ASPHALT SURFACED ROADS & PARKING LOTS

PAVER™ DISTRESS IDENTIFICATION MANUAL

DEVELOPED BY:

US ARMY CORPS OF ENGINEERS
ERDC-CERL

SPONSORED BY:

SUSTAIN SUPPORT DEFEND

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NAVFAC

FOREWORD

This document is a revision and technical update of the original *PAVER™ Asphalt Distress Manual* by M.Y. Shahin and S.D. Kohn (USACERL, June 1989). This update was prepared for HQ IMCOM, Public Works Division. The Technical Monitor was Ali A. Achmar.

The work was conducted by the U.S. Army Corps Of Engineers, ERDC-CERL. The Principal Investigator was M.Y. Shahin.

June 2009

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REFERENCES

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OBJECTIVE AND SCOPE OF THIS MANUAL

This manual contains distress definitions and measurement methods for asphalt surfaced roads and parking lots. This information is used to determine the Pavement Condition Index (PCI).

IDENTIFYING AND MEASURING ASPHALT PAVEMENT DISTRESSES

New PAVER™ users often ask about identification and counting methods for various distresses. Detailed answers to these questions are included for each distress under the heading “How To Measure.” For the reader’s convenience, the most frequently raised issues are addressed below:

1. ***ALLIGATOR CRACKING:*** If alligator cracking and rutting occur in the same area, each is recorded separately at its respective severity level.
2. ***BLEEDING WITH POLISHED AGGREGATE:*** If bleeding is counted, polished aggregate is not counted in the same area.
3. ***SPALLING:*** In PAVER™, spalling is defined as the further breaking of asphalt or loss of materials around cracks or joints.
4. ***CRACK SEVERITY:*** If a crack varies in severity along its entire length, each portion showing an identifiable level should be recorded individually. If the different severity levels cannot easily be divided into distinct portions, the crack should be rated at the highest severity level present.
5. ***DISTRESSES WITHIN PATCHES:*** Distresses (including cracking and potholes) found in a patched area are not recorded separately. The effect of the distress on the patch, however, is taken into consideration when determining the severity level of the patch.
6. ***POLISHED AGGREGATE:*** A significant amount of polished aggregate should be present before it is counted.

The reader should note that the items above are general issues and do not stand alone as inspection criteria. To measure each distress type properly the inspector must be familiar with the individual distress criteria, which are described and illustrated on the pages that follow.

RIDE QUALITY ASSESSMENT

Ride quality must be assessed in order to establish a severity level for the following distress types:

- •Bumps
- •Shoving
- •Corrugation
- •Swells
- •Railroad Crossings

To assess ride quality for these distresses, the inspector should use the following severity level definitions:

L	Low: Vehicle vibrations (e.g., from corrugation) are noticeable, but no reduction in speed is necessary for comfort or safety; and/ or individual bumps or settlements cause the vehicle to bounce slightly, but create little discomfort.
M	Medium: Vehicle vibrations are significant and some reduction in speed is necessary for safety and comfort; and/ or individual bumps or settlements cause the vehicle to bounce significantly, creating some discomfort.
H	High: Vehicle vibrations are so excessive that speed must be reduced considerably for safety and comfort; and/ or individual bumps or settlements cause the vehicle to bounce excessively, creating substantial discomfort, safety hazard, or high potential vehicle damage.

The inspector should drive at the posted speed in a sedan that is representative of cars typically seen in local traffic. Pavement sections near stop signs should be rated at a deceleration speed appropriate for the intersection.

ALLIGATOR OR FATIGUE CRACKING (1)

Description

Alligator or fatigue cracking is a series of interconnecting cracks caused by fatigue failure of the asphalt concrete surface under repeated traffic loading. Cracking begins at the bottom of the asphalt 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 longitudinal 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 generally less than 1½ ft (0.5 m) on the longest side. Alligator cracking occurs only in areas subjected to repeated traffic loading, such as wheel paths. (Pattern-type cracking that occurs over an entire area not subjected to loading is called “block cracking,” which is not a load-associated distress.)

