The preparation of this document was financed in part through an Airport Improvement Program grant from the Federal Aviation Administration (Project Number 3-19-0000-021-2014) as provided under Section 505 of the Airport and Airway Improvement Act of 1982, as amended. The contents do not necessarily reflect the DOT’s official views or the policy of the FAA. Acceptance of this report by the FAA does not in any way constitute a commitment on the part of the United States to participate in any development depicted therein nor does it indicate the proposed development is environmentally acceptable in accordance with appropriate public laws.
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INTRODUCTION

Applied Pavement Technology, Inc. (APTech), with assistance from Robinson Engineering Company, updated the airport pavement management system (APMS) for the Iowa Department of Transportation, Office of Aviation (Iowa DOT). During this project, pavement conditions at Clarinda Municipal - Schenck Field Airport were assessed in October 2014 using the Pavement Condition Index (PCI) procedure.

During a PCI inspection, the types, severities, and amounts of distress present in a pavement are quantified. This information is then used to develop a composite index that represents the overall condition of the pavement in numerical terms, ranging from 0 (failed) to 100 (excellent). The PCI provides an overall measure of condition and an indication of the level of work that will be required to maintain or repair a pavement. The distress information also provides insight into what is causing the pavement to deteriorate, which is the first step in selecting the appropriate repair action to correct the problem.

Programmed into an APMS, PCI information is used to determine when preventive maintenance actions (such as crack or joint sealing) are advisable, and also to identify the most cost-effective time to perform major rehabilitation (such as an overlay or whitetopping). The importance of identifying not only the type of repair but also the optimal time of repair is illustrated in Figure 1. This figure shows that there is a point in a pavement’s life cycle where the rate of deterioration increases and if the pavement is allowed to continue to deteriorate, the repair costs will increase significantly as the pavement structure becomes compromised. Eventually, the pavement structure will become so degraded that costly reconstruction remains the only alternative.

Figure 1. Pavement condition versus cost of repair.

(Referenced from http://www.fhwa.dot.gov/pavement/preservation/ppc0621.cfm)
The pavement evaluation results for Clarinda Municipal - Schenck Field Airport are presented within this report and can be used by the Iowa DOT, the Federal Aviation Administration (FAA), and Clarinda Municipal - Schenck Field Airport to prioritize and schedule pavement maintenance and rehabilitation (M&R) actions at the airport. In addition to this report, a web-based Interactive Data Exchange Application (IDEA) that is accessible from the Iowa DOT’s website containing the pavement management information collected during this project is provided.
PAVEMENT INVENTORY

Approximately 532,888 square feet of runway, taxiway, and apron pavements were evaluated at Clarinda Municipal - Schenck Field Airport, as illustrated in Figure 2. This figure also shows the area-weighted age in years of the pavements.

Figure 2. Pavement inventory.

The pavement network at Clarinda Municipal - Schenck Field Airport was divided into branches, sections, and sample units for pavement management purposes. A branch is a single entity that serves a distinct function. For example, a runway is considered a branch because it serves a single function (allowing aircraft to take off and land). Taxiways and aprons are also separate branches.

A branch is further divided into sections. Traditionally, sections are defined as parts of the branch that share common attributes, such as cross-section, last construction date, traffic level, and performance. Using the traditional approach, if a runway was built in 1968 and then extended in 1984, it would be comprised of two separate sections.

A pavement section is subdivided into sample units to estimate its overall condition. Portions of these sample units are evaluated during pavement inspections, and this information is extrapolated to predict the condition of the section as a whole. Figure 3, a network definition map, shows how the pavement network was divided into management units and identifies the sample units that were evaluated during the pavement inspection at Clarinda Municipal - Schenck Field Airport.
FIGURE 3. NETWORK DEFINITION MAP.
PAVEMENT EVALUATION

Pavement Evaluation Procedure

APTech inspected the pavements at Clarinda Municipal - Schenck Field Airport using the PCI procedure. This procedure is described in FAA Advisory Circular (AC) 150/5380-6C, *Guidelines and Procedures for Maintenance of Airport Pavements* and FAA AC 150/5380-7B, *Airport Pavement Management Program (PMP)*, both located in Appendix A of this report, and ASTM D5340-12, *Standard Test Method for Airport Pavement Condition Index Surveys*. The PCI provides a numerical indication of overall pavement condition, as illustrated in Figure 4. The types and amounts of deterioration are used to calculate the PCI of the section. The PCI scale ranges from a value of 0 (representing a pavement in a failed condition) to a value of 100 (representing a pavement in excellent condition).

Figure 4. Visual representation of PCI scale.

<table>
<thead>
<tr>
<th>Typical Pavement Surface$^1$</th>
<th>PCI</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Typical Pavement Surface" /></td>
<td>100</td>
</tr>
<tr>
<td><img src="image2" alt="Typical Pavement Surface" /></td>
<td>60</td>
</tr>
<tr>
<td><img src="image3" alt="Typical Pavement Surface" /></td>
<td>15</td>
</tr>
</tbody>
</table>

$^1$Photographs shown are not specific to Clarinda Municipal - Schenck Field Airport.
In general terms, pavements above a PCI of 65 that are not exhibiting significant load-related distress will benefit from preventive maintenance actions, such as crack sealing or joint resealing. Pavements with a PCI of 40 to 65 may require major rehabilitation, such as an overlay or whitetopping. Often, when the PCI is less than 40, reconstruction is the only viable alternative due to the substantial damage to the pavement structure. Figure 5 illustrates how the appropriate repair type varies with the PCI of a pavement section.

Figure 5. PCI versus repair type.

<table>
<thead>
<tr>
<th>PCI</th>
<th>Repair</th>
</tr>
</thead>
<tbody>
<tr>
<td>86-100</td>
<td>Preventive Maintenance</td>
</tr>
<tr>
<td>71-85</td>
<td></td>
</tr>
<tr>
<td>56-70</td>
<td>Major Rehabilitation</td>
</tr>
<tr>
<td>41-55</td>
<td></td>
</tr>
<tr>
<td>26-40</td>
<td>Reconstruction</td>
</tr>
<tr>
<td>11-25</td>
<td></td>
</tr>
<tr>
<td>0-10</td>
<td></td>
</tr>
</tbody>
</table>

The types of distress identified during the PCI inspection provide insight into the cause of pavement deterioration. PCI distress types are characterized as load-related (such as alligator cracking on asphalt-surfaced pavements or shattered slabs on portland cement concrete [PCC] pavements), climate/durability-related (such as weathering [climate-related on asphalt-surfaced pavements] and durability cracking [durability-related on PCC pavements]), and other (distress types that cannot be attributed solely to load or climate/durability). Understanding the cause of distress helps in selecting a rehabilitation alternative that corrects the cause and thus eliminates its recurrence.

Appendix B identifies the distress types considered during a PCI inspection and describes the likely cause of each distress type. It should be noted that a PCI is based on visual signs of pavement deterioration and does not provide a measure of structural capacity.

**Pavement Evaluation Results**

The pavements at Clarinda Municipal - Schenck Field Airport were inspected on October 8, 2014. The 2014 area-weighted condition of Clarinda Municipal - Schenck Field Airport is 79, with conditions ranging from 71 to 100 (on a scale of 0 [failed] to 100 [excellent]). During the previous pavement inspection in 2011, the area-weighted PCI of the airport was 86.

Figure 6 summarizes the overall condition of the pavements at Clarinda Municipal - Schenck Field Airport and Figure 7 presents area-weighted condition (average PCI adjusted to account for
the relative size of the pavement sections) by branch use. Figure 8 is a map that displays the condition of the evaluated pavements. Table 1 summarizes the results of the pavement evaluation. Appendix C presents photographs taken during the PCI inspection, and Appendix D contains detailed information on the distresses observed during the visual survey. Appendix E includes detailed work history information that was collected during the record review process. A CD with a copy of the Clarinda Municipal - Schenck Field Airport PAVERTM database is attached to the inside of the front cover of this report.

Figure 6. Overall condition at Clarinda Municipal - Schenck Field Airport.
Figure 7. Condition by branch use at Clarinda Municipal - Schenck Field Airport.
(Values on chart are area-weighted)
FIGURE 8. PCI MAP.

T02CD-01 (89)
R02CD-02 (79)
R13CD-02 (97)
A01CD-01 (93)
T01CD-01 (88)
R02CD-01 (71)
R13CD-01 (98)
T03CD-01 (100)
A01CD-01 (93)
Table 1. Pavement evaluation results.

<table>
<thead>
<tr>
<th>Branch</th>
<th>Section</th>
<th>Surface Type</th>
<th>Section Area (sf)</th>
<th>LCD</th>
<th>2014 PCI</th>
<th>% Distress Due to:</th>
<th>Distress Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>A01CD</td>
<td>01</td>
<td>PCC</td>
<td>96,940</td>
<td>1/1/1997</td>
<td>93</td>
<td>0</td>
<td>21</td>
</tr>
<tr>
<td>R02CD</td>
<td>01</td>
<td>PCC</td>
<td>301,325</td>
<td>1/1/1997</td>
<td>71</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>02</td>
<td>PCC</td>
<td>74,993</td>
<td>6/1/1997</td>
<td>79</td>
<td>22</td>
<td>8</td>
</tr>
<tr>
<td>R13CD</td>
<td>01</td>
<td>PCC</td>
<td>5,980</td>
<td>1/1/1997</td>
<td>98</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>02</td>
<td>PCC</td>
<td>5,860</td>
<td>1/1/1997</td>
<td>97</td>
<td>0</td>
<td>64</td>
</tr>
<tr>
<td>T01CD</td>
<td>01</td>
<td>PCC</td>
<td>15,894</td>
<td>1/1/1997</td>
<td>88</td>
<td>0</td>
<td>16</td>
</tr>
<tr>
<td>T02CD</td>
<td>01</td>
<td>PCC</td>
<td>15,574</td>
<td>6/1/1997</td>
<td>89</td>
<td>0</td>
<td>56</td>
</tr>
<tr>
<td>T03CD</td>
<td>01</td>
<td>PCC</td>
<td>16,322</td>
<td>4/3/2009</td>
<td>100</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

1See Figure 3 for the location of the branch and section.

2 AC = asphalt cement concrete; AAC = asphalt overlay on AC; PCC = portland cement concrete; APC = asphalt overlay on PCC.

3 LCD = last construction date.

4 Distress due to load includes those distresses attributed to a structural deficiency in the pavement, such as alligator (fatigue) cracking or rutting on asphalt-surfaced pavements or shattered slabs on PCC pavements.

5 Distress due to climate or durability includes those distresses attributed to either the aging of the pavement and the effects of the environment (such as weathering or block cracking in asphalt-surfaced pavements) or to a materials-related problem (such as durability cracking in a concrete pavement).

6 L&T Cracking = Longitudinal and Transverse Cracking; LTD Cracking = Longitudinal, Transverse, and Diagonal Cracking.
**Inspection Comments**

Clarinda Municipal – Schenck Field Airport was inspected on October 8, 2014. There were eight pavement sections defined during the inspection.

**Runways**

Runway 2-20 consisted of two sections. Section 01, the majority of the runway pavement, had medium-severity joint seal damage recorded throughout. Significant amounts of low-severity alkali-silica reaction (ASR) and small quantities of low- and medium-severity longitudinal, transverse, and diagonal (LTD) cracking, low-severity patching, and low- and medium-severity corner and joint spalling were also observed. Section 02, the southern end runway extension, had low-severity joint seal damage identified. Moderate amounts of low- and medium-severity ASR and small quantities of low- and medium-severity LTD cracking and low-severity small patching were also noted in this section.

Runway 13-31 was defined by two sections that tied in the turf portion of Runway 13-31 with the Runway 2-20 pavement. Section 01 was located to the west of Runway 2-20 and Section 02 was located to the east of Runway 2-20. Both sections had low-severity joint seal damage observed at the time of inspection. In addition, isolated shrinkage cracking was identified in Section 02.

**Taxiways**

Taxiway 01 was defined by one section that connected Runway 2-20 to the apron. Low-severity joint seal damage and small amounts of low-severity ASR were the only distresses noted in this section.

Taxiway 02, a turnaround at the Runway 2 approach, consisted of one section with medium-severity joint seal damage and low-severity ASR recorded.

Taxiway 03, a turnaround at the Runway 20 approach, was defined by one section with no distresses present at the time of inspection.

