



Rapid Set

To Summarize: With proper maintenance and rehab strategies, Concrete pavements can last a lifetime

Questions or Comments?

gmitchell@acpa.org