Severity Levels

Fine, longitudinal hairline cracks running parallel to each other with no, or only a few interconnecting cracks. The cracks are not spalled.

Further development of light alligator cracks into a pattern or network of cracks that may be lightly spalled.

Network or pattern cracking has progressed so that the pieces are well defined and spalled at the edges. Some of the pieces may rock under traffic.

How To Measure

Alligator cracking is measured in square feet (square meters) of surface area. The major difficulty in measuring this type of distress is that two or three levels of severity often exist within one distressed area. If these portions can be easily distinguished from each other, they should be measured and recorded separately. However, if the different levels of severity cannot be divided easily, the entire area should be rated at the highest severity present. If alligator cracking and rutting occur in the same area, each is recorded separately at its respective severity level.

1 ALLIGATOR

BLEEDING (2)

Description

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 is caused by excessive amounts of asphaltic cement or tars in the mix, excess application of a bituminous sealant, and/ or low air void content. It occurs when asphalt fills the voids of the mix during hot weather and then expands onto the pavement surface. Since the bleeding process in not reversible during cold weather, asphalt or tar will accumulate on the surface.

Severity Levels

L — Bleeding has only occurred to a very slight degree and is noticeable only during a few days of the year. Asphalt does not stick to shoes or vehicles.

M — Bleeding has occurred to the extent that asphalt sticks to shoes and vehicles during only a few weeks of the year.

H — Bleeding has occurred extensively and considerable asphalt sticks to shoes and vehicles during at least several weeks of the year.

How To Measure

Bleeding is measured in square feet (square meters) of surface area. If bleeding is counted, polished aggregate should not be counted.

2 BLEEDING

BLOCK CRACKING (3)

Description

Block cracks are interconnected cracks that divide the pavement into approximately rectangular pieces. The blocks may range in size from approximately 1 by 1 foot (0.3 by 0.3 m) to 10 by 10 feet (3 by 3 m). Block cracking is caused mainly by shrinkage of the asphalt concrete and daily temperature cycling (which results in daily stress/ strain cycling). It is not load-associated. Block cracking usually indicates that the asphalt has hardened significantly. Block cracking normally occurs over a large portion of the pavement area, but sometimes will occur only in non-traffic areas. This type of distress differs from alligator cracking in that alligator cracks form smaller, many-sided pieces with sharp angles. Also, unlike block, alligator cracks are caused by repeated traffic loadings, and are therefore found only in traffic areas (i.e., wheel paths).

Severity Levels

Blocks are defined by low severity* cracks.

