



U.S. Department  
of Transportation

**Federal Aviation  
Administration**

# Advisory Circular

**Subject:** Guidelines and Procedures for  
Maintenance of Airport Pavements

**Date:** DRAFT  
**Initiated by:** AAS-100

**AC No:** 150/5380-6C  
**Change:**

**1. Purpose.** This Advisory Circular (AC) provides guidelines and procedures for maintaining airport pavements.

**2. Cancellation.** This AC cancels AC 150/5380-6B, Guidelines and Procedures for Maintenance of Airport Pavements, dated September 28, 2007.

**3. Application.** The guidelines and procedures contained in this AC are recommended by the Federal Aviation Administration (FAA) for the maintenance and minor repairs of airport pavements. This AC offers general guidance for maintenance and is neither binding nor regulatory.

Use of this AC is not mandatory. For major maintenance projects, the airport should utilize plans and specifications developed under the direction of a pavement design engineer.

For all maintenance and repair projects funded with federal grant monies through the Airport Improvement Program (AIP) and with revenue from the Passenger Facility Charge (PFC) Program, the airport must use the guidelines and specifications for materials and methods in AC 150/5370-10, Standards for Specifying Construction of Airports.

Pavement maintenance discussed in this AC is specific to airfield pavements. Maintenance of airport access roads and other non-aeronautical pavements may typically use state Department of Transportation highway standards.

**4. Principal changes.** The AC contains the following principal changes:

- a. Revision and reformatting of entire AC.
- b. Added paragraph on Operational Safety on Airports During Construction in Chapter 1.
- c. Simplified Chapter 2. Moved information on friction, drainage, etc., into Chapter 2.
- d. Added paragraph on Wildlife Hazard Attractants and Mitigation with respect to drainage systems to Chapter 2.

e. Updated and simplified tables for “Quick Guide for Maintenance and Repair of Common Pavement Surface Problems.”

f. Deleted Tables 6-2 through 6-10.

g. Deleted “Pavement Maintenance Management Program” from appendices. Information has been moved to AC 150/5380-7, Airport Pavement Management Program.

h. Deleted “Generic Specifications” and “Generic Typical Details” and replaced with typical repair procedures.

i. Updated Bibliography.

**5. Related reading material.** The publications in Appendix B, Bibliography, provide further guidance and technical information.

**6. Metric units.** Throughout this AC, customary English units will be used followed with “soft” (rounded) conversion to metric units. The English units shall govern.

**7. Comments or suggestions** for improvements to this AC should be sent to:

Manager, Airport Engineering Division  
Federal Aviation Administration  
ATTN: AAS-100  
800 Independence Avenue, S.W.  
Washington, DC 20591

**8. Copies of this AC.** This AC is available on the FAA Airport website:  
[http://www.faa.gov/regulations\\_policies/advisory\\_circulars/](http://www.faa.gov/regulations_policies/advisory_circulars/).

**Michael J. O'Donnell**  
Director of Airport Safety and Standards

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## CHAPTER 1. Introduction to Airport Pavement Maintenance

### 1.1. General.

This advisory circular (AC) provides information on the types of pavement distress that occur to airport pavements and typical corrective action during preventive and remedial maintenance activities. Maintenance includes preventative and any regular or recurring work necessary to preserve existing airport pavements in good condition. Replacing individual parts and mending portions of a pavement are considered minor repair. Typical preventative and regular or recurring pavement maintenance includes: routine cleaning, filling, and/or sealing of cracks; patching pavement; seal coating; grading pavement edges; maintaining pavement drainage systems; and restoring pavement markings. The major objective in the design and construction of pavements is to provide adequate load-carrying capacity; good ride quality necessary for the safe operation of aircraft; and good friction characteristics under all weather conditions.

Some older pavements were not designed for today's aircraft fleet and are exposed to much greater loads than those initially considered. FAA airport pavement design is based upon a minimum 20 year structural life, with the understanding that regular, routine maintenance is performed. Without regular maintenance, the pavement may not achieve the intended structural life.

Airport pavements require continual routine maintenance, rehabilitation and upgrading. Immediately after completion, airport pavements begin a gradual deterioration attributable to weather and loading. Normal distresses in the pavement structure due to weathering, fatigue effects, and differential movement in the underlying subbase occur over a period of years. This gradual deterioration is accelerated by, but not limited to, faulty construction techniques, substandard materials, or poor workmanship. Traffic loads in excess of those forecast during pavement design may also contribute to shorten pavement life.

The most effective means of preserving airport runways, taxiways, and apron pavement areas is to implement a comprehensive maintenance program. An effective maintenance program takes a coordinated, budgeted, and systematic approach to both preventive and remedial maintenance. A systematic approach assures continual vigilance and many airports using this approach have experienced tangible benefits. The comprehensive maintenance program should be updated annually and feature a schedule of inspections and a list of required equipment and products. The airport should systematically make repairs and take preventive measures when necessary.

Airport Improvement Program (AIP) grants require many airports to develop and maintain an effective airport pavement maintenance-management program. The FAA also encourages airports that are not specifically required to develop maintenance programs to do so as a means of preserving their facilities. Refer to AC 150/5380-7, Airport Pavement Management Program (PMP), for information on PMP.

Early detection and repair of pavement defects is the most important preventive maintenance procedure. Failure to perform routine maintenance during the early stages of deterioration will eventually result in serious pavement distresses that require extensive repairs that will be costly in terms of dollars and closure time. The cause of pavement distresses must first be determined

so an airport can select a repair method that not only corrects the present damage, but will also prevent or retard its progression.

Airports should prioritize long term solutions rather than focusing on immediate short-term remedies. The selection of a rehabilitation method should consider both economic and engineering impacts of all practicable alternatives. The cost of rehabilitation alternatives should be compared over some finite period of time (life cycle), considering the future economic consequences of a repair method as well as the initial rehabilitation maintenance costs.

## **1.2. Operational Safety on Airports During Construction.**

Airports are complex environments, and procedures and conditions associated with construction and maintenance activities often affect aircraft operations and can jeopardize operational safety. Safety considerations are paramount and may make operational impacts unavoidable. However, careful planning, scheduling, and coordination of construction and maintenance activities can minimize disruption of normal aircraft operations and avoid situations that compromise the airport's operational safety. An airport operator has overall responsibility for all activities on an airport, including construction and maintenance. The airport operator must understand how construction and maintenance activities and aircraft operations affect one another to be able to develop an effective plan to complete the project.

An effective project construction safety and phasing plan (CSPP) should be developed for maintenance activities. The development of the CSPP includes identifying the areas of the airport affected by the project; the impact to normal airport operations, if any and any temporary changes that are required with respect to air traffic operations, aircraft rescue and fire-fighting (ARFF) or other operations; and how risk will be managed. AC 150/5370-2, Operational Safety on Airports During Construction provides additional information and guidance about safety on airports during construction.

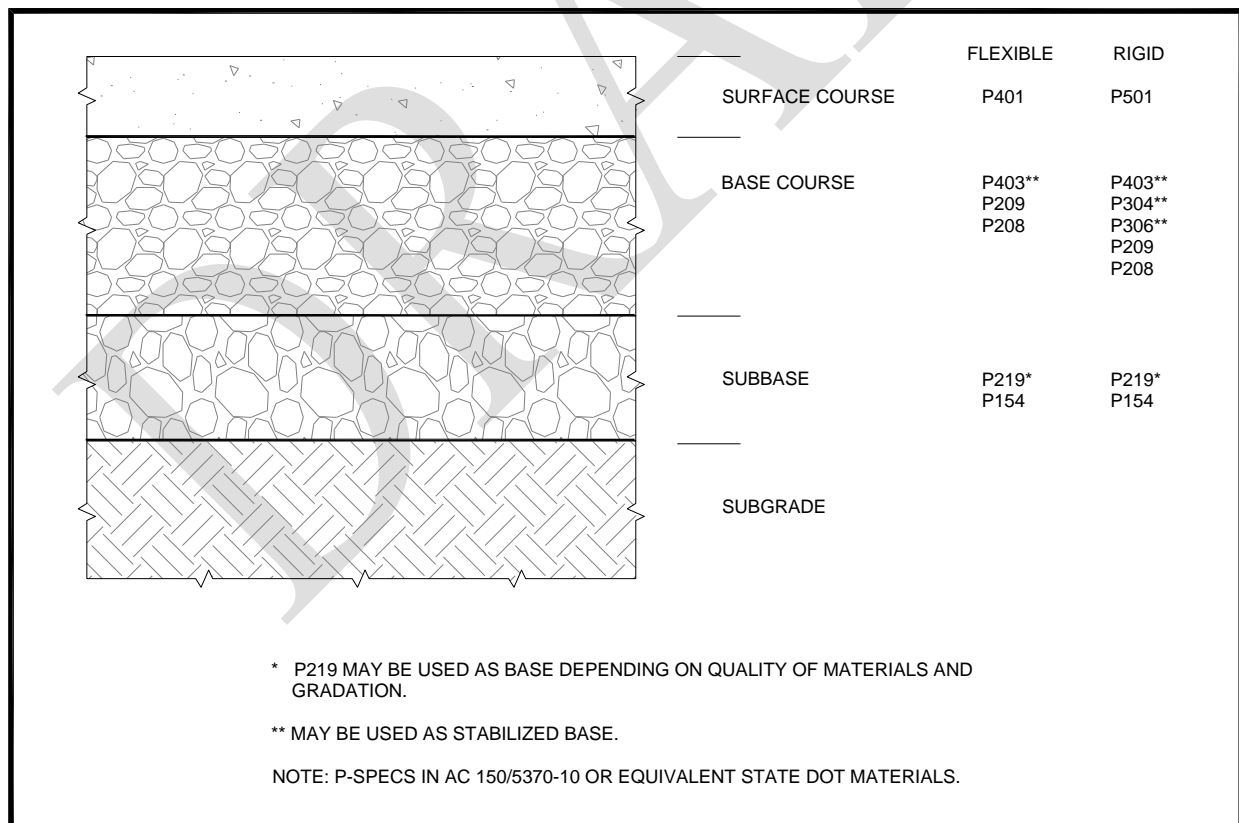
## CHAPTER 2. Airport Pavements

### 2.1. General.

Airport pavements are designed, constructed, and maintained to support the critical loads imposed by aircraft and to produce a firm, stable, smooth, skid-resistant, all-year, all-weather surface free of debris or other particles that may be blown or picked up by propeller wash or jet blast. The quality and thickness of the pavement must ensure the pavement will not fail under the imposed loads and the pavement must be durable enough to withstand the abrasive action of traffic, adverse weather conditions, and other deteriorating influences. To ensure the necessary strength of the pavement and to prevent unmanageable distresses from developing, the airport should consider various design, construction, and material-related parameters. For guidance and design standards for pavements, refer to AC 150/5320-6, Airport Pavement Design and Evaluation. For materials and methods for construction of airports, refer to AC 150/5370-10, Standards for Specifying Construction of Airports. The AC's are available at <http://www.faa.gov/airports>.

### 2.2. Types of Pavements.

Pavements generally fall into two types: flexible and rigid. Figure 2-1 shows a typical pavement structure and acceptable materials for each layer.



**Figure 2-1. Typical Pavement Structure**

**2.2.1. Flexible Pavement Composition and Structure.** Flexible pavements support loads through bearing. They comprise several layers of carefully selected materials designed to gradually distribute loads from the pavement surface to the layers underneath. The design ensures the load transmitted to each successive layer does not exceed the layer's load-bearing capacity. The various layers composing a flexible pavement section and the functions the various layers perform are described below.

**a. Bituminous Surface (Wearing Course).** The bituminous surface, or wearing course, is made up of a mixture of various selected aggregates bound together with asphalt cement or other bituminous binders. The material used in the surface course is commonly referred to as Hot-Mix Asphalt (HMA). The HMA prevents the penetration of surface water into the base course; provides a smooth, well-bonded surface free from loose particles, which might endanger aircraft or people; resists the stresses caused by aircraft loads; and supplies a skid-resistant surface without causing undue wear on tires.

**b. Base Course.** The base course serves as the principal structural component of the flexible pavement. It distributes the imposed wheel load to the pavement foundation, the subbase, and/or the subgrade. The base course must have sufficient quality and thickness to prevent failure in the subgrade and/or subbase, withstand the stresses produced in the base itself, resist vertical pressures that tend to produce consolidation and distortion of the surface course, and resist volume changes caused by fluctuations in its moisture content. The quality of the base course is a function of its composition, physical properties, and compaction of the material. The materials composing the base course are select hard, durable aggregates, which generally fall into two main classes: stabilized and granular. The stabilized bases normally consist of crushed or uncrushed aggregate bound with a stabilizer, such as Portland cement or asphalt cement. The granular bases normally consist of crushed or uncrushed aggregate constructed on a prepared subgrade.

**c. Subbase.** The subbase layer is used in areas where frost action is severe or the subgrade soil is weak. The subbase course functions like the base course, but the material requirements for the subbase are not as strict as those for the base course because the subbase is subjected to lower load stresses. The subbase consists of stabilized or properly compacted granular material.

**d. Subgrade.** The subgrade is the compacted soil layer that forms the foundation of the pavement section. Subgrade soils are subjected to lower stresses than the surface, base, and subbase courses. Since load stresses decrease with depth, the controlling subgrade stress usually lies at the top of the subgrade. The combined thickness of subbase, base, and surface course must be great enough to reduce the stresses occurring in the subgrade to values that will not cause excessive distortion or displacement of the subgrade soil layer.

**2.2.2. Rigid Pavement Composition and Structure.** Rigid pavements support loads through flexural action. Rigid pavements normally use Portland cement concrete (PCC) as the prime structural element. Depending on conditions, engineers may design the PCC pavement slab with plain, lightly reinforced, continuously reinforced, or pre-stressed concrete. The PCC pavement slab is usually placed on a compacted granular or treated subbase supported by a compacted subgrade. The subbase provides uniform stable support and may provide subsurface drainage. The PCC pavement slab has considerable flexural strength and spreads the applied loads over a



large area. Rigid pavement strength is most economically built into the PCC pavement slab itself with optimum use of low-cost materials under the slab. The various layers composing a rigid pavement section and the functions the various layers perform are described below.

