LE MARS MUNICIPAL AIRPORT
PAVEMENT MANAGEMENT REPORT

Prepared For:
Iowa Department of Transportation
Office of Aviation

Prepared By:
Applied Pavement Technology, Inc.

Office of Aviation
Iowa Department of Transportation

January 2010

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PAVEMENT MANAGEMENT REPORT

PREPARED FOR:

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF AVIATION

PREPARED BY:

APPLIED PAVEMENT TECHNOLOGY, INC.

IN ASSOCIATION WITH:

ROBINSON ENGINEERING COMPANY

January 2010

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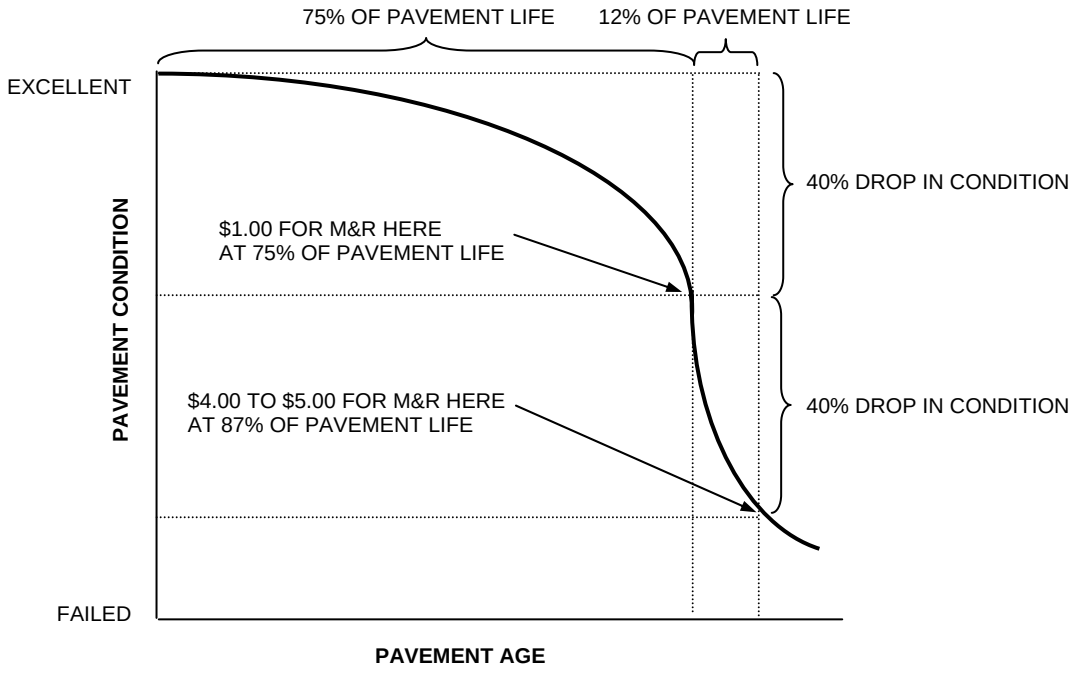
INTRODUCTION

Applied Pavement Technology, Inc. (APTech), with assistance from Robinson Engineering Company, updated the airport pavement management system (APMS) for the Iowa Department of Transportation (Iowa DOT). During this project, pavement conditions at Le Mars Municipal Airport were assessed in September 2009 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 number 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 sealing) are advisable, and also to identify the most cost-effective time to perform major rehabilitation (such as an overlay). 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. The financial impact of delaying repairs beyond this point can be severe.

Figure 1. Pavement condition versus cost of repair.



The pavement evaluation results for Le Mars Municipal Airport are presented within this report and can be used by the Iowa DOT, the Federal Aviation Administration (FAA), and Le Mars Municipal Airport to prioritize and schedule pavement maintenance and rehabilitation actions at the airport.

PAVEMENT INVENTORY

Approximately 422,466 square feet of runway, taxiway, and apron pavements were evaluated at Le Mars Municipal Airport, as shown in Figure 2. This figure also shows the area-weighted age of the pavements.

Figure 2. Pavement inventory.

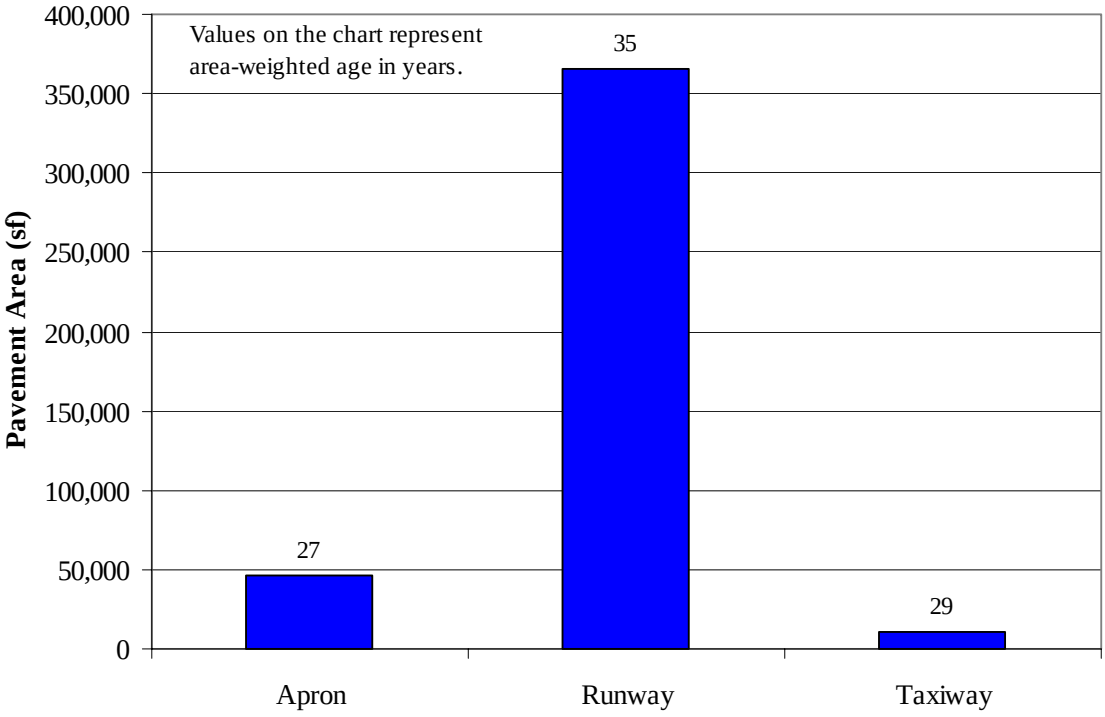
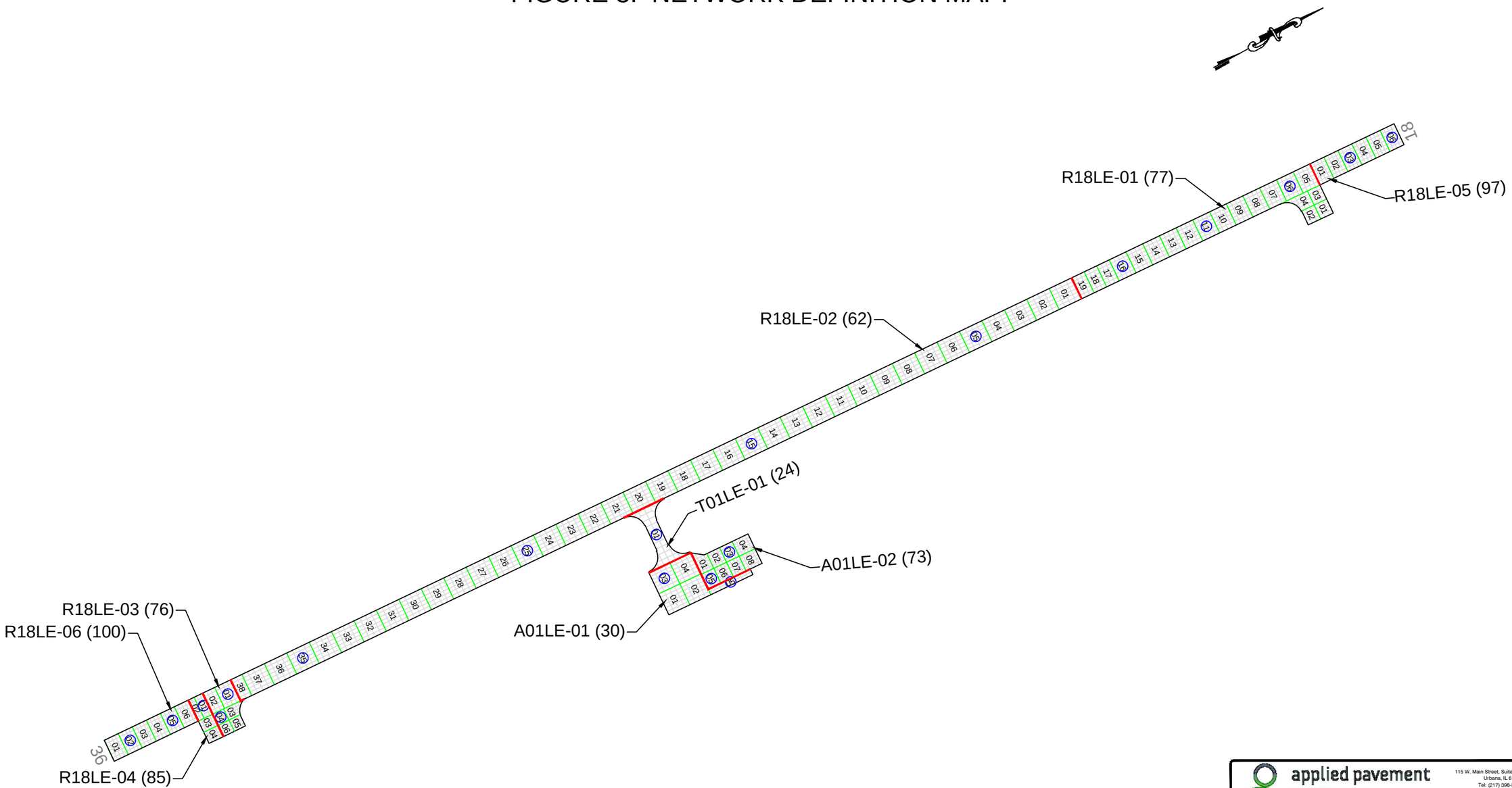


Figure 3 is a network definition map that identifies the pavements at Le Mars Municipal Airport that were evaluated during this project. This map shows how the pavement network was divided into branches, sections, and sample units for pavement management purposes. It also shows the nomenclature used in the MicroPAVER pavement management database to identify the different pavement areas.

FIGURE 3. NETWORK DEFINITION MAP.



NETWORK DEFINITION LEGEND

- BRANCH IDENTIFIER
- SECTION IDENTIFIER
- PCI VALUE

R18LE-02 (72)

- SECTION BREAK LINE
- SAMPLE UNIT BREAK LINE
- SLAB JOINT
- 03 SAMPLE UNIT NUMBER
- 03 SAMPLE UNIT INSPECTED
- 03 ADDITIONAL SAMPLE UNIT

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AGENCY: Iowa Department of Transportation, Office of Aviation			
LOCATION: Le Mars Municipal Airport, Le Mars, Iowa			
PAGE TITLE: Network Definition Map			
PROJECT DATE: October 2009	CREATION DATE: October 2009	PROJECT MANAGER: MRC	JOB NUMBER: 08-121-AM01
DRAWING SCALE: 1:300	LAST MODIFIED DATE: November 2009	REVISED BY: BEH	DRAWN BY: BEH
FILENAME: Le Mars.dwg		LAYOUT NAME/NUMBER: NET. DEF.	PAGE NUMBER: 3

PAVEMENT EVALUATION

Pavement Evaluation Procedure

APTech inspected the pavements at Le Mars Municipal Airport using the PCI procedure. This procedure is described in FAA Advisory Circular (AC) 150/5380-6B, which is located in Appendix A, and ASTM Standard D5340. 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 value of the section. The PCI ranges from 0 to 100, with 100 representing a pavement in excellent condition.

Figure 4. Visual representation of PCI scale.

Typical Pavement Surface[1]	PCI
	100
	60
	5

[1]Photographs shown are not specific to the project.

It should be noted that a PCI value is based on visual signs of pavement deterioration and does not provide a measure of structural capacity.

In general terms, pavements with a PCI of 65 to 100 that are not exhibiting significant load-related distress will benefit from preventive maintenance actions, such as crack sealing and surface treatments. Pavements with a PCI of 40 to 65 may require major rehabilitation, such as an overlay. 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.

PCI		Repair Type
81 – 100		Preventive Maintenance
66 – 80		
51 – 65		Major Rehabilitation
41 – 50		
0 – 40		Reconstruction

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 cement concrete [AC] pavements or corner breaks on portland cement concrete [PCC] pavements), climate/durability-related (such as weathering [climate-related on AC pavements] and D-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 the likely cause of each distress type.

Pavement Evaluation Results

The pavements at Le Mars Municipal Airport were inspected on September 16, 2009. The 2009 area-weighted condition of Le Mars Municipal Airport is 69, with conditions ranging from 24 to 100 (on a scale of 0 [failed] to 100 [excellent]). During the previous pavement inspection in 2005, the area-weighted PCI of the airport was 75.

Figures 6 and 7 provide graphs summarizing the overall condition of the pavements at the Le Mars Municipal Airport. Figure 8 is a map that displays the condition of the pavements evaluated. 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 MicroPAVER database is attached to the inside of the front cover of this report.

Figure 6. Overall condition.

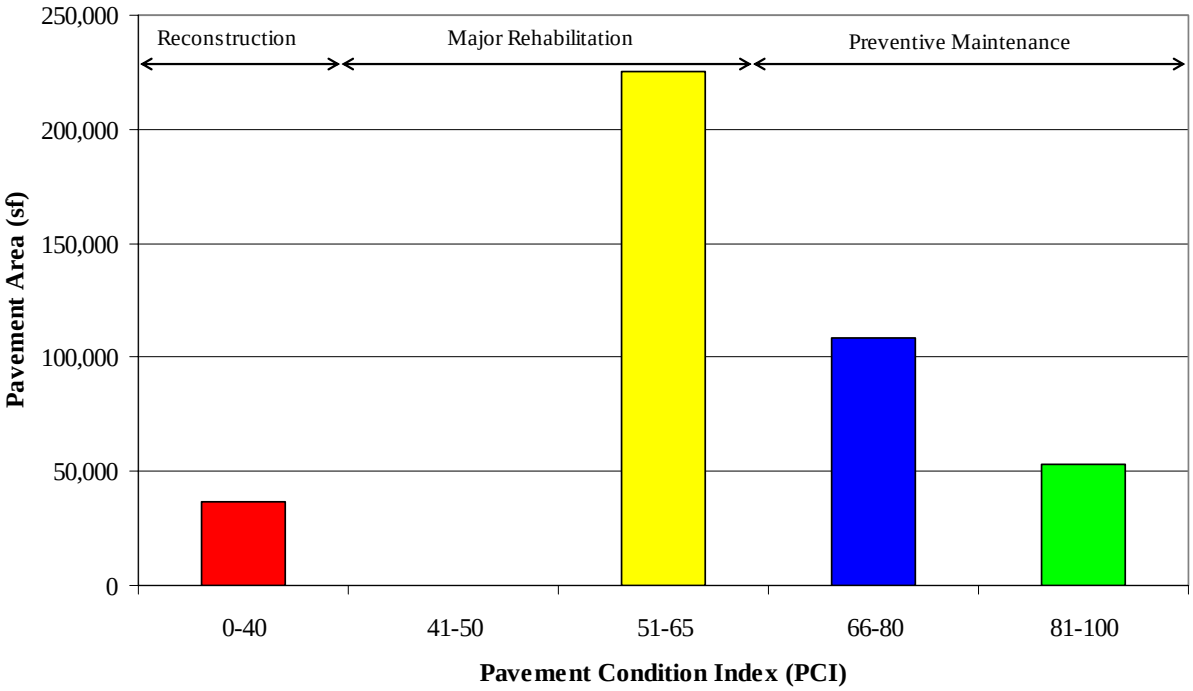


Figure 7. Condition by use.