**Apron**

The apron area was comprised of one section with only low-severity joint seal damage and isolated amounts of low-severity faulting and ASR identified.
PAVEMENT MAINTENANCE AND REHABILITATION PROGRAM

Using the information collected during the pavement inspection, a 5-year rehabilitation program was developed for Clarinda Municipal - Schenck Field Airport. In addition, a 1-year plan for localized preventive maintenance (such as crack sealing and patching) was prepared. The PAVER™ pavement management software was used to perform this analysis.

Analysis Parameters

Localized Maintenance Policies and Unit Costs
Localized maintenance policies were developed for asphalt-surfaced and PCC pavements. These policies, shown in Appendix F, identify the localized maintenance actions that the Iowa DOT considered appropriate to correct different distress types and severities. The Iowa DOT provided the unit costs for each of the localized maintenance actions in the maintenance policies, and these costs are provided in Appendix F. Please note that this information is of a general nature for the entire state. The maintenance policies and unit costs may require adjustment to reflect specific conditions at Clarinda Municipal - Schenck Field Airport.

Major Rehabilitation Unit Costs
PAVER™ estimates the cost of major rehabilitation based on the PCI of the pavement. The Iowa DOT provided these costs, and they are presented in Appendix F. If major rehabilitation is recommended in the 5-year program, further engineering investigation will be needed to identify the most appropriate rehabilitation action and to more accurately estimate the cost of such work.

Budget and Inflation Rate
An unlimited budget with a start date of July 1, 2015 and an inflation rate of 2.5 percent was used during the analysis.

Analysis Approach

The 5-year program was prepared with the goal of maintaining the pavements above established critical PCIs. The Iowa DOT set the critical PCI at 65 for runways, 60 for taxiways, and 55 for aprons. During this analysis, major rehabilitation was recommended for pavements in the year they dropped below their critical PCI.

For the first year (2015) of the analysis only, a localized preventive maintenance plan was developed for pavement sections that were above their critical PCI. If major rehabilitation was triggered for a section in 2016 or 2017, then localized maintenance was not recommended for 2015. While localized preventive maintenance should be an annual undertaking at Clarinda Municipal - Schenck Field Airport, it is not possible to accurately predict the propagation of cracking and so on. Therefore, the airport should budget for maintenance every year and can use the 2015 maintenance plan as a baseline for that work. As the pavements age, it can be assumed that the amount of localized maintenance required will increase.
Analysis Results

A summary of the M&R program for Clarinda Municipal - Schenck Field Airport is presented in Table 2. Detailed information on the recommended localized maintenance plan for 2015 is contained in Appendix G.

Table 2. 5-year M&R program under an unlimited funding analysis scenario.

<table>
<thead>
<tr>
<th>Year</th>
<th>Branch¹</th>
<th>Section¹</th>
<th>Surface Type²</th>
<th>Type of Repair³</th>
<th>Estimated Cost⁴</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>R02CD</td>
<td>01</td>
<td>PCC</td>
<td>Localized Maintenance</td>
<td>$123,481</td>
</tr>
<tr>
<td></td>
<td></td>
<td>02</td>
<td>PCC</td>
<td>Localized Maintenance</td>
<td>$11,839</td>
</tr>
<tr>
<td></td>
<td>T02CD</td>
<td>01</td>
<td>PCC</td>
<td>Localized Maintenance</td>
<td>$3,908</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Total:</td>
<td>$139,228</td>
</tr>
</tbody>
</table>

¹See Figure 3 for the location of the branch and section.

²AC = asphalt cement concrete; AAC = asphalt overlay on AC; PCC = portland cement concrete; APC = asphalt overlay on PCC.

³Major Rehabilitation: such as pavement reconstruction or an overlay. Localized Maintenance: such as crack sealing or patching.

⁴Cost estimates are based on broad statewide numbers and should be adjusted to reflect local costs.

The recommendations made in this report are based on a broad network level analysis and are meant to provide Clarinda Municipal - Schenck Field Airport with an indication of the type of pavement-related work required during the next 5 years. Further engineering investigation may be needed to identify which repair action is most appropriate. In addition, the provided cost estimates are based on overall unit costs for the entire state, and Clarinda Municipal - Schenck Field Airport should adjust the plan to reflect local costs.

Because an unlimited budget was used in the analysis, the pavement repair program may need to be adjusted to take into account economic and/or operational constraints. Also, the identification of the need for a project does not mean that state or federal funding will be available in the year it is indicated. It is important to remember that regardless of the recommendations presented within this report, Clarinda Municipal - Schenck Field Airport is responsible for repairing pavements where existing conditions pose a hazard to safe operations.

General Maintenance Recommendations

In addition to the specific maintenance actions presented in Appendix G, it is recommended that the following strategies are considered for prolonging pavement life:

1. Regularly inspect all safety areas of the airport, and document all inspection activity. A sample form that can be used to perform these inspections is provided in Table 3 of this report.

2. Provide a method of tracking all maintenance activities that occur as a result of inspections. These need to be reported to the FAA and Iowa DOT. This is important as this information is used to update the APMS records and is required to remain in compliance with Public Law 103-305 (see the next section of this report for further information on this law).
3. Conduct an aggressive campaign against weed growth through timely herbicide applications and/or mowing programs for the safety areas. Vegetation growth in pavement cracks is very destructive and significantly increases the rate of pavement deterioration.

4. Implement a periodic crack and joint sealing program. Keeping water and debris out of the pavement system by sealing cracks and joints is a proven method of cost-effectively extending the life of the pavement system.

5. Ensure that dirt does not build up along the edges of the pavements. This can create a “bathtub” effect, reducing the ability of water to drain away from the pavement system.

6. Closely monitor the movement of heavy equipment, particularly farming, construction, and fueling equipment, to make sure it is only operating on pavements that are designed to accommodate heavy loads. Failure to restrict heavy equipment to appropriate areas may result in the premature failure of airport pavements.

**FAA Requirements (Public Law 103-305)**

Since the Clarinda Municipal - Schenck Field Airport is in the National Plan of Integrated Airport Systems (NPIAS), the airport sponsor is required to keep the airport in a viable operating condition. This includes maintaining airport pavements in accordance with Public Law 103-305. Public Law 103-305 states that after January 1, 1995, NPIAS airport sponsors must provide assurances or certifications that an airport has implemented an effective airport pavement maintenance management system (PMMS) before the airport will be considered for federal funding of pavement replacement or reconstruction projects. To be in full compliance with the federal law, the PMMS must include the following components, at minimum: pavement inventory, pavement inspections, record keeping, information retrieval, and program funding.

This report serves as a complete pavement inventory and detailed inspection. To remain in compliance with the law, the airport will also need to undertake monthly drive-by inspections of pavement conditions and track pavement-related maintenance activities.

FAA AC 150/5380-6C and FAA AC 150/5380-7B provide detailed guidance pertaining to the requirements for an acceptable pavement management program. Appendix A of FAA AC 150/5380-7B outlines what needs to be included in a PMP to remain in compliance with this law and Grant Assurance #11. Following is a copy of this Appendix, along with instructions for supplementing this report so that all requirements are met.

**FAA AC 150/5830-7B, Appendix A. Pavement Management Program (PMP)**

*Note – the italicized words are direct quotations from the FAA AC.*

*An effective PMP specifies the procedures to follow to assure that proper preventative and remedial pavement maintenance is performed. The program should identify funding or anticipated funding and other resources available to provide remedial and preventive maintenance activities. An airport sponsor may use any format deemed appropriate, but the program needs to, as a minimum, include the following:*

**A-1.1. Pavement Inventory.** The following must be depicted:
a. Identification of all runways, taxiways, and aprons with pavement broken down into sections each having similar properties

The network definition map provided in Figure 3 of this report shows the location of all runways, taxiways, and aprons at Albia Municipal Airport. If any new pavements are constructed or any pavement areas are permanently closed, this map must be updated. Updates can be done by submitting your project plans to the Iowa DOT after project completion.

b. Dimensions of pavement sections

The dimensions of all runways, taxiways, and aprons are stored in the PAVERTM database. Appendix D provides information on length, width, and area. In addition, the network definition map (Figure 3) is drawn to scale. Any changes to pavement dimensions must be recorded.

c. Type of pavement surface

The type of pavement for each section at the airport is listed in Table 1 of this report and is also stored in the PAVERTM database. Any changes to pavement type (through an overlay or reconstruction) must be recorded.

d. Year of construction and/or most recent major rehabilitation

Dates for pavement construction, rehabilitation, or reconstruction must be recorded.

e. Whether AIP or PFC funds were used to construct, reconstruct, or repair the pavement

Funding sources for all pavement projects should be recorded.

A-1.2. PMP Pavement Inspection Schedule. Airports must perform a detailed inspection of airfield pavements at least once a year for the PMP. If a pavement condition index (PCI) survey is performed, as set forth in ASTM D5340, Standard Test Method for Airport Pavement Condition Index Surveys, the frequency of the detailed inspection by PCI surveys may be extended to three years. Less comprehensive routine daily, weekly, and monthly maintenance inspections required for operations should be addressed.

This report consists of a detailed inspection that will extend the inspection period to 3 years. It is the airport sponsor’s responsibility to perform a monthly drive-by inspection. A sample form that you can be used to perform these inspections is provided in Table 3 of this report.
**A-1.3. Record Keeping.** The airport must record and keep on file complete information about all detailed inspections and maintenance performed until the pavement system is replaced. The types of distress, their locations, and remedial action, scheduled or performed, must be documented. The minimum information recorded includes:

a. Inspection date

b. Location

c. Distress types

d. Maintenance scheduled or performed

Items a through c are satisfied by this inspection report. Item d is the responsibility of the airport, as is record keeping of the monthly drive-by inspections.

**A-1.4. Information Retrieval.** An airport sponsor may use any form of record keeping it deems appropriate so long as the information and records from the pavement survey can generate required reports, as necessary.

Keep this report, monthly drive-by inspection reports, construction updates, and all records of maintenance activities in a readily accessible location so that you can easily retrieve information as requested by the FAA.
Table 3. Pavement inspection report.

<table>
<thead>
<tr>
<th>Location[1]</th>
<th>Branch</th>
<th>Section</th>
<th>Distress Description/Dimensions/Severity/Recommended Action</th>
<th>Description of Repair</th>
<th>Date Performed</th>
<th>Cost</th>
<th>Funding Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>A01CD</td>
<td>01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R02CD</td>
<td>01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R13CD</td>
<td>01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T01CD</td>
<td>01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Inspected By: _________________________
Date Inspected: ______________________
Table 3. Pavement inspection report (continued).

<table>
<thead>
<tr>
<th>Location 1</th>
<th>Inspected By: _________________________</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date Inspected: ________________________</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Location</th>
<th>Maintenance Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inspection Record</strong></td>
<td><strong>Description of Repair</strong></td>
</tr>
<tr>
<td><strong>Branch</strong></td>
<td><strong>Section</strong></td>
</tr>
<tr>
<td>T02CD</td>
<td>01</td>
</tr>
<tr>
<td>T03CD</td>
<td>01</td>
</tr>
</tbody>
</table>

1See Figure 3 for the location of the branch and section.
SUMMARY

This report documents the results of the pavement evaluation conducted at Clarinda Municipal - Schenck Field Airport. During a visual inspection of the pavements in 2014, it was found that the overall condition of the pavement network is a PCI of 79. A 5-year pavement repair program, shown in Table 2, was generated for Clarinda Municipal - Schenck Field Airport, which revealed that approximately $139,228 needs to be expended on M&R. Clarinda Municipal - Schenck Field Airport should utilize these study results to assist in planning for future maintenance needs as part of the airport CIP planning process.
APPENDIX A

FAA AC 150/5380-6C
AND
FAA AC 150/5380-7B
Subject: Guidelines and Procedures for Maintenance of Airport Pavements  
Date: 10/10/2014  
Initiated by: AAS-100  
AC No: 150/5380-6C  
Change:

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


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 highway standards.

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

   a. Revised and reformatted 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. Split Table 6-1 into two tables; updated and simplified tables for Quick Guide for Maintenance and Repair of Common Rigid Pavement Surface Problems and Quick Guide for Maintenance and Repair of Common Flexible Pavement Surface problems.
f. Deleted Tables 6-2 through 6-10 from previous release.

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

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, U. S. customary units will be used followed with “soft” (rounded) conversion to metric units. The U. S. customary units govern.

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

   Federal Aviation Administration  
   Airport Engineering Division (AAS-100)  
   800 Independence Avenue, S.W.  
   Washington, DC 20591

8. **Copies of this AC.** This AC is available on the FAA Airport website:  

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 preventive 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 preventive 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. Timely maintenance and repair of pavements is essential in maintaining adequate load-carrying capacity, good ride quality necessary for the safe operation of aircraft, good friction characteristics under all weather conditions, and minimizing the potential for foreign object debris (FOD).

