2024 - 2025

AIRFIELD PAVEMENT

INSPECTION TRAINING

FDOT AVIATION


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2024 - 2025

AIRFIELD PAVEMENT

INSPECTION TRAINING

PREFACE

This Airfield Pavement Inspection Reference Manual has been updated with the latest information from the Federal Aviation Administration (FAA) and the ASTM D5340-23. Additional distress pictures were added for clarity and easy recognition for inspectors while in the field and also to reflect the purposes of the updates from these two latest revisions. In 1995, the Congress of the United States mandated that the FAA required, as a condition of Grant in Aid, that airports should be prepared to present documentation of a Pavement Management Program (PMP) for airfield pavement that has been previously constructed, reconstructed, or repaired with Federal assistance. This Airfield Pavement Inspection Reference Manual has been developed by the Florida Department of Transportation Central Aviation Office (FDOT AO) to assist Florida airport owner/operators to comply with the FAA airfield pavement inspection requirements. Periodic and systematic airfield pavement inspections serve to enhance and extend the useful pavement service life and provide for the safe use of various airfield pavements throughout the airport.

The Pavement Condition Index (PCI) method of documenting pavement conditions is the preferred choice of the FAA and was developed by the United States Army Corps of Engineers in the 1970s. This index allows for a systematic, standardized, and objective assessment of pavement condition based on visual examination.

To accommodate the Airfield Pavement Management Program and the PCI calculation process, the FAA has provided PAVEAIR software which is a public, web-based application designed to assist organizations in the evaluation, management, and maintenance of their pavement networks.

USE OF MANUAL

Examples of numerous pavement distress types identified in this Airfield Pavement Inspection Manual (APIM) are presented by name to assist airfield pavement inspectors. The various illustrations, charts and supporting information descriptions are presented to aid in the identification, severity, location, extent, and probable cause of pavement distress for both flexible and rigid airfield pavement types.

The systematic visual inspection system can be used to establish a Pavement Management Program (PMP) that can be specifically tailored to meet the individual and specific pavement maintenance needs of a particular airport.

The majority of the photographs of various pavement conditions were collected by the FDOT AO and assembled specifically for the development of this APIM. A limited number of photographs are also presented and referenced in the following websites:

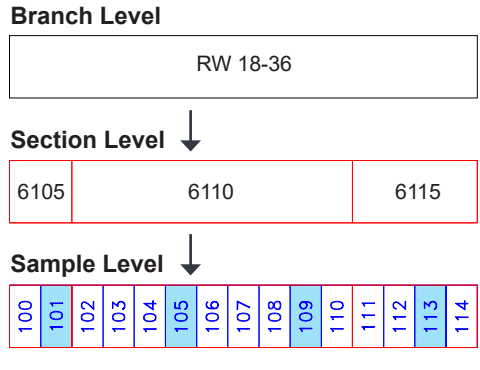
- https://theconstructor.org/transportation/corrugation-shoving-flexible-pavements/30886/,
- http://lgam.wikidot.com/corrugations, and
- https://champaignil.gov/2012/07/05/pavement-blow-up-on-olympian-drive/

DISCLAIMER:

This manual has been approved by the Florida Department of Transportation (FDOT) and is based on information from FAA, ASTM, and various sources. While reasonable care has been taken in preparing this document, no responsibility or liability is accepted for errors or facts or for any opinion expressed herein.

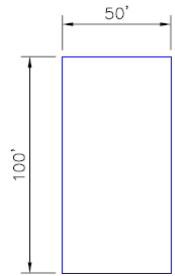
Common Pavement Management Terminology

Pavement Management Terminology	Common Definition	Airport Example
Network	Totality of pavement assets maintained by the Airport.	“Tallahassee International Airport - Airfield Pavements”
Branch Name	Commonly defined asset name as established by Airport and by use.	“Runway 18-36”
Branch ID	Codified shorthand name for commonly defined asset established for database identification.	“RW 18-36”
Section ID	Codified identification for pavement asset that is distinct by pavement composition, work history, aircraft loading, or condition.	“6105”
Sample Unit	A numeric identification of an area of pavement (5,000 ± 2,000 SF of AC or 20 ± 8 slabs of PCC) that has been inspected in accordance with ASTM D5340-23.	“100”



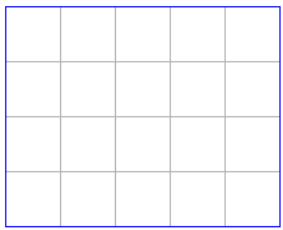
Sample Unit Size – Flexible Pavement

- 5,000 contiguous square feet ± 2,000 square feet



Sample Unit Size – Rigid Pavement

- 20 slabs ± 8 slabs



FDOT SAPMP Sampling Rate

- The FDOT Statewide Airfield Pavement Management Program (SAPMP) generally follows the sampling rate guidelines below.

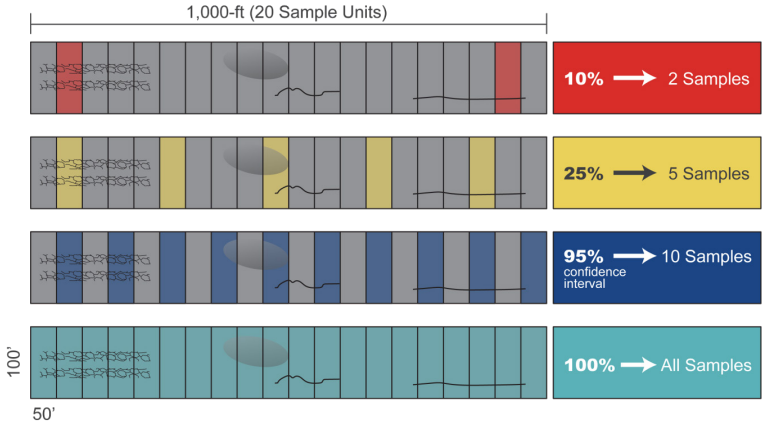
Flexible Pavement

Number of Total Sample Units in Section	Sample Units to Inspect	
	Runways	Taxiways, Aprons, and Others
1 - 4	1	1
5 - 10	2	1
11 -15	3	2
16 - 30	5	3
31 - 40	7	4
41 - 50	8	5
51 or more	20% but ≤ 20	10% but ≤ 10

Rigid Pavement

Number of Total Sample Units in Section	Sample Units to Inspect	
	Runways	Taxiways, Aprons, and Others
1 - 3	1	1
4 - 6	2	1
7 - 10	3	2
11 - 15	4	2
16 - 20	5	3
21 - 30	7	3
31 - 40	8	4
41 - 50	10	5
51 or more	20% but ≤ 20	10% but ≤ 10

Sampling Rate – Example 20 AC Sample Units



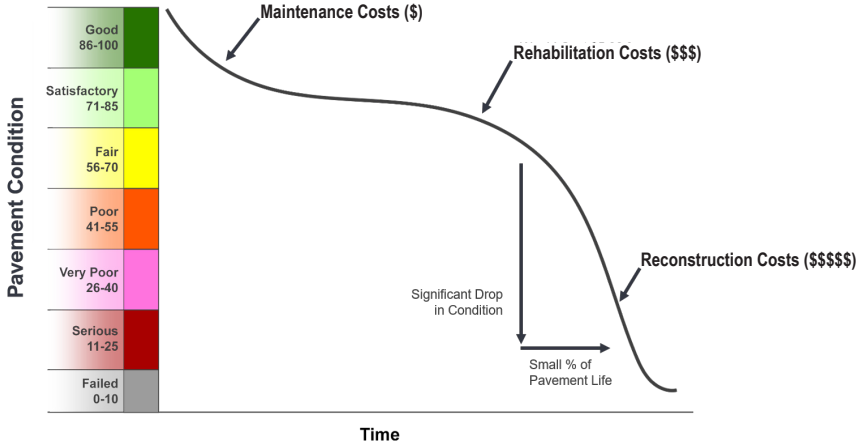
The above graphic displays the impact that various sampling rates can have on distress identification.

PCI Definition

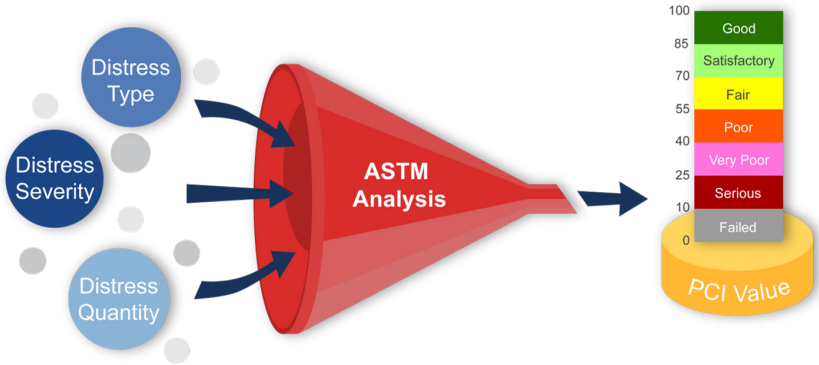
- A numerical rating of the pavement functional condition that ranges from 0 to 100 with 0 being the worst possible condition and 100 being the best possible condition.

Color	Range	Condition Rating
	86-100	Good
	71-85	Satisfactory
	56-70	Fair
	41-55	Poor
	26-40	Very Poor
	11-25	Serious
	0-10	Failed

Pavement Life Cycle



ASTM Basics


Distress Type
Distress Severity
Distress Quantity
ASTM Analysis
100
85
70
55
40
25
10
0
Good
Satisfactory
Fair
Poor
Very Poor
Serious
Failed
PCI Value

Load-Related Distresses

- Load, or structural, related issues can stem from repeated or heavy traffic loading, an under-designed pavement section, weakened subgrade layers due to moisture, and pavement that is beyond its usable life.
- Many of these factors can cause permanent deformation and cracking to the pavement extending beyond the surface to subgrade layers.
- These distresses may be indicators of fatigue and/or overload.

- AC Pavements
  1. Alligator Cracking
  2. Rutting

- PCC Pavements
  1. Corner Break
  2. Longitudinal, Transverse, and Diagonal (LTD) Cracking
  3. Shattered Slab / Intersecting Cracks

Climate/Durability-Related Distresses

- Climatic factors include moisture, rainfall, temperature, and freeze/thaw.
- These conditions can contribute to shrinkage and expanding of pavement, inundation of water to the subgrade, and the loss of material over time.

- AC Pavements
  1. Block Cracking
  2. Joint Reflection Cracking
  3. Longitudinal and Transverse (LT) Cracking
  4. Patching and Utility Cut Patching
  5. Raveling
  6. Weathering

- PCC Pavements
  1. Blowup
  2. Durability “D” Cracking
  3. Joint Seal Damage

Construction/Material-Related Distresses

- Construction and material related factors can include sub-standard aggregates, chemical reactions within the pavement matrix, an imbalanced mix-design, and improper construction techniques such as lack of curing time and over-finishing of surfaces.
- Some of these factors may appear immediately after construction, while some may take time to develop before appearing.

- AC Pavements
  1. Bleeding
  2. Corrugation
  3. Depression
  4. Polished Aggregate
  5. Shoving
  6. Slippage Cracking
  7. Swelling

- PCC Pavements
  1. Alkali Silica Reaction (ASR)
  2. Popouts
  3. Scaling
  4. Shrinkage Cracking

Other-Related Distresses

- Other distress factors include causes that are not typically attributed to load, climate, or construction/material issues.
- These factors can include surface damage from aircraft operations and defects or patch repairs of the pavement surface.