(Values on the chart are area-weighted)

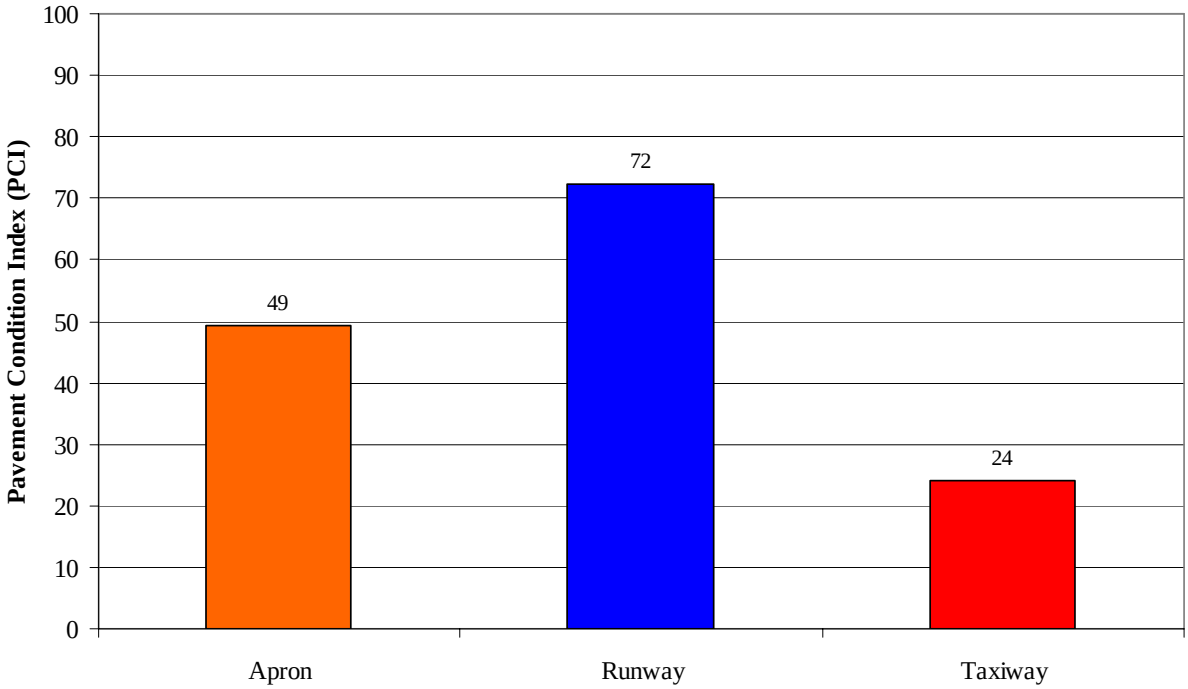
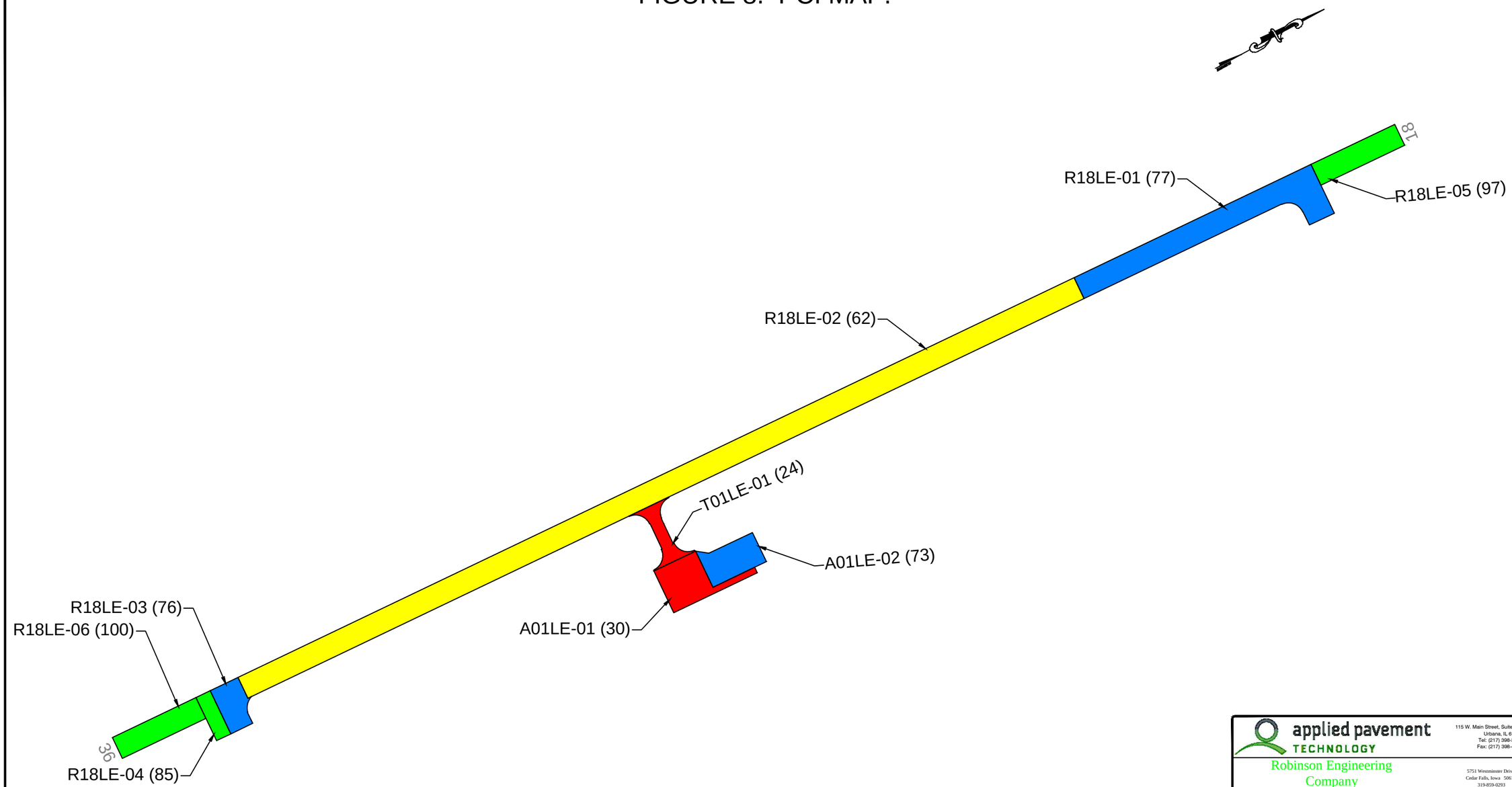


FIGURE 8. PCI MAP.



LEGEND

BRANCH IDENTIFIER
SECTION IDENTIFIER
PCI VALUE
R18LE-02 (72)
SECTION BREAK LINE

PAVEMENT CONDITION INDEX

PCI	REPAIR TYPE
81-100	PREVENTIVE MAINTENANCE
66-80	
51-65	MAJOR REHABILITATION
41-50	
0-40	RECONSTRUCTION

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AGENCY: Iowa Department of Transportation
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LOCATION: Le Mars Municipal Airport
Le Mars, Iowa

PAGE TITLE: 2009 Pavement Condition Index Map

PROJECT DATE:	CREATION DATE:	PROJECT MANAGER:	JOB NUMBER:
October 2009	October 2009	MRC	08-121-AM01
DRAWING SCALE: 1:300	LAST MODIFIED DATE: November 2009	REVISED BY: BEH	DRAWN BY: BEH
FILENAME: Le Mars.dwg		LAYOUT NAME/NUMBER: PCI	PAGE NUMBER: 7

Table 1. Pavement evaluation results.

Le Mars Municipal Airport								
Branch[1]	**Section**	**Surface Type[2]**	**Section Area (sf)**	**LCD[3]**	**2009 PCI**	**% Distress due to:**		**Distress Types**
						Load[4]	**Climate or Durability[5]**	
A01LE	01	PCC	25,500	5/1/1980	30	64	1	Linear Cracking, Joint Spall, Shattered Slab, Popouts, Corner Break, Durability Cracking
	02	PCC	20,610	5/1/1984	73	61	0	Shattered Slab, Corner Break, Linear Cracking, Corner Spall, Popouts, Small Patch, Large Patch
R18LE	01	PCC	73,363	5/1/1980	77	25	0	Joint Spall, Popouts, Corner Spall, Linear Cracking, Small Patch
	02	PCC	225,000	6/1/1964	65	49	4	Small Patch, Linear Cracking, Joint Seal Damage, Corner Spall, Joint Spall, Popouts, Large Patch
	03	PCC	14,256	5/1/1980	76	44	7	Small Patch, Popouts, Shattered Slab, Linear Cracking, Joint Seal Damage
	04	PCC	7,905	5/1/1996	85	84	0	Linear Cracking, Joint Spall
	05	PCC	22,500	7/1/2007	97	0	0	Popouts
	06	PCC	22,500	7/1/2007	100	0	0	No Distress
T01LE	01	PCC	10,832	5/1/1980	24	72	0	Shattered Slab, Joint Spall, Popouts, Linear Cracking

[1]See 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, rutting, or shattered concrete slabs.

[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 and raveling or block cracking in asphalt pavements) or to a materials-related problem (such as durability cracking in a concrete pavement).

Inspection Notes

Le Mars Municipal Airport was inspected on September 16, 2009. There were nine pavement sections defined during the inspection.

Runway

Six sections are defined on Runway 18-36. Section 01, the northern portion of the runway, is in satisfactory condition with significant amounts of popouts recorded. In addition, small quantities of low-severity linear cracking, low- and medium-severity joint spalling, and medium-severity corner spalling were observed. Isolated areas of low-severity patching were also noted. Section 02, the majority of the runway, is in fair condition with low-severity joint seal damage observed throughout along with extensive amounts of popouts, low- and medium-severity linear cracking, and low-severity small patching. Additionally, small quantities of low- and medium-severity large patching and all severities of spalling were noted. Sections 03 and 04, located near the Runway 36 approach, are in satisfactory to good condition. Low-severity joint seal damage and extensive amounts of popouts were recorded throughout Section 03 along with small quantities of low-severity linear cracking, shattered slabs, and patching. Small quantities of low-severity linear cracking and joint spalling were observed in Section 04. Sections 05 and 06, runway extensions located at either end of the runway, were recently constructed and are in excellent condition. Isolated areas of popouts were identified in Section 05 and no distresses were noted in Section 06 at time of inspection.

Taxiway

Taxiway 01 consists of one section in failed condition with significant quantities of popouts and low- and medium-severity linear cracking and shattered slabs recorded. Additionally, moderate amounts of all severities of joint spalling were identified.

Apron

Two sections are defined in the terminal apron area. Section 01, the southern portion of the terminal apron area, is in failed condition with extensive amounts of low- and medium-severity linear cracking, low-severity shattered slabs, all severities of joint spalling, and popouts recorded. In addition, small quantities of low-severity corner breaking and durability cracking were noted. Section 02, the northern portion of the terminal apron area, is in satisfactory condition with extensive amounts of low-severity linear cracking and low- and medium-severity patching observed. Additionally, moderate quantities of popouts, low- and medium-severity corner spalling, and low-severity shattered slabs along with small amounts of medium-severity corner breaking were identified.

PAVEMENT MAINTENANCE AND REHABILITATION PROGRAM

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

Analysis Parameters

Localized Maintenance Policies and Unit Costs

Localized maintenance policies were developed for AC 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. 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 Le Mars Municipal Airport.

Major Rehabilitation Unit Costs

MicroPAVER 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 and an inflation rate of 4.5 percent were used during the analysis.

Analysis Approach

The 5-year program was prepared with the goal of maintaining the pavements above established critical PCI values. 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 value.

For the first year (2010) of the analysis only, a localized preventive maintenance plan was developed for pavement sections that were above their critical PCI value. If major rehabilitation was triggered for a section in 2011 or 2012, then localized maintenance was not recommended for 2010. While localized preventive maintenance should be an annual undertaking at Le Mars Municipal 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 2010 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 major rehabilitation program for Le Mars Municipal Airport is presented in Table 2. Detailed information on the localized maintenance plan for 2010 is contained in Appendix G.

Table 2. Five-year major rehabilitation program under an unlimited funding analysis scenario.

Year	Branch[1]	Section	Type of Repair[2]	Estimated Cost[3]
2010	A01LE	01	Major Rehabilitation	$394,649
	R18LE	02	Major Rehabilitation	$1,645,876
	T01LE	01	Major Rehabilitation	$167,641
			Total:	**$2,208,167**

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

[2]Major Rehabilitation: such as pavement reconstruction or an overlay.

[3]Cost 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 Le Mars Municipal 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 cost estimates provided are based on a statewide policy, and Le Mars Municipal Airport should adjust the plan to reflect local costs.

Because an unlimited budget was used in the analysis, it is possible that the pavement repair program will need to be adjusted to take into account economic and/or operational constraints. It is important to remember that regardless of the recommendations presented within this report, Le Mars Municipal 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. Conduct an aggressive campaign against weed growth through timely herbicide applications. Vegetation growing in pavement cracks is very destructive and significantly increases the rate of pavement deterioration.

2. Implement a periodic crack sealing program. Keeping water and debris out of the pavement system through sealing cracks is a proven method of extending the life of the pavement system in a cost-effective manner.

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

4. 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 Le Mars Municipal 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.

The FAA has an Advisory Circular (AC) that provides detailed guidance pertaining to the requirements for an acceptable pavement management program. Appendix 1 of FAA AC 150/5380-6B outlines what needs to be included in a PMMS 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 150/5830-6B, Appendix 1. Pavement Maintenance Management Program

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

An effective pavement maintenance management program specifies the procedures to be followed to assure that proper preventative and remedial pavement maintenance is performed. An airport sponsor may use any format it deems appropriate, but the program must, as a minimum, include the following:

A-1. Pavement Inventory. *The following must be depicted in an appropriate form and level of detail:*

a. *Location of all runways, taxiways, and aprons*

The network definition map provided in Figure 3 of this report shows the location of all runways, taxiways, and aprons at Le Mars 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*

The dimensions of all runways, taxiways, and aprons are stored in the MicroPAVER 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*

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

d. *Year of construction or most recent major rehabilitation*

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

e. *Whether Federal financial assistance was used to construct, reconstruct, or repair the pavement*

Funding sources for all pavement projects should be recorded.

A-2. Inspection Schedule.

a. ***Detailed Inspection.*** *Trained personnel must perform a detailed inspection of airfield pavements at least once a year. If a history of recorded pavement deterioration in the form of a Pavement Condition Index (PCI) survey as set forth in ASTM D 5340, Standard Test Method for Airport Pavement Condition Index Surveys, is available, the frequency of inspections may be extended to 3 years.*

This report consists of a detailed inspection that will extend the inspection period to 3 years.

b. ***Drive-By Inspection.*** *A drive-by inspection must occur a minimum of once per month to detect unexpected changes in the pavement condition.*

It is the airport sponsor's responsibility to perform a monthly drive-by inspection. A sample form that you can use to perform these inspections is provided in Table 3.

A-3. Record Keeping. *The airport must record and keep on file for a minimum of 5 years complete information about all detailed inspections and maintenance performed. The types of distress, their locations, and remedial action, scheduled or performed, must be documented. The minimum information to be recorded is listed below:*

a. *Inspection date*

b. *Location*

c. *Distress types*

d. *Maintenance scheduled or performed*

For drive-by inspections, records must include the date of inspection and any maintenance 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-4. Information Retrieval. *An airport sponsor may use any form of record keeping it deems appropriate, so long as the information and records produced by the pavement survey can be retrieved as necessary for any reports required by the FAA.*

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.

A-5. Program Funding. *The program should identify funding and other resources available to provide remedial and preventive maintenance activities.*

The estimated amount of immediate localized maintenance needs is provided in Appendix G. Maintenance needs that have been identified in Appendix G should be considered and included in the development of the airport's 5-year capital improvement program. The airport is responsible for performing preventive maintenance as needed. Local, state, and federal funding sources can be considered when developing a comprehensive pavement maintenance plan.

Table 3. Pavement inspection report.

Inspected By: _____
Date Inspected: _____

Inspection Record			Maintenance Action			
Location[1]		Distress Description/Dimensions/Severity/ Recommended Action	Description of Repair	Date Performed	Cost	Funding Source
Branch	Section					
A01LE	01					
	02					
R18LE	01					
	02					
	03					
	04					

Table 3. Pavement inspection report (continued).

Inspected By: _____
Date Inspected: _____

Inspection Record			Maintenance Action			
Location[1]		Distress Description/Dimensions/Severity/ Recommended Action	Description of Repair	Date Performed	Cost	Funding Source
Branch	Section					
R18LE	05					
	06					
T01LE	01					

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

SUMMARY

This report documents the results of the pavement evaluation conducted at Le Mars Municipal Airport. During a visual inspection of the pavements in 2009, it was found that the overall condition of the pavement network is a PCI of 69. A 5-year pavement repair program was generated for Le Mars Municipal Airport, which revealed that approximately $2,208,167 needs to be expended on major rehabilitation to maintain the pavements above their critical PCI levels.