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, among other things, faulty construction techniques, substandard materials, or poor workmanship. Traffic loads in excess of those forecast during pavement design may also contribute to shortened pavement life.

The most effective means of preserving airport runways, taxiways, aprons, and other 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 ensures 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.

This chapter is a very general and brief overview of airport pavements. Airport pavements are designed, constructed, and maintained to support the critical loads imposed by aircraft. Airport pavements 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 ACs are available at http://www.faa.gov/regulations_policies/advisory_circulars/.

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](image)
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 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 (10 cm).

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 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 that 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 daylighted 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 (e.g., 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 edges 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 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/).


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 pavement maintenance/repair procedures and help determine 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 D5340, Standard Test Method for Airport Pavement Condition Index Surveys. Refer to AC 150/5380-7 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.


In addition to collecting information from visual inspections of the pavement areas and historical construction records, 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, ASTM D5340, 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. The following 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 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. This type of cracking is not load associated.

   (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 (0.3 m by 0.3 m) to 10 feet by 10 feet (3 m by 3 m). 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 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 (0.6 m) 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. The following types of disintegration commonly 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 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 progresses at a higher rate 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, a 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. The following types of distortion commonly occur in flexible pavement.

(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 distresses.

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

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

3.2.2. Rigid pavement distresses.

a. Cracking. Cracks in rigid pavements often result from stresses caused by expansion and contraction or warping of the pavement. Overloading, loss of subgrade support, and insufficient and/or improperly cut joints acting singly or in combination are also possible causes. The following types of cracking typically occur in rigid pavements.

(1) Longitudinal, transverse, and diagonal cracks. A combination of repeated loads and shrinkage stresses usually causes this type of distress. It is characterized by cracks that divide the slab into two or three pieces that may indicate poor construction techniques, underlying pavement layers that are structurally inadequate for the applied load, or pavement overloads.

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

(3) Durability “D” cracking. D cracking usually appears as a pattern of cracks running in the vicinity of and parallel to a joint or linear crack. It is caused by the concrete’s inability to withstand environmental factors such as freeze-thaw cycles because of variable expansive aggregates. This type of cracking may eventually lead to disintegration of the concrete within 1 to 2 feet (0.3 m to 0.6 m) of the joint or crack.

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

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

b. Joint seal damage. Joint seal damage is any condition that enables incompressible 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).

d. 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 typically falls into the following categories.

(1) Scaling, map cracking, and crazing. 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 crazing refers to a network of shallow hairline cracks that extend only through the upper surface of the concrete. Crazing usually results from improper curing and/or finishing of the concrete and may lead to scaling of the surface.

(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 forms 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 that 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 (0.6 m) 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 (0.6 m) 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, although not common, usually occur at a transverse crack or joint that 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 (2.5 to 10 cm) in diameter and from 1/2 to 2 inches (1.3 to 5 cm) deep. A popout may also be caused by a singular piece of large aggregate that breaks loose from the concrete surface or caused by 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 progresses at a higher rate than the original pavement. Patching is usually divided into two types:

(a) Small. A small patch is defined as an area less than 5 ft² (0.5 m²).

(b) Large and utility cuts. A large patch is defined as an area greater than 5 ft² (0.5 m²). 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. The following 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, 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. Crushing the naturally polished aggregates creates rough angular faces that provide good skid resistance.
(2) **Contaminants.** Rubber deposits building up over a period of time will reduce the surface friction characteristics of a pavement. Oil spills and other contaminants will also reduce the surface friction characteristics. In addition, buildup of rubber deposits in pavement grooves will reduce the effectiveness of the grooves and increase the likelihood of hydroplaning.
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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. The failure of airport pavements and drainage features can be directly attributed to inadequate maintenance characterized by the absence of a vigorously followed inspection program. 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 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 is thoroughly inspected, potential problem areas are identified, and proper corrective measures are 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. **Recordkeeping.** 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. **AC 150/5380-7, Airport Pavement Management Program (PMP),** provides additional guidance.
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 who are trained in the various repair techniques and who are familiar with the materials and equipment necessary to perform the routine pavement maintenance. 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. Equivalent state pavement specifications may also 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. HMA for maintenance and repair should be equivalent or better than the existing pavement. P-401, Hot Mix Asphalt (HMA) Pavements or P-403, Hot Mix Asphalt (HMA) Pavements (Base, Leveling or Surface Course) in AC 150/5370-10; or equivalent state pavement specifications should 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.


5.2.4. Crack filler material. Material for filling cracks should meet ASTM D5078, 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, that 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 dictate acceptable products. State Departments of Transportation (DOTs) 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 the following.

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. **Jackhammers.** Jackhammers with chisel heads 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.

5.3.3. **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.

5.3.4. **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.

5.3.5. **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 such as brooms or milling heads. Their small size and maneuverability make them ideal for maintenance activities.

5.3.6. **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.

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

5.3.8. **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.

5.3.9. **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.

5.3.10. **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 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.

5.3.11. **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 a crack saw to pivot about its own axis to more exactly follow random crack patterns easily.

5.3.12. **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.

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

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

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

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

5.3.17. **Hot air lance.** A hot air lance can be used to dry and heat cracks in existing bituminous material.


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) damage 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 provides additional guidance to help manage debris hazards associated with maintenance activities.

The first step in rehabilitating or preparing a pavement for repair 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 that are cosmetic and typically do not require repairs.

Refer to AC 150/5370-10, Items P-604 Compression Joint Seals for Concrete Pavements and P-605, Joint Sealants for Concrete Pavements for information and guidance on joint and crack sealants. A silicone sealant per ASTM D5893 can be used for edge joints between flexible and rigid pavements. Silicone should 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 they are 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 of 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 (0.6 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 are 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

<table>
<thead>
<tr>
<th>Problem</th>
<th>Repair</th>
<th>Probable Cause</th>
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</table>
| Weathering/Oxidation             | - Apply surface treatment  
- Overlay                  | - Environment  
- Lack of timely surface treatments |
| Cracks                           | - Remove old sealer material if present  
- Clean and prepare cracks  
- Seal/reseal cracks  
- 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.) | - Age  
- Environmental conditions  
- Bitumen too hard or overheated in mix  
- Sealant defects (e.g., incorrect application temperature, improper sealant selection, improper crack preparation) |
| Alligator or fatigue cracking    | - Remove and replace damaged pavement, including the base and/or subbase course if required. | - Base and/or Subgrade failure  
- Overload  
- Under-designed surface course (too thin) |
| Patches                          | - Remove/replace.  
- Repair and Resurface | - Inadequate/Improper repair detail/material  
- Age |
| Surface irregularities (e.g., rutting, wash-boarding, birdbaths) | - Remove and replace damaged areas  
- Surface grinding/milling | - Traffic  
- Age |
| Loss of Skid Resistance          | - Remove rubber/surface contamination  
- Apply surface treatment | - Rubber deposits/surface contamination  
- Polished aggregate  
- Improper surface treatment |
| Bleeding                         | - Blot with sand and remove sand prior to resuming aircraft operations. Excessive bleeding may require removal and replacement of pavement. | - Overly rich mix/low air void content. Bleeding may be a precursor to other surface deformities forming, e.g., rutting, wash-boarding, etc. |
| 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 |
Table 6-2. Quick guide for maintenance and repair of common rigid pavement surface problems

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

The following typical details and repair procedures are intended for use for minor maintenance repair of airport pavements. 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.
A1. PROCEDURE FOR CRACK REPAIR OF FLEXIBLE PAVEMENT

WEATHER AND TEMPERATURE REQUIREMENTS

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

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 inch (2.5 cm) 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 Xs, barricades, signs, etc.; and all NOTAMS have been 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 × 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 ¼ inch to ⅜ 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.
### MATERIAL REQUIREMENTS

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM D977</td>
<td>Standard Specification for Emulsified Asphalt</td>
</tr>
<tr>
<td>ASTM D6690</td>
<td>Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements</td>
</tr>
</tbody>
</table>

State Department of Transportation specifications for pavements
A2. PARTIAL DEPTH CRACK REPAIR IN FLEXIBLE PAVEMENT

WEATHER AND TEMPERATURE REQUIREMENTS

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

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 (2.5 cm).

1. Review the construction safety and phasing plan (CSPP). Ensure all pavement closures have all required items in place, such as lighted Xs, barricades, signs, etc.; and all NOTAMS have been 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 (0.6 m) wide by 2 to 3 inches (5 to 8 cm) 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 the 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 a 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 HMA equivalent or better than the existing pavement. Use P-401, 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 has cured.
11. Completely clean the work area before opening to aircraft traffic.
### MATERIAL REQUIREMENTS

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<tbody>
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<tr>
<td>ASTM D3628</td>
<td>Standard Practice for Selection and Use of Emulsified Asphalts</td>
</tr>
<tr>
<td>ASTM D6690</td>
<td>Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements</td>
</tr>
<tr>
<td>P-401</td>
<td>Hot Mix Asphalt (HMA) Pavements, AC 150/5370-10, Standards for Specifying Construction of Airports</td>
</tr>
<tr>
<td>P-403</td>
<td>Hot Mix Asphalt (HMA) Pavements (Base, Leveling, or Surface Course), AC 150/5370-10, Standards for Specifying Construction of Airports</td>
</tr>
</tbody>
</table>

State Department of Transportation specifications for pavements
**WEATHER AND TEMPERATURE REQUIREMENTS**

- Do not begin crack repair during inclement weather.
- HMA should not be placed upon a wet surface or when the surface temperature of the underlying course is less than 45°F (7°C).

**REPAIR PROCEDURE**

Use this procedure to conduct full depth repairs of flexible pavements and to repair cracks greater than 1 inch (2.5 cm) in flexible pavements 5 inches (13 cm) or less in thickness.

1. Review the construction safety and phasing plan (CSPP). Ensure all pavement closures have all required items in place, such as lighted Xs, barricades, etc.; and all NOTAMS have been 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 (0.6 m) 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 a 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 HMA equivalent to or better than the existing pavement. Use P-401, 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 has cured.

9. Completely clean the work area before opening to aircraft traffic.
**MATERIAL REQUIREMENTS**

<table>
<thead>
<tr>
<th>Standard/Code</th>
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<tbody>
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<tr>
<td>P-401</td>
<td>Hot Mix Asphalt (HMA) Pavements, AC 150/5370-10, Standards for Specifying Construction of Airports</td>
</tr>
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<td>P-403</td>
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</tr>
<tr>
<td>P-603</td>
<td>Bituminous Tack Coat, AC 150/5370-10, Standards for Specifying Construction of Airports</td>
</tr>
</tbody>
</table>

State Department of Transportation specifications for pavements
Figure A-4. Rigid pavement repair – plan view
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 C309** Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
- **ASTM D6690** 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 Xs, barricades, etc.; and all NOTAMS have been 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 (0.6 m) beyond the limits of the break and make saw cuts perpendicular to the constructed joints from these points until they intersect. See Figure A-4.
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 (2.5 cm) of the depth of the dowel or tie bar. Use 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., jackhammers 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 deformed tie-bars in each face of the parent panel by drilling horizontal holes into the face and using an epoxy bonding agent.
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 (8 cm) from the location of the existing dowels which were cut off. Space dowel bars at least 3 inches (8 cm) 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 the 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 a vibrator. Concrete should meet the requirements of P-501 or State DOT specifications for pavements.
15. Finish the surface to match existing pavement.
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**

<table>
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</tr>
<tr>
<td>ASTM D6690</td>
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</tr>
<tr>
<td>P-501</td>
<td>Portland Cement Concrete (PCC) Pavement, AC 150/5370-10, Standards for Specifying Construction of Airports</td>
</tr>
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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 Xs, barricades, etc.; and all NOTAMS have been 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 (0.6 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. See Figure A-4.
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 (2.5 cm) 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 that 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., jackhammers 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 deformed tie-bars in the face of the parent panel by drilling horizontal holes in to the face and using an epoxy bonding agent.
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 (8 cm) from the location of the existing cut dowels. Space dowel bars at least 3 inches (8 cm) 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 to 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 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 the pavement to aircraft traffic.
20. Do not allow traffic until the 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.

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<table>
<thead>
<tr>
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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 Xs, barricades, etc.; and all NOTAMS have been 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 (0.6 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 (2.5 cm) 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 that 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., jackhammers 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. 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.
11. Install dowels by drilling and epoxying into the PCC pavement at least 3 inches (8 cm) from the location of the existing dowels which were cut off. Space dowel bars at least 3 inches (8 cm) 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. 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 a vibratory. Use concrete meeting the requirements of P-501 or State DOT specifications for pavements.
15. Finish the surface to match the existing surface.
17. Remove the nonabsorbent board or other approved material (Step 2) and place joint sealant per ASTM D6690 (Step 3).
18. Thoroughly clean the work area before opening the pavement to aircraft traffic.
19. Do not allow traffic until the 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.