- AC Pavements
  1. Jet-Blast Erosion
  2. Oil Spillage

- PCC Pavements
  1. Corner Spalling
  2. Joint Spalling
  3. Large Patching and Utility Cut
  4. Pumping
  5. Settlement or Faulting
  6. Small Patching

Distress Severity

Low	Visible but not likely to need maintenance
Medium	Obvious, may require maintenance
High	Requires maintenance
None	For some distresses it is sufficient to note the presence of a distress

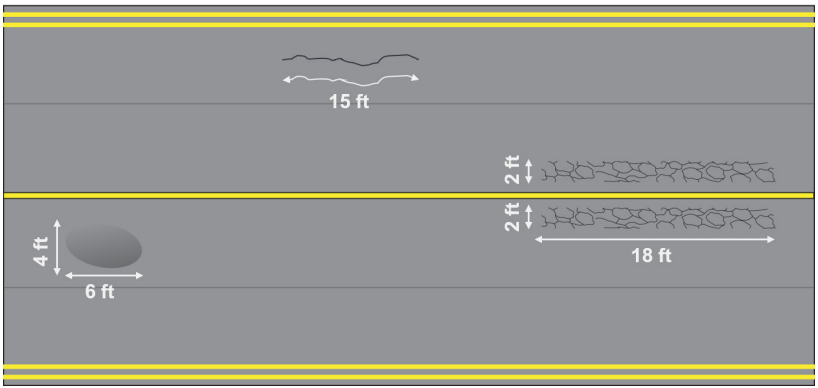
Low

Medium

High

Distress Quantity – Flexible Pavement

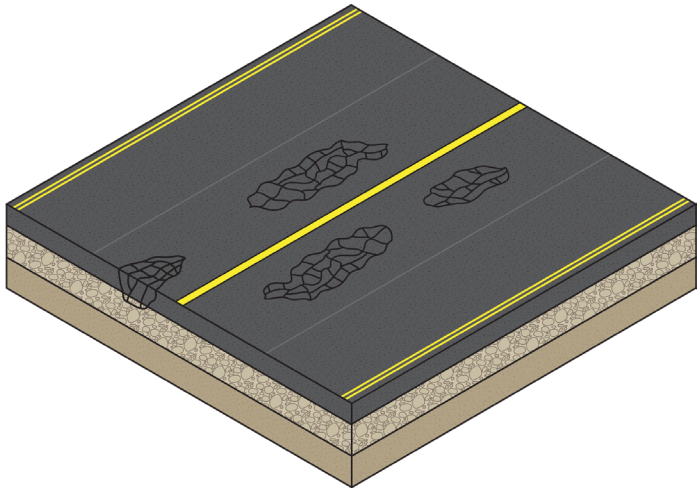
- Linear Feet (ft) or Square Feet (ft^2) (depending upon the distress type)



AC Distress Overview

Distress Mechanism	Distress Type
Load	Alligator Cracking
	Rutting
Climate/Durability	Block Cracking
	Joint Reflection Cracking
	Longitudinal and Transverse (LT) Cracking
	Patching and Utility Cut Patching
	Raveling
	Weathering
Construction/Material	Bleeding
	Corrugation
	Depression
	Polished Aggregate
	Shoving
	Slippage Cracking
	Swelling
Other	Jet-Blast Erosion
	Oil Spillage

Alligator Cracking



Alligator Cracking

Definition:

- Alligator or fatigue cracking is a series of interconnected cracks caused by fatigue failure of the AC surface under repeated traffic loading.
- The cracking initiates at the bottom of the AC surface (or stabilized base) where tensile stress and strain are highest under a wheel load. The cracks propagate to the surface initially as a series of parallel cracks.
- After repeated traffic loading, the cracks connect, forming many-sided, sharp-angled pieces, that develop a pattern resembling chicken wire or the skin of an alligator.
- The pieces are **less than 2 ft** on the longest side.
- Alligator cracking is considered a major structural distress.

Location:

- Areas subjected to repeated traffic loadings, such as wheel paths

Cause:

- Fatigue failure of the AC surface under repeated traffic loading

Alligator Cracking

Severity	Cracking Pattern	Spalling/FOD Potential
Low	Fine, Parallel Hairline Cracks, with Few Intersecting	None
Medium	Well-Defined Interconnecting Cracks	Little to None
High	Well-Defined Interconnecting Cracks	Spalled with Some FOD Potential Loose or Missing Pieces

How to measure:

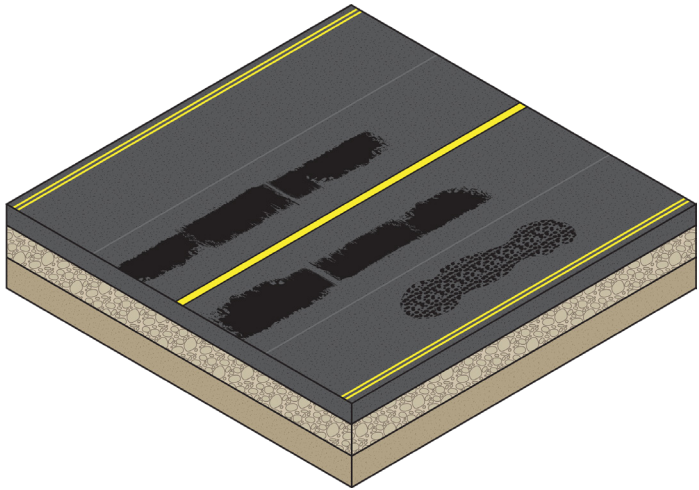
- Area (square feet) of affected pavement surface
- Many times two or three levels of severity exist within one distressed area. If these portions can be easily distinguished from one another, they should be measured and recorded separately
- If different levels of severity cannot be divided, the entire area should be rated at the highest severity level present
- If alligator cracking and rutting occur in the same area, each is recorded separately at its respective severity level
- If alligator cracking is recorded, no block cracking or longitudinal and transverse (LT) cracking should be recorded in the same area

Alligator Cracking - Low Severity

Alligator Cracking - Medium Severity

Alligator Cracking - High Severity

Bleeding



Bleeding

Definition:

- Bleeding is a film of bituminous material on the pavement surface that creates a shiny, glass-like, reflecting surface that usually becomes quite sticky.
- Bleeding occurs when asphalt fills the voids of the mix during hot weather and then expands out onto the surface of the pavement.
- Since the bleeding process is not reversible during cold weather, asphalt or tar will accumulate on the surface.

Location:

- Areas subject to traffic

Cause:

- Excessive amounts of asphaltic cement or tars in the mix
- Low air void content

Bleeding

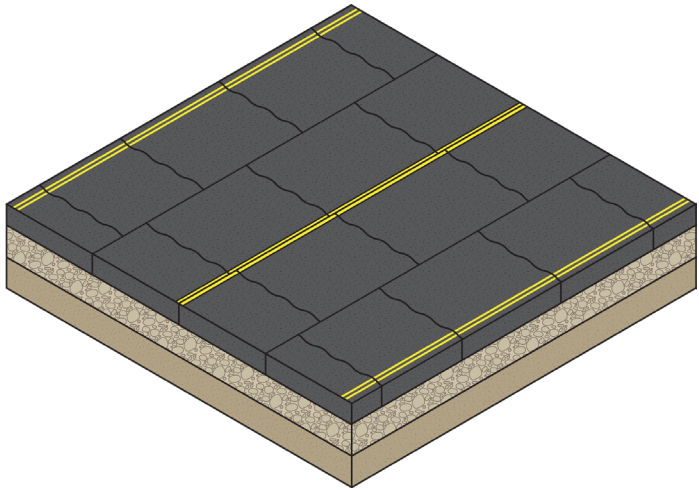
No degrees of severity are defined. It is sufficient to indicate that bleeding exists.

How to measure:

- Area (square feet) of affected pavement surface
- If bleeding is counted, polished aggregate is not counted in the same area

Bleeding - No Severity

Block Cracking



Block Cracking

Definition:

- Block cracks are interconnected cracks that divide the pavement into approximately rectangular pieces ranging in size from approximately **1 by 1 ft to 10 by 10 ft**.
- The occurrence of block cracking usually indicates that the asphalt has hardened significantly.
- This type of distress differs from alligator cracking in that the alligator cracks form smaller, many-sided pieces with sharp angles. Also unlike block cracks, alligator cracks are caused by repeated traffic loading and are, therefore, located in traffic areas.

Location:

- Over a large portion of pavement area
- Sometimes occur only in nontraffic areas

Cause:

- Shrinkage of the asphalt concrete (AC)
- Daily temperature cycling

Block Cracking

Severity	Filled or Non-Filled	Filler Condition	Crack Width	FOD Potential	Spalling
Low	Non-Filled	-	≤ 1/4 in.	None	Light to None
	Filled	Satisfactory	Any Width	None	Light to None
Medium	Either	-	Any Width	Some	Moderate
	Non-Filled	-	> 1/4 in.	Some	Light to None
	Filled	Unsatisfactory	> 1/4 in.	Some	Light to None
High	Either	-	Any Width	Definite	Severe

How to measure:

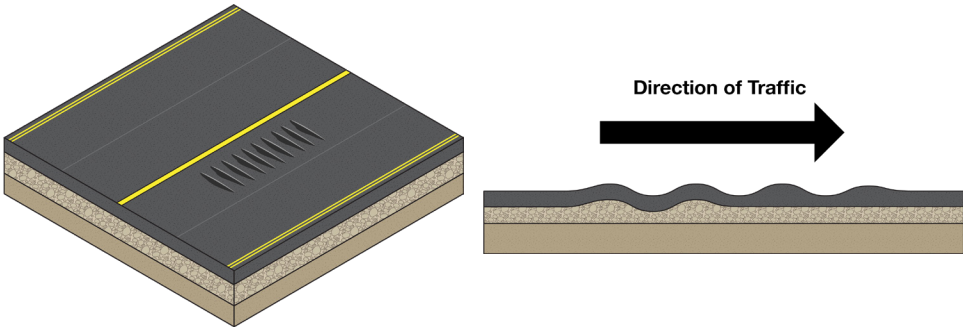
- Area (square feet) of affected pavement surface
- Usually occurs at one severity level in a given pavement section; however, any areas having distinctly different levels of severity should be measured and recorded separately
- For asphalt pavement, not including AC over PCC, if block cracking is recorded, no alligator cracking or longitudinal and transverse cracking should be recorded in the same area
- For asphalt overlay over concrete, block cracking, alligator cracking, joint reflection cracking, and longitudinal and transverse cracking reflected from old concrete should all be recorded separately

Block Cracking - Low Severity

Block Cracking - Medium Severity

Block Cracking - High Severity

Corrugation



Corrugation

Definition:

- Corrugation is a series of closely spaced ridges and valleys (ripples) occurring at fairly regular intervals (usually less than 5 ft) along the pavement.

Location:

- Perpendicular to the traffic direction

Cause:

- Traffic action combined with an unstable pavement surface or base

Corrugation

Severity	Visibility	Ride Quality	Mean Depth	
			Runways and High-Speed Taxiways	Taxiways and Aprons
Low	Minor	No Significant Impact	< 1/4 in.	< 1/2 in.
Medium	Noticeable	Significantly Impacts	1/4 in. - 1/2 in.	1/2 in. - 1 in.
High	Easily Noticeable	Severely Impacts	> 1/2 in.	> 1 in.

