Ch 3. Identifying distresses

A variety of distresses can occur on a flexible pavement. This chapter explains how to identify each distress and its various levels of severity, what causes the distress, and how to measure the distress (for a survey). The level of severity governs what treatment may be used and is defined as low (L), medium (M), or high (H).

Some distresses are referred to as structural, which means that they are caused by traffic loading rather than by environmental factors. Because thin maintenance surfaces do not add structure to a pavement, it is necessary to identify structural distresses and provide a means of repair before a TMS is applied.

Bleeding

Identification

Asphalt binder is pushed to surface of the pavement and the appearance is usually shiny and black. Bleeding can occur over the entire pavement but is more common in wheel paths.

Causes

Asphalt mix was too rich with binder or too much binder was applied on a seal coat. Traffic works aggregate into the pavement, collapses air voids, and pushes excess binder to the surface.

Measurement

Measured in square feet of surface area.

Severity rating

Low—Bleeding has occurred to a slight degree. Aggregate is still exposed on the surface. Asphalt does not stick to shoes (figure 5).

Medium—Bleeding has occurred to the extent that shoes begin to stick and leave imprints. Aggregate is marginally visible.

High—Bleeding has occurred to the extent that asphalt sticks to shoes. Shoe soles and tire treads are left in the surface. Aggregate is barely visible (figure 6).

Figure 5. Low levels of bleeding are often the result of too mcuh asphalt binder being pushed to the surface, but aggregate is still exposed, and asphalt does not stick.

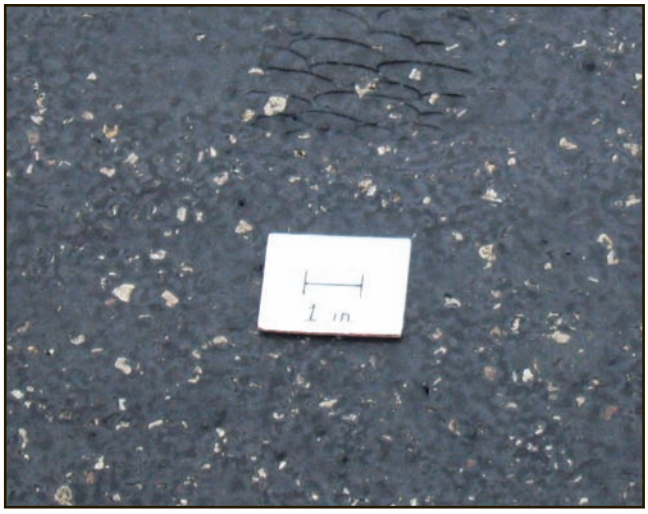

Figure 6. In high ratings of bleeding on pavements, shoes and tires stick to the surface and aggregate is barely visible.

Bumps and sags

Identification

Bumps are small, localized bulges of the pavement surface. Sags are small, abrupt depressions of the pavement surface.

Causes

Bumps and sags are caused by buckling or bulging of underlying PCC slabs or frost heave.

Measurement

Measured in lineal feet.

Severity rating

Low—Causes small problems with ride quality.

Medium—Causes moderate problems with ride quality.

High—Cause major problems with ride quality.

Cracking

Alligator cracking

Identification

Alligator cracking is a structural distress composed of interconnected cracks that have the appearance of alligator scales. Alligator cracking is typically found in wheel paths and may be accompanied by rutting.

Causes

Alligator cracks form in areas of repeated traffic loads. The traffic loads cause high stress in the bottom of the pavement. This stress cracks the pavement starting from the bottom and working up to the surface. The cracking begins with hairline longitudinal cracks in the wheel paths and, as the pavement ages, the cracks begin to interconnect and form small blocks.

Measurement

Measured in square feet of surface area.

Severity rating

Low—Longitudinal cracks have formed, but few interconnecting cracks have formed. Cracks are tight and have not spalled. Pavement does not pump under loading (figure 7).

