EXPANDING THE REALM OF POSSIBILITY

Airfield Pavement Maintenance Needs – When To Apply

Presentation to:

SWIFT

September 2007 Jim W. Hall, Jr.





Dynamics of Distresses









Causes of Distresses (AC Pavements)

- Load Related
 - Alligator cracks
 - Rutting
 - Shoving/Slippage cracks
 - Longitudinal cracks
- Climate Related
 - Block cracks
 - Longitudinal cracks

- Materials Related
 - Raveling
- Construction Related
 - Lane Joint cracks
 - Raveling
 - Bleeding
 - Shoving



Causes of Distresses (PCC Pavements)

- Load Related
 - Corner Breaks
 - Linear cracks
 - Shattered slab
 - Pumping
- Climate Related
 - Durability Cracks

- Materials Related
 - Pop-Outs
 - Durability cracking
- Construction Related
 - Scaling
 - Spalls
 - Shrinkage cracks



Common Early Distresses

- AC
 - Poor compaction can cause cracks in paving lane joint
 - Cracks in first few years with raveling after 3 to 5 years
- PCC
 - Joint spalls due to over-working of concrete
 - Shrinkage cracks
 - Corner breaks
 - Patches cause distress
- Juncture at AC/PCC lack of expansion space





Distress Progression Linear Cracking









Distress Progression Alligator Cracking









Distress Progression Durability Cracks









Foreign Object Damage

Many distress types produce debris termed FOD
Damage to tires
Ingested into jet engines





Foreign Object Damage

Spall particles in joint

Poor quality patch causes FOD

Pavement Condition Index

- Provides measure of surface condition
- Considers distress types and impacts on performance
- ASTM D 5340

PAVEMENT CONDITION INDEX

PCI results displayed in color-coded layouts show areas of different surface distress conditions.

Deterioration Rates (Comox Airfield)

- PCC pavement
- Rate = 0.75 PCI / Year

- AC pavement
- Rate = 1.10 PCI/Year

Deterioration Rates (Baggotville Airfield)

- PCC pavement
- Rate = 0.75 PCI / Year

- AC pavement
- Rate = 1.58 PCI/Year

Deterioration Rates (Nellis AFB, Nevada)

- PCC pavement
- Rate = 0.66 PCI / Year

AC pavement
Rate = 2.00 PCI/Year

Deterioration Rates (Elmendorf AFB, Alaska)

Maintenance Policies (AC Pavements)

Distress Types	Severity Levels	Options for Repair
41. Alligator Cracking	Low	Do nothing
(Series of interconnecting cracks caused by fatigue failure under repeated traffic loading.)	Medium	Patching-AC Deep
randre under repeated trainie rouding.)	High	Patching-AC Deep
42. Bleeding (A film of bituminous material on the surface that creates a shiny, glass like, reflecting surface.)	No Severity	Do nothing
43. Block Cracking	Low	Do nothing
(Interconnecting cracks that divide the pavement into approximately rectangular pieces.)	Medium	Seal cracks
	High	Seal cracks
44. Corrugation	Low	Do nothing
(Closely spaced ridges and valleys occurring at fairly regular intervals along the payement.)	Medium	Patching-AC Deep
	High	Patching-AC Deep
45. Depression	Low	Do nothing
(Localized surface areas having elevations slightly lower that those of the surrounding payement.)	Medium	Patching-AC Shallow
is wer that those of the sufficiencing parentena)	High	Patching-AC Deep

Maintenance Policies (AC Pavements)

Distress Types	Severity Levels	Options for Repair
46. Jet Blast (Erosion causes darkened areas on the pavement surface where bituminous binder has been burned.)	No Severity	Patching-AC Shallow
47. Joint Reflection Cracking	Low	Do nothing
(Cracks from AC pavement over a PCC pavement, longitudinal & transverse PCC slabs.)	Medium	Seal cracks
	High	Seal cracks
48. Longitudinal & Transverse Cracks	Low	Do nothing
(Cracks parallel to the pavement's centerline or extending across the pavement at right angles.)	Medium	Seal cracks
	High	Seal cracks
49. Oil Spillage (Deterioration or softening of the pavement surface caused by spillage of oil, fuel, or other solvents.)	No Severity	Patching-AC Shallow
50. Patching and Utility Cut Patching	Low	Do nothing
(A defect, no matter how well it is performing.)	Medium	Seal cracks
	High	Patching-AC Deep