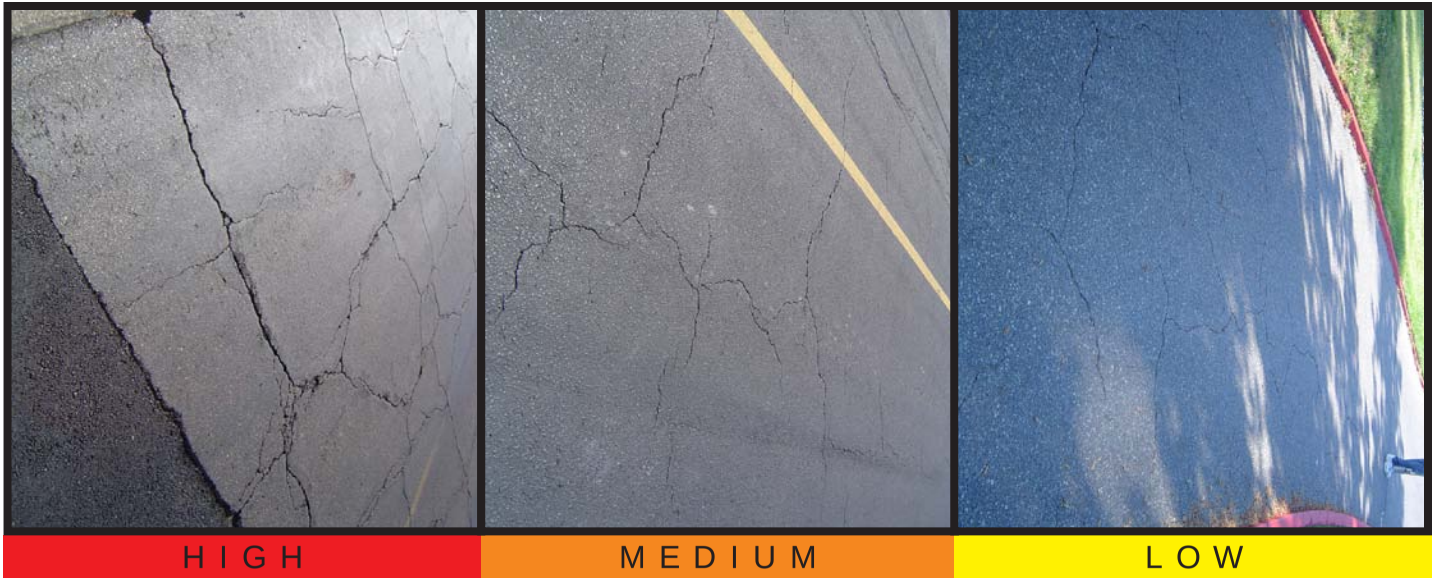
Blocks are defined by medium severity* cracks.

Blocks are defined by high severity* cracks.

How To Measure

Block cracking is measured in square feet (square meters) of surface area. It usually occurs at one severity level in a given pavement section. However, if areas of different severity levels can be easily distinguished from one another, they should be measured and recorded separately.

* See definitions of longitudinal transverse cracking.



3 BLOCK CRACK.

BUMPS AND SAGS (4)

Description

Bumps are small, localized, upward displacements of the pavement surface. They are different from shoves in that shoves are caused by unstable pavement. Bumps, on the other hand, can be caused by several factors, including:

1. Buckling or bulging of underlying PCC slabs in AC overlay over PCC pavement.
2. Frost heave (ice, lens growth).
3. Infiltration and buildup of material in a crack in combination with traffic loading (sometimes called “tenting”).

Sags are small, abrupt, downward displacements of the pavement surface. If bumps appear in a pattern perpendicular to traffic flow and are spaced at less than 10 feet (3 m), the distress is called corrugation. Distortion and displacement that occur over large areas of the pavement surface, causing large and/or long dips in the pavement should be recorded as “swelling.”

Severity Levels

Bump or sag causes low severity ride quality.

Bump or sag causes medium severity ride quality.

Bump or sag causes high severity ride quality.

How To Measure

Bumps or sags are measured in linear feet (linear meters). If the bump occurs in combination with a crack, the crack is also recorded.

4 BUMPS & SAGS

CORRUGATION (5)

Description

Corrugation (also known as “washboarding”) is a series of closely spaced ridges and valleys (ripples) occurring at fairly regular intervals, usually less than 10 feet (3 m) along the pavement. The ridges are perpendicular to the traffic direction. This type of distress is usually caused by traffic action combined with an unstable pavement surface or base.

Severity Levels

L Corrugation produces low severity ride quality.

M Corrugation produces medium severity ride quality.

H Corrugation produces high severity ride quality.

How To Measure

Corrugation is measured in square feet (square meters) of surface area.

HIGH
MEDIUM
LOW

DEPRESSION (6)

Description

Depressions are localized pavement surface areas with 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 a “birdbath” area; on dry pavement, depressions can be spotted by looking for stains caused by ponding water. Depressions are created by settlement of the foundation soil or are a result of improper construction. Depressions cause some roughness, and when deep enough or filled with water, can cause hydroplaning.

Severity Levels: Maximum Depth of Depression

½ to 1 in. (13 to 25 mm)

1 to 2 in. (25 to 50 mm)

More than 2 in. (50 mm)

How To Measure

Depressions are measured in square feet (square meters) of surface area.