Medium—Cracks are beginning to form small blocks. Cracks are beginning to spall. Pavement does not pump under loading.

High—A dense network of cracks has formed. Cracks have spalled. Pavement pumps when loaded (figure 8).

Block cracking

Identification

Cracks form large rectangles in the pavement. The blocks range from 1–10 square feet. Block cracking usually occurs over the entire pavement, not just in wheel paths. Block cracking is not an indication of structural failure.

Causes

Block cracking is caused by the shrinkage of the pavement due to daily temperature cycling. It most commonly appears in desert climates where there are wide differences between daytime and nighttime temperatures.

Figure 7. Low levels of alligator cracking begin with a few hairline longitudinal cracks, but pavement do not pump under loading.

Measurement

Measured in square feet of surface area.

Severity rating

Low—Cracks are less than ¼ inch wide or have been sealed (and seal is still in good condition).

Medium—Cracks are ¼ to ¾ inch wide.

High—Cracks are wider than ¾ inch and are spalling (figure 9).

Edge cracking

Identification

Cracks along the edge of the pavement near the shoulder.

Causes

Cracks can be caused by inadequate support, subbase failure due to water intrusion, and traffic loading.

Measurement

Measured in lineal feet.

Severity rating

Low—Cracks are ¼ inch wide or less, with no breakup or raveling.

Medium—Cracks are ¼ to ¾ inch wide with some breakup and raveling.

High—Considerable breakup or raveling along the edge.

Joint reflection cracking

Identification

Cracks mirror joints in an underlying overlay or PCC pavement. Cracks are usually very straight and intersect at right angles.

Causes

When the joints in the underlying layers move, the surface layer moves and reflects the joint cracks. Movement of the underlying pavement may be vertical, caused by traffic, or horizontal, caused by shrinkage.

Figure 8. High alligator cracking is a network of cracks that have formed and grown into blocks. Areas where dense cracks have formed pump when loaded.

Figure 9. High block cracking ratings are those with cracks wider than ¾ inch that are spalling. They occur over in large rectangles over the entire pavement.

Measurement

Measured in lineal feet.

Severity rating

Low—Cracks are less than ¼ inch wide or have been sealed (and seal is still in good condition).

Medium—Cracks are ¼ to ¾ inch wide (figure 10).

High—Cracks are wider than ¾ inch and/or spalling.

Longitudinal cracking

Identification

Cracks parallel to the direction of traffic. The cracks are commonly located in wheel paths and at construction joints (figure 11). These cracks indicate structural failure.

Causes

Some cracks form at the bottom of the pavement layer under the wheel path and propagate to the surface. Other cracks are formed at construction joints and are caused by a lack of fine aggregate at the surface or poor compaction resulting in a weak bond between the two pavements. Still other longitudinal cracks are caused by paving machine–induced segregation. Sometimes paving machines place excess coarse aggregate in the middle of the screed where the augers are attached to the auger drive shaft. Longitudinal cracks sometimes appear above this coarse aggregate.

Measurement

Measured in lineal feet.

Severity rating

Low—Cracks are less than ¼ inch wide or have been sealed (and seal is still in good condition).

Medium—Cracks are ¼ to ¾ inch wide (figure 12).

High—Cracks are wider than ¾ inch and/or spalling.

Transverse/thermal cracking

Identification

Transverse cracks run perpendicular to the direction of the road. These cracks typically start at the top and move towards the bottom.

Figure 10. Medium ratings of joint reflection cracking, cracks that mirror joints, are those with cracks 1/4 to 3/4 inch wide.

Figure 11. Longitudinal cracking can occur down the centerline where construction joints intersect, parallel to the direction of traffic.

Figure 12. Medium ratings of longitudinal cracking, cracks that parallel the direction of traffic, are those with cracks 1/4 to 3/4 inch wide.

Causes

Transverse cracks are typically caused by the thermal shrinkage of the pavement.

Measurement

Measured in lineal feet.