APPENDIX A

FAA AC 150/5380-6B

U.S. Department
of Transportation

Federal Aviation Administration

Advisory Circular

Subject: GUIDELINES AND PROCEDURES FOR MAINTENANCE OF AIRPORT PAVEMENTS	**Date:** September 28, 2007 **Initiated by:** AAS-100	**AC No:** 150/5380-6B **Change:**

1. PURPOSE. This Advisory Circular (AC) provides guidelines and procedures for maintaining rigid and flexible airport pavements.

2. CANCELLATION. This AC cancels AC 150/5380-6A, *Guidelines and Procedures for Maintenance of Airport Pavements,* dated 7/14/03.

3. APPLICATION. The Federal Aviation Administration (FAA) recommends these guidelines for airport pavements, as appropriate.

4. PRINCIPAL CHANGES. The following principal changes are incorporated:

a. Added the distress types that were not originally included, as defined within American Society for Testing and Materials (ASTM) D 5340 *Standard Test Method for Airport Pavement Condition Index Surveys*.

b. Added Tables 6-2 through 6-10 to familiarize the user with each distress type and its recommended method(s) for repair/maintenance.

c. Added generic specifications for maintenance products to provide guidance in selection of materials and products regularly used for airfield pavement maintenance for use on Airport Improvement Program funded projects.

d. Added select generic typical details to provide guidance in the installation of materials and repair procedures.

5. RELATED READING MATERIAL. The publications in Appendix D, Bibliography, provide further guidance and technical information.

6. METRIC UNITS. To promote an orderly transition to metric units, the text and figures include both English and metric dimensions. The metric conversions are based on operational significance and may not be exact equivalents. Until there is an official changeover to the metric system, the English dimensions should be used.

7. COMMENTS OR SUGGESTIONS for improvements to this AC should be sent to:

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

8. COPIES OF THIS AC. The Office of Airport Safety and Standards is in the process of making ACs available to the public through the Internet. These ACs may be accessed through the FAA home page (www.faa.gov). A printed copy of this AC and other ACs can be ordered from the U.S. Department of Transportation, Subsequent Distribution Office, Ardmore East Business Center, 3341 Q 75th Avenue, Landover, MD 20785.

David L. Bennett
Director of Airport Safety and Standards

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CHAPTER 1. INTRODUCTION TO AIRPORT PAVEMENT MAINTENANCE.

1-1. PURPOSE OF ADVISORY CIRCULAR. Airport managers and technical/maintenance personnel responsible for the operation and maintenance of airports continually face problems with pavement distress and deterioration. This advisory circular (AC) provides information on the types of pavement distress that occur and recommends corrective actions to undertake during preventive and remedial maintenance. The Federal Aviation Administration (FAA) recommends that airports follow American Society for Testing and Materials (ASTM) D 5340, *Standard Test Method for Airport Pavement Condition Index Surveys,* when conducting preventive maintenance inspections. This standard employs the visual distress identification and rating system known as the Pavement Condition Index (PCI).

1-2. BACKGROUND OF ADVISORY CIRCULAR. The aviation community has a large investment in airport pavements. The major objective in the design and construction of these pavements is to provide adequate load-carrying capacity and good ride quality necessary for the safe operation of aircraft under all weather conditions. Immediately after completion, airport pavements begin a gradual deterioration that is attributable to several factors. Traffic loads in excess of those forecast during pavement design can shorten pavement life considerably. Normal distresses in the pavement structure result from surface weathering, fatigue effects, and differential movement in the underlying subbase over a period of years. In addition, faulty construction techniques, substandard materials, or poor workmanship can accelerate the pavement deterioration process. Consequently, airport pavements require continual routine maintenance, rehabilitation, and upgrading.

a. Many pavements were not designed for servicing today's aircraft, which impose loads much greater than those initially considered. Also, the frequency of takeoffs and landings at many airports has increased considerably. Both factors result in accelerated deterioration of the pavement structure. To assure safe operations, airports must make special efforts to upgrade and maintain pavement serviceability.

b. The most effective means of preserving airport runways, taxiways, and apron pavement areas is to implement a comprehensive maintenance program. To be effective, such a program must take a coordinated, budgeted, and systematic approach to both preventive and remedial maintenance. 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 listing of required equipment and products. The airport should systematically make repairs and take preventive measures, when necessary, on an annual basis at a minimum. A systematic approach assures continual vigilance and permits the stockpiling of maintenance materials, which assures their availability for routine and emergency maintenance.

Airport Improvement Program grant conditions now require many airports to develop and maintain an effective airport pavement maintenance management program. The FAA, however, also encourages airports that are not specifically required to develop maintenance programs to do so as a means of preserving their facilities. An effective pavement maintenance program can take many forms but must include several basic items, see Appendix A.

c. Two major elements contribute to pavement deterioration: the effects of weathering and the action of aircraft traffic. 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 may eventually result in serious pavement distresses that require extensive repairs that will be costly in terms of dollars and closure time. In all cases of pavement distress manifestations, the causes of the problem should first be determined. If the causes are known, an airport can select a repair method that will not only correct the present damage, but also prevent or retard its progression.

d. The selection of a specific rehabilitation method involves considering both economic and engineering impacts. Airports should prioritize long-term effects rather than focusing on immediate short-term remedies. They should compare the cost of rehabilitation alternatives over some finite period of time (life cycle) and consider the future economic consequences of a repair method as well as the initial rehabilitating maintenance costs.

e. The present or immediate costs of a pavement rehabilitation/maintenance project include actual costs of the repairs and the estimated costs that airport users will incur because of the project. Airport user costs include those experienced by airlines, fixed base operators, concession operators, and others due to traffic delays, re-routings, etc. Future costs include those incurred later in the life cycle (depending on the life expectancy of the repair) plus the routine maintenance costs expected over the same period. A comparative analysis of these costs for the various alternatives will suggest the most economical rehabilitation scheme.

CHAPTER 2. AIRPORT PAVEMENTS: COMPOSITION AND FUNCTION.

2-1. INTRODUCTION TO AIRPORT PAVEMENTS. Airport pavements are designed, constructed, and maintained to support the critical loads imposed on them and to produce a smooth, skid-resistant, and safe-riding surface. The pavement must be of such quality and thickness to ensure it will not fail under the loads imposed and 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. This chapter helps airports assess these parameters by providing information on the composition of pavement sections and the functional aspects of flexible and rigid pavement components.

2-2. CLASSIFICATION OF AIRPORT PAVEMENTS. Generally, pavements fall into two classes: rigid and flexible pavements. For guidance and design standards refer to current version of AC 150/5320-6, *Airport Pavement Design and Evaluation*.

Combinations of different pavement types and stabilized layers form complex pavements that can be classified as variations of the normal rigid and flexible types. Overlay pavements—existing pavement structures that are overlaid by either of the pavement types—are also common.

2-3. RIGID PAVEMENT COMPOSITION AND STRUCTURE. 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, prestressed, or fibrous concrete. The PCC pavement slab usually lies on a compacted granular or treated subbase, which is supported, in turn, 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. Figure 2-1 illustrates a typical rigid pavement structure. Rigid pavements have a high degree of rigidity. Figure 2-2 shows how this inflexibility and the resulting beam action enable rigid pavements to distribute loads over large areas of the subgrade. Better rigid pavement performance requires that support for the PCC pavement slab be uniform. Rigid pavement strength is most economically built into the PCC pavement slab itself with optimum use of low-cost materials under the slab.

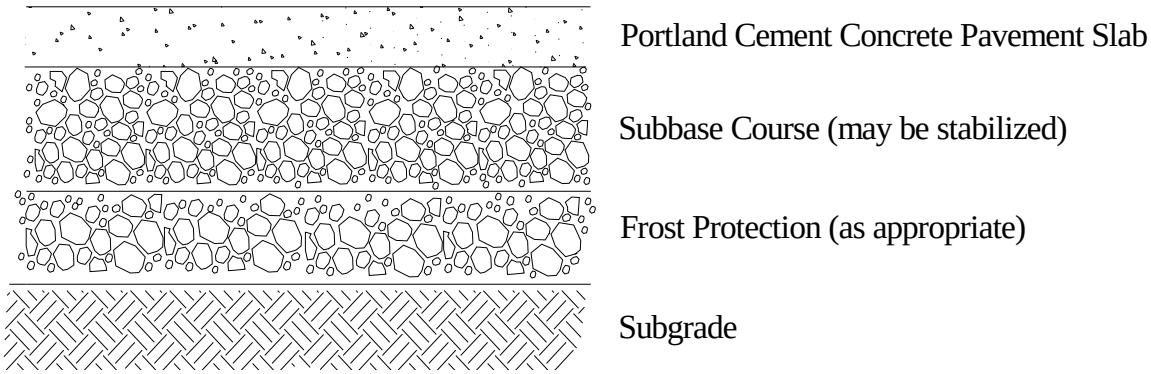

Figure 2 - 1. Typical Rigid Pavement Structure

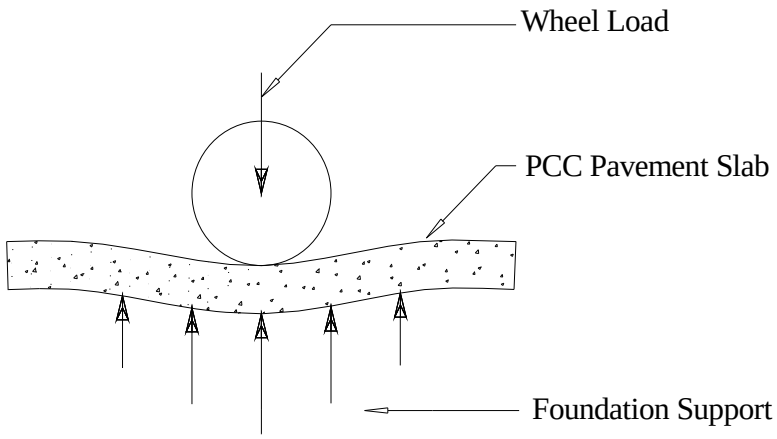

Figure 2 - 2. Transfer of Wheel Load to Foundation in Rigid Pavement Structure

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

b. Subbase. The subbase provides uniform stable support for the pavement slab. The subbase 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 mud pumping of fine-grained soils. Rigid pavements generally require a minimum subbase thickness of 4 inches (100 mm).

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

d. Frost Protection Layer. In areas where freezing temperatures occur and where frost-susceptible soil with a high ground water table exists, engineers must consider frost action when designing pavements. Frost action includes both frost heave and loss of subgrade support during the frost-melt period. Frost heave may cause a portion of the pavement to rise because of the nonuniform formation of ice crystals in a frost-susceptible material (see Figure 2-3). Thawing of the frozen soil and ice crystals may cause pavement damage under loads. The frost protection layer functions as a barrier against frost action and frost penetration into the lower frost-susceptible layers.

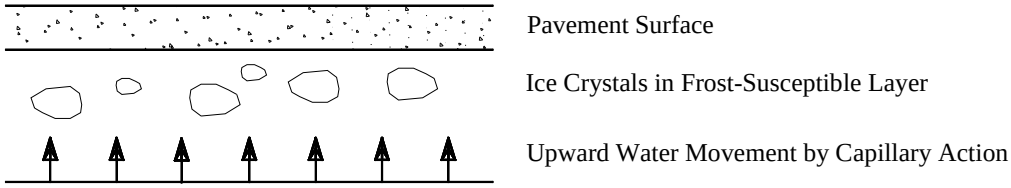

Figure 2 - 3. Formation of Ice Crystals in Frost-Susceptible Soil

e. Subgrade. The subgrade is the compacted soil layer that forms the foundation of the pavement system. 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 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.

Since subgrade soils vary considerably, the interrelationship of texture, density, moisture content, and strength of subgrade material is complex. The ability of a particular soil to resist shear and deformation will vary with its density and moisture content. In this regard, the soil profile of the subgrade requires careful examination. The soil profile is the vertical arrangement of layers of soils, each of which may possess different properties and conditions. Soil conditions are related to the ground water level, presence of water-bearing strata, and the properties of the soil, including soil density, particle size, moisture content, and frost penetration. Since the subgrade soil supports the pavement and the loads imposed on the pavement surface, it is critical to examine soil conditions to determine their effect on grading and paving operations and the need for underdrains.

2-4. FLEXIBLE PAVEMENT COMPOSITION AND STRUCTURE. Flexible pavements support loads through bearing rather than flexural action. 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. A typical flexible pavement section is shown in Figure 2-4. Figure 2-5 depicts the distribution of the imposed load to the subgrade. The various layers composing a flexible pavement and the functions they perform are described below:

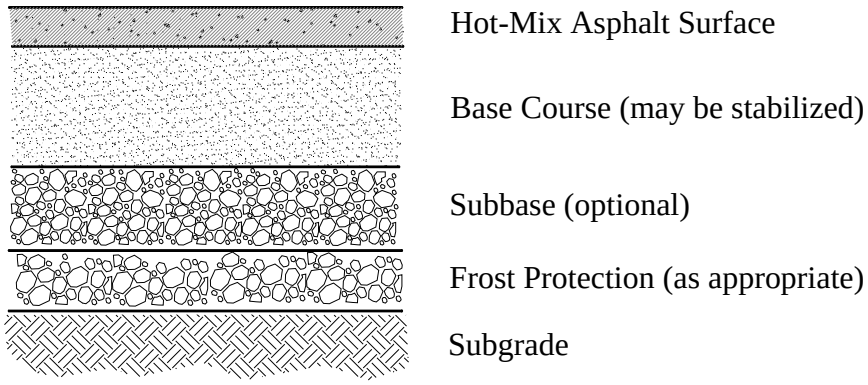

Figure 2 - 4. Typical Flexible Pavement Structure

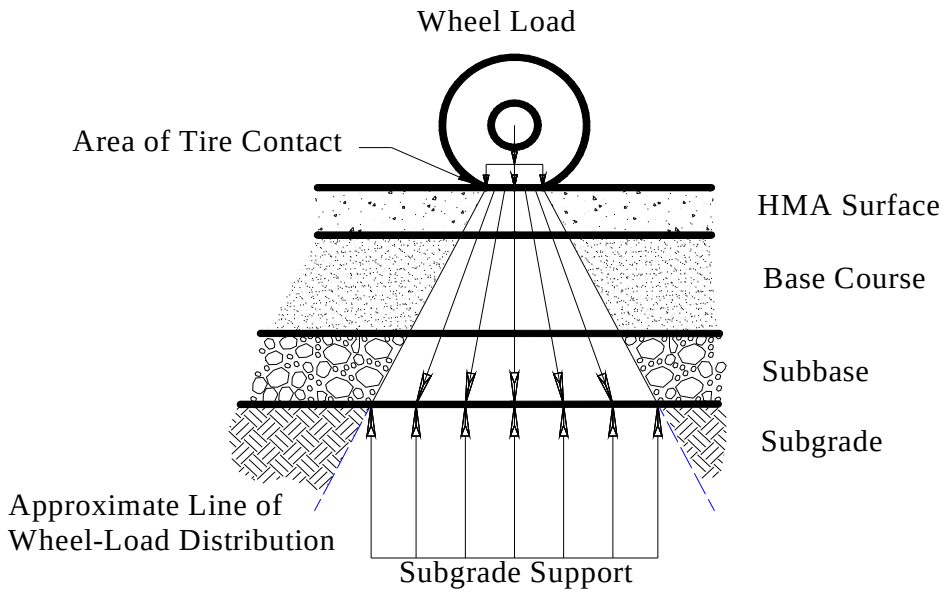

Figure 2 - 5. Distribution of Wheel Load in Flexible Pavement

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). This surface prevents the penetration of surface water to 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 result in distortion of the surface course, and resist volume changes caused by fluctuations in its moisture content. The materials composing the base course are select hard and durable aggregates, which generally fall into two main classes: stabilized and granular. The stabilized bases normally consist of crushed or uncrushed aggregate bound with a stabilizer, such as Portland cement or bitumen. The quality of the base course is a function of its composition, physical properties, and compaction of the material.

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

d. Frost Protection Layer. Some flexible pavements require a frost protection layer. This layer functions the same way in either a flexible or a rigid pavement. (See paragraph 2-3d.)

e. Subgrade. The subgrade is the compacted soil layer that forms the foundation of the pavement system. Subgrade soils are subjected to lower stresses than the surface, base, and subbase courses. Since load stresses decrease with depth, the controlling subgrade stress usually lies at the top of

the subgrade. The combined thickness of subbase, base, and wearing surface 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. (See paragraph 2-3e for factors affecting subgrade behavior.)