HIGH
MEDIUM
LOW

EDGE CRACKING (7)

Description

Edge cracks are parallel to and usually within 1 to 1½ feet (0.3 to 0.5 m) of the outer edge of the pavement. This distress is accelerated by traffic loading and can be caused by frost-weakened base or subgrade near the edge of the pavement. The area between the crack and pavement edge is classified as raveled if it is broken up (sometimes to the extent that pieces are removed).

Severity Levels

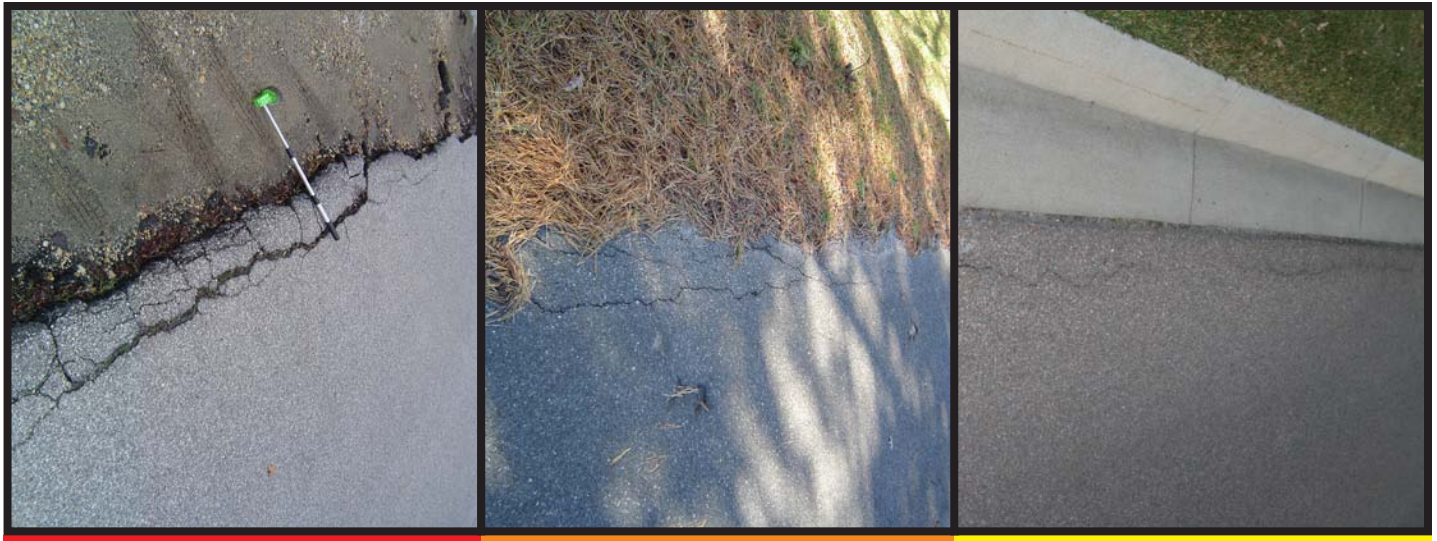

Low or medium cracking with no breakup or raveling.


Medium cracks with some breakup and raveling.


Considerable breakup or raveling along the edge.

How To Measure

Edge cracking is measure in linear feet (linear meters).



7 EDGE CRACK.

JOINT REFLECTION CRACKING (8) (FROM LONGITUDINAL AND TRANSVERSE PCC SLABS)

Description

This distress occurs only on asphalt-surfaced pavements that have been laid over a PCC slab. It does not include reflection cracks from any other type of base (i.e., cement- or lime-stabilized); these cracks are caused mainly by thermal- or moisture-induced movement of the PCC slab beneath the AC surface. This distress is not load-related; however, traffic loading may cause a breakdown of the AC surface near the crack. If the pavement is fragmented along a crack, the crack is said to be spalled. A knowledge of slab dimension beneath the AC surface will help to identify these distresses.