**a. PCC Pavement Slab (Surface Course).** The PCC pavement slab provides structural support to the aircraft, provides a skid-resistant surface, and prevents the infiltration of surface water into the subbase.

**b. Base.** The base provides uniform stable support for the pavement slab. The base also serves to control frost action, provide subsurface drainage, control swelling of subgrade soils, provide a stable construction platform for rigid pavement construction, and prevent pumping of fine-grained soils. Rigid pavements generally require a minimum base thickness of 4 inches (100 mm).

**c. Stabilized Base.** All new rigid pavements designed to accommodate aircraft weighing 100,000 pounds (45,000 kg) or more must have a stabilized base. The structural benefit imparted to a pavement section by a stabilized base is reflected in the modulus of subgrade reaction assigned to the foundation.

**d. Subbase.** The subbase layer is used in areas where frost action is severe or the subgrade soil is weak. The subbase course functions like the base course, but the material requirements for the subbase are not as strict as those for the base course because the subbase is subjected to lower load stresses. The subbase consists of stabilized or properly compacted granular material.

**e. Subgrade.** The subgrade is the compacted soil layer that forms the foundation of the pavement section. Subgrade soils are subjected to lower stresses than the surface and subbase courses. These stresses decrease with depth, and the controlling subgrade stress is usually at the top of the subgrade unless unusual conditions exist. Unusual conditions, such as a layered subgrade or sharply varying water content or densities, may change the locations of the controlling stress. The soils investigation should check for these conditions. The pavement structure above the subgrade must be capable of reducing stresses imposed on the subgrade to values that are low enough to prevent excessive distortion or displacement of the subgrade soil layer.

### 2.3. Drainage of Airport Pavements.

Maintenance of the airport drainage system is essential in airport pavement preventive maintenance. No other factor plays a more important role in the ability of a pavement to withstand the effects of weather and traffic. The drainage system collects and removes surface water runoff, removes excess ground water, lowers the water table, and protects slopes from erosion. An inadequate drainage system can cause saturation of the subgrade and subbase, slope erosion, and loss of the load-bearing capacity of the paved surfaces.

Water has a detrimental effect on pavement performance, primarily by either weakening subsurface materials or eroding material by free water movement. For flexible pavements, the weakening of the base, subbase, or subgrade when saturated with water is one of the main causes of pavement failures. In rigid pavement, free water, trapped between the concrete surface and an impermeable layer directly beneath the concrete, will move due to pressure caused by loadings.

This movement of water (referred to as pumping) erodes the subsurface material, creating voids under the concrete surface. In frost areas, subsurface water will contribute to frost damage by heaving during freezing and loss of subgrade support during thawing. Poor subsurface drainage can also contribute to secondary damage such as durability cracking (D cracking) or swelling of subsurface materials.

The type, speed, and volume of traffic will influence the criteria used in the design of pavement drainage systems. For rigid pavements, pumping is greatly increased as the volume and speed of the traffic increases. For flexible pavements, the buildup of pore pressures as a result of high-volume, high-speed traffic is a primary cause of the weakening of the pavement structure. For these reasons, the criteria for a subsurface drainage system under airfield runways and taxiways will be more stringent than for airfield parking aprons or other pavements that have low-volume and low-speed traffic.

The two types of water to be considered are surface water and subsurface water. Surface water is the most important source of water and the source of most concern. Subsurface water is important in frost areas and areas of very high water table or areas of artesian water because the free water collects under the surface by freeze/thaw action. In many areas, perched water may develop under pavements due to a reduced rate of evaporation of the water from the surface. Where drainage is required for surface and subsurface water, it is generally good practice for each system to function independently.

**a. Surface Drainage.** Surface drainage controls, collects, and disposes of water from rainstorms and melting snow and ice that accumulate on the surface of the pavement and nearby ground. Surface drainage of pavements is achieved by constructing the pavement surface and adjacent ground in a way that allows for adequate runoff. The water may be collected at the edges of the paved surface. Although some water will enter the pavement structure through cracks, open joints, and other surface openings, this penetration may be kept to a minimum by proper surface maintenance procedures. Surface water should not be allowed to enter a subdrainage system because it often contains soil particles which may cause the subdrains to silt up.

**b. Subsurface Drainage.** Subsurface drainage is provided for the pavement by a permeable layer of aggregate or permeable stabilized layers with longitudinal pipes for collecting the water and outlet pipes for rapid removal of the water from the subsurface drainage system. Subsurface drains may also consist of perforated collection pipes or conduits in a permeable sand or gravel trench encased in geotextiles with outlet pipes. These systems remove excess water from pavement foundations to prevent weakening of the base and subgrade and to reduce damage from frost action. Subsurface drainage placed at the pavement edge also minimizes surface runoff from entering the perimeter of the pavement structure.

AC 150/5320-5, Airport Drainage Design, contains additional guidance and technical information on airport drainage.

**2.3.1. Maintenance of Subsurface Drainage Systems.** Commitment to maintenance is as important as providing subsurface drainage systems. In fact, an improperly maintained drainage system can cause more damage to the pavement structure than if no drainage were provided at

all. Poor maintenance leads to clogged or silted outlets and edge-drain pipes, missing rodent screens, excessive growth of vegetation blocking outlet pipes and openings on day-lighted bases, and growth of vegetation in side ditches. These problems can potentially cause the back up of water within the pavement system, thereby defeating the purpose of providing the drainage system. Inspections and maintenance of subsurface drainage systems should be made an integral part of the policy of any agency installing these systems.

**2.3.2. Drainage Inspection.** The pavement maintenance program should take into account the importance of adequate drainage of surface and ground water because water is directly or partly responsible for many pavement failures and deterioration. Sufficient drainage for collection and disposal of surface runoff and excess ground water is vital to the stability and serviceability of pavement foundations. Trained personnel should conduct periodic and complete inspections of drainage systems and record and correct defective conditions of surface and subsurface drainage systems. Runway and taxiway edge drains and catch basins should be inspected at intervals (i.e., spring, summer, fall, and winter) and monitored following unusually heavy rainfall. The personnel making the inspection should look for distress signals that may indicate impending problems including: ponding of water; soil buildup at pavement edge preventing runoff; eroded ditches and spill basins; broken or displaced inlet grates or manhole covers; clogged or silted inlet grates and manhole covers; blocked subsurface drainage outlets; broken or deformed pipes; backfill settlement over pipes; erosion around inlets; generally poor shoulder shaping and random erosion; and discoloration of pavement at joints or cracks.

**2.3.3. Wildlife Hazard Attractants and Mitigation.** Throughout the planning, design, construction, and maintenance of airport surface storm drainage and subsurface drainage systems the airport owner must emphasize and address the elimination and/or mitigation of drainage features in the project(s) that could attract hazardous wildlife on and/or around an airport. Refer to the following documents and sites for guidance on wildlife hazards at airports:

a. AC 150/5200-33, Hazardous Wildlife Attractants On or Near Airports, contains guidance on certain land uses that have the potential to attract hazardous wildlife on or near airports. The AC is available at: [http://www.faa.gov/airports/resources/advisory\\_circulars/](http://www.faa.gov/airports/resources/advisory_circulars/).

b. Wildlife Hazard Management at Airports, A Manual for Airport Personnel, is available at: [http://www.faa.gov/airports/airport\\_safety/wildlife/problem/media/2005\\_FAA\\_Manual\\_complete.pdf](http://www.faa.gov/airports/airport_safety/wildlife/problem/media/2005_FAA_Manual_complete.pdf).

c. Additional information on wildlife issues can be found on the FAA Guidance on Wildlife website at: [http://www.faa.gov/airports/airport\\_safety/wildlife/guidance/](http://www.faa.gov/airports/airport_safety/wildlife/guidance/).

## **2.4. Pavement Management Program (PMP).**

A PMP provides one method of establishing an effective maintenance and repair system. A PMP is a systematic and consistent procedure for scheduling maintenance and rehabilitation based on maximizing benefits and minimizing costs. A PMP not only evaluates the present condition of a pavement, but also can be used to forecast its future condition. By projecting the rate of deterioration, a PMP can facilitate a life-cycle cost analysis for various alternatives and help determine when to apply the best alternative.

The primary component of any PMP is the ability to track a pavement's deterioration and determine the cause of the deterioration. This requires an evaluation procedure that is objective, systematic, and repeatable. One such procedure is the Pavement Condition Index (PCI). The PCI is a rating of the surface condition of a pavement and indicates functional performance. A PCI evaluation may also provide an indication of the pavement's structural performance. Periodic PCI determinations on the same pavement will show the change in performance level over time. Airports can use the pavement condition survey to develop pavement performance data. Distress intensity recorded over time helps determine how the pavement is performing. The rate at which the distress intensity increases is a good indicator of the pavement performance. The PCI is determined in accordance with procedures contained in ASTM D 5340, Standard Test Method for Airport Pavement Condition Index Surveys. Refer to AC 150/5380-7, Airport Pavement Management Program, for additional information on PMP.

## **2.5. Friction.**

Airports should maintain runway pavements that provide surfaces with good friction characteristics under all weather conditions. Over time, the skid-resistance of runway pavement deteriorates due to a number of factors, the primary ones being mechanical wear and polishing action from aircraft tires rolling or braking on the pavement and the accumulation of contaminants, chiefly rubber, on the pavement surface. The effect of these two factors is directly dependent upon the volume and type of aircraft traffic. Other influences on the rate of deterioration includes, but is not limited to, local weather conditions, the type of pavement (HMA or PCC), the materials used in original construction, any subsequent surface treatment, drainage, and airport maintenance practices.

AC 150/5320-12, Measurement, Construction, and Maintenance of Skid Resistant Airport Pavement Surfaces, provides guidance on frequency and procedures for conducting friction surveys. Visual observations made during a pavement inspection are an inadequate predictor of skid resistance.

Contaminants, such as rubber deposits, dust particles, jet fuel, oil spillage, water, snow, ice, and slush, all cause friction loss on runway pavement surfaces. Removal and runway treatment for snow, ice, and slush are covered in AC 150/5200-30, Airport Winter Safety and Operations. The most persistent contaminant problem is deposit of rubber from tires of landing jet aircraft. Rubber deposits occur at the touchdown areas on runways and can be quite extensive. Heavy rubber deposits can completely cover the pavement surface texture causing loss of aircraft braking capability and directional control, particularly when runways are wet.

## **2.6. Nondestructive Testing (NDT).**

In addition to collecting information from visual inspections of the pavement area and about runway history, airports should consider collecting data from nondestructive testing. Such data may be used to evaluate the pavement load-carrying capacity. Refer to AC 150/5370-11, Use of Nondestructive Testing Devices in the Evaluation of Airport Pavements, for information on NDT.

## CHAPTER 3. Pavement Distress

### 3.1. General.

This chapter provides a discussion and description of the types of pavement distress and relates them to likely causal factors. Various external signs or indicators make the deterioration of a pavement apparent, and often reveal the probable causes of the failure. AC 150/5380-7, Airport Pavement Management Program; ASTM D5340, Standard Test Method for Airport Pavement Condition Index Surveys; and ASTM D6433, Standard Practice for Roads and Parking Lots Pavement Condition Index Surveys provide additional information on distresses.

### 3.2. Types of Pavement Distress.

The discussions of problems related to pavement distress are generally based on whether the pavement has a flexible or rigid surface type.

#### 3.2.1. Flexible Pavement Distresses.

**a. Cracking.** Cracks in flexible pavements are caused by deflection of the surface over an unstable foundation, shrinkage of the surface, thermal expansion and contraction of the surface, poorly constructed lane joints, or reflection cracking. Five types of cracks commonly occur in flexible pavements.

**(1) Longitudinal and Transverse Cracks.** Longitudinal and transverse cracks may result from shrinkage or contraction of the hot mix asphalt (HMA) surface. Shrinkage of the surface material is caused by oxidation and age hardening of the asphalt material. Contraction is caused by thermal fluctuations. Poorly constructed paving lane joints may accelerate the development of longitudinal joint cracks.

**(2) Block Cracking.** Block cracks are interconnected cracks that divide the pavement into approximately rectangular pieces. The blocks may range in size from approximately 1 foot by 1 foot (0.3m by 0.3m) to 10 feet by 10 feet (3m by 3m). Block cracking is caused mainly by contraction of the asphalt and daily temperature cycling that results in daily stress/strain cycling. It is not load associated. 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 sometimes will occur only in non-traffic areas. Block cracking differs from alligator cracking which is discussed in (4) below.

**(3) Reflection Cracking.** Vertical or horizontal movement in the pavement beneath an overlay cause this type of distress. This movement may be due to expansion and contraction caused by temperature and moisture changes or traffic loads. The cracks in HMA overlays reflect the crack pattern or joint pattern in the underlying pavement. They occur most frequently in HMA overlays on Portland cement concrete (PCC) pavements. However, they may also occur on overlays of HMA pavements when cracks or joints in the old pavement have not been properly repaired.

**(4) Alligator or Fatigue Cracking.** Alligator or fatigue cracking is a series of interconnecting cracks caused by fatigue failure of the HMA surface under repeated traffic

loading. The cracking begins at the bottom of the HMA surface (or stabilized base) where tensile stress and strain are highest under a wheel load. The cracks propagate to the surface initially as a series of parallel cracks. After repeated traffic loading or excessive deflection of the HMA surface over a weakened or under-designed foundation or interlayer, the cracks connect, forming many sided sharp angled pieces that develop a pattern resembling chicken wire or alligator skin. The pieces are less than 2 feet (0.6m) on the longest side.

**(5) Slippage Cracks.** Slippage cracks appear when braking or turning wheels 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 the pavement structure. These cracks are crescent or half-moon-shaped with the two ends pointing away from the direction of traffic.

**b. Disintegration.** Disintegration in a flexible pavement is typically caused by climate, insufficient compaction of the surface, insufficient asphalt binder in the mix, loss of adhesion between the asphalt coating and aggregate particles, or severe overheating of the mix. Six types of disintegration common occur.