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<td>Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete</td>
</tr>
<tr>
<td>ASTM C881</td>
<td>Standard Specifications for Epoxy-Resin-Base Bonding Systems for Concrete</td>
</tr>
<tr>
<td>ASTM D6690</td>
<td>Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements</td>
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<td>State Department of Transportation specifications for pavements</td>
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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 Xs, barricades, etc.; and all NOTAMS have been 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 (5 cm) in depth and approximately 3 inches (8 cm) beyond the limit of the spall area. Saw cuts should be straight lines defining the perimeter of the spall repair area. The spall repair area should 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., jackhammers 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 the pavement to aircraft traffic.
Appendix B. Bibliography

1. American Concrete Pavement Association (ACPA), http://www.acpa.org/:
   - Joint and Crack Sealing and Repair for Concrete Pavements (TB012P), 1993.

2. The Asphalt Institute (AI), http://www.asphaltinstitute.org/:
   - Asphalt Overlays for Highway and Street Rehabilitation, MS-17, 3rd Edition.

   - AC 150/5200-18, Airport Safety Self-Inspection.
   - AC 150/5200-30, Airport Winter Safety and Operations.
   - AC 150/5200-33, Hazardous Wildlife Attractants On or Near Airports.
   - AC 150/5210-24, Airport Foreign Object Debris (FOD) Management.
   - AC 150/5320-5, Airport Drainage Design.
   - AC 150/5320-6, Airport Pavement Design and Evaluation.
   - AC 150/5320-12, Measurement, Construction, and Maintenance of Skid Resistant Airport Pavement Surfaces.
   - AC 150/5370-2, Operational Safety on Airports During Construction.
• AC 150/5370-10, Standards for Specifying Construction of Airports.

• AC 150/5370-11, Use of Nondestructive Testing Devices in the Evaluation of Airport Pavements.

• AC 150/5380-7, Airport Pavement Management Program.


• UFC 3-270-01, Asphalt Maintenance and Repair, 15 March 2001.

• 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.
1. What is the purpose of this advisory circular (AC)?

This advisory circular (AC) discusses the Airport Pavement Management Program (PMP) concept, its basic essential components, and how it is used to make cost-effective decisions about pavement maintenance and rehabilitation (M&R). The terms “pavement management program (PMP),” “pavement maintenance-management program (PMMP),” and “pavement management system (PMS)” are interchangeable. A PMP is a set of defined procedures for collecting, analyzing, maintaining, and reporting pavement data. A PMP assists airports in finding optimum strategies for maintaining pavements in a safe serviceable condition over a given period for the least cost. A PMP should take into account not only inspection procedures and condition assessment, maintenance protocols and procedures, management and oversight of completed works, but also staff competence needs.

This AC is for airport sponsors, state aviation organizations, engineers, and maintenance personnel responsible for implementing a PMP. Federally obligated airports must perform a detailed inspection of airfield pavements at least once a year for the PMP. If a pavement condition index (PCI) survey is performed, as set forth in ASTM D5340, Standard Test Method for Airport Pavement Condition Index Surveys, the frequency of the detailed inspections by PCI surveys may be extended to three years. The PMP inspections are in addition to routine maintenance inspections for operations.

2. Does this AC cancel any prior ACs?

This AC cancels AC 150/5380-7A, Airport Pavement Management Program, dated September 1, 2006.

3. To whom does this AC apply?

The Federal Aviation Administration (FAA) recommends the guidance in this AC. In general, use of this AC is not mandatory. However, use of this AC is mandatory for all projects funded with federal grant monies through the Airport Improvement Program (AIP) and with revenue from the Passenger Facility Charges (PFC) Program. See Grant Assurance No. 11, Pavement Preventive Maintenance, No. 34, Policies, Standards, and Specifications, and PFC Assurance No. 9, Standards and Specifications.
AC 150/5380-7B

FAA Order 5100.38, Airport Improvement Program Handbook, provides guidance and sets forth policies and procedures for the administration of the AIP including eligibility and justification requirements.

4. What are the principal changes in this AC?
   
   a. Included airfield inspection frequency requirement in paragraph 1, above, and Appendix A.
   
   b. Added information on requirements to implement a PMP in paragraph 3, i.e., AIP Grant Assurance 11.
   
   c. Added discussion on pavement preservation concept and new Figure 2 to paragraph 2.0.
   
   d. Added new Appendix A, Pavement Management Program (PMP), which addresses minimum PMP requirements. This information was previously included in AC 150/5380-6, Guidelines and Procedures for Maintenance of Airport Pavements.
   
   e. Added new Appendix B, Pavement Condition Index (PCI) Method.
   
   f. Added new Appendix C, PAVERTM Distress Identification Manuals, with link to manuals.
   
   g. Updated Appendix D, Related Reading Material.

5. Where can I send comments or suggestions to the AC?

Send comments or suggestions for improving this AC to—

Federal Aviation Administration
Airport Engineering Division (AAS-100)
800 Independence Avenue SW
Washington DC 20591

6. Where can I get copies of this AC?

All Office of Airport Safety and Standards ACs are available online at:
http://www.faa.gov/airports/resources/advisory_circulars/.

Michael J. O’Donnell
Director of Airport Safety and Standards
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1.0 Background.

Historically, some airport sponsors have made decisions about pavement maintenance and rehabilitation (M&R) based on immediate need or experience rather than long-term planning or documented data on effective M&R methods. This approach did not allow the airport sponsor to evaluate the cost effectiveness of alternative M&R strategies, and it led to the inefficient use of available M&R funds.

Every airport sponsor needs to decide the most cost effective way to allocate available funds. This has typically been done based on either experience or the evaluation of existing pavement conditions. Using the experience approach, the airport staff applies M&R procedures which their experience indicates is the best solution for the problem. This approach results in the repeated application of a few select alternatives which may not lead to a preferred rehabilitation strategy, considering pavement performance and life-cycle cost. Using the existing condition approach, the pavement network is evaluated by its condition indicators. M&R alternatives, based on these indicators, are chosen based solely on the condition of the pavement, which may not be the most efficient alternative, and does not take into account life-cycle cost comparisons between M&R alternatives.

Because these approaches have worked reasonably well in the past, some airports have adopted them as standard procedures, ignoring new methods, materials and technologies. These approaches fail to answer some basic questions for the use of limited M&R funds. For example, if you are planning a pavement rehabilitation project such as an overlay, how do you make the best decision if funds are only available to do a full 4-inch overlay over half the pavement in need of M&R in a given funding year? Will there be sufficient funds in the next funding cycle to complete the full 4-inch overlay on the remaining pavements? Should you do a 2-inch overlay over all pavement this year? What is the effect on the pavement since these decisions impact future pavement conditions? What course(s) of action do you take? What are the consequences?

The selection of the best course of action can be determined based on the predicted effects of each action. For example, by placing a thin overlay on all pavements, there will be an immediate improvement to all the pavements. However, due to rapid deterioration of the overlays, there will probably be a need for further rehabilitation in a short period of time. If, in addition to other pavements needing work, some of the overlaid pavements need rehabilitation action again next year, the overall condition of the pavement network will eventually deteriorate. Alternatively, if a few selected pavements receive the full thickness overlay, they will not need rehabilitation for many years. During subsequent years, remaining pavements can then receive full thickness overlays, so the number of pavements needing rehabilitation will ultimately decrease. With this strategy, however, overall pavement condition will be worse in the short term because pavements that were not overlaid will continue to deteriorate until they are rehabilitated.

To determine which of these actions is preferable, you must be able to predict the future consequences of the various scenarios. This requires an understanding of the life span of the M&R method selected, i.e., in our example, a thick (e.g., 4-inch) versus thin (2-inch) overlay. Airports must also have a good understanding of the rate of pavement deterioration, with and without maintenance, and the causes of current pavement deterioration such as environmental or
pavement loading conditions. Predicting consequences of M&R scenarios requires experience and the application of best practices and engineering judgment in the decision-making process.

The implementation of a pavement management program (PMP) improves the decision-making process, expands its scope, allows for feedback based on choices made, and ensures that consistent decisions are made throughout an organization. If the consequences are predicted using a predetermined methodology, such as a PMP, it becomes possible to analyze previous predictions and improve on the prediction procedure over a period of time, regardless of management or staff turnover.

2.0 Airport Pavement Management Program (PMP).

A PMP provides a consistent, objective, and systematic procedure for establishing facility policies, setting priorities and schedules, allocating resources, and budgeting for pavement maintenance and rehabilitation. It can also quantify information and provide specific recommendations for actions required to maintain a pavement network at an acceptable level of service while minimizing the cost of maintenance and rehabilitation. A PMP not only evaluates the present condition of a pavement, but also predicts its future condition through the use of pavement condition indicators. By projecting the rate of deterioration, a life-cycle cost analysis can be made for various alternatives to determine the optimal time to apply the best M&R alternative and avoid higher M&R costs in the future.

Figure 1 illustrates how pavement typically deteriorates and the relative cost of rehabilitation at various times throughout its life. A pavement generally performs well for the majority of its life, after which it reaches a “critical condition” and begins to deteriorate rapidly. Maintaining and preserving a pavement in good condition versus rehabilitating a pavement in fair to poor condition is four to five times less expensive and increases pavement useful life. The number of years a pavement stays in “good” condition before reaching the point of rapid deterioration depends on several factors, including construction type and quality, pavement use, climate, and maintenance.
Figure 1. Typical Pavement Condition Life Cycle.

Figure 1 also shows that the ideal time for major rehabilitation is just as a pavement’s rate of deterioration begins to increase. Maintenance and rehabilitation solutions would be easy to plan if pavements exhibited clear signs they had reached this point, but unfortunately, they do not. The shape of the deterioration curve, and the optimal maintenance and repair points, vary considerably within a pavement network. A pavement experiencing a sudden increase in operations or aircraft loading will have a tendency to deteriorate more rapidly than a pavement deteriorating solely from environmental causes. A pavement deteriorating from environmental damage may have a number of cracks that need filling, but still remain structurally sound. Conversely, this same pavement may be in the early stages of load damage deterioration, which can only be detected with testing. Because it is difficult to determine when a pavement has reached the critical condition, a PMP helps identify the optimal rehabilitation point and allows decision-makers to target available resources where they will be most effective. The PMP does this by making use of data from a pavement condition rating system that helps predict future conditions and indicate whether the distress is load or environmentally related.

Information on pavement deterioration, by itself, is not sufficient to answer questions involved in selecting cost-effective M&R strategies. For example, should a pavement be sealed, recycled, or resurfaced? This type of decision requires information on the cost of various M&R procedures and their effectiveness. Effectiveness in this case means the proposed solution targets the pavement deficiency, improves the pavement condition, recovers the M&R costs, and extends the useful life of the pavement.
A PMP enables a user to store pavement condition and maintenance information in a database using the program’s resources to determine the most cost-effective solution for pavement maintenance issues.

Figure 2 illustrates the pavement preservation concept, which begins with an application of M&R techniques early in a pavement’s life. An effective pavement preservation program addresses pavements while they are still in good condition and before any serious damage occurs. By applying a cost-effective treatment at the right time, the pavement condition is improved. The cumulative effect of systematic, successive preservation treatments is to minimize or eliminate costly repairs and postpone costly rehabilitation and reconstruction. During the life of a pavement, the cumulative cost of the series of pavement preservation treatments is substantially less than the cost of the more extensive, higher cost of reconstruction and generally more economical than the cost of major rehabilitation. Additionally, performing a series of successive pavement preservation treatments during the life of a pavement is less disruptive to users than the long closures normally associated with reconstruction projects.

![Figure 2. Pavement Preservation Concept.](image-url)

When implementing a PMP, note the distinction between rehabilitation and routine maintenance activities. Routine maintenance is required to preserve the pavement to achieve the design life of the pavement. Routine maintenance consists of work planned and performed on a routine basis to maintain and preserve the condition of the airport pavements and is an integral part of the overall pavement preservation concept. This includes items such as yearly crack sealing and daily inspections of the airport pavement system.
2.1 Benefits of a PMP.

A PMP can provide several benefits, including:

- Increased pavement useful life.
- An objective and consistent evaluation of the condition of a network of pavements.
- A systematic and documentable engineering basis for determining M&R needs including consideration of future operational needs and/or planned airport expansion projects.
- Identifying budget requirements necessary to maintain pavement functionality.
- Documentation on the present and future condition of the pavements.
- Identifying the impact on the pavement if no major repairs are performed.

