

Chapter 7 - Pavement Maintenance

Introduction

An airport's pavement construction techniques are as critical as the design in providing a safe operational area for aircraft operations. Normal aircraft pavement distresses, weathering, poor drainage, and movement of the underlying layer begin immediately after construction. Because of the continued deterioration, a routine maintenance schedule and plan becomes critical.

The Federal Aviation Administration Act of 1994, Section 107 (e) requires that an application for replacement or reconstruction of an airport pavement may be approved only if the sponsor has provided assurances or certifications that the airport has implemented an effective pavement maintenance and management program.

A summary of the steps needed to institute a pavement maintenance program are outlined below:

- Evaluate the Pavement
- Prepare a Cost Analysis
- Commence Inspection Procedures
- Institute Preventive Maintenance Procedures
- Institute Restoration Maintenance Procedures

Normal disintegration, increased air traffic activities, and weathering conditions are some of the variables that affect pavement deterioration. Pavement deterioration begins immediately following construction, making it imperative to start a routine inspection schedule. Early detection and repair of pavement problems are the most important preventative maintenance steps that can be taken to prolong the life of pavements.

This chapter will provide information on pavement types, various types of problems and pavement deterioration, and recommended corrective maintenance actions as provided by the Federal Aviation Administration (FAA) in the Advisory Circular AC 150/5380-6A, "Guidelines and Procedures for Maintenance of Airport Pavements".

Pavement Types

Airport pavements are designed, constructed, and maintained to support the critical loads imposed on the pavement and to produce a smooth and safe riding surface. The pavement must be of such quality and thickness that it will not fail under the loads of aircraft and be durable enough to withstand the abrasive action of traffic, adverse weather conditions, and other deteriorating influences. Pavements are divided into three classes: rigid pavements, flexible pavements, and overlays.

Rigid Pavements

Rigid pavements are normally composed of portland cement concrete (PCC) as the prime structural element. Depending upon conditions, the pavement slab may be designed with plain, lightly reinforced, continuously reinforced, pre-stressed, or fibrous concrete. The concrete slab is usually placed on a compacted granular subbase which, in turn, is supported by a compacted sub-grade. A typical rigid pavement structure is shown in **Figure 7.1**. These pavements possess a high degree of rigidity. This rigidity enables rigid pavements to distribute loads over large areas of the sub-grade as shown in **Figure 7.2**. For better pavement performance, it is important that support for the entire concrete slab is uniform. Rigid pavement construction strength is most economically built into the slab itself with optimum use of low-cost materials under the slab.

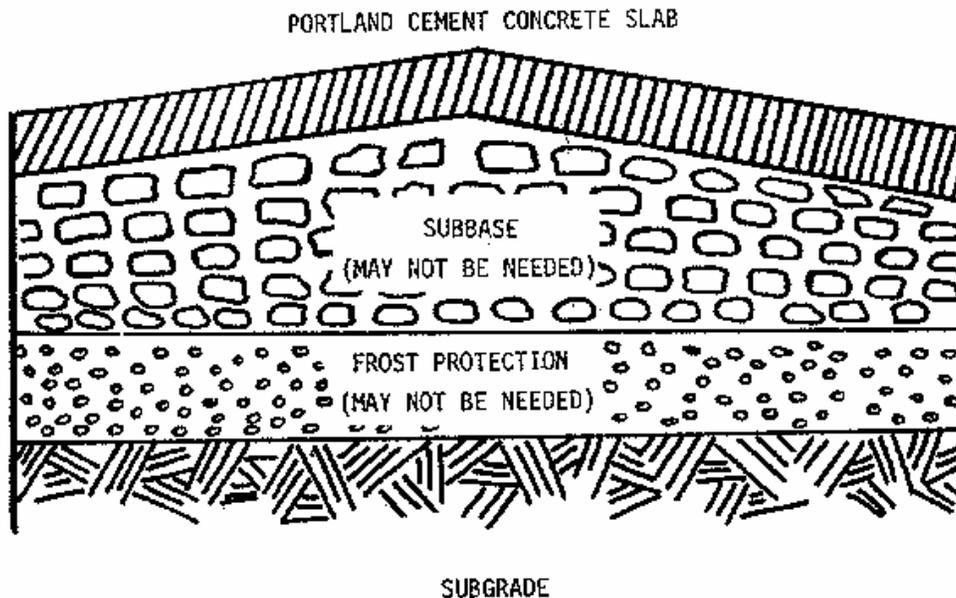


Figure 7.1: Typical Rigid Pavement Structure

Rigid pavement consists of the following layers:

- **Concrete Slab (Surface Layer)** - Provides a skid-resistant surface, prevents the infiltration of surface water, and provides structural support to the aircraft.
- **Subbase** - Provides uniform, stable support for the pavement slab. A minimum subbase thickness of 4 inches is generally required under rigid pavements. Other functions of the subbase are to control frost action, provide subsurface drainage, control swell of sub-grade soils, and prevent mud-pumping of fine grained soils.
- **Stabilized Subbase** - Required for all new rigid pavements designed to accommodate aircraft weighing 100,000 pounds or more.

- **Frost Protection Layer** - provides a barrier against frost action and frost penetration into the lower frost-susceptible layers.
- **Subgrade** - Compacted soil layer which forms the foundation for the pavement system. Subgrade soils are subjected to lower stresses than the surface and subbase courses. These stresses decrease with depth, and the controlling sub-grade stress is usually at the top of the sub-grade unless unusual conditions exist. Soil conditions are related to the ground water level, density, moisture content, and frost penetration. Since the sub-grade soil supports the pavement and the loads imposed on the pavement surface, it is critical to investigate soil conditions to determine their effect on grading and paving operations and the necessity for underdrains.