2-5. AIRPORT PAVEMENT OVERLAYS. Airport pavement overlays may correct deteriorating pavement surfaces, improve ride quality or surface drainage, maintain structural integrity, or increase pavement strength. Overlays are used when a pavement is damaged by overloading, requires strengthening to serve heavier aircraft, shows severe ponding because of uneven settling, or has simply served its design life and is worn out. Airport pavement overlays generally consist of either PCC or HMA pavements, and the resulting pavement system may be classified as either rigid or flexible for load-support purposes.

2-6. RECYCLED PAVEMENT STRUCTURES. The pavement elements discussed in paragraphs 2-4 and 2-5 also apply to pavements composed of recycled layers except that in-situ materials are recycled and used in place of importing selected materials. In-situ materials may be crushed, blended, rehandled, and/or treated to produce a controlled pavement layer. Recycled layers may make up the entire pavement structure or be used in combination with existing and/or new pavement layers. Recent advances in equipment and recycling techniques have allowed the use of in-place, recycled rigid pavements as base courses for both rigid and flexible pavement reconstruction.

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CHAPTER 3. PAVEMENT DISTRESS.

3-1. GENERAL. Various external signs or indicators make the deterioration of a pavement apparent, and often reveal the probable causes of the failure. This chapter provides a detailed discussion and description of the types of pavement distress and relates them to likely causal factors.

3-2. TYPES OF PAVEMENT DISTRESS. The discussions of problems related to pavement distress are generally based on whether the pavement has a rigid or flexible surface type. However, while different distresses possess their own particular characteristics, the various types generally fall into one of the following broad categories:

a. Cracking

b. Joint Seal Damage

c. Disintegration

d. Distortion

e. Loss of skid resistance

ASTM D 5340, *Standard Test Method for Airport Pavement Condition Index Surveys*, provides detailed examples of each distress. The Pavement-Transportation Computer Assisted Structural Engineering (PCASE) software package and the Department of Defense Unified Facilities Guide include similar examples. The PCASE software is available from the U.S. Army Corp of Engineers at **https://transportation.wes.army.mil/triservice/pcase**. The Unified Facilities Guide is available from several sources, including **http://www.wbdg.org/ccb** and **http://65.204.17.188/report/doc_ufc.html**.

3-3. 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. Several different types of cracking can occur:

(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. These types of cracks can 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. This type of break is 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 crack differs from a corner spall in that the crack 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 (30 to 60 cm) 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 (6.4 mm) from the slab surface and may be primarily in the finished surface paste only.

b. Joint Seal Damage. Joint seal damage is any condition that enables soil or rocks to accumulate in the joints or that allows infiltration of water. Accumulation of 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 subbase. 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, and/or not properly cleaning the joint before sealing.

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

(1) Scaling, Map Cracking, and 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. Alkali-Silica Reactivity (ASR) is another source of distress associated with map cracking. ASR is caused by an expansive reaction between aggregates containing silica and alkaline pore solutions of the cement paste.

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

(3) Corner Spalling. Corner spalling is the raveling or breakdown of the slab within approximately 2 feet (60 cm) of the corner. It differs from a corner break in that the spall usually angles downward to intersect the joint, while a break extends vertically through the slab. The same mechanisms that cause joint spalling often cause corner spalling, but this type of distress may appear sooner because of increased exposure.

(4) 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.

(5) Blowups. Blowups 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. Popouts usually range from approximately 1 to 4 inches (25 to 100 mm) in diameter and from 1/2 to 2 inches (13 to 51 mm) deep. A popout may also be a singular piece of large aggregate that breaks loose from the concrete surface or may be clay balls in the concrete mix. Per ASTM D 5340, to count a slab as having this type of distress, an average greater than three Popouts per square yard (per square meter) is needed. If there is doubt in the average being greater than three Popouts per square yard, then at least three random 1-square yard areas should be evaluated.

(7) Patching. A patch is defined as an area where the original pavement has been removed and replaced by a filler material. Patching is usually divided into two types:

(a) Small. A small patch is defined as an area less than 5 ft^2 (0.5 m^2).

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

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

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

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

3-4. FLEXIBLE PAVEMENT DISTRESSES.

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

(1) Longitudinal and Transverse Cracks. Longitudinal and transverse cracks often 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 joints cracks.

(2) Block Cracking. Block cracks are interconnected cracks that divide the pavement into approximately rectangular pieces. The blocks may range in size from approximately 1 by 1 foot (0.3M by 0.3M) to 10 by 10 feet (3M by 3M). Block cracking is caused mainly by contraction of the asphalt and daily temperature cycling (that results in daily stress/strain cycling). It is not load associated. The occurrence of block cracking usually indicates that the asphalt has hardened significantly. Block cracking normally occurs over a large portion of pavement area, but sometimes will occur only in nontraffic areas. This type of distress differs from alligator cracking in that the alligator cracks form smaller, many-sided pieces with sharp angles. Also, unlike block cracks, alligator cracks are caused by repeated traffic loadings and are, therefore, located only in traffic areas (that is, wheel paths).

(3) Reflection Cracking. Vertical or horizontal movements in the pavement beneath an overlay cause this type of distress. These movements 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 wherever 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 initiates 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 by excessive deflection of the HMA surface over a weakened or under-designed foundation, the cracks connect, forming many sided sharp angled pieces that develop a pattern resembling chicken wire or alligator skin. The pieces are less than 2 feet (0.6M) on the longest side.

(5) Slippage Cracks. Slippage cracks appear when braking or turning wheels cause the pavement surface to slide and deform. This usually occurs when there is a low-strength surface mix or poor bond between the surface and the next layer of the pavement structure. These cracks are crescent or half-moon-shaped with the two ends pointing away from the direction of traffic.

b. Disintegration. Disintegration in a flexible pavement is caused by 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.

(1) Raveling and Weathering. The most common type of disintegration in HMA pavements is raveling/weathering. Raveling/weathering is the wearing away of the pavement surface caused by the dislodging of aggregate particles and the loss of asphalt binder. This distress may indicate that the asphalt binder has aged and hardened significantly. As the raveling/weathering continues, larger pieces are broken free, and the pavement takes on a rough and jagged appearance and can produce a significant source for Foreign Object Debris/Damage (FOD).

(2) Potholes. A pothole is defined as a disruption in the pavement surface where a potion 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 are worked loose, they may eventually be picked out of the surface by continued wheel loads, thus forming 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.

(3) 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.

(4) 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).

(5) 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. A patch is considered a defect in the pavement, regardless of how well it is performing. Deterioration of patch areas affects the riding quality and has FOD potential.

c. Distortion. Distortion in HMA pavements is caused by foundation settlement, insufficient compaction of the pavement courses, lack of stability in the bituminous mix, poor bond between the surface and the underlying layer of the pavement structure, and swelling soils or frost action in the subgrade. Four types of distortion commonly occur:

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

(2) Corrugation. Corrugation results from a form of plastic surface movement typified by ripples across the surface. Corrugation can be caused by a lack of stability in the mix and 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 or lateral stresses produced by adjacent PCC pavement during expansion.

(4) Depression. Depressions are localized low areas of limited size. In many instances, light depressions become noticeable only after a rain, when ponding creates "birdbath" areas. Depressions may result from traffic heavier than that for which the pavement was designed, 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 swell 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 subject to wear, and buildup of contaminants. In bituminous pavements, a loss of skid resistance may result from the following:

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

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

(3) Bleeding. Bleeding is characterized by a film of bituminous material on the pavement surface that resembles a shiny, glass-like, reflecting surface that usually becomes quite sticky. It is caused by excessive amounts of asphalt binder in the mix and/or low air-void content and 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.

3-5. DRAINAGE OF AIRPORT PAVEMENTS.

a. A proper drainage system is essential to preventive maintenance. Probably no other factor plays such an important role in determining the ability of a pavement to withstand the effects of weather and traffic. The drainage system collects and removes surface water runoff, removes excess underground water, lowers the water table, and protects all slopes from erosion. An inadequate drainage system can cause saturation of the subgrade and subbase, damage to slopes by erosion, and loss of the load-bearing capacity of the paved surfaces. Whenever pavement failure occurs, the airport should investigate the possibility of deficient drainage.

b. The damage mechanism of free water in the pavement system is related to the amount of free water in the boundaries between the structural layers of the pavement system. When water fills the voids and spaces at the boundaries between layers, heavy wheel loads applied to the surface of the pavement produce impacts on the water comparable to a water-hammer type of action. The resulting water pressure causes erosion of the pavement structure and ejection of the material out of the pavement.

c. There are two general classes of drainage systems: surface and subsurface. Classification depends on whether the water is on or below the surface of the ground at the point where it is first

intercepted or collected for disposal. Where both types of drainage are required, it is generally good practice for each system to function independently.

(1) 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 in ditches, gutters, and catch basins. Surface water should not be allowed to enter a subdrainage system as it often contains soil particles in suspension. As the water percolates through the granular material of the subdrain, these particles cause it to silt up. Inevitably, some water will enter the pavement structure through cracks, open joints, and other surface openings, but this penetration may be kept to a minimum by proper surface maintenance procedures.

(2) Subsurface Drainage. Subsurface drainage is provided for the pavement by a permeable layer of aggregate or permeable stabilized layers—such as cement-treated or asphalt-treated layers under the full width of the traveled way—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 trenches placed at the pavement edge also prevent surface runoff moisture from entering the pavement structure from the pavement perimeter.

d. The current version of AC 150/5320-5, *Airport Drainage*, contains additional guidance and technical information.

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CHAPTER 4. GUIDELINES FOR INSPECTION OF PAVEMENTS.

4-1. INTRODUCTION TO PAVEMENT INSPECTION. This chapter presents guidelines and procedures for inspection of airport pavements. Airports should prioritize the upkeep and repair of all pavement surfaces in the aircraft operating areas of the airport to ensure continued 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. Many cases exist where inadequate maintenance characterized by the absence of a vigorously followed inspection program directly attributed to failures of airport pavements and drainage features. It should be noted that maintenance, no matter how effectively carried out, cannot overcome or compensate for a major design or construction inadequacy. However, it can prevent the total and possibly disastrous failure that can result from such deficiencies. The maintenance inspection can reveal at an early stage where a problem exists and thus provide enough warning and time to permit corrective action. Postponement of minor maintenance can develop into a major pavement repair project. The FAA recommends that airports follow ASTM D 5340, *Standard Test Method for Airport Pavement Condition Index Surveys*, when conducting preventive maintenance inspections. This standard employs the visual distress identification and rating system known as the Pavement Condition Index (PCI).

Although there are numerous distress types associated with airfield pavements, a particular concern on airfield pavements is the possibility that pavement distress will generate loose material that may strike aircraft propellers or be ingested into jet engines. This loose material and the resulting damage are commonly labeled as foreign object debris/damage (FOD). FOD can cause considerable damage to an aircraft and increase the cost of maintaining the aircraft in a safe operating condition. More important, FOD can cause undetected damage to an aircraft, making it unsafe to operate. In addition to the pavement inspection procedures noted below, all pavement inspections should address the issue of FOD to minimize its potential hazard. The most recent version of AC 150/5380-5, *Debris Hazards at Civil Airports*, provides guidance on reducing FOD hazards.

4-2. INSPECTION PROCEDURES. Maintenance is an ongoing process and a critical responsibility of airport personnel. Truly effective maintenance programs require a series of scheduled, periodic inspections or surveys, conducted by experienced engineers, technicians, or maintenance personnel. These surveys must be controlled to ensure that each element or feature being inspected is thoroughly checked, potential problem areas are identified, and proper corrective measures are recommended. The maintenance program must provide for adequate follow-up of the inspection to ensure that the corrective work is expeditiously accomplished and recorded. Although the organization and scope of maintenance activities will vary in complexity and degree from airport to airport, the general types of maintenance required are similar, regardless of airport size or extent of development.

a. Inspection Schedules. The airport is responsible for establishing a schedule for pavement inspections. Inspection schedules should ensure that all areas, particularly those that are not observed daily, are thoroughly checked. All paved areas should be inspected at least twice a year. In temperate climates, inspections should occur once in the spring and once in the fall. Severe storms or other conditions that may adversely affect the pavement may necessitate additional thorough inspections. Airport personnel should also solicit reports from airport users and conduct daily drive-by-type inspections.

b. Record keeping. The airport should prepare and maintain complete records of all inspections and maintenance performed. These records should document the severity level of existing distress types, their locations, their probable causes, remedial actions, and results of follow up inspections

and maintenance. In addition, the files should contain information on potential problem areas and preventive or corrective measures identified. Records of materials and equipment used to perform all maintenance and repair work should also be kept on file for future reference. Such records may be used later to identify materials and remedial measures that may reduce maintenance costs and improve pavement serviceability.

4-3. FRICTION SURVEYS. Airports should maintain runway pavements that provide surfaces with good friction characteristics under all weather conditions. Parameters that affect the skid resistance of wet pavement surfaces include the following:

a. Texture depth

b. Rubber deposits

c. Paint marking

d. Pavement abnormalities, such as rutting, raveling, and depression

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

4-4. NONDESTRUCTIVE TESTING. In addition to collecting information from visual inspections of the pavement area and about runway history, airports should consider collecting data from nondestructive testing. Such data are used to evaluate the pavement load-carrying capacity. Loads are applied to the pavement through loading plates or wheels, and the pavement deflection response is recorded. The stiffness or strength of the airport pavement can be related to the magnitude of these deflections. Nondestructive testing involves a large number of readings, and a statistical average is used. Instructions for taking the measurements and evaluating the test results to determine the load-carrying capacity of the pavement structure are contained in the current version of AC 150/5370-11, *Use of Nondestructive Testing Devices in the Evaluation of Airport Pavements*.

4-5. DRAINAGE SURVEYS. The maintenance program should take into account the importance of adequate drainage of surface and ground water because water is directly or partly responsible for many pavement failures and deterioration. Sufficient drainage for collection and disposal of surface runoff and excess ground water is vital to the stability and serviceability of pavement foundations. Trained personnel should conduct periodic and complete inspections of drainage systems and record and correct defective conditions of surface and subsurface drainage systems. Runway and taxiway edge drains and catch basins should be inspected at intervals (i.e., spring, summer, fall, and winter) and monitored following unusually heavy rainfall. The personnel making the inspection should look for distress signals that may indicate impending problems. These distress signals include the following:

a. Ponding of water

b. Soil buildup at pavement edge preventing runoff

c. Eroded ditches and spill basins

d. Broken or displaced inlet grates or manhole covers

e. Clogged or silted inlet grates and manhole covers

f. Blocked subsurface drainage outlets

g. Broken or deformed pipes

h. Backfill settlement over pipes

i. Erosion around inlets

j. Generally poor shoulder shaping and random erosion

k. Discoloration of pavement at joints or cracks

4-6. PAVEMENT MANAGEMENT SYSTEMS. Airport pavement management systems (APMS) provide one method of establishing an effective maintenance and repair system. An APMS is a systematic and consistent procedure for scheduling maintenance and rehabilitation based on maximizing benefits and minimizing costs. An APMS 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, an APMS can facilitate a life-cycle cost analysis for various alternatives and help determine when to apply the best alternative.

a. The primary component of any APMS 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. The PCI is determined in accordance with procedures contained in ASTM D 5340, *Standard Test Method for Airport Pavement Condition Index Surveys*.

b. The current version of AC 150/5380-7, *Airport Pavement Management System*, outlines the basic concepts of an APMS.

4-7. PAVEMENT PERFORMANCE. 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.

4-8. PAVEMENT MAINTENANCE MANAGEMENT PROGRAM. Any airport requesting Federal funds for a project to replace or reconstruct a pavement under the airport grant assistance program must have implemented a pavement maintenance program. Appendix A contains the minimum requirements for such a program.

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CHAPTER 5. MATERIALS AND EQUIPMENT.

5-1. GENERAL. Normal day-to-day pavement maintenance requires only hand tools, but some maintenance necessitates specialized equipment. For example, cleaning out joints in PCC pavements is best accomplished with hand-operated, motor-driven machines especially designed for the task. Specialized sawing equipment may be required to establish the proper joint sealant shape dimension when sealing cracks in HMA pavement. Equipment to apply nontoxic herbicides may be necessary to prevent weeds from growing until sealant materials can be applied. Expedient plow-type devices also aid in removing old joint material. Joint sealing can be accomplished by hand pouring from kettles with narrow spouts, but some sealing materials require pressure application with specialized equipment.