2.2 Components of a PMP.

To take full advantage of a PMP, pavement condition information must be collected and continually updated to keep data current. Alternative rehabilitation strategies must be identified along with decision criteria and a maintenance policy that will determine which rehabilitation procedures are employed. Further, the PMP requires models for prediction of performance, cost of alternate strategies, and optimization procedures that consider the entire pavement life cycle.

A system for accomplishing these objectives includes:

- A systematic means for collecting and storing information regarding existing pavement structure and pavement condition.
- An objective and repeatable system for evaluating pavement condition.
- Procedures for predicting future pavement condition.
- Procedures for modeling both past and future pavement performance conditions.
- Procedures to determine the budget requirements to meet management objectives, such as the M&R budget required to keep a pavement at a specified pavement condition index (PCI) level or the M&R budget required to improve to a target PCI level.
- Procedures for formulating and prioritizing M&R projects.

The components of a PMP include:

2.2.1 Database. There are several elements critical to making good pavement M&R decisions: pavement inventory; pavement structure; M&R history, including costs; information on the condition of a pavement; and traffic data. This data can be stored in a PMP database.

2.2.1.1 Pavement Inventory. Location of all runways, taxiways, and aprons; dimensions; type of pavement; year of construction and/or most recent major rehabilitation; and whether AIP or PFC funds were used to construct, reconstruct, or repair the pavement.

2.2.1.2 Pavement structure. Knowing when the pavement was originally built, the structural composition (material and thickness), and subsequent overlays, rehabilitation, etc., is key to analyzing problems and designing solutions. “As built” records should provide this information. If they are not available or if records are suspect, it may be necessary to perform
nondestructive and/or destructive testing to determine the existing pavement’s thickness and composition of the structural layers. Additional information regarding the pavements structural load bearing capacity, e.g., pavement classification number (PCN) may be beneficial. Additional information on PCN is available in AC 150/5335-5, Standardized Method of Reporting Airport Pavement Strength – PCN.

2.2.1.3 M&R history. A history of all M&R performed and its associated costs will provide valuable information on the effectiveness of various M&R procedures on pavements. An airport should also track and document routine maintenance activities including the types and severities of distresses repaired, type of work, quantities, and cost of work performed to help determine the effectiveness of different maintenance and rehabilitation strategies within a PMP.

2.2.1.4 Pavement condition data. A fundamental component of any PMP is the ability to track pavement condition. This requires an evaluation process that is objective, systematic, and repeatable. A pavement condition rating system, such as the PCI rating system described in ASTM International (ASTM) D5340, Standard Test Method for Airport Pavement Condition Index Surveys (see Appendix B for an overview of PCI), provides a rating of the surface condition of a pavement with implications of structural performance. Regular collection of pavement condition data is essential for tracking pavement performance, modeling pavement performance, and determining when to schedule M&R. Changes in pavement conditions, as documented in routine pavement inspections, may require a need for a more detailed PCI survey since the structural condition of a pavement cannot be determined solely from a visual inspection.

2.2.1.5 Traffic data. Data about the current and future operational needs including operations and type of aircraft using the pavement is beneficial when analyzing probable causes of deterioration and when evaluating alternate M&R procedures.

2.2.2 System capabilities.

2.2.2.1 Predicting current and future pavement condition. A PMP needs to be capable of predicting current and future pavement condition. Condition predictions are necessary to develop optimum, multi-year M&R plans. Pavement deterioration is affected by many factors including environment, surface condition, structural condition, change in traffic operations, etc. Overall pavement condition cannot be determined solely from the results of pavement inspections.

2.2.2.2 Determining optimum M&R plans for a given budget. A PMP should be capable of producing an optimum M&R plan that identifies where and when M&R is required and approximately how much it will cost. This data will assist in setting priorities that fit predetermined M&R budgets.

2.2.2.3 Determining budget requirements to meet management objectives. A PMP should be capable of determining the budget requirements to meet specified management objectives. Typical management objectives include maintaining pavements above a specified condition and/or eliminating major M&R requirements over a specified number of years.
2.2.2.4 Facilitating the formulation and prioritization of M&R projects. In addition to developing optimum M&R plans at the network level, a PMP should facilitate the formulation and prioritization of M&R projects. Engineering judgment, however, remains a key component in transforming the optimum M&R plans into practical executable projects.

2.3 PMP Management.

There are several terms that need to be defined to explain pavement management:

- **Pavement Network** – a logical unit for organizing pavements into a structure for the purpose of pavement management. A network will consist of one or more pavement branches, which in turn may consist of one or many pavement sections. The network is the point of origin for the hierarchy of pavement management structures. For example, a network can be all the pavements on an airport or all the pavements in the state airport system.

- **Pavement Branch** – a readily identifiable part of the pavement network with a distinct function. For example, an airfield pavement such as each individual runway, taxiway or apron is considered a separate branch. Each branch consists of at least one section.

- **Pavement Section** – a section is the smallest management unit when considering the application and selection of M&R treatments for a branch. Each branch consists of at least one section, but may consist of more if pavement characteristics vary throughout the branch. Factors to consider when dividing branches into sections includes, but is not limited to: pavement structure, type, age and condition; traffic composition and frequency (current and future); construction history; pavement function; and drainage facilities and shoulders. A pavement section is defined as a subordinate of a pavement branch, which in turn will be a subordinate of a parent pavement network.

Managing a pavement system effectively requires decision-making at two levels: network and project. PMP software (paragraph 3.0) can be used to assist in making pavement management decisions.

2.3.1 Network-level management. In network-level management, questions are answered about short-term and long-term budget needs, the overall condition of the network (current and future), and pavements to be considered at the project level. A network level evaluation can be utilized to optimize funding and prioritize M&R techniques so decisions are made for the management of an entire pavement network. For example, local consideration, might comprise all the pavements on an airport and, for state consideration, all the pavements in the state airport system.

2.3.1.1 Using PMP software at the network level. In addition to providing an automated tool for storing information about specific pavements, PMP software includes the ability to produce standard and customized user-defined reports. These reports can help the user make decisions about inspection scheduling, pavements needing rehabilitation, budget forecasting, routine maintenance projects, current pavement conditions, and future condition predictions.
2.3.1.2 **Condition prediction.** Condition prediction is used as the basis for developing inspection schedules and identifying pavements requiring maintenance or rehabilitation. Once pavements requiring future work are identified, a budget for the current year and for several years into the future can be developed. By using an agency’s prioritization scheme, maintenance policy, and M&R costs and then comparing the budget to the actual funds available for the current year, the software produces a list of potential projects. This list becomes the link to project-level management.

2.3.2 **Project-level management.** In project-level management, decisions are made about the most cost-effective M&R alternative for the pavements identified in the network analysis. However, factors may change the optimum M&R strategy between the time of the last PMP and the actual development of a project. At this level, each specified pavement should have a new detailed condition survey. A project normally consists of multiple pavement sections and may include different M&R actions for different sections. Roughness and friction measurements may be useful for project development. Nondestructive and/or destructive tests may be necessary to determine the pavement’s load-carrying capacity.

2.3.2.1 **Using PMP software at the project level.** PMP software can use a number of engineering measurements to quantify a pavement’s condition. Nondestructive test data, friction measurements, roughness measurements, and drainage information may be entered into the PMP database. This information is used to identify feasible alternatives that can correct existing deficiencies. The various alternatives identified, including no action, are then compared on a life-cycle cost basis. The results, combined with budget and management constraints, produce the current year’s maintenance and repair program.

2.3.2.2 **Roughness.** Roughness measurements can be helpful when there is evidence of roughness issues, usually in the form of frequent pilot complaints. Roughness measurement is of greater value when the pavement is in very good condition with little or no distress. It has less value if reconstruction is imminent. AC 150/5380-9, Guidelines and Procedures for Measuring Airfield Pavement Roughness, provides guidelines and procedures for measuring and evaluating runway roughness.

2.3.2.3 **Friction.** Friction measurements should be made on a periodic basis to measure the skid-resistance of runway pavement due to the accumulation of contaminants, chiefly rubber, on the pavement surface; and the mechanical wear and polishing action from aircraft tires rolling or braking on the pavement. AC 150/5320-12, Measurement, Construction, and Maintenance of Skid Resistant Airport Pavement Surfaces, provides recommendations for friction measurements.

2.4 **Reports.**

There are numerous reports that can be developed using the data from a PMP. PMP software can assist in the decision-making process by allowing the user to run standard and customized reports. PMP software allows the user to customize the reports to include only the pavements and/or conditions of interest and to generate various budget/condition scenarios. Reports typically include the following:
2.4.1 Inventory Report. This report lists all pavements in a network and contains information such as surface type, location, area, and pavement function, i.e., runway, taxiway, apron.

2.4.2 Inspection Scheduling Report. This report allows the user to schedule inspections based on minimum acceptable condition levels and rates of deterioration. The PMP should have annual detailed inspections and include provisions for less comprehensive daily, weekly, and monthly inspections. Federally obligated airports must perform a detailed inspection of airfield pavements at least once a year for the PMP. If a pavement condition index (PCI) survey is performed, as set forth in ASTM D5340, Standard Test Method for Airport Pavement Condition Index Surveys, the frequency of the detailed inspections by PCI surveys may be extended to three years. The PMP inspections are in addition to routine maintenance inspections for operations.

2.4.3 Pavement Condition Report. This report provides the user with a tabulation of pavement condition for the current and future years. The report provides the condition of individual pavement sections and the overall network condition. The projected condition is used to assist in planning future maintenance and repair needs and to inform management of present and future conditions.

2.4.4 Budget Planning Report. This report allows the user to project the budgets required to maintain the pavement network above a user-specified condition level. For each pavement selected, the report predicts the year in which the minimum condition or PCI will be reached and calculates the cost of repair. The budget planning report should include both routine maintenance activities, pavement preservation activities, and major rehabilitation activities for a given planning timeframe.

2.4.5 Network Maintenance Report. This report uses the agency’s maintenance strategy, which is stored in the database, and applies it to the distresses identified in the latest PCI survey.

2.4.6 Economic Analysis Report. This report can assist the user in selecting the most cost-effective alternative for a pavement repair. For each feasible alternative, the user must input initial costs, periodic maintenance costs (i.e., annual crack sealing), future maintenance costs (i.e., surface treatments), interest rates, and discount rates. The program performs a life-cycle cost analysis and provides the user with a means of comparing the effectiveness of the various repair alternatives. The program allows the user to vary interest rates, repair costs, and timing so their effect on alternatives can be analyzed.

2.4.7 Other Reports. Based upon local needs and conditions, other reports may be beneficial.

3.0 PMP Software.

When developing a PMP, airports can use any of several existing software options. PMP software allows for storage of pavement condition history, nondestructive testing data, and construction and maintenance history, including cost data. It provides many capabilities, including evaluation of current conditions, prediction of future conditions, identification of M&R
needs, inspection scheduling, economic analysis, and budget planning. PMP software can be tailored to each airport based on past performance of the alternatives.

3.1 **PAVER™.**

PAVER™ is a PMP application developed by the U.S. Army Construction Engineering Research Laboratory sponsored by the FAA. PAVER™ development and updating is supported by the FAA, Federal Highway Administration, U.S. Army, U.S. Air Force, and U.S. Navy to meet current user needs. PAVER™ provides pavement management capabilities to (1) develop and organize the pavement inventory; (2) assess the current condition of pavements; (3) develop models to predict future conditions; (4) report on past and future pavement performance; (5) develop scenarios for M&R based on budget or condition requirements; and (6) plan projects. Additional information on the PMP software is available at the following website: [http://paver.colostate.edu/](http://paver.colostate.edu/).

3.2 **FAA PAVEAIR.**

FAA PAVEAIR is a web-based airport PMP using the concept originally developed in PAVER™ that provides users with historic and current information about airport pavement construction, maintenance and management. The program offers users a planning tool capable of modeling airport pavement surface degradation due to external effects such as traffic and the environment. FAA PAVEAIR is accessible at the following website: [https://faapaveair.faa.gov](https://faapaveair.faa.gov).

3.3 **Other PMP Software.**

Various firms have developed similar software using the concept originally developed in PAVER™ that provides pavement evaluation and management services. Any software that meets the minimum requirements for a PMP as described in Appendix A is acceptable.
Appendix A. Pavement Management Program (PMP).

