APPENDIX B

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Table B-4 Moisture-Related Distress in Rigid Pavements.............................................. B-32
B.1 Typical Pavement Distress Type - Severity Description

This portion of the appendix contains general descriptions of the major types of distress that may be encountered in both flexible and rigid pavements. Also noted is a typical description of three severity levels associated with each distress. This information, along with an estimate of the amount of each distress-severity combination, represents an example of the minimum information needs required for a thorough condition survey.

If a pavement has more than one type of distress, the distress that requires the greatest overlay thickness governs. However, if the distress that requires the greatest overlay thickness occurs only in isolated areas, restoring the distressed area to its original condition and then using the overlay thickness required for the more extensive, but less serious, distress may be more economical. For example, if a flexible pavement has a rutting distress throughout, which would require only a leveling course and a minimum overlay thickness, but also has isolated areas of alligator cracking, which would indicate a significant structural overlay, restoring the alligator-cracked areas by patching and then using a minimum or lesser thickness of structural overlay may be more economical.

Note: For the distress types and severity descriptions, the following letters refer to different levels of severity:

L -- Low
M -- Medium
H -- High
### B.2 Identification of Distress Types for Asphalt Surfaced Pavements

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<td>B-19</td>
<td>Stripping</td>
<td>X</td>
<td></td>
</tr>
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</table>
ALLIGATOR OR FATIGUE CRACKING

Description: Alligator or fatigue cracking is a series of interconnecting cracks caused by fatigue failure of the asphalt concrete surface or asphalt stabilized base under repeated traffic loading. The cracking initiates at the bottom of the asphalt surface or asphalt stabilized base where tensile stress and strain is highest under a wheel load. The cracks propagate to the surface initially as one or more longitudinal 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 usually less than one foot on the longest side. Alligator cracking occurs only in areas that are subjected to repeated traffic loadings. Therefore, it would not occur over an entire area unless the entire area was subjected to traffic loading. Alligator cracking does not occur in asphalt overlays over concrete slabs. Pattern-type cracking which occurs over an entire area that is not subjected to loading is rated as block cracking, which is not a load-associated distress. Alligator cracking is considered a major structural distress.

Severity Levels:

L -- Longitudinal disconnected hairline cracks running parallel to each other. The cracks are not spalled. Initially there may only be a single crack in the wheel path (defined as Class 1 cracking at AASHTO Road Test).

M -- Further development of low-severity alligator cracking into a pattern of pieces formed by cracks that may be lightly surface-spalled. Cracks may be sealed (defined as Class 2 cracking at AASHTO Road Test).

H -- Medium alligator cracking has progressed so that pieces are more severely spalled at the edges and loosened until the cells rock under traffic. Pumping may exist (defined as Class 3 cracking at AASHTO Road Test).

Remarks: Alligator cracking indicates the pavement is structurally inadequate for the traffic it is carrying. For AC overlays, repair the areas which are severely distressed and design the overlay in accordance with recommended procedures.
Bleeding

**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 asphalt cement in the mix and/or low air 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 will accumulate on the surface.

**Severity Levels:** No degrees of severity are defined. Bleeding should be noted when it is extensive enough to cause a reduction in skid resistance.

**Remarks:** If bleeding and related problems are the only distress, it is hard to justify, economically, a structural overlay.
BLOCK CRACKING

**Description:** Block cracks divide the asphalt surface into approximately rectangular pieces. The blocks range in size from approximately 1 ft² to 100 ft². Cracking into larger blocks are generally rated as longitudinal and transverse cracking. 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, although load can increase the severity of individual cracks from low to medium to high. The occurrence of block cracking usually indicates that the asphalt has hardened significantly. Block cracking normally occurs over a large portion of pavement area, but will sometimes 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 cracks, alligator cracks are caused by repeated traffic loadings and are, therefore, located only in trafficked areas, i.e., wheel paths.

**Severity Levels:**

L -- Blocks are defined by either (1) non-sealed cracks that are non-spalled, i.e., sides of the crack are vertical, or have only minor spalling with a 1/4-inch or less mean width, or (2) sealed cracks having a sealant in satisfactory condition to prevent moisture infiltration.

M -- Blocks are defined by either (1) sealed or non-sealed cracks that are moderately spalled; (2) non-sealed cracks that are not spalled or have only minor spalling, but have a mean width greater than approximately ¼-inch, or (3) sealed cracks that are not spalled or have only minor spalling, but have sealant in unsatisfactory condition.