Most normal maintenance projects, however, require the following:

a. Mechanical Hammers. Mechanical hammers can be used to break PCC pavement slabs for easy removal. These hammers can also drill slabs. When using mechanical hammers, maintenance staff should take precautions to avoid damaging adjacent slabs.

b. Trailer-Type Asphalt Kettles. The use of trailer-type asphalt kettles can expedite patching and spot sealing. Kettles equipped with a powered hand-spray bar are valuable maintenance and repair items.

c. Compaction Equipment. Compaction of HMA patches and subbase repairs can be accomplished with hand tampers, but small vibrating compactors produce better and more-uniform results. These vibrating compactors are easy to operate, are transportable in small vehicles, work well in confined areas, and do an excellent job.

d. Distributors. A large-scale project such as seal coating an extensive area requires specialized equipment, including pressure distributors for bitumen, aggregate spreaders, and rollers. Generally, contractors or others organized for such large-scale activities should perform this type of work.

e. Work Crew. Two to six people, trained in the various techniques of repairing and familiar with the tools available to them, can perform the routine maintenance required by pavement surfaces. If the work requires more staff, it will probably be a major repair and require methods, materials, and equipment beyond those used for normal maintenance.

5-2. COMMON MATERIALS FOR MAINTENANCE AND REPAIR. The materials listed below are commonly used for maintenance and repair of pavements.

a. Hot-Mix Asphalt. 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.

b. Tack Coat. A tack coat, usually a light application of emulsified asphalt, is 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.

c. Prime Coat. A prime coat of emulsified or cutback asphalt is applied to an aggregate base course for the following purposes:

(1) To waterproof the surface of the base

(2) To plug capillary voids

(3) To promote adhesion between the base and the surface course

d. Fog Seal. A fog seal is a light application of emulsified asphalt used to rejuvenate the surface of a HMA pavement.

e. Aggregate Seal. This process is used to seal the surface of weathered pavements. Aggregate seals consist of sprayed asphalts that are immediately covered with aggregate and rolled to seat the aggregate in the asphalt coating. The FAA does not recommend aggregate seals for airfield pavements because of the potential for propeller and engine damage caused by loose aggregates.

f. Slurry Seal. A slurry seal is a mixture of asphalt emulsion, fine aggregate, mineral filler, and water. The mixture is prepared in slurry form and applied in a film approximately 1/8 inch (3 mm) thick. Slurry seals are used to seal small cracks, correct surface conditions, and improve the skid resistance of pavement surfaces.

g. Coal-Tar Sealer. Coal-tar sealer is a coal-tar-based product designed to coat the surface and protect the pavement against fuel spill damage and the intrusion of air and water. It is cold applied and should be periodically reapplied and maintained. Coal-tar sealers may contain fine aggregates to enhance traction and applied in multiple coatings.

h. Crack and Joint Sealing Material for Flexible Pavement. Material for sealing cracks should meet ASTM standards for the type of pavement and service for which the pavement is intended.

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

(2) Some airports have used silicone sealants to seal cracks and joints in bituminous pavements. Proper use of silicone sealants requires that the material modulus be matched to the application. If silicone sealants are used, they should meet ASTM D 5893, *Standard Specification for Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements.*

i. Crack and Joint Sealing Material for Rigid Pavement. Material for sealing joints in Portland cement concrete pavement may be hot- or cold-applied compounds, as long as they meet the following standards:

(1) ASTM D 3406, *Standard Specification for Joint Sealant, Hot Applied, Elastomeric–Type, for Portland Cement Concrete Pavements.*

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

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

(4) ASTM D 7116, *Standard Specification for Joint Sealants, Hot Applied, Jet Fuel Resistant Types, for Portland Cement Concrete*. It is important to note that joint sealants conforming to ASTM D 7116 are not compatible with asphalt pavements and should only be used for rigid pavements.

(5) Federal Specification SS-S-200E, *Sealing Compounds, Two-Component, Jet-Blast Resistant, Cold Applied, for Portland Cement Concrete Pavement.*

j. Crack Filler Material for Flexible or Rigid Pavement. Material for filling cracks in rigid or flexible pavement should meet ASTM D 5078, *Standard Specification for Crack Filler, Hot-Applied, for Asphalt Concrete and Portland Cement Concrete Pavements*.

k. Precured Joint Sealing Material for Rigid Pavement. Precured material for sealing joints in rigid pavement should meet ASTM C 1518, *Standard Specification for Precured Elastomeric Silicone Joint Sealants*.

l. 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.

m. Epoxy Grouts and Concretes. There are many types of epoxy resins; the type to be used depends on the intended application. Under normal conditions, mixed resins may be workable up to 1 hour after mixing. Repairs with epoxy materials are costly, so their use should be limited to small areas and their application left to experienced personnel.

5-3. EQUIPMENT USED FOR PAVEMENT MAINTENANCE. There are many different types and models of equipment airports can use for pavement maintenance. Maintenance crews commonly use the equipment listed below for the following types of projects:

a. Pavement Removal.

(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.

(2) Cutting Disks. A cutting disk is a circular, heavy-duty steel plate with a sharpened edge. The disk is usually attached to a motor grader or other piece of equipment capable of pushing the disk through a bituminous pavement. It is limited to approximately 3 inches (8 cm) in cutting depth. Since the cutting disk is much faster than a saw, its use should be considered when larger areas must be removed.

(3) Jackhammers. Jackhammers with a chisel head are commonly used for cutting pavement surfaces.

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

(5) Cold Milling Machines. Cold milling machines use an adjustable rotating mandrel with cutting bits to remove various depths of pavement material. Bits can be added or

removed to vary the cutting width and roughness. Advantages of cold milling include speed of removal, precision of removal, and grade control.

(6) Hand Tools. Hand tools can be used to make vertical cuts through pavements and to break up deteriorated pavement. Chisels, sledgehammers, shovels, pry bars, and picks fall into this category of equipment.

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

(8) Dump Trucks. Dump trucks are used to haul removed pavement and repair materials.

b. Maintenance Equipment.

(1) Asphalt Kettle. Asphalt kettles are usually small-tractor-mounted units that have the capacity to heat and store 40 to 500 gallons (150 – 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.

(2) Aggregate Spreaders. Aggregate spreaders can be either truck-mounted or separate units. They are used to evenly place a controlled amount of sand or aggregate on an area.

(3) Hand Tools. Rakes, lutes, and other such hand tools are used to move and level material placed in a patch area.

c. Compaction Equipment.

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

(2) 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.

(3) Rubber-Tired Rollers. Rubber-tired rollers are self-powered and used to compact HMA pavement.

d. Crack and Joint Sealing Equipment.

(1) Joint Plow. A joint plow is used to remove old sealer from joints. This is usually a specially made tool attached to a skid-steer loader.

(2) Joint Router. A joint router is used to clear existing cracks or joints to be resealed. A router is usually a self-powered machine operating a rotary cutter or revolving cutting tool. A rotary routing tool with a V-shaped end can be used for cleaning out random cracks. The FAA does not recommend rotary cutting tools for PCC pavements due to excessive fracturing of aggregates. The use of a random crack saw is preferred.

(3) 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. Maximum straight line cutting depth is 1-1/2 inches (38 mm). A center mounted blade configuration allows that crack saws to pivot about its own axis to more exactly follow random crack patterns easily.

(4) Power Brush. A power-driven wire brush may be used to clean joints after all of the old joint sealer has been removed.

(5) Air Compressor and Sand Blasting. Sand blasting may be used for final removal of old joint sealant, and the FAA recommends it as the final cleaning method for PCC surfaces prior to application of new sealant. Joints and cracks should be blown out with clean compressed air immediately before applying new sealer. Air compressors should be equipped with oil and moisture traps to prevent contaminating the cleaned surface.

(6) Pavement Sweeper. A pavement sweeper can be used for cleaning the pavement surface and removing excess aggregate. Cleaning operations are necessary in preparation for seal coating and crack filling.

(7) 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 a pressure base attached directly to a pump unit on the kettle.

(8) Pouring Pot. A pouring pot is hand carried or mounted on a hand-pushed pot dolly and used to pour hot sealing materials into a previously prepared crack or joint.

(9) High-pressure Water Sprayer. A water sprayer can be used to clean out joints prior to resealing and to clean vertical faces of pavement to be patched.

(10) Hot Air Lance. A hot air lance enhances adhesion by drying and heating cracks in existing bituminous material while removing debris prior to crack sealing.

e. Removal of Pavement Markings.

(1) High Pressure Water Jet. A high-pressure water jet, with proper selection of spray nozzle and pressure, can be highly effective in removal of pavement markings.

(2) Abrasive Blasting. Pavement markings can be removed by the impact of edged particles accelerated by pressurized air, although care must be exercised to avoid damage to the pavement surface.

(3) Solvent Cleaning. Chemical agents can be employed to remove markings from pavement, but proper attention must be paid to environmental concerns and cleanup.

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CHAPTER 6. METHODS OF REPAIR.

6-1. GENERAL. This chapter describes various methods airports can use to correct airfield pavement distress. While these repair methods apply to specific types of distress and pavements, they should all take into account the possibility of FOD to aircraft. Untidy repair activities may leave potential FOD at or near the repair sites. Improperly constructed repairs may disintegrate and cause a FOD potential. All maintenance activities must include quality control monitoring to assure that repairs are conducted properly and clean-up activities undertaken to remove this potential. The current version of AC 150/5380-5, *Debris Hazards at Civil Airports*, provides additional guidance to help eliminate debris hazards associated with maintenance activities.

a. Visible evidence of excessive stress levels 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 maintenance program and adequate repair procedures.

b. In all cases of pavement distress, the first step in rehabilitating a pavement is to determine the causes of distress. Then, the proper procedures for repair - 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 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.

c. 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.

d. 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.

6-2. REPAIR METHODS FOR RIGID PAVEMENTS.

a. Crack Repair and Sealing. Sealing cracks prevents surface moisture from entering the pavement structure. This type of repair first requires establishing a properly shaped sealant reservoir, which should be done with a saw rather than with router equipment, because routers use a mechanical impact to remove material and can cause micro-cracks in the concrete. Refer to Figures C-1A and C-1B in Appendix C for generic typical details for crack repair and sealing.

(1) Longitudinal, Transverse, and Diagonal Cracks. The procedures for repairing these types of cracks are discussed in the following generic specifications of Appendix B.

(a) Item M-361, Hot-Applied Joint and Crack Sealants for Rigid (Portland Cement Concrete) and Flexible (Bituminous) Pavements.

(b) Item M-362, Silicone Joint and Crack Sealants for Rigid (Portland Cement Concrete) and Flexible (Bituminous) Pavements.

(2) Corner Breaks. The procedures for repairing these types of breaks are discussed in the following generic specification of Appendix B: Item M-564, Repair of Pavement Distresses in Rigid (Portland Cement Concrete) Pavements. Refer to Figures C-2 and C-3 in Appendix C for generic typical details for repairing corner breaks, including the placement of dowel bars or tie-bars as necessary.

(3) "D" Cracking. This type of distress usually requires repairing the complete slab since "D" cracking will normally reappear adjacent to the repaired areas. Temporary repairs can be made using the technique noted in paragraph 6-2a(2) or 6-2b(1).

(4) Joint Seal Damage. The procedures for repairing joint seal damage are discussed in the following generic specifications of Appendix B.

(a) Item M-361, Hot-Applied Joint and Crack Sealants for Rigid (Portland Cement Concrete) and Flexible (Bituminous) Pavements.

(b) Item M-362, Silicone Joint and Crack Sealants for Rigid (Portland Cement Concrete) and Flexible (Bituminous) Pavements.

(c) In addition to these generic specifications above, when addressing joint seal damage of an existing preformed sealant, that existing joint sealant may be replaced with new preformed sealant depending on the condition of the joint. If the joint can be re-sawn straight and at a uniform width, even if that joint width is greater than the existing joint width, preformed sealant may be used. In this case, the area of repair must extend from one joint intersection to the next joint intersection. Partial replacement is not acceptable. Refer to Figure C-4 in Appendix C for a generic typical detail for re-sealing/re-sawing joints.

(5) Shrinkage Cracks. Shrinkage cracks are non-structural and non-propagating. These types of cracks should be considered cosmetic and not subject to conventional repairs. Epoxy cement surface pasting of shrinkage cracks may hide the blemishes, but is not considered critical for the longevity of the pavement.

b. Disintegration. If not impeded in its early stages, disintegration can progress rapidly until the pavement requires complete rebuilding. Refer to Figures C-5 through C-9 in Appendix C for generic typical details for repairing joint spalling, corner spalling, and blowups, including the placement of dowel bars or tie-bars as necessary if full-depth replacement is required. Refer to Figures C-10 and C-11 in Appendix C for generic typical details of saw cut control joints for rigid pavement repairs.

(1) Scaling, Map Cracking, and Crazing. This distress is often noticeable with little or no surface deterioration. Severe cases of scaling, map cracking, or crazing can produce considerable FOD, which can damage propellers and jet engines. If the distress is severe and produces FOD, the repair method is to remove the immediate surface and provide a thin bonded overlay. The procedures for repairing these types of distress are discussed in the following generic specification of Appendix B: Item M-564, Repair of Pavement Distresses in Rigid (Portland Cement Concrete) Pavements.

(2) Joint Spalling and Corner Spalling. The procedure for the repair of spalls is discussed in the following generic specification of Appendix B: Item M-564, Repair of Pavement Distresses in Rigid (Portland Cement Concrete) Pavements.

(3) Shattered Slab/Intersecting Cracks. A shattered slab requires replacing the full slab. Follow the same procedures used for blowup repairs except remove unstable subgrade materials and replace with select material. Correct poor drainage conditions by installing drains for removal of excess water.

(4) Blowups. Blowups may be repaired using the procedures discussed in the following generic specification of Appendix B: Item M-564, Repair of Pavement Distresses in Rigid (Portland Cement Concrete) Pavements.

(5) Popouts. Popouts may be filled with the same materials as used for repairing cracks or joints in PCC pavements.

(6) Patching. Patching small, large or utility cuts typically require removal and replacement of the patch as discussed in the following generic specification of Appendix B: Item M-564, Repair of Pavement Distresses in Rigid (Portland Cement Concrete) Pavements. For extensive large patches, removal and replacement of the slab is recommended. Refer to Figures C-8 and C-9 in Appendix C for generic typical details for patching, including the placement of dowel bars or tie-bars as necessary and installation of nonabsorbent board when the patch is a joint.

c. Distortion. If not too extensive, some forms of distortion, such as that caused by settlement, can be remedied by raising the slab to the original grade. Slabjacking procedures may be used to correct this type of distress. In slabjacking, a grout is pumped under pressure through holes cored in the pavement into the void under the pavement. This creates an upward pressure on the bottom of the slab in the area around the void. The upward pressure lessens as the distance from the grout hole increases. Thus, it is possible to raise one corner of a slab without raising the entire slab. Due to the special equipment and experience required, slabjacking is usually best performed by specialty contractors. An option for repairing some types of settlement or faulting, which are not extensive in grade variation, is to micro-mill the pavement surface to true and level.

d. Loss of Skid Resistance. Rehabilitation treatment includes resurfacing, milling, diamond grinding, and surface cleaning. Grooving may be considered when a loss of skid resistance is observed. Grooving does not impact the surface texture but does provide a channel for water that becomes trapped between a pavement and the tire to escape. Grooving thus minimizes the potential for hydroplaning during wet conditions.

(1) Polished Aggregate. Since polished aggregate distress normally occurs over an extensive area, consider milling, grooving, or diamond grinding the entire pavement surface. PCC and HMA resurfacing may also be used to correct this condition.

(2) Contaminants. Remove rubber deposits with high-pressure water or biodegradable chemicals.

6-3. 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. Consequently, such full-depth repairs should be considered temporary, and corrective long-term repairs should be scheduled. Temporary repair for corner cracks, diagonal cracks, blowups, and spalls can be made using the

procedures discussed in the following generic specification of Appendix B: Item M-363, Bituminous Pavement Repair for Patching Flexible (Bituminous) Pavements and Temporary Repairs to Rigid (Portland Cement Concrete) Pavements. Refer to Figures C-12 and C-13 in Appendix C for generic typical details of temporary patching of rigid pavements with flexible pavement.

6-4. REPAIR METHODS FOR FLEXIBLE PAVEMENTS.

a. Crack Sealing. Cracking takes many forms. In some cases, simple crack filling may be the proper corrective action. Refer to Figures C-14 through C-19 in Appendix C for generic typical details for crack sealing. Some cracks, however, require complete removal of the cracked area and the installation of drainage.