Maintenance Policies (AC Pavements)

Distress Types	Severity Levels	Options for Repair
51. Polished Aggregate (Polishing of aggregate caused by repeated traffic.)	No Severity	Do nothing
52. Raveling and Weathering	Low	Do nothing
(The wearing away of the pavement surface caused by dislodging of aggregate and loss of AC binder)	Medium	Do nothing
disiduging of aggregate and loss of AC onder.)	High	Patching-AC Shallow
53. Rutting	Low	Do nothing
(A surface depression in the wheel path.)	Medium	Patching-AC Deep
	High	Patching-AC Deep
54. Shoving	Low	Do nothing
(Pavement growth of PCC that shoves the AC	Medium	Patching-AC Shallow
pavements, causing ment to swell and clack.)	High	Patching-AC Deep
55. Slippage Cracking (Cracks by sliding/deforming of pavement surface.)	No Severity	Patching-AC Shallow
56. Swelling	Low	Do nothing
(An upward bulge in the pavement's surface.)	Medium	Patching-AC Deep
	High	Patching-AC Deep

Maintenance Policies (PCC Pavements)

Distress Type & Description	Severity Levels	Options for Repair
61. Blowup	Low	Partial-depth patch
(Occurs at a transverse crack or joint that is not wide enough to permit expansion)	Medium	Full-depth patch
to permit expansion.)	High	Slab replacement
62. Corner Break	Low	Do nothing
(Crack that intersects the joints at a distance less than or equal to one half of the slab length)	Medium	Full-depth patch
equal to one han of the slab length.)	High	Full-depth patch
63. Longitudinal, Transverse & Diagonal Cracks	Low	Do nothing
(Cracks dividing the slab into two or three pieces.)	Medium	Seal cracks
	High	Full-depth patch
64. Durability ("D") Cracking	Low	Do nothing
(Cracking caused by the concrete's inability to withstand	Medium Full-depth patcl	
environmental factors.)	High	Slab replacement
65. Joint Seal Damage	Low	Do nothing
(Any condition that allows water infiltration or enables	Medium	Do nothing
son/tocks to accumulate in the joints.)	High	Seal joints

Maintenance Policies (PCC Pavements)

Distress Type & Description	Severity Levels	Options for Repair	
66. Patching (small)	Low	Do nothing	
(Where original pavement has been removed and replaced by a filler material)	Medium	Partial-depth patch	
	High	Partial-depth patch	
67. Patching (large-over 5 ft ²) and Utility Cut	Low	Do nothing	
(Where original pavement has been replaced or because of placement of underground utilities)	Medium Seal cracks		
pracement of underground utilities.)	High	Full-depth patch	
68. Popouts (Small piece of pavement that breaks loose from the surface due to freeze-thaw/expansive aggregates.)	No Severity	Do nothing	
69. Pumping (Ejection of material by water through joints or cracks caused by deflection of the slab under load.)	No Severity	Under-seal	
70. Scaling, Map Cracking & Crazing	Low	Do nothing	
(A network of shallow, fine, or hairline cracks that extend only through the upper surface of the slab.)	Medium	Partial-depth patch	
unough the upper surface of the stab.)	High	Slab replacement	

Maintenance Policies (PCC Pavements)