A-1.0 An effective PMP specifies the procedures to follow to assure that proper preventative and remedial pavement maintenance is performed. The program should identify funding or anticipated funding and other resources available to provide remedial and preventive maintenance activities. An airport sponsor may use any format deemed appropriate, but the program needs to, as a minimum, include the following:

A-1.1. Pavement inventory. The following must be depicted:

- Identification of all runways, taxiways, and aprons with pavement broken down into sections each having similar properties.
- Dimensions of pavement sections.
- Type of pavement surface.
- Year of construction and/or most recent major rehabilitation.
- Whether AIP or PFC funds were used to construct, reconstruct, or repair the pavement.

A-1.2. PMP Pavement Inspection Schedule.

Airports must perform a detailed inspection of airfield pavements at least once a year for the PMP. If a pavement condition index (PCI) survey is performed, as set forth in ASTM D5340, Standard Test Method for Airport Pavement Condition Index Surveys, the frequency of the detailed inspection by PCI surveys may be extended to three years. Less comprehensive routine daily, weekly, and monthly maintenance inspections required for operations should be addressed.

A-1.3. Record keeping.

The airport must record and keep on file complete information about all detailed inspections and maintenance performed until the pavement system is replaced. The types of distress, their locations, and remedial action, scheduled or performed, must be documented. The minimum information recorded includes:

- Inspection date
- Location
- Distress types
- Maintenance scheduled or performed

A-1.4. Information retrieval.

An airport sponsor may use any form of record keeping it deems appropriate so long as the information and records from the pavement survey can generate required reports, as necessary.
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Appendix B. Pavement Condition Index (PCI) Method.

B-1.0 Most PMP software use the PCI method. ASTM has adopted the PCI as a pavement condition rating standard for airfield pavements. ASTM D5340, Standard Test Method for Airport Pavement Condition Index Surveys, covers the determination of airport pavement condition through visual surveys of pavement using the PCI method to quantify pavement condition. ASTM D6433, Standard Practice for Roads and Parking Lots Pavement Condition Index Surveys, covers the determination of road and parking lot pavement condition.

B-2.0 The PCI is a numerical indicator that reflects the structural integrity and surface operational condition of a pavement. It is based on an objective measurement of the type, severity, and quantity of distress. By projecting the rate of deterioration, a life-cycle cost analysis can be performed for various M&R alternatives. Not only can the best alternative be selected, but the optimal time of application can also be determined. The PCI values range from 0 to 100, as shown in Figure B-1 where 0 indicates a failed pavement and 100 is a new pavement.

![Figure B-1. Example PCI Rating Scales for Airfield Pavements.](image-url)
B-3.0 The distress types for hot mix asphalt (HMA) and PCC pavements are identified in ASTM D5340; which describes each distress type, severity levels, and measurement of each distress. This information is also included in the PAVERTM Distress Identification Manuals referenced in Appendix C in this AC, as well as the PAVERTM and PAVEAIR programs.
Appendix C. PAVERTM Distress Identification Manuals.

C-1.0 This appendix includes a link to the PAVERTM Distress Identification Manuals developed by the U.S. Army Corps of Engineers Army Engineering Research and Development Center – Construction Engineering Research Laboratory (USACE ERDC-CERL). The manuals contain distress definitions, severity levels, and measuring methods for asphalt and concrete surfaced airfields, respectively. The information in these manuals can be used to determine the PCI of airfield pavements.


C-2.0 The manuals are available at the FAA Airports websites:


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Appendix D. Related Reading Material.

D-1.0 Electronic copies of the latest versions of the following FAA publications are available on the FAA website at http://www.faa.gov/airports_airtraffic/airports/resources/advisory_circulars/.

- AC 150/5320-5, Airport Drainage Design.
- AC 150/5320-6, Airport Pavement Design and Evaluation.
- AC 150/5320-12, Measurement, Construction, and Maintenance of Skid Resistant Airport Pavement Surfaces.
- AC 150/5335-5, Standardized Method of Reporting Airport Pavement Strength – PCN.
- AC 150/5380-6, Guidelines and Procedures for Maintenance of Airport Pavements.
- AC 150/5380-9, Guidelines and Procedures for Measuring Airfield Pavement Roughness.
- FAA Order 5100.38, Airport Improvement Program Handbook.

D-2.0 Copies of ASTM Standards can be obtained from ASTM International at http://www.astm.org/.


D-6.0 Unified Facilities Criteria (UFC) 3-270-08, Pavement Maintenance Management. A copy of the publication is available at the following website: http://www.wbdg.org/ccb/DOD/UFC/ufc_3_270_08.pdf.
APPENDIX B

CAUSE OF DISTRESS TABLES
Table B-1. Cause of pavement distress, asphalt-surfaced pavements.

<table>
<thead>
<tr>
<th>Distress Type</th>
<th>Probable Cause of Distress</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alligator Cracking</td>
<td>Fatigue failure of the asphalt concrete surface under repeated traffic loading.</td>
</tr>
<tr>
<td>Bleeding</td>
<td>Excessive amounts of asphalt cement or tars in the mix and/or low air void content.</td>
</tr>
<tr>
<td>Block Cracking</td>
<td>Shrinkage of the asphalt concrete and daily temperature cycling; it is not load associated.</td>
</tr>
<tr>
<td>Corrugation</td>
<td>Traffic action combined with an unstable pavement layer.</td>
</tr>
<tr>
<td>Depression</td>
<td>Settlement of the foundation soil or can be “built up” during construction.</td>
</tr>
<tr>
<td>Jet Blast</td>
<td>Bituminous binder has been burned or carbonized.</td>
</tr>
<tr>
<td>Joint Reflection</td>
<td>Movement of the concrete slab beneath the asphalt concrete surface because of thermal and moisture changes.</td>
</tr>
<tr>
<td>Longitudinal and Transverse Cracking</td>
<td>Cracks may be caused by 1) a poorly constructed paving lane joint, 2) shrinkage of the asphalt surface due to low temperatures or hardening of the asphalt, or 3) reflective cracking caused by cracks in an underlying portland cement concrete (PCC) slab.</td>
</tr>
<tr>
<td>Oil Spillage</td>
<td>Deterioration or softening of the pavement surface caused by the spilling of oil, fuel, or other solvents.</td>
</tr>
<tr>
<td>Patching</td>
<td>N/A</td>
</tr>
<tr>
<td>Polished Aggregate</td>
<td>Repeated traffic applications.</td>
</tr>
<tr>
<td>Raveling</td>
<td>Asphalt binder may have hardened significantly, causing coarse aggregate pieces to dislodge.</td>
</tr>
<tr>
<td>Rutting</td>
<td>Usually caused by consolidation or lateral movement of the materials due to traffic loads.</td>
</tr>
<tr>
<td>Shoving</td>
<td>Where PCC pavements adjoin flexible pavements, PCC “growth” may shove the asphalt pavement.</td>
</tr>
<tr>
<td>Slippage Cracking</td>
<td>Low strength surface mix or poor bond between the surface and the next layer of the pavement structure.</td>
</tr>
<tr>
<td>Swelling</td>
<td>Usually caused by frost action or by swelling soil.</td>
</tr>
<tr>
<td>Weathering</td>
<td>Asphalt binder and/or fine aggregate may wear away as the pavement ages and hardens.</td>
</tr>
</tbody>
</table>
Table B-2. Cause of pavement distress, portland cement concrete pavements.

<table>
<thead>
<tr>
<th>Distress Type</th>
<th>Probable Cause of Distress</th>
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<tbody>
<tr>
<td>Alkali-Silica Reaction (ASR)</td>
<td>Chemical reaction of alkalis in the portland cement with certain reactive silica minerals. ASR may be accelerated by the use of chemical pavement deicers.</td>
</tr>
<tr>
<td>Blow-Up</td>
<td>Incompressibles in the joints.</td>
</tr>
<tr>
<td>Corner Break</td>
<td>Load repetition combined with loss of support and curling stresses.</td>
</tr>
<tr>
<td>Cracks</td>
<td>Combination of load repetition, curling stresses, and shrinkage stresses.</td>
</tr>
<tr>
<td>Durability Cracking</td>
<td>Concrete’s inability to withstand environmental factors such as freeze-thaw cycles.</td>
</tr>
<tr>
<td>Joint Seal Damage</td>
<td>Stripping of joint sealant, extrusion of joint sealant, weed growth, hardening of the filler (oxidation), loss of bond to the slab edges, or absence of sealant in the joint.</td>
</tr>
<tr>
<td>Patching (Small and Large)</td>
<td>N/A</td>
</tr>
<tr>
<td>Popouts</td>
<td>Freeze-thaw action in combination with expansive aggregates.</td>
</tr>
<tr>
<td>Pumping</td>
<td>Poor drainage, poor joint sealant.</td>
</tr>
<tr>
<td>Scaling</td>
<td>Over finishing of concrete, deicing salts, improper construction, freeze-thaw cycles, and poor aggregate.</td>
</tr>
<tr>
<td>Settlement</td>
<td>Upheaval or consolidation.</td>
</tr>
<tr>
<td>Shattered Slab</td>
<td>Load repetition.</td>
</tr>
<tr>
<td>Shrinkage</td>
<td>Setting and curing of the concrete.</td>
</tr>
<tr>
<td>Spalling (Joint and Corner)</td>
<td>Excessive stresses at the joint caused by infiltration of incompressible materials or traffic loads; weak concrete at the joint combined with traffic loads.</td>
</tr>
</tbody>
</table>
APPENDIX C

INSPECTION PHOTOGRAPHS
R02CD-01. ASR (Sample Unit No. 03) (1).

R02CD-01. ASR (Sample Unit No. 03) (2).
R02CD-01. Overview.

R02CD-02. ASR (Sample Unit No. 02).
R02CD-02. Overview.

R13CD-01. Overview.
T01CD-01. ASR (Sample Unit No. 06).

T01CD-01. Overview.
T02CD-01. ASR (Sample Unit No. 02).

T02CD-01. Overview.
T03CD-01. Overview.

A01CD-01. Overview.
APPENDIX D

INSPECTION REPORT
# Re-inspection Report

**Network:** CL<br>
**Name:** CLARINDA MUNICIPAL - SCHENCK FIELD AIRPORT

<table>
<thead>
<tr>
<th>Section</th>
<th>Use</th>
<th>Area</th>
<th>From</th>
<th>To</th>
<th>Last Const.</th>
<th>Area</th>
<th>Width</th>
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<tbody>
<tr>
<td>01 of 1</td>
<td>APRON</td>
<td>96,940.00 SqFt</td>
<td>HANGER</td>
<td>TAXIWAY 01</td>
<td>01/01/1997</td>
<td>460.00 Ft</td>
<td>185.00 Ft</td>
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## Slab Details

- **Slabs:** 620<br>- **Slab Width:** 12.50 Ft<br>- **Slab Length:** 12.50 Ft<br>- **Joint Length:** 12,971.00 Ft<br>- **Shoulder:** Street Type: Grade: 0.00 Lanes: 0

**Surface:** PCC<br>**Family:** IowaPCCAPSC<br>**Zone:** Category: Rank: P

**Area:** 96,940.00 SqFt<br>**Length:** 460.00 Ft<br>**Width:** 185.00 Ft

## Sample Details

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<th>PCI</th>
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<td>04</td>
<td>R</td>
<td>20.00 Slabs</td>
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<tr>
<td>11</td>
<td>R</td>
<td>20.00 Slabs</td>
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<td>23</td>
<td>R</td>
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**Sample Comments:**

- 65 JOINT SEAL DAMAGE L 20.00 Slabs Comments:
- 76 ASR L 3.00 Slabs Comments:
- 71 FAULTING L 2.00 Slabs Comments:
- 65 JOINT SEAL DAMAGE L 20.00 Slabs Comments:
- 65 JOINT SEAL DAMAGE L 1.00 Slabs Comments:
- 65 JOINT SEAL DAMAGE L 20.00 Slabs Comments:
- 65 JOINT SEAL DAMAGE L 20.00 Slabs Comments:
Re-inspection Report

IA2014all
Report Generated Date: February 03, 2015

Network: ICL Name: CLARINDA MUNICIPAL - SCHENCK FIELD AIRPORT

Branch: R02CD Name: RUNWAY 02/20 AT CLARINDA Use: RUNWAY Area: 376,318.00SqFt

Section: 01 of 2 From: RUNWAY END 02 To: RUNWAY END 20 Last Const.: 01/01/1997
Surface: PCC Family: IowaPCCRWSC Zone: Category: Rank: P
Area: 301,325.00SqFt Length: 4,000.00Ft Width: 75.00Ft
Slabs: 1,928 Slab Width: 12.50Ft Slab Length: 12.50Ft Joint Length: 43,925.00Ft
Shoulder: Street Type: Grade: 0.00 Lanes: 0