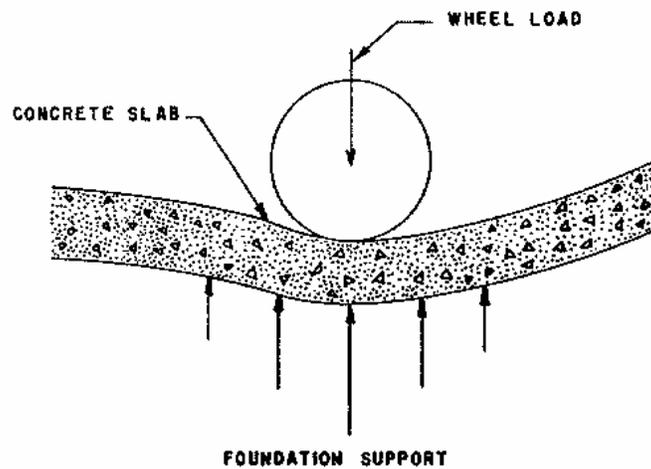


Figure 7.2: Transfer Of Wheel Load To Foundation In Rigid Pavement Structure

Flexible Pavements

Flexible pavements support loads through bearing rather than flexural action. They are composed of several layers of carefully selected materials designed to gradually distribute loads from the pavement surface to the layers underneath. The design is such that the load transmitted to each successive layer does not exceed the layer's load bearing capacity. A typical flexible pavement section is shown in **Figure 7.3**. **Figure 7.4** depicts the distribution of the load imposed on the sub-grade. The various layers of flexible pavement and their functions they perform are as follows:

- **Bituminous Surface or Wearing Course** - Bituminous surface, or wearing course, comprised of a mixture of various selected aggregates bound together with asphalt cement, heavy grades of tars, or other bituminous binders. Its function is to prevent the penetration of water to the base course; provide a smooth surface, free from loose particles (which might endanger aircraft or persons); resist the stresses developed as a result of aircraft loads; and furnish a skid-resistant surface without causing undue wear on tires.

- Base Course** - Principal structural component of the flexible pavement. It distributes the imposed wheel load to the pavement foundation, the subbase and/or the sub-grade. The base course must be of a quality and thickness to prevent failure in the sub-grade and/or the subbase, withstand the stresses produced in the base itself, resist vertical pressures that tend to produce consolidation and result in distortion of the surface course, and resist volume changes caused by fluctuations in its moisture content. The materials comprising the base course are select, hard and durable aggregates which generally fall into two main classes: stabilized and granular. The stabilized bases normally consist of crushed and uncrushed aggregate that has been bound with a stabilizer such as cement or bitumen.

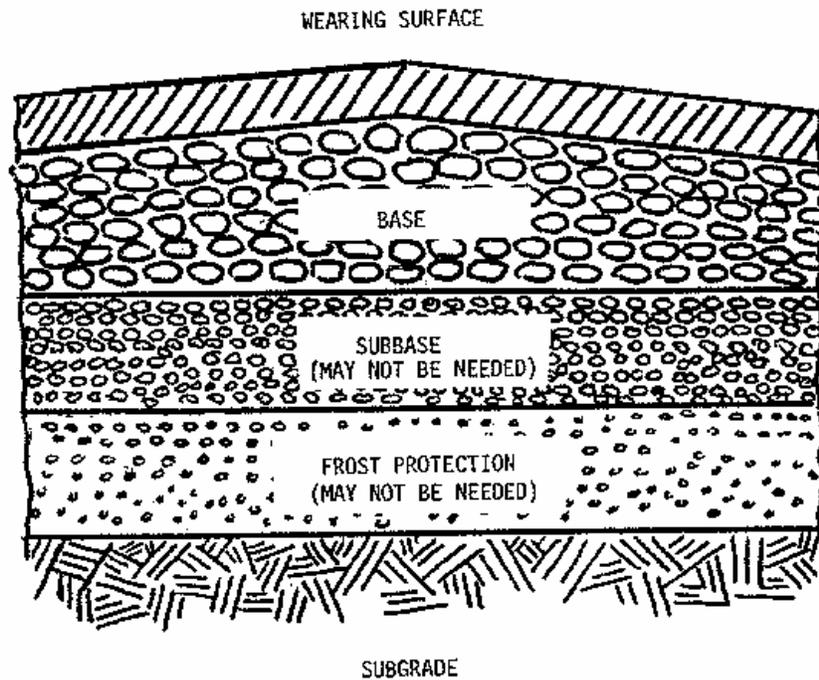


Figure 7.3: Typical Flexible Pavement Structure

- Subbase** - Layer used in areas where frost action is severe or in locations where the subgrade soil is extremely weak. The function of the subbase course is similar to the base course. The material requirements for the subbase are subjected to lower load stresses. The subbase consists of stabilized or granulated materials properly compacted.
- Frost Protection Layer** - The frost protection layer functions are previously discussed under the “Rigid Pavements” section.
- Subgrade** - Compacted soil layer which forms the foundation for the pavement system. Subgrade soils are subjected to lower stresses than the surface, base, and subbase courses. Since load stresses decrease with depth, the controlling sub-grade stress is usually at the top of the sub-grade. The combined thickness of subbase, base, and wearing surface

must be great enough to reduce the stresses occurring in the sub-grade soil layer. Factors affecting sub-grade behavior are previously discussed under the “Rigid Pavements” section.

