Appendix A

Pavement Failure Identification

IDENTIFYING AND CORRECTING PAVEMENT FAILURES

The key to proper maintenance of asphalt pavements is to understand the causes of failures and the action(s) needed for correction before any repair work is done. To make the most of maintenance budgets, proven methods must be used to correct failures and to prevent their recurrence.

The following section provides basic information on the most common types of pavement failures, including their probable cause and the measures recommended for their correction. Personnel involved in asphalt maintenance operations must be well advised, trained, and properly equipped. With diligent application, the following section can assist in helping them achieve an efficient, effective, and consistent asphalt pavement maintenance system.

Types of Pavement Failures

The following photographs illustrate the types of pavement failures most commonly encountered in asphalt pavements. Next to each photograph is a description of the failure type, probable cause of the failure, and recommended correction.

Bleeding or Flushing

This distress is caused by excess asphalt in the surface layer. Contributing factors include insufficient or excess covering stone, lack of proper rolling during placement, or failure to protect a newly constructed surface from traffic until the asphalt has cured sufficiently.

Minor bleeding can often be corrected by applying coarse sand or stone screenings to blot up excess asphalt.

Major bleeding can be corrected by cutting off excess asphalt with a motor grader or removing it with a "heater planer." If the resulting surface is excessively rough, resurfacing may be necessary.

Corrugations and Shoving

Corrugations and shoving are caused by instability in the asphalt layers caused by a mixture that is too rich in asphalt, has too high of a proportion of fine aggregate, has coarse or fine aggregate that is too rounded or too smooth-textured, or has asphalt cement that is too soft. Corrugations and shoving may also be caused by excessive moisture, contamination caused by oil spillage, or lack of curing time between placing seal treatments. This type of distress frequently occurs at grade intersections as a result of braking forces imposed by stopping vehicles.

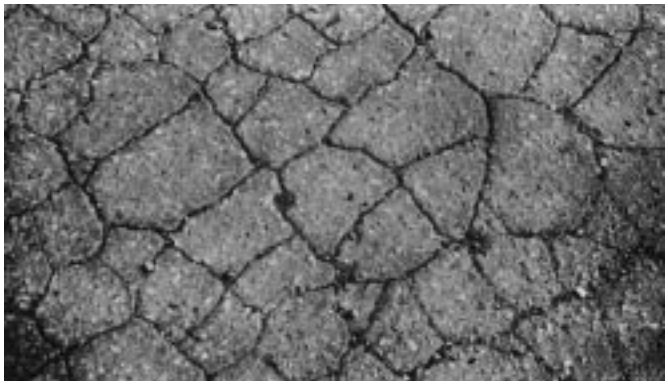
To repair corrugations in an aggregate base overlain with a thin surface treatment, scarify the pavement, add aggregate as needed, mix well, re-compact, prime, and then resurface. Where the surface has 2 inches or more of asphalt plant mix, corrugations can be removed with a ''heater planer.'' After removal of corrugations, cover with a new surface treatment or new asphalt overlay. To repair shoved areas, remove surface and base as necessary and replace with a more stable material to prevent a recurrence. For out-of-season inclement weather repairs, smooth shoved areas with patching if the surface unevenness is hazardous to traffic.

Cracking, Alligator

Interconnected cracks forming a series of small polygons resembling an alligator's skin are called alligator cracks. There are numerous kinds of alligator cracks, some of which are illustrated and discussed below.

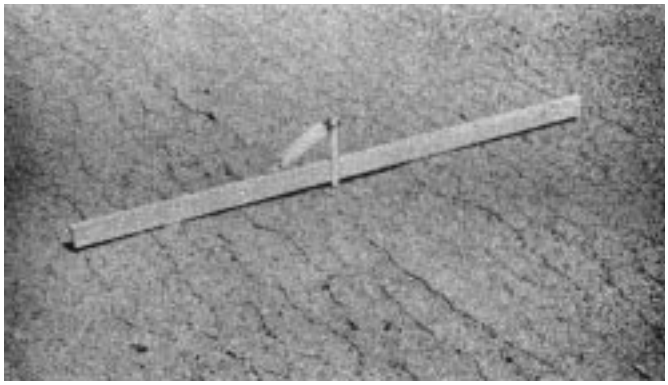
In situ investigations must be performed to determine the most probable of several causes of alligator cracking. If poor drainage is implicated, corrections should be made as quickly as possible. Should the pavement be properly drained, then the base is probably inadequate, and the pavement will require reconstruction or a heavy resurfacing. Major resurfacing will also be required if cracking results from the fatigue effect of repetitive heavy truck loads. If the cause of distress cannot be corrected soon (rebuilding of the pavement may be several years in the future), temporary repairs may be required.