How to measure:

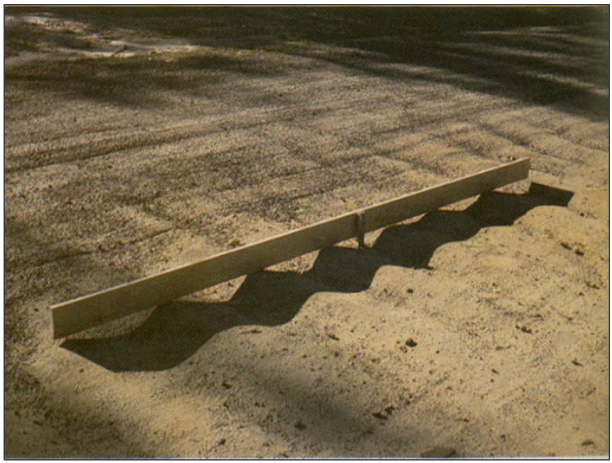
- Area (square feet) of affected pavement surface
- The mean elevation difference between the ridges and valleys of the corrugations indicate the level of severity
- To determine the mean elevation difference, a 10-foot straightedge should be placed perpendicular to the corrugations so that the depth of the valleys can be measured in inches
- The mean depth is calculated from 5 such measurements

Corrugation - Low Severity

Corrugation - Medium Severity

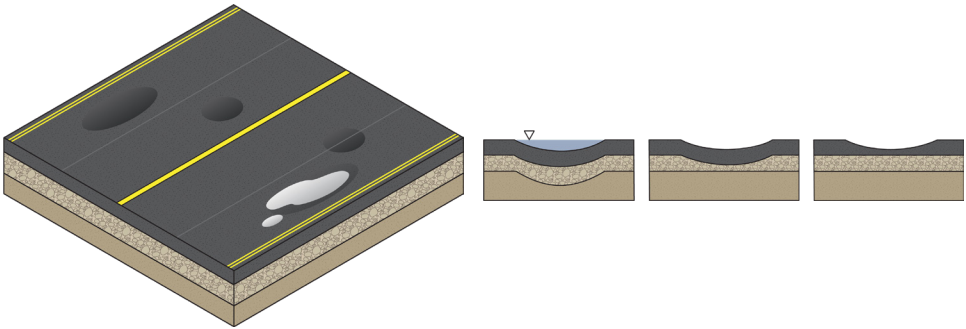
(Anupoju, n.d.)

Corrugation - High Severity



(The Local Government & Municipal Knowledge Base, n.d.)

Depression



Depression

Definition:

- Depressions are localized pavement surface areas having elevations slightly lower than those of the surrounding pavement.
- In many instances, light depressions are not noticeable until after a rain, when ponding water creates “birdbath” areas; but the depressions can also be located without rain because of stains created by ponding of water.
- Depressions cause roughness and, when filled with water of sufficient depth, could cause hydroplaning of aircraft.

Location:

- Aprons
- Paving lane joint

Cause:

- Settlement of the foundation soil
- Poor construction

Depression

Severity	Visibility	Ride Quality	Hydroplaning Potential	Max Depth	
				Runways and High-Speed Taxiways	Taxiways and Aprons
Low	Observed in stained areas	Slightly Impacts	May Cause	1/8 in. - 1/2 in.	1/2 in. - 1 in.
Medium	Observed	Moderately Impacts	Causes	1/2 in. - 1 in.	1 in. - 2 in.
High	Readily Observed	Severely Impacts	Definitely Causes	> 1 in.	> 2 in.

How to measure:

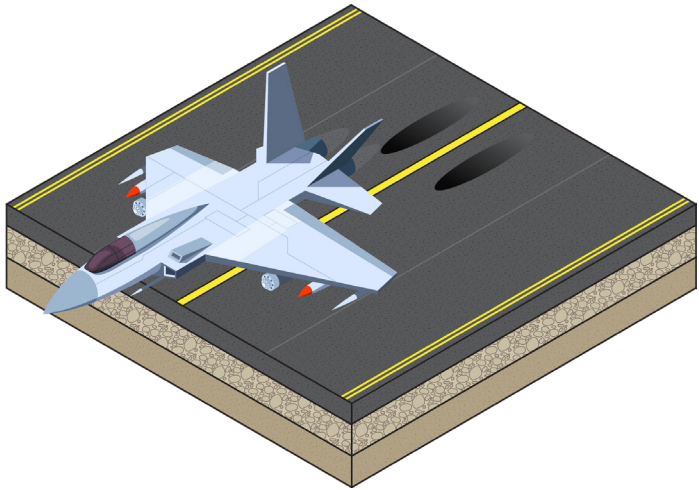
- Area (square feet) of affected pavement surface
- The maximum depth of the depression determines the level of severity
- This depth can be measured by placing a 10-foot straightedge across the depressed area and measuring the maximum depth in inches
- Depressions larger than 10 feet across must be measured by using a stringline

Depression - Low Severity

Depression - Medium Severity

Depression - High Severity

Jet-Blast Erosion



Jet-Blast Erosion

Definition:

- Jet-blast erosion causes darkened areas on the pavement surface where bituminous binder has been burned or carbonize.
- Localized burned areas may vary in depth up to approximately ½ in.

Location:

- Movement areas
- Run-up aprons

Cause:

- Jet-blast

Jet-Blast Erosion

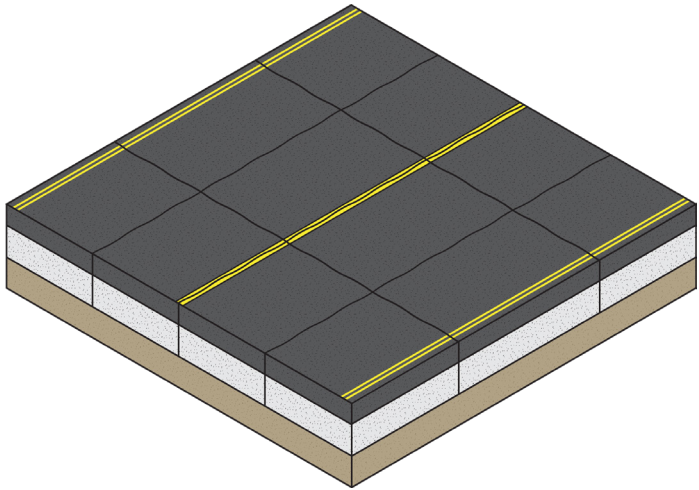
No degrees of severity are defined. It is sufficient to indicate that jet-blast erosion exists.

How to measure:

- Area (square feet) of affected pavement surface

Jet-Blast Erosion - No Severity

Joint Reflection Cracking



Joint Reflection Cracking

Definition:

- Joint reflection cracking occurs only on pavements having an asphalt or tar surface over a PCC slab.
- This category does not include reflection cracking from any other type of base (that is, cement stabilized, lime stabilized). Such cracks are listed as longitudinal and transverse cracks.
- A knowledge of slab dimensions beneath the AC surface will help to identify these cracks.
- Traffic loading may cause a breakdown of the AC near the crack, resulting in spalling and FOD potential.

Location:

- Pavements having an asphalt or tar surface over a PCC slab

Cause:

- Movement of the PCC slabs beneath the AC surface because of thermal and moisture changes

Joint Reflection Cracking

Severity	Filled or Non-Filled	Filler Condition	Crack Width	FOD Potential	Spalling
Low	Non-Filled	-	≤ 1/4 in.	Little to None	Light to None
	Filled	Satisfactory	Any Width	Little to None	Light to None
Medium	Either	-	Any Width	Some	Moderate
	Non-Filled	-	> 1/4 in.	Little to None	Light to None
	Filled	Unsatisfactory	Any Width	Little to None	Light to None
High	Either	-	Any Width	Definite	Severe

How to measure:

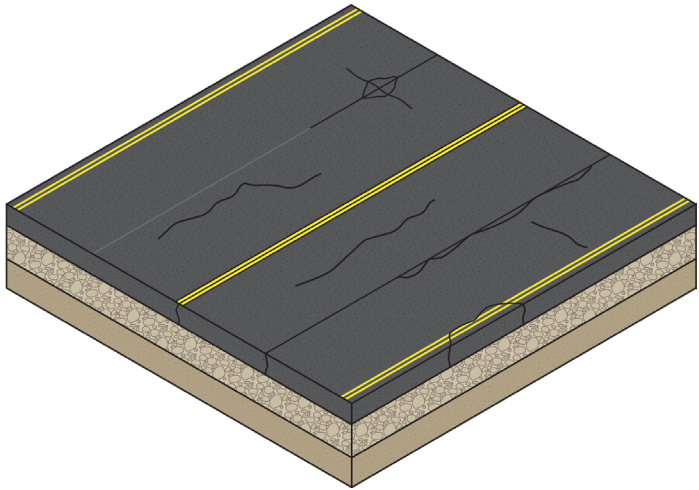
- Linear feet
- The length and severity level of each crack should be identified and recorded
- If the crack does not have the same severity level along its entire length, each portion should be recorded separately
- If the different levels of severity in a portion of a crack cannot be easily divided, that portion should be rated at the highest severity present
- If the pavement is fragmented along the crack, the crack is said to be spalled

Joint Reflection Cracking - Low Severity

Joint Reflection Cracking - Medium Severity

Joint Reflection Cracking - High Severity

Longitudinal and Transverse (LT) Cracking



Longitudinal and Transverse (LT) Cracking

Definition:

- Longitudinal cracks are parallel to the pavement's center line or laydown direction.
- Transverse cracks extend across the pavement at approximately right angles to the pavement's center line or direction of laydown.

Location:

- Paving lane joint

Cause:

- Longitudinal and transverse cracking:
  - — Shrinkage of AC surface due to low temperatures or hardening of the asphalt
  - — A reflective crack caused by cracks beneath the surface course, including cracks in PCC slabs (but not at PCC joints)
- Longitudinal cracking:
  - — A poorly constructed paving lane joint

Longitudinal and Transverse (LT) Cracking

Severity	Filled or Non-Filled	Filler Condition	Crack Width	FOD Potential	Spalling
Low	Non-Filled	-	≤ 1/4 in.	Little to None	Light to None
	Filled	Satisfactory	Any Width	Little to None	Light to None
Medium	Either	-	Any Width	Some	Moderate
	Non-Filled	-	> 1/4 in.	Little to None	Light to None
	Filled	Unsatisfactory	Any Width	Little to None	Light to None
High	Either	-	Any Width	Definite	Severe

How to measure:

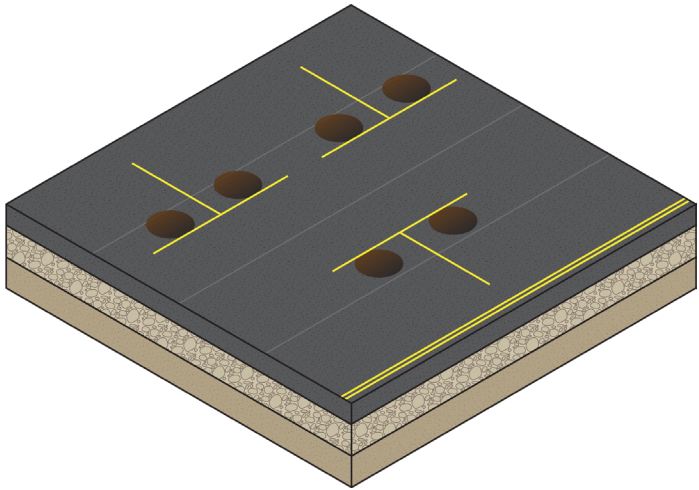
- Linear feet
- The length and severity of each crack should be identified and recorded
- If the crack does not have the same severity level along its entire length, each portion of the crack having a different severity level should be recorded separately
- If pavement is fragmented along a crack, the crack is said to be spalled
- If longitudinal and transverse (LT) cracking is recorded, no alligator cracking or block cracking should be recorded in the same area

Longitudinal and Transverse (LT) Cracking - Low Severity

Longitudinal and Transverse (LT) Cracking - Medium Severity

Longitudinal and Transverse (LT) Cracking - High Severity

Oil Spillage



Oil Spillage

Definition:

- Oil spillage is the deterioration or softening of the pavement surface caused by the spilling of oil, fuel, or other solvents.