Distress Type & Description	Severity Levels	Options for Repair	
71. Settlement or Faulting	Low	Do nothing	
(Difference of elevation at a joint or crack caused by	Medium Slab grinding		
upileaval of consolidation.)	High	Slab replacement	
72. Shattered Slab, Intersecting Cracks	Low	Do nothing	
(Cracks that break the slab into four or more pieces due to	Medium	Seal cracks	
overloading of madequate support, of both.)	High	Slab replacement	
73. Shrinkage Cracks (Hairline cracks only a few feet long and do not extend across the entire slab.)	No Severity	Do nothing	
74. Spalling (transverse and longitudinal joint)	Low	Do nothing	
(Breakdown of the slab edges within 2 ft of the side of the	Medium	Partial-depth patch	
joint.)	High	Partial-depth patch	
75. Spalling (Corner)	Low	Do nothing	
(Raveling or breakdown of the slab within approximately 2 ft of the corner)	Medium	Partial-depth patch	
It of the corner.)	High	Partial-depth patch	

Mill and Overlay Strategy

- Condition goes back to 100 each application
- Significant life extension

Preventive Maintenance Only

- Condition does not go back to 100 each application
- Incremental life extension

Life Expectancy of M&R

M&R Treatment	Typical Life
Mill and Overlay	8 to 12 years
Patching AC - Partial-depth	3 to 5 years
Patching AC - Full-depth	5 to 7 years
Patching - PCC Partial-depth	3-8 years
Patching - PCC Full depth	7 to 10 years
Slab Replacement	12 to 20 years
Crack/joint seal in PCC	4 to 10 years
Crack seal in AC	3 to 6 years
Rejuvenators	1 to 5 years

Typical M&R Costs (for Canada)

M&R Activity	Cost per Unit	Unit of Measure
Patching - AC Shallow	\$86.60	m ²
Patching - AC Deep	\$82.88	m ²
Crack Sealing - AC	\$10.70	m
Crack Sealing - PCC	\$10.70	m
Patching - PCC Partial Depth	\$207.50	m ²
Patching - PCC Full Depth	\$416.25	m ²
Slab Replacement - PCC	\$159.24	m ²
Joint Seal (Localized)	\$10.70	m
Undersealing - PCC	\$2.42	m
Grinding (Localized)	\$16.60	m ²
Mill and Overlay 50 mm AC	\$19.73	m ²
Total reconstruct AC	\$61.36	m ²
Total reconstruct PCC	\$136.03	m ²

M&R Cost by Condition (for Canada)

Local Cost Factors for Canada

Location	Cost Factor
Comox	1.07
Bagotville	0.95
Cold Lake	1.02
Winnipeg	0.92
Moose Jaw	0.95
Trenton	0.93
Greenwood	0.95

Pavement Management

- Periodic distress surveys to assess condition
- Inventory of pavements for age, use, and dimensions
- PMS software for projecting future condition
- Criteria for critical PCI levels and operational requirements
- PMS software determines M&R needs for each pavement section
- PMS software prioritizes M&R projects and projected costs

Pavement Management

Projection of future condition

PMS Implementation

- MicroPAVER is the most widely used PMS software
- MicroPAVER does the following:
 - Estimates future pavement condition
 - Applies maintenance policies and costs for M&R activities
 - Sets priorities for pavement rank and use
 - Determines level of serviceability
 - Conducts analysis and decision making
 - Estimates future cost of M&R
 - Prioritizes M&R needs over time

MicroPAVER PMS Software

Selection of Pavement for M&R

- Section to receive M&R based on:
 - Funds available
 - Importance of pavement
 - Primary, Secondary, Tertiary
 - >Runways, Taxiways, Aprons
 - Current pavement condition
 - Critical PCI level
 - Structural distresses versus other causes
 - Maintenance policies
 - Major M&R overrides need for Preventive M&R
 - Size of projects