**(1) Raveling.** Raveling is the wearing away of the pavement surface caused by the dislodging of aggregate particles. This distress may indicate that the asphalt binder has aged and hardened significantly. As the raveling continues, larger pieces break free, and the pavement takes on a rough and jagged appearance which can produce a significant source for Foreign Object Debris/Damage (FOD).

**(2) Weathering.** Weathering is the wearing away of the asphalt binder and fine aggregate matrix from the pavement surface. The asphalt surface begins to show signs of aging which may be accelerated by climatic conditions. Loss of fine aggregate matrix is noticeable and may be accompanied by fading of the asphalt pavement color.

**(3) Potholes.** A pothole is defined as a disruption in the pavement surface where a portion of the pavement material has broken away, leaving a hole. Most potholes are caused by fatigue of the pavement surface. As fatigue cracks develop, they interlock forming alligator cracking. When the sections of cracked pavement work loose, they may eventually be picked out of the surface by continued wheel loads, and form a pothole. In northern climates, where freeze-thaw cycles are severe, pothole development is exacerbated due to the continuous freeze-thaw action and may not be related solely to traffic patterns. Although possible, potholes are not a common distress to airfields.

**(4) Asphalt Stripping.** Asphalt stripping is caused by moisture infiltration into the HMA pavement structure leading to “stripping” of the bituminous binder from the aggregate particles. Asphalt stripping of HMA pavements may also be caused by cyclic water-vapor pressures within the mixture scrubbing the binder from the aggregates.

**(5) Jet Blast Erosion.** Jet blast erosion is defined as a darkened area of pavement surface where the bituminous binder has been burned or carbonized. Localized burned areas may vary in depth up to approximately 1/2-inch (13 mm).

**(6) Patching and Utility Cut Patch.** A patch is defined as an area where the original pavement has been removed and replaced by a filler material. Deterioration of a patch typically

has a higher rate of deterioration than the original pavement. Deterioration of patch areas affects the ride quality and creates FOD potential.

**c. Distortion.** Distortion in flexible 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, and swelling soils or frost action in the subgrade. Five types of distortion commonly occur.

**(1) Rutting.** A rut is characterized by a surface depression in the wheel path. In many instances, ruts become noticeable only after a rainfall when the wheel paths fill with water. This type of distress is caused by a permanent deformation in any one of the pavement layers or subgrade, resulting from the consolidation or displacement of the materials due to traffic loads.

**(2) Corrugation.** Corrugation results from a form of plastic surface movement typified by ripples across the surface. Corrugation can be caused by a lack of stability in the mix or a poor bond between material layers.

**(3) Shoving.** Shoving is the localized bulging of a pavement surface. It can be caused by lack of stability in the mix, shear movement at an interlayer, or lateral stresses produced by adjacent PCC pavement during expansion.

**(4) Depressions.** Depressions are localized low areas of limited size. Light depressions are typically only noticeable after a rain, when ponding creates "birdbath" areas. Depressions may result from heavier traffic than the pavement was designed for; localized settlement of the underlying pavement layers; or poor construction methods.

**(5) Swelling.** An upward bulge in the pavement's surface characterizes swelling. It may occur sharply over a small area or as a longer gradual wave. Both types of swelling may be accompanied by surface cracking. A swell is usually caused by frost action surrounding dissimilar material types in the subgrade or by swelling soil.

**d. Loss of Skid Resistance.** Factors that decrease the skid resistance of a pavement surface and can lead to hydroplaning include too much asphalt in the bituminous mix; too heavy a tack coat; poor aggregate which is subject to wear; paint; and buildup of contaminants. In flexible pavements, a loss of skid resistance may result from the following.

**(1) Polished Aggregate.** Aggregate polishing is caused by repeated traffic applications. Polished aggregate is present when the portion of aggregate extending above the asphalt is either very small, of poor quality, or there are no rough or angular particles to provide good skid resistance.

**(2) Contaminants.** Accumulation of rubber particles, oils, or other external materials on the pavement surface will reduce the skid resistance of a pavement. Buildup of rubber deposits in pavement grooves will reduce the effectiveness of the grooves and increase the likelihood of hydroplaning.

**(3) Bleeding.** Bleeding is characterized by a film of bituminous material on the pavement surface that resembles a shiny, glass-like, reflecting surface that usually becomes quite

491 sticky. It is caused by excessive amounts of asphalt binder in the mix and/or low air-void  
492 content. Bleeding occurs when asphalt binder fills the voids in the mix during hot weather and  
493 then expands out onto the surface of the pavement. Bleeding may also result when an excessive  
494 tack coat is applied prior to placement of the HMA surface. Since the bleeding process is not  
495 reversible during cold weather, asphalt binder will accumulate on the surface. Extensive  
496 bleeding may cause a severe reduction in skid resistance.

497 **(4) Fuel/Oil Spillage.** Continuous fuel/oil spillage on a HMA surface will soften the  
498 asphalt. Areas subject to only minor fuel/oil spillage will usually heal without repair, and only  
499 minor damage will result.

### 500 **3.2.2. Rigid Pavement Distresses.**

501 **a. Cracking.** Cracks in rigid pavements often result from stresses caused by expansion and  
502 contraction or warping of the pavement. Overloading, loss of subgrade support, and insufficient  
503 and/or improperly cut joints acting singly or in combination are also possible causes. Several  
504 different types of cracking can occur.

505 **(1) Longitudinal, Transverse, and Diagonal Cracks.** A combination of repeated loads  
506 and shrinkage stresses usually causes this type of distress. It is characterized by cracks that  
507 divide the slab into two or three pieces. May indicate poor construction techniques, underlying  
508 pavement layers that are structurally inadequate for the applied load, or pavement overloads.

509 **(2) Corner Breaks.** Load repetition, combined with loss of support and curling stresses,  
510 usually causes cracks at the slab corner. The lack of support may be caused by pumping or loss  
511 of load transfer at the joint. Corner breaks are characterized by a crack that intersects the joints  
512 at a distance less than or equal to one-half of the slab length on both sides, measured from the  
513 corner of the slab. A corner break differs from a corner spall in that the break extends vertically  
514 through the entire slab thickness; a corner spall intersects the joint at an angle.

515 **(3) Durability "D" Cracking.** "D" cracking usually appears as a pattern of cracks  
516 running in the vicinity of and parallel to a joint or linear crack. It is caused by the concrete's  
517 inability to withstand environmental factors such as freeze-thaw cycles because of variable  
518 expansive aggregates. This type of cracking may eventually lead to disintegration of the  
519 concrete within 1 to 2 feet (30 to 60 cm) of the joint or crack.

520 **(4) Shrinkage Cracking.** Shrinkage cracks are hairline cracks that are usually only a  
521 few feet long and do not extend across the entire slab. They are formed during the setting and  
522 curing of the concrete and usually do not extend through the depth of the slab. Typically,  
523 shrinkage cracks do not extend greater than 1/4-inch (6 mm) from the slab surface and may be  
524 primarily in the finished surface paste only.

525 **(5) Shattered Slab/Intersecting Cracks.** A shattered slab is defined as a slab where  
526 intersecting cracks break up the slab into four or more pieces. This is primarily caused by  
527 overloading due to traffic and/or inadequate foundation support.

528 **b. Joint Seal Damage.** Joint seal damage is any condition that enables incompressible  
529 foreign material such as soil or rocks to accumulate in the joints or that allows infiltration of



water. Accumulation of foreign materials prevents the slabs from expanding and may result in buckling, shattering, or spalling. Water infiltration through joint seal damage can cause pumping or deterioration of the base. Typical types of joint seal damage include stripping of joint sealant, extrusion of joint sealant, hardening of the filler (oxidation), loss of bond to the slab edges, and absence of sealant in the joint. Joint seal damage is caused by improper joint width, use of the wrong type of sealant, incorrect application, not properly cleaning the joint before sealing, and/or climate (aging).

**c. Disintegration.** Disintegration is the breaking up of a pavement into small, loose pieces including the dislodging of aggregate particles. Improper curing and finishing of the concrete, unsuitable aggregates, and improper mixing of the concrete can cause this distress. Disintegration falls into several categories.

**(1) Scaling, Map Cracking, and Crazeing.** Scaling is the disintegration and loss of the wearing surface. A surface weakened by improper curing or finishing and freeze-thaw cycles can lead to scaling. Map cracking or crazeing refers to a network of shallow hairline cracks that extend only through the upper surface of the concrete. Crazeing usually results from improper curing and/or finishing of the concrete and may lead to scaling of the surface.

**(2) Alkali-Silica Reactivity (ASR).** ASR is another source of distress associated with map cracking. ASR is caused by an expansive reaction between alkalis and certain reactive silica minerals which form a gel. The gel absorbs water, causing expansion which may damage the concrete and adjacent structures. Alkalis are most often introduced by the Portland cement within the pavement. ASR may be indicated by cracking of the concrete pavement (often in a map pattern); white, brown, gray or other colored gel or staining may be present at the crack surface; and/or an increase in concrete volume (expansion) that may result in distortion of adjacent or integral structures or physical elements.

**(3) Joint Spalling.** Joint spalling is the breakdown of the slab edges within 2 feet (60 cm) of the side of the joint. A joint spall usually does not extend vertically through the slab but intersects the joint at an angle. Joint spalling often results from excessive stresses at the joint or crack caused by infiltration of incompressible materials or weak concrete at the joint (caused by overworking) combined with traffic loads. Joint spalling also results when dowels, which prevent slab movement, become misaligned either through improper placement or improper slippage preparation.

**(4) Corner Spalling.** Corner spalling is the raveling or breakdown of the slab within approximately 2 feet (60 cm) 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. The same mechanisms that cause joint spalling often cause corner spalling, but this type of distress may appear sooner because of increased exposure.

**(5) Blowups.** Blowups usually occur at a transverse crack or joint which is not wide enough to permit expansion of the concrete slabs. Insufficient width may result from infiltration of incompressible materials into the joint space or by gradual closure of the joint caused by expansion of the concrete due to ASR. When expansive pressure cannot be relieved, 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, although blowups can also appear at drainage structures (manholes, inlets, etc.). The frequency and severity of blowups may increase with an asphalt overlay due to the additional heat absorbed by the dark asphalt surface. They generally occur during hot weather because of the additional thermal expansion of the concrete.

**(6) Popouts.** A popout is defined as a small piece of pavement that breaks loose from the concrete surface. This is caused by freeze-thaw action in combination with expansive aggregates and can be caused by ASR. Popouts usually range from approximately 1 to 4 inches (25 to 100 mm) in diameter and from 1/2 to 2 inches (13 to 50 mm) deep. A popout may also be a singular piece of large aggregate that breaks loose from the concrete surface or clay balls in the concrete mix.

**(7) Patching.** A patch is defined as an area where the original pavement has been removed and replaced by a filler material. Deterioration of a patch typically has a higher rate of deterioration than the original pavement. Patching is usually divided into two types:

**(a) Small.** A small patch is defined as an area less than 5 ft<sup>2</sup> (0.5 m<sup>2</sup>).

**(b) Large and Utility Cuts.** A large patch is defined as an area greater than 5 ft<sup>2</sup> (0.5 m<sup>2</sup>). A utility cut is defined as a patch that has replaced the original pavement due to placement of underground utilities.

**d. Distortion.** Distortion refers to a change in the pavement surface's original position, and it results from foundation settlement, expansive soils, frost-susceptible soils, or loss of fines through improperly designed subdrains or drainage systems. Two types of distortion generally occur.

**(1) Pumping.** The deflection of the slab when loaded may cause pumping, which is characterized by the ejection of water and underlying material through the joints or cracks in a pavement. As the water is ejected, it carries particles of gravel, sand, clay, or silt with it, resulting in a progressive loss of pavement support that can lead to cracking. Evidence of pumping includes surface staining and base or subgrade material on the pavement close to joints or cracks. Pumping near joints indicates poor joint-load transfer, a poor joint seal, and/or the presence of ground water.

**(2) Settlement or Faulting.** Settlement or faulting is a difference in elevation at a joint or crack caused by upheaval or non-uniform consolidation of the underlying pavement layer(s) material. This condition may result from loss of fines, frost heave, loss of load transfer device, or swelling soils.

**e. Loss of Skid Resistance.** Skid resistance refers to the ability of a pavement to provide a surface with the desired friction characteristics under all weather conditions. It is a function of the surface texture. Loss of skid resistance is caused by the wearing down of the textured surface through normal wear and tear or the buildup of contaminants.

**(1) Polished Aggregates.** Some aggregates become polished quickly under traffic. Naturally polished aggregates create skid hazards if used in the pavement without crushing.

610 Crushing the naturally polished aggregates creates rough angular faces that provide good skid  
611 resistance.

612       **(2) Contaminants.** Rubber deposits building up over a period of time will reduce the  
613 surface friction characteristics of a pavement. Oil spills and other contaminants will also reduce  
614 the surface friction characteristics.

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## CHAPTER 4. Guidelines for Inspection of Pavements.

### 4.1. Introduction to Pavement Inspection.

Airports should prioritize the upkeep and repair of all pavement surfaces in the aircraft operating areas of the airport to help ensure safe aircraft operations. While deterioration of the pavements from usage and exposure to the environment cannot be completely prevented, a timely and effective maintenance program can minimize this deterioration. Adequate and timely maintenance is the greatest single means of controlling pavement deterioration. Inadequate maintenance characterized by the absence of a vigorously followed inspection program can be directly attributed to failures of airport pavements and drainage features. Maintenance, no matter how effectively carried out, cannot overcome or compensate for a major design or construction inadequacy, but it can prevent the total and possibly disastrous failure that can result from such deficiencies. Maintenance inspections reveal at an early stage where a problem exists and provide warning and sufficient time to perform corrective action. Postponement of minor maintenance may evolve into major pavement repairs. Visible evidence of excessive stress and/or environmental distress in pavement systems may include cracks, holes, depressions, and other types of pavement distresses. The formation of distresses in airport pavements may severely affect the structural integrity, ride quality, and safety of airport pavements. To alleviate the effects of distresses and to improve the airport pavement serviceability, airports should adopt an effective and timely inspection and maintenance program and adequate repair procedures.