Location:

- Non-movement areas

Cause:

- The spilling of oil, fuel, or other solvents

Oil Spillage

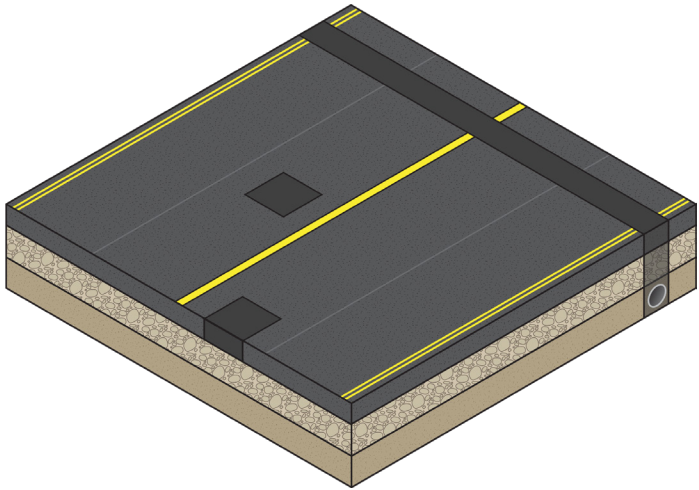
No degrees of severity are defined. It is sufficient to indicate that oil spillage exists.

How to measure:

- Area (square feet) of the affected pavement surface
- A stain is not a distress unless material has been lost or binder has been softened
- If hardness is approximately the same as on surrounding pavement, and if no material has been lost, do not record as a distress

Oil Spillage - No Severity

Patching and Utility Cut Patching



Patching and Utility Cut Patching

Definition:

- A patch is considered a defect, no matter how well it is performing.

Location:

- Anywhere

Cause:

- Utility construction
- Pavement repair

Patching and Utility Cut Patching

Severity	Patch Condition	Ride Quality	FOD Potential
Low	Good	No Impact	None
Medium	Somewhat Deteriorated	Slightly Impacts	Some
High	Badly Deteriorated	Significantly Impacts	High

How to measure:

- Area (square feet) of affected pavement surface
- If a single patch has areas of differing severity levels, these areas should be measured and recorded separately
- Any distress found in a patched area will not be recorded; however, its effects on the patch will be considered when determining the patch's severity level
- A very large patch (area > 2,500 ft^2) or feathered-edge pavement, may qualify as an additional sample unit or as a separate section

Patching and Utility Cut Patching - Low Severity

Patching and Utility Cut Patching - Medium Severity

Patching and Utility Cut Patching - High Severity

Polished Aggregate

Polished Aggregate

Definition:

- Polished aggregate is present when close examination of a pavement reveals that the portion of aggregate extending above the asphalt is either very small, or there are no rough or angular aggregate particles to provide good skid resistance.

Location:

- Areas subject to high traffic volumes

Cause:

- Repeated traffic applications

Polished Aggregate

No degrees of severity are defined. It is sufficient to indicate that polished aggregate exists.

How to measure:

- Area (square feet) of affected pavement surface
- Polished aggregate areas should be compared visually with adjacent nontraffic areas. If the surface texture is substantially the same in both traffic and nontraffic areas, polished aggregate should not be counted
- A significant amount of polished aggregate should be present before its counted
- If bleeding is counted, polished aggregate is not counted in the same area

Polished Aggregate - No Severity

Raveling

Raveling

Definition:

- Raveling is the dislodging of coarse aggregate particles from the pavement surface.
- A surface treatment that is coming off should be counted as raveling.

Location:

- Pavements subject to unique climatic cycling
- Paint removal due to water blasting
- Travel lanes

Cause:

- Loss of bond between aggregate particles and asphalt binder
- Mechanical dislodging caused by certain types of traffic or operation

Raveling - Dense Mix

Severity	# of Missing Coarse Aggregate Particles in a Representative Square Yard	% of Representative Square Yard with Missing Aggregate Clusters	FOD Potential
Low	5 - 20	< 2%	Little to None
Medium	21 - 40	2% - 10%	Some
High	> 40	> 10%	Significant

How to measure:

- Area (square feet) of affected pavement surface
- If in doubt about a severity level, three (3) representative areas of one square yard each should be examined and the number of missing coarse aggregate particles counted
- Mechanical damage caused by hook drags, tire rims, or snowplows is counted as areas of high severity raveling
- If raveling is recorded, weathering should not be recorded in the same area

Raveling - Dense Mix - Low Severity

Raveling - Dense Mix - Medium Severity

Raveling - Dense Mix - High Severity

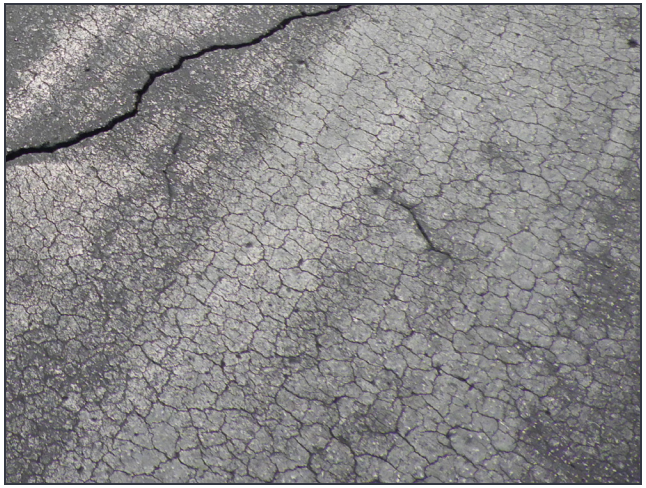
Raveling - Surface Treatment

Severity	Scaled Area	Surface Cracking Width
Low	< 1%	< 1/4 in.
Medium	1% - 10%	≥ 1/4 in.
High	> 10%	Surface is Peeling Off

How to measure:

- Area (square feet) of affected pavement surface
- Mechanical damage caused by hook drags, tire rims, or snowplows is counted as areas of high severity raveling
- If raveling is recorded, weathering should not be recorded in the same area

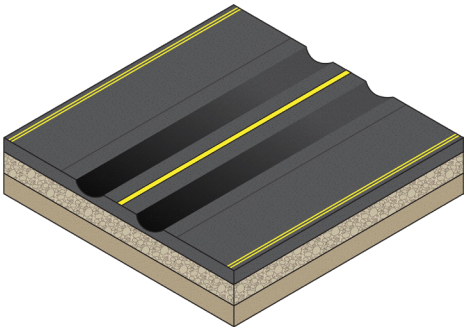
Raveling - Surface Treatment - Low Severity

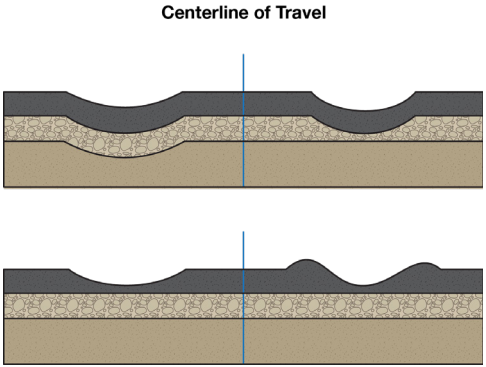


Raveling - Surface Treatment - Medium Severity

Raveling - Surface Treatment - High Severity

Rutting





Rutting

Definition:

- A rut is a surface depression in the wheel path.
- Pavement uplift may occur along the sides of the rut; however, in many instances ruts are noticeable only after a rainfall, when the wheel paths are filled with water.
- Rutting stems from a permanent deformation in any of the pavement layers or subgrade, usually caused by consolidation or lateral movement of the materials due to traffic loads.
- Significant rutting can lead to major structural failure of the pavement.

Location:

- Wheel path

Cause:

- A permanent deformation in any of the pavement layers or subgrade
- Consolidation or lateral movement of the materials due to traffic loads

Rutting

Severity	Mean Rut Depth
Low	1/4 in. - 1/2 in.
Medium	> 1/2 in. - 1 in.
High	> 1 in.

How to measure:

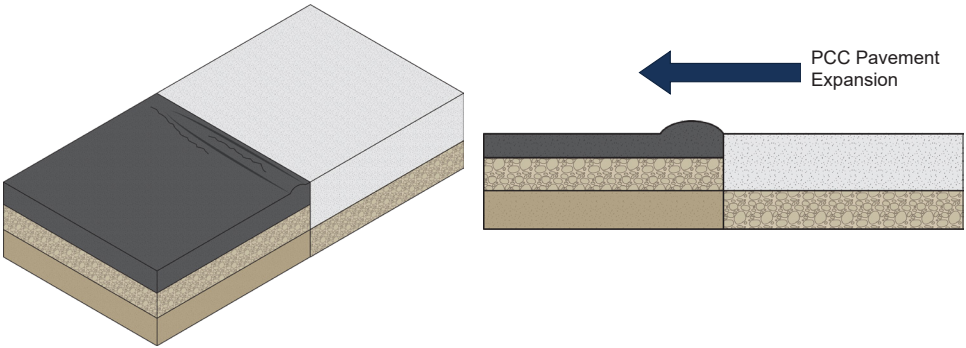
- Area (square feet) of affected pavement surface
- Severity is determined by the mean depth of the rut. To determine the mean depth, a straightedge should be laid across the rut and the maximum depth measured. The mean depth should be computed from the measurements taken along the length of the rut.
- If alligator cracking and rutting occur in the same area, each is recorded at the respective severity level

Rutting - Low Severity

Rutting - Medium Severity

Rutting - High Severity

Shoving



Shoving

Definition:

- PCC pavements occasionally increase in length at ends where they adjoin flexible pavements (commonly referred to as “pavement growth”). This “growth” shoves the asphalt- or tar-surfaced pavements, causing them to swell and crack.
- The PCC slab “growth” is caused by a gradual opening up of the joints as they are filled with incompressible materials that prevent them from reclosing.

Location:

- Interface of flexible and rigid pavements

Cause:

- Climatic cycling
- Incompressible materials in joints

Shoving

Severity	Roughness	Break-up of Asphalt	Height Differential
Low	None	None	< 3/4 in.
Medium	Moderate	Little to None	3/4 in. - 1½ in.
High	Severe	Severe	> 1½ in.

How to measure:

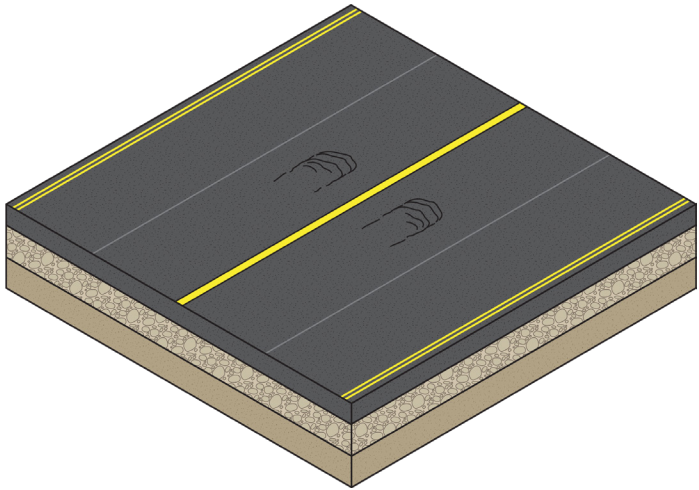
- Area (square feet) of affected pavement surface
- Shoving is measured by determining the area in square feet of the swell caused by shoving

Shoving - Low Severity

Shoving - Medium Severity

Shoving - High Severity

Slippage Cracking



Slippage Cracking

Definition:

- Slippage cracks are crescent- or half-moon-shaped cracks having two ends pointed away from the direction of traffic.
- They are produced when braking or turning wheels cause the pavement surface to slide and deform.
- This usually occurs when there is a low-strength surface mix or poor bond between the surface and next layer of pavement structure.