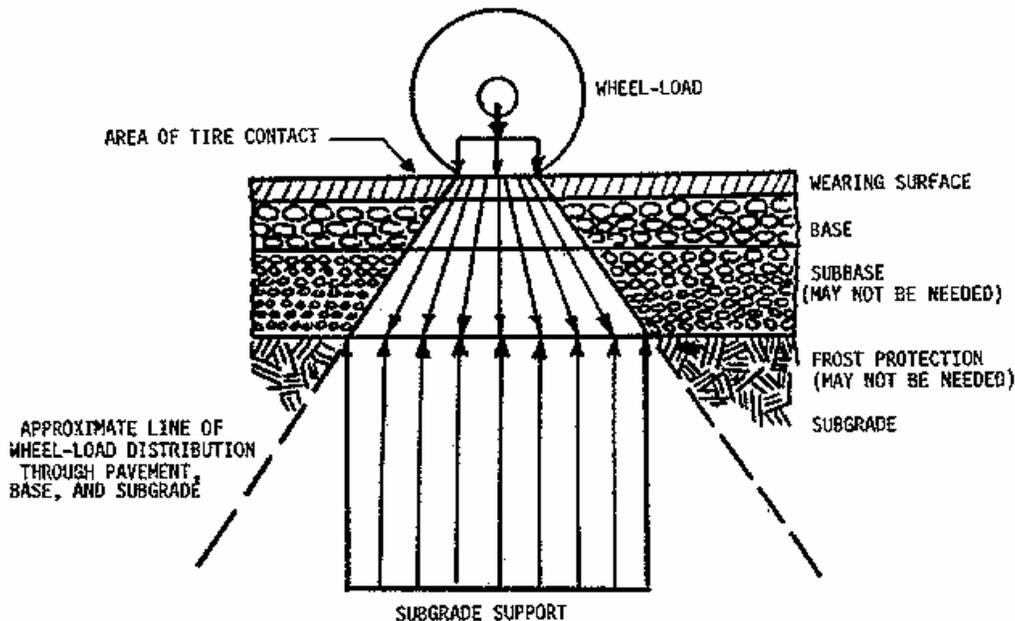


Figure 7.4: Distribution Of Load Stress In Flexible Pavement Design

Overlays

Pavement overlays are usually undertaken to correct deteriorating pavement surfaces, to improve ride quality or surface drainage, to maintain the structural integrity, or to increase pavement strength. For instance, a pavement may have been damaged by overloading; it may require strengthening to serve heavier aircraft; uneven settling may have caused severe puddling; or the original pavement simply may have served its useful life and is worn out. Generally, airport pavement overlays consist of either Portland Cement Concrete or bituminous concrete.

Pavement Distress

Visible evidence of excessive stress levels in pavement systems includes cracks, holes, depressions, and other types of pavement distresses. Pavement distresses in airport pavements, such as cracks, affect the structural integrity, ride quality, and safety of airport pavements by allowing water and foreign particles to deteriorate the pavement at a faster rate. Pavement repairs should be made as soon as possible, even when they may be considered minor. Repairing small distresses initially and at a relatively small cost, can save large amounts of money in the future. A delay in repairing pavements may allow minor distresses to progress into major failures, thus needing large-scale costly repairs.

Figure 7.5 displays a cross section of pavement with various crack types.

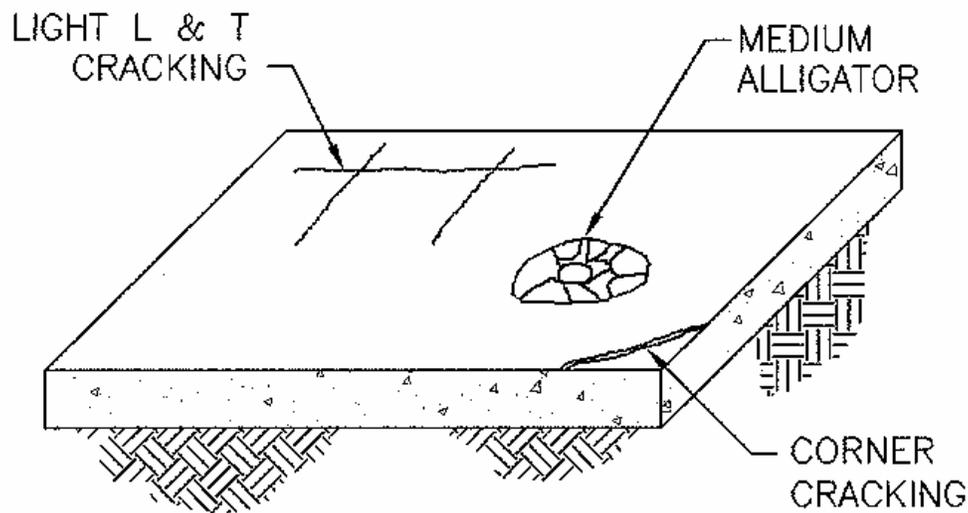


Figure 7.5: Distressed Pavement (Cracking)

Repair procedures to prevent further pavement damage may be limited by weather conditions. For example, filling cracks is more effective in cool and dry weather conditions, whereas pothole patches adhere best during warm and dry days. Seal coats and other surface treatments require warm and dry weather for best results.

Portland Cement Concrete (PCC) Pavement Distresses

Discussions of problems relating to pavement distress are generally based on pavement type; concrete or bituminous. However, while each has its own particular characteristics, the various pavement distresses for bituminous and concrete pavements generally fall into one of the following broad categories: cracking, distortion, disintegration, or skid resistance. The repair procedures discussed in this chapter are only suggested and in no way should be taken over the advice of an experienced engineer who should be consulted before undertaking any large repair project.

Crack Repair And Sealing

Cracking often results from stresses caused by contraction or warping of the pavement. Overloading, loss of sub-grade support, insufficient and/or improperly cut joints acting singularly or in combination are also possible causes. Sealing should be considered only for cracks that are open wide enough to allow the entry of joint sealant or mechanical routing tools. The following sections describe types of cracks in concrete pavements, along with some suggested repair procedures.

Longitudinal, Transverse, And Diagonal Cracks

Longitudinal, transverse, and diagonal cracks are usually caused by a combination of repeated loads and shrinkage stresses and are characterized by cracks which divide the slab into two or more pieces.

Repair Procedure

- Route out a groove about 3/8 inch wide and 3/4 inch deep around the crack.
- Clean out with compressed air. The crack must be free of dirt, dust, and other material that might prevent bonding of the sealant.
- Fill the crack with sealant materials.

Corner Cracks

Corner cracks are caused by load repetition combined with loss of support and curling stresses. This type of break is characterized by a crack that intersects the joints at a distance less than one-half of the slab length on both sides, measured from the corner slabs. A corner crack differs from a corner spall in that the crack extends vertically through the entire slab thickness, while a corner spall intersects the joint at an angle.

Repair Procedure

The following procedure is used to repair corner cracks accompanied by loss of sub-grade support. For low severity cracks, the procedure for crack sealant should be used:

- Make a vertical cut with a concrete saw and remove the broken corner.
- Add subbase material, if necessary, and compact.
- Clean the vertical faces of the remainder of the slab with a high-pressure water jet or compressed air.
- Coat the faces of the adjacent slab with a bond-breaking compound to prevent bonding of the new concrete.
- Maintain the existing joint by using temporary inserts or by sawing the required kerf.
- Coat the clean surface with sand-cement epoxy grout.
- Place the Portland Cement Concrete in the patch area while the grout is still tacky.
- After the concrete has cured, remove the joint inserts or saw a kerf.
- Seal joints

“D” Cracking

“D” cracking usually appears as a pattern of cracks running in the vicinity of and parallel to a joint or linear crack. It is caused by the concrete's inability to withstand environmental factors such as freeze-thaw cycles.

Repair Procedure

The repair procedure of this type of distress usually requires that the complete slab be repaired since normally “D” cracking will show up again adjacent to the repaired areas.

Joint Seal Damage

Joint seal damage is any condition which enables soil or rocks to accumulate in the joints or allows infiltration of water. Accumulation of materials prevents the slabs from expanding and may result in buckling, shattering, or spalling. Typical types of joint seal damage include stripping, extrusion, hardening of the joint sealant, loss of bond with the slab edges, and the absence of sealant in the joint. Joint sealant damage is caused by improper joint width, use of the wrong type of sealant, incorrect application, and/or not cleaning the joint properly before sealing.

Repair Procedure

- Use joint router to remove the joint sealing material to a depth of at least 1 inch.
- Reface the sides of the joint to expose sound concrete that is free of old sealer. This may be accomplished with a power saw.
- Use a power wire brush to remove debris.
- Blow out the joints with compressed air.
- Seal joints with hot or cold compounds. Hot poured sealants should be injected into the joint through nozzles shaped to penetrate into the joint and fill the gap from the bottom. On small jobs, hand-pouring pots may be used.

Disintegration

Disintegration is the breaking up of a pavement into small, loose particles and is caused by improper curing and finishing of the concrete, unsuitable aggregates, and improper mixing of the concrete. It also includes dislodging of aggregate particles. If not corrected in the early stages, disintegration can progress until the pavement requires complete rebuilding. The following sections describe types of disintegration distress along with some suggested repair procedures.

Scaling, Map Cracking, And Crazing

Scaling, map cracking, and crazing refer to a network of shallow hairline cracks that extend only through the upper surface of the concrete. Crazing usually results from improper curing and/or finishing of the concrete and may lead to scaling of the surface. Scaling is the disintegration caused by improper curing or finishing, freeze-thaw cycles, and unsuitable aggregate.

Repair Procedure

- Make a vertical cut with a concrete saw about 1 to 2 inches deep at the perimeter of the scaled area.
- Break out the broken concrete with pneumatic tools until sound concrete is exposed.
- Clean the area with compressed air or high-pressure water jet.
- Coat the surface of the old concrete with a thin coat of sand-cement grout. Dampen the surface with water before applying the grout.
- Place the Portland Cement Concrete while the grout is still wet.
- If the patch crosses or abuts a working joint, the joint must be continued through the patch.

Joint Spalling And Corner Spalling

Joint spalling often results from excessive stresses at the joint or crack caused by infiltration of incompressible materials. Weak concrete at the joint (caused by overworking at the time of construction) combined with traffic loads is another cause of spalling. Joint spalling is the breakdown of the slab edges within 2 feet of the side of the joint. A joint spall usually does not extend vertically through the slab but intersects the joint at an angle.

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

Repair Procedure

- Make a vertical cut with a concrete saw 1 inch in depth and approximately 2 inches behind the spalled area.
- Break out the unsound concrete with air hammers or pneumatic drills and blowout the area with compressed air.
- Pressure rinse the area to be replaced.
- Treat the surface with a grout mixture to insure a good bond between the existing pavement and the new concrete. Apply the grout immediately before placing the patch mixture and spread with a stiff broom or brush to a depth of 1/16 inch.
- Place a thin strip of wood or metal coated with bond-breaking material in the joint groove and tamp the new mixture into the old surface. The mix should be air-entrained and designed to produce concrete without a slump which will require tamping to place in the patch.
- After edging of the patch has been completed, it should be finished to a texture matching the adjacent area.
- After curing for a minimum of 3 days, the open joint should be filled with joint material prior to opening to traffic.

Blowups

Blowups usually occur at a transverse crack or joint. They generally occur in hot weather, usually at a transverse crack in the joint that is not wide enough to permit expansion of the concrete slabs. Insufficient width is usually caused by infiltration of incompressible materials into the joint space. When expansion cannot relieve enough pressure, a localized upward movement of the slab edges (buckling) or shattering will occur in the vicinity of the joint. Blowups normally occur only in thin pavement sections.

Repair Procedure

- Make a vertical cut with a concrete saw approximately 6 inches outside of each end of the broken area.
- Break out the concrete with pneumatic tools and remove concrete down to the subbase/sub-grade material.
- Add subbase material, if necessary, and compact.

- In reinforced pavement construction, joint techniques should be used to tie the new concrete to the old reinforced material. Any replacement joints should be doweled and built to joint specifications. For simplicity of construction, all tiebars, dowels, and reinforcement may be omitted from small interior pavement patches on well compacted subgrades.
- Dampen the sub-grade and the edges of the old concrete.
- Place the concrete on the area to be patched.
- Use ready-mixed concrete if it is satisfactory and can be obtained economically. It may be desirable to use a mixture providing high early strength in order to permit the earliest possible use.
- Finish the concrete so that the surface texture resembles that of the existing pavement.
- Immediately after completing the finishing operations, the surface should be properly cured. Either a moist cure or curing compound may be used.

Shattered Slab

Shattered Slab is defined as a slab where intersecting cracks break up the slab into four or more pieces. This is caused by overloading and/or inadequate foundation support.

Repair Procedure

Follow the same procedures for blowup repairs except that unstable sub-grade materials should be removed to a minimum depth of 12 inches and replaced with select material. Poor drainage conditions should be corrected by the installation of drains to remove excess water.

Distortion

Distortion is a change in the pavement surface from its original position and results from foundation settlement, expansive soils, frost susceptible soils, or loss of fine grain soils through improperly designed subdrains of the drainage system. If not too extensive, some forms of distortion such as from settlement can be remedied by raising the slab to the original grade. The following sections describe types of distress due to distortion along with some suggested repair procedures.

Pumping And Settlement

Pumping is characterized by the ejection of material by water through joints or cracks, caused by deflection of the slab under passing loads. As the water is ejected, it carries particles of gravel, sand, clay, or silt resulting in a progressive loss of pavement support that can lead to cracking. Surface staining and base or sub-grade material on the pavement close to joints or cracks are evidence of pumping. Pumping near joints indicates a poor joint seal and the presence of ground water.

Settlement or faulting is a difference in elevation at a joint or crack caused by upheaval or differential consolidation. This condition may result from loss of fine grain soils from frost heave or from swelling.

Repair Procedure

Slabjacking procedures may be used to correct this type of distress. In slabjacking, a grout is pumped under pressure through holes bored in the pavement into the space under the pavement. This creates an upward pressure on the bottom of the slab in the areas around the space. The upward pressure lessens as the distance from the grout hole increases. Thus, it is possible to raise one corner of a slab without raising the entire slab. Because of the special equipment and experience required, slabjacking is usually best done by specialty contractors.

Skid Resistance

Skid resistance refers to the ability of a pavement to provide a surface with good friction characteristics under all weather conditions and is a function of the surface texture or the buildup of contaminants. The idea is to have enough surface friction to prevent skidding. Treatment includes resurfacing, grooving, milling, and surface cleaning. The following sections describe distresses leading to a loss in skid resistance along with some suggested repair procedures.

Polished Aggregates

Some polished aggregates will become polished quickly under traffic. Others are naturally polished and will be a skid hazard if used in the pavement without crushing.

Repair Procedure

Since polished aggregate distress normally occurs over an extensive area, grooving or milling of the entire pavement surface should be considered. Concrete or bituminous resurfacing may also be used to correct this condition.

Contaminants

Contaminants such as rubber deposits building up over a period of time will reduce the surface friction characteristics of a pavement.

Repair Procedure

Rubber deposits may be removed by use of high-pressure water or biodegradable chemicals. Any water discharges from this activity should not be allowed to enter the storm drainage system.

Bituminous Concrete Patches For Concrete Pavement:

Broken concrete areas can be patched with bituminous concrete as an interim measure. Repair for corner cracks, diagonal cracks, blowups, and spalls can be made using the following procedure

- Make a vertical cut with a concrete saw completely through the slab.
- Break out the concrete with pneumatic tools and remove the broken concrete down to the subbase/sub-grade material.
- Add subbase/sub-grade material if required and compact.
- Apply prime coat to subbase material.
- Apply tack coat to sides of slab.

- Place bituminous concrete in layers not exceeding 3 inches.
- Compact each layer with a vibratory-plate compactor, roller, or mechanical rammers.

Normal traffic may be permitted on bituminous patches immediately after completion of the patch.

Bituminous Pavement Distresses

Cracking

Cracking in bituminous pavements is caused by deflection of the surface over an unstable foundation, shrinkage of the surface, poorly constructed land joints, or reflective cracking. Cracking takes many forms and in some cases, simple crack filling may be the proper corrective action. In others, complete removal of the cracked area and the installation of drainage may be necessary. The following sections describe types of cracking found in bituminous pavements along with some suggested repair procedures.

Longitudinal And Transverse Cracks

Longitudinal and transverse cracks are caused by shrinkage of the bituminous concrete surface. Longitudinal cracks are also caused by poorly constructed lane joints.

Repair Procedure

Narrow cracks (less than 1/8 inch) are too small to seal effectively. In areas where narrow cracks are present, a seal coat, slurry seal, or fog coat may be applied. Wide cracks (greater than 1/8 inch) should be sealed using the following procedure:

- Clean out crack with compressed air to remove all loose particles.
- Fill cracks with a prepared joint sealer.

Alligator Or Fatigue Cracks

Alligator Cracks are interconnected cracks that form a series of small blocks resembling an alligator skin. They may be caused by fatigue failure of the bituminous surface under repeated loading or by excessive deflection of the surface over an unstable foundation. The unstable support is usually the result of water saturation of the bases or sub-grade.

Repair Procedure

Permanent repairs by patching may be carried out as follows:

- Remove the surface and base as deep as necessary to reach a firm foundation. In some cases, a portion of the sub-grade may also have to be removed. A power saw should be used to make a vertical cut through the pavement. The cut should be square or rectangular.
- Replace base material with material equal to that removed. Compact each layer placed.
- Apply prime coat to the base material and vertical faces of existing pavement.
- Place bituminous concrete and compact.
- Temporary repairs can be made by applying a seal coat to the affected area.

Block Cracking

Block cracking is caused by shrinkage of the asphalt concrete and daily temperature cycles which result in daily stress/strain. These are interconnected cracks that divide the pavement into approximately rectangular pieces. The occurrence of this type of distress usually indicates that the asphalt has hardened significantly. Block cracking generally occurs over a large portion of the pavement area and may sometimes occur only in non-traffic areas.

Repair Procedure

If serious, the pavement slab should be replaced.

Slippage Cracks

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

Repair Procedure

One repair method commonly used for slippage cracks involves removing the affected area and patching with plant-mixed asphalt material. The specific steps are as follows:

- Remove the slipping area and at least 1 foot into the surrounding pavement. Make the cut faces straight and vertical. A power pavement saw makes a fast and neat cut.
- Clean the surface of the exposed underlying layer with a broom and compressed air.
- Apply a light tack coat.
- Place enough hot plant-mixed asphalt material in the cutout area to make the compacted surface the same grade as that of the surrounding pavement.

Reflection Cracks

Reflection cracks are caused by vertical or horizontal movements in the pavement beneath an overlay brought on by expansion and contraction with temperature and moisture changes. These cracks in asphalt overlays reflect the crack pattern in the underlying pavement. They occur most frequently in asphalt overlays on Portland Cement Concrete pavements. However, they may also occur on overlays of asphalt pavements wherever cracks in the old pavement have not been properly repaired.

Disintegration

Disintegration in a bituminous pavement is caused by insufficient compaction of the surface, insufficient asphalt in the mix, or overheating of the mix. If not stopped in its early stages, disintegration can progress until the pavement needs complete rebuilding. The following section describes a type of disintegration found in bituminous pavements along with a suggested repair procedure.

Raveling

Raveling is the wearing away of the pavement surface caused by the dislodging of aggregate particles and loss of asphalt binder. As the raveling continues, larger pieces break free, and the pavement takes on a rough and jagged appearance.

Repair Procedure

Further deterioration from raveling may be prevented by the following:

- Sweep the surface free of all dirt and loose aggregate material.
- Apply a fog seal diluted with equal parts of water.
- Close area to traffic until the seal has cured.
- Apply a surface treatment such as an aggregate seal coat.
- A pavement planning machine, such as a heater-plane, may be used to soften the surface of the pavement; then, apply a seal coat or bituminous overlay.

Distortion

Distortion in bituminous pavements is caused by foundation settlement, insufficient compaction of the pavement courses, lack of stability in the bituminous mix, poor bond between the surface and the underlying layer of the pavement structure, or swelling soils or frost action in the sub-grade. Repair techniques range from leveling the surface by filling with new material to complete removal of the affected area and replacing with new material. The following sections describe types of distortion found in bituminous pavements along with some suggested repair procedures.

Rutting

Rutting is characterized as a surface depression in the wheel path. Ruts are most often noticeable only after a rainfall when the wheel paths are filled with water. This type of problem is caused by a permanent imperfection in any of the pavement layers or the sub-grade and its cause is due to traffic loads.

Repair Procedure

- Determine how serious the rutting problem is by measuring with a straightedge or stringline. Outline the areas to be filled.
- Apply a light tack coat of asphalt emulsion diluted with equal parts of water.
- Spread dense-graded asphalt concrete with paver and compact. Be sure that the material is feathered at the edge.
- Place a thin overlay of bituminous concrete over the entire area.

Corrugation And Shoving

Corrugation results from a form of plastic surface movement typified by ripples across the surface. Shoving is a form of plastic movement resulting in localized bulging of the pavement surface. Corrugation and shoving can be caused by lack of stability in the mix and poor bond between material layers.

Repair Procedure

The repair procedure for this type of distress is the same as for patch repair or alligator cracking described previously.

Depressions

Depressions are localized low areas of limited size. In many instances, light depressions are not noticeable until after a rain, when pounding creates “birdbath” areas. Depressions can be caused by heavier traffic than what the pavement was designed for, by localized settlement of the underlying layers, or by poor construction methods.

Repair Procedure

- Determine the limits of the depression with a straightedge or stringline. Outline it on the pavement surface with a marking crayon.
- If grinding equipment is available, grind down the area to provide a vertical face around the edge. If this equipment is not available, this step may be omitted.
- Thoroughly clean the entire area to at least 1 foot beyond the marked limits.
- Apply a light tack coat of asphalt emulsion diluted with equal parts of water to the cleaned area.
- Allow the tack coat to cure.
- Spread enough bituminous concrete in the depression to bring it to the original grade when compacted. The correct way to repair a deep depression is to begin in the deepest part of the depression and place a thin layer, the surface of which when compacted, will be parallel to the original pavement surface. Successive layers are placed in the same manner.
- If the pavement was not ground down, the edges of the patch should be feather-edged by careful raking and manipulation of the material. However, in raking, care should be taken to avoid segregation of the coarse and fine particles of the mixture.
- Thoroughly compact the patch with a vibrator-plate compactor, roller, or hand tamps.

Swelling

Swelling is characterized by an upward bulge in the pavement's surface. It may occur sharply over a small area or as a longer gradual wave. Both types of a swell may be accompanied by surface cracking. A swell is usually caused by frost action in the sub-grade or by swelling soil.

Repair Procedure

The repair procedure is the same as for patch repair or alligator cracking described previously.

Skid Resistance

Factors which decrease the skid resistance of a pavement surface include too much asphalt in the bituminous mix, too heavy a prime coat, poor aggregate subject to wear, and buildup of contaminants. Treatment includes removal of excess asphalt, resurfacing, grooving to improve surface drainage, and removal of rubber deposits. The following sections describe factors which contribute to lower skid resistance along with some suggested repair procedures.

Bleeding

Bleeding is characterized by a film of bituminous material on the pavement surface which resembles a shiny, glass-like reflecting surface that usually becomes quite sticky. It is caused by excessive amounts of asphalt cement or tars in the mix and/or low air-void content and occurs when asphalt fills the pavement. Since the bleeding process is not reversible during cold weather, asphalt or tar will accumulate on the surface. Extensive bleeding may cause a severe reduction in skid resistance.

Repair Procedure

Repair procedures using hot sand or aggregate are as follows:

- Apply slag screenings, sand, or rock screenings to the affected area. The aggregate should be heated to at least 300°F and spread at the rate of 10 to 15 pounds per square yard.
- Immediately after spreading, roll with a rubber-tired roller.
- When the aggregate has cooled, sweep off loose particles.
- Repeat the process, if necessary.
- A pavement planing machine, such as a heater-planer, may be used to remove the excess asphalt; specifically:
 - Remove the asphalt film with a heater-planer,
 - Leave the surface as planed, or
 - Apply either a plant-mixed surface treatment or seal coat.

Polished Aggregate

Polished aggregate is caused by repeated traffic applications. It occurs when the aggregate extending above the asphalt is either very small or poor quality, or contains no rough or angular particles to provide good skid resistance.

Repair Procedure

One means of correcting this condition is to cover the surface with an aggregate seal coat. Grooving or milling the pavement surface may also be used.

Fuel Spillage

Fuel spillage on bituminous surfaces over time will soften the asphalt. Areas subject to only minor fuel spillage will usually heal without repair, and only minor damage will result.

Repair Procedure

Permanent repairs for areas subjected to continuous fuel spillage consist of removal of the damaged pavement and replacement with Portland Cement Concrete or an overlay with a tar emulsion seal coat.

Contaminants

Contaminants, such as rubber, over a period of time will reduce the skid resistance of a pavement.

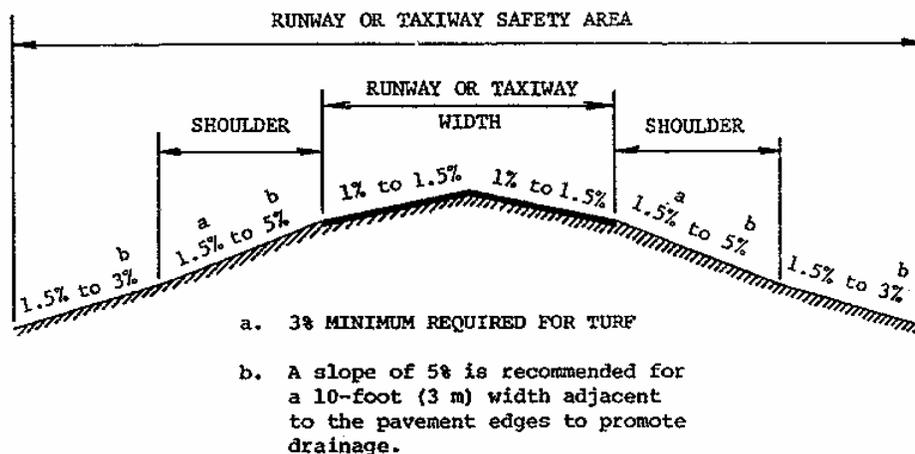
Repair Procedure

Rubber deposits may be removed by using high-pressure water or biodegradable chemicals. Discharges from this activity should be prohibited from entering the storm drainage system.

Drainage

A proper drainage system is a fundamental consideration of preventive maintenance. Pavement failures should always be investigated for inadequate drainage. Probably no other factor plays such an important role in determining the ability of a pavement to withstand the effects of weather and traffic. The purpose of airport drainage is to dispose of the water which may interfere with the safe and efficient operation of the airport. The drainage system collects and removes surface water runoff, removes excess underground water, lowers the water table, and protects all slopes from erosion. An inadequate drainage system can cause saturation of the subgrade and subbase, damage to slopes by erosion, and loss of the load-bearing capacity of the paved surfaces.

Water damage to pavement is related to the amount of water in the boundaries between the structural layers of the pavement. When water fills the voids and spaces at the boundaries between the layers, heavy wheel loads applied to the surface of the pavement produce impacts on the water that are comparable to a water-hammer type action. The resulting water pressure causes erosion of the pavement structure and ejection of material out of the pavement. Drainage is discussed in detail in the FAA Advisory Circular AC 150/5320-5B "Airport Drainage." **Figure 7.6** illustrates recommended grade slopes for proper runway and taxiway drainage. **Figure 7.7** illustrates the effects an improper drainage slope can cause on runways and taxiways.



GENERAL NOTES:

1. A 1.5 inch (3.8 cm) drop from paved to unpaved surfaces is recommended.
2. Drainage ditches may not be located within the safety area.