Although there are numerous distress types associated with airfield pavements, a particular concern on airfield pavements is the possibility that pavement distress will generate loose material that may strike aircraft propellers or be ingested into jet engines. This loose material and the resulting damage are commonly labeled as foreign object debris/damage (FOD). FOD can cause considerable damage to an aircraft and increase the cost of maintaining the aircraft in a safe operating condition. More important, FOD can cause undetected damage to an aircraft, making it unsafe to operate. All pavement inspections should address the issue of FOD to minimize its potential hazard. AC 150/5210-24, Airport Foreign Object Debris (FOD) Management, provides guidance on reducing FOD hazards.

AC 150/5200-18, Airport Safety Self-Inspection provides information on airport self-inspection operational items such as pavement areas, safety areas, markings, signs, lighting, aircraft rescue and fire-fighting, fueling operations, navigational aids, ground vehicles, obstructions, public protection, hazard management, construction, and snow and ice control.

### 4.2. Inspection Procedures.

Maintenance is an ongoing process and a critical responsibility of airport personnel. Effective maintenance programs require a series of scheduled, periodic inspections, conducted by experienced engineers, technicians, or maintenance personnel. These inspections must be controlled to ensure that each element or feature being inspected is thoroughly checked, potential problem areas identified, and proper corrective measures recommended and implemented. The maintenance program must provide for adequate follow-up to ensure corrective work is expeditiously accomplished and recorded. The organization and scope of maintenance activities

will vary in complexity and degree from airport to airport, however, the general types of maintenance required will be similar.

**4.2.1 Inspection Schedules.** The airport is responsible for establishing a schedule for regular and routine pavement inspections to ensure all areas are thoroughly inspected. Conditions that may adversely affect the pavement, such as severe weather, may necessitate additional inspections. Airport personnel should also solicit reports from airport users and conduct daily drive-by-type inspections.

**4.2.2. Record keeping.** The airport should prepare and maintain records of all inspections and maintenance performed. These records should document the existing distresses, locations, probable causes, remedial actions required, and any follow up inspections and maintenance required. Records of materials and equipment used for maintenance and repair work should also be kept on file for future reference. Periodic review of these references may help reduce maintenance costs and improve pavement performance.

## CHAPTER 5. Materials and Equipment

### 5.1. General.

Maintenance includes any regular or recurring work necessary to preserve existing airport pavements in good condition. Work typically involves the care or cleaning of existing airport pavement and incidental or minor pavement repair. Maintenance activities typically require a work crew of two to six people, trained in the various repair techniques who are familiar with the materials and equipment necessary to perform the routine pavement maintenance required. Work requiring more staff is typically beyond the scope of normal maintenance activities. The following sections identify commonly used materials and equipment for normal maintenance activities. Additional information on materials and methods is also available in AC 150/5370-10, Standards for Specifying Construction of Airports or equivalent state pavement specifications may be used.

### 5.2. Common Materials for Maintenance and Repair.

The materials listed below are commonly used for maintenance and repair of pavements.

**5.2.1. Hot-Mix Asphalt (HMA).** HMA is a blend of asphalt binder and well-graded, high-quality aggregates. The materials are mixed in a plant and placed and compacted while hot. HMA is used for construction of new airfield pavement and patching and overlay of airfield pavements. P-403, Hot Mix Asphalt (HMA) Pavements (Base, Leveling or Surface Course) in AC 150/5370-10, or equivalent state pavement specifications may be used.

**5.2.2. Tack Coat.** A tack coat is a light application of emulsified asphalt applied to an existing pavement to provide a bond with an overlying course, such as a HMA overlay. A tack coat is also used on the sides of an existing pavement that has been cut vertically before patching. Asphalt emulsions are manufactured in several grades and are selected by the desired setting time. P-603, Bituminous Tack Coat in AC 150/5370-10 or equivalent state specifications may be used.

**5.2.3. Crack and Joint Sealing Material.** Material for sealing cracks should meet ASTM standards for the type of pavement and service for which the sealant is intended.

**5.2.3.1.** ASTM D 5893, Standard Specification for Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements.

**5.2.3.2.** ASTM D 6690, Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.

**5.2.4. Crack Filler Material.** Material for filling cracks should meet ASTM D 5078, Standard Specification for Crack Filler, Hot-Applied, for Asphalt Concrete and Portland Cement Concrete Pavements.

**5.2.5. Concrete.** Concrete is a blend of Portland cement, fine and coarse aggregate, and water, with or without additives. Concrete is used to repair a distressed Portland cement concrete pavement so it may be used at its original designed capacity. P-501, Portland

Cement Concrete Pavement in AC 150/5370-10 or equivalent state pavement specifications with non-reactive materials may be used.

**5.2.6. Other Materials and Products.** There are many other products available, such as epoxy resins and special concrete mixtures, which may be used for repair of pavements. The selection and use of these products must be in accordance with the manufacturers' requirements for the intended application. Local experience and conditions will dictate acceptable products. State DOT's may also maintain list of materials that have performed well in a geographic area. AC 150/5370-10 is another good source of information on materials and methods used for construction on airports.

### **5.3. Equipment for Pavement Maintenance.**

There are many different types and models of equipment airports can use for pavement maintenance. Some commonly used pavement maintenance equipment include:

**5.3.1. Power Saws.** A pavement power saw is usually a one-person-operated, dolly-mounted unit with an abrasive circular blade. This type of saw can cut a straight line through flexible or rigid pavements and leave vertical sides. A random crack saw has a small diameter saw blade capable of tracking the crack.

**5.3.2. Cutting Disks.** A cutting disk is a circular, heavy-duty steel plate with a sharpened edge. The disk is usually attached to a motor grader or other piece of equipment capable of pushing the disk through a bituminous pavement. It is limited to approximately 3 inches (75 mm) in cutting depth. Since the cutting disk is much faster than a saw, its use should be considered when larger areas must be removed.

**5.3.3. Jackhammers.** Jackhammers with a chisel head are commonly used for removal of existing pavement surfaces. Jackhammers must be used with caution to avoid damage to remaining pavement. Light, 30 pound (14 kg) or less, chipping hammers should be used to prepare partial depth repair patches.

**5.3.4. Pavement Grinders.** A pavement grinder may be a one-person-operated, dolly-mounted unit with an abrasive cylindrical head 4 inches (10 cm) or more wide, or it may be variable-width diamond grinding equipment. Diamond grinding is a common rehabilitation technique used for tasks as varied as paint removal and pavement texturing.

**5.3.5. Cold Milling Machines.** Cold milling machines use an adjustable rotating mandrel with cutting bits to remove various depths of pavement material. Bits can be added or removed to vary the cutting width and roughness. The milling machine shall operate without tearing or gouging the underlying material, leaving a finished surface that provides a good bond for the repair. The milling machine shall be capable of cutting a vertical edge without chipping or spalling the edges of the remaining pavement or a saw must be used to create a vertical edge for the patch.

**5.3.6. Hand Tools.** Hand tools such as chisels, sledgehammers, shovels, pry bars, and picks can be used to remove deteriorated pavement. Rakes, lutes, and other such hand tools are used to move and level material placed in a patch area.



**5.3.7. Front-end Loaders and Skid-steer Loaders.** Front-end loaders are useful when loading trucks with removed pavement. Skid-steer loaders are small versatile loaders that can be equipped with numerous attachments. Their small size and maneuverability make them ideal for maintenance activities.

**5.3.8. Dump Trucks.** Dump trucks are used to haul removed pavement and repair materials.

**5.3.9. Asphalt Kettle.** Asphalt kettles are usually small-tractor-mounted units that have the capacity to heat and store 40 to 500 gallons (150 to 2000 liters) of bituminous material. A pump forces the liquid material through spray nozzles located on a hand-held hose. These units are used for priming and tacking on small jobs and for crack or surface sealing of HMA surfaces.

**5.3.10. Vibratory Plate Compactors.** Vibratory plate compactors are hand-operated units used to compact granular base or HMA plant-mix materials.

**5.3.11. Vibratory and Non Vibratory Steel-Wheel Rollers.** Steel-wheel rollers are used to compact material, including HMA in patchwork areas. Smaller rollers can be hand operated, while large rollers are self-powered.

**5.3.12. Joint Plow.** A joint plow is used to remove old sealer from joints. This is usually a specially made tool attached to a small loader or tractor.

**5.3.13. Joint Router.** A joint router is used to clear existing cracks or joints to be resealed. A router is usually a self-powered machine operating a rotary cutter or revolving cutting tool. A rotary routing tool with a V-shaped end can be used for cleaning out random cracks. The use of a random crack saw is preferred for PCC pavements.

**5.3.14. Random Crack Saw.** A random crack saw is designed to follow irregular crack patterns in concrete and asphalt surfaces. The crack saw utilizes small diameter, dry-cut diamond blades in standard widths to create smooth sided cuts to prepare surfaces for proper crack filling. A center mounted blade configuration allows crack saws to pivot about its own axis to more exactly follow random crack patterns easily.

**5.3.15. Power Brush.** A power-driven wire brush may be used for initial joint cleaning.

**5.3.16. Air Compressor and Sand Blasting.** Sand blasting may be used for final removal of old joint sealant, and is recommended for the final cleaning method for PCC surfaces prior to application of new sealant. Joints and cracks should be blown out with clean, dry compressed air immediately before applying new sealant. Air compressors must be equipped with oil and moisture traps to prevent contaminating the cleaned surface.

**5.3.17. Pavement Sweeper.** A pavement sweeper can be used for cleaning the pavement surface and removing excess aggregate before and after repairs.

**5.3.18. Heating Kettle.** A heating kettle is a mobile, indirect-fired double boiler used to melt hot-applied joint sealing material. It is equipped with a means to agitate and circulate the

781 sealer to ensure uniform heating and melting of the entire charge in the kettle. Sealants may  
782 be applied to joints with an applicator attached directly to a pump unit on the kettle.

783 **5.3.19. Pouring Pot.** A pouring pot, hand carried or mounted on a hand-pushed pot dolly, is  
784 used to pour hot sealing materials into a prepared crack or joint.

785 **5.3.20. High-pressure Water.** High-pressure water, with the proper selection of spray nozzle  
786 and pressure, can be used to clean out joints prior to resealing and to clean vertical faces of  
787 pavement to be patched. Pressure should be monitored and controlled to the minimum  
788 necessary to minimize any damage to the remaining pavement.

789 **5.3.21. Hot Air Lance.** A hot air lance can be used to dry and heat cracks in existing  
790 bituminous material.

## CHAPTER 6. Pavement Repair Methods.

### 6.1. General.

This chapter describes various repair methods airports can use to correct airfield pavement distress. While these repair methods apply to specific types of distress and pavements, methods used should take into account the possibility of foreign object debris (FOD) to aircraft. FOD is defined as any object, live or not, located in an inappropriate location in the airport environment that has the capacity to injure airport or air carrier personnel and damage aircraft. FOD damage is any damage attributed to a foreign object that can be expressed in physical or economic terms which may or may not downgrade the product's safety or performance characteristics. Repair activities may leave potential FOD at or near the repair sites. All maintenance activities must include quality control to assure that repairs are conducted properly and clean-up activities undertaken to remove FOD potential. AC 150/5210-24, Airport Foreign Object Debris (FOD) Management, provides additional guidance to help manage debris hazards associated with maintenance activities

The first step in rehabilitating or preparing a pavement is to identify the causes of distress. Then, the proper procedures for repairing - which will not only correct the damage, but also prevent or retard its further occurrence - may be applied. Pavement repairs should be made as quickly as possible after the need for them arises to help ensure continued and safe aircraft operations. Airports should perform repairs at early stages of distress, even when the distresses are considered minor. A delay in repairing pavements may allow minor distresses to progress into major failures. While deterioration of pavements due to traffic and adverse weather conditions cannot be completely prevented, maintenance and repair programs can significantly reduce the rate of deterioration and minimize the damage.

Weather conditions may limit repair measures undertaken to prevent further pavement damage. For example, rehabilitation by crack filling is more effective in cool and dry weather conditions, whereas pothole patches, seal coats, and other surface treatments require warm, dry weather for best results. This does not mean that resurfacing work cannot be performed under cold and damp conditions or that crack filling cannot be done in warm weather. Rather, these repairs just require much greater care when made during such periods. The procedures in Appendix A list the weather and temperature limitations for each repair procedure. When emergency pavement repairs are required and weather conditions exceed the procedure recommendations, the initial repair will be temporary and replaced as soon as weather conditions permit.

## **6.2. Repair Methods for Flexible Pavements.**

**6.2.1. General.** The selection of a repair method for flexible pavements will depend on the type of damage; climate; experience; and availability of materials among others. Table 6-1 summarizes some common problems and potential repair methods.

**6.2.2. Crack Repair.** Cracks take many forms such as longitudinal, transverse, block, alligator, slippage, and reflection cracks. For some such as longitudinal and transverse cracks, simple crack filling may be the proper corrective action. Refer to Appendix A1 and Figure A-1 for crack repair in flexible pavement.

**6.2.3. Partial and Full Depth Repair.** Some cracks may require partial or full depth repair of the damaged pavement. Partial depth repairs may be an alternative for pavements greater than 5 inches (13 cm) thick. Full depth repairs are typically required for pavement less than 5 inches (13 cm) thick. Refer to Appendix A2 and Figure A-2 for partial depth crack repair in flexible pavement. Refer to Appendix A3 and Figure A-3 for full depth crack repair in flexible pavement.

## **6.3. Repair Methods for Rigid Pavements.**

**6.3.1. General.** The selection of a repair method for rigid pavements will depend on the type of damage; climate; experience; and availability of materials among others. Table 6-2 summarizes some common problems and potential repair methods. Refer to Appendix A4 and Figure A-4 for a plan view of typical rigid pavement full depth repairs including a corner break; partial slab replacement; and full depth slab replacement.