(1) Longitudinal, Transverse, Reflection, and Block Cracking. The procedures for repairing these types of cracks are discussed in the following generic specifications of Appendix B.

(a) Item M-361, Hot-Applied Joint and Crack Sealants for Rigid (Portland Cement Concrete) and Flexible (Bituminous) Pavements.

(b) Item M-462, Cold-Applied Joint and Crack Sealants for Flexible (Bituminous) Pavements.

(c) Item M-362, Silicone Joint and Crack Sealants for Rigid (Portland Cement Concrete) and Flexible (Bituminous) Pavements.

(d) Item M-461, Hot-Applied Crack Sealants/Fillers with Fibers for Flexible (Hot-Mix Asphalt) Pavement Overlays.

(2) Alligator Cracking. Permanent repairs by patching may be carried out as discussed in the following generic specification of Appendix B: Item M-363, Bituminous Pavement Repair for Patching Flexible (Bituminous) Pavements and Temporary Repairs to Rigid (Portland Cement Concrete) Pavements. The temporary measure would be the application of an asphalt emulsion, with or without aggregate, to seal the area to reduce FOD potential.

(3) Slippage Cracks. One repair method commonly used for slippage cracks involves removing the affected area and patching with HMA plant-mixed material. Specific steps are discussed in the following generic specification of Appendix B: Item M-363, Bituminous Pavement Repair for Patching Flexible (Bituminous) Pavements and Temporary Repairs to Rigid (Portland Cement Concrete) Pavements. The temporary measure would be the application of an asphalt emulsion, with or without aggregate, to seal the area to reduce FOD potential.

b. Disintegration. If not impeded in its early stages, disintegration can progress rapidly until the pavement requires complete rebuilding. Permanent repairs by patching may be carried out as discussed in the following generic specification of Appendix B: Item M-363, Bituminous Pavement Repair for Patching Flexible (Bituminous) Pavements and Temporary Repairs to Rigid (Portland Cement Concrete) Pavements. Sealer-rejuvenator products can be applied to retard disintegration. The products help reverse the aging process of the surface asphalt. Deterioration from raveling may also be impeded by applying a light fog seal or a slurry seal. The basic procedures for either surface treatment are as follows:

(1) Sweep the surface free of all dirt and loose aggregate material.

(2) Apply the surface treatment.

(3) Close to traffic until the seal has cured.

c. Distortion. Repair techniques for distortion range from leveling the surface by filling with new material to completely removing the affected area and replacing with new material as discussed in the following generic specification of Appendix B: Item M-363, Bituminous Pavement Repair for Patching Flexible (Bituminous) Pavements and Temporary Repairs to Rigid (Portland Cement Concrete) Pavements. Cold milling can be employed prior to overlaying for many of these distresses. Temporary measures for these types of distresses are discussed in the following paragraphs.

(1) Rutting. The industry provides numerous products that are capable of temporarily repairing rutted surfaces. Any of the products considered for use should have a proven track record with the local State Department of Transportation (DOT) and should be on the current State's DOT listing of pre-approved products and materials for this particular type of repair. For example, these products include polymer modified cementitious based materials, polymer modified noncementitious based materials, polymer modified asphalt based materials, and epoxy resin based elastomeric compounds. Important typical physical properties to consider when selecting the product include tensile strength, elongation, hardness, compressive strength, resilience to deflection, impact resistance, and bonding strength. Follow manufacturer's recommendations for installation requirements based on the selected product and pavement conditions.

(2) Corrugation and Shoving or Swelling. The repair procedure for these types of distress is the same as for patch repair of alligator cracking.

d. Loss of Skid Resistance. Treatment for loss of skid resistance includes removal of excess asphalt for bleeding conditions, resurfacing, grooving to improve surface drainage, and removing of rubber deposits.

(1) Polished Aggregate. One means of correcting this condition is to cover the surface with an aggregate seal coat. Grooving, milling, or diamond grinding the pavement surface are also useful techniques.

(2) Contaminants. Rubber deposits may be removed by use of high-pressure water or biodegradable chemicals.

(3) Bleeding. For minor bleeding, a pavement milling or grinding machine may be used to remove the excess asphalt by milling off 1/8 inch to 1/4 inch (3 to 6 mm) of pavement. Prior to milling or grinding, the use of infra-red heaters to soften the HMA pavement surface should be tried. After heating of the pavement surface, scrape the asphalt binder from the surface, apply blotter-sand, roll with a steel-drum roller, then remove any excess blotter-sand from the surface. Repeat the process if bleeding re-occurs through the blotter-sand.

(4) Fuel/Oil Spillage. Permanent repairs for areas subjected to continuous fuel/oil spillage consist of removal of the damaged pavement and replacement with rigid or flexible pavement. For isolated areas, treat with a biodegradable chemical cleaner made especially for cleaning pavements, and apply a coal-tar emulsion seal coat or other fuel-resistant coating.

6-5. ADDITIONAL REPAIR METHODS. The following documents describe repair procedures in greater detail:

- MS-16, Asphalt in Pavement Maintenance. Asphalt Institute

- Unified Facilities Criteria (UFC) 3-270-01 O&M: Asphalt Maintenance and Repair. USCOE, NFEC, AFCESA
- Unified Facilities Criteria (UFC) 3-270-04 O&M: Concrete Repair. USCOE, NFEC, AFCESA
- Unified Facilities Criteria (UFC) 3-270-03 O&M: Concrete Crack and Partial-Depth Spall Repair. USCOE, NFEC, AFCESA

The Unified Facilities Criteria manuals can be accessed at **http://www.wbdg.org/ccb, http://www.wbdg.org/references/pa_dod.php, http://pdc.usace.army.mil/library/ufc,** or at **http://65.204.17.188/report/doc_ufc.html**.

Tables 6-1 through 6-10 summarize maintenance and repair procedures for rigid and flexible pavements.

Table 6 - 1. QUICK GUIDE FOR MAINTENANCE AND REPAIR OF COMMON PAVEMENT SURFACE PROBLEMS

PROBLEM	PROBABLE CAUSE	REPAIR
Crack and joint sealer missing or not bonded to slabs	- Faces of joints (cracks) not clean when filled - Incorrect application temperature of sealer - Wrong kind of seal material - Improper joint width	- Remove old material sealer if extensive areas affected; clean (preferably by sandblasting) joints and cracks; reseal properly.
Random cracking	- Uncontrolled shrinkage (improper joint spacing) - Overstressed slabs - Slab support lost - Subgrade settlement - Bitumen too hard or overheated in mix	- Clean and seal newly formed cracks; replace subbase to establish support; - If pavement being overloaded, probably will require overlay.
or breakup	**Rigid Pavement** - Overworked finishing operation - Inadequate curing **Flexible Pavement** - Overheated binder - Poor aggregate gradation - Insufficient binder - Incorrect binder or aggregate - Fuel spillage - Stripping	**Rigid Pavement** - Remove and replace panel - Resurface with thin bonded concrete - Resurface area with a bituminous concrete. **Flexible Pavement** - Apply seal coat - Overlay.
Joint (1) faulting or (2) spalling	**Faulting (1)** - Variable support for un-bonded slabs - Loss of load-transfer capability **Spalling (2)** - Incompressible matter in joint spaces - Excessive joint finishing	**Faulting (1)** - Remove problem slab; replace slab (dowel to existing pavement). **Spalling (2)** - Clean joint; refill with bituminous-sand mix; reseal.
Pumping	- Saturated pavement foundation - Lack of subbase	- Prevent entrance of water (correct the drainage problem) - Pump slurry under slabs to reseal - Replace slabs and slab foundation - Install drainage.

PROBLEM	PROBABLE CAUSE	REPAIR
Surface irregularities (rutting, washboarding, birdbaths, undulations)	**Rigid Pavement** - Poor placing control - Broken slabs - Poor finishing **Flexible Pavement** - Non-uniform settlement from inadequate compaction of pavement components or fill - Unstable mix (poor aggregate gradation, too rich, etc.) - Poor laying control	**Rigid Pavement** - Patch local areas - Overlay if widespread **Flexible Pavement** - Patch local areas - Apply leveling course - Roto-mill.
Bleeding of bituminous binder	- Too much binder in mix (overly rich mix)	- Scrape off excess material; blot with sand. NOTE: Bleeding is usually an indication that other surface deformities (rutting, washboarding, etc.) will occur.
Potholes	- Water entering pavement structures - Segregation in base course material	- Remove and replace base (and subbase if required); replace surface and seal.
Oxidation of bituminous binder	- Lack of timely seal coat - Binder overheated in mixing - Wrong grade of asphalt for climate	- Apply seal coat - Heater planer - Resurface.
Map cracking, crazing, alligator cracking	**Rigid Pavement** - Excessive surface finishing - Alkali-Aggregate Reactivity **Flexible Pavement** - Overload - Oxidized binder - Underdesigned surface course (too thin)	**Rigid Pavement** - If surface deforms or breaks, resurface, grind. **Flexible Pavement** - Overlay - Apply seal coat.
Popouts at joints	- Dowel misaligned	- Fill popout hole with bituminous concrete or bituminous sand mix (if recurring, may require replacement of slabs).
Slab blowup	- Incompressible material in joints preventing slab from expanding - Alkali-Aggregate Reactivity	- Replace slab in blowup area; clean and reseal joints.
Slipperiness	**Rigid Pavement** - Improper finish (too smooth) - Improper type of curing membrane - Excessive curing membrane - Polished aggregate - Rubber deposits **Flexible Pavement** - Overly rich mix - Poorly designed mix - Polished aggregate - Improperly applied seal coat - Wrong kind of seal coat - Rubber deposits	**Rigid Pavement** - If finish too smooth, resurfacing required to provide texture - Wire broom to remove curing membrane - Grooving - Remove rubber. **Flexible Pavement** - Apply textured seal coat - Grooving - Remove rubber.

Table 6 - 2. MAINTENANCE AND REPAIR OF RIGID PAVEMENT SURFACES – CRACKING

PAVEMENT DISTRESS	PAVEMENT DISTRESS SEVERITY		MAINT./ REPAIR TYPE	SUGGESTED MAINT./ REPAIR METHOD	MATERIAL DESCRIPTION
Longitudinal, Transverse, or Diagonal Cracking	L	surface crack	R/P	No action	none
	M	< 1/8" (3.2 mm) wide	R/P	No action	none
	H	≥ 1/8" (3.2 mm) wide	R/P	Rotary-random saw and seal	hot-applied sealant
					cold-applied sealant
Corner Breaks	N	pavement ≤ 12" (0.3M) thick	R/P	Full-depth repair w/ #4 rebar	conventional mix
					pre-packaged mix w/ aggregate
					rapid setting, early strength
	N	pavement > 12" (0.3M) thick	R/P	Full-depth repair w/ #5 rebar	conventional mix
					rapid setting, early strength
	N	joints parallel direction of/ or oblique to traffic	R/P	Full-depth repair w/ load transfer bars	conventional mix
					rapid setting, early strength
Durability "D" Cracking	N		R/P	Remove and replace entire slab	conventional mix
			T/E	Same repair as Corner Breaks	
				Same repair as Scaling, Map Cracking, or Crazing	
				Partial depth repair, mill 2-3" (5-7.6 cm)	High quality HMA
Shrinkage Cracking	N		R	No action	none
			Other	Fill voids w/ cement paste	epoxy cement

LEGEND:

N =	No degree of severity	R =	Recommended
L =	Low	P =	Permanent
M =	Medium	T =	Temporary
H =	High	E =	Emergency

Table 6 - 3. MAINTENANCE AND REPAIR OF RIGID PAVEMENT SURFACES – JOINT SEAL DAMAGE

PAVEMENT DISTRESS	PAVEMENT DISTRESS SEVERITY		MAINT./ REPAIR TYPE	SUGGESTED MAINT./ REPAIR METHOD	MATERIAL DESCRIPTION
Joint Seal Damage	N	Conventional joint seal	R/P	Remove old and reseal joint	hot-applied sealant
					cold-applied sealant
	N	Preformed compression joint seal	R/P	Remove old and reseal joint	hot-applied sealant
					cold-applied sealant
					preformed sealant

LEGEND:

N =	No degree of severity	R =	Recommended
L =	Low	P =	Permanent
M =	Medium	T =	Temporary
H =	High	E =	Emergency

Table 6 - 4. MAINTENANCE AND REPAIR OF RIGID PAVEMENT SURFACES – DISINTEGRATION

PAVEMENT DISTRESS	PAVEMENT DISTRESS SEVERITY	MAINT./ REPAIR TYPE	SUGGESTED MAINT./ REPAIR METHOD	MATERIAL DESCRIPTION
Scaling, Map Cracking, or Crazing	L	R/P	Seal	Penetrating concrete sealer
			No action	none
	M	T/E	Micro-mill and seal	surface asphalt emulsion
	H	R/P	Micro-mill to grade install thin bonded overlay	high performance concrete
		R/P	Remove and replace if extensive area	conventional mix
				rapid setting, early strength
Joint Spalling	N	R/P	Saw cut, remove unsound concrete and patch	pre-packaged mix w/ aggregate
				pre-packaged mix w/o aggregate
				rapid setting, early strength
		T/E	Remove unsound concrete, patch	HMA pavement overlay
Corner Spalling	N	R/P	Saw cut, remove unsound concrete and patch	pre-packaged mix w/ aggregate
				pre-packaged mix w/o aggregate
				rapid setting, early strength
		T/E	Remove unsound concrete, patch	HMA pavement overlay
Shattered Slab/ Intersecting Cracks	N	R/P	Remove and replace entire slab	conventional mix
Blowups	N	R/P	Remove and replace concrete full-depth	conventional mix
Popouts	L ≤ 2" (5 cm) diameter	R/P	Seal	hot-applied sealant
				cold-applied sealant
				elastomeric compound

PAVEMENT DISTRESS	PAVEMENT DISTRESS SEVERITY	MAINT./ REPAIR TYPE	SUGGESTED MAINT./ REPAIR METHOD	MATERIAL DESCRIPTION
	M - H > 2" (5 cm) diameter	R/P	Patch w/ elastomeric compound w/ aggregate	Elastomeric compound w/ aggregate
Patching, Small	L	R	No action	None
	M	R/P	Remove and replace the patch	pre-packaged mix w/ aggregate
				pre-packaged mix w/o aggregate
				rapid setting, early strength
		T/E	Seal cracks within patch	hot-applied sealant
				cold-applied sealant
	H	R/P	Remove and replace the patch	pre-packaged mix w/ aggregate
				pre-packaged mix w/o aggregate
				rapid setting, early strength
Patching, Large and Utility Cut	L	R/P	No action	none
	M	T/E	Seal cracks within patch	hot-applied sealant
				cold-applied sealant
		R/P	Repair distressed area only	Same as Patching, Small
		R/P	Remove and replace the patch	conventional mix
		T/E	Remove and replace the patch	rapid setting, early strength
	H	R/P	Remove and replace the patch/slab	conventional mix
		T/E	Remove and replace the patch	rapid setting, early strength

LEGEND:

N =	No degree of severity	R =	Recommended
L =	Low	P =	Permanent
M =	Medium	T =	Temporary
H =	High	E =	Emergency

Table 6 - 5. MAINTENANCE AND REPAIR OF RIGID PAVEMENT SURFACES – DISTORTION

PAVEMENT DISTRESS	PAVEMENT DISTRESS SEVERITY		MAINT./ REPAIR TYPE	SUGGESTED MAINT./ REPAIR METHOD	MATERIAL DESCRIPTION
Pumping	L - M	Minimal movement	R/P	Base stabilization, slab leveling, and saw cut	expandable foam injection
					cementitious grout pump under pressure through holes cored in pavement into void
	H	movement ≥ 1" (2.5 cm)	R/P	Base stabilization, slab-leveling, saw cut, and install load transfer devices	expandable foam injection
					cementitious grout pump under pressure through holes cored in pavement into void
Settlement or Faulting	L	no movement	R/P	Micro-mill surface to true and level	none
	M - H	movement	R/P	Slabjacking	cementitious grout pump under pressure through holes cored in pavement into void
					expandable foam injection

LEGEND:

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L =	Low	P =	Permanent
M =	Medium	T =	Temporary
H =	High	E =	Emergency