M&R Recommendations

Recommendations for M&R Based on Unlimited Funds						
Maintenance	Work	Quantity Cast		PO	I	
Policy	Description	Quantity	Cost	Before	After	
	Runway 15L/33	R (R01A, R02C, 2	R03A)			
Preventative	Crack sealing-AC	285 linear ft	\$730			
Preventative	Crack Sealing-PCC	337 linear ft	\$888			
Preventative	Joint Seal (Localized)	4,499 LF	\$8,415			
Preventative	Patching-PCC Partial Depth	4 sq ft	\$102	96	96	
Total Cost	\$10),138				
Runway15C/33C (R04A, R05C, R06C, R07C, R08A)						
Preventative	Crack Sealing-PCC	200 lf	\$526			
Preventative	Joint Seal (Localized)	2,301 LF	\$4,811			
Preventative	Grinding (Localized)	46 sq yd	\$423			
Preventative	Patching-AC Shallow	1,191 sq ft	\$2,377			
Preventative	Patching-PCC Full Depth	31 sq yd	\$2,228			
Preventative	Patching-PCC Partial Depth	5 sq ft	\$113			
Preventative	Slab Replacement-PCC	32 sq yd	\$2,174			
Major Under Critical	Major M&R	786,875 sq ft	\$3,287,501	64	91	
Major Above Critical	Major M&R	132,500 sq ft	\$402,953			
Total Cost	\$3,70					

MicroPAVER Multi-Year Budget

- Pavement sections prioritized
- Cost allocation for different budget scenarios
- Unfunded work pushed into future

Budget			Average PCI				
		Fu	Inded				
Year	Stopgap	Preventive	Major Under Critical	Major Above Critical	Unfunded	Before	After
		Mi	nimum Ann	ual Budget			
2002	\$894,487	\$635,154	N/A	N/A	N/A	75	75
2003	\$202,077	\$438,793	N/A	N/A	N/A	75	72
2004	\$221,302	\$521,621	N/A	N/A	N/A	72	69
2005	\$242,379	\$545,785	N/A	N/A	N/A	69	66
2006	\$266,703	\$602,927	N/A	N/A	N/A	66	65
Total				\$4,571,228			
\$1,000,000 Annual Budget							
2002	\$614,268	\$384,141	\$0	\$0	\$14,377,528	75	75
2003	\$199,603	\$438,793	\$354,588	\$0	\$14,660,621	75	75
2004	\$216,747	\$524,389	\$210,200	\$0	\$15,231,558	75	72
2005	\$236,195	\$551,817	\$158,532	\$0	\$16,517,428	72	70
2006	\$260,006	\$612,182	\$41,835	\$0	\$17,280,384	70	68
Total	\$4,803,295						
\$2.500.000 Annual Budget			ual Budget				
2001	\$872,145	\$627,417	\$639,195	\$2,429,147	\$12,916,710	75	80
2002	\$183,374	\$433,059	\$1,812,244	\$2,428,677	\$12,200,566	80	80
2003	\$186,849	\$532,124	\$1,463,297	\$2,182,269	\$11,339,838	80	79
2004	\$182,484	\$578,423	\$1,577,827	\$2,338,733	\$10,936,228	79	77
2005	\$175,972	\$663,384	\$771,154	\$1,610,510	\$10,604,869	77	75
Total				\$10,989,337			
	\$5,000,000 Annual Budget			ual Budget			
2001	\$687,584	\$627,417	\$3,372,200	\$4,977,591	\$10,183,705	75	83
2002	\$128,971	\$449,177	\$3,979,747	\$4,557,894	\$7,132,575	83	84
2003	\$72,100	\$577,684	\$3,268,680	\$3,918,464	\$4,185,183	84	83
2004	\$24,604	\$643,671	\$2,683,121	\$3,351,396	\$2,255,910	83	82
2005	\$27,905	\$747,649	\$0	\$775,554	\$2,323,588	82	79
Total				\$17,580,900			

Projection of M&R Costs

Strategy for Extended Life

- PCI of 100 to Critical (70)
 Preventive Maintenance
- PCI 70 to 40
 - AC Mill and overlay plus some spot repairs
 - PCC Selective slab replacements
 - ≻ 20% at PCI 40
 - ≻ 10% at PCI 50
 - ≻ 5% at PCI 60

PCI below 40 - Reconstruction

For more information:

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