Location:

- Areas of braking and turning

Cause:

- Braking or turning wheels causing the pavement surface to slide and deform
- Low-strength surface mix
- Poor bond between the surface and next layer of pavement

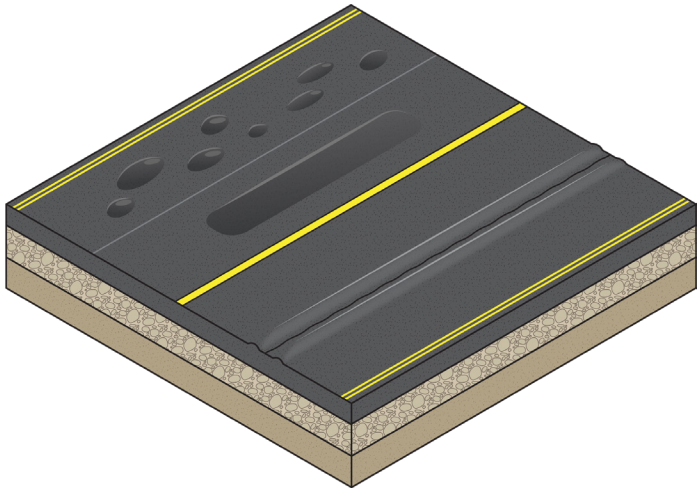
Slippage Cracking

No degrees of severity are defined. It is sufficient to indicate that slippage cracking exists.

How to measure:
- Area (square feet) of affected surface area

Slippage Cracking - No Severity

Swelling



Swelling

Definition:

- A swell characterized by an upward bulge in the pavement's surface.
- A swell may occur sharply over a small area or as a longer, gradual wave.
- Either type of swell can be accompanied by surface cracking.

Location:

- Anywhere

Cause:

- Frost action in the subgrade
- Swelling soil
- On the surface of an asphalt overlay (over PCC) as a result of a blowup in the PCC slab
- In AAC pavement, when previous cracks weren't properly cleaned and sealed before overlay

Swelling

Severity	Visibility	Ride Quality	Height Differential	
			Runways and High-Speed Taxiways	Taxiways and Aprons
Low	Barely Visible	Minor Impact	< 3/4 in.	< 1½ in.
Medium	Observed	Significantly Impacts	3/4 in. - 1½ in.	1½ in. - 3 in.
High	Readily Observed	Severely Impacts	> 1½ in.	> 3 in.

How to measure:

- Area (square feet) of affected pavement surface
- The severity rating should consider the type of pavement section (that is, runway, taxiway, or apron)

Swelling - Low Severity

Swelling - Medium Severity

Swelling - High Severity

Weathering

Weathering

Definition:

- The wearing away of the asphalt binder and fine aggregate matrix from the pavement surface.
- Pavement may be relatively new (as new as 6 months)

Location:

- Anywhere

Cause:

- Climatic cycling

Weathering

Severity	Fine Aggregate Matrix	Exposure of Coarse Aggregate
Low	Noticeable loss with some fading of asphalt color	Beginning (< 1 mm)
Medium	Noticeable loss	≤ 1/4 width of longest side of coarse aggregate
High	Considerable loss leading to potential loss of coarse aggregate	> 1/4 width of longest side of coarse aggregate

How to measure:
- Area (square feet) of affected pavement surface
- Surface wear is not recorded if medium or high severity raveling is recorded

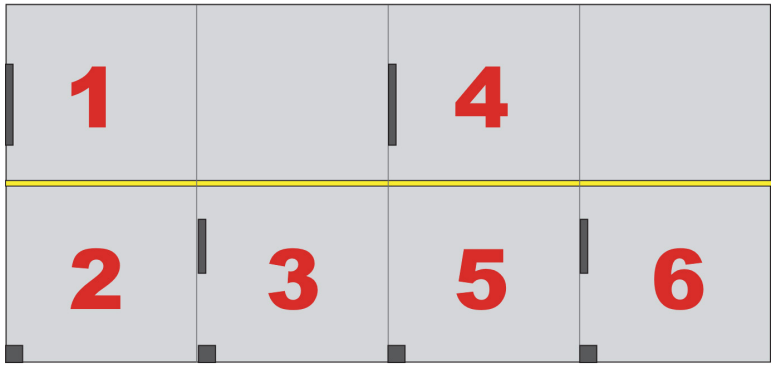
Weathering - Low Severity

Weathering - Medium Severity

Weathering - High Severity

Distress Quantity – Rigid Pavement

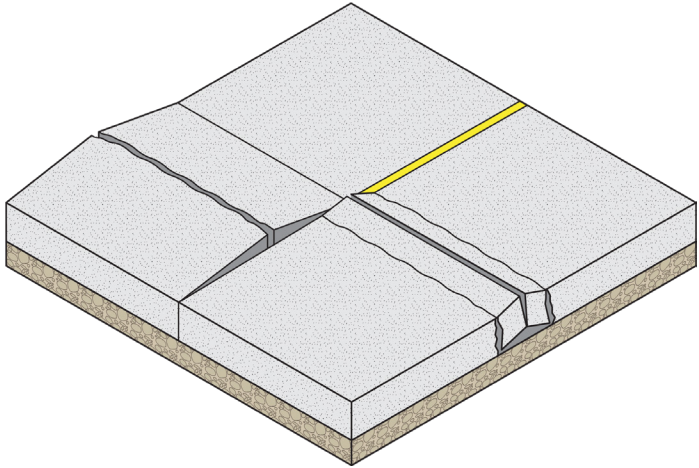
- Number of slabs



PCC Distress Overview

Distress Mechanism	Distress Type
Load	Corner Break
	Longitudinal, Transverse, and Diagonal (LTD) Cracking
	Shattered Slab/Intersecting Cracks
Climate/Durability	Blowup
	Durability "D" Cracking
	Joint Seal Damage
Construction/Material	Alkali Silica Reaction (ASR)
	Popouts
	Scaling
	Shrinkage Cracking
Other	Corner Spalling
	Joint Spalling
	Large Patching and Utility Cut
	Pumping
	Settlement or Faulting
	Small Patching

Blowup



Blowup

Definition:

- Blowups occur in hot weather, usually at a transverse crack or joint that is not wide enough to permit expansion of the concrete slabs. The insufficient width is usually caused by inflation of incompressible materials into the joint space.
- When expansion cannot relieve enough pressure, a localized upward movement of the slab edges (buckling) or shattering will occur in the vicinity of the joint.

Location:

- Transverse crack
- Joints
- Utility cuts
- Drainage inlets

Cause:

- Joints not wide enough to permit expansion of the concrete slabs

Blowup

Severity	Roughness	Mean Depth	
		Runways and High-Speed Taxiways	Taxiways and Aprons
Low	Slight Roughness	< 1/2 in.	1/4 in. - 1 in.
Medium	Significant Roughness	1/2 in. - 1 in.	1 in. - 2 in.
High	Pavement is Inoperable		

How to count:

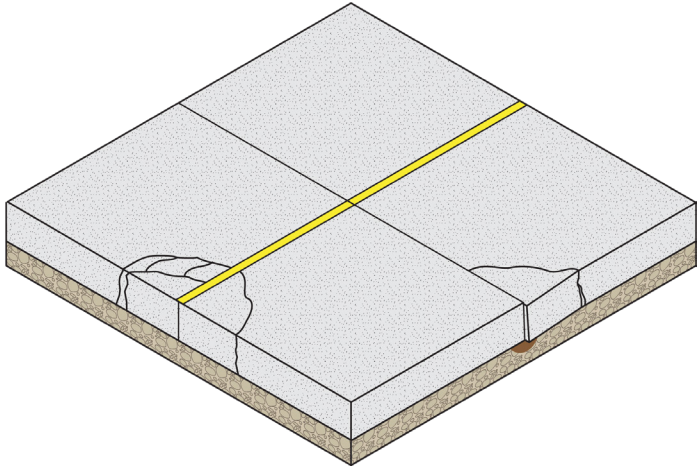
- At a crack, it is counted as being in one slab
- At a joint, two slabs are affected and should be recorded as occurring in two slabs

Blowup - Low Severity

Blowup - Medium Severity

Blowup - High Severity

Corner Break



Corner Break

Definition:

- A corner break is a crack that intersects the joints at a distance less than or equal to one half of the slab length on both sides, measured from the corner of the slab.
- A corner break differs from a corner spall in that the crack extends vertically through the entire slab thickness, while a corner spall intersects the joint at an angle.

Location:

- Corner of the slab

Cause:

- Load repetition combined with loss of support and curling stresses

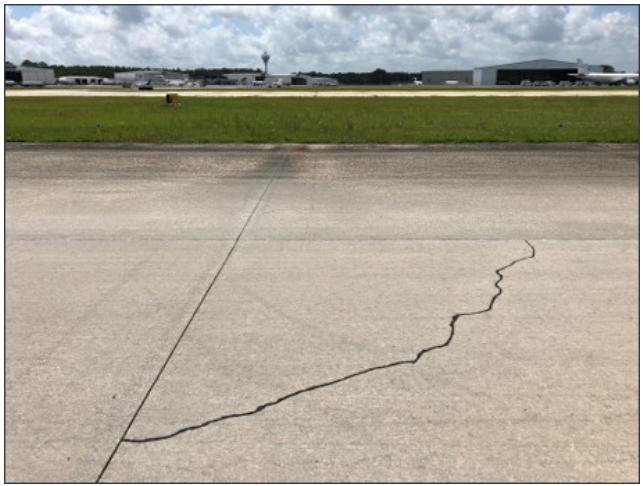
Corner Break

Severity	Filled or Non-Filled	Filler Condition	Crack Width	FOD Potential	Spalling	Internal Cracking
Low	Non-Filled	-	< 1/8 in.	None	Light to None	None
	Filled	Satisfactory	Any Width	None	Light to None	None
Medium	Either	-	Any Width	Some	Moderate	None
	Either	-	Any Width	None	Light to None	Lightly Cracked
	Non-Filled	-	1/8 in. - 1 in.	None	Light to None	None
	Filled	Unsatisfactory	Any Width	None	Light to None	None
High	Either	-	Any Width	Definite	Severe	None
	Either	-	Any Width	None	Light to None	Severely Cracked
	Non-Filled	-	> 1 in.	None	Light to None	None

How to count:

- A distressed slab is recorded as one slab if it contains:
  - — A single corner break
  - — More than one break of a particular severity
  - — If two or more breaks of different severity, record the highest severity
- If the corner break is faulted 1/8” or more, increase severity to the next higher level
- If the corner break is faulted more than ½”, rate the corner break at high severity
- If faulting in corner is incidental to faulting in the slab, rate faulting separately
- If the crack intersects both joints more than 2 ft from the corner, it is a corner break. If it is less than 2 ft, unless you can verify the crack is vertical, call it a spall

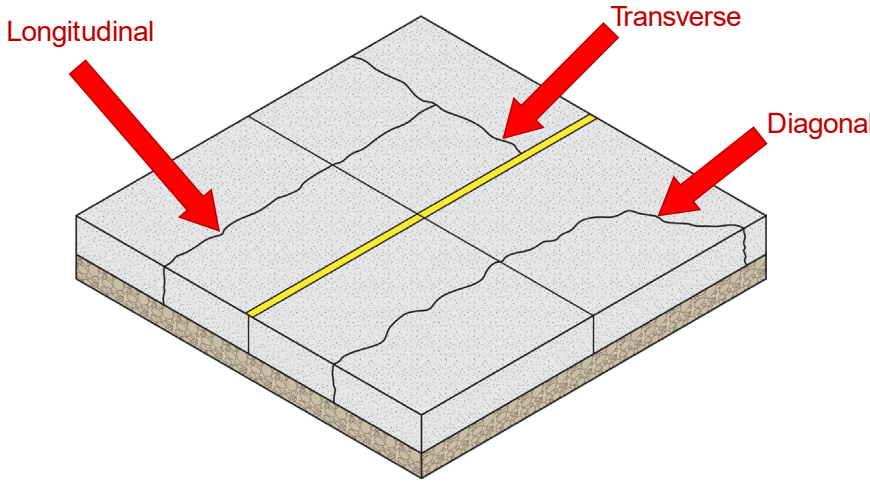
Corner Break - Low Severity



Corner Break - Medium Severity

Corner Break - High Severity

Longitudinal, Transverse, and Diagonal (LTD) Cracking



Longitudinal, Transverse, and Diagonal (LTD) Cracking

Definition:

- Also referred to as Linear Cracking.
- These cracks, that divide the slab into two or three pieces, are usually caused by a combination of load repetition, curling stresses, and shrinkage stresses.
- Low-severity cracks are usually not considered major structural distresses.
- Medium- or high-severity cracks are usually working cracks and are considered major structural distresses.