Alligator Cracking without Surface Distortion



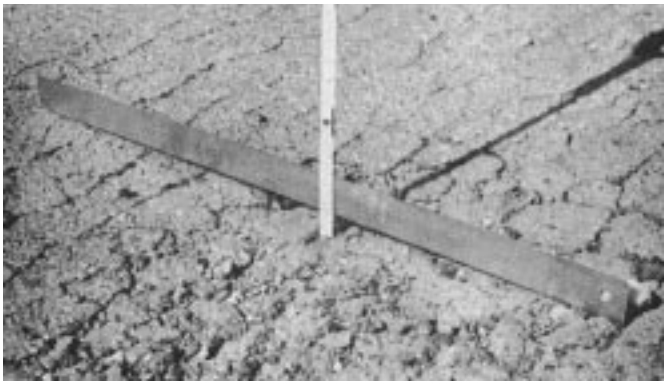
Skin patching should be applied when weather permits. This is often a temporary measure and should not be considered a permanent correction of a major problem. Alligator cracking generally requires removal of the cracked pavement and an asphalt patch of at least 4 inches in depth.

Alligator Cracking with Distortion of Intact Surfaces



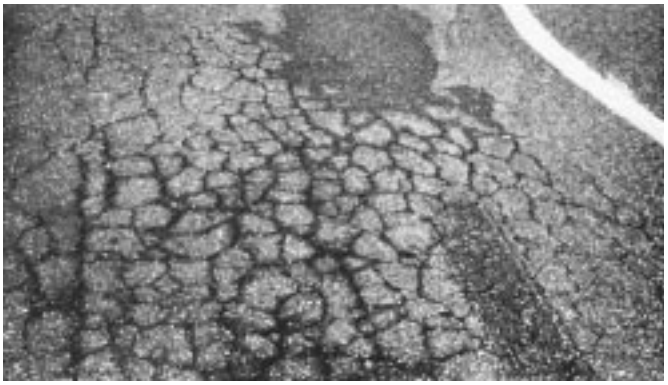
Where distortion is 1 inch or less and the existing surface is intact, a skin patch should be applied. Where distortion is more than 1 inch and the existing surface is intact, a tack coat should be applied followed by an Asphalt Concrete overlay.

Alligator Cracking with Broken Surfaces



Where the existing surface is badly cracked and loose (regardless of amount of distortion), remove old surface, tack area, and repair using Asphalt Concrete. Sound judgment should be used to determine when the existing surface is considered firm and should remain in place or when it is considered loose and should be removed before placing the Asphalt Concrete overlay.

Alligator Cracking with Surface Distortion and Pumping



There are several causes of this type of distress. Often poor drainage resulting in a wet base and/or subgrade is responsible. If the pavement is properly drained, then water is getting to the base and/or subgrade from cracks or holes in the surface or from moisture coming up through the subgrade.

This distress should be repaired as follows:

1. Cut out pavement and wet material.
2. If the base or surface is wet from underneath, install necessary underdrains to prevent future saturation.
3. Prime area.
4. Replace with a minimum of 4 inches of Asphalt Concrete.
5. Compact Asphalt Concrete.

For out-of-season inclement weather repair, keep the area filled with either cold patch material or treated aggregate base.

Note: If you follow the photographs on random surface cracks and alligator cracking, you can see how surface distress can progress from undesirable to intolerable because of lack of proper drainage. This is not to imply that poor drainage is the only cause of surface cracking. However, it is often a major contributor.

Cracking, Edge

The following items discussing edge cracks concern those pavement surfaces underlain by base material and not areas where the surface has been gradually widened over the years until its edge is inadequately supported by a base layer.

Cracking without surface distortion is usually caused by lack of shoulder (lateral) support. When the surface is distorted, possible causes are more diverse. In some cases, the base layer may be of insufficient quality or thickness to support the traffic loads. Poor drainage is also a frequent cause. Is water getting in from the top, sides, or bottom? Is base failure causing distortion and allowing water to wet the base and/or subgrade? Is a clogged ditch line causing water to seep through porous shoulder material and saturate the base and subgrade? Corrective measures should be undertaken as soon as possible.