Table 6 - 6. MAINTENANCE AND REPAIR OF RIGID PAVEMENT SURFACES – LOSS OF SKID RESISTANCE

PAVEMENT DISTRESS	PAVEMENT DISTRESS SEVERITY	MAINT./ REPAIR TYPE	SUGGESTED MAINT./ REPAIR METHOD	MATERIAL DESCRIPTION
Polished Aggregate	N	R/P	Micro-mill entire surface	none
			Diamond grind entire surface	none
			Grooving	none
			Resurfacing	HMA pavement overlay
				thin bonded PCC overlay
Contaminants	N	R	Surface Cleaning	high-pressure water
				Biodegradable chemicals

LEGEND:

N =	No degree of severity	R =	Recommended
L =	Low	P =	Permanent
M =	Medium	T =	Temporary
H =	High	E =	Emergency

Table 6 - 7. MAINTENANCE AND REPAIR OF FLEXIBLE PAVEMENT SURFACES – CRACKING

PAVEMENT DISTRESS	PAVEMENT DISTRESS SEVERITY		MAINT./ REPAIR TYPE	SUGGESTED MAINT./ REPAIR METHOD	MATERIAL DESCRIPTION
Longitudinal, Transverse, Block, or Reflection Cracking	L	< 1/8"(3.2 mm) wide	R/P	No action	none
			T/E	Seal coat	coal-tar pitch emulsion
				Slurry seal	emulsified asphalt
				Fog coat	emulsified asphalt
	M	≥ 1/8" (3.2 mm) wide & < 1/4" (6.4 mm) wide	R/P	Rout, clean and seal	hot-applied sealant
					cold-applied sealant
	M	≥ 1/4" (6.4 mm) wide & < 3/4" (19 mm) wide	R/P	Rout, clean and seal	hot-applied sealant
					cold-applied sealant
	H	≥ 3/4" (19 mm) wide & 1-1/4" (32 mm) wide	R/P	Pavement < 4" (102 mm) thick, remove and replace (i.e., saw/mill, remove existing pavement, repave and seal saw cuts)	State DOT modified surface mix *
				Pavement ≥ 4" (102 mm) thick, remove and replace (i.e., mill, remove existing pavement, repave and seal saw cuts)	State DOT modified surface mix *
			T/E	Rout edges only, clean, and seal	hot-applied sealant
					cold-applied sealant
	H	≥ 1-1/4" (32 mm) wide & 2-1/4" (57 mm) wide	R/P	Pavement < 4" (102 mm) thick, remove and replace	State DOT modified surface mix *
				Pavement ≥ 4" (102 mm) thick, remove and replace	State DOT modified surface mix *
			T/E	Rout edges only, clean, install backer rod, and seal	hot-applied sealant
					cold-applied sealant
	H	≥ 2-1/4" (57 mm) wide	R/P	Pavement < 4" (102 mm) thick, remove and replace	State DOT modified surface mix *

PAVEMENT DISTRESS	PAVEMENT DISTRESS SEVERITY	MAINT./ REPAIR TYPE	SUGGESTED MAINT./ REPAIR METHOD	MATERIAL DESCRIPTION
			Pavement ≥ 4" (102 mm) thick, remove and replace	State DOT modified surface mix *
Alligator or Fatigue Cracking	N	R/P	Saw cut area, remove and replace	State DOT modified surface mix *
		T/E	Slurry seal	emulsified asphalt
			Seal coat	coal-tar pitch emulsion
Slippage	N	R/P	Remove and replace	State DOT modified surface mix *
		T/E	Crack seal	hot-applied
				cold-applied
			Slurry seal	emulsified asphalt

LEGEND:

N = No degree of severity
L = Low
M = Medium
H = High

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P = Permanent
T = Temporary
E = Emergency

* - "State DOT modified surface mix" refers to a modified standard mix with a minimum of 5% retained on the 1/2-inch (12.7 mm) sieve and 0% passing the 3/4-inch (19 mm) sieve.

Table 6 - 8. MAINTENANCE AND REPAIR OF FLEXIBLE PAVEMENT SURFACES – DISINTEGRATION

PAVEMENT DISTRESS	PAVEMENT DISTRESS SEVERITY	MAINT./ REPAIR TYPE	SUGGESTED MAINT./ REPAIR METHOD	MATERIAL DESCRIPTION
Potholes	N	R/P	Saw cut area, remove and replace	State DOT modified surface mix *
		T/E	Prepare existing pothole, remove loose loose material, fill and compact	hot-applied, polymer modified asphalt binder w/ aggregate
				cold-applied, emulsified asphalt w/ aggregate
Raveling and Weathering	N Small Area	R/P	Remove and replace	State DOT modified surface mix *
		T/E	Seal coat	coal-tar pitch emulsion
			Slurry seal	emulsified asphalt
			Apply rejuvenator	sealer-rejuvenator
	N Large Area	R/P	Overlay	State DOT modified surface mix *
				FAA P-401
		T/E	Seal coat	coal-tar pitch emulsion
			Slurry seal	emulsified asphalt
			Apply rejuvenator	sealer-rejuvenator
Asphalt Stripping	N	R/P	Remove to sound pavement & replace	State DOT modified surface mix *
Jet Blast Erosion	N	R	No action	none
		R/P	Partial-depth patch	State DOT modified surface mix *
		T/E	Apply rejuvenator	sealer-rejuvenator

PAVEMENT DISTRESS	PAVEMENT DISTRESS SEVERITY	MAINT./ REPAIR TYPE	SUGGESTED MAINT./ REPAIR METHOD	MATERIAL DESCRIPTION
Patching and Utility Cut Patch	L	R/P	No action	none
	M	T/E	Seal cracks	hot-applied sealant
				cold-applied sealant
			Repair distressed area (small) only	State DOT modified surface mix *
		R/P	Remove and replace the patch	State DOT modified surface mix *
				FAA P-401
	H	R/P	Remove and replace the patch	State DOT modified surface mix *
				FAA P-401

LEGEND:

N = No degree of severity
L = Low
M = Medium
H = High

R = Recommended
P = Permanent
T = Temporary
E = Emergency

* - "State DOT modified surface mix" refers to a modified standard mix with a minimum of 5% retained on the 1/2-inch sieve and 100% passing the 3/4-inch sieve.

Table 6 - 9. MAINTENANCE AND REPAIR OF FLEXIBLE PAVEMENT SURFACES – DISTORTION

PAVEMENT DISTRESS	PAVEMENT DISTRESS SEVERITY	MAINT./ REPAIR TYPE	SUGGESTED MAINT./ REPAIR METHOD	MATERIAL DESCRIPTION
Rutting	N	R/P	Remove and replace	State DOT modified surface mix *
		T/E	Patch w/ elastomeric compound w/ aggregate	elastomeric compound w/ aggregate
Corrugation and Shoving	N	R/P	Saw cut area, remove and replace	State DOT modified surface mix *
				FAA P-401
		T/E	Slurry seal	emulsified asphalt
			Seal coat	coal-tar pitch emulsion
Depression	N	R/P	Remove and replace	State DOT modified surface mix *
				FAA P-401
Swelling	N	R/P	Saw cut area, remove and replace	State DOT modified surface mix *
				FAA P-401
		T/E	Slurry seal	emulsified asphalt
			Seal coat	coal-tar pitch emulsion

LEGEND:

N = No degree of severity
L = Low
M = Medium
H = High

R = Recommended
P = Permanent
T = Temporary
E = Emergency

* - "State DOT modified surface mix" refers to a modified standard mix with a minimum of 5% retained on the 1/2-inch sieve and 100% passing the 3/4-inch sieve.

Table 6 - 10. MAINTENANCE AND REPAIR OF FLEXIBLE PAVEMENT SURFACES – LOSS OF SKID RESISTANCE

PAVEMENT DISTRESS	PAVEMENT DISTRESS SEVERITY	MAINT./ REPAIR TYPE	SUGGESTED MAINT./ REPAIR METHOD	MATERIAL DESCRIPTION
Polished Aggregate	N	R/P	Slurry seal	emulsified asphalt
		P	Micro-milling or diamond grinding	none
			Grooving	none
			Overlay	State DOT modified surface mix *
				FAA P-401
Contaminants	L	R/P	Clean surface	high-pressure water
				Biodegradable chemicals
	M	R/P	Clean surface and apply coal-tar emulsion seal coat	coal-tar pitch emulsion
	H	R/P	Remove and replace	State DOT modified surface mix * FAA P-401
Bleeding	N	R/P	Scrap surface and blotter-sand-roll	blotter sand
			Mill and repave	State DOT modified surface mix *
				FAA P-401
Fuel/Oil Spillage	L - M Isolated Areas	R/P	Clean w/ application of biodegradable chemicals	Biodegradable chemicals
		R/P	Clean and application of coal-tar emulsion seal coat	coal-tar pitch emulsion
	H Areas of continuous spillage	R/P	Remove and replace	State DOT modified surface mix *
				FAA P-401
				conventional PCC mix

LEGEND:

N =	No degree of severity	R =	Recommended
		P =	Permanent
L =	Low	T =	Temporary
M =	Medium	E =	Emergency
H =	High		

* - “State DOT modified surface mix” refers to a modified standard mix with a minimum of 5% retained on the 1/2-inch sieve and 100% passing the 3/4-inch sieve.

APPENDIX A. PAVEMENT MAINTENANCE MANAGEMENT PROGRAM

An effective pavement maintenance management program specifies the procedures to be followed to assure that proper preventative and remedial pavement maintenance is performed. An airport sponsor may use any format it deems appropriate, but the program must, as a minimum, include the following:

A-1. Pavement Inventory. The following must be depicted in an appropriate form and level of detail:

a. Location of all runways, taxiways, and aprons

b. Dimensions

c. Type of pavement

d. Year of construction or most recent major rehabilitation

e. Whether Federal financial assistance was used to construct, reconstruct, or repair the pavement.

A-2. Inspection Schedule.

a. Detailed Inspection. Trained personnel must perform a detailed inspection of airfield pavements at least once a year. If a history of recorded pavement deterioration in the form of a Pavement Condition Index (PCI) survey as set forth in ASTM D 5340, *Standard Test Method for Airport Pavement Condition Index Surveys*, is available, the frequency of inspections may be extended to 3 years.

b. Drive-By Inspection. A drive-by inspection must occur a minimum of once per month to detect unexpected changes in the pavement condition.

A-3. Record Keeping. The airport must record and keep on file for a minimum of 5 years complete information about all detailed inspections and maintenance performed. The types of distress, their locations, and remedial action, scheduled or performed, must be documented. The minimum information to be recorded is listed below:

a. Inspection date

b. Location

c. Distress types

d. Maintenance scheduled or performed

For drive-by inspections, records must include the date of inspection and any maintenance performed.

A-4. Information Retrieval. An airport sponsor may use any form of record keeping it deems appropriate, so long as the information and records produced by the pavement survey can be retrieved as necessary for any reports required by the FAA.

A-5. Program Funding. The program should identify funding and other resources available to provide remedial and preventive maintenance activities.

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APPENDIX B. GENERIC SPECIFICATIONS

(GENERIC SPECIFICATION #01)

ITEM M-361 HOT-APPLIED JOINT AND CRACK SEALANTS FOR RIGID (PORTLAND CEMENT CONCRETE) AND FLEXIBLE (BITUMINOUS) PAVEMENTS

DESCRIPTION

361-1.1 This item consists of providing and installing a resilient and adhesive **[joint][crack]** sealant, hot-applied, capable of effectively sealing **[joints][cracks]** in rigid (PCC) or flexible (bituminous) pavements. This item includes the removal of existing, loose, or damaged sealant material where applicable, preparation of the **[joints][cracks]**, preparation of the sealant material, and the complete installation of the sealant repair system. The selection of sealant material products will be based on climate conditions, past performance of products, and at the discretion of the engineer.

MATERIALS

361-2.1 The repair material will be a hot-applied sealant conforming to the requirements of ASTM D 6690, as listed in Table 1, for the classification type specified below. The engineer will evaluate performance based on local conditions.

a. *Type I* – A joint and crack sealant capable of maintaining an effective seal in moderate climates. The material is tested for low temperature performance at -18°C (-64.4°F) using 50% extension.

b. *Type II* – A joint and crack sealant capable of maintaining an effective seal in most climates. The material is tested for low temperature performance at -29°C (-84.2°F) using 50% extension.

c. *Type III* – A joint and crack sealant capable of maintaining an effective seal in most climates. The material is tested for low temperature performance at -29°C (-84.2°F) using 50% extension. Special tests are included.

d. *Type IV* – A joint and crack sealant capable of maintaining an effective seal in climates experiencing very cold temperatures. The material is tested for low temperature performance at -29°C (-84.2°F) using 200% extension.

****

The Engineer will select the materials to be used for the sealant and delete the paragraphs from 361-2.1a to 361-2.1.d that do not apply.

****

Table 1. Sealant Requirements per Classification Type

	*
Cone Penetration at 25°C (77°F), per ASTM D 5329	*
Softening Point, °C (°F), per ASTM D 36	80 (176) minimum
Bond, non-immersed, per ASTM D 5329	*
Bond, water immersed, per ASTM D 5329	*
Resilience, %, per ASTM D 5329	*
Oven Aged Resilience, %, per ASTM D 5329	*
Asphalt Compatibility, per ASTM D 5329	Pass[B]

[A] The development of at any time during the test procedure of a crack, separation, or other opening over 6mm (0.24 in) deep, in the sealant or between the sealant and the concrete block will constitute failure of the test specimen. The depth of crack, separation or other opening will be measured perpendicular to the side of the sealant showing the defect.

[B] There will be no failure in adhesion, formation of an oily exudate at the interface between the sealant and asphaltic concrete of other deleterious effects on the asphaltic concrete or sealant when tested at 60°C (140°F).

****

The Engineer will specify the applicable sealant requirements. Asterisks denote insertion points.

Table 1. Sealant Requirements per Classification Type

	Type I	Type II	Type III	Type IV
Cone Penetration at 25°C (77°F) per ASTM D 5329	**90 max**	**90 max**	**90 max**	**90-150**
Softening Point °C (°F) per ASTM D 36, minimum	**80 (176)**	**80 (176)**	**80 (176)**	**80 (176)**
Bond, non-immersed per ASTM D 5329	**Two out of three 25.4 mm specimens pass [A] 5 cycles at 50% ext at -18°C (-64.4°F)**	**Three 12.7 mm specimens pass [A] 3 cycles at 50% ext at -29°C (-84.2°F)**	**Three 12.7 mm specimens pass [A] 3 cycles at 50% ext at -29°C (-84.2°F)**	**Three 12.7 mm specimens pass [A] 3 cycles at 200% ext at -29°C (-84.2°F)**
Bond, water immersed per ASTM D 5329	**--**	**--**	**Three 12.7 mm specimens pass [A] 3 cycles at 50% ext at -29°C (-84.2°F)**	**--**
Resilience, % per ASTM D 5329	**--**	**60 min**	**60 min**	**60 min**
Oven Aged Resilience, % per ASTM D 5329	**--**	**--**	**60 min**	**--**
Asphalt Compatibility per ASTM D 5329	**Pass [B]**	**Pass [B]**	**Pass [B]**	**Pass [B]**

[A] The development of at any time during the test procedure of a crack, separation, or other opening over 6mm (0.24 in) deep, in the sealant or between the sealant and the concrete block will constitute failure of the test specimen. The depth of crack, separation or other opening will be measured perpendicular to the side of the sealant showing the defect.

[B] There will be no failure in adhesion, formation of an oily exudate at the interface between the sealant and asphaltic concrete of other deleterious effects on the asphaltic concrete or sealant when tested at 60°C (140°F).

****

361-2.2 Heating of Materials. The hot-applied sealant will be heated in conformance with ASTM D 5167, Standard Practice for Melting of Hot-Applied Joint and Crack Sealant and Filler for Evaluation.

CONSTRUCTION METHODS

361-3.1 Time of Application. [Joints][Cracks] will be sealed as soon after completion of the pavement preparation as feasible and preferably before the pavement is opened to traffic, including construction equipment. The pavement temperature must be above 50°F (10°C) at the time of installation of the hot-applied **[joint][crack]** sealing material.