Location:

- Mid panel

Cause:

- Combination of load repetition, curling stresses, and shrinkage stresses

Longitudinal, Transverse, and Diagonal (LTD) Cracking

Severity	Filled or Non-Filled	Filler Condition	Crack Width	FOD Potential	Spalling
Low	Non-Filled	-	< 1/8 in.	None	Light to None
	Filled	Satisfactory	Any Width	None	Light to None
Medium	Either	-	Any Width	Some	Moderate
	Non-Filled	-	1/8 in. - 1 in.	None	Light to None
	Filled	Unsatisfactory	Any Width	None	Light to None
High	Either	-	Any Width	Definite	Severe
	Non-Filled	-	> 1 in.	None	Light to None

How to count:

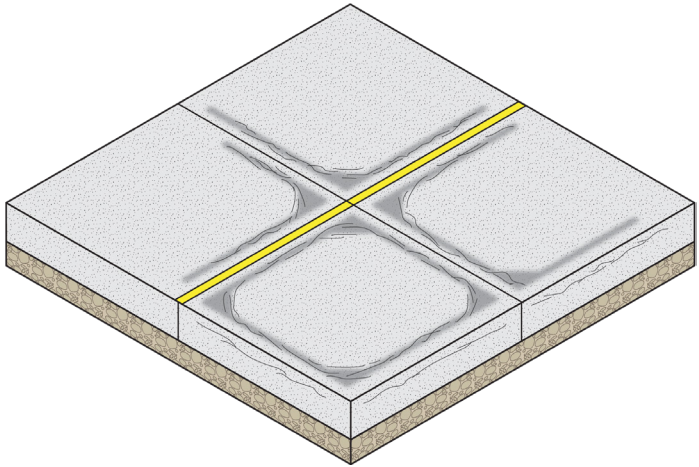
- Once the severity has been identified, the distress is recorded as one slab
- Cracks used to define and rate corner breaks, “D” cracks, patches, shrinkage cracks, and spalls are not recorded as LTD cracks
- If a slab is divided into four or more pieces, reference shattered slab/intersecting cracks

Longitudinal, Transverse, and Diagonal (LTD) Cracking - Low Severity

Longitudinal, Transverse, and Diagonal (LTD) Cracking - Medium Severity

Longitudinal, Transverse, and Diagonal (LTD) Cracking - High Severity

Durability “D” Cracking



Durability “D” Cracking

Definition:

- Durability cracking is caused by the concrete’s inability to withstand environmental factors, such as freeze-thaw cycles.
- It usually appears in a pattern of cracks running parallel to a joint or linear crack. A dark coloring can usually be seen around the fine durability cracks.
- This type of cracking may eventually lead to disintegration of the concrete within 1 to 2 ft of the joint or crack.

Location:

- A pattern of cracks running parallel to a joint or linear crack

Cause:

- Inability to withstand environmental factors, such as freeze-thaw cycles

Durability “D” Cracking

Severity	Portion of Slab Effected	Disintegration	FOD Potential
Low	Limited	Little to None	None
Medium	Considerable	Little to None	Little to None
	Limited	Some	Some
High	Considerable	High	High

How to count:

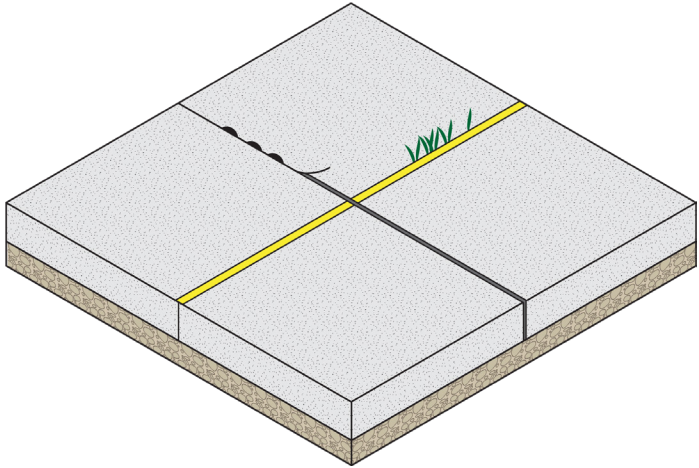
- When the distress is located and rated at one severity, it is counted as one slab. If more than one severity level is found, the slab is counted as having the higher severity distress
- If “D” cracking is counted, scaling on the same slab should not be recorded

Durability “D” Cracking - Low Severity

Durability “D” Cracking - Medium Severity

Durability “D” Cracking - High Severity

Joint Seal Damage



Joint Seal Damage

Definition:

- Joint seal damage is any condition that enables soil or rocks to accumulate in the joints or allows significant infiltration of water.
- Typical types of joint seal damage are:
  - — Stripping of joint sealant
  - — Extrusion of joint sealant
  - — Weed growth
  - — Hardening of the filler (oxidation)
  - — Loss of bond to the slab edges
  - — Lack or absence of sealant in the joint
- Premolded joint sealers have these additional criteria:
  - — Sealer must be elastic and firmly pressed against the joint walls
  - — Sealer must be below the joint edge

Location:

- The joints
- Areas where solvents are applied

Cause:

- Incompressible materials within the joint
- Poor installation
- Climatic cycling
- Vegetation management
- Hardening of joint seal due to age/oxidation

Joint Seal Damage

Severity	General Condition	Degree of Damage	Replacement Needed
Low	Good	Minor	None
Medium	Fair	Moderate	Within 2 years
High	Poor	Severe (≥ 10%)	Immediately

How to count:

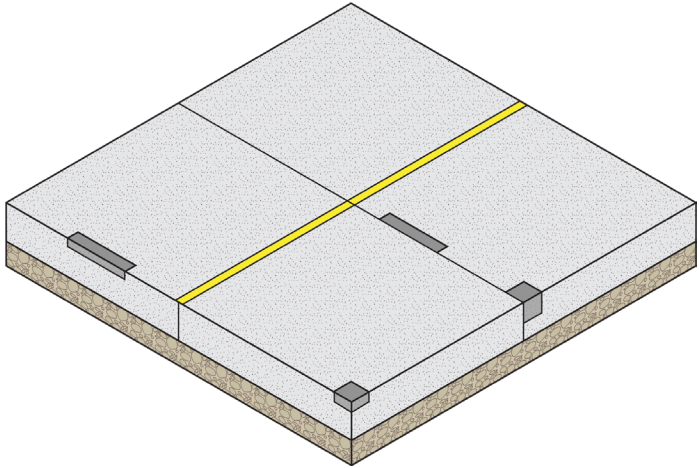
- Joint seal damage is not counted on a slab-by-slab basis, but is rated based on the overall condition of the sealant in the sample unit
- Joint sealer is in satisfactory condition if it prevents entry of water into the joint, it has some elasticity, and if there is no vegetation growing between the sealer and the joint

Joint Seal Damage - Low Severity

Joint Seal Damage - Medium Severity

Joint Seal Damage - High Severity

Small Patching



Small Patching

Definition:

- A patch is an area where the original pavement has been removed and replaced with filler material.
- For condition evaluation, a small patch is less than 5 ft^2.

Location:

- Along joints

Cause:

- The repair of spalls

Small Patching

Severity	Patch Deterioration	FOD Potential
Low	Little to None	None
Medium	Moderate	Minor
High	Considerable	High

How to count:

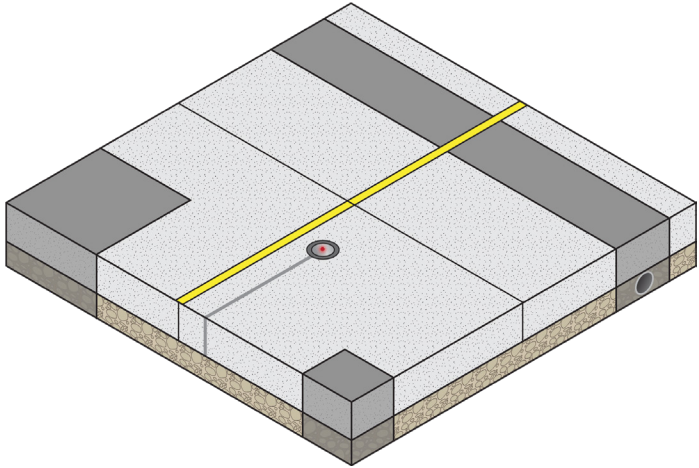
- If one or more small patches having the same severity level are located in a slab, it is counted as one slab containing that distress
- If more than one severity level occurs, it is counted as one slab with the higher severity level being recorded

Small Patching - Low Severity

Small Patching - Medium Severity

Small Patching - High Severity

Large Patching and Utility Cut



Large Patching and Utility Cut

Definition:

- A patch is an area where the original pavement has been removed and replaced with filler material.
- For condition evaluation, a large patch is greater than 5 ft^2.
- A utility cut is a patch that has replaced the original pavement because of placement of underground utilities.

Location:

- Anywhere

Cause:

- Construction of underground utilities
- Repair of existing pavement

Large Patching and Utility Cut

Severity	Patch Deterioration	FOD Potential
Low	Little to None	None
Medium	Moderate	Some
High	Considerable	High

How to count:

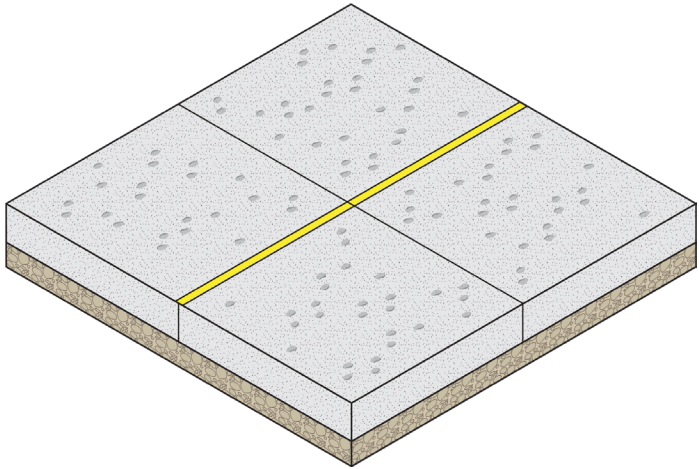
- If one or more large patches having the same severity level are located in a slab, it is counted as one slab containing that distress
- If more than one severity level occurs, it is counted as one slab with the higher severity level being recorded

Large Patching and Utility Cut - Low Severity

Large Patching and Utility Cut - Medium Severity

Large Patching and Utility Cut - High Severity

Popouts



Popouts

Definition:

- A popout is a small piece of pavement that breaks loose from the surface due to freeze-thaw action in combination with expansive aggregates.
- Popouts usually range from approximately 1 to 4 in. in diameter and ½ to 2 in. deep.