H -- Blocks are well defined by cracks that are severely spalled.

**Remarks:** Block cracking is usually the result of shrinkage of the surface asphalt mixture. It is primarily an environmental and materials problem, but can be enhanced by traffic. If block cracking is of low severity, a surface treatment of seal and chips or a minimum thickness of AC is probably adequate. If block cracking is severe, and secondary deterioration along the cracks is present, then a structural overlay of AC may be necessary. Unless evidence of severe traffic enhancement of the block cracking exists, a PCC overlay can probably not be justified.
CORRUGATION OR SHOVING

Description: Corrugation is a form of plastic movement typified by ripples across the asphalt pavement surface. It occurs usually at points where traffic starts and stops. Corrugation usually occurs in asphalt layers that lack stability in warm weather, but may also be attributed to excessive moisture in a subgrade, contamination of the mix, or lack of aeration of liquid asphalt mixes.

Severity Levels:

L -- Corrugations cause some vibration of the vehicle that creates no discomfort.

M -- Corrugations cause significant vibration of the vehicle that creates some discomfort.

H -- Corrugations cause excessive vibration of the vehicle that creates substantial discomfort, and/or a safety hazard, and/or vehicle damage, requiring a reduction in speed for safety.

Remarks: Corrugation is usually the result of shoving in asphaltic materials with insufficient stability. It can, however, also be caused by instability of the underlying layers. If the corrugations are due to instability of the pavement layers, these unsuitable materials should be replaced before overlaying. If the unstable materials are replaced, then a structural overlay of asphaltic concrete is a reasonable solution. In some instances, however, even the most stable asphalt material will exhibit corrugations. These would normally occur at locations where frequent and rapid decelerations occur, such as at a traffic light, at the bottom of a grade, or at an approach to a control light or sign on a heavily trafficked pavement. Under these conditions PCC may be more suitable. Cost of the PCC should be compared to cost and convenience of frequent restoration of the asphalt overlay.
DEPRESSION

Description: 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 rainstorm, when ponding water creates "birdbath" areas. The depressions can also be located without rain because of stains created by oil droppings from vehicles. Depressions can be caused by settlement of the foundation soil or can be "built in" during construction. Depressions cause roughness and when filled with water of sufficient depth, could cause hydroplaning of vehicles.

Severity Levels:

L -- Depressions cause some bounce of the vehicle that creates no discomfort.

M -- Depressions cause significant bounce of the vehicle that creates some discomfort.

H -- Depressions cause excessive bounce of the vehicle that creates substantial discomfort, and/or a safety hazard, and/or vehicle damage, requiring a reduction in speed for safety.

Remarks: Depression may be caused by a wide variety of causes. If the depressions are local and the cause can be eliminated, for example, a poorly compacted backfill over a utility line, then a patch and surface treatment may be adequate. If, however, the cause for the depressions is deep seated and cannot be removed, than leveling course plus AC surface or a surface treatment would be a better solution.
JOINT REFLECTION CRACKING FROM PCC SLAB

Description: This distress occurs only on pavements having an asphalt concrete surface over a jointed portland cement concrete (PCC) slab. Distress occurs at transverse and longitudinal joints, i.e., widening joints. This distress does not include reflection cracking away from a joint or from any other type of base, i.e., cement stabilized base, as these cracks are identified as “Longitudinal and Transverse Cracking.” Joint reflection cracking is caused mainly by movement of the PCC slab beneath the asphalt concrete (AC) surface because of thermal and moisture changes; it is generally not load-initiated. However, traffic loading may cause a breakdown of the AC near the initial crack, resulting in spalling. A knowledge of slab dimensions beneath the AC surface will help to identify these cracks.

Severity Levels:

L -- Cracks have either minor spalling or no spalling and can be sealed or non-sealed. If non-sealed, the cracks have a mean width of $\frac{1}{4}$-inch or less, sealed cracks are of any width, but their sealant material is in satisfactory condition to prevent substantial water infiltration. No significant bump occurs when a vehicle crosses the crack.