Section Comments:

Last Inspect. Date: 10/08/2014 Total Samples: 80 Surveyed: 9
Conditions: PCI: 71

Inspection Comments:

Sample Number: 03 Type: R Area: 24.00Slabs PCI = 71
Sample Comments:
76 ASR L 16.00 Slabs Comments:
75 CORNER SPALLING M 1.00 Slabs Comments:
65 JOINT SEAL DAMAGE M 24.00 Slabs Comments:

Sample Number: 13 Type: R Area: 24.00Slabs PCI = 74
Sample Comments:
76 ASR L 18.00 Slabs Comments:
65 JOINT SEAL DAMAGE M 24.00 Slabs Comments:

Sample Number: 23 Type: R Area: 24.00Slabs PCI = 76
Sample Comments:
76 ASR L 11.00 Slabs Comments:
75 CORNER SPALLING L 1.00 Slabs Comments:
65 JOINT SEAL DAMAGE M 24.00 Slabs Comments:

Sample Number: 33 Type: R Area: 24.00Slabs PCI = 71
Sample Comments:
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65 JOINT SEAL DAMAGE M 24.00 Slabs Comments:
76 ASR L 15.00 Slabs Comments:

Sample Number: 43 Type: R Area: 24.00Slabs PCI = 73
Sample Comments:
76 ASR L 24.00 Slabs Comments:
65 JOINT SEAL DAMAGE M 24.00 Slabs Comments:

Sample Number: 53 Type: R Area: 24.00Slabs PCI = 74
Sample Comments:
76 ASR L 20.00 Slabs Comments:
65 JOINT SEAL DAMAGE M 24.00 Slabs Comments:

Sample Number: 63 Type: R Area: 24.00Slabs PCI = 76
Sample Comments:
76 ASR L 14.00 Slabs Comments:
65 JOINT SEAL DAMAGE M 24.00 Slabs Comments:

Sample Number: 73 Type: R Area: 24.00Slabs PCI = 67
Sample Comments:
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74 JOINT SPALLING M 1.00 Slabs Comments:
Re-inspection Report

IA2014all
Report Generated Date: February 03, 2015

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<td>74 JOINT SPALLING</td>
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<td>65 JOINT SEAL DAMAGE</td>
<td>M</td>
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Sample Number: 80 Type: R Area: 24.00 Slabs PCI = 54

Sample Comments:

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# Re-inspection Report

**IA2014all**

**Report Generated Date:** February 03, 2015

**Network:** ICL  
**Name:** CLARINDA MUNICIPAL - SCHENCK FIELD AIRPORT

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**Family:** IowaPCCRWSC  
**Zone:**  
**Category:**  
**Rank:** P

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**Slabs:** 480  
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**Slab Length:** 12.50 Ft  
**Joint Length:** 10,925.00 Ft

**Shoulder:**  
**Street Type:**  
**Grade:** 0.00  
**Lanes:** 0

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**Section Comments:**

**Last Insp. Date:** 10/08/2014  
**Total Samples:** 20  
**Surveyed:** 4

**Conditions:** PCI: 79

**Inspection Comments:**

### Sample Comments:

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<td>66 SMALL PATCH</td>
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<td>76 ASR</td>
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<td>76 ASR</td>
<td>M</td>
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<tr>
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<td>M</td>
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**Conditions:** PCI: 98

**Sample Number:** 02

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**Sample Comments:**

65 JOINT SEAL DAMAGE L 18.00 Slabs Comments:
Re-inspection Report

Report Generated Date: February 03, 2015

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Section Comments:

Last Insp. Date: 10/08/2014 Total Samples: | 2 | Surveyed: | 1 |

Conditions: | PCI : 97 |

Inspection Comments:

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Sample Comments:

65 JOINT SEAL DAMAGE L 20.00 Slabs Comments:

73 SHRINKAGE CRACKING N 1.00 Slabs Comments:
# Re-inspection Report

**Network:** ICL  
**Name:** CLARINDA MUNICIPAL - SCHENCK FIELD AIRPORT

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**Surface:** PCC  
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**Length:** 314.00 Ft  
**Width:** 40.00 Ft

**Slabs:** 159  
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**Slab Length:** 10.00 Ft  
**Joint Length:** 2,158.00 Ft

**Shoulder:**  
**Street Type:**  
**Grade:** 0.00  
**Lanes:** 0

**Conditions:** PCI : 88

**Inspection Comments:**

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<tr>
<td>65 JOINT SEAL DAMAGE</td>
<td>L</td>
<td>20.00 Slabs</td>
<td>Comments:</td>
<td></td>
</tr>
</tbody>
</table>
## Re-inspection Report

**Network:** ICL  
**Name:** CLARINDA MUNICIPAL - SCHENCK FIELD AIRPORT

### Branch: T02CD - TAXIWAY 02 AT CLARINDA

- **Use:** TAXIWAY  
- **Area:** 15,574.00SqFt

<table>
<thead>
<tr>
<th>Section</th>
<th>01</th>
<th>From: END OF R01CD-02</th>
<th>To: END OF TAXIWAY</th>
<th>Last Const.: 06/01/1997</th>
</tr>
</thead>
</table>

- **Surface:** PCC  
- **Family:** IowaP CCTWSC

- **Area:** 15,574.00SqFt  
- **Length:** 262.50Ft  
- **Width:** 35.00Ft

- **Slabs:** 138  
- **Slab Width:** 9.00Ft  
- **Slab Length:** 12.50Ft  
- **Joint Length:** 1,458.33Ft

- **Shoulder:**  
- **Street Type:**  
- **Grade:** 0.00  
- **Lanes:** 0

- **Conditions:** PCI: 89

- **Last Insp. Date:** 10/08/2014  
- **Total Samples:** 6  
- **Surveyed:** 2

### Inspection Comments:

<table>
<thead>
<tr>
<th>Sample Number</th>
<th>02</th>
<th>Type: R</th>
<th>Area: 20.00Slabs</th>
<th>PCI = 87</th>
</tr>
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<tbody>
<tr>
<td>Sample Comments:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>76 ASR</td>
<td>L</td>
<td>2.00 Slabs</td>
<td>Comments:</td>
<td></td>
</tr>
<tr>
<td>65 JOINT SEAL DAMAGE</td>
<td>M</td>
<td>20.00 Slabs</td>
<td>Comments:</td>
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</table>

<table>
<thead>
<tr>
<th>Sample Number</th>
<th>05</th>
<th>Type: R</th>
<th>Area: 15.00Slabs</th>
<th>PCI = 93</th>
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<tbody>
<tr>
<td>Sample Comments:</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>65 JOINT SEAL DAMAGE</td>
<td>M</td>
<td>15.00 Slabs</td>
<td>Comments:</td>
<td></td>
</tr>
</tbody>
</table>
## Re-inspection Report

**Network:** ICL  
**Name:** CLARINDA MUNICIPAL - SCHENCK FIELD AIRPORT

<table>
<thead>
<tr>
<th>Branch:</th>
<th>T03CD</th>
<th>Name:</th>
<th>TAXIWAY 03</th>
<th>Use: TAXIWAY</th>
<th>Area: 16,322.00 SqFt</th>
</tr>
</thead>
</table>

**Section:** 01 of 1  
**From:** RUNWAY 20  
**To:** END  
**Surface:** PCC  
**Family:** IowaP CCTWSC  
**Area:** 16,322.00 SqFt  
**Length:** 275.00 Ft  
**Width:** 37.00 Ft  
**Slabs:** 207  
**Slab Length:** 8.75 Ft  
**Slab Width:** 9.00 Ft  
**Joint Length:** 1,981.41 Ft  
**Shoulder:**  
**Street Type:**  
**Grade:** 0.00  
**Lanes:** 0  

**Last Insp. Date:** 10/08/2014  
**Total Samples:** 8  
**Surveyed:** 2  
**Conditions:** PCI: 100

### Inspection Comments:

<table>
<thead>
<tr>
<th>Sample Number:</th>
<th>03</th>
<th>Type: R</th>
<th>Area: 24.00 Slabs</th>
<th>PCI = 100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample Comments:</td>
<td>&lt;NO DISTRESSES&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sample Number:</th>
<th>07</th>
<th>Type: R</th>
<th>Area: 24.00 Slabs</th>
<th>PCI = 100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample Comments:</td>
<td>&lt;NO DISTRESSES&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX E

WORK HISTORY REPORT
## Work History Report

### Pavement Database: IA2014all

**Date:** 02/03/2015  
**1 of 2**

<table>
<thead>
<tr>
<th>Network</th>
<th>Branch</th>
<th>Use</th>
<th>Work Code</th>
<th>Work Description</th>
<th>Cost</th>
<th>Thickness (in)</th>
<th>Major M&amp;R</th>
<th>Comments</th>
</tr>
</thead>
</table>
| **ICL** | **A01CD** | **APRON AT CLARINDA** | **01A01CDICL** | **Section:** 01  
**Surface:** PCC  
**Use:** APRON  
**Rank P Length:** 460.00 Ft  
**Width:** 185.00 Ft  
**True Area:** 96,940.00 SqF | 06/01/2012  
01/01/1997 | JS-LC  
NC-PC | Joint Seal (Localized)  
New Construction - PCC | $0  
$0 | 0.00  
0.00 | False  
True  
EST |  

<table>
<thead>
<tr>
<th>Network</th>
<th>Branch</th>
<th>Use</th>
<th>Work Code</th>
<th>Work Description</th>
<th>Cost</th>
<th>Thickness (in)</th>
<th>Major M&amp;R</th>
<th>Comments</th>
</tr>
</thead>
</table>
| **ICL** | **R02CD** | **RUNWAY 02/20 AT CLARINDA** | **01R02CDICL** | **Section:** 01  
**Surface:** PCC  
**Use:** RUNWAY  
**Rank P Length:** 4,000.00 Ft  
**Width:** 75.00 Ft  
**True Area:** 301,325.00 SqF | 06/01/2012  
01/01/1997 | JS-LC  
NC-PC | Joint Seal (Localized)  
New Construction - PCC | $0  
$0 | 0.00  
0.00 | False  
True  
EST |  

<table>
<thead>
<tr>
<th>Network</th>
<th>Branch</th>
<th>Use</th>
<th>Work Code</th>
<th>Work Description</th>
<th>Cost</th>
<th>Thickness (in)</th>
<th>Major M&amp;R</th>
<th>Comments</th>
</tr>
</thead>
</table>
| **ICL** | **R02CD** | **RUNWAY 02/20 AT CLARINDA** | **02R02CDICL** | **Section:** 02  
**Surface:** PCC  
**Use:** RUNWAY  
**Rank S Length:** 1,000.00 Ft  
**Width:** 75.00 Ft  
**True Area:** 74,993.00 SqF | 06/01/2012  
01/01/1997 | JS-LC  
INITIAL | Joint Seal (Localized)  
Initial Construction | $0  
$0 | 0.00  
0.00 | False  
True  
EST |  

<table>
<thead>
<tr>
<th>Network</th>
<th>Branch</th>
<th>Use</th>
<th>Work Code</th>
<th>Work Description</th>
<th>Cost</th>
<th>Thickness (in)</th>
<th>Major M&amp;R</th>
<th>Comments</th>
</tr>
</thead>
</table>
| **ICL** | **R13CD** | **RUNWAY 13/31 AT CLARINDA** | **01R13CDICL** | **Section:** 01  
**Surface:** PCC  
**Use:** RUNWAY  
**Rank S Length:** 87.50 Ft  
**Width:** 75.00 Ft  
**True Area:** 5,980.00 SqF | 06/01/2012  
01/01/1997 | JS-LC  
INITIAL | Joint Seal (Localized)  
Initial Construction | $0  
$0 | 0.00  
0.00 | False  
True  
EST |  

<table>
<thead>
<tr>
<th>Network</th>
<th>Branch</th>
<th>Use</th>
<th>Work Code</th>
<th>Work Description</th>
<th>Cost</th>
<th>Thickness (in)</th>
<th>Major M&amp;R</th>
<th>Comments</th>
</tr>
</thead>
</table>
| **ICL** | **R13CD** | **RUNWAY 13/31 AT CLARINDA** | **02R13CDICL** | **Section:** 02  
**Surface:** PCC  
**Use:** RUNWAY  
**Rank S Length:** 88.00 Ft  
**Width:** 75.00 Ft  
**True Area:** 5,860.00 SqF | 06/01/2012  
01/01/1997 | JS-LC  
INITIAL | Joint Seal (Localized)  
Initial Construction | $0  
$0 | 0.00  
0.00 | False  
True  
EST |  

<table>
<thead>
<tr>
<th>Network</th>
<th>Branch</th>
<th>Use</th>
<th>Work Code</th>
<th>Work Description</th>
<th>Cost</th>
<th>Thickness (in)</th>
<th>Major M&amp;R</th>
<th>Comments</th>
</tr>
</thead>
</table>
| **ICL** | **T01CD** | **TAXIWAY 01 AT CLARINDA** | **01T01CDICL** | **Section:** 01  
**Surface:** PCC  
**Use:** TAXIWAY  
**Rank P Length:** 314.00 Ft  
**Width:** 40.00 Ft  
**True Area:** 15,894.00 SqF | 06/01/2012  
01/01/1997 | JS-LC  
NC-PC | Joint Seal (Localized)  
New Construction - PCC | $0  
$0 | 0.00  
0.00 | False  
True  
EST |  

<table>
<thead>
<tr>
<th>Network</th>
<th>Branch</th>
<th>Use</th>
<th>Work Code</th>
<th>Work Description</th>
<th>Cost</th>
<th>Thickness (in)</th>
<th>Major M&amp;R</th>
<th>Comments</th>
</tr>
</thead>
</table>
| **ICL** | **T02CD** | **TAXIWAY 02 AT CLARINDA** | **01T02CDICL** | **Section:** 01  
**Surface:** PCC  
**Use:** TAXIWAY  
**Rank P Length:** 262.50 Ft  
**Width:** 35.00 Ft  
**True Area:** 15,574.00 SqF | 06/01/2012  
01/01/1997 | JS-LC  
INITIAL | Joint Seal (Localized)  
Initial Construction | $0  
$0 | 0.00  
0.00 | False  
True  
EST |  

<table>
<thead>
<tr>
<th>Network</th>
<th>Branch</th>
<th>Use</th>
<th>Work Code</th>
<th>Work Description</th>
<th>Cost</th>
<th>Thickness (in)</th>
<th>Major M&amp;R</th>
<th>Comments</th>
</tr>
</thead>
</table>
| **ICL** | **T03CD** | **TAXIWAY 03** | **01T03CDICL** | **Section:** 01  
**Surface:** PCC  
**Use:** TAXIWAY  
**Rank P Length:** 275.00 Ft  
**Width:** 37.00 Ft  
**True Area:** 16,322.00 SqF | 04/03/2009  
04/02/2009  
04/01/2009 | NU-IN  
BA-AG  
SB-AG | New Construction - Initial  
Base Course - Aggregate  
Subbase - Aggregate | $0  
$0  
$0 | 6.00  
6.00  
12.00 | True  
False  
False |  

**Federal Funding $190,054**
Summary:

<table>
<thead>
<tr>
<th>Work Description</th>
<th>Section Count</th>
<th>Area Total (SqFt)</th>
<th>Thickness Avg (in)</th>
<th>Thickness STD (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Course - Aggregate</td>
<td>1</td>
<td>16,322.00</td>
<td>6.00</td>
<td></td>
</tr>
<tr>
<td>Initial Construction</td>
<td>4</td>
<td>102,407.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Joint Seal (Localized)</td>
<td>7</td>
<td>516,566.00</td>
<td>.00</td>
<td>.00</td>
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<tr>
<td>New Construction - Initial</td>
<td>1</td>
<td>16,322.00</td>
<td>6.00</td>
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</tr>
<tr>
<td>New Construction - PCC</td>
<td>3</td>
<td>414,159.00</td>
<td>.00</td>
<td>.00</td>
</tr>
<tr>
<td>Subbase - Aggregate</td>
<td>1</td>
<td>16,322.00</td>
<td>12.00</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX F

MAINTENANCE POLICIES
AND UNIT COST TABLES
Table F-1. Localized preventive maintenance policy, asphalt-surfaced pavements.

<table>
<thead>
<tr>
<th>Distress Type</th>
<th>Severity Level</th>
<th>Maintenance Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alligator Cracking</td>
<td>Low</td>
<td>Monitor</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>AC Patch</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>AC Patch</td>
</tr>
<tr>
<td>Bleeding</td>
<td>N/A</td>
<td>Monitor</td>
</tr>
<tr>
<td>Block Cracking</td>
<td>Low</td>
<td>Monitor</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>Crack Seal</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>Crack Seal</td>
</tr>
<tr>
<td>Corrugation</td>
<td>Low</td>
<td>Monitor</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>AC Patch</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>AC Patch</td>
</tr>
<tr>
<td>Depression</td>
<td>Low</td>
<td>Monitor</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>Monitor</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>AC Patch</td>
</tr>
<tr>
<td>Jet Blast</td>
<td>N/A</td>
<td>AC Patch</td>
</tr>
<tr>
<td>Joint Reflection Cracking</td>
<td>Low</td>
<td>Monitor</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>Crack Seal</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>Crack Seal</td>
</tr>
<tr>
<td>Longitudinal and Transverse Cracking</td>
<td>Low</td>
<td>Monitor</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>Crack Seal</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>Crack Seal</td>
</tr>
<tr>
<td>Oil Spillage</td>
<td>N/A</td>
<td>AC Patch</td>
</tr>
<tr>
<td>Patching</td>
<td>Low</td>
<td>Monitor</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>AC Patch</td>
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<tr>
<td></td>
<td>High</td>
<td>AC Patch</td>
</tr>
<tr>
<td>Polished Aggregate</td>
<td>N/A</td>
<td>Monitor</td>
</tr>
<tr>
<td>Raveling</td>
<td>Low</td>
<td>Monitor</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>AC Patch</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>AC Patch</td>
</tr>
<tr>
<td>Rutting</td>
<td>Low</td>
<td>Monitor</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>Monitor</td>
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<tr>
<td></td>
<td>High</td>
<td>AC Patch</td>
</tr>
<tr>
<td>Shoving</td>
<td>Low</td>
<td>Monitor</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>AC Patch</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>AC Patch</td>
</tr>
<tr>
<td>Slippage Cracking</td>
<td>N/A</td>
<td>AC Patch</td>
</tr>
<tr>
<td>Swelling</td>
<td>Low</td>
<td>Monitor</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
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<tr>
<td></td>
<td>High</td>
<td>AC Patch</td>
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<tr>
<td>Weathering</td>
<td>Low</td>
<td>Monitor</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>Monitor</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>AC Patch</td>
</tr>
</tbody>
</table>
Table F-2. Localized preventive maintenance policy, portland cement concrete pavements.

<table>
<thead>
<tr>
<th>Distress Type</th>
<th>Severity Level</th>
<th>Maintenance Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alkali-Silica Reaction (ASR)</td>
<td>Low</td>
<td>Monitor</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>Slab Replacement</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>Slab Replacement</td>
</tr>
<tr>
<td>Blow-Up</td>
<td>Low</td>
<td>Slab Replacement</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>Slab Replacement</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>Slab Replacement</td>
</tr>
<tr>
<td>Corner Break</td>
<td>Low</td>
<td>Crack Seal</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>Full Depth PCC Patch</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>Full Depth PCC Patch</td>
</tr>
<tr>
<td>Cracks</td>
<td>Low</td>
<td>Monitor</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>Crack Seal</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>Slab Replacement</td>
</tr>
<tr>
<td>Durability Cracking</td>
<td>Low</td>
<td>Monitor</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>Full Depth Patch</td>
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<tr>
<td></td>
<td>High</td>
<td>Slab Replacement</td>
</tr>
<tr>
<td>Joint Seal Damage</td>
<td>Low</td>
<td>Monitor</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>Joint Seal</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>Joint Seal</td>
</tr>
<tr>
<td>Patching</td>
<td>Low</td>
<td>Monitor</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>Full Depth PCC Patch</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>Full Depth PCC Patch</td>
</tr>
<tr>
<td>Popouts</td>
<td>N/A</td>
<td>Monitor</td>
</tr>
<tr>
<td>Pumping</td>
<td>N/A</td>
<td>Monitor</td>
</tr>
<tr>
<td>Scaling</td>
<td>Low</td>
<td>Monitor</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>Partial Depth PCC Patch</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>Slab Replacement</td>
</tr>
<tr>
<td>Settlement</td>
<td>Low</td>
<td>Monitor</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>Grinding</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>Slab Replacement</td>
</tr>
<tr>
<td>Shattered Slab</td>
<td>Low</td>
<td>Crack Seal</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>Slab Replacement</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>Slab Replacement</td>
</tr>
<tr>
<td>Shrinkage</td>
<td>N/A</td>
<td>Monitor</td>
</tr>
<tr>
<td>Spalling (Joint and Corner)</td>
<td>Low</td>
<td>Monitor</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>Partial Depth PCC Patch</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>Partial Depth PCC Patch</td>
</tr>
</tbody>
</table>
Table F-3. 2015 unit costs for preventive maintenance actions.

<table>
<thead>
<tr>
<th>Maintenance Action</th>
<th>Unit Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC Patch – AC Pavement</td>
<td>$13.06/sf</td>
</tr>
<tr>
<td>Crack Sealing – AC Pavement</td>
<td>$2.23/lf</td>
</tr>
<tr>
<td>PCC Patch – Spall Repair (partial depth)</td>
<td>$33.44/sf</td>
</tr>
<tr>
<td>PCC Patch – Full Depth</td>
<td>$14.94/sf</td>
</tr>
<tr>
<td>Crack Sealing – PCC Pavement</td>
<td>$2.68/lf</td>
</tr>
<tr>
<td>Joint Resealing – PCC Pavement</td>
<td>$2.68/lf</td>
</tr>
<tr>
<td>Grinding – PCC Pavement</td>
<td>$0.32/sf</td>
</tr>
<tr>
<td>Slab Replacement – PCC Pavement</td>
<td>$14.94/sf</td>
</tr>
</tbody>
</table>

Table F-4. 2015 unit costs (per square foot) based on PCI Ranges.

<table>
<thead>
<tr>
<th>Pavement Type</th>
<th>0</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
<th>80</th>
<th>90</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt</td>
<td>$9.28</td>
<td>$9.28</td>
<td>$9.28</td>
<td>$9.28</td>
<td>$4.39</td>
<td>$4.39</td>
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<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>PCC</td>
<td>$15.48</td>
<td>$15.48</td>
<td>$15.48</td>
<td>$15.48</td>
<td>$7.32</td>
<td>$7.32</td>
<td>$7.32</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
</tbody>
</table>
APPENDIX G

YEAR 2015 LOCALIZED MAINTENANCE DETAILS
Table G-1. Year 2015 localized maintenance details.

<table>
<thead>
<tr>
<th>Branch1</th>
<th>Section1</th>
<th>Distress Type2</th>
<th>Severity</th>
<th>Distress Quantity</th>
<th>Unit</th>
<th>Maintenance Action</th>
<th>Estimated Cost3</th>
</tr>
</thead>
<tbody>
<tr>
<td>R02CD</td>
<td>01</td>
<td>LTD Cracking</td>
<td>Medium</td>
<td>9</td>
<td>Slabs</td>
<td>Crack Sealing - PCC</td>
<td>$299</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Joint Seal Damage</td>
<td>Medium</td>
<td>1,928</td>
<td>Slabs</td>
<td>Joint Seal (Localized)</td>
<td>$117,720</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Joint Spalling</td>
<td>Medium</td>
<td>18</td>
<td>Slabs</td>
<td>Patching - PCC Partial Depth</td>
<td>$3,855</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Corner Spalling</td>
<td>Medium</td>
<td>18</td>
<td>Slabs</td>
<td>Patching - PCC Partial Depth</td>
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<tr>
<td>02</td>
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<td>LTD Cracking</td>
<td>Medium</td>
<td>5</td>
<td>Slabs</td>
<td>Crack Sealing - PCC</td>
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</tr>
<tr>
<td>T02CD</td>
<td>01</td>
<td>ASR</td>
<td>Medium</td>
<td>5</td>
<td>Slabs</td>
<td>Slab Replacement - PCC</td>
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<td>Joint Seal Damage</td>
<td>Medium</td>
<td>138</td>
<td>Slabs</td>
<td>Joint Seal (Localized)</td>
<td>$3,908</td>
</tr>
</tbody>
</table>

1See Figure 3 for the location of the branch and section.
2L&T Cracking = Longitudinal and Transverse Cracking; LTD Cracking = Longitudinal, Transverse, and Diagonal Cracking.
3Cost estimates are shown in 2015 dollar amounts. These estimates are based on broad statewide numbers and should be adjusted to reflect local costs.
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