**6.3.1.1. Crack Repair and Joint Sealing.** Sealing cracks prevents surface moisture from entering the pavement structure. This type of repair may require establishing a sealant reservoir. A concrete saw is preferable to router equipment because a router can cause micro-cracks in the adjacent concrete pavement. Shrinkage cracks are non-structural and non-propagating cracks which are cosmetic and typically do not require repairs.

Refer to AC 150/5370-10, Standards for Specifying Construction of Airports, Items P-604 Compression Joint Seals for Concrete Pavement and P-605, Joint Sealants for Concrete Pavements for information and guidance on joint and crack sealants. A silicone sealant per ASTM D5893, Standard Specification for Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavement, can be used for edge joints between flexible and rigid pavements. Silicone shall not be used to seal flexible pavement to flexible pavement joints.

**6.3.1.2. Full Depth Repair.** Full depth rigid pavement repair requires the complete removal of the damaged concrete pavement. The base and sub base material may also require repair if it is damaged during removal of the pavement or by water infiltration and subsequent pumping action.

**a. Corner Break.** A corner break is a crack that intersects the joints of a slab at a distance less than or equal to one-half the slab length on both sides of the slab, measured from the corner to the slab. The crack extends vertically through the entire slab thickness. Load repetition

combined with loss of support and curling stresses cause corner breaks. Refer to Appendix A5 and Figure A-5 for full depth repair of a corner break.

**b. Partial Slab Replacement.** Refer to Appendix A6 and Figure A-6 for partial slab replacement procedures.

**c. Full Slab Replacement.** Refer to Appendix A7 and Figure A-7 for full slab replacement procedures.

### **6.3.1.3. Partial depth repair**

**a. Joint Spall Repair.** Joint spalling is the breakdown of the slab edges within 2 feet (.6 m) of the side of the joint. A joint spall usually does not extend vertically through the slab, intersecting the joint at an angle. Refer to Appendix A8 and Figure A-8 for joint spall repair procedures.

### **6.4. Temporary Patching of Rigid Pavements.**

Broken rigid pavement areas can be patched with flexible pavement as an interim measure. Full-depth HMA repairs will interrupt the structural integrity of the rigid pavement and may lead to additional failures. Such full-depth repairs should be considered temporary, and corrective long-term repairs must be scheduled.

The minimum depth of repair for Portland cement concrete should be 2 inches (5 cm). Repairs made thinner than 2 inches (5 cm) usually deteriorate quickly on an airfield pavement. (Most distresses needing repair will extend at least 2 inches (5 cm) into the pavement.) Rigid pavement repairs that are thinner than 2 inches (5 cm) may benefit from the use of epoxy materials.

**Table 6-1. Quick Guide for Maintenance and Repair of Common Flexible Pavement Surface Problems**

<b>Problem</b>	<b>Repair</b>	<b>Probable Cause</b>
Weathering/ Oxidation	<ul style="list-style-type: none"> <li>- Apply surface treatment.</li> <li>- Overlay.</li> </ul>	<ul style="list-style-type: none"> <li>- Environment</li> <li>- Lack of timely surface treatments</li> </ul>
Cracks	<ul style="list-style-type: none"> <li>- Remove old sealer material if present.</li> <li>- Clean and prepare cracks.</li> <li>- Seal/reseal cracks.</li> <li>- Joint heating may be an option for longitudinal cracks when under the direction of an engineer. (Operate heaters to avoid excessive heat on the pavement.)</li> </ul>	<ul style="list-style-type: none"> <li>- Age</li> <li>- Environmental conditions</li> <li>- Bitumen too hard or overheated in mix</li> <li>- Sealant defects (e.g. incorrect application temperature, improper sealant selection, improper crack preparation)</li> </ul>
Alligator or fatigue cracking	<ul style="list-style-type: none"> <li>- Remove and replace damaged pavement, including the base and/or subbase course if required.</li> </ul>	<ul style="list-style-type: none"> <li>- Base and/or Subgrade failure</li> <li>- Overload</li> <li>- Under-designed surface course (too thin)</li> </ul>
Patches	<ul style="list-style-type: none"> <li>- Remove/replace.</li> <li>- Repair and Resurface.</li> </ul>	<ul style="list-style-type: none"> <li>- Inadequate/Improper repair detail/material</li> <li>- Age</li> </ul>
Surface irregularities (e.g. rutting, wash-boarding, birdbaths)	<ul style="list-style-type: none"> <li>- Remove and replace damaged areas.</li> <li>- Surface grinding/milling.</li> </ul>	<ul style="list-style-type: none"> <li>- Traffic</li> <li>- Age</li> </ul>
Slipperiness	<ul style="list-style-type: none"> <li>- Remove rubber/surface contamination.</li> <li>- Apply surface treatment.</li> </ul>	<ul style="list-style-type: none"> <li>- Rubber deposits/surface contamination</li> <li>- Polished aggregate</li> <li>- Improper surface treatment</li> </ul>
Bleeding	<ul style="list-style-type: none"> <li>- Blot with sand and remove sand prior to resuming aircraft operations. Excessive bleeding may require removal and replacement of pavement.</li> </ul>	<ul style="list-style-type: none"> <li>- Overly rich mix. Bleeding may be a precursor to other surface deformities forming e.g. rutting, wash-boarding, etc.</li> </ul>
Drainage	<ul style="list-style-type: none"> <li>- Grade pavement shoulders, clear drainage path.</li> <li>- Clean out drainage structures e.g. edge drains, outfalls, etc.</li> </ul>	<ul style="list-style-type: none"> <li>- Poor maintenance of drainage facilities</li> <li>- Poor maintenance of grade</li> </ul>

**Table 6-2. Quick Guide for Maintenance and Repair of Common Rigid Pavement Surface Problems**

<b>Problem</b>	<b>Repair</b>	<b>Probable Cause</b>
Joint sealant damage	- Remove old sealant; clean joints; reseal.	- Age - Environmental conditions - Sealant defects (e.g. incorrect application temperature, improper sealant selection, improper joint preparation)
Cracks	- Clean and seal cracks. - Repair/replace slab. - Evaluate adequacy of pavement structure; may require strengthening.	- Loss of slab support - load repetition; curling stresses; and shrinkage stresses
Corner Breaks	- Seal and maintain until full depth patch	- Loss of slab support - Load repetition and curling stresses
Joint spalling	- Remove loose material; refill with approved product; reseal. - Partial depth repair.	- Latent defects i.e. excessive finishing - Incompressible matter in joint spaces - Snow plow damage
Slab blowup	- Replace slab in blowup area; clean and reseal joints.	- Incompressible material in joints preventing slab from expanding
Slipperiness	- Remove rubber/surface contamination. - Grinding.	- Rubber deposits/surface contamination - Age, i.e. surface wear
Drainage	- Grade pavement shoulders, clear drainage path. - Clean out drainage structures e.g. edge drains, outfalls, etc.	- Poor maintenance of drainage facilities - Poor maintenance of grade
Popouts	- Remove FOD.	- Material
Patches	- Remove/replace.	- Inadequate/Improper repair detail/material - Age

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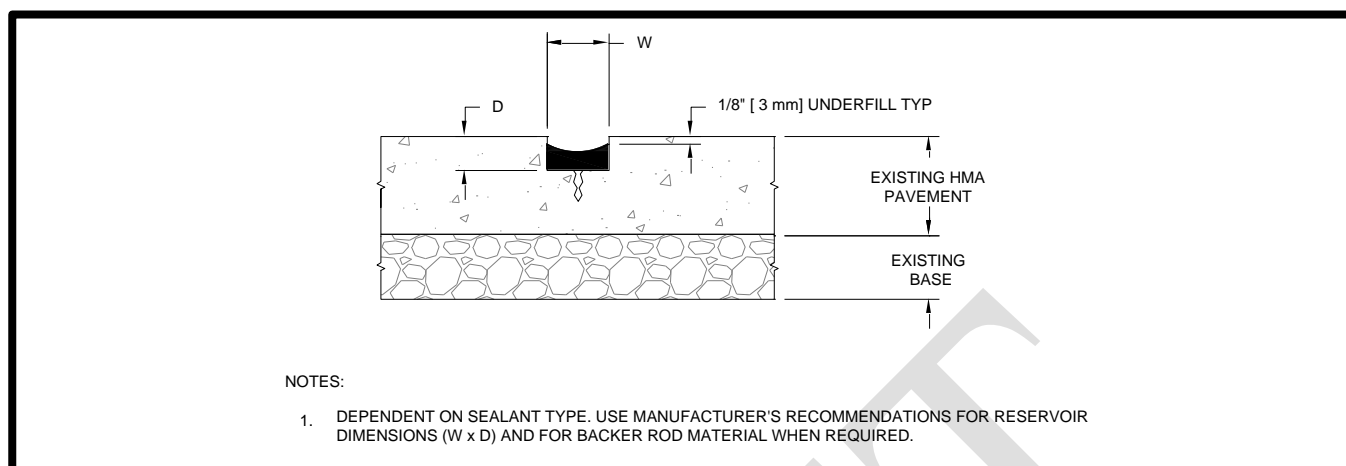
891 **Appendix A. Repair Procedures**

892 The following typical details and repair procedures are intended for use for minor maintenance  
893 repair of airport pavements. For major maintenance projects, the airport should utilize plans and  
894 specifications developed under the direction of a pavement design engineer.

895 For all maintenance and repair projects funded with federal grant monies through the Airport  
896 Improvement Program (AIP) and with revenue from the Passenger Facility Charge (PFC)  
897 Program, the airport must use the guidelines and specifications for materials and methods in AC  
898 150/5370-10, Standards for Specifying Construction of Airports.

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**A1. PROCEDURE FOR CRACK REPAIR OF FLEXIBLE PAVEMENT****Figure A-1. Crack Repair of Flexible Pavement****Weather and Temperature Requirements**

- Do not begin crack repair during inclement weather.
- The pavement temperature shall be 50°F (10°C) and rising or meet the manufacturer's recommendations at the time of application of the joint sealing material.
- Do not apply sealant if moisture is observed in the joint.

**PREPARATION**

To choose sealant:

- Consider your geographic area, climate, and past performance of the sealant
- Hot-applied sealants must meet the requirements of ASTM D6690
- Cold-applied sealants must meet the requirements of ASTM D977

**REPAIR PROCEDURE**

Use this procedure to repair cracks less than 1 (25 mm) inch in width in flexible pavements.

1. Review the construction safety and phasing plan (CSPP). Ensure all pavement closures have all required items in place, such as lighted X's,

barricades, signs, etc.; and all NOTAMS issued for affected areas of the airfield.

2. Mark the limits of the area of crack repair.
3. Use an air compressor with an operable oil and water trap, to clean all cracks with compressed hot air.
4. If necessary, saw or rout the cracks to the required width and depth. Use the sealant manufacturer's specifications to determine the sealant reservoir dimensions (W x D).
5. Inspect the cracks for proper width, depth, alignment, and preparation. Make sure the crack surface faces are dry.
6. To obtain the width and depth ratio required by the sealant manufacturer's specifications, may require installation of backer rod. Make sure the backer rod:
  - Meets the requirements of ASTM D5249
  - Is compatible with the sealant
  - Is 25% larger in diameter than the width of the sealant reservoir
7. Apply the sealant uniformly from the bottom to the top of the crack avoiding voids or entrapping air.
8. Make sure the surface of the sealant remains  $\frac{1}{4}$  inch to  $\frac{3}{8}$  inch (6 mm to 9 mm) below the existing pavement surface.
9. Do not allow traffic until the sealants have cured.
10. Completely clean the work area before opening to aircraft traffic.

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**MATERIAL REQUIREMENTS**

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ASTM D977      Standard Specification for Emulsified Asphalt

927

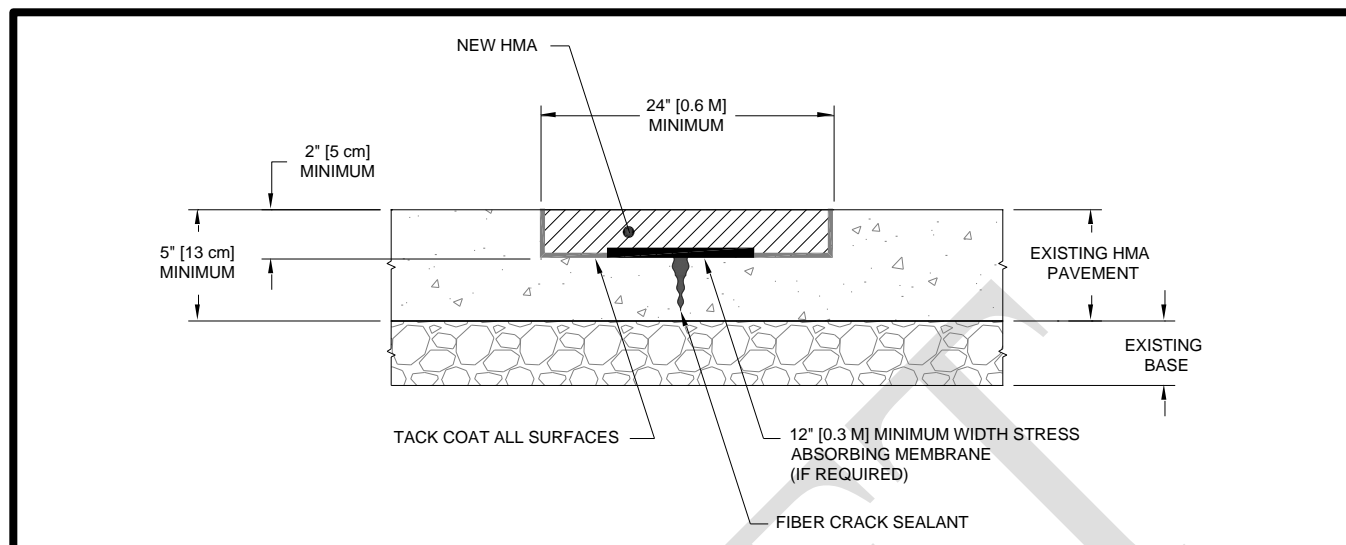
ASTM D5249      Standard Specification for Backer Material for Use with Cold- and  
Hot-Applied Joint Sealants in Portland-Cement Concrete and Asphalt  
928 Joints  
929

930

ASTM D 6690      Standard Specification for Joint and Crack Sealants, Hot Applied, for  
Concrete and Asphalt Pavements  
931

932

State Department of Transportation Specifications for Pavements

**A2. PARTIAL DEPTH CRACK REPAIR IN FLEXIBLE PAVEMENT****Figure A-2. Partial Depth Crack Repair in Flexible Pavement****Weather and Temperature Requirements**

- Do not begin crack repair during inclement weather.
- HMA shall not be placed upon a wet surface or when the surface temperature of the underlying course is less than 45° F (7° C).
- The pavement temperature shall be 50°F (10°C) and rising or meet the manufacturers recommendations at the time of application of the joint sealing material.
- Do not apply sealant if moisture is observed in the joint.