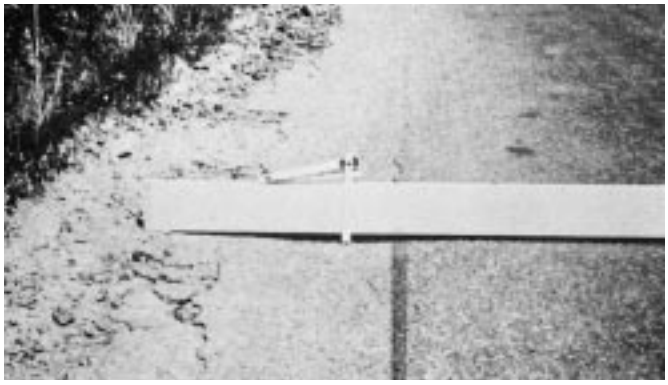
Edge Cracks without Surface Distortion

The first step is to correct the problem of lack of lateral support if necessary. For cracks less than 1/4 inch in width, no maintenance is required. A skin patch is sufficient for larger cracks.

Edge Cracks with Distortion of Intact Surfaces

Where distortion is 1 inch or less and the existing surface is intact, a skin patch should be applied. Where distortion is more than 1 inch and existing surface is intact, tack area and build up with Asphalt Concrete.

Edge Cracks with Broken Surfaces



Where the existing surface is badly cracked and loose, regardless of distortion, the old surface must be removed. Prior to replacing the surface, consideration should be given to the necessity of first replacing the base material if it has been pushed up and out into the shoulder. This action will have reduced the amount of base material that remains in place and thus will have reduced the strength of the pavement. If this condition exists, it should be corrected by either replacing the base material or by building up the depressed area with Asphalt Concrete.

Sound judgment should be used to determine whether the existing surface is considered firm and should remain in place or if it is considered loose and should be removed and replaced. When Asphalt Concrete is used to replace the base material, it should be of equal or greater strength than the material it replaces.

Edge Cracks with Surface Distortion and Pumping

To repair such distress, take the following steps:

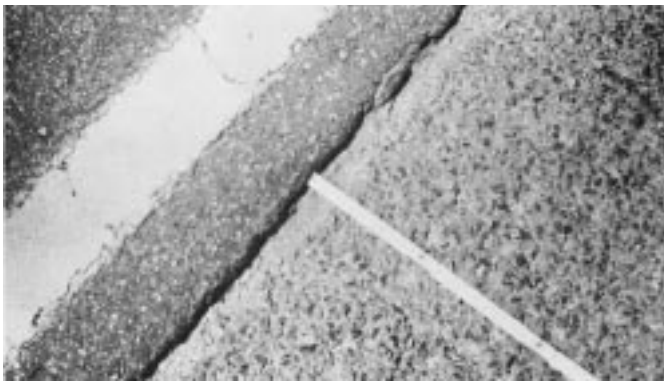
1. Remove unsuitable material.
2. Install any necessary underdrains.
3. Replace base with a well-graded aggregate.
4. Compact aggregate.
5. Prime area.
6. Replace surface using Asphalt Concrete.

When inclement weather prohibits proper repair, try to keep the distressed area filled with cold patch material.

Cracking, Joint

Joint cracks occur where the shoulder or paved wedge separates from the mainline pavement or along weak seams of adjoining pavement spreads in the surface layers.

Joint Crack at Pavement Edge



This distress is caused by wetting or drying action beneath the shoulder surface caused by conditions that trap water and allow it to stand along and seep through the joint between the shoulder and the mainline surface.

If the cracking is less than 1/4 inch in width, no maintenance is required. Otherwise, a crack should be filled with a cutback or emulsified asphalt.

Joint Crack at Lane Joints

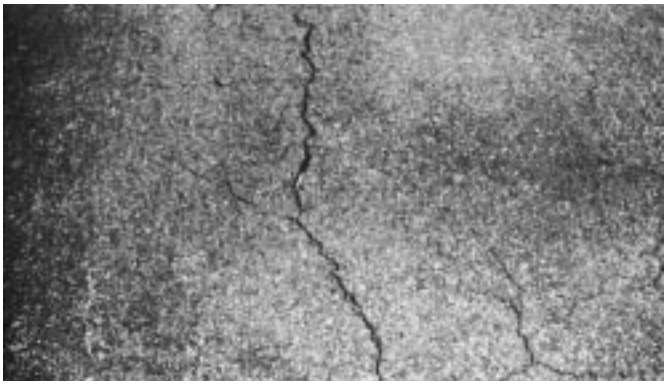
Distress is caused by a weak seam between adjoining spreads in the courses of the pavement.

If the cracking is less than 1/4 inch in width, no maintenance is required. Otherwise, the crack should be filled with a cutback or emulsified asphalt.

Cracking, Random

The causes of random cracking are numerous and, in its early stages, difficult to determine. Consequences range from severe, such as deep foundation settlement, to slight, such as a construction error or mishap.

Narrow Cracks



For cracking less than 1/4 inch in width, take no action. If associated distress of another type exists, the cracking will progress, and remedial action will ultimately be required.

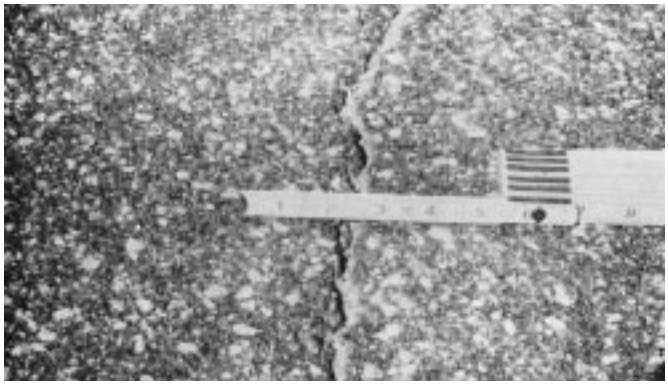
Wide Cracks

When random cracks reach 1/4 inch or more in width, remedial action is often required. However, the appropriate action may be difficult to determine. On some pavements, cracking will not progress significantly from year to year. Previous experience and/or the traffic volume and type of pavement may indicate that it is not necessary to take immediate action. Sound judgment should be used when deciding if action should be taken in this case. In most cases, the crack should either be covered with a skin patch or be filled with a cutback or emulsified asphalt and covered with sand.

Note: Both methods are acceptable, and good judgment should be used to determine which method is best according to the particular distress, materials available, and previous experience.

Cracking, Reflection

Reflection cracking is caused by vertical and horizontal movements in the pavement beneath overlays that result from expansion and contraction with temperature or moisture changes. Reflection cracking is very apparent where plant mix has been placed over Portland Cement Concrete pavement or where old alligator cracks have propagated up through an overlay or patch.



If reflection cracks are no more than 1/4 inch in width, no maintenance is required. Larger cracks should be filled with a cutback or an emulsified asphalt and covered with sand.

Such treatment is seldom permanent when applied to overlays over old Portland Cement Concrete pavement. Continual expansion and contraction of the concrete causes conventionally repaired cracks to reappear quickly. A single course surface treatment over the existing pavement immediately preceding the overlay is a good crack relief measure that minimizes reflective cracking.

Cracking, Shrinkage

Shrinkage cracking appears on the pavement surface as interconnected cracks forming a series of polygons, usually having sharp angles at the corners. Unlike alligator cracking, which is associated primarily with traffic loading, shrinkage cracking is caused by volume change within the Asphalt Concrete, the aggregate base, and/or the subgrade layers.

If the shrinkage cracking is severe and has seriously weakened the pavement structure, a structural overlay will be necessary to restore it. Most likely, however, the cracking will not be progressive, and a surface treatment – preceded by filling the larger cracks with a cutback or emulsified asphalt – will suffice for surface restoration.

Cracking, Slippage

Slippage cracks are crescent-shaped cracks that usually point in the direction of traffic movement. They result from insufficient bond between the surface and underlaying courses, caused by dust, oil, rubber, dirt, water, or no tack coat between the two courses.

To repair slippage cracks, neatly remove the unbonded section of the surface, apply a suitable tack, and replace the surface with a high quality Asphalt Concrete. During inclement weather, keep the exposed area filled with cold mix material if it is likely to be a traffic hazard.

Cracking, Transverse

A transverse crack follows a course approximately at right angles to the pavement center line, usually extending across the full pavement width. In Iowa, transverse cracks are most often the result of reflection cracking. However, they can also result from stresses induced by low-temperature contraction of the pavement, especially if the asphalt is hard and brittle.

Repair procedures for transverse cracking are similar to those for reflection cracking.

Polished Aggregate

Although uncrushed gravels often have surfaces that are initially smooth and potentially hazardous, crushed rock initially has a rough, skid-resistant texture. Under the action of traffic, however, some aggregates – including many limestones – become polished and slick, especially when wet. The likelihood of aggregate becoming polished increases with the volume of traffic. Because polished aggregate results in a loss of skid resistance, it is potentially hazardous. The most economical repair is to apply a skid-resistant surface treatment.