Severity rating

Low—Cracks are of low severity. Cracks are less than ¼ inch or have been sealed (and seal is still in good condition).

Medium—Cracks are of medium severity. Cracks are between ¼ inch and ¾ inch (figure 13).

High—Cracks are of high severity. Cracks are wider than ¾ inch and are spalling (figure 14).

Oxidation

Identification

Surface of the pavement is a light gray. Surface binder is brittle. Aggregate can be easily removed from the surface (figure 15).

Figure 13. Medium ratings of transverse cracking, cracks that run perpendicular to the direction of the road, are those with cracks 1/4 to 3/4 inch wide.

Causes

Ultraviolet rays from the sun. Exposure to water.

Measurement

The entire surface of the pavement will be oxidized.

Severity rating

None.

Figure 14. High severity ratings of transverse cracking are wider than 3/4 inch wide and are spalling.

Figure 15. Oxidation of pavement is caused by exposure to the sun and to water, causing binder to become brittle.

Patching and utility cut patching

Identification

An area of the pavement has been replaced with new material to repair the existing pavement. This includes pothole and utility patches. Patching is considered a distress because the structure of the pavement has been altered.

Measurement

Measured in square feet of surface area.

Severity rating

Low—Patch is in good condition (visual inspection). Ride quality is good.

Medium—Patch has moderately deteriorated. Ride quality is mediocre (figure 16).

High—Patch has completely deteriorated and requires replacement. Ride quality is poor.

Figure 16. Medium ratings of patching are areas moderately deteriorated that had been replaced with new material.

Pocking

Identification

Individual pieces of aggregate have dislodged from the pavement surface and left small voids (figure 17).

Causes

In some cases, asphalt binder becomes hard and brittle from oxidation, allowing the stone to break away. In other cases, some pieces of aggregate may expand or prematurely deteriorate and work out of the pavement under traffic or snowplowing.

Measurement

None.

Severity rating

None.

Figure 17. Pocking occurs when pieces of aggregate become dislodge or deteriorate prematurely.

Polished aggregate

Identification

Smooth appearance of the pavement. When touched, there is little to no friction on the surface of the pavement (figure 18).

Figure 18. Polished aggregate is smooth pavement with little or no friction. (FHWA)

Causes

Repeated traffic applications. Aggregate with poor abrasion resistance.

Measurement

Measured in square feet of surface area.

Severity rating

None.

Potholes

Identification

Bowl-shaped holes in the pavement surface. Generally, the area surrounding the pothole is alligator cracked. Growth is accelerated by water pooling inside of the hole (figure 19 and 20).

Causes

Poor surface mixtures or structural failure of the pavement.

Measurement

Measured by counting the number of low-, medium-, and high-severity occurrences.

Severity rating:

Average Diameter of Pothole	Maximum Depth of Pothole		
	½ to 1 in.	1 to 2 in.	> 2 in.
4 to 8 in.	Low	Low	Medium
8 to 18 in.	Low	Medium	Medium
18 to 30 in.	Medium	High	High

Rutting

Identification

A surface depression runs parallel to traffic and is located in the wheel path.

Causes

There are three possible causes. (1) If the pavement has risen around the edges of the rut, the rut is most likely caused by an unstable mix that flows out from under the wheel and moves to the edges. (2) If there are longitudinal cracks at the bottom of the rut, it is most likely caused by structural failure

Figure 19. Potholes are a bowl-shaped hole in the pavement surface generally surrounded by alligator cracking.

Figure 20. High severity rated potholes are 1–2+ inches deep and range from 18–30 inches in diameter.

of the sub-base (figure 21). (3) If the rut has neither of these characteristics, the rut is likely the result of insufficient compaction during construction and subsequent traffic compaction of the asphalt. After a rut is fully compacted, filling it with slurry seal or micro-surfacing can provide a relatively permanent repair. Progressive rutting (rutting that continues to grow deeper and wider) is a result of a poor sub-base or an unstable mix. If rutting is progressive, filling with slurry seal or micro-surfacing will only provide a temporary solution.