**REPAIR PROCEDURE**

Use this procedure to repair HMA Pavements that are 5 inches (13 cm) or greater in thickness with cracks greater than 1 inch (25 mm).

1. Review the construction safety and phasing plan (CSPP). Ensure all pavement closures have all required items in place, such as lighted X's, barricades, signs, etc.; and all NOTAMS issued for affected areas of the airfield.
2. Mark the limits of the area of crack repair.
3. Saw cut or mill out an area 24 inches (60 cm) wide by 2 to 3 inches (50 mm to 75 mm) deep

centered on the crack. Extend the saw cut or mill out the area a minimum of 12 inches (30 cm) beyond the limits of the distressed pavement area.

4. Use an air compressor with an operable oil and water trap to clean all cracks with compressed hot air.
5. Fill crack flush with fiber crack filler per the sealant manufacturer's specifications. Apply the sealant uniformly from the bottom to the top of the crack avoiding voids or entrapping air.
6. Apply a 12 inch (30 cm) repair membrane centered over the crack. (Installation of the membrane is optional.)
7. Apply tack coat to the bottom and sides of the repair area. Make sure the tack meets the requirements of P-603 and ASTM D3628.
8. Fill the patch area with P-403 or equivalent State DOT dense mix and compact to the minimum density specified.
9. Use a straight-edge to verify the patch is flush with adjacent pavement.
10. Do not allow traffic until the HMA have cured.
11. Completely clean the work area before opening to aircraft traffic.

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**MATERIAL REQUIREMENTS**

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959    ASTM D977        Standard Specification for Emulsified Asphalt

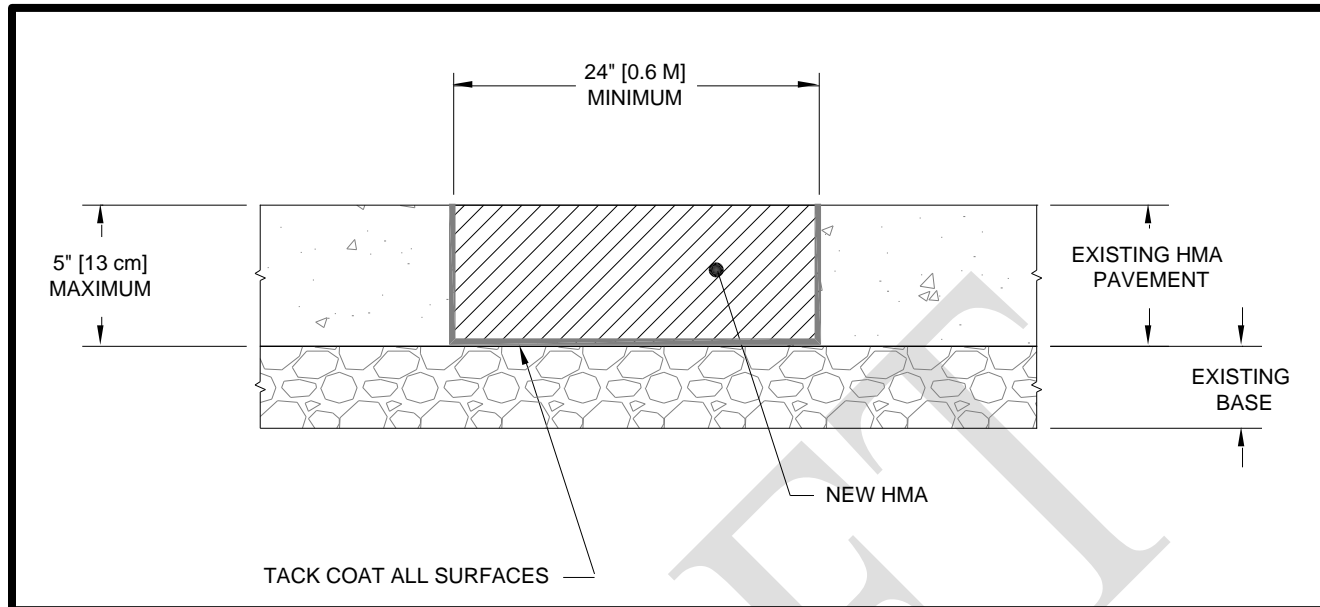
960    ASTM D3628        Standard Practice for Selection and Use of Emulsified Asphalts

961    ASTM D 6690        Standard Specification for Joint and Crack Sealants, Hot Applied, for  
962                            Concrete and Asphalt Pavements

963    P-403                Hot Mix Asphalt (HMA) Pavements (Base, Leveling, or Surface  
964                            Course), AC 150/5370-10, Standards for Specifying Construction of  
965                            Airports

966    State Department of Transportation Specifications for Pavements

967

**A3. FULL DEPTH CRACK REPAIR IN FLEXIBLE PAVEMENT****Figure A-3. Full Depth Crack Repair in Flexible Pavement****Weather and Temperature Requirements**

- Do not begin crack repair during inclement weather.
- HMA shall not be placed upon a wet surface or when the surface temperature of the underlying course is less than 45° F (7° C).
- The pavement temperature shall be 50°F (10°C) and rising or meet the manufacturer's recommendations at the time of application of the joint sealing material.
- Do not apply sealant if moisture is observed in the joint.

**REPAIR PROCEDURE**

Use this procedure to conduct full depth repairs of flexible pavements and to repair cracks greater than 1 inch (25 mm) in flexible pavements 5 inches (13 cm) or less.

1. Review the construction safety and phasing plan (CSPP). Ensure all pavement closures have all

required items in place, such as lighted X's, barricades, etc.; and all NOTAMS issued for affected areas of the airfield.

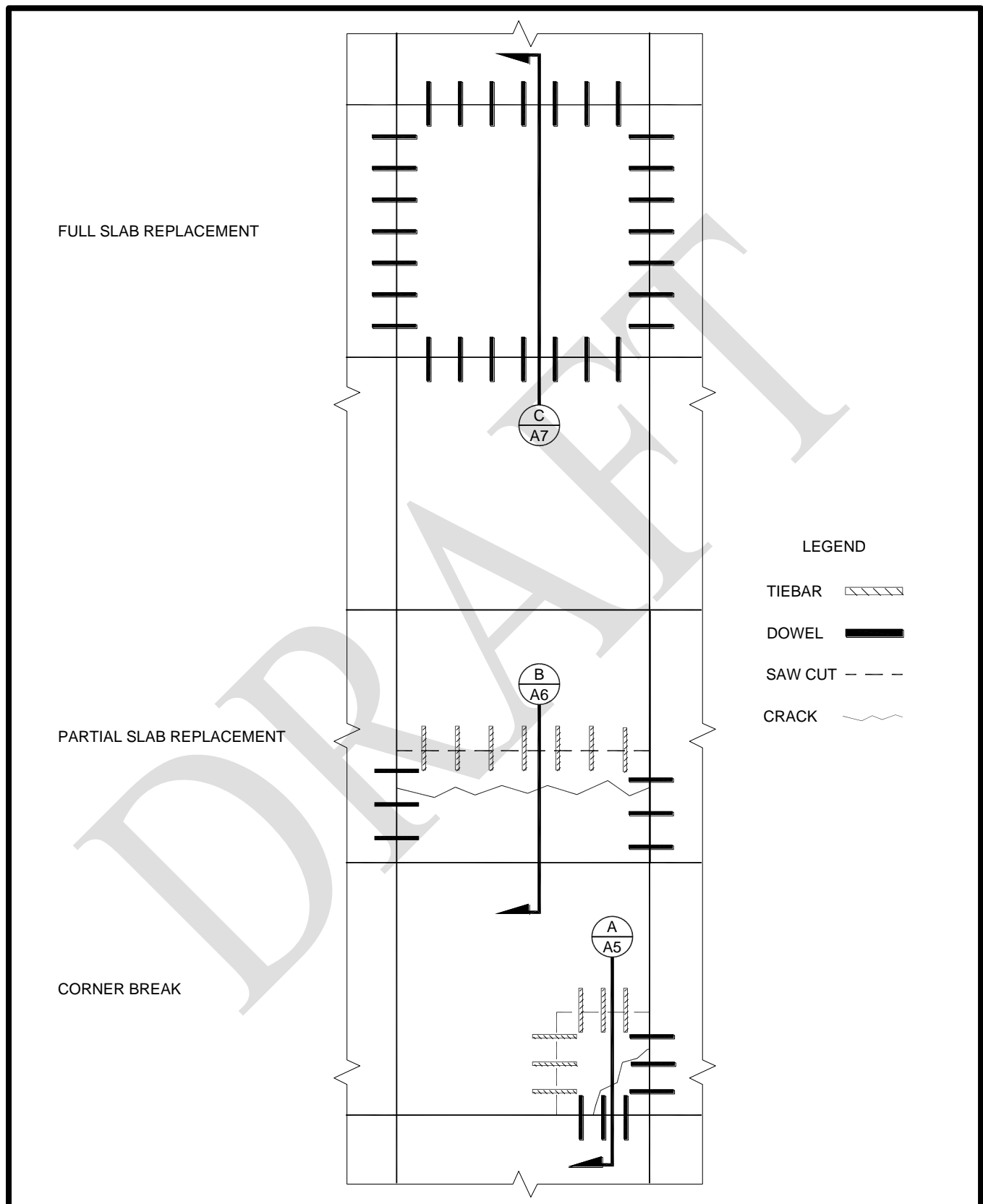
2. Mark the limits of the area of crack repair.
3. Saw cut or mill out an area 24 inches (60 cm) wide to the full depth of the HMA centered on the crack. Extend the saw cut or mill out an area a minimum of 12 inches (30 cm) beyond the limits of the distressed pavement area.
4. Repair and re-compact the base as necessary.
5. Apply tack coat to the bottom and sides of the repair area. Make sure the tack meets the requirements of P-603 and ASTM D3628.
6. Fill the patch area with P-403 or equivalent State DOT dense mix and compact to the minimum density specified.
7. Use a straight-edge to verify that the patch is flush with adjacent pavement.
8. Do not allow traffic until HMA have cured.
9. Completely clean the work area before opening to aircraft traffic.

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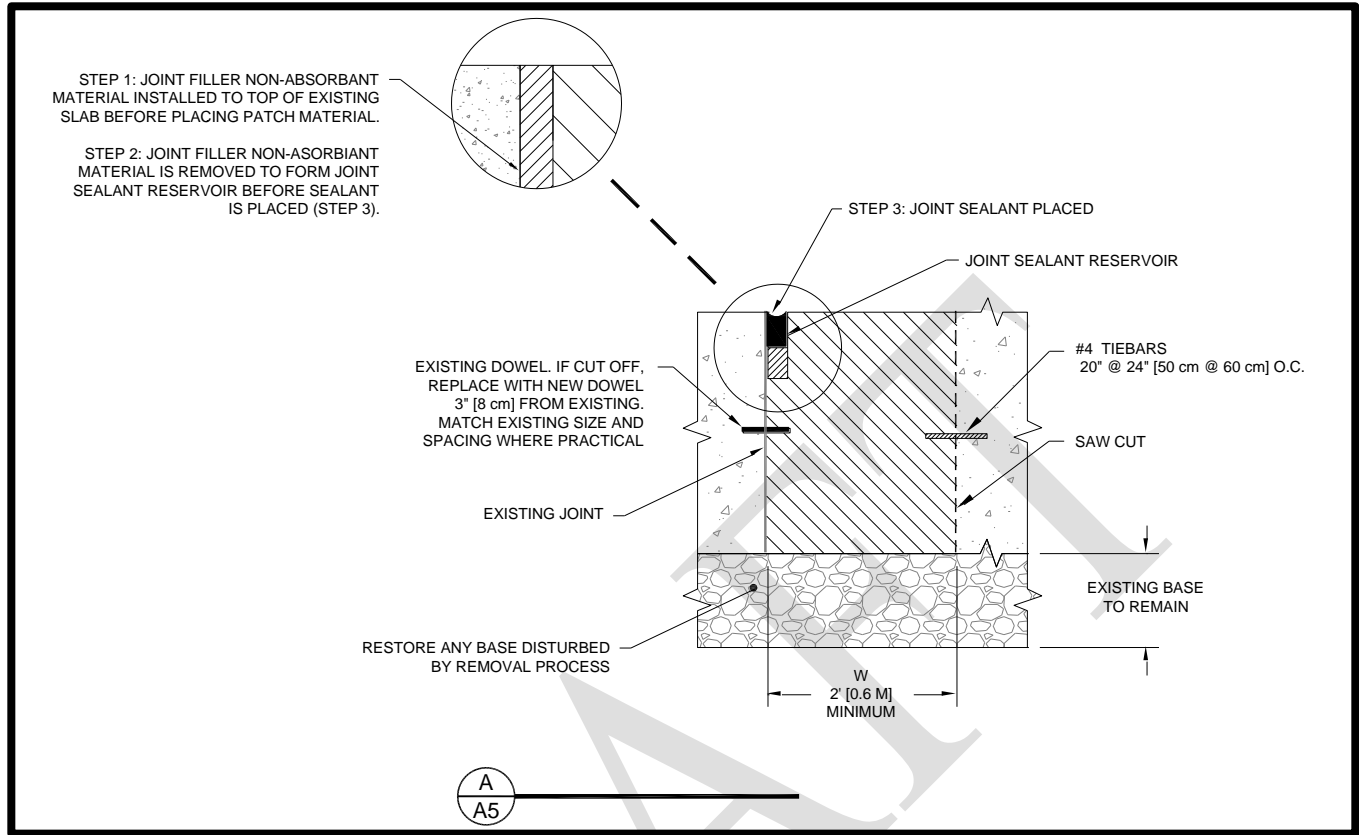
**MATERIAL REQUIREMENTS**