Potholes

Potholes occur most frequently during the winter months when it is difficult to make the most desirable repairs. Consequently, it is often necessary to repair potholes in ways that are less than permanent. General patching should not be done during inclement weather except to correct hazardous conditions. Sound judgment must be exercised when making repairs during poor weather conditions.

Potholes are caused by water penetrating the surface and causing the base and/or subgrade to become wet and unstable. They also may be caused by a surface that is too thin or that lacks

sufficient asphalt content, lacks sufficient base, or has too many or too few fines. Did you and/or your personnel fail to perform maintenance that would have prevented pothole formation? If water is the culprit, it is caused by a cracked surface, high shoulders or pavement depressions ponding water on the pavement, porous or open surface, or clogged side ditches? Correct the cause of the problem as soon as possible.

Potholes in Surface Treatments over Aggregate Base

To repair potholes in surface treatments, take the following actions:

1. Clean out hole.
2. Remove any wet base.
3. Shape hole so that it has vertical sides.
4. Prime hole.
5. Fill hole with Asphalt Concrete.

Potholes in Asphalt Concrete

To repair potholes in Asphalt Concrete, take the following actions:

1. Clean out hole.
2. Remove any wet base.
3. Square up pothole so that it has neat lines both perpendicular and parallel to the center line and has vertical sides.
4. Prime the pothole.
5. Fill the pothole with Asphalt Concrete.

Raveling

Raveling is caused by a dry brittle surface; dirty, dusty, or soft aggregate; patching beyond base material; lack of compaction of surface during construction; too little asphalt in mix; or excessive heating during mixing.

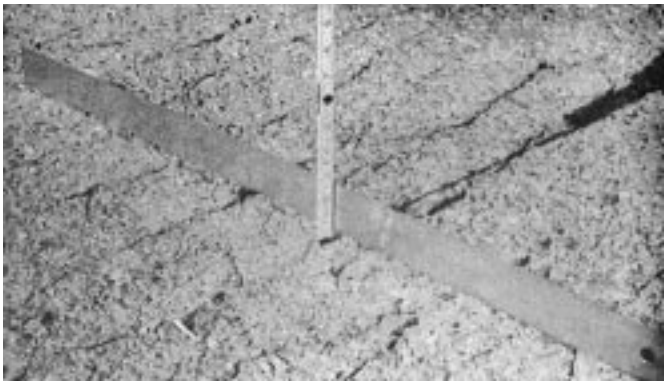
When a small percentage of the pavement is raveling, repair with a skin patch (this includes edge raveling). When a large percentage of the pavement shows raveling, the pavement should be resurfaced.

Note: If the raveling is not a part of the paved surface, no action should be taken. In other words, don't patch beyond the edge of the pavement.

Channels or Rutting

Channels are caused by heavy loads and high tire pressures, subgrade settlement caused by saturation, poor construction methods, or asphalt mixtures of inadequate strength.

Intact Surface



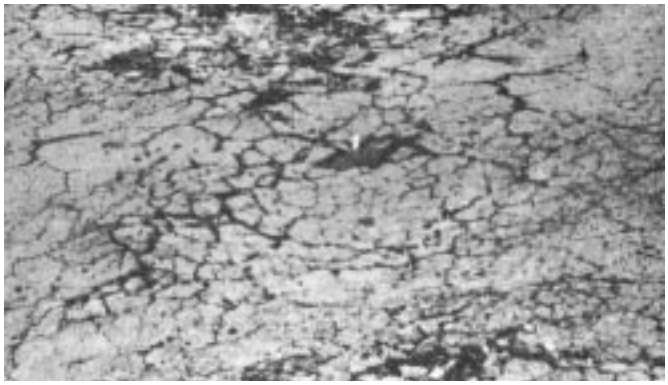
Where the depression is 1 inch or less and the surface is cracked but still largely intact, skin patch the area. Where the depression is more than 1 inch and the surface is cracked but still largely intact, repair with asphalt concrete.

Disintegrated Surface

Where the surface is badly cracked and loose (regardless of amount of depression), remove the old surface. If the area shows signs of mud being pumped to the surface, remove all wet material, replace base material, compact, prime, and build up with Asphalt Concrete.

Upheaval or Frost Boil

Upheaval is caused by expansion of freezing moisture in the lower courses of the pavement or subgrade or by the swelling effect of moisture in expansive soils.



When this distress occurs, repair by installing combination drains as necessary and replacing base and surface.