Location:

- Pavements in colder climate areas

Cause:

- Freeze-thaw action in combination with expansive aggregates

Popouts

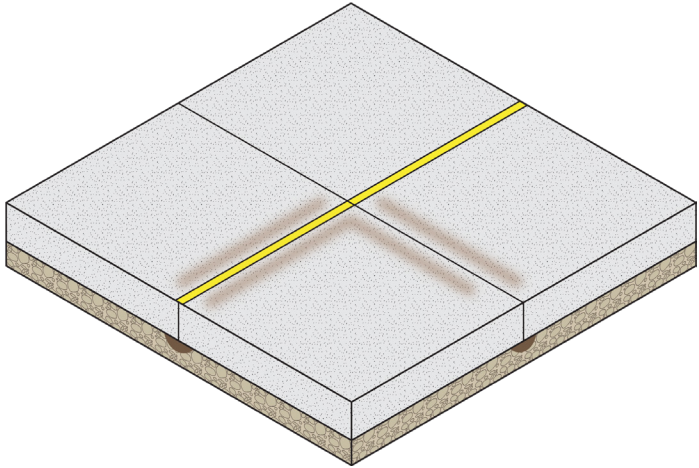
No degrees of severity are defined for popouts. However, popouts must be extensive before they are counted as a distress; that is, average popout density must exceed approximately three (3) popouts per square yard over the entire slab area.

How to count:

- The density of the distress must be measured
- If there is any doubt about the average being greater than three (3) popouts per square yard, at least three (3) random 1-yd^2 areas should be checked. When the average is greater than this density, the slab is counted

Popouts - No Severity

Pumping



Pumping

Definition:

- Pumping is the ejection of material by water through joints or cracks caused by deflection of the slab under passing loads. As water is ejected, it carries particles of gravel, sand, clay, or silt resulting in a progressive loss of pavement support.
- Surface staining and base or subgrade material on the pavement close to joints or cracks are evidence of pumping. Pumping near joints indicates poor joint sealer and loss of support, which will lead to cracking under repeated loads.
- The joint seal must be identified as defective before pumping can be said to exist.
- Pumping can occur at cracks as well as joints.

Location:

- Along joints or cracks
- Interface between AC and PCC pavement

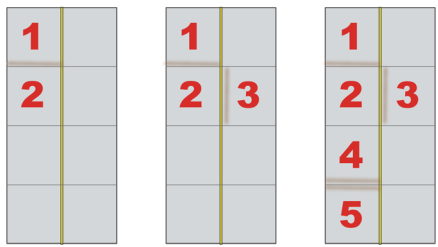
Cause:

- Inadequate base material
- Inadequate load transfer between pavements
- Poor joint sealant

Pumping

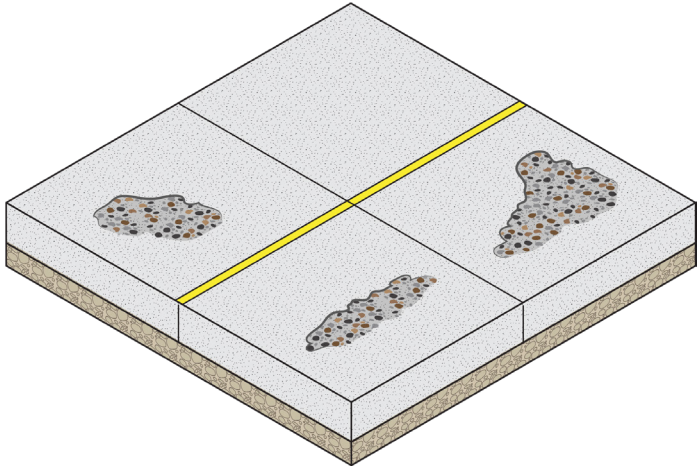
No degrees of severity are defined. It is sufficient to indicate that pumping exists.

How to count:
- One pumping joint between two slabs is counted as two slabs
- If the remaining joints around the slab are also pumping, one slab is added per additional pumping joint



Pumping - No Severity

Scaling



Scaling

Definition:

- Scaling is exhibited by delamination or disintegration of paste on the slab surface to the depth of the defect.
- Surface deterioration caused by construction defects, material defects and environmental factors.
  - — Construction defects generally occur over a portion of the slab
  - — Material defects generally occur over several slabs that were affected by the concrete batches
  - — Environmental factors generally occur over a large area for freezing and isolated areas for thermal effects

Location:

- Anywhere

Cause:

- Construction defects:
  - — Over-finishing
  - — Addition of water to the pavement surface during finishing
  - — Lack of curing
  - — Attempted surface repairs of fresh concrete with mortar
- Material defects:
  - — Inadequate air entrainment for the climate
- Environmental factors:
  - — Freezing of concrete before adequate strength gained
  - — Thermal cycles from certain aircraft

Scaling

Severity	% Surface Paste Loss Over Slab Area	FOD Potential
Low	< 1%	None
Medium	1% - 10%	Some
High	>10%	High

How to count:

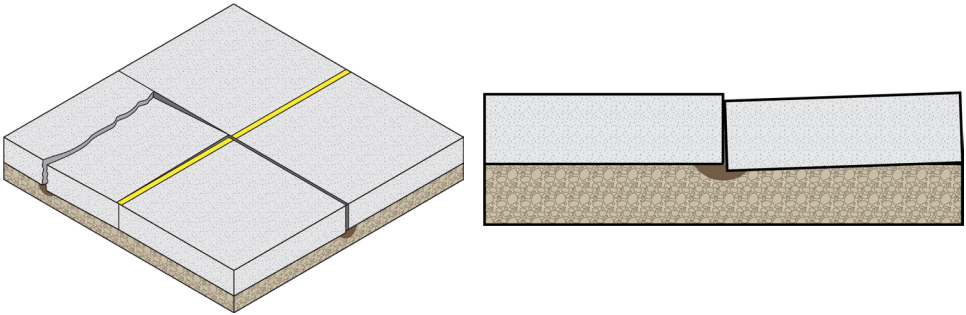
- If two or more levels of severity exist on a slab, the slab is counted as one slab having the maximum level of severity
- If “D” cracking is counted, scaling is not counted

Scaling - Low Severity

Scaling - Medium Severity

Scaling - High Severity

Settlement or Faulting



Settlement or Faulting

Definition:

- Settlement or faulting is a difference of elevation at a joint or crack caused by upheaval or consolidation.
- Construction-induced elevation differential is not rated in PCI procedures.

Location:

- Along joints

Cause:

- Poor subsurface conditions

Settlement or Faulting

Severity	Height Differential	
	Runways and High-Speed Taxiways	Taxiways and Aprons
Low	< 1/4 in.	1/8 in. - <1/2 in.
Medium	1/4 in. - 1/2 in.	1/2 in. - 1 in.
High	> 1/2 in.	> 1 in.

How to count:

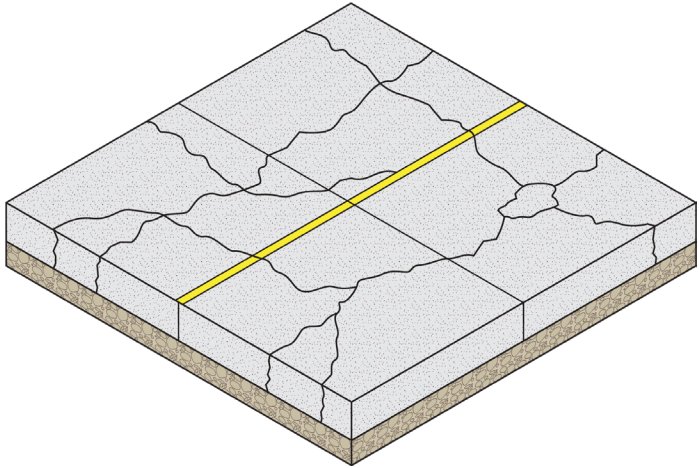
- A fault between two slabs is counted as one slab
- Severity levels are defined by the difference in elevation across the fault and the associated decrease in ride quality and safety as severity increases
- A straightedge or level should be used to aid in measuring the difference in elevation between the two slabs

Settlement or Faulting - Low Severity

Settlement or Faulting - Medium Severity

Settlement or Faulting - High Severity

Shattered Slab/Intersecting Cracks



Shattered Slab/Intersecting Cracks

Definition:

- Intersecting cracks are cracks that break the slab into four (4) or more pieces due to overloading or inadequate support, or both.
- The high severity level of this distress type is referred to as a shattered slab.
- If all pieces or cracks are contained within a corner break, the distress is categorized as a severe corner break.

Location:

- Anywhere

Cause:

- Overloading
- Inadequate support

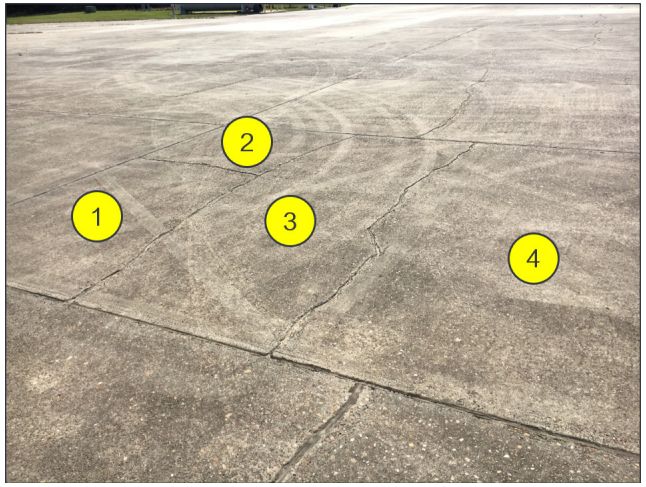
Shattered Slab/Intersecting Cracks

Severity	Number of Pieces	Crack Density and Severity
Low	4 - 5	> 85% at low severity
Medium	4 - 5	> 15% at medium severity
	6+	> 85% at low severity
High	4 - 5	Any at high severity
	6+	> 15% at medium or high severity

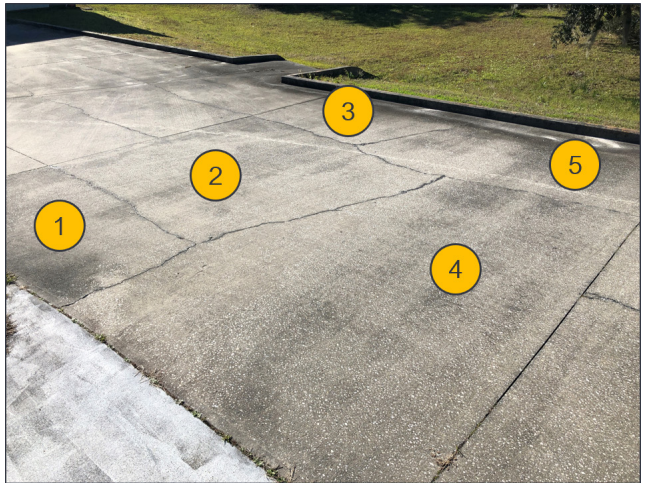
How to count:

- No other distress should be recorded if the slab is medium or high severity level since the severity of this distress would affect the slab's rating substantially
- Shrinkage cracks should not be counted in determining whether or not the slab is broken up into four or more pieces

Shattered Slab/Intersecting Cracks - Low Severity

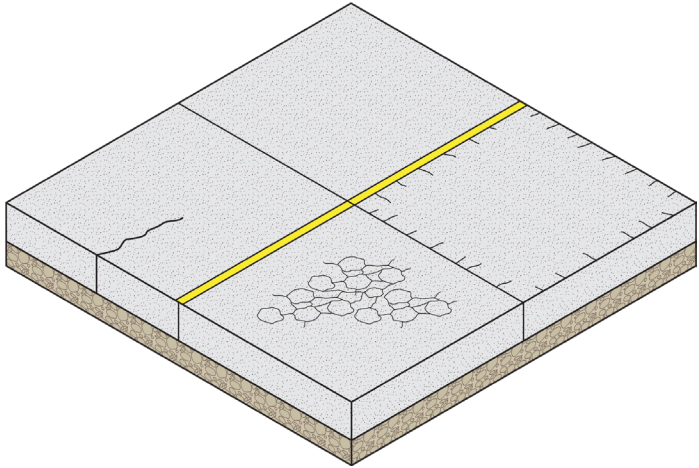


Shattered Slab/Intersecting Cracks - Medium Severity



Shattered Slab/Intersecting Cracks - High Severity

Shrinkage Cracking



Shrinkage Cracking

Definition:

- Shrinkage cracking is typically categorized in two forms: **drying shrinkage** and **plastic shrinkage**.
- **Drying shrinkage** occurs over time as moisture leaves the pavement. These cracks form when subsurface resistance to the shrinkage is present and may extend through the entire depth of the slab.
- **Plastic shrinkage** occurs shortly after the pavement is placed and rapid drying of the surface occurs while the pavement is still plastic.
  - Plastic shrinkage caused by **environmental conditions** during time of placement appears as a series of parallel cracks, usually 1 to 3 ft apart, perpendicular to the joint, and does not extend very deep into the pavement's surface.
  - Plastic shrinkage caused by **construction finishing** appears as a series of inter-connected hairline cracks, or pattern cracking, and is often observed over a majority of the slab surface. This condition is also referred to as map cracking or crazing.

Shrinkage Cracking

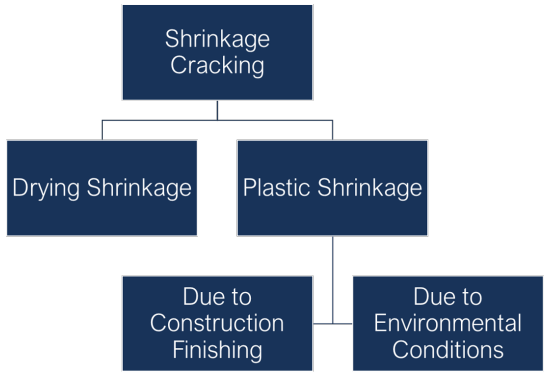
Location:

- Anywhere

Cause:

- Drying shrinkage:
  - — Hardened pavement continues to shrink as excess water not needed for cement hydration evaporates
  - — They form when subsurface resistance to the shrinkage is present and may extend through the entire depth of the slab
- Plastic shrinkage (caused by environmental conditions):
  - — High winds
  - — Low humidity
  - — High ambient and/or concrete temperatures
- Plastic shrinkage (caused during construction finishing):
  - — Overfinishing/overworking the pavement
  - — Finishing the pavement while bleed water is on the surface

Shrinkage Cracking - Flow Chart



Shrinkage Cracking

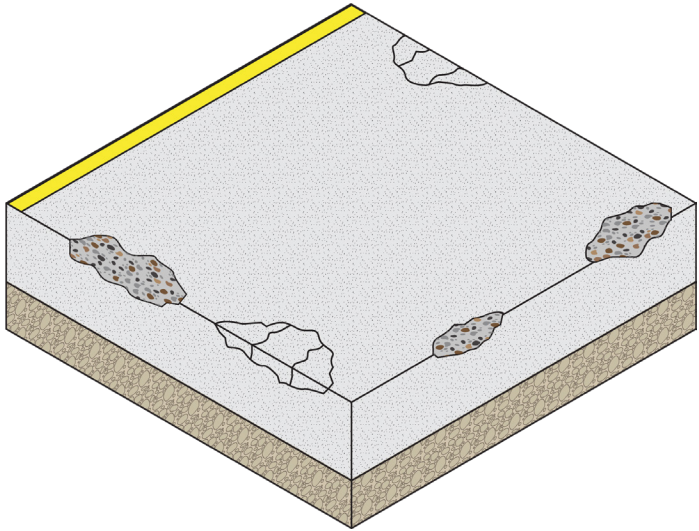
No degrees of severity are defined. It is sufficient to indicate that shrinkage cracking exists.

How to count:

- If one or more shrinkage cracks or area of pattern cracking (map cracking) exists on one particular slab, and FOD hazard or potential is not present, the slab is counted as one slab with shrinkage cracking

Shrinkage Cracking - No Severity

Joint Spalling



Joint Spalling

Definition:

- Joint spalling is the breakdown of the slab edges within 2 ft of the side of the joint.
- A joint spall usually does not extend vertically through the slab but intersects the joint at an angle.

Location:

- Along joints

Cause:

- Weak concrete at the joint (caused by overworking) combined with traffic loads
- Excessive stresses at the joint or crack caused by infiltration of incompressible materials or traffic load

Joint Spalling

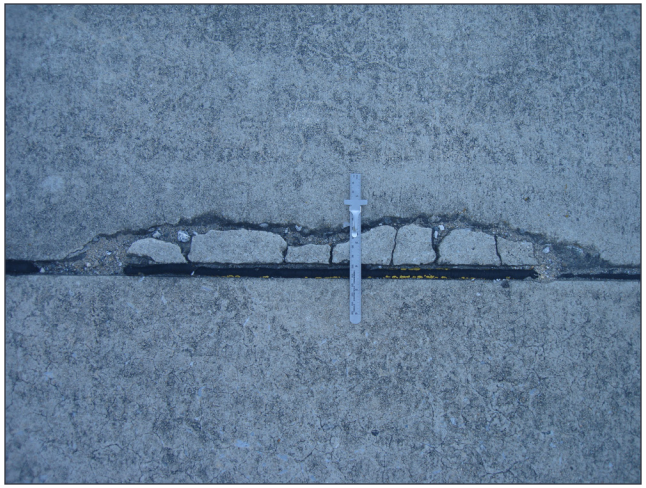
Severity	Length of Spall	# of Internal Pieces	Joint Fraying	FOD Potential
Low	≤ 2 ft	-	-	Little to None
	> 2 ft	-	Light	Little to None
		≤ 3	-	Little to None
Medium	≤ 2 ft	-	-	Considerable
	> 2 ft	-	Moderate	Some
		≤ 3	-	Some
		> 3	-	Little to None
High	> 2 ft	-	Severe	High
		> 3	-	High

How to count:

- If the joint spall is located along the edge of one slab, it is counted as one slab with joint spalling
- If spalling is located on more than one edge of the same slab, the edge having the highest severity is counted and recorded as one slab
- Joint spalling can also occur along the edges of two adjacent slabs. If this is the case, each slab is counted as having joint spalling
- If a joint spall is small enough, less than 3 in. wide, to be filled during a joint seal repair, it should not be counted
- If less than 2 ft of the joint is lightly frayed, the spall should not be counted

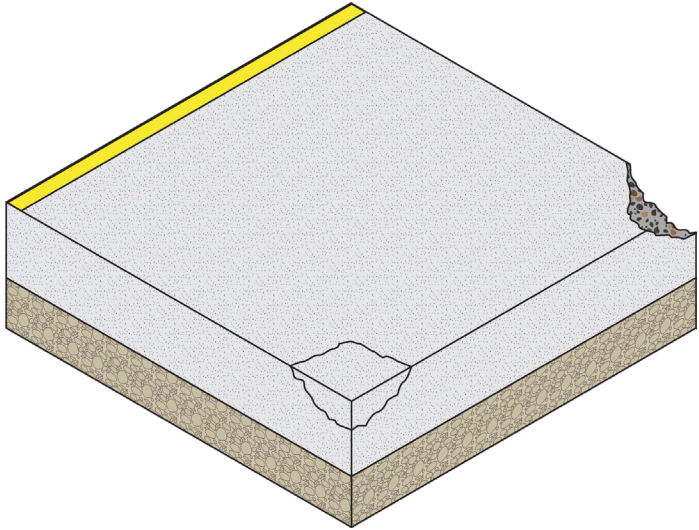
Joint Spalling - Low Severity

Joint Spalling - Medium Severity



Joint Spalling - High Severity

Corner Spalling



Corner Spalling

Definition:

- Corner spalling is the raveling or breakdown of the slab within approximately 2 ft of the corner.
- A corner spall differs from a corner break in that the spall usually angles downward to intersect the joint, while a break extends vertically through the slab.

Location:

- Corner of the slab

Cause:

- Weak concrete (caused by overworking) combined with traffic loads
- Excessive stresses caused by infiltration of incompressible materials or traffic load

Corner Spalling

Severity	# of Internal Pieces	Defining Crack Severity	FOD Potential
Low	1	Medium	Little to None
	≤ 2	Low	Little to None
Medium	-	-	Some
	1	High	Some
	≥ 2	Medium	Some
High	-	-	High
	≥ 2	High	High

How to count:

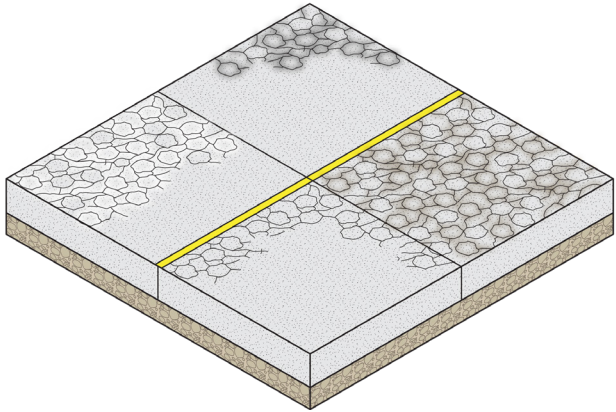
- If one or more corner spalls having the same severity level are located in a slab, the slab is counted as one slab with corner spalling
- If more than one severity level occurs, it is counted as one slab having the higher severity level
- A corner spall smaller than 3 in. wide, measured from the edge of the slab, and filled with sealant is not recorded

Corner Spalling - Low Severity

Corner Spalling - Medium Severity

Corner Spalling - High Severity

Alkali Silica Reaction (ASR)



Alkali Silica Reaction (ASR)

Definition:

- ASR is caused by a chemical reaction between alkalis and certain reactive silica minerals, which form a gel. The gel absorbs water, causing expansion which may damage the concrete and adjacent structures.
- Visual indicators that ASR may be present include:
  - Cracking of the concrete pavement (often in a map pattern)
  - White, brown, gray, or other gel or staining may be present at the crack surface
  - Aggregate popouts
  - Increase in concrete volume (expansion) that may result in distortion of adjacent or integral structure or physical elements
- Because ASR is material-dependent, ASR is generally present throughout the pavement section. Coring and concrete petrographic analysis is the only definitive method to confirm the presence of ASR.

Location:

- Geographic regions with ASR susceptible aggregate sources

Cause:

- Chemical reaction between alkalis and certain reactive silica minerals
- Alkalis are most often introduced by the Portland cement within the pavement
- May be accelerated by chemical pavement deicers

Alkali Silica Reaction (ASR)

Severity	Predominant Crack Width	Evidence of Slab Movement	FOD Potential
Low	≤ 1 mm	Little to None	Little to None
Medium	> 1 mm	Some	Some
High	-	-	High
	"Slab surface integrity and function significantly degraded. Pavement requires immediate repairs."		

How to count:

- Once the severity has been identified, the distress is recorded as one slab
- No other distresses should be recoded if high severity ASR is recorded

Alkali Silica Reaction (ASR) - Low Severity

Alkali Silica Reaction (ASR) - Medium Severity

Alkali Silica Reaction (ASR) - High Severity

Any questions or comments regarding the Airfield Pavement Inspection Reference Manual, please contact:

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