Figure 7.6: Recommended Proper Grade Slopes For Runways And Taxiways

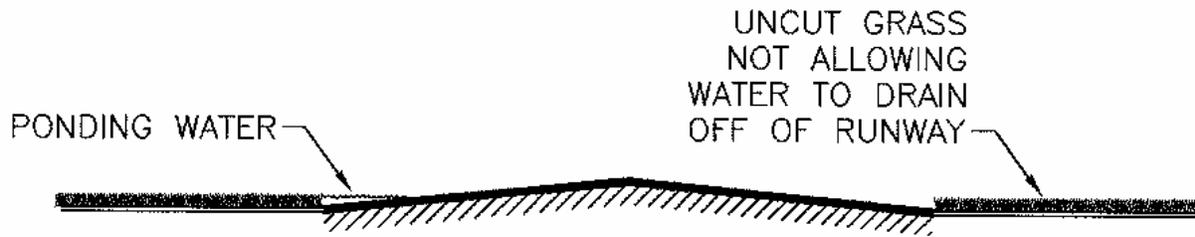


Figure 7.7: Effects On Runways And Taxiways From Poor Drainage Slopes

There are two classes of drainage systems, surface and subsurface. Classification depends on whether the water is on or below the surface of the ground at the point where it is first intercepted or collected for disposal. Where both types of drainage are required, it is generally better for each system to function independently.

The purpose of surface drainage is to control and collect water from rainstorms and melting snow and ice. Surface drainage of pavements is achieved by constructing the pavement surface to allow for adequate runoff. Surface water may be collected at the edges of the paved surface in ditches, gutters, and catch basins. Inevitably, some water will enter the pavement structure through cracks, open joints, and other surface openings, but this may be kept to a minimum by proper surface maintenance procedures.

Subsurface drainage is provided for the pavement by a highly permeable layer of sand-aggregate mixture placed under the full width of the travel way. Longitudinal pipes for collecting the water and an outlet removes excess water from the subsurface drainage system. Drainage removes excess water from pavement foundations to prevent weakening of the base and subgrade layers and to reduce damage from frost action.

Pavement Inspection

While deterioration of pavement due to usage and exposure cannot be completely prevented, a timely and effective maintenance program can reduce this deterioration to a minimum level. Lack of adequate and timely maintenance is the single greatest cause of pavement deterioration. The maintenance inspection can reveal at an early stage where a problem exists and, thus, provide the warning and time to permit a corrective repair project. Postponing a minor maintenance item can develop into a major costly pavement repair project.

Inspection Procedures

Maintenance is a continuous function and is the responsibility of airport personnel. A series of scheduled, periodic inspections, conducted by an experienced engineer or trained maintenance personnel, must be carried out in an effective maintenance program. These surveys must be controlled to insure that each element or feature being inspected is thoroughly checked, that

potential problem areas are identified, and that proper corrective measures are recommended. The maintenance program must provide for adequate follow-up to determine that the corrective work is quickly accomplished and recorded. Although the organization and extent of maintenance activities will vary from airport to airport, the general types of maintenance are relatively the same regardless of airport size or extent of development.

What to do: Inspection of all paved or surfaced areas should be scheduled at least twice a year. One inspection should be scheduled for spring and one for fall. Any unusual storms or other conditions which might have a generally adverse effect on the pavements would also necessitate a complete inspection.

What to look for:

1. Unsealed old cracks and joints
2. Random cracking (transverse, longitudinal, corner)
3. Surface breakup (scaling, raveling)
4. Joint faulting or spalling
5. Pumping or rocking of slabs
6. Surface irregularities (bird baths, washboard)
7. Bleeding
8. Potholing
9. Bitumen oxidation
10. Map cracking, alligator cracking, crazing
11. Pop-outs or slab blowup
12. Slipperiness
13. Extruded joint material
14. Bitumen erosion from solvents
15. Miscellaneous settlement
16. Surface rutting or grooving
17. Binder stripping
18. Broken curbs and walks

Materials, Equipment And Manpower

Normal day-to-day pavement maintenance requires only hand tools, but certain specialized equipment may sometimes be needed. Routing-out of joints in concrete pavements is best accomplished by a hand operated, motor-driven machine especially designed for that purpose. Joint sealing can be accomplished by hand pouring from kettles with narrow spouts, but some sealing materials require pressure application and must be applied with specialized equipment.

If concrete slabs must be broken, the use of mechanical hammers is recommended (air, gasoline, electric). These hammers can also be used for drilling slabs. Large-scale work, for example seal coating of extensive areas, requires specialized equipment, such as pressure distributors for bitumens, aggregate spreaders, and rollers. As a general rule, work of this type is performed by contractors or others organized for such large-scale activities.

Patching and spot sealing can be speeded up by using trailer-type asphalt kettles. Those equipped with a powered handspray bar are valuable maintenance and repair items. Compaction of patches can be accomplished with hand tampers but better results can be assured if small vibrating compactors are used. These vibrating compactors are easy to operate, transportable in small vehicles, can work in very confined areas, and do an excellent job.

Two to six men, trained in the various techniques of repairing and familiar with the tools available to them, can perform the routine maintenance required on the pavement surfaces. Work requiring more than this size crew would normally be considered as a major repair and will require application of methods, materials, and equipment beyond the normal maintenance project.

References

Federal Aviation Administration Advisory Circular AC 150/5380-6A, "Guidelines and Procedures for Maintenance of Airport Pavements"

Federal Aviation Administration Advisory Circular AC 150/5380-7A, "Pavement Management System"

Federal Aviation Administration Advisory Circular AC 150/5320-5B, "Airport Drainage"