990		
991	ASTM D977	Standard Specification for Emulsified Asphalt
992	ASTM D3628	Standard Practice for Selection and Use of Emulsified Asphalts
993	ASTM D 6690	Standard Specification for Joint and Crack Sealants, Hot Applied, for
994		Concrete and Asphalt Pavements
995	P-403	Hot Mix Asphalt (HMA) Pavements (Base, Leveling, or Surface
996		Course), AC 150/5370-10, Standards for Specifying Construction of
997		Airports
998	P-603	Bituminous Tack Coat, AC 150/5370-10, Standards for Specifying
999		Construction of Airports
1000	State Department of Transportation Specifications for Pavements	



**A4. RIGID PAVEMENT REPAIR – PLAN VIEW****Figure A-4. Rigid Pavement Repair -- Plan View**

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**A5. FULL DEPTH REPAIR IN RIGID PAVEMENT – CORNER BREAK****Figure A-5. Full Depth Repair in Rigid Pavement – Corner Break****Repair Procedure and Weather and Temperature Requirements are on the back of this page.****MATERIAL REQUIREMENTS**

ASTM A1078	Standard Specification for Epoxy-Coated Steel Dowels for Concrete Pavement
ASTM A615	Standard Specifications for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM C 309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM D 6690	Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements
P-501	Portland Cement Concrete (PCC) Pavement, AC 150/5370-10, Standards for Specifying Construction of Airports
State Department of Transportation Specifications for Pavements	

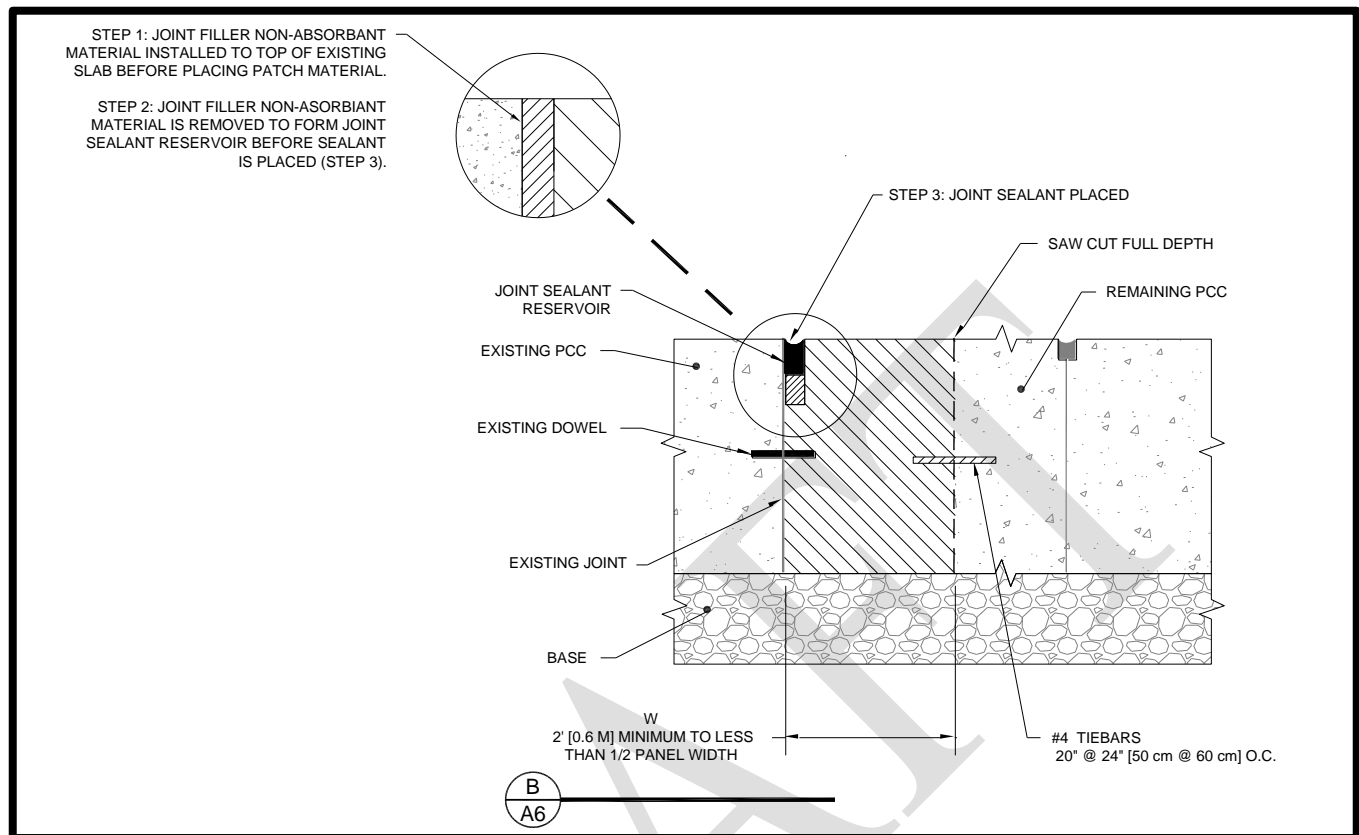
**WEATHER AND TEMPERATURE  
REQUIREMENTS**

- Do not begin repairs during inclement weather.
- Do not place concrete unless the ambient temperature is at least 40° F (4° C) and rising and the concrete temperature is greater than or equal to 50° F (10° C).
- Do not place concrete on frozen base, ice, or snow.
- When the ambient temperature exceeds 85° F (29° C), sprinkle the adjacent concrete and base with water immediately before placing concrete.
- Place concrete at the coolest temperature practicable, and never allow the placed concrete temperature to exceed 90° F (32° C).

**REPAIR PROCEDURE**

1. Review the construction safety and phasing plan (CSPP). Ensure all pavement closures have all required items in place, such as lighted X's, barricades, etc.; and all NOTAMS issued for affected areas of the airfield.
2. Mark the limits of the area to be repaired. For corner breaks the repair area should be square.
3. Make a full-depth saw cut along the constructed joints at least 2 feet (.6 m) beyond the limits of the break and make saw cuts perpendicular to the constructed joints from these points until they intersect.
4. If dowels or tie bars are present along any edges, either of the following options is acceptable:
  - If dowels or tie bars will be exposed and saved, saw edges full depth just beyond the end of the dowels or tie bars. Carefully saw joints on the joint line to within 1 inch (25 mm) of the depth of the dowel or tie bar. Use a light 30 pound (14 kg) or less jackhammers or other approved equipment to carefully break up and remove the narrow strips of concrete along the doweled edges.
  - If dowel or tie bars are cut and replaced, make a full depth saw cut along the constructed joint cutting the dowels and tie bars.
5. Take care to prevent damage to remaining dowels, tie bars, or concrete.
6. Use light weight equipment i.e. a jack hammer less than 30 pounds (14 kg), hand tools, etc., to remove the

- remaining damaged PCC pavement. Work from inside the saw cut toward the edge of the slab of the area being removed to prevent damage to the pavement remaining.
7. Remove by hand all loose material and vacuum to minimize any disturbance to the subgrade or base materials.
  8. Restore subgrade or base material if required.
  9. Install #4 deformed tie-bars in each face of the parent panel by drilling horizontal holes into the face and using an epoxy bonding agent. Space the tie-bars equidistant at 24 inches (.6 m) on center.
  10. If existing dowel bars have been cut and removed, install new dowel bars of the type and size of the existing dowel bars in the joint that parallels the direction of traffic. On aprons and areas where traffic may be oblique to joints, install dowels in both joint faces.
  11. Install dowels by drilling and epoxying into the PCC pavement at least 3 inches (75 mm) from the location of the existing dowels which were cut off. Space dowel bars at least 3 inches (75 mm) from the edge of the repair area and at least one bar spacing apart at corners of intersecting joints.
  12. Oil the exposed ends of dowel bars prior to backfilling repair area with concrete.
  13. Install nonabsorbent board or other approved material within the limits of the joint seal reservoir (Step 1). The nonabsorbent board will be a standard ½ inch (13 mm) asphalt impregnated fiber-board or other approved material. For joints wider than ½ inch (13 mm), adjust the width of the nonabsorbent board to fit the joint width.
  14. Fill the repair area with concrete and consolidate with vibrator. Concrete shall meet the requirements of P-501 or State DOT Specifications for Pavements.
  15. Finish the surface to match existing pavement.
  16. Spray with curing compound per ASTM C309.
  17. Remove the nonabsorbent board (Step 2) and place joint sealant per ASTM D6690 and manufacturer's requirements (Step 3).
  18. Do not allow traffic until the patch has cured.
  19. Completely clean the work area before opening the pavement to aircraft traffic.

**A6. FULL DEPTH REPAIR IN RIGID PAVEMENT – PARTIAL SLAB REPLACEMENT****Figure A-6. Full Depth Repair in Rigid Pavement – Partial Slab Replacement****Repair Procedure and Weather and Temperature Requirements are on the back of this page.****MATERIAL REQUIREMENTS**

ASTM A1078	Standard Specification for Epoxy-Coated Steel Dowels for Concrete Pavement
ASTM A615	Standard Specifications for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM C 309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM D 6690	Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements
P-501	Portland Cement Concrete (PCC) Pavement, AC 150/5370-10, Standards for Specifying Construction of Airports
State Department of Transportation Specifications for Pavements	

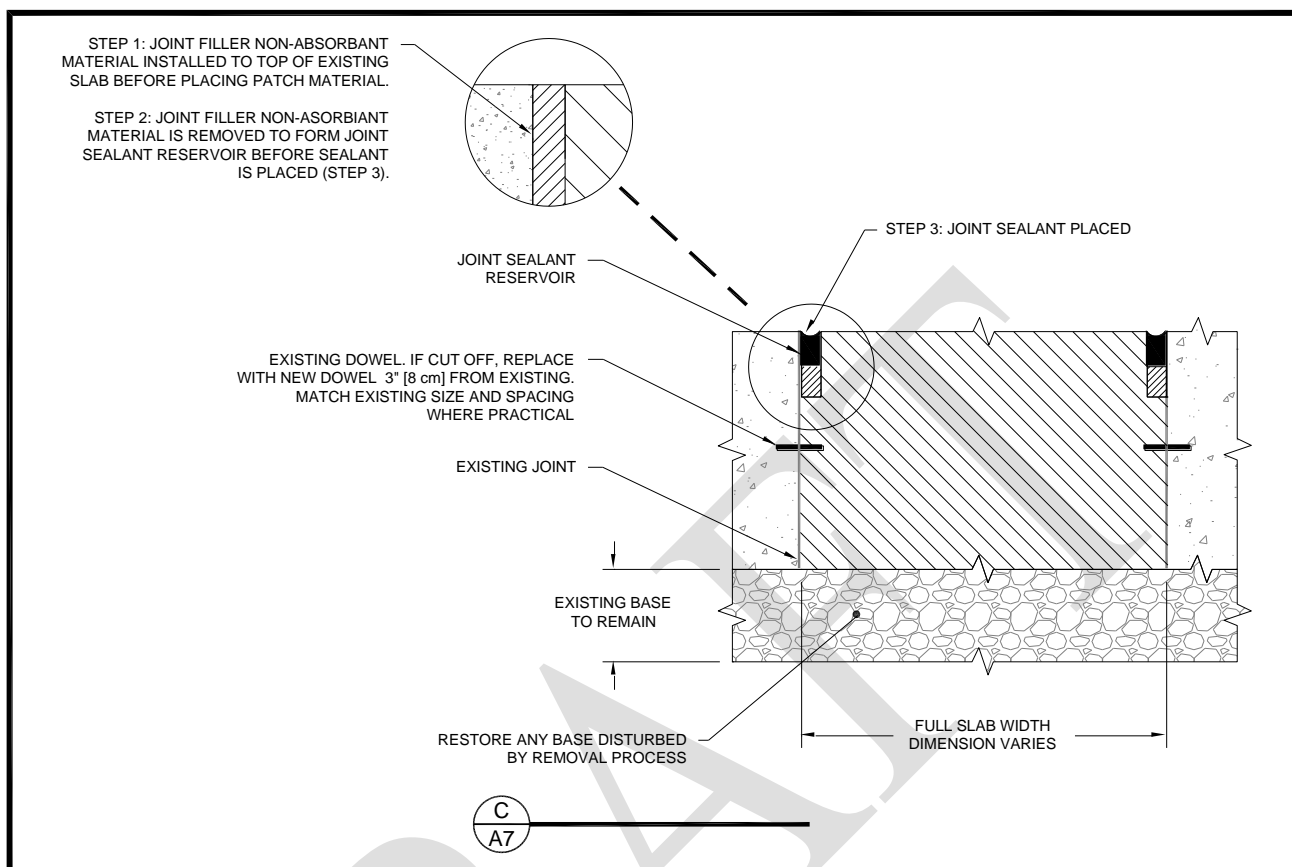
**WEATHER AND TEMPERATURE  
REQUIREMENTS**

- Do not begin repairs during inclement weather.
- Do not place concrete unless the ambient temperature is at least 40° F (4° C) and rising and the concrete temperature is greater than or equal to 50° F (10° C).
- Do not place concrete on frozen base, ice, or snow.
- When the ambient temperature exceeds 85° F (29° C), sprinkle the adjacent concrete and base with water immediately before placing concrete.
- Place concrete at the coolest temperature practicable, and never allow the placed concrete temperature to exceed 90° F (32° C).

**REPAIR PROCEDURE**

1. Review the construction safety and phasing plan (CSPP). Ensure all pavement closures have all required items in place, such as lighted X's, barricades, etc.; and all NOTAMS issued for affected areas of the airfield.
2. Mark the limits of the area to be repaired.
3. Make a full-depth saw cut along the constructed joints at least 2 feet (.6 m) beyond the limits of the damaged pavement and make a saw cut perpendicular to the constructed joints from these points across the width of the pavement panel.
4. If dowels or tie bars are present along any edges, either of the following options is acceptable:
  - If dowels or tie bars will be exposed and saved, saw edges full depth just beyond the end of the dowels or tie bars. Carefully saw joints on the joint line to within 1 inch (25 mm) of the depth of the dowel or tie bar. Carefully break up and remove the narrow strips of concrete along doweled edges using light 30 pound (14 kg) or less jackhammers, or other approved equipment.
  - If dowels or tie bars are to be cut and replaced, make a full depth saw cut along the constructed joint cutting the dowels and tie bars.
5. Take care to prevent damage to the dowels, tie bars, or to concrete which remains in place.
6. Make additional saw cuts within the limits of the repair area dividing the repair area into quarters.

7. Use light weight equipment i.e. jack hammer less than 30 pounds (14 kg), hand tools, etc. to remove the damaged PCC pavement. Work from inside the saw cut toward the interior of the area being removed to prevent damage to the pavement remaining.
8. Remove by hand all loose material and vacuum to minimize any disturbance to the subgrade or base materials.
9. Restore subgrade or base material if required.
10. Install #4 deformed tie-bars in the face of the parent panel by drilling horizontal holes in to the face and using an epoxy bonding agent. Space the tie-bars equidistant at 24 inches (.6 m) on center.
11. If existing dowel bars have been cut and removed, install dowel bars of the type and size of the existing dowel bars in the joints that are parallel to the direction of traffic. On aprons and areas where traffic may be oblique to joints, install dowels in both joint faces.
12. Install dowels by drilling and epoxying into the PCC pavement at least 3 inches (75 mm) from the location of the existing cut dowels. Space dowel bars at least 3 inches (75 mm) from the edge of the repair area and at least one bar spacing apart at corners of intersecting joints.
13. Oil the exposed ends of dowel bars prior the backfilling repair are with concrete.
14. Install nonabsorbent board or other approved material within the limits of the joint seal reservoir (Step 1). The nonabsorbent board will be a standard ½ inch (13 mm) asphalt impregnated fiber-board. For joints wider than ½ inch (13 mm), adjust the width of the nonabsorbent board to fit the joint width.
15. Fill the repair area with concrete and consolidate with a vibrator. Use concrete meeting the requirements of P-501 or State DOT Specifications for Pavements.
16. Finish the surface to match the existing surface.
17. Spray with curing compound per ASTM C309.
18. Remove the nonabsorbent board or other approved material (Step 2) and place joint sealant per ASTM D6690 (Step 3).
19. Thoroughly clean the work area before opening pavement to aircraft traffic.
20. Do not allow traffic until concrete has cured.

**A7. FULL DEPTH REPAIR IN RIGID PAVEMENT – FULL SLAB REPLACEMENT****Figure A-7. Full Depth Repair in Rigid Pavement – Full Slab Replacement****Repair Procedure and Weather and Temperature Requirements are on the back of this page.****MATERIAL REQUIREMENTS**

ASTM A1078	Standard Specification for Epoxy-Coated Steel Dowels for Concrete Pavement
ASTM A615	Standard Specifications for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM C 309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM D 6690	Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements
P-501	Portland Cement Concrete (PCC) Pavement, AC 150/5370-10, Standards for Specifying Construction of Airports
State Department of Transportation Specifications for Pavements	

**WEATHER AND TEMPERATURE  
REQUIREMENTS**

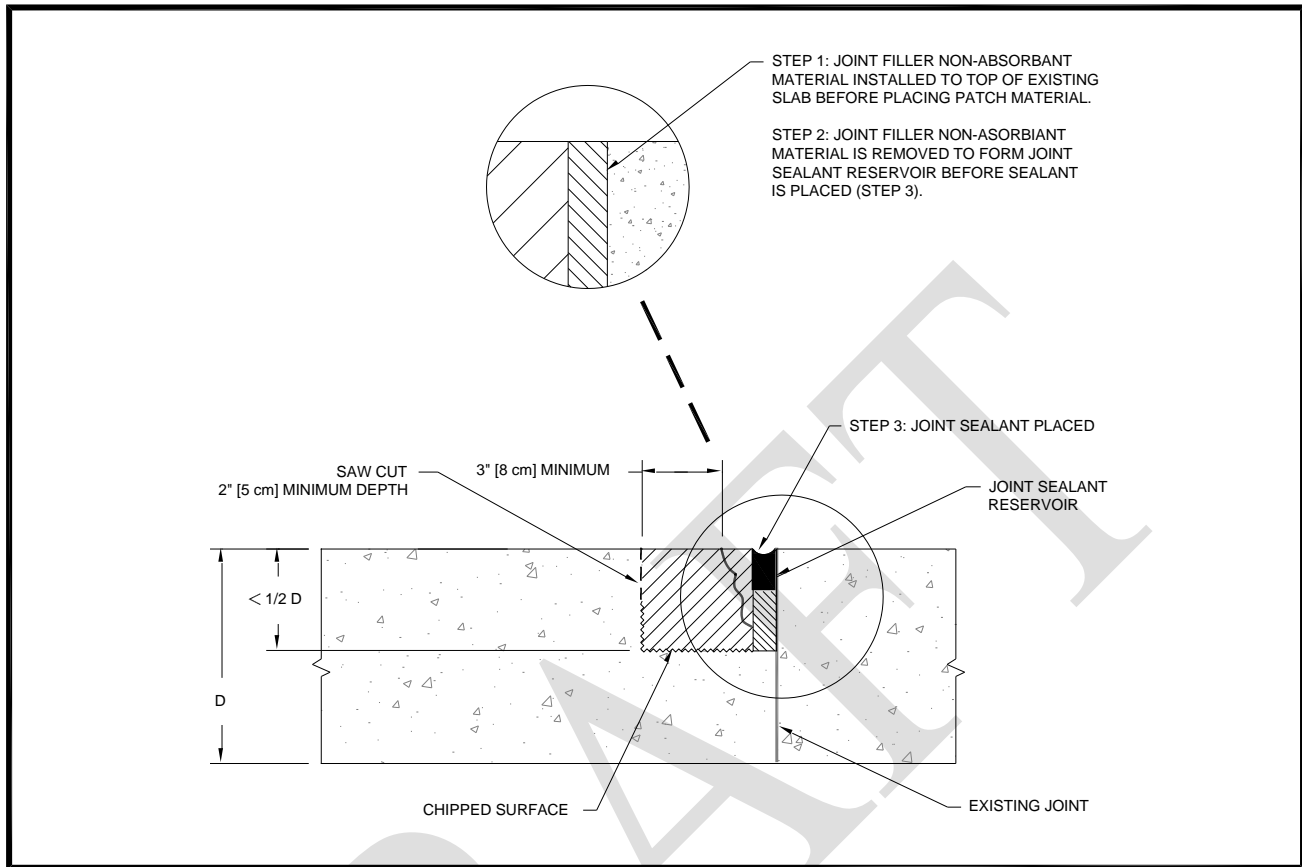
- Do not begin repairs during inclement weather.
- Do not place concrete unless the ambient temperature is at least 40° F (4° C) and rising and the concrete temperature is greater than or equal to 50° F (10° C).
- Do not place concrete on frozen base, ice, or snow.
- When the ambient temperature exceeds 85° F (29° C), sprinkle the adjacent concrete and base with water immediately before placing concrete.
- Place concrete at the coolest temperature practicable, and never allow the placed concrete temperature to exceed 90° F (32° C).

**REPAIR PROCEDURE**

1. Review the construction safety and phasing plan (CSPP). Ensure all pavement closures have all required items in place, such as lighted X's, barricades, etc.; and all NOTAMS issued for affected areas of the airfield.
2. Mark the limits of the area to be repaired.
3. Make a full-depth saw cut along the constructed joints at least 2 feet (.6 m) beyond the limits of the damaged pavement and make a saw cut perpendicular to the constructed joints from these points across the width of the pavement panel.
4. If dowels or tie bars are present along any edges, either of the following options is acceptable:
  - If dowels or tie bars will be exposed and saved, edges will be sawed full depth just beyond the end of the dowels or tie bars. Carefully saw joints on the joint line to within 1 inch (25 mm) of the depth of the dowel or tie bar. Carefully break up the narrow strips of concrete along doweled edges using light 30 pound (14 kg) or less jackhammers, or other approved equipment.
  - If dowels or tie bars are to be cut and replaced, make a full depth saw cut along the constructed joint cutting the dowels and tie bars.
5. Take care to prevent damage to the dowels, tie bars, or to concrete which remains in place.
6. Make additional saw cuts within the limits of the repair area dividing the repair area into quarters.

7. Use light weight equipment i.e. jack hammer less than 30 pounds (14 kg), hand tools, etc. to remove the damaged PCC pavement. Work from inside the saw cut toward the interior of the area being removed to prevent damage to the pavement remaining.
8. Remove by hand all loose material and vacuum to minimize any disturbance to the subgrade or base materials.
9. Restore subgrade or base material if required.
10. Install #4 deformed tie-bars in the face of the parent panel by drilling horizontal holes in to the face and using an epoxy bonding agent. Space the tie-bars equidistant at 24 inches (.6 m) on center.
11. If existing dowel bars have been cut and removed, install dowel bars of the type and size of the existing dowel bars in the joints that are parallel to the direction of traffic. On aprons and areas where traffic may be oblique to joints, install dowels in both joint faces.
12. Install dowels by drilling and epoxying into the PCC pavement at least 3 inches (75 mm) from the location of the existing dowels which were cut off. Space dowel bars at least 3 inches (75 mm) from the edge of the repair area and at least one bar spacing apart at corners of intersecting joints.
13. Oil the exposed ends of dowel bars prior the backfilling repair area with concrete.
14. Install nonabsorbent board or other approved material within the limits of the joint seal reservoir (Step 1). The nonabsorbent board will be a standard ½ inch (13 mm) asphalt impregnated fiber-board. For joints wider than ½ inch (13 mm), adjust the width of the nonabsorbent board to fit the joint width.
15. Fill the repair area with concrete and consolidate with vibrator. Use concrete meeting the requirements of P-501 or State DOT Specifications for Pavements.
16. Finish the surface to match existing surface.
17. Spray with curing compound per ASTM C309.
18. Remove the nonabsorbent board or other approved material (Step 2) and place joint sealant per ASTM D6690 (Step 3).
19. Thoroughly clean the work area before opening pavement to aircraft traffic.
20. Do not allow traffic until concrete has cured.



**A8. JOINT SPALL REPAIR IN RIGID PAVEMENT****Figure A-8. Joint Spall Repair in Rigid Pavement**

**Repair Procedure and Weather and Temperature Requirements are on the back of this page.**

**Material Requirements**

ASTM C309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C881	Standard Specifications for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM D 6690	Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements
P-501	Portland Cement Concrete (PCC) Pavement, AC 150/5370-10, Standards for Specifying Construction of Airports
State Department of Transportation Specifications for Pavements	

**WEATHER AND TEMPERATURE  
REQUIREMENTS**

- Do not begin repairs during inclement weather.
- Do not place concrete unless the ambient temperature is at least 40° F (4° C) and rising and the concrete temperature is greater than or equal to 50° F (10° C).
- Do not place concrete on frozen base, ice, or snow.
- When the ambient temperature exceeds 85° F (29° C), sprinkle the adjacent concrete and base with water immediately before placing concrete.
- Place concrete at the coolest temperature practicable, and never allow the placed concrete temperature to exceed 90° F (32° C).

**REPAIR PROCEDURE**

1. Review the construction safety and phasing plan (CSPP). Ensure all pavement closures have all required items in place, such as lighted X's, barricades, etc.; and all NOTAMS issued for affected areas of the airfield.
2. Mark the limits of the area of spall repair.
3. Make vertical saw cuts a minimum of 2 inches (50 mm) in depth and approximately 3 inches (75 mm) beyond the limit of the spall area. Saw cuts shall be straight lines defining the perimeter of the spall repair area. Spall repair area shall be a rectangular area.
4. When there are adjacent spall repair areas within a slab, the minimum distance between spall repair areas is 1-1/2 feet (45 cm). When spall repair areas are less than 1-1/2 feet (45 cm) apart, combine the spall repair areas into one repair. When the spall repair areas are greater than 1-1/2 feet (45 cm) apart, maintain separate spall repair areas.

5. Chip out and remove all unsound concrete and at least ½ inch (13 mm) of visually sound concrete between the saw cut and the joint, or crack.
6. Use light weight equipment i.e. jack hammer less than 30 pounds (14 kg), hand tools, etc. to remove the damaged PCC pavement. Work from inside the saw cut toward the joint to prevent damage to the remaining pavement.
7. Remove all loose material by hand and vacuum to minimize any damage to the remaining pavement.
8. Clean the spall repair area with high-pressure water.
9. Place nonabsorbent board or other approved material (Step 1) in the existing joint and form a new joint sealant reservoir adjacent to the repair area. Maintain the joint through the full depth of the spall repair and prevent a bond between the patch and the adjacent slab.
10. Prepare the surface of the joint repair area in accordance with the manufacturer's recommendations for the material used for the repair. This may require treating the surface of the spall repair with a neat cement grout or a liquid bonding agent.
11. Place the patch.
12. Finish the patch to match the texture of the adjacent pavement.
13. Cure the patch in accordance with the material manufacturer's recommendations.
14. Remove the nonabsorbent board or other approved material from the joint (Step 2) and place joint sealant per ASTM D6690 (Step 3).
15. Protect the patch from traffic until the material has set.
16. Thoroughly clean the work area before opening pavement to aircraft traffic.

**APPENDIX B. Bibliography**

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- UFC 3-270-02, Asphalt Crack Repair, 15 March 2001.
- UFC 3-270-03, Concrete Crack and Partial-Depth Spall Repair, 15 March 2001.
- UFC 3-270-04, Concrete Repair, 15 March 2001.