Measurement

Measured in square feet of surface area (figure 22).

Severity rating

Low—Ruts are ¼ to ½ inch deep.
Medium—Ruts are ½ to 1 inch deep.
High—Ruts are >1 inch deep.

Shoving and corrugation

Identification

A permanent longitudinal displacement of a localized area of a pavement surface. Shoving produces a wave or bump in the asphalt. Shoving failures usually occur on hills, curves, and intersections. Shoving can also occur where an asphalt pavement abuts a concrete pavement. Corrugation is the repetition of shoving and is perpendicular to the direction of traffic (figure 23).

Causes

Shoving is caused by braking or accelerating vehicles that displace the asphalt mix. When shoving is located at the transition from a PCC to an ACC pavement, it is caused by the thermal expansion of the PCC. The expanding PCC pushes the asphalt pavement, causing the distress.

Measurement

Measured in square feet of surface area.

Severity rating

Low—Causes small problems with ride quality.
Medium—Causes moderate problems with ride quality.

Figure 21. Longitudinal cracks at the bottom of rutting are often caused by structural failure of the subbase.

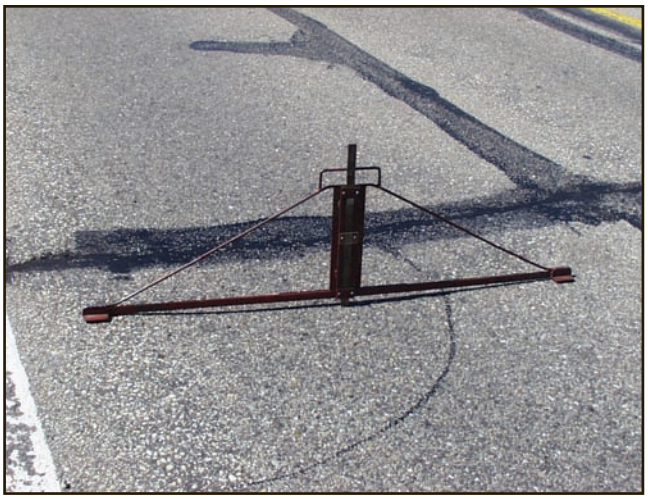

Figure 22. Rutting occurs in the wheel path, and is measured in square feet of surface area.

Figure 23. Shoving or corrugation of pavement surface is a longitudinal wave or bump in the asphalt, usually on hills, curves, or intersections.

High—Cause major problems with ride quality.

Spalling

Identification

An existing crack of any type begins to form parallel satellite cracks.

Causes

Stresses from traffic cause cracks to roll down near the edges. When these stresses are too great on the pavement, new cracks begin to form parallel to the old crack.

Measurement

None.

Severity rating

None.

Weathering/raveling

Identification

The pavement surface is pitted and rough due to loss of aggregate.

Causes

Oxidation makes the binder brittle so that pieces of aggregate can break out of the mix. Tracked vehicles or studded tires can also contribute. On thin maintenance surfaces, causes of raveling usually include snow plow damage, traffic, or a poor design. Loss of aggregate may also be caused by an insufficient amount of binder or poor compatibility between the aggregate and binder.

Measurement

Measured in square feet of area.

Severity rating

Low—Aggregate or binder has started to wear away. Surface is starting to pit.

Medium—Aggregate or binder has worn away. Surface is moderately rough and pitted.

High—Aggregate or binder has worn away considerably. Surface is very rough and severely pitted.

Figure 24. Low level spalling where parallel satellite cracks are beginning to form.

Figure 25. High severity raveling of a seal coat.

Figure 26. New ravleing of a pavement surface.

References

Strategic Highway Research Program (SHRP). (1993). "Distress identification manual for the Long-Term Pavement Performance Project." SHRP-P-338, National Research Council, Washington, DC.

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