M - One of the following conditions exists: (1) cracks are moderately spalled and can be either sealed or non-sealed of any width, (2) sealed cracks are not spalled or have only minor spalling, but the sealant is in a condition so that water can freely infiltrate, (3) non-sealed cracks are not spalled or are only lightly spalled, but the mean crack width is greater than $\frac{1}{4}$-inch, (4) low-severity random cracking exists near the crack or at the corners of intersecting cracks, or (5) the crack causes a significant bump to a vehicle.

H -- (1) Cracks are severely spalled and/or medium or high random cracking exists near the crack or at the corners of intersecting cracks, or (2) the crack causes a severe bump to a vehicle.
LANE SHOULDER DROP-OFF OR HEAVE

Description: Lane/shoulder drop-off or heave occurs wherever a difference in elevation is present between the traffic lane and the shoulder. Typically, the outside shoulder settles due to consolidation or a settlement of the underlying granular or subgrade material or pumping of the underlying material. Heave of the shoulder may occur due to frost action or swelling soils. Drop-off of granular or soil shoulder is generally caused from blowing away of shoulder material by passing traffic.

Severity Level: Severity level is determined by computing the mean difference in elevation between the traffic lane and shoulder.

L -- 1 inch
M -- 2 - 1 inch
H -- 3 - 2 inch

Remarks: Lane/shoulder heave is frequently caused by a difference in thermal insulation of a frost susceptible soil between the pavement lane and shoulder so that the shoulder heaves due to frost action or due to swelling soils. Lane/shoulder drop-off is frequently due to consolidation of the shoulder materials or abrasions of the shoulder along the interface. In either event, a layer of asphalt concrete will decrease the thermal difference between the lane and shoulder and will strengthen the shoulder against further consolidation. Any cracks that develop along the lane/shoulder interface should be filled and sealed before placing the AC, and covering the interface cracks with a waterproofing membrane before overlaying may be desirable. Consideration should also be given to recycling the shoulder material and reworking it into a satisfactory shoulder/lane junction.
LANE/SHOULDER JOINT SEPARATION

Description: Lane/shoulder joint separation is the widening of the joint between the traffic lane and the shoulder, generally due to movement in the shoulder. If the joint is tightly closed or well sealed so water cannot enter, or, if no joint exists due to full-width paving, then lane/shoulder joint separation is not considered a distress. If the shoulder is not paved, i.e., gravel or grass, then the severity should be rated as high. If curbing exists, then the distress should be rated according to the width of the joint between the asphalt surface and curb.

Severity Level: Severity level is determined by the mean joint opening. No severity level is counted if the joint is well sealed to prevent moisture intrusion.

L -- 0.04 - 0.12 inch
M -- 0.12 - 0.40 inch
H -- 0.40 inch

Remarks: Usually, lane/shoulder separation can be corrected by filling and sealing the resulting crack and adding a minimum thickness overlay or surface treatment. It is sometimes helpful to widen and clean the joint before sealing.
LONGITUDINAL AND TRANSVERSE CRACKING
WITHOUT PCC SLAB JOINT REFLECTION

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, or (3) reflection of cracks beneath the surface course, including cracks in PCC slabs (but not at PCC slab joints). Transverse cracks extend across the pavement centerline or direction of laydown. They may be caused by item (2) or (3) above. These types of cracks are not usually load-associated.

Severity Levels:

L -- Cracks have either minor spalling or no spalling, and cracks can be sealed or non-sealed. If sealed, cracks have a mean width of ¼-inch or less, sealed cracks are of any width, but their sealant is in satisfactory condition to prevent substantial water infiltration. No significant bump occurs when a vehicle crosses the crack.

M -- One of the following conditions exists: (1) cracks are moderately spalled and can be either sealed or non-sealed of any width, (2) sealed cracks are not spalled or have only minor spalling, but the sealant is in a condition so that water can freely infiltrate, (3) non-sealed cracks are not spalled or have only minor spalling, but the mean crack width is greater than 1/4 inch, (4) low severity random cracking exists near the crack or at the corners of intersecting cracks, or (5) the crack causes a significant bump to a vehicle.

H -- (1) Cracks are severely spalled, and/or medium or high-random cracking exists near the crack or at the corners of intersecting cracks, or (2) the crack causes a severe bump to a vehicle.

Remarks: Lane cracking is usually the result of a cold joint or improper compaction at the junction of parallel paving lanes. After filling and sealing the joint, a surface treatment or minimum thickness of AC overlay should be applied. Use of a waterproofing membrane over the filled cracks is optional.

Transverse cracking is due to thermal shrinkage of the AC pavement. Use of softer asphalts will frequently reduce the transverse cracking. If the cracks remain at a uniform level, that is without depression or tenting, and if no secondary cracking along the initial cracking exists, then the cracks should be left untreated. If the existing pavement is rough due to depression or tenting along the cracks, or if secondary cracking exists, the pavement should be leveled and overlaid with a minimum thickness AC.
PATCH DETERIORATION

Description: A patch is an area where the original pavement has been removed and replaced with either similar or different material.

Severity Level:

L -- Patch is in very good condition and is performing satisfactorily.

M -- Patch is somewhat deteriorated, having low to medium level soft areas with any types of distress.

H -- Patch is badly deteriorated and soon needs replacement.

Remarks: Unless an underlying cause exists such as a base failure, water problems, or subgrade failure, most patch deterioration is due to poor patching procedures or improper materials. Thus, the patch should be replaced and the surface covered with a surface treatment or a minimum thickness AC overlay.
POLISHED AGGREGATE

**Description:** Polished aggregate 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 no rough or angular aggregate particles are present to provide good skid resistance.

**Severity Levels:** No degrees of severity are defined. However, the degree of polishing should be significant in reducing skid resistance before it is included as a distress.

**Remarks:** A classic case for a surface treatment, especially a porous friction course or a minimum thickness AC overlay with non-polishing aggregates. If structural defects are present in the existing pavement, these should be first eliminated.
POTHOLES

Description: A bowl shaped hole of various sizes in the pavement surface. The surface has broken into small pieces by alligator cracking or by localized disintegration of the mixture and the material is removed by traffic. Traffic loads force the underlying materials out of the hole, increasing the depth.

Severity Levels:

<table>
<thead>
<tr>
<th>Depth (inches)</th>
<th>Area ((\text{ft}^2))</th>
<th>&lt;1</th>
<th>1-3</th>
<th>&gt;3</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1</td>
<td></td>
<td>L</td>
<td>L</td>
<td>M</td>
</tr>
<tr>
<td>1-2</td>
<td></td>
<td>M</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>&gt;2</td>
<td></td>
<td>M</td>
<td>H</td>
<td>H</td>
</tr>
</tbody>
</table>

Remarks: Potholes are the advanced stage of other types of distress, especially alligator cracking, and indicate an inadequate pavement structure. Underlying causes of potholes should be first corrected and all loose and unsound materials removed. The pothole should be patched and overlaid with a structural overlay.
RAVELING AND WEATHERING

**Description:** Raveling and weathering are the wearing away of the pavement surface caused by the dislodging of aggregate particles (raveling) and loss of asphalt binder (weathering). They generally indicate that the asphalt binder has hardened significantly.

**Severity Levels:**

**L** -- Aggregate or binder has started to wear away but has not progressed significantly.

**M** -- Aggregate and/or binder has worn away and the surface texture is moderately rough and pitted. Loose particles generally exist.

**H** -- Aggregate and/or binder has worn away and the surface texture is severely rough and pitted.

**Remarks:** Raveling and weathering are material and environment related problems. Therefore, the most practical solution is to cover the raveling material with a minimum covering. Rejuvenators may also be used on the existing surface before placing the overlay or surface treatments. Reworking and recycling the weathered material should also be considered.
RUTTING

Description: A rut is a surface depression in the wheel paths. 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, and is usually caused by consolidation or lateral movement of the materials due to traffic loads. Rutting may be caused by plastic movement in the mix in hot weather or inadequate compaction during construction. Significant rutting can lead to major structural failure of the pavement and hydroplaning potential. Wear of the surface in the wheel paths from studded tires can also cause a type of “rutting.”

Severity Levels: Mean Rut Depth Criteria
L -- >2 inch
M -- 1-2 inches
H -- <1 inch

Remarks: Rutting is usually the result of plastic flow and consolidation in the AC surface of the pavement. Sometimes the surface rutting is increased by rutting of the base materials. Unless a significant portion of the rutting is in the base layer, adding an AC overlay of the same stability will not eliminate the tendency of the pavement to rut. If a higher stability AC is used, this will retard the rate of rutting but may increase other problems such as transverse cracking and weathering of the AC.
SLIPPAGE CRACKING

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

Severity Levels: No degrees of severity are defined. Indicating that a slippage crack exists is sufficient.

Remarks: Slippage cracks are the result of an inadequate bond between the surface and base and may be magnified by the same factors that cause corrugation of the AC surface, i.e., excessive moisture in the subgrade, contamination of the mix or low air voids. Corrective actions given for corrugation are also appropriate for slippage cracking.
STRIPPING

**Description:** Stripping in an asphalt concrete is a physical separation of the asphalt cement film from the aggregate in the asphalt concrete. The strength and integrity of an asphalt concrete material are the direct result of the bonding and waterproofing provided by the asphalt cement. When the cement is no longer bonded to the aggregate, little or no resistance to deformation under load exists. The integrity of the material is lost.

**Severity Levels:** No degrees of severity are defined. The potential for stripping to develop should be examined in the mix design phase, and for rehabilitation, should be investigated by visual observation of cores taken from the pavement.

**Remarks:** A material exhibiting stripping may require removal before rehabilitation.
### Table B-2 Index of Distress Types for Rigid Pavements

<table>
<thead>
<tr>
<th>Page</th>
<th>Description</th>
<th>Primarily Traffic Load Caused</th>
<th>Primarily Climate/Materials Caused</th>
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<tbody>
<tr>
<td>B-21</td>
<td>Blowup</td>
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<tr>
<td>B-22</td>
<td>Corner Break</td>
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<td>B-23</td>
<td>Depression</td>
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<tr>
<td>B-24</td>
<td>Faulting-Transverse Joints &amp; Cracks</td>
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</tr>
<tr>
<td>B-25</td>
<td>Longitudinal Cracks</td>
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<td>X</td>
</tr>
<tr>
<td>B-26</td>
<td>Pumping and Water Bleeding</td>
<td>X (M, H)</td>
<td>X (L)</td>
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<tr>
<td>B-27</td>
<td>Reactive Aggregate Distress</td>
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<td>B-28</td>
<td>Rutting</td>
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<td>B-29</td>
<td>Spalling (Transverse and Longitudinal Joints &amp; Cracks)</td>
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</tr>
<tr>
<td>B-30</td>
<td>Transverse and Diagonal Cracks</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
BLOWUP

Description: Most blowups occur during the spring and hot summer at a transverse joint or wide crack. Infiltration of incompressible materials into the joint or crack during cold periods results in high compressive stresses in hot periods. When this compressive pressure becomes too great, a localized upward movement of the slab or shattering occurs at the joint or crack. Blowups are accelerated due to a spalling away of the slab at the bottom, creating reduced joint contact area. The presence of freeze-thaw damage also weakens the concrete near the joint, resulting in increased spalling and blowup potential.

Severity Levels:

L  -- Blowup has occurred, but only causes some bounce of the vehicle that creates no discomfort.

M  -- Blowup causes a significant bounce of the vehicle that creates some discomfort. Temporary patching may have been placed because of the blowup.

H  -- Blowup causes excessive bounce of the vehicle, which creates substantial discomfort, and/or a safety hazard, and/or vehicle damage, requiring a reduction in speed for safety.

Remarks: If blowups are infrequent, then it may be possible to merely patch the slab and use no overlay. If overlays are used, the pavement must first be patched and minimum overlay thickness used. Adding an overlay to a PCC slab may not stop further blowups, but may retard the frequency of this type of distress.
CORNER BREAK

Description: A corner break is a crack that intersects the joints at a distance less than six feet on each side measured from the corner of the slab. A corner break extends vertically through the entire slab thickness. It should not be confused with a corner spall, which intersects the joint at an angle through the slab and is typically within one foot from the slab corner. Heavy repeated loads combined with pumping, poor load transfer across the joint, and thermal curling and moisture warping stresses result in corner breaks.

Severity Levels:

L  -- Crack is tight (hairline). Well-sealed cracks are considered tight. No faulting or breakup of broken corners exists. Crack is not spalled.

M  -- Crack is working and spalled at medium severity, but breakup of broken corner has not occurred. Faulting of crack or joint is less than 2 inch. Temporary patching may have been placed because of corner break.

H  -- Crack is spalled at high severity, the corner piece has broken into two or more pieces, or faulting of crack or joint is more than 2 inch.

Remarks: Corner breaks indicate either structural inadequacy of the pavement or loss of corner support due to pumping. If the corner break is due to pumping, the slabs should be supported by slab jacking before overlaying. Bonded PCC overlays could be used if the existing pavement is restored to its initial condition before overlaying. If an AC overlay is used, steps must be taken to minimize reflective cracking, such as the steps indicated below for transverse cracking distress. When unbonded concrete overlays are used, the existing pavement should first be leveled with an AC leveling course.
FAULTING OF TRANSVERSE JOINTS AND CRACKS

**Description:** Faulting is the difference of elevation across a joint or crack. Faulting is caused in part by a buildup of loose materials under the approach slab near the joint or crack as well as depression of the leave slab. The buildup of eroded or infiltrated materials is caused by pumping from under the leave slab and shoulder (free moisture under pressure) due to heavy loads. The warp and/or curl upward of the slab near the joint or crack due to moisture and/or temperature gradient contributes to the pumping condition. Lack of load transfer contributes greatly to faulting.

**Severity Levels:**

L  --  Average faulting is equal to or less than 1/16 inch.

M  --  Average faulting is more than 1/16 but less than 1/5 inch.

H  --  Average faulting is equal to or more than 1/5 inch.

**Remarks:** Faulting is usually due to pumping of subbase material and failure of load transfer systems. Pumping must be eliminated by slab undersealing if the overlay is to be effective. For bonded PCC overlays, the pavement should be undersealed, milled level and the joints filled before overlaying. For unbonded PCC overlays, the pavement could be corrected by use of diamond grinding or crack and seating and then leveled with an AC leveling course before overlaying. AC overlays should be placed on the existing pavement after undersealing, but steps must be taken to retard reflection cracking at the joints.
LONGITUDINAL CRACKS

Description: Longitudinal cracks occur generally parallel to the centerline of the pavement. They are often caused by improper construction of longitudinal joints or by a combination of heavy load repetition, loss of foundation support, and thermal and moisture gradient stresses.

Severity Levels:

L  --  Hairline (tight) crack with no spalling or faulting, or a well-sealed crack with no visible faulting or spalling.

M  --  Working crack with a moderate or less severe spalling and/or faulting less than 2 inch.

H  --  A crack with width greater than 1 inch; a crack with a high severity level of spalling; or a crack faulted 2 inch or more.

Remarks: If faulted, the pavement should be corrected by crack and seating or diamond grinding. For application of a bonded PCC overlay, mill the surface level before placing overlay. For unbonded PCC overlay, level the existing surface with an AC leveling course before overlaying. To retard reflective cracking in the PCC overlay, use deformed reinforcement bars or heavy mesh across the cracks in the existing surface. If AC overlay is used, the overlay should be of adequate thickness to retard reflective cracking.
PUMPING AND WATER BLEEDING

Description: Pumping is the movement of material by water pressure beneath the slab when it is deflected under a heavy moving wheel load. Sometimes the pumped material moves around beneath the slab, but often it is ejected through joints and/or cracks, particularly along the longitudinal lane or at the shoulder joint with an asphalt shoulder. Beneath the slab, particle movement typically occurs counter to the direction of traffic across a joint or crack that results in a buildup of loose materials under the approach slab near the joint or crack. Often some fine materials (silt, clay, sand) are pumped out, leaving a thin layer of relatively loose clean sand and gravel beneath the slab, along with voids, causing loss of support. Pumping occurs even in pavement sections containing stabilized subbases.

Water bleeding occurs when water seeps out of joints and/or cracks. Many times it drains out over the shoulder in low areas.

Severity Levels:

L  -- Water is forced out of a joint or crack when trucks pass over the joints or cracks; water is forced out of the lane/shoulder longitudinal joint when trucks pass along the joint; or water bleeding exists. No fines can be seen on the surface of the traffic lanes or shoulder.

M  -- A small amount of pumped material can be observed near some of the joints or cracks on the surface of the traffic lane or shoulder.

H  -- A significant amount of pumped materials exists on the pavement surface of the traffic lane or shoulder along the cracks or joints.

Remarks: Overlays alone will generally not stop pumping and bleeding. Pumping and bleeding pavements must be under sealed to stop the cause of the problem before any surficial treatments are applied. After under sealing, the pavements may be overlaid with bonded or unbonded PCC or an AC overlay as desired to improve the surface properties of the pavements.
REACTIVE AGGREGATE DISTRESS

Description: Reactive aggregates either expand in alkaline environments or develop prominent siliceous reaction rims in concrete. It may be an alkali-silica reaction or an alkali-carbonate reaction. As expansion occurs, the cement matrix is disrupted and cracks. It appears as a map-cracked area; however, the cracks may go deeper into the concrete than in normal map cracking. It may affect most of the slab or may first appear at joints and cracks.

Severity Levels: Only two levels of distress have been defined.

L  -- Fine alligator-type cracks exist but no matrix exists between cracks to act as an integral structure.

H  -- Cracks have opened to the point where individual particles are not interlocked. Particles may be rocking or removed by traffic.

Remarks: Rehabilitation of PCC pavements with reactive aggregates is greatly dependent on the severity of the distress at the time of the overlay. If the overlay is placed when the reactive level is low, bonded PCC overlays may be suitable. If the distress developed to a severe level, bonded concrete overlays may be unreliable. Use of an AC overlay is common but it has a limited life expectancy due to the continuing deterioration of the existing PCC. Unbonded PCC pavements are the most reliable type overlay on severe level reactive aggregate problems. It must be kept in mind that while an overlay may increase the serviceable life of the pavement, the overlay may not retard the rate of deterioration of the existing concrete. This point is particularly important to keep in mind when considering bonded concrete overlays.
SPALLING OF TRANSVERSE AND LONGITUDINAL JOINTS AND CRACKS

Description:  Spalling of cracks and joints is the cracking, breaking, fraying or chipping of the slab edges within 2 feet of the joint or crack.  A spall usually does not extend vertically through the whole slab thickness, but extends to intersect the joint at an angle.  Spalling usually results from (1) excessive stresses at the joint or crack caused by infiltration of incompressible materials and subsequent expansion, (2) disintegration of the concrete from freeze-thaw action of "D" cracking, (3) weak concrete at the joint caused by honeycombing, (4) poorly designed or constructed load transfer device, i.e., misalignment, corrosion, and/or (5) heavy repeated traffic loads.

Severity Levels:

L  -- A spall less than two feet long; if spall is broken into pieces and fragmented, it must not extend more than three inches from the joint or crack.  A spall more than two feet long with spall held tightly in place; if spall is cracked, it cannot be broken into more than three pieces.  The joint is lightly frayed with fray extending no more than three inches from the edge of the joint or crack.

M  -- A spall is broken into pieces or fragmented and spall extends more than three inches from joint or crack.  Some pieces may be loose and/or missing, but the spalled area does not present a tire damage or safety hazard.  The joint or crack is moderately frayed with fray extending more than three inches from the edge of the joint or crack, but not causing tire damage or a safety hazard.  Temporary patching has been placed because of spalling.

H  -- The joint is severely spalled or frayed to the extent that a tire damage or a safety hazard exists.

Remarks:  Extensive spalling of cracks and joints usually indicates excessive relative movements of pavements under load.  This would indicate the need for an increase in structural capacity of the slab.  This can be provided by bonded or unbonded PCC or AC overlays.  If a bonded PCC overlay is used, the joints should be milled down to sound concrete before overlaying.  For all types of overlays the joints and cracks should be cleaned and filled before overlaying.
SPALLING OF LONGITUDINAL JOINT AND CRACK

SPALLING OF TRANSVERSE JOINT AND CRACK
TRANSVERSE AND DIAGONAL CRACKS

**Description:** Linear cracks are caused by one or a combination of the following: heavy load repetition, thermal and moisture gradient stresses, and drying shrinkage stresses. Medium or high-severity cracks are working cracks and are considered major structural distresses. They may sometimes be due to deep-seated differential settlement problems. Hairline cracks that are less than 6 feet long are not rated.

**Severity Levels:**

- **L** -- Hairline or tight crack longer than 6 feet with no spalling or faulting, a well-sealed crack with no visible faulting or spalling.

- **M** -- Working crack with low to medium severity level of spalling, and/or faulting less than 2 inch. Temporary patching may be present.

- **H** -- A crack with width of greater than 1 inch; a crack with a high-severity level of spalling; or a crack faulted 2 inch or more.

**Remarks:** Transverse and diagonal cracking usually indicates a structural inadequacy in the existing pavement. Bonded PCC pavements could be used for this only if the existing pavement can be substantially restored to its original condition before overlaying, as transverse and diagonal cracks will usually reflect through the bonded overlay. Such cracks will also reflect through most AC overlays and steps must be taken to retard the reflection cracking problem by use of thick overlays, overlays with a fabric, cushion layers, etc. Even with the steps to retard reflection cracking, the most seriously distressed area should be patched before overlaying.
Distresses can be related to particular moisture properties of the materials in the pavement. If the existence of these properties is not recognized and corrected where possible, the rehabilitation work will be wasted by allowing the same type of moisture-related distress to occur again. The recognition of the amount, severity and cause of moisture damage also plays an important role in the selection of the rehabilitation scheme to be utilized on the pavement. This information will help in the structural evaluation of the pavement.

Moisture-related distresses develop from two major groupings of factors that influence the moisture condition in a pavement.

1. External factors are the climatic factors in an area that regulates the supply of moisture to the pavement.
2. Internal factors are those properties of the pavement materials whose interaction with moisture influences pavement performance.

The recognition of each distress and the mechanism causing that distress are necessary if the correct rehabilitation procedures are to be selected. Each distress type that develops within a pavement will be load or environment-related or a combination of the two. Moisture will serve to accelerate this deterioration when it is environment related. To prevent future deterioration, the moisture problems must be recognized and corrected.

The fact that moisture problems may appear in any layer emphasizes the necessity of having a logical procedure for examining the pavement in order to determine the cause of the problem. Nondestructive testing (NDT) will indicate the overall structural level of the pavement. However, NDT alone cannot identify which component of the pavement is responsible for the strength loss. The distress analysis must be utilized in conjunction with the NDT analysis in order to identify potential moisture related problems. If the subgrade has moisture problems that caused the distress, as determined in the distress survey, it may do no good to overlay the pavement, recycle it, or rework and stabilize the base without also addressing the subgrade. If the base or subbase has moisture problems, it will be wasteful to rehabilitate, restore, or overlay without addressing the moisture problems through reworking or stabilization of the base and/or consideration of drainage of the granular layer.

Tables B-3 and B-4 contain a breakdown of the more common distress types for flexible and rigid pavements. Several of these are moisture related and are influenced by the climate.
### Table B-3 Moisture-Related Distress in Flexible Pavements

<table>
<thead>
<tr>
<th>TYPE</th>
<th>DISTRESS MANIFESTATION</th>
<th>MOISTURE PROBLEM</th>
<th>CLIMATIC PROBLEM</th>
<th>MATERIAL PROBLEM</th>
<th>LOAD ASSOCIATED</th>
<th>STRUCTURAL DEFECT BEGINS IN</th>
</tr>
</thead>
<tbody>
<tr>
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<td></td>
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<td>Surface Defects</td>
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<tr>
<td>Bleeding</td>
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<td>No</td>
<td>No</td>
<td>Bitumen</td>
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<td>Surface Deformation</td>
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<tr>
<td>Bump or Depression</td>
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<td>Strength-Moisture</td>
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<td>Depression</td>
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<td>Settlement, Fill Material</td>
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<td>Front-Heave</td>
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<td>Cracking</td>
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<td>Strength-Moisture</td>
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<td>Transverse</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes, Temp. Susceptible</td>
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### Table B-4 Moisture-Related Distress in Rigid Pavements

<table>
<thead>
<tr>
<th>TYPE</th>
<th>DISTRESS MANIFESTATION</th>
<th>MOISTURE PROBLEM</th>
<th>CLIMATIC PROBLEM</th>
<th>MATERIAL PROBLEM</th>
<th>LOAD ASSOCIATED</th>
<th>STRUCTURAL DEFECT BEGINS IN</th>
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<td>Spalling</td>
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<td>No</td>
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<td>Rich Mortar</td>
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<td>Blow-up</td>
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<td>No</td>
<td>Thermal Properties</td>
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<td>Settlement</td>
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<td>Curling</td>
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<td>Follows Pumping</td>
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<td>Diagonal</td>
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<td>Cracking Follows</td>
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<td>Moisture Buildup</td>
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<td>Punch Out</td>
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<td>Deformation Follows Cracking</td>
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<td>Joint</td>
<td>Produces Damage Later</td>
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<td>No</td>
<td>Proper filler and clean edges</td>
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<td>Joint</td>
</tr>
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</table>

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