Severity Levels

L — One of the following conditions exists: (1) Non-filled crack width is less than ⅜ in. (10 mm), or (2) filled crack of any width (filler in satisfactory condition).

M — One of the following conditions exists: (1) Non-filled crack width is greater than or equal to ⅜ in. (10 mm) and less than 3 in. (75 mm); (2) non-filled crack less than or equal to 3 in. (75 mm) surrounded by light secondary cracking, or (3) filled crack of any width surrounded by light secondary cracking.

H — One of the following conditions exists: (1) Any crack filled or non-filled surrounded by medium or high severity secondary cracking; (2) non-filled cracks greater than 3 in. (75 mm), or (3) A crack of any width where approximately 4 in. (100 mm) of pavement around the crack are severely raveled or broken.

How To Measure

Joint reflection cracking is measured in linear feet (linear meters). The length and severity level of each crack should be identified and recorded separately. For example, a crack that is 50 feet (15 m) long may have 10 feet (3 m) of high severity cracks; which are all recorded separately. If a bump occurs at the reflection crack, it is also recorded.

8 JOINT REFL.

LANE/ SHOULDER DROP-OFF (9)

Description

Lane/ shoulder drop-off is a difference in elevation between the pavement edge and the shoulder. This distress is caused by shoulder erosion, shoulder settlement, or by building up the roadway without adjusting the shoulder level.

Severity Levels

L — The difference in elevation between the pavement edge and shoulder is > 1 in. (25 mm) and ≤ 2 in. (50 mm).

M — The difference in elevation is > 2 in. (50 mm) and ≤ 4 in. (100 mm).

H — The difference in elevation is > 4 in. (100 mm).

How To Measure

Lane/ shoulder drop-off is measured in linear feet (linear meters).

9 LANE DROP-OFF

LONGITUDINAL AND TRANSVERSE CRACKING (10) (NON-PCC SLAB JOINT REFLECTIVE)

Description

Longitudinal cracks are parallel to the pavement's centerline or laydown direction. They may be caused by:

1. A poorly constructed paving lane joint.
2. Shrinkage of the AC surface due to low temperatures or hardening of the asphalt and/or daily temperature cycling.
3. A reflective crack caused by cracking beneath the surface course, including cracks in PCC slabs (but not PCC joints).

Transverse cracks extend across the pavement at approximately right angles to the pavement centerline or direction of laydown. These types of cracks are not usually load-associated.

Severity Levels

One of the following conditions exists: (1) non-filled crack width is less than ⅜ in. (10 mm), or (2) Filled crack of any width (filler in satisfactory condition).

One of the following conditions exists: (1) non-filled crack width is greater than or equal to ⅜ in. (10 mm) and less than 3 in. (75 mm); (2) non-filled crack is less than or equal to 3 in. (75 mm) surrounded by light and random cracking, or (3) filled crack is of any width surrounded by light random cracking.

One of the following conditions exists: (1) any crack filled or non-filled surrounded by medium or high severity random cracking, (2) non-filled crack greater than 3 in. (75 mm), or (3) a crack of any width where approximately 4 in. (100 mm) of pavement around the crack is severely broken.

How To Measure

Longitudinal and transverse cracks are measured in linear feet (linear meters). The length and severity of each crack should be 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.

10 LONG. CRACK.

PATCHING AND UTILITY CUT PATCHING (11)

Description

A patch is an area of pavement that has been replaced with new material to repair the existing pavement. A patch is considered a defect no matter how well it is performing (a patched area or adjacent area usually does not perform as well as an original pavement section). Generally, some roughness is associated with this distress.

Severity Levels

L Patch is in good condition and satisfactory. Ride quality is rated as low severity or better.

M Patch is moderately deteriorated and/ or ride quality is rated as medium severity.

H Patch is badly deteriorated and/ or ride quality is rated as high severity. Needs replacement soon.