361-3.2 Preparation of Joints in Rigid Pavements

a. Removal of Existing Joint Sealant. All existing joint sealants will be removed by routing / plowing. Any remaining sealant / debris will be removed by use of wire brushes or other tools as necessary. In some instances, re-sawing the joints may be required. This is only recommended in areas where the existing joint faces cannot be thoroughly cleaned to satisfactorily promote the effectiveness and adherence of the new sealant. If re-sawing the joints is required, immediately after sawing, the resulting slurry will be completely removed from the joint and adjacent area by flushing with a jet of water, and by use of other tools as necessary. The joints will be allowed sufficient time to dry prior to re-sealing. The joint reservoir width to depth ratio should be as close to 1:1 as practical when re-sawing is required. The use of backer material is recommended to obtain the desired ratio at the reservoir or as recommended by the sealant manufacturer.

b. Sealing. Immediately before sealing, the joints will be thoroughly cleaned of all remaining laitance, curing compound, and other foreign material. Cleaning will be accomplished by sandblasting. Sandblasting will be accomplished in a minimum of two passes. One pass per joint face with the nozzle held at an angle directly toward the joint face and not more that 3 inches from it. Upon completion of cleaning, the joints will be blown out with compressed air free of oil and water. Only air compressors with operable oil and water traps will be used to prepare the joints for sealing. The joint faces will be surface dry when the seal is applied. The surface of the installed sealant material will be 1/4-inch to 3/8-inch below the existing pavement surface.

361-3.3 Preparation of Joints in Flexible Pavements

a. Removal of Existing Joint Sealant. All existing joint sealants will be removed by routing / plowing. Any remaining sealant / debris will be removed by use of a hot lance and compressed air free of oil and water. In some instances, re-sawing the joints may be required. This is only recommended in areas where the existing joint faces cannot be thoroughly cleaned to satisfactorily promote the effectiveness and adherence of the new sealant. If re-sawing the joints is required, immediately after sawing, the joint faces will be cleaned by use of a hot lance and compressed air free of oil and water. If wet sawing equipment is used, the joints will be allowed sufficient time to dry following preparation and prior to re-sealing. The joint reservoir width to depth ratio should be as close to 1:1 as practical when re-sawing is required. The use of backer material is recommended to obtain the desired ratio at the reservoir or as recommended by the sealant manufacturer.

b. Sealing. Immediately before sealing, the joints will be thoroughly cleaned of all remaining laitance and other foreign material. Cleaning will be accomplished by use of a hot lance. Upon completion of cleaning, the joints will be blown out with compressed air free of oil and water. Only air compressors with operable oil and water traps will be used to prepare the joints for sealing. The joint faces will be surface dry when the seal is applied. The surface of the installed sealant material will be 1/4-inch to 3/8-inch below the existing pavement surface.

361-3.4 Preparation of Cracks in Rigid Pavements

a. Sawing. All cracks will be cleaned of any debris or laitance by use of wire brushes or other tools as necessary. In some instances, sawing the cracks may be required. If sawing the joints is required, immediately after sawing, the resulting slurry will be completely removed from the crack and adjacent area by flushing with a jet of water, and by use of other tools as necessary. The crack will be allowed sufficient time to dry prior to sealing. When sawing cracks, the reservoir ratio should be 1:1 with a 3/8-inch minimum width recommended.

b. Sealing. Immediately before sealing, the cracks will be thoroughly cleaned of all remaining laitance, curing compound, and other foreign material. Cleaning will be accomplished by sandblasting. Sandblasting will be accomplished in a minimum of two passes. One pass per crack face with the nozzle held at an angle directly toward the crack face and not more that 3 inches from it. Upon completion of cleaning, the cracks will be blown out with compressed air free of oil and water. Only air compressors with operable oil and water traps will be used to prepare the cracks for sealing. The crack faces will be surface dry when the seal is applied. The surface of the installed sealant material will be 1/4-inch to 3/8-inch below the existing pavement surface.

361-3.5 Preparation of Cracks in Flexible Pavements

a. Sawing / Routing. All cracks will be cleaned of any debris or laitance by use of a hot lance and compressed air free of oil and water. In some instances, sawing or routing the cracks may be required. If sawing/routing the cracks is required, immediately after sawing/routing, the resulting debris will be completely removed from the crack and adjacent area by a hot lance and compressed air free of oil and water, and by use of other tools as necessary. The crack will be allowed sufficient time to dry prior to sealing. When sawing/routing cracks, the reservoir ratio should be 1:1 with a 3/8-inch minimum width recommended.

b. Sealing. Immediately before sealing, the cracks will be thoroughly cleaned of all remaining laitance and other foreign material. Cleaning will be accomplished by use of a hot lance. Upon completion of cleaning, the cracks will be blown out with compressed air free of oil and water. Only air compressors with operable oil and water traps will be used to prepare the cracks for sealing. The crack faces will be surface dry when the seal is applied. The surface of the installed sealant material will be 1/4-inch to 3/8-inch below the existing pavement surface.

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Delete the paragraphs from 361-3.2 to 361-3.5 that do not apply.

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361-3.6 INSTALLATION OF SEALANTS. [Joints][Cracks] will be inspected for proper width, depth, alignment, and preparation, and will be approved by the Engineer before sealing is allowed. Sealants will be installed in accordance with the following requirements:

a. Hot Poured Sealants. The **[joint][crack]** sealant will be applied uniformly solid from bottom to top and will be filled without formation of entrapped air or voids. The sealant surface when complete will be 1/4-inch and 3/8-inch below existing pavement surface. A backing material will be placed to obtain the desired width to depth ratio and will be both non-reactive and non-adhesive to the pavement or the sealant material. The heating kettle will be an indirect heating type, constructed as a double boiler. A positive temperature control and mechanical agitation will be provided. The sealant will not be heated to

more than 20°F (-11°C) below the safe heating temperature. The safe heating temperature can be obtained from the manufacturer's shipping container. A direct connecting pressure type extruding device with nozzles shaped for insertion into the joint will be provided. Any sealant spilled on the surface of the pavement, structures and/or lighting fixtures will be removed immediately.

b. Backer Rod Material. The use of a backer rod material or bond breaker in the bottom of the **[joint][crack]** to be filled is recommended to control the depth of the sealant, to achieve the desired shape factor, reservoir width to depth ration, and to support the sealant against indentation and sag. Backer rod materials and bond breakers should be compatible with the sealant, should not adhere to the sealant, should be compressible without extruding the sealant, and should recover to maintain contact with the **[joint][crack]** faces when the **[joint][crack]** is open. The backer rod will be 25 percent larger in diameter than the width of the reservoir.

METHOD OF MEASUREMENT

361-4.1 The sealant material will be measured by the **[gallon (liter)][pound (kg)][linear foot (meter)][square yard (square meter)][lump sum]** of sealant in place, completed, and accepted.

BASIS OF PAYMENT

361-5.1 Payment for sealing material will be made at the contract unit price bid per **[gallon (liter)][pound (kg)][linear foot (meter)][square yard (square meter)][lump sum]**. This price will be full compensation for furnishing all materials, for all preparation, delivering, and placing of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item **M-361**-5.1	**[Joint][Crack]** Sealant – per **[gallon (liter)][pound (kg)][linear foot (meter)][square yard (square meter)][lump sum]**

TESTING REQUIREMENTS

ASTM D 36	Standard Test Method for Softening Point of Bitumen (Ring-and-Ball Apparatus)
ASTM D 5167	Standard Practice for Melting of Hot-Applied Joint and Crack Sealant and Filler for Evaluation

MATERIAL REQUIREMENTS

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

END ITEM M-361

(GENERIC SPECIFICATION #02)

ITEM M-362 SILICONE JOINT AND CRACK SEALANTS FOR RIGID (PORTLAND CEMENT CONCRETE) AND FLEXIBLE (BITUMINOUS) PAVEMENTS

DESCRIPTION

362-1.1 This specification includes the crack sealing and the repair and replacement of existing joint sealants in both flexible (bituminous) and rigid (PCC) pavements using a self-leveling silicone sealant. The items include the removal of existing joint materials, preparation of cracks and joints, and the installation of sealant in the cracks and joints. For flexible pavements, the use of a silicone sealant is restricted to edge joints between flexible and rigid pavements only. Silicone should not be used to seal flexible pavement to flexible pavement joints.

MATERIALS

362-2.1 The sealant for crack repair and joint replacement will be a one-part silicone material formulation capable of being applied with a pressure applicator. The sealant will be a self-leveling, non-acid producing and cure on exposure to air.

362-2.2 Backer Rod Material. The backer rod will be compatible with the sealant. The backer rod will be non-reactive and non-adhesive with the pavement or the sealant. The backer rod will conform to the requirements of ASTM D 5249.

362-2.3 Sealant Material. The sealant will be a low modulus type, as stated by the manufacturer, and meet the following requirements of ASTM D 5893:

Physical Requirements	ASTM D 5893 Requirements
Cure Evaluation	Pass at 21 days
Extrusion Rate (ASTM C 1183)	Type S, 50 ml/min. minimum
Tack Free Time (ASTM C 679)	5 hr. maximum
Hardness (ASTM C 661)	
-29°C (-20°F), Type A2	25 max.
23°C (73°F), Type 00	30 min.
Rubber Properties in Tension	
Ultimate Elongation	600% minimum
Stress at 150% Elongation	310 K pa (45 psi) max.
Resilience	75% minimum

362-2.4 Preparation of Materials. No preparation of materials required.

CONSTRUCTION METHODS

362-3.1 Time of Application. [Joints][Cracks] will be sealed as soon after completion of the pavement preparation as feasible and preferably before the pavement is opened to traffic, including construction

equipment. The pavement temperature must be above 40°F (4°C) at the time of installation of the cold-applied **[joint][crack]** sealing material. For new rigid pavement, manufacturers may recommend waiting a period of 3 weeks for curing prior to sealant application.

362-3.2 Preparation of Joints in Rigid Pavements

a. Removal of Existing Joint Sealant. All existing joint sealants will be removed by plowing or use of hand tools. Any remaining sealant / debris will be removed by use of wire brushes or other tools as necessary. In some instances, re-sawing the joints may be required. This is only recommended in areas where the existing joint faces cannot be thoroughly cleaned to satisfactorily promote the effectiveness and adherence of the new sealant. If re-sawing the joints is required, immediately after sawing, the resulting slurry will be completely removed from the joint and adjacent area by flushing with a jet of water, and by use of other tools as necessary. The joints will be allowed sufficient time to dry prior to re-sealing. The joint reservoir width to depth ratio should be as close to 2:1 as practical, with a minimum width of 3/8 inches preferred, when re-sawing is required. The use of backer material is recommended to obtain the desired ratio at the reservoir or as recommended by the sealant manufacturer.

b. Sealing. Immediately before sealing, the joints will be thoroughly cleaned of all remaining laitance and other foreign material. Cleaning will be accomplished by sandblasting. Sandblasting will be accomplished in a minimum of two passes. One pass per joint face with the nozzle held at an angle directly toward the joint face and not more that 3 inches from it. Upon completion of cleaning, the joints will be blown out with compressed air free of oil and water. Only air compressors with operable oil and water traps will be used to prepare the joints for sealing. The joint faces will be surface dry when the seal is applied. The surface of the installed sealant material will be 1/4-inch to 3/8-inch below the existing pavement surface.

362-3.3 Preparation of Joints in Flexible Pavements

a. Removal of Existing Joint Sealant. All existing joint sealants will be removed by routing. Any remaining sealant / debris will be removed by use of a hot lance and compressed air free of oil and water. In some instances, re-sawing the joints may be required. This is only recommended in areas where the existing joint faces cannot be thoroughly cleaned to satisfactorily promote the effectiveness and adherence of the new sealant. If re-sawing the existing joints is required, immediately after sawing, the joint faces will be cleaned by use of a hot lance and compressed air free of oil and water. The joint reservoir width to depth ratio should be as close to 2:1 as practical, with a minimum width of 3/8 inches preferred, when re-sawing is required. The use of backer material is recommended to obtain the desired ratio at the reservoir or as recommended by the sealant manufacturer.

b. Sealing. Immediately before sealing, the joints will be thoroughly cleaned of all remaining laitance and other foreign material. Cleaning will be accomplished by use of a hot lance. Upon completion of cleaning, the joints will be blown out with compressed air free of oil and water. Only air compressors with operable oil and water traps will be used to prepare the joints for sealing. The joint faces will be allowed to cool to the ambient temperature and will be surface dry when the seal is applied. The surface of the installed sealant material will be 1/4-inch to 3/8-inch below the existing pavement surface.

362-3.4 Preparation of Cracks in Rigid Pavements

a. Sawing. All cracks will be cleaned of any debris or laitance by use of wire brushes or other tools as necessary. In some instances, sawing the cracks may be required. If sawing the cracks is required, immediately after sawing, the resulting slurry will be completely removed from the crack and

adjacent area by flushing with a jet of water, and by use of other tools as necessary. The crack will be allowed sufficient time to dry prior to sealing. When sawing cracks, the reservoir ratio should be 2:1 with a 3/8-inch minimum width recommended.

b. Sealing. Immediately before sealing, the cracks will be thoroughly cleaned of all remaining laitance and other foreign material. Cleaning will be accomplished by sandblasting. Sandblasting will be accomplished in a minimum of two passes. One pass per crack face with the nozzle held at an angle directly toward the crack face and not more that 3 inches from it. Upon completion of cleaning, the cracks will be blown out with compressed air free of oil and water. Only air compressors with operable oil and water traps will be used to prepare the cracks for sealing. The crack faces will be surface dry when the seal is applied. The surface of the installed sealant material will be 1/4-inch to 3/8-inch below the existing pavement surface.

362-3.5 Preparation of Cracks in Flexible Pavements

a. Routing. All cracks will be cleaned of any debris or laitance by use of a hot lance and compressed air free of oil and water. In some instances, routing the cracks may be required. If routing the cracks is required, immediately after routing, the resulting debris will be completely removed from the crack and adjacent area by a hot lance and compressed air free of oil and water, and by use of other tools as necessary. The crack will be allowed sufficient time to dry prior to sealing. When routing cracks, the reservoir ratio should be 2:1 with a 3/8-inch minimum width recommended.

b. Sealing. Immediately before sealing, the cracks will be thoroughly cleaned of all remaining dust and debris. Cleaning will be accomplished by use of a hot lance. Upon completion of cleaning, the cracks will be blown out with compressed air free of oil and water. Only air compressors with operable oil and water traps will be used to prepare the cracks for sealing. The joint faces will be allowed to cool to the ambient temperature and will be surface dry when the seal is applied. The surface of the installed sealant material will be 1/4-inch to 3/8-inch below the existing pavement surface.

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Delete the paragraphs from 362-3.2 to 362-3.5 that do not apply.

****

362-3.6 INSTALLATION OF SEALANTS. [Joints][Cracks] will be inspected for proper width, depth, and preparation, and will be approved by the Engineer before sealing is allowed. Sealants will be installed in accordance with the following requirements:

a. Silicone Sealants. The **[joint][crack]** sealant will be applied uniformly solid from bottom to top and will be filled without formation of entrapped air or voids. Backing rod material will be placed as per sealant manufacturer's requirements and will be both non-reactive and non-adhesive to the pavement and the sealant material. A direct connecting pressure type extruding device with nozzles shaped for insertion into the joint will be provided. Any sealant spilled on the surface of the pavement, structures and/or lighting fixtures will be removed immediately.

b. Backer Rod Material. The use of backer rod material or bond breaker in the bottom of the **[joint][crack]** to be filled is recommended to control the depth of the sealant, to achieve the desired shape factor, and to support the sealant against indentation and sag. Backer rod materials and bond breakers should be compatible with the sealant, should not adhere to the sealant, should be compressible without extruding the sealant, and should recover to maintain contact with the **[joint][crack]** faces when the

[joint][crack] is open. The backer rod will be 25 percent larger in diameter than the width of the reservoir.

METHOD OF MEASUREMENT

362-4.1 The sealant material will be measured by the **[gallon (liter)][pound (kg)][linear foot (meter)][lump sum]** of sealant in place, completed, and accepted.

BASIS OF PAYMENT

362-5.1 Payment for sealing material will be made at the contract unit price bid per **[gallon (liter)][pound (kg)][linear foot (meter)][lump sum]**. This price will be full compensation for furnishing all materials, for all preparation, delivering, and placing of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item **M-362**-5.1	**[Joint][Crack]** Sealant – per **[gallon (liter)][pound (kg)][linear foot (meter)][lump sum]**

TESTING REQUIREMENTS

ASTM C 661	Standard Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer
ASTM C 679	Standard Test Method for Tack-Free Time of Elastomeric Sealants
ASTM C 1183	Standard Test Method for Extrusion Rate of Elastomeric Sealants

MATERIAL REQUIREMENTS

ASTM D 5249	Standard Specification for Backer Material for Use with Cold- and Hot-Applied Joint Sealants in Portland Cement Concrete and Asphalt Joints
ASTM D 5893	Standard Specification for Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements

END ITEM M-362

(GENERIC SPECIFICATION #03)

ITEM M-363 BITUMINOUS PAVEMENT REPAIR FOR PATCHING FLEXIBLE (BITUMINOUS) PAVEMENