THE Louis Berger Group, INC.

Pavement Evaluation & Rating

ALACPA Short Course on Pavements Maintenance

Course Objective

- Introduction to Pavement Evaluation & Rating
  - Evaluation process
  - Distress types
  - Typical repairs
  - Rating system of PCC & HMA surface conditions
  - Logging pavement survey into the airport's PMP

Course Basis

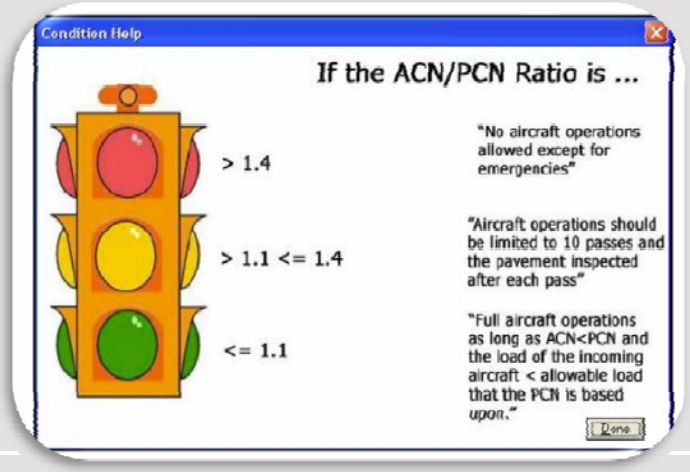
- The course is based on the engineering principles established by:
  - ICAO
  - FAA
  - NASA
  - FHWA, and
  - USACE

Airfield Pavement Basic Function

- Provide adequate bearing capacity
- Provide good riding qualities
- Provide good surface friction characteristics
- Other requirements
  - Longevity
  - Ease of maintenance

Pavement Survey Purpose

- Assess the abilities of the existing pavement to support different types, weights or volume of aircraft traffic
- Determine condition for planning or design of improvements for the airport
- Evaluation is essentially the reverse engineering of the pavement

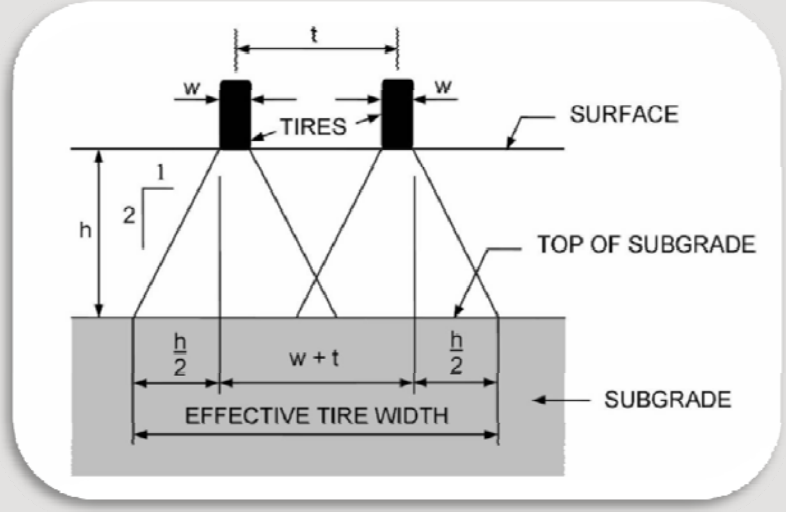


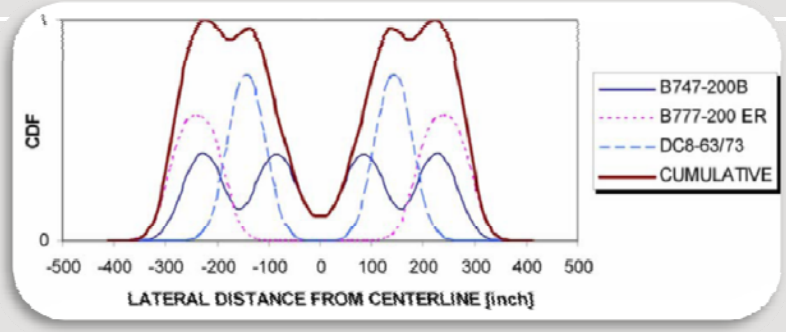
Pavement Evaluation

- Three Main Types of Evaluation
  - Structural (Pavement Classification Number)
  - Surface (Pavement Condition Index)
  - Friction (Pavement Roughness)

Pavement Structural Survey

- Pavement Classification Number (PCN)
- Determines the load bearing capacity of the pavement section





Pavement Surface Survey

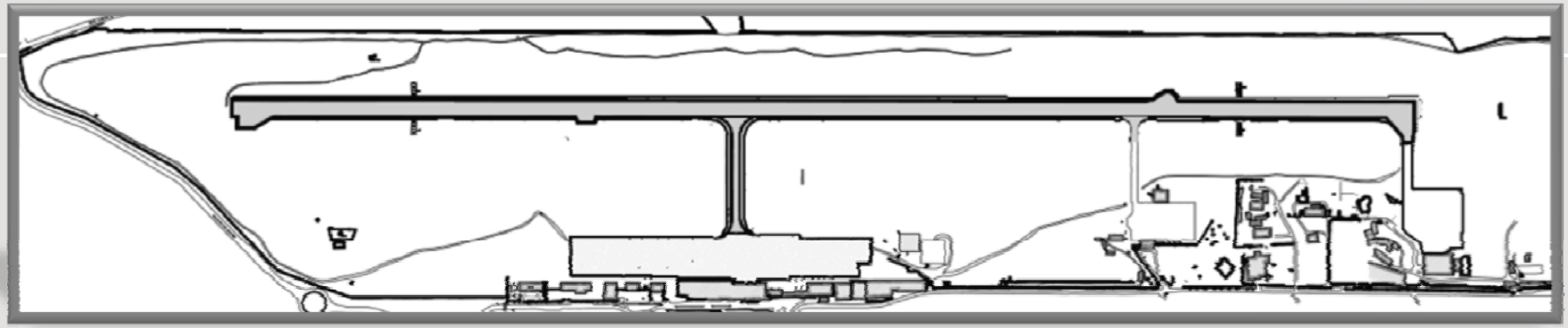
- Pavement Condition Index (PCI)
- Identifies the different surface defects and links them to a cause
- Understanding the cause of the current condition is important in selecting the appropriate remedy

Pavement Friction (Roughness) Survey

- Surface Friction Coefficient and Macrotexture Depth
- Identifies the pavement skid resistance “surface braking ability”
- Monitoring helps maintain a safe skid free surface

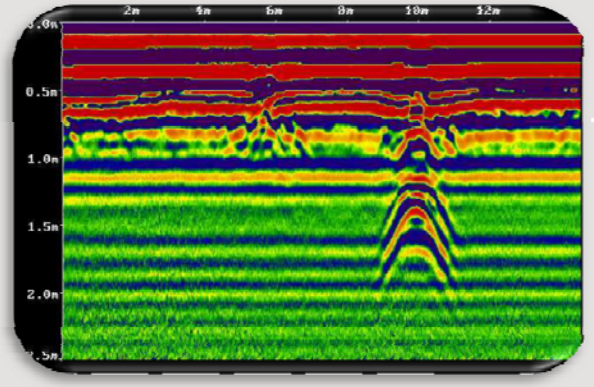
Pavement Survey Process

- Create a pavement inventory, (topographic survey)
- Obtain history/records of airport pavement
- Perform field surveys
- Collect, analyze data and create pavement condition values
- Review history and create pavement management plan



Structural Evaluation Process (PCN)

- Records Research
- Site inspection
- Sampling & Testing
  - Direct samples
  - Nondestructive Testing
    - Falling Weight Deflectometer
    - Ground Penetrating radar
- Pavement Condition Index
- Current Traffic Data
- Recording the data collected



Structural Evaluation Flexible Pavement

- Layer Thickness
- Subgrade CBR
- Layer Properties
- Aircraft Traffic data
- Using the Collected Properties determine PCN

Structural Evaluation Concrete Pavement

- Layer Thickness
- Concrete Flexural Strength
- Subgrade Properties
- Layer Properties
- Aircraft Traffic data
- Using the Collected Properties determine PCN

Pavement Structural Evaluation

- As lighter weight and fuel efficient aircrafts are being developed, the wheel loading is remaining constant or increasing due to additional passenger and cargo carrying ability.
- Future growth of today's airports are directly connected with the ability of the airfield pavement to withstand larger loads and frequencies.
- The structure capabilities survey of the existing airfield pavement is important in determining the allowable aircraft mix and frequency that the pavement can manage before failing structurally.
- The FAA representatives will speak more about this topic at tomorrows seminar.

Pavement Surface Evaluation

- Discussion:
  - Flexible and concrete pavement common defects and causes
  - Rating flexible pavement
  - Recording and mapping pavement inspection
  - Analyzing historic and current condition imputing such into the PMP, and
  - Creating a Maintenance & Repair Plan (MRP)

Pavement Condition Index (PCI)

- The key to a useful pavement evaluation is identifying different types of pavement distress and linking them to a cause
- Understanding the cause of the current condition along with the historic deterioration rate, assist in making appropriate maintenance and rehabilitation plans

Surface Evaluation Process (PCI)

- Inventory of the Airfield Pavement
- Records Research
- Site inspection
  - Surface Defects
  - Surface deformation
  - Cracks
  - Patches
- Pavement Condition Index
- Current Traffic Data
- Recording the data collected

Common Pavement Surface Condition & Defects

- Flexible Pavement
  - Surface defects
  - Surface deformation
  - Cracks
  - Patches & Potholes
- Concrete Pavement
  - Surface defects
  - Joints
  - Pavement cracks
  - Pavement distortion

Flexible Pavement Defects

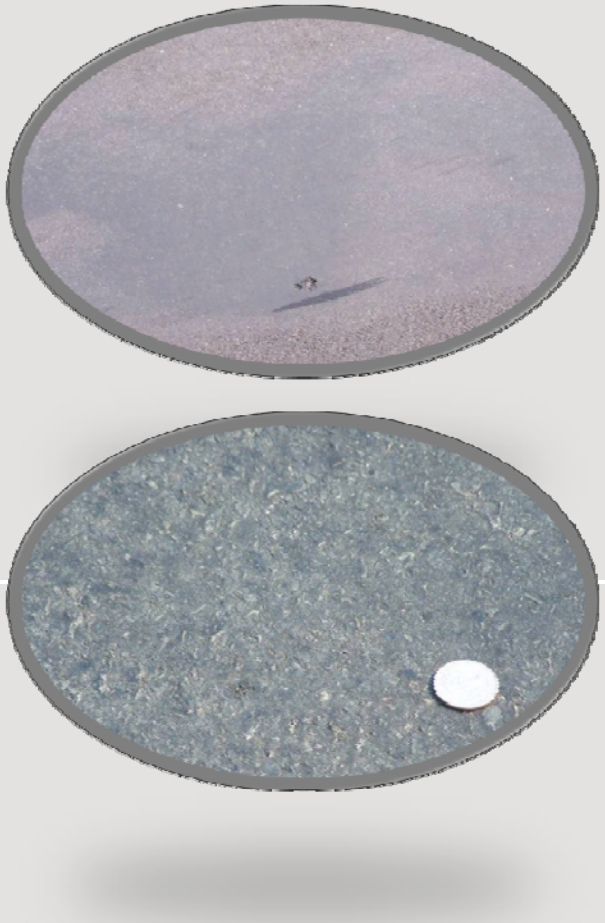
- Raveling: the progressive loss of pavement material from the surface downward
- Causes:
  - Stripping of bituminous film from aggregate
  - Hardening due to aging
  - Poor compaction
  - Insufficient binder content
- Moderate lost of fine
- Severe lost of coarse

Flexible Pavement Defects

- Polishing: smooth slippery surface caused by traffic wearing off the sharp edges of the aggregate (Microtexture)
- Repair with an overlay or retexturing pavement surface

Flexible Pavement Defects

- Flushing: excess asphalt on the surface of the pavement
- Cause:
  - Poor initial HMA mix design
  - Sealcoat over a flushed polished surface
- Repair with an overlay or retexturing pavement surface



Flexible Pavement Deformation

- Rutting: displacement of material, creating channels in wheel paths
- Cause:
  - Traffic compaction
  - Displacement of unstable material
  - Base/subgrade consolidation
- Repair may require pavement full depth reconstruction, milling and overlay of failed asphalt layer
- Cause of the pavement failure must be determined before repair is executed

Flexible Pavement Distortion

- Shoving/Rippling: displacement of surface material
- Cause:
  - Asphalt mixture is unstable
  - Poor quality aggregate
  - Improper mix
- Other pavement distortion may be caused by base settlement or frost heave

Flexible Pavement Cracks

- Thermal Cracks: often regularly spaced, 100-meters or so, space will reduce over time due to aging
- Cause:
  - Movement due to temperature changes and hardening of asphalt due to age
  - Differential thermal stresses
- Cracks need to be sealed to prevent water intrusion
- Routing and cleaning creaks will improve the sealants performance

Flexible Pavement Cracks

- Reflection Cracks: Cracks in overlays that reflect the crack pattern of the pavement underneath
- Cause:
  - Movement in the underlying pavement due to temperature changes
- Prevention: placement of petro-mat over substantial size cracks, yet may not be 100 % effective
- Repair: route and seal cracks

Flexible Pavement Cracks

- Slippage Cracks: crescent or round cracks caused by the slippage of the upper asphalt pavement layer from the underlying pavement.
- Cause:
  - Improper tacking
  - Poor mix design
  - Asphalt mixture is unstable
- Repair by removing by milling the failing pavement and placing new overlay

Flexible Pavement Cracks

- Joint & Edge Cracks: Joint cracks are construction joints that have open up.
- Joint cracks are created due to poor construction and the lack of saw cutting cold edge and tack coating on the edge of the abutting pavement section
- Sealing the gap reduces moisture from seeping into the pavement layers and causing additional damage
- Edge cracks are typically around 30-cm from the edge of pavement and are caused by poor shoulder support
- Edge cracking typically requires the reconstruction of the effected areas

Flexible Pavement Cracks

- Block Cracks: Interconnected cracks forming large blocks.
- Cracks intersect at nearly right angles, and range in from 30-cm to over 3-meters
- Cause:
  - Shrinking and hardening of pavement, close spacing indicates advanced aging
- Sealing the cracks with surface treatments reduces moisture from seeping into the pavement layers and causing additional damage
- Milling and overlay of pavement eventually will be required

Flexible Pavement Cracks

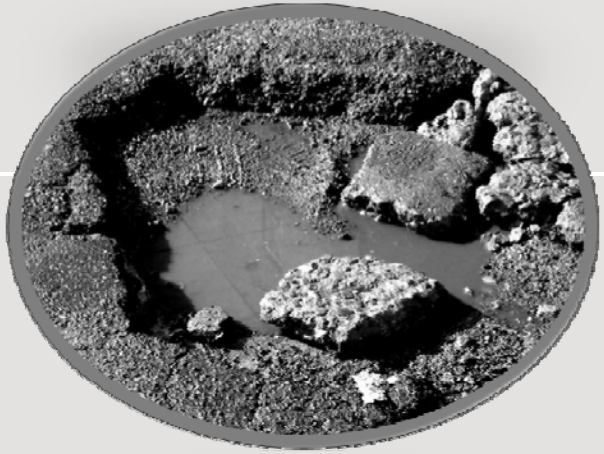
- Alligator Cracks: interconnected cracks forming small pieces in size from 25-mm to 150-mm.
- Cause:
  - Pavement failure due to traffic loading (Fatigue)
  - Inadequate pavement base or subgrade
- Repair: excavate failed section and reconstruct pavement section from the subgrade on up
- Recommend geotechnical explorations for cause of base failure, inadequate drainage may be the cause

Flexible Pavement Patches and Pot Holes

- Patches: Surface repairs that were performed due to utility installation or pavement repair.
- Utility trenches that settled due to poor compaction creates depressions, cracking or other distortions.
- Pavement repairs that have failed will show similar depressions, cracking or other distortions
- Repairs for either case is to remove the failing pavement section and reconstruct
- Geotechnical investigation will be required to confirm the failing element

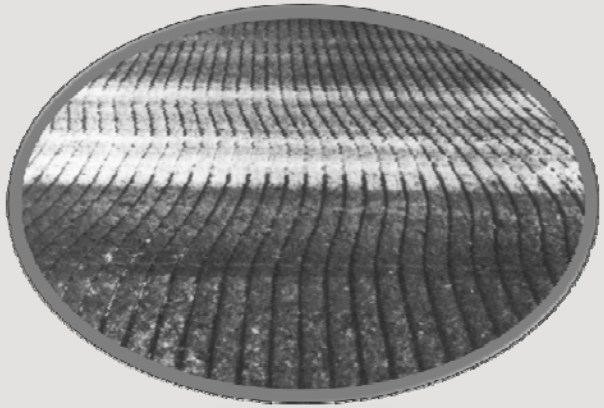
Flexible Pavement Patches and Pot Holes

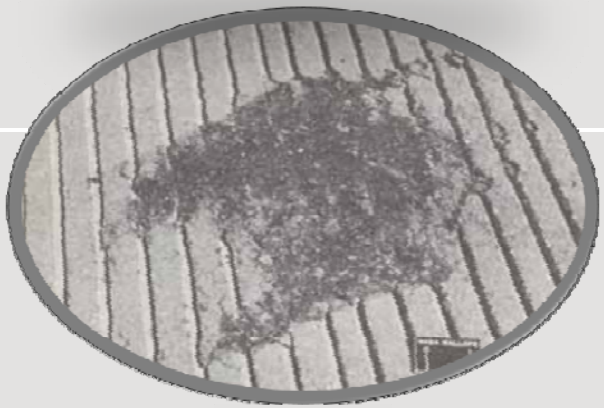
- Potholes: holes and loss of pavement
- Cause: traffic loading, fatigue and in adequate pavement section design often combined with poor drainage
- Localize repair by excavating failed area and reconstruct pavement section



Flexible Pavement Groove Deformation

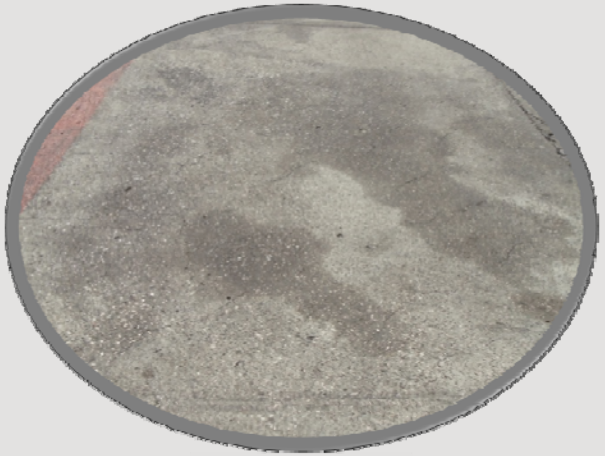
- Groove Deformation: the distortion of the grooved HMA pavement or edge collapse.
- Cause:
  - Plastic flow in HMA lack of stiffness,
  - Cohesion failure of binder to aggregate,
  - Freeze thaw cycles
  - Poor mix design causing raveling
- Repair typically requires the removal of the affected areas and the placement of a new overlay and grooving

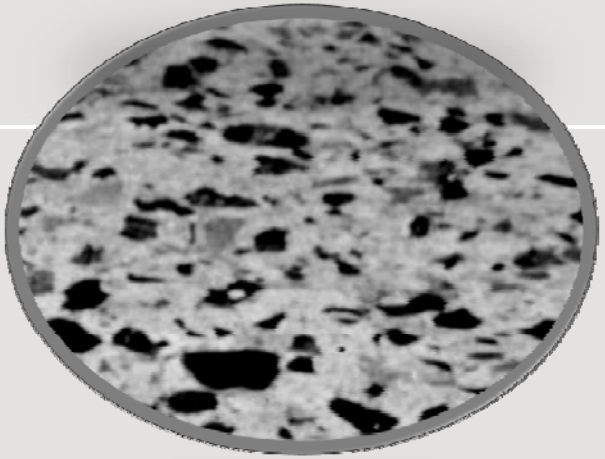




Concrete Pavement Defects

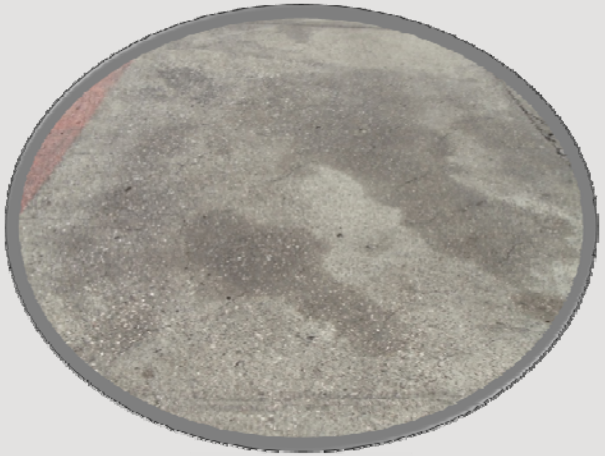
- Polishing: worn or polished surface from traffic wearing of the mortar and skid resistance texture
- An asphalt overlay or grinding the concrete can restore the surface





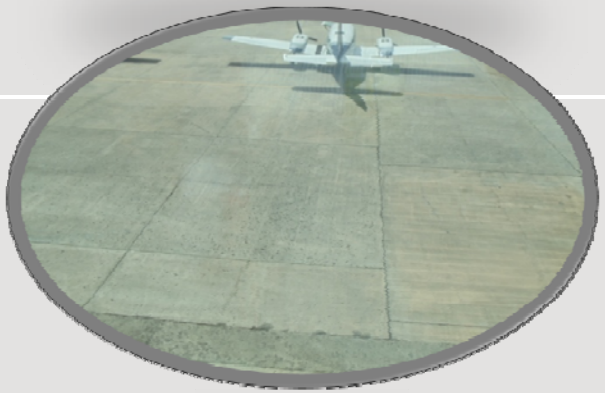
Concrete Pavement Defects

- Map Cracking: Pattern of fine cracks usually space within several centimeters; usually develops into squares or other geometrical pattern
- Cause:
  - Improper curing or over working of the surface during finishing
  - Aggregate quality alkali-silica reactivity (ASR)
- Repair:
  - Limited to severe conditions
  - Asphalt overlay
  - Partial depth patching



Concrete Pavement Defects

- Pop-Outs: Individual pieces of large aggregate that popped out of the surface
- Cause:
  - Chert (microfibrous sedimentary rock) or other absorbent aggregate that deteriorates under freeze and thaw conditions
- Repair: Typically pop-outs alone will not affect pavement serviceability, yet the popped-out aggregate creates FOD; Severe areas may be patched, overlay or slab replaced

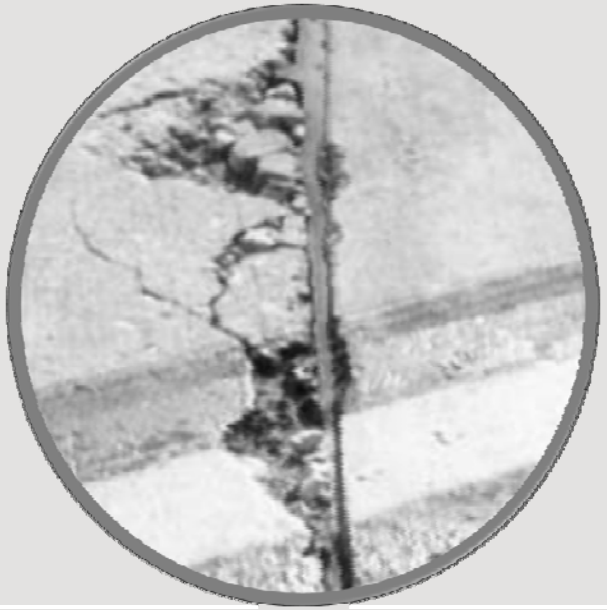


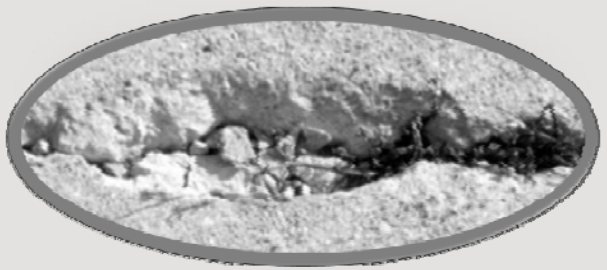
Concrete Pavement Defects

- Scaling: surface deterioration that causes the loss of fine aggregate and mortar
- Cause:
  - Concrete not air-entrained, making the surface susceptible to freeze and thaw
  - Chemical reaction due to alkali-silica reactivity (ASR)
- Repair:
  - Small areas may be grinded to remove surface along with partial patching
  - Severe scaling requires slap replacement

Concrete Pavement Defects

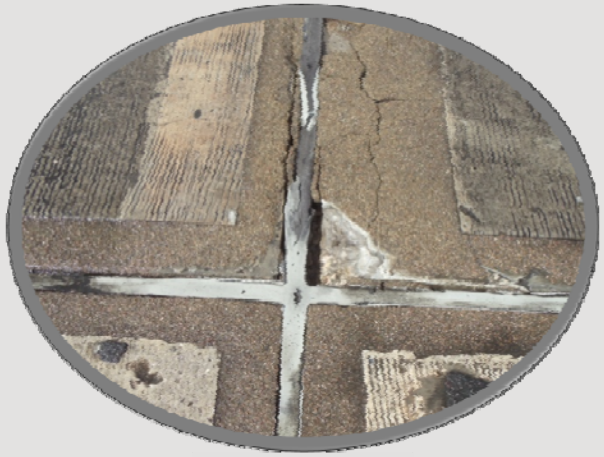
- Spalling: loss of a piece of concrete pavement from the surface or along the edges of cracks or joints
- Cause:
  - Poor quality of material
  - Freeze and thaw action
- Repair:
  - Small spalled areas can be patched
  - Large areas and spalling at joints requires for slab replacement





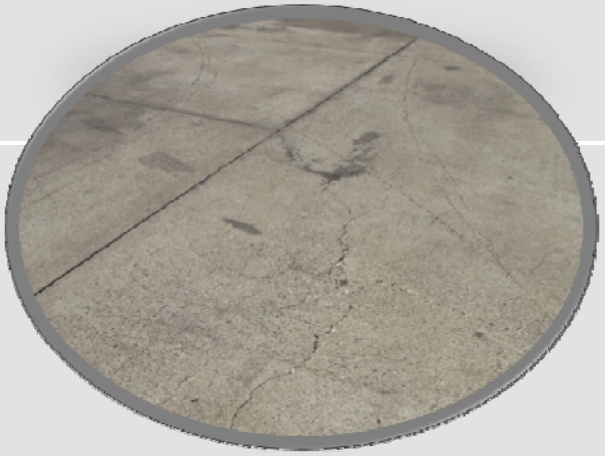
Concrete Pavement Defects

- Joints: Spalling along joints, parallel cracks adjacent to joints
- Cause:
  - Age-deterioration of material
  - Settlement, instability or pumping of subgrade
  - Waiting to long to saw the contraction or construction joint
  - Leaking joint sealant, freeze & thaw action
- Repair:
  - Keep joint clean free of debris and water
  - Patching for small spalls
  - Full slab replacement for severe deterioration



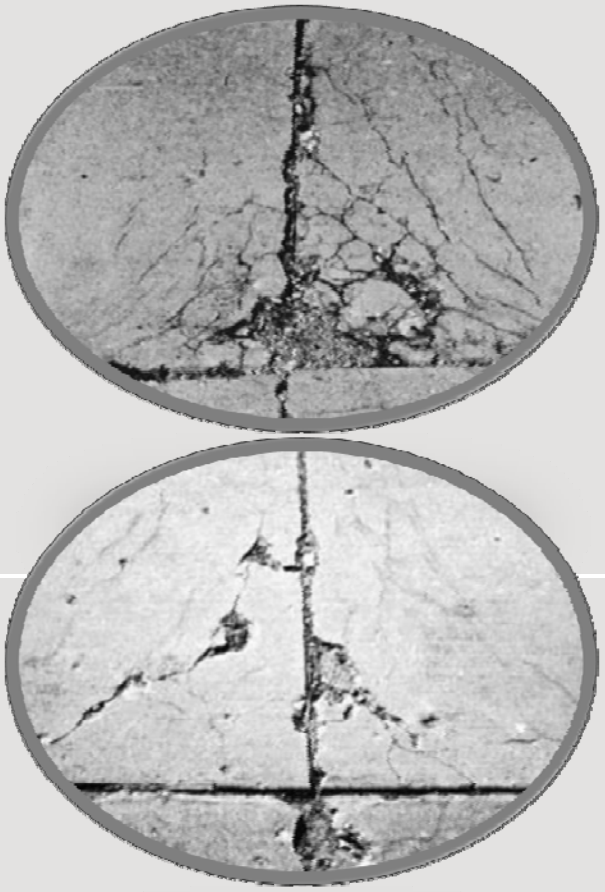
Concrete Pavement Defects

- Slab Cracks: cracks which divide the slab into 2 or more pieces
- Cause:
  - Thermal stress, poor subgrade or heavy loading
  - Joint spacing too far apart
  - Slab length to width ration greater than 1.25
- Repair:
  - Cracks can deteriorate further if not sealed
  - Patch small spalling
  - Replace slab and repair subgrade if cracking is extensive



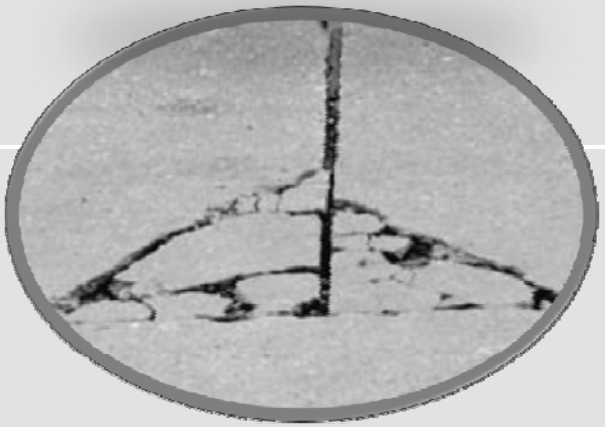
Concrete Pavement Joints Defects

- D-Cracks: fine cracking and dark discoloration adjacent to the joint, once visible on the surface pavement material is usually severely deteriorated.
- Cause:
  - Poor quality aggregate
  - Aggregate able to absorb water
- Repair:
  - Seal joints helps slow the deterioration
  - Milling and patching is a short term repair
  - Full slab replacement is most effective alternative



Concrete Pavement Cracks

- Corner Cracks: Diagonal cracks that develop near the corner of a pavement slab, forming a triangle at the joint
- Cause:
  - Insufficient soil support
  - Concentrated stress due to temperature related slab movements
  - Traffic loading
- Repair:
  - Localized failure may be patched
  - Widespread failures should have pavement section replaced

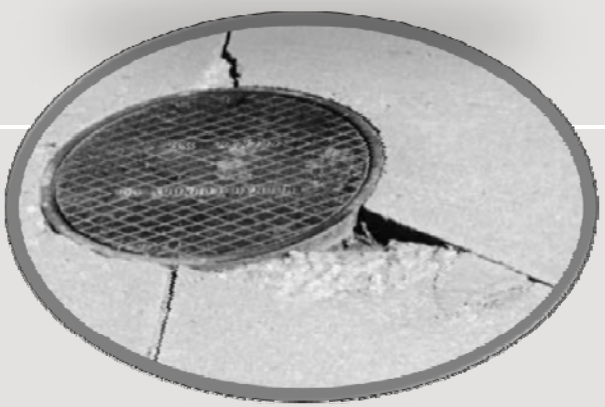


Concrete Pavement Cracks

- Meander Cracks: cracks which appear to wander randomly across a slab or multiple slabs
- Cause:
  - Settlement due to unstable subgrade or base
  - Frost heave and spring thaw
  - Local in nature and may not indicate a general pavement problem
- Repair:
  - Minor cracks should be sealed to prevent water intrusion
  - Severe cracking requires slab replacement

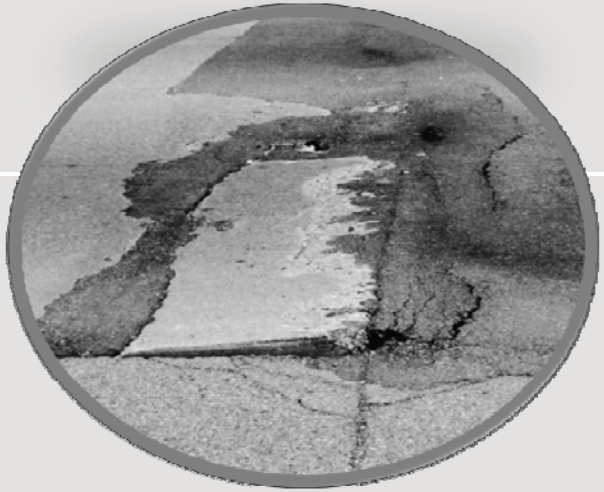
Concrete Pavement Cracks

- Manhole-Inlet Cracks: localized cracks radiating out or around the structure
- Cause:
  - Slab around structure is not reinforced
  - Lack of expansion joints around structure
  - Pavement cannot accommodate movement due to temperature or frost heave
  - Subgrade failure around structure
- Repair:
  - Sealing and patching may slow deterioration
  - Full slab replacement with reinforced concrete pavement may be required for severe cases



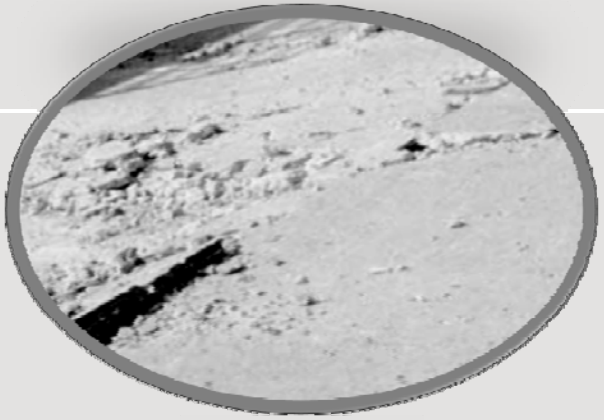
Concrete Pavement Distortion

- Pavement Settling or Heave: portion of the pavement that either's bulges upward or settles downward like a gentle swale or dip
- Causes:
  - Unstable or poorly drained subgrade
  - Poorly compacted base, typically at utility trenches
  - Frost heave or thaw consolidation of subbase
- Repairs:
  - Improve subgrade drainage and stabilize base along with pavement reconstruction
  - Installation of an under drain system and/or subgrade enhancements



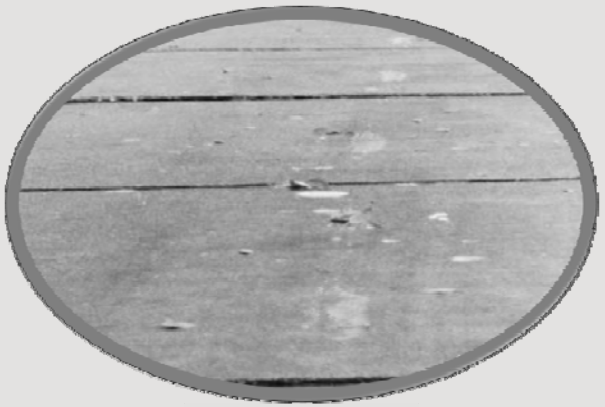
Concrete Pavement Distortion

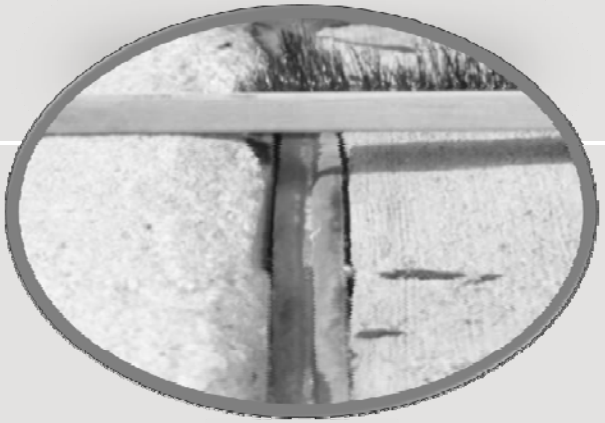
- Blowups: Slabs which are either push up or crushed at the joints
- Cause:
  - Incompressible material has entered the expansion joint
  - Lack of sufficient number of expansion joints
- Repair:
  - Install pressure relief joints
  - Clean existing joints and repair damage joints by either patching or reconstructing slabs effected



Concrete Pavement Distortion

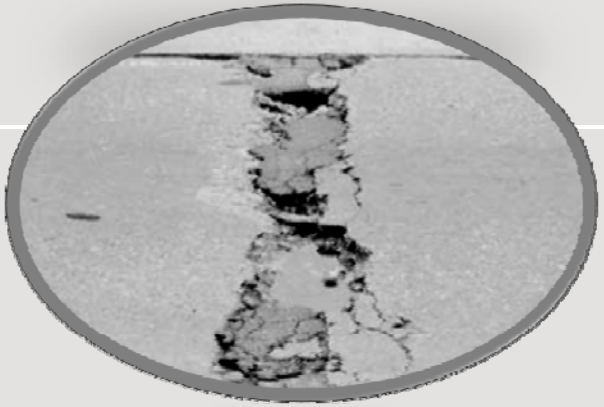
- Faulting: Joints and cracks that develop a step between the two adjacent slabs
- Cause:
  - Subgrade failure
  - Pumping of the subgrade or base which creates voids
  - Settlement of adjacent slab
- Repair:
  - Minor faulting can be corrected by surface grinding
  - Severe cases requires for slab replacement





Concrete Pavement Distortion

- Utility Repairs, Patches and Potholes: Partial slab replacements that show settlement, joint deterioration or distress
- Cause:
  - Localized failure of subgrade
  - Poor concrete mix/patch work
  - Poor or failed material
- Repair:
  - Patching of spalling is a temporary fix
  - Full slab replacement and re-compaction of subgrade is usually required



Summary of Pavement Deterioration

- Deterioration of pavement has two general causes:
  - Environmental due to weathering and aging
  - Structural caused by repeated traffic loading
- Obviously, most pavement deterioration results from both structural and environment causes
- The rate the pavement deteriorates depend on the environment, traffic loading, original construction quality and interim maintenance
- Recognizing defects and understanding their cause helps rate pavement condition and select an effective repair

Pavement Rating

- Once significant pavement deterioration begins it is common to see the pavement decline rapidly
- This is usually due to a combination of traffic loading, aging and effects of additional moisture seeping into cracks
- To evaluate an individual segment, first determine its general condition, using ASTM D5340
- Review the individual pavement and select the appreciate rating
- Typically a given payment may have only one or two types of distress for any particular rating
- In addition to indicating the surface condition, a given rating also encompass recommendation for the needed repairs and maintenance

AIRFIELD PAVEMENT INVENTORY

Airfield _____ Condition survey date _____

Done by _____

Facility (runway, taxiway, apron) _____

Feature description _____

Feature location _____

Feature area _____

Construction date _____

Pavement type: ☐ Asphalt ☐ Concrete Layer thicknesses: _____ _____ _____

Maintenance history _____

PASER Rating (5 = Excellent, 4 = Good, 3 = Fair, 2 = Poor, 1 = Failed) ☐

Comments on pavement and drainage conditions _____

Recommended maintenance _____

Recommended rehabilitation _____

Inspection Procedure/Sampling Units

- Identify samples by use, such as runway, taxiway apron
- Divide each single use area into sections based on the pavement design, construction history, traffic and condition
- Divide the sections into sample units
- Define a sample unit into 8-meter by 8-meter widths and lengths for asphalt or into individual concrete slabs if slabs are not greater than 8-meter by 8-meter
- Individual sample units must be marked in the field to allow inspectors and quality control personnel to easily locate them, and sketches detailing location must also be created
- Number of sample units may vary from:
  - All of the samples units in the section
  - A number of units that provides a 95% confidence level

Inspection Procedure/Sampling Units

- All sample units in the section may be inspected to determine the section average PCI
- Minimum number of sample units (*n*) that must be surveyed within a given section to obtain a statistically adequate estimate (95% confidence) of the PCI of the section is calculated using the following formula and rounding *n* to the next highest number

$$n = Ns^2/((e^2/4)(N-1)+s^2)$$

e = acceptable error in estimating PCI (+/- 5%),

s = standard deviation of the PCI from one sample unit to another. Initial inspection deviation is assumed to be 10 for HMA and 15 for PCC. This assumption should be checked as described below after the PCI is determined. Subsequent inspections the standard deviation from the proceeding inspection should be used to determine *n*,

N = total number of sample units in the section

Inspection Procedure/Sampling Units

- Obtaining the 95% confidence level is critical, the adequacy of the number of sample units surveyed must be confirmed. The number of units was estimated based on an assumed value. Calculate the actual standard of deviation as follows:

$$s = \sqrt{\sum_{i=1}^{n} (PCI_i - PCI_f)^2 / (n-1)}$$

PCI_i = PCI surveyed sample unit I,
PCI_f = mean PCI of surveyed sample units, and
n = total mean number of sample units surveyed

- Calculate the revised minimum of sample units to be surveyed using the calculated standard of deviation.

Inspection Procedure/Sampling Units

- If the revised number of sample units is greater than the number of units already surveyed, select and survey additional random sample units.
- Samples should be evenly spaced across the section
- Repeat the process of checking the revised number of sample units and surveying additional samples units until the survey equals or exceeds the minimum required samples units (n) in the aforementioned equations

Inspection Procedure

- Inspect each sample unit chosen
- Sketch the sample unit, including orientation
- Record the branch and section number, and number and type of the sample unit (random or additional)
- Record sample unit size measured with an hand odometer

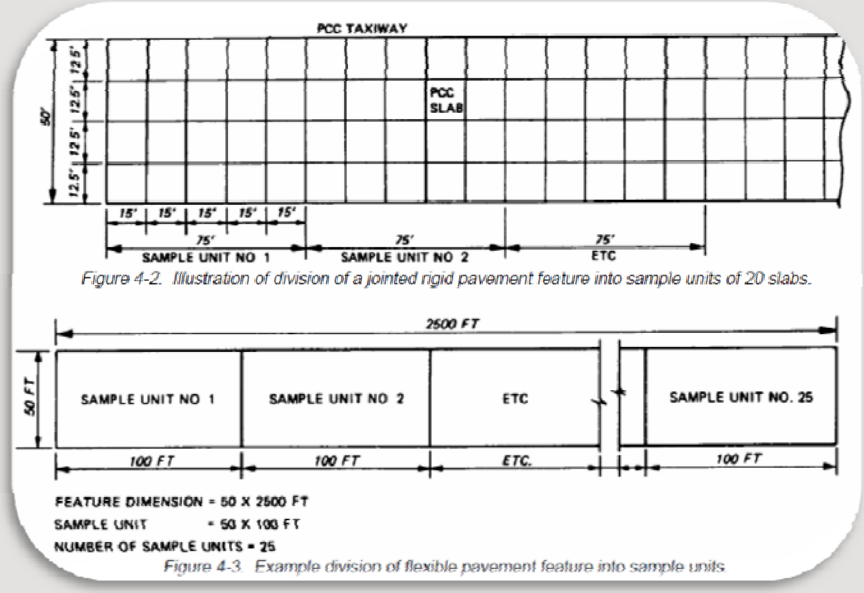


Figure 4-2. Illustration of division of a jointed rigid pavement feature into sample units of 20 slabs.

Figure 4-3. Example division of flexible pavement feature into sample units.

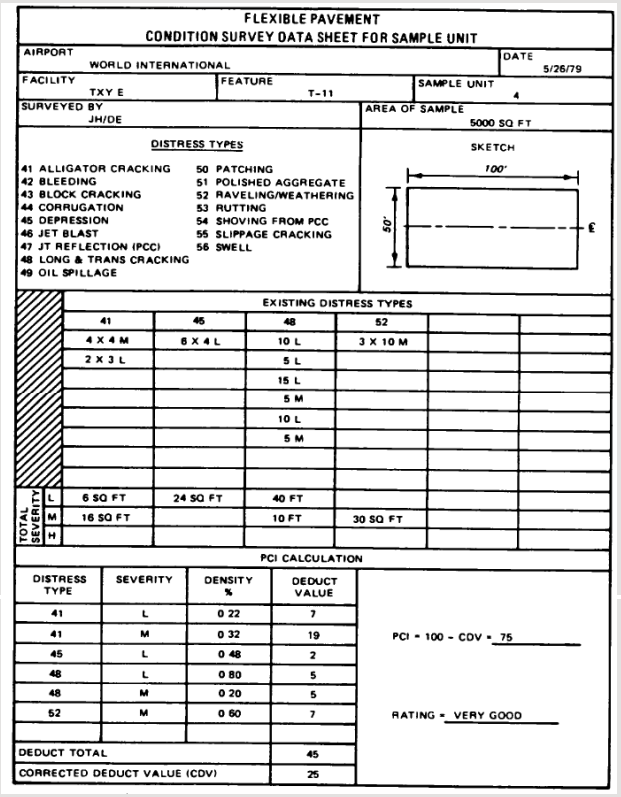
Inspection Procedure

- Conduct the distress inspection by walking over the sample unit being surveyed, measuring the quantity of each survey level of every distress type present and recording the data
- Distress must correspond in types and severities described in Appendix X1 for HMA or X2 for PCC of ASTM D5340
- Summarize each distress type and severity level in either square meters or linear meters, depending on distress
- Repeat this procedure for every sample unit to be inspected

Calculating PCI for HMA

- Utilizing the condition survey data sheet shown to collect and quantify the distress type and severity level of each sample unit and record the 'Total Severities"
- Typical HMA Distress Types:

Distress Types	Distress Types
41 Alligator Cracking	49 Oil Spillage
42 Bleeding	50 Patching
43 Block Cracking	51 Polished Aggregate
44 Corrugation	52 Raveling/Weathering
45 Depression	53 Rutting
46 Jet Blast	54 Shoving from PCC
47 Joint Reflection	55 Slippage Cracking
48 Long & Trans Cracking	56 Swell



FLEXIBLE PAVEMENT
CONDITION SURVEY DATA SHEET FOR SAMPLE UNIT

AIRPORT: WORLD INTERNATIONAL | DATE: 5/26/79
FACILITY: TXY E | FEATURE: T-11 | SAMPLE UNIT: 4
SURVEYED BY: JH/DE | AREA OF SAMPLE: 5000 SQ FT

DISTRESS TYPES

41 ALLIGATOR CRACKING
42 BLEEDING
43 BLOCK CRACKING
44 CORRUGATION
45 DEPRESSION
46 JET BLAST
47 JT REFLECTION (PCC)
48 LONG & TRANS CRACKING
49 OIL SPILLAGE
50 PATCHING
51 POLISHED AGGREGATE
52 RAVELING/WEATHERING
53 RUTTING
54 SHOVING FROM PCC
55 SLIPPAGE CRACKING
56 SWELL

SKETCH: 100' × 50'

EXISTING DISTRESS TYPES

	41	45	48	52		
	4 X 4 M	6 X 4 L	10 L	3 X 10 M		
	2 X 3 L		5 L			
			15 L			
			5 M			
			10 L			
			5 M			
TOTAL SEVERITY L	6 SQ FT	24 SQ FT	40 FT			
TOTAL SEVERITY M	16 SQ FT		10 FT	30 SQ FT		
TOTAL SEVERITY H						

PCI CALCULATION

DISTRESS TYPE	SEVERITY	DENSITY %	DEDUCT VALUE
41	L	0 22	7
41	M	0 32	19
45	L	0 48	2
48	L	0 80	5
48	M	0 20	5
52	M	0 60	7
DEDUCT TOTAL			45
CORRECTED DEDUCT VALUE (CDV)			25

PCI = 100 - CDV = 75

RATING = VERY GOOD

Calculating PCI for HMA

- Level of Distress - Low

Severity	Severity Description
Low (L)	Fine hairline cracks, cracks not spalling; Block cracking that are nonspalling or light spalled, non filled cracks; minor corrugation; localized light depression, shallow ponding water; joint reflection & longitudinal cracks has light spalling, 3-mm in width sealed or nor sealed; raveling around cracks less than 3-mm or in small localized areas (2% max per square meter); oil spillage; patches in good condition; no polishing; seal coat surface cracks less than 3-mm less than 1%;rutting less than 13-mm deep; slight asphalt shoving with no slippage cracks; swell is barely visible less than 20-mm, minor effect on ride; surface begins to show signs of aging, fading of color, loss of fines

Calculating PCI for HMA

- Level of Distress - Medium

Severity	Severity Description
Medium (M)	Light to medium alligator cracking, network of cracks which may spall; some bleeding; block cracking sealed or not sealed, moderate spalling, cracks greater than 6-mm, corrugations are noticeable, affects ride; depressions can be observed, moderately affects ride; reflection & longitudinal cracks sealed or not sealed with moderate spalling, cracks greater than 6-mm, cracking next to existing cracks; raveling around cracks average cracks up to 25-mm; oil spill damage to pavement; patches are somewhat deteriorated; polished asphalt; up to 10% per square meter of raveling; slurry seal scaling up to 10%, cracks in sealer up to 6-mm; raveling surface up to 25% per square meter; rutting greater than 13-mm but less than 25-mm; significant of shoving with slippage cracks; swelling can be observed without difficulty effects ride; weather loss of fine aggregate, coarse aggregate exposed

Calculating PCI for HMA

- Level of Distress - High

Severity	Severity Description
High (H)	Network or pattern cracking progressed, pieces are well defined and spalled; asphalt bleeding; block cracks are well defined and are spalled; corrugation are easily noticed, effects ride severely; depressions readily observed, effects ride severely; reflection 7 longitudinal cracks are severely spalled, sealed or not sealed width exceeds 25-mm; oil spillage damage; patches deteriorated and effects ride; surface polish evident; raveling exceeds 10% per square meter or 25% of sample unit, significant raveling; seal coating scaling over 10% and coating is pealing off; rutting exceeds 25-mm in depth; large amounts of shoving with slippage cracks; swelling can be readily observed, severely affects ride; weathering exposed coarse aggregate greater than 6-mm, considerable loss of fine aggregate and some los of coarse aggregate

Calculating PCI for HMA

- Utilizing the data collected in the field survey, sum up the quantity of each distress type at each severity level and record them in the “Total Severity” section
- Divide the “Total Severity” value of each distress type by the total area of the sample unit and multiply by a 100 to convert into a percent, record this number in the ‘Density” section for each distress type and severity
- Determine the deduct value (DV) for each distress type and severity level from the distress deduct value curve Appendix X3 of ASTM D5340-11
- Determine the maximum corrected deduct value (CDV):

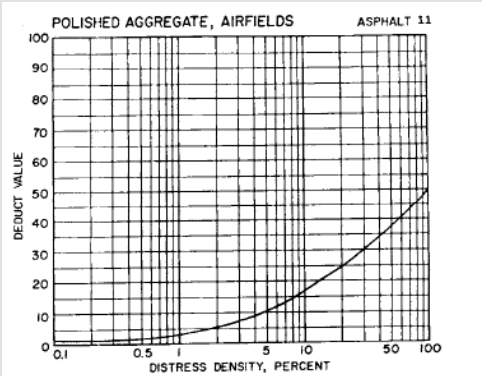


FIG. X3.13 Polished Aggregate

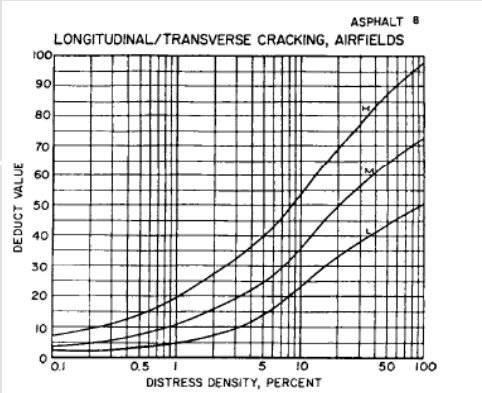


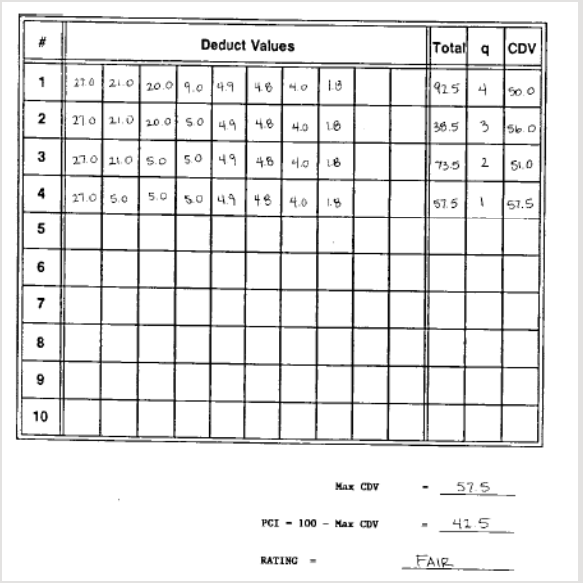
FIG. X3.9 Longitudinal/Transverse Cracking

Calculating PCI for HMA

- If none or only one individual DV is greater than five, the total value is to be used in place of the maximum CDV; otherwise the maximum CDV must be calculated as shown below; note the determination of the maximum CDV from individual DV is identical for HMA and PCC
  - Determine *m*, the maximum allowable number of distresses:

    $m = 1+(9/95)(100\text{-}HDV) \leq 10$

    HDV = highest individual DV obtained form Appendix X3
  - Enter *m* largest DVs on line 1 of the adjacent table
  - Sum the DVs and enter the summation in the "Total" column
  - Count the number of DVs greater than 5 and enter it under "q"



#	Deduct Values										Total	q	CDV
1	27.0	21.0	20.0	9.0	4.9	4.8	4.0	1.8			92.5	4	50.0
2	27.0	21.0	20.0	5.0	4.9	4.8	4.0	1.8			88.5	3	56.0
3	27.0	21.0	5.0	5.0	4.9	4.8	4.0	1.8			73.5	2	51.0
4	27.0	5.0	5.0	5.0	4.9	4.8	4.0	1.8			57.5	1	57.5
5													
6													
7													
8													
9													
10													

Max CDV = 57.5

PCI = 100 - Max CDV = 42.5

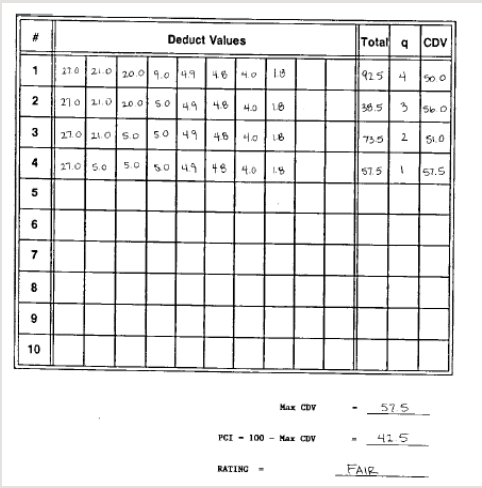
RATING = FAIR

Calculating PCI for HMA

- Look up appropriate correction with “Total” and “q” values to determine the CDV, Appendix X3 ASTM D5340-11
- Copy the DVs onto the next line, changing the smallest DV greater than 5 (only one DV), sum up the DVs total and Count the number of DVs greater than 5 and enter it under their approbiate box, Look up appropriate correction with “Total” and “q” values to determine the CDV, Appendix X3 ASTM D5340-11
- Repeat copying the DVs on to the next line, reducing the next lowest DV greater than 5 until “q” is equal to one
- Maximum CDV is the largest value in the “CDV” column

- Utilizing the maximum CDV, subtract it from 100 to obtain the PCI

  PCI = 100 - CDV



#	Deduct Values										Total	q	CDV
1	27.0	21.0	20.0	9.0	4.9	4.8	4.0	1.8			92.5	4	50.0
2	27.0	21.0	20.0	5.0	4.9	4.8	4.0	1.8			88.5	3	56.0
3	27.0	21.0	5.0	5.0	4.9	4.8	4.0	1.8			73.5	2	51.0
4	27.0	5.0	5.0	5.0	4.9	4.8	4.0	1.8			57.5	1	57.5
5													
6													
7													
8													
9													
10													

Max CDV = 57.5

PCI = 100 - Max CDV = 42.5

RATING = FAIR

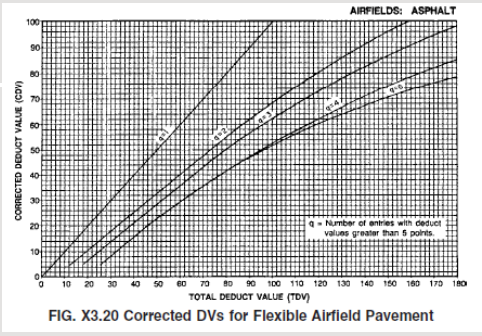
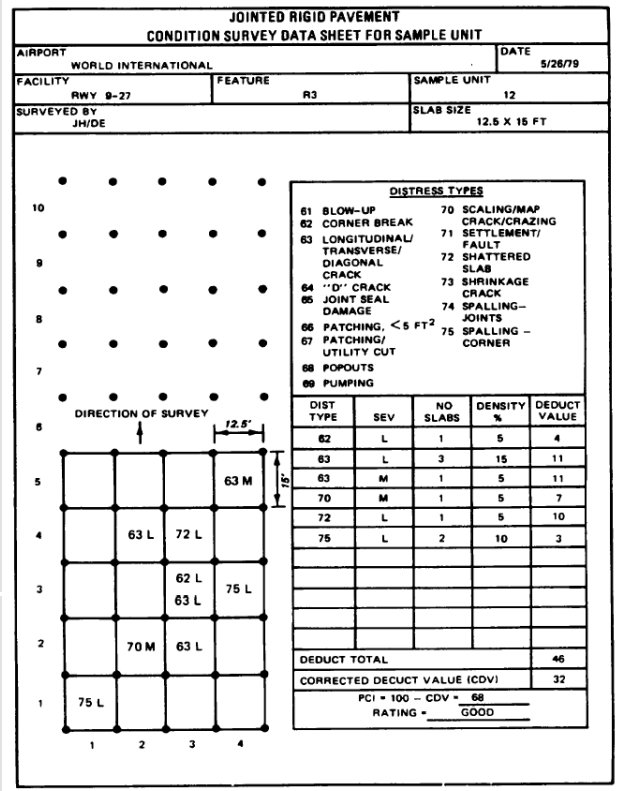


FIG. X3.20 Corrected DVs for Flexible Airfield Pavement

Calculating PCI for PCC

- Utilizing the condition survey data sheet shown to collect and quantify the distress type and severity level of each sample unit and record the 'Total Severities"
- Typical PCC Distress Types:

Distress Types	Distress Types
61 Blow-up	69 Pumping
62 Corner Break	70 Scaling, Map Cracking
63 Longitudinal, Transverse Diagonal Cracks	71 Settlement or Fault
64 D Cracks	72 Shattered Slab
65 Joint Seal Damage	73 Shrinkage Cracks
66 Patching < 0.5 m^2	74 Spalling Joints
67 Patching Utility Cut	75 Spalling Corner
68 Pop-Outs	



JOINTED RIGID PAVEMENT
CONDITION SURVEY DATA SHEET FOR SAMPLE UNIT

AIRPORT: WORLD INTERNATIONAL | DATE: 5/26/79
FACILITY: RWY 9-27 | FEATURE: R3 | SAMPLE UNIT: 12
SURVEYED BY: JH/DE | SLAB SIZE: 12.5 X 15 FT

DISTRESS TYPES

61 BLOW-UP
62 CORNER BREAK
63 LONGITUDINAL/ TRANSVERSE/ DIAGONAL CRACK
64 "D" CRACK
65 JOINT SEAL DAMAGE
66 PATCHING, <5 FT²
67 PATCHING/ UTILITY CUT
68 POPOUTS
69 PUMPING
70 SCALING/MAP CRACK/CRAZING
71 SETTLEMENT/ FAULT
72 SHATTERED SLAB
73 SHRINKAGE CRACK
74 SPALLING–JOINTS
75 SPALLING – CORNER

DIRECTION OF SURVEY
12.5'
15'
63 M
63 L
72 L
62 L
63 L
75 L
70 M
63 L
75 L

DIST TYPE	SEV	NO SLABS	DENSITY %	DEDUCT VALUE
62	L	1	5	4
63	L	3	15	11
63	M	1	5	11
70	M	1	5	7
72	L	1	5	10
75	L	2	10	3
DEDUCT TOTAL				46
CORRECTED DECUCT VALUE (CDV)				32

PCI = 100 – CDV = 68
RATING = GOOD

Calculating PCI for PCC

- Level of Distress - Low

Severity	Severity Description
Low (L)	Blow-up less than 13-mm, buckling or shattering, pavement still operational; corner cracks has little to no spalling, mean width less than 3-mm; longitudinal - transverse cracks with little or minor spalling, crack less than 3-mm in width; D-cracking defined by hairline cracks in limited area of slab, little disintegration; joint sealer in good condition, minor amount of damage or de-bonding; patching is functioning well with little to no deterioration; No pumping of pavement; minimal loss of surface paste (scaling); faulting less than 6-mm; slab shattering limited, slab broken into four or five pieces defined by low severity cracks; Light shrinkage cracks, hairline crack; spalling over 60-cm long broken into several pieces, frayed joint edges less than 25-mm; Corner spalling with low severity cracks; Alkali Silica Reaction (ASR) minimal, potential cracks or pop-outs, surface tight, cracks predominantly 1-mm or less

Calculating PCI for PCC

- Level of Distress - Medium

Severity	Severity Description
Medium (M)	Blowup up to 25-mm, buckling or shattering, pavement still operational; corner cracks with moderate spalling, non filled cracks up to 25-mm in width, corner break is cracked; longitudinal cracks moderately spalled, cracks width up to 25-mm, slab divided into multiple pieces with at least one severe crack; D-cracking has developed over a considerable amount of the slab area with little disintegration, corner cracks; joint sealant in fair condition over entire survey area, sealant needs replacement, some joints indicate pumping debris, sealer is pliable, vegetation growth; patches has moderate deterioration or spalling; visible pumping; pop outs ; moderate loss of surface paste, loose mortar and aggregates; faulting up to 25-mm; slab cracked into four or five pieces, 15% of cracks of medium severity or 85% cracks in low severity; spall over 60-cm long, broken into multiple pieces with medium to severe cracks, moderately frayed joint edges; corners spalling; ASR distress, crack intensity, fragments along cracks, surface pop out

Calculating PCI for PCC

- Level of Distress - High

Severity	Severity Description
High (H)	Blowup up to 50-mm, buckling or shattering, pavement is inoperable; corner cracks severely spalled, cracks width greater than 25-mm, creating tire damage; joint sealer is in poor condition over the entire survey sample, sealant needs immediate replacement, has over 10% of joints meeting medium severity criteria or if 10% of sealant is missing; patches are deteriorated with spalling and cracking; pop-outs, pumping is obvious; high severity of scaling, low durability concrete, layer of surface mortar is observable at the perimeter of the scaled area; Faulting exceeds 25-mm; Slabs shattered severely, slab broken into multiple pieces multiple severe to moderate cracks; spalls over 60-cm long broken into multiple pieces with severe cracks; corner cracks has spalled into multiple pieces defined by fragment cracks with loose or absent pieces; ASR has loose or missing concrete fragment, slab integrity and function significantly degraded and pavement requires immediate repair

Calculating PCI for PCC

- Utilizing the data collected in the field survey, sum up the quantity of each distress type at each severity level and record them in the “Total Severity” section
- Divide the “Total Severity” value of each distress type by the total area of the sample unit and multiply by a 100 to convert into a percent, record this number in the ‘Density” section for each distress type and severity
- Determine the deduct value (DV) for each distress type and severity level from the distress deduct value curve Appendix X4 of ASTM D5340-11
- Determine the maximum corrected deduct value (CDV):

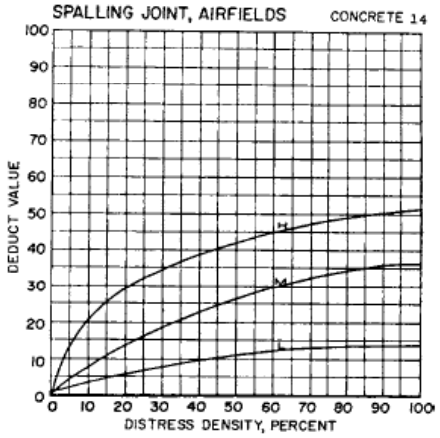


FIG. X4.14 Joint Spalling

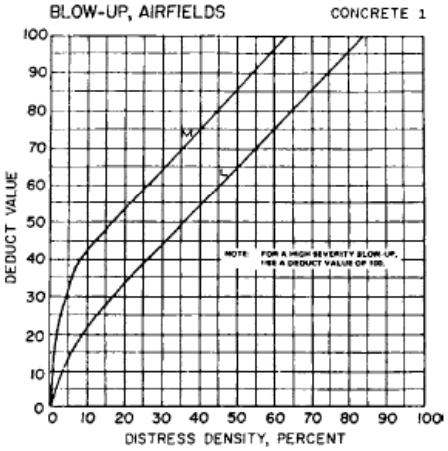


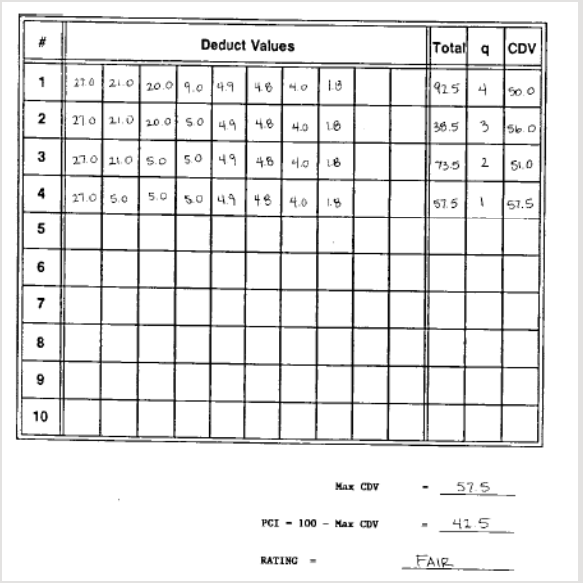
FIG. X4.1 Blowup

Calculating PCI for PCC

- If none or only one individual DV is greater than five, the total value is to be used in place of the maximum CDV; otherwise the maximum CDV must be calculated as shown below; note the determination of the maximum CDV from individual DV is identical for HMA and PCC
  - Determine *m*, the maximum allowable number of distresses:

    $m = 1+(9/95)(100-HDV) \leq 10$

    HDV = highest individual DV obtained form Appendix X3
  - Enter *m* largest DVs on line 1 of the adjacent table
  - Sum the DVs and enter the summation in the "Total" column
  - Count the number of DVs greater than 5 and enter it under "q"



#	Deduct Values										Total	q	CDV
1	27.0	21.0	20.0	9.0	4.9	4.8	4.0	1.8			92.5	4	50.0
2	27.0	21.0	20.0	5.0	4.9	4.8	4.0	1.8			88.5	3	56.0
3	27.0	21.0	5.0	5.0	4.9	4.8	4.0	1.8			73.5	2	51.0
4	27.0	5.0	5.0	5.0	4.9	4.8	4.0	1.8			57.5	1	57.5
5													
6													
7													
8													
9													
10													

Max CDV = 57.5

PCI = 100 - Max CDV = 42.5

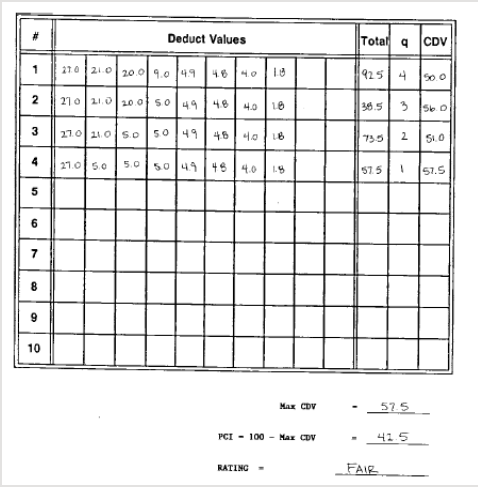
RATING = FAIR

Calculating PCI for PCC

- Look up appropriate correction with “Total” and “q” values to determine the CDV, Appendix X4 ASTM D5340-11
- Copy the DVs on to the next line, changing the smallest DV greater than 5 (only one DV), sum up the DVs total and Count the number of DVs greater than 5 and enter it under their approbiate box, Look up appropriate correction with “Total” and “q” values to determine the CDV, Appendix X4 ASTM D5340-11
- Repeat copying the DVs on to the next line, reducing the next lowest DV greater than 5 until “q” is equal to one
- Maximum CDV is the largest value in the “CDV” column

• Utilizing the maximum CDV, subtract it from 100 to obtain the PCI

PCI = 100 - CDV



#	Deduct Values										Total	q	CDV
1	27.0	21.0	20.0	9.0	4.9	4.8	4.0	1.8			92.5	4	50.0
2	27.0	21.0	20.0	5.0	4.9	4.8	4.0	1.8			88.5	3	56.0
3	27.0	21.0	5.0	5.0	4.9	4.8	4.0	1.8			73.5	2	51.0
4	27.0	5.0	5.0	5.0	4.9	4.8	4.0	1.8			57.5	1	57.5
5													
6													
7													
8													
9													
10													

Max CDV = 57.5

PCI = 100 - Max CDV = 42.5

RATING = FAIR

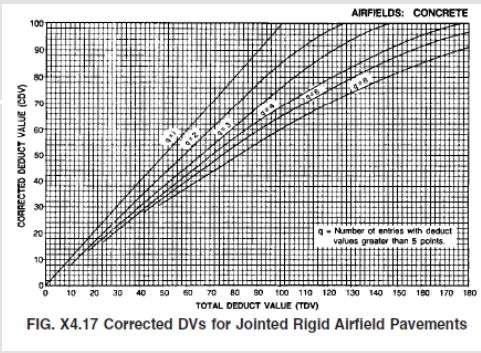
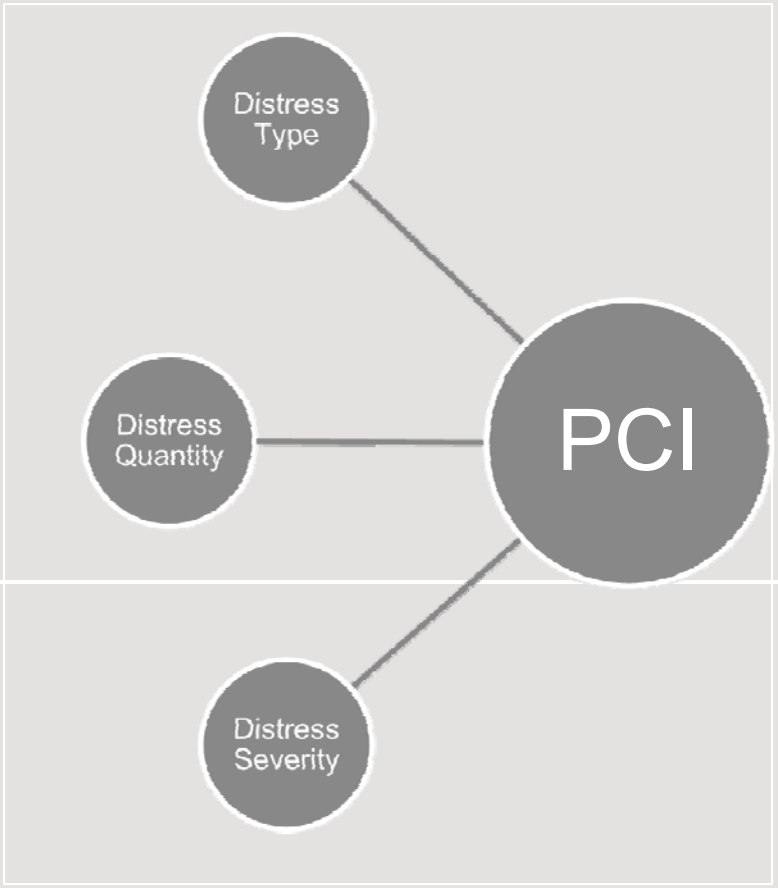


FIG. X4.17 Corrected DVs for Jointed Rigid Airfield Pavements

FAA Pavement Rating System



Excellent	• Rating 5 • PCI 100-86
Good	• Rating 4 • PCI 85-56
Fair	• Rating 3 • PCI 55-41
Poor	• Rating 2 • PCI 40-11
Failed	• Rating 1 • PCI 10-0

FAA HMA Pavement Rating System

Surface Rating	Visible Distress*	General Condition - Treatment Measures
5 Excellent	None, initial thermal cracks, all narrow less than 3-mm	New pavement less than 5-years old. No maintenance or isolated crack sealing required
4 Good	Additional thermal cracking. Cracks generally spaced more than 15-meters apart. Less than 10% of cracks need sealing. Minimal or slight raveling. No distortion. Patches in good condition.	Recent sealcoat or pavement over 5-years old. Seal open joints and replace sealant where needed
3 Fair	Moderate raveling. Thermal cracks and joints generally spaced less than 15-meters apart. Crack sealing or repair of sealant needed for 10% to 25% of cracks or joints. Edge cracks along 10% of pavement edge. Block cracks pattern with 2 to 3 meter apart. Isolated alligator cracking and poor patches. Minor distortion or crack settlement less than 30-mm.	Seal open cracks and joints. Replace failed sealant. Apply new surface treatment or thin overlay. Minor patching and joint repair.
2 Poor	Frequent thermal cracks. Wide cracks and joints with raveling cracks. Crack deterioration along 25% or more. Edge cracks up to 25% of pavement edges. Block cracks spaced 1.5-meters apart or less. Alligator cracking or poor patches up to 20% of surface area. Distortion or settlement 30 to 60-mm	Needs significant crack sealing plus patching and repair on up to 25% of pavement surface. Overlay entire area with structural overlay.
1 Failed	Widespread, severe cracking with raveling and deterioration. Alligator cracking and potholes over 20% of area. Distortion over 60-mm.	Condition may be limiting service. Needs reconstruction

** A given pavement segment may only have one or two types of distress rather than all of the types listed for a particular rating*

FAA PCC Pavement Rating System

Surface Rating	Visible Distress*	General Condition -Treatment Measures
5 Excellent	None	New pavement or recent major concrete rehabilitation. Like new condition. Less than 5-years old. No maintenance required
4 Good	Hairline or sealed cracks 3-mm wide or less. Map cracking. Pop-outs	Concrete over 5-years old. Shows sign of wear. Minor spot repair of cracks or joint sealant
3 Fair	Several slabs broken into two pieces by slab cracks. Corner cracking on several slabs, 6-mm wide with no spalling. Joint sealant mostly in good condition, less than 10% needing replacement. Several patches in fair to good condition. Map cracking or scaling on 10% or less of surface area. Slight faulting, less than 6-mm in several location.	First sign of significant slab cracking, corner cracking, scaling, or faulting. Several patches. Joint sealant repair required. Isolated repair of joint or patch
2 Poor	Many slab cracks, some breaking the slab into three or more pieces. Cracks open 3-mm or cracks spalling. D-cracks at several joints. Sealant failure over 10% of joints. Several patches in fair to poor condition with crack in patch and uneven surfaces. Faulting 6-mm to 12-mm in several locations. Severe or extensive scaling	Needs sealant replacement on more than 10% of cracks or joints. Partial depth or full depth joint repair or patch replacement. Repair faulted joints. Replace or overlay slabs with severe scaling. Bonded or unbounded concrete overlay.
1 Failed	Many wide cracks with failed sealant and grass. Extensive crack and joint spalling . Slabs extensively cracked and shattered. Many corner breaks with spalling. D-cracks with spalling. Patches in poor condition with spalling. Numerous faults over 12-mm	Extensive full depth joint repair or slab replacement. Extensive patching and complete overlay. Complete reconstruction.

** A given pavement segment may only have one or two types of distress rather than all of the types listed for a particular rating*

HMA Surface Condition Rating 5

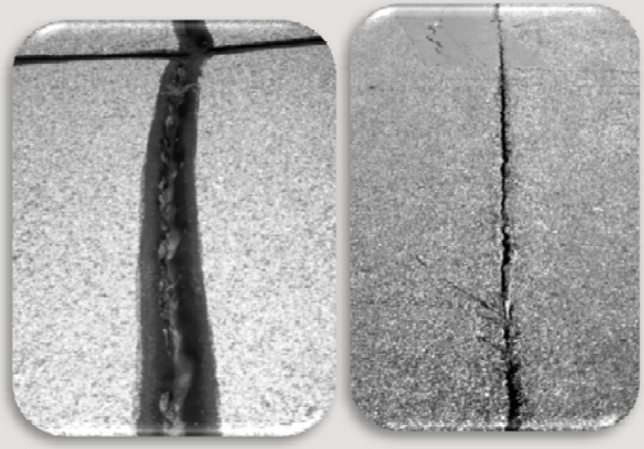
- Excellent:
  - pavement with no visible defects
  - Typically new pavement with less than 5-years of service
  - Initial thermal cracks less than 3-mm in width
  - Surface texture meets ICAO/FAA roughness levels for new pavement
  - No maintenance required

PCC Surface Condition Rating 5

- Excellent:
  - Pavement with no visible defects
  - Typically new pavement with less than 5-years of service
  - Surface texture meets ICAO/FAA roughness levels for new pavement
  - No maintenance required

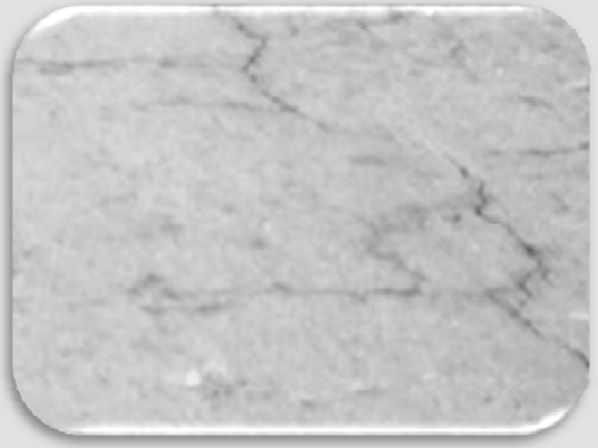
HMA Surface Condition Rating 4

- Good:
  - Recent sealed coat
  - Pavement over 5-years in service
  - Cracks are all sealed and spaced at 3 to 6 meter apart, less than 10% of surface cracks
  - No distortion and patches
  - Surface texture meets ICAO/FAA roughness levels
  - Little to no maintenance required



PCC Surface Condition Rating 4

- Good:
  - Pavement over 5-years
  - Minor spot repairs
  - Cracks are all sealed or less than 10% of joints require sealing
  - Hairline or sealed cracks less than 3-mm
  - Surface texture meets ICAO/FAA roughness levels
  - No distortion and patches
  - Little to no maintenance required

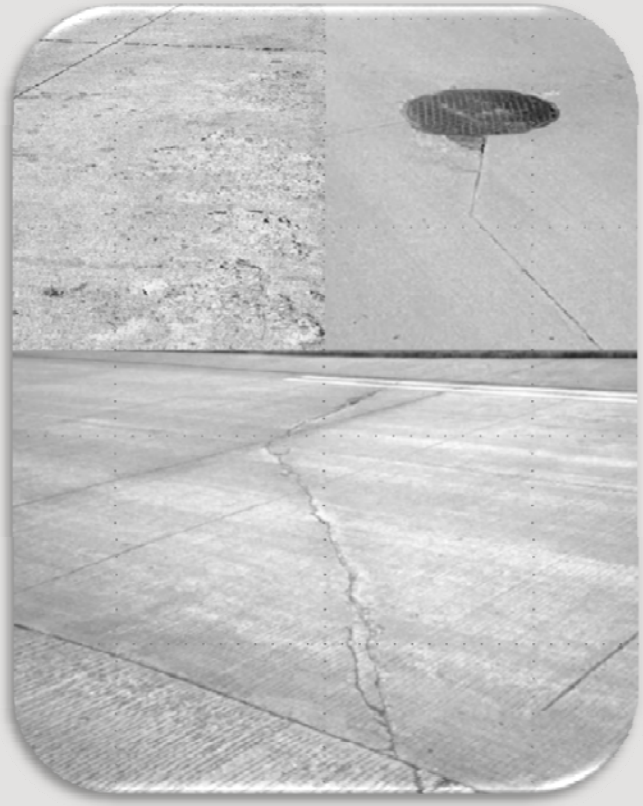


HMA Surface Condition Rating 3

- Fair
  - Moderate raveling
  - Thermal cracks spaced around 15-meters apart
  - Crack sealing or sealant repair needed on 10-25% of cracks or joints
  - Edge cracks on 10% or less of pavement edges
  - Block cracks 2 to 3 meters apart
  - Isolated alligator cracks
  - Poor patches
  - Surface texture exceeds minimal ICAO/FAA roughness levels yet falls below maintenance planning levels

PCC Surface Condition Rating 3

- Fair
  - Significant slab cracking, corner cracks, without spalling
  - Cracks are 6-mm wide with no spalling
  - Map cracking or scaling on less than 10%
  - Slight faulting less than 6-mm in several locations
  - Several patches in good to fair condition
  - Joint sealant repair required for 10% of joints
  - Surface texture exceeds minimal ICAO/FAA roughness levels yet falls below maintenance planning levels

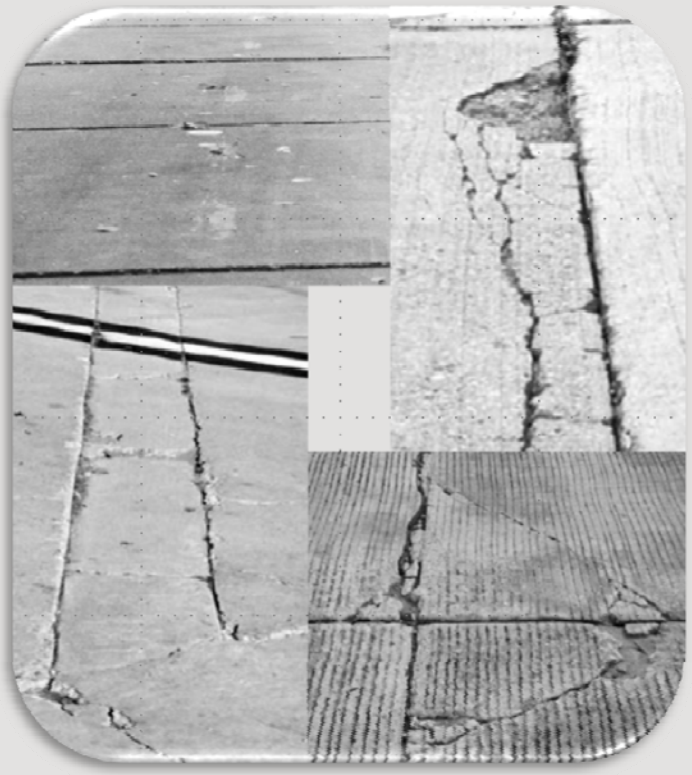


HMA Surface Condition Rating 2

- Poor
  - Moderate to severe raveling
  - Frequent thermal cracks
  - Deterioration over 25% of cracks or joints
  - Edge cracks over 25% of pavement edges
  - Block cracks less than 2-meters apart
  - Alligator cracks up to 20% of surface area
  - Poor patches, distortion and settlement up to 25 to 50-mm
  - Surface texture slightly above minimal ICAO/FAA roughness levels yet falls below maintenance planning levels

PCC Surface Condition Rating 2

- Poor
  - Many slab cracking, corner cracks, with spalling
  - Cracks are 3-mm wide with spalling
  - Severe map cracking or scaling
  - Slight faulting up to 12-mm in several locations
  - Several patches in fair to poor condition
  - Joint sealant failure for over 10% of joints
  - Surface texture slightly above minimal ICAO/FAA roughness levels yet falls below maintenance planning levels



HMA Surface Condition Rating 1

- Failed Surface
  - Widespread severe cracking with raveling and deterioration
  - Alligator cracking and pot holes over 20% of pavement service
  - Distortion of pavement surface over 50-mm
  - Large sections of failed pavement with FOD
  - Patches have failed and settled up to 50-mm
  - Surface texture is below minimal ICAO/FAA roughness levels

PCC Surface Condition Rating 1

- Failed Surface
  - Many wide cracks and sealant failure with vegetation growth
  - Extensive crack and joint spalling
  - Slabs extensively cracked or shattered
  - D-cracks with spalling
  - Numerous faulting less than 12-mm
  - Several patches have failed
  - Pavement with severe scaling
  - Surface texture is below minimal ICAO/FAA roughness levels

Advice on Rating Airfield Pavements

- Inventory & Field Inspection
- Pavement Feature
- Averaging & Comparing Sections
- Assessing Drainage Condition
- Planning Annual Maintenance & Repairs

Advice on Rating Airfield Pavements

- Inventory & Field Inspection
  - An actual field inspection means looking at the entire pavement system as a whole and preparing a detailed written summery of the condition
  - A thorough survey can be helpful to compare pavement features, and rating decisions are likely to be more consistent since the system is being evaluated as a whole within a relative short time
  - Inspections also encourage the review of specific conditions important to pavement maintenance, such as drainage, strength and safety
  - Written inventory is useful in making decisions
  - Having a written record and objective information also improves credibility with funding agencies
  - Written inventory is very useful in documenting changing pavement conditions
  - Annual budgets and long range planning are best done when based on actual neeeds documented with a written inventory

Advice on Rating Airfield Pavements

- Pavement Feature
  - Inventory and pavement condition data are normally organized by dividing the pavements into segments or features
  - A detailed topographic survey or aerial photo of the entire airfield is a must; helpful in identifying individual features, such as runways, taxiways, taxilanes and aprons
  - Within each category, the pavement should be separated into similar construction features, such as pavement type, thickness, and age should be rated separately
  - Runways and taxiways with consistent material, thickness and age can be considered one feature. Composite runways can be broken into multiple rating segments
  - Aprons should be broken out similarly, yet additional breakdown of use should be considered, i.e. cargo, terminal passenger, maintenance hanger, etc.
  - Helpful to describe the slabs or panels and size of the segments, which can be used to prepare maintenance or construction estimates.

Advice on Rating Airfield Pavements

- Averaging & Comparing Sections
  - No pavement section is entirely consistent, also surfaces in one section may not have all of the types of distress listed for any particular rating
  - Objective is to rate the condition that represents the majority of the pavement, small isolated conditions should not influence the rating
  - It is useful to note these anomalies on the inventory so this information can be used in planning specific improvement projects
  - Occasionally surface conditions vary significantly within a feature/segment
  - Overall purpose of condition rating is to be able to compare each feature/segments relative to all the other feature/segments of the entire airport pavement system

Advice on Rating Airfield Pavements

- Assessing Drainage Condition
  - Moisture and poor pavement drainage are significant factors in pavement deterioration
  - Assessment of the drainage condition during the pavement surveying is highly recommended
  - Simply include an overview of all of the airfield drainage components when surveying the pavement surface condition
  - Consider both the pavement surface and the drainage collection system, i.e. ditches, catch basin, etc.
  - Pavements should be able to quickly shed water, ditches should be deep enough to channel the runoff away from the airfield efficiently
  - Check pavement crowns, slopes, low areas and if channels are overgrown, pipes are partially clogged or catch basins are covered with debris
  - Maintenance of the stormwater management system is critical for the pavement integrity

Advice on Rating Airfield Pavements

- Planning Annual Maintenance & Repairs Budgets
  - Relating a normal maintenance or rehabilitation procedure to the surface rating scheme helps manager use the rating system
  - Individual surface rating should not automatically dictate the final maintenance or rehabilitation technique
  - Future traffic projections, original construction, and pavement strength should be factored into the comprehensive rehabilitation plans, along with the current rating

Survey Rating and the PMP

- The pavement field survey, surface condition index values, along with the field notes and sketches should be all inputted into the airports Pavement Management Program (PMP).
- By inputting such data, a historic log of each survey and deterioration rates can be easily accessible for future reference

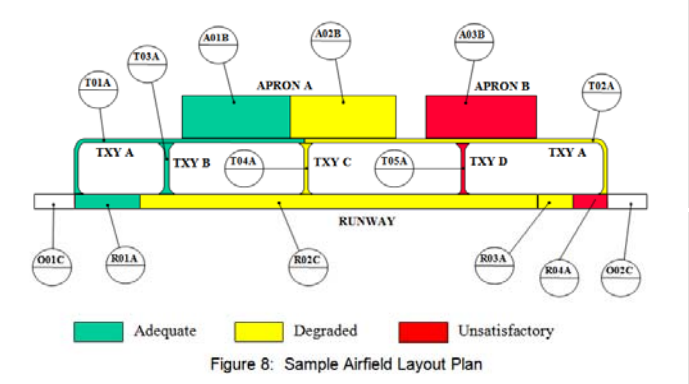
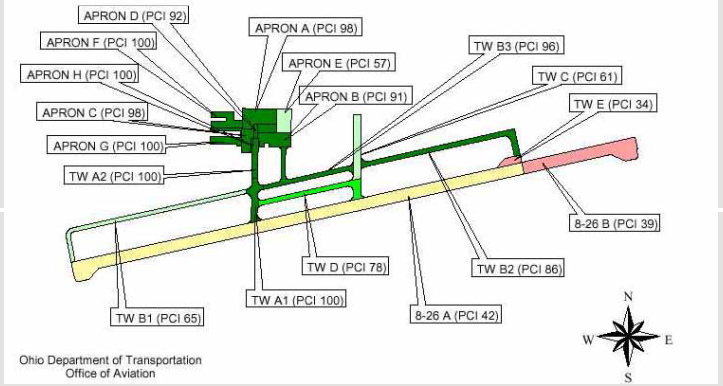


Figure 8: Sample Airfield Layout Plan



In Closing

- Using funds most efficiently requires good planning and accurate identification of appropriate rehabilitation projects
- Assessing pavement conditions is an essential first step in this process
- Pavement surface condition rating procedures has proven effective in improving decision making and making efficient use of funds
- The data collected combined with additional testing, pavement structure and surface friction test, provides a more comprehensive pavement management program

References

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Forum for Open Discussion