How To Measure

Patching is rated in square feet (square meters) of surface area. However, if a single patch has areas of differing severity, these areas should be measured and recorded separately. For example, a 27 ft^2 (2½ m^2) patch may have 11 ft^2 (1 m^2) of medium severity and 16 ft^2 (1½ m^2) of low severity. These areas would be recorded separately. Any distress found in a patched area will not be recorded; however, its effect on the patch will be considered when determining the patch's severity level. No other distresses (e.g., shoving and cracking) are recorded within a patch; even if the patch material is shoving or cracking, the area is rated only as a patch. If a large amount of pavement has been replaced, it should not be recorded as a patch, but considered as new pavement (e.g., replacement of a complete intersection).


HIGH
MEDIUM
LOW

POLISHED AGGREGATE (12)

Description

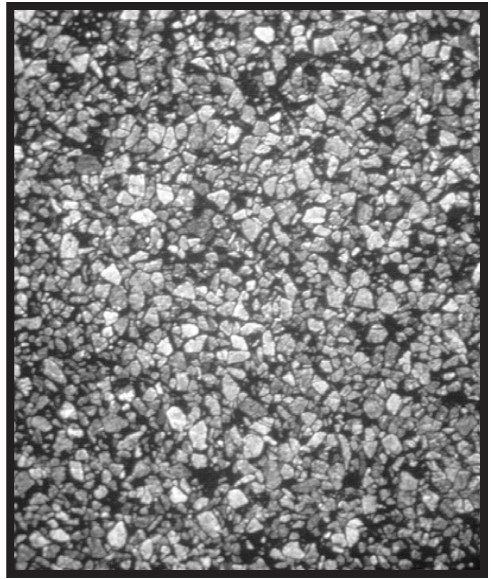
This distress is caused by repeated traffic applications. Polished aggregate is present when close examination of a pavement reveals that the portion of aggregate extending above the asphalt is either very small, or there are no rough or angular aggregate particles to provide good skid resistance. When the aggregate in the surface becomes smooth to the touch, adhesion with vehicle tires is considerably reduced. When the portion of aggregate extending above the surface is small, the pavement texture does not significantly contribute to reducing vehicle speed. Polished aggregate should be counted when close examination reveals that the aggregate extending above the asphalt is negligible, and the surface aggregate is smooth to the touch. This type of distress is indicated when the number on a skid resistance test is low or has dropped significantly from a previous rating.

Severity Levels

No degrees of severity are defined. However, the degree of polishing should be clearly evident in the sample unit in that the aggregate surface should be smooth to the touch.

How To Measure

Polished aggregate is measured in square feet (square meters) of surface area. If bleeding is counted, polished aggregate should not be counted.



12 POLISHED AGG.

POTHOLES (13)

Description

Potholes are small, usually less than 30 in. (760 mm) in diameter, bowl-shaped depressions in the pavement surface. They generally have sharp edges and vertical sides near the top of the hole. When holes are created by high severity alligator cracking, they should be identified as potholes, not as weathering.

Severity Levels

The levels of severity for potholes less than 30 in. (760 mm) in diameter are based on both the diameter and the depth of the pothole, according to Table 1.

Table 1. Levels Of Severity For Potholes.

	Average Diameter (in.) (mm)		
Maximum Depth Of Pothole (in.) (mm)	**4 to 8 in. (100 to 200 mm)**	**8 to 18 in. (200 to 460 mm)**	**18 to 30 in. (460 to 760 mm)**
½ to ≤ 1 in. (13 to 25 mm)	L	L	M
> 1 to ≤ 2 in. (25 to 50 mm)	L	M	H
> 2 in. (50 mm)	M	M	H

If the pothole is more than 30 in. (760 mm) in diameter, the area should be determined in square feet and divided by 5 ft^2 (0.5 m^2) to find the equivalent number of holes. If the depth is 1 in. (25 mm) or less, the holes are considered medium severity. If the depth is more than 1 in. (25 mm), they are considered high severity.

How To Measure

Potholes are measured by counting the number that are low, medium, and high severity, and recording them separately.

13 POTHOLES

RAILROAD CROSSING (14)

Description

Railroad crossing defects are depressions or bumps around and/ or between tracks.

Severity Levels

Railroad crossing causes low severity ride quality.

Railroad crossing causes medium severity ride quality.

Railroad crossing causes high severity ride quality.

How To Measure

The area of the crossing is measured in square feet (square meters) of surface area. If the crossing does not affect ride quality, it should not be counted. Any large bump created by the tracks should be counted as part of the crossing.

HIGH MEDIUM LOW

14 RAILROAD

RUTTING (15)

Description

A rut is a surface depression in the wheel paths. Pavement uplift may occur along the sides of the rut, but in many instances, ruts are noticeable only after a rainfall when the paths are filled with water. Rutting stems from a permanent deformation in any of the pavement layers or subgrades, usually caused by consolidated or lateral movement of the materials due to traffic load.

Severity Levels: Mean Rut Depth

- L — ¼ to ½ inch (6 to 13 mm)
- M — > ½ to 1 inch (13 to 25 mm)
- H — > 1 inch (25 mm)

How To Measure

Rutting is measured in square feet (square meters) of surface area and its severity is determined by the mean depth of the rut (see above). The mean rut depth is calculated by laying a straight edge across the rut, measuring its depth, then using measurements taken along the length of the rut to compute its mean depth in inches (mm).

15 RUTTING

SHOVING (16)

Description

Shoving is a permanent displacement of a localized area of the pavement surface caused by traffic loading. When traffic pushes against the pavement, it produces a short, abrupt wave in the pavement surface. This distress normally occurs only in unstable liquid asphalt mix (cutback or emulsion) pavements.

Shoves also occur where asphalt pavements abut PCC pavements; the PCC pavements increase in length and push the asphalt pavement, causing the shoving.

Severity Levels

L Shove causes low severity ride quality.

M Shove causes medium severity ride quality.

H Shove causes high severity ride quality.

How To Measure

Shoves are measured in square feet (square meters) of surface area. Shoves occurring in patches are considered in rating the patch, not as a separate distress.

16 SHOVING

SLIPPAGE CRACKING (17)

Description

Slippage cracks are crescent or half-moon shaped cracks, having two ends pointed in the direction of travel. They are produced when braking or turning wheels cause the pavement surface to slide or deform. This distress usually occurs in overlaps when there is a poor bond between the surface and the next layer of the pavement structure.

Severity Level

L — Average crack width is < ⅜ in. (10 mm).

M — One of the following conditions exists: (1) average crack width is ≥ ⅜ and < 1½ in. (≥ 10 and < 38 mm); (2) the area around the crack is moderately spalled and/ or surrounded with secondary cracks.

H — One of the following conditions exists: (1) the average crack width is ≥ 1½ in. (38 mm), or (2) the area around the crack is broken into easily removed pieces.

How To Measure

The area associated with a given slippage crack is measured in square feet (square meters) and rated according to the highest level of severity in the area.

17 SLIPPAGE

SWELL (18)

Description

Swell is characterized by an upward bulge in the pavement's surface—a long, gradual wave more than 10 ft (3 m) long. Swelling can be accompanied by surface cracking. This distress is usually caused by frost action in the subgrade or by swelling soil.

Severity Level

L — Swell causes low severity ride quality. Low severity swells are not always easy to see, but can be detected by driving at the speed limit over the pavement section. An upward motion will occur at the swell if it is present.

M — Swell causes medium severity ride quality.

H — Swell causes high severity ride quality.

How To Measure

The surface area of the swell is measured in square feet (square meters).

18 SWELL

RAVELING (19)

Description

Raveling is the dislodging of coarse aggregate particles. Raveling may be caused by insufficient asphalt binder, poor mixture quality, insufficient compaction, segregation, or stripping.

Dense Mix Severity Levels

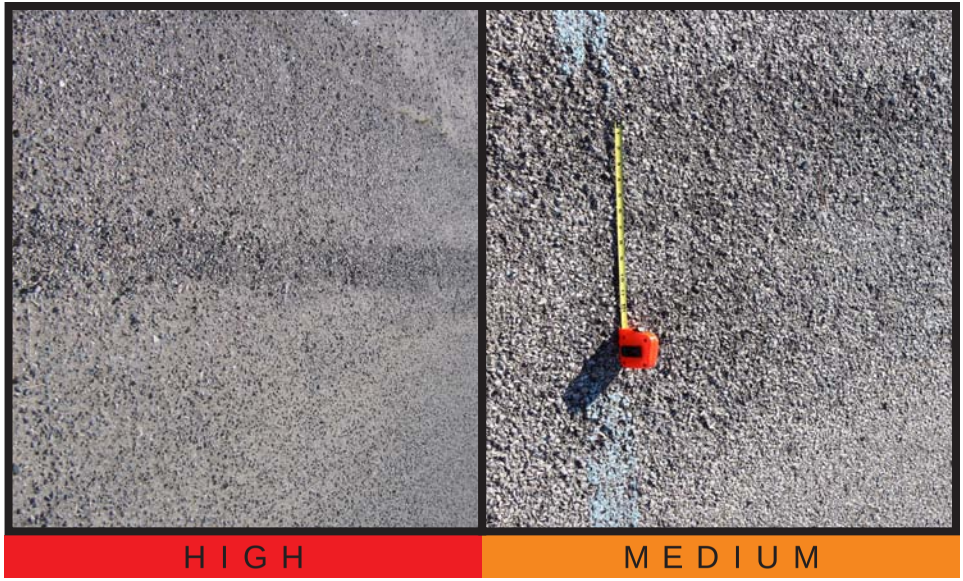
As used herein, coarse aggregate refers to predominant coarse aggregate size of the asphalt mix, and aggregate clusters refers to when more than one adjoining coarse aggregate piece is missing. If in doubt about a severity level, three representative areas of one square yard each (square meters) should be examined and the number of missing aggregate particles/ clusters is counted.

Considerable loss of coarse aggregate, greater than 20 per square yard (square meter), and/ or clusters of missing coarse aggregate are present.

Surface is very rough and pitted, may be completely removed in places.

How To Measure

Raveling is measured in square feet (square meters) of surface area. Mechanical damage caused by such things as hook drags, tire rims, or snowplows is counted as raveling. If raveling is present, weathering (surface wear) is not recorded.



19 RAVELING

WEATHERING (SURFACE WEAR) - DENSE MIX ASPHALT (20)

Description

The wearing away of the asphalt binder and fine aggregate matrix.

Severity Levels

As used herein, coarse aggregate refers to predominant coarse aggregate size of the asphalt mix. Loss or dislodging of coarse aggregate is covered under raveling

Surface wear is normally caused by oxidation, inadequate compaction, insufficient asphalt content, excessive natural sand, surface water erosion, and traffic. Weathering occurs faster in areas with high solar radiation.

Asphalt surface beginning to show signs of aging which may be accelerated by climatic conditions. Loss is the fine aggregate matrix is noticeable and may be accompanied by fading of the asphalt color. Edges of the coarse aggregates are beginning to be exposed (less than 0.05 in. or 1 mm). Pavement may be relatively new (as new as 6 months old).

Loss of fine aggregate matrix is noticeable and edges of coarse aggregate have been exposed up to ¼ width (of the longest side) of the coarse aggregate due to the loss of fine aggregate matrix.

Edges of coarse aggregate have been exposed greater than ¼ width (of the longest side) of the coarse aggregate. There is considerable loss of fine aggregate matrix leading to potential or some loss of coarse aggregate.

How To Measure

Surface Wear is measured in square feet (square meters). Surface Wear is not recorded where medium and/ or high severity raveling is recorded.

20 WEATHERING


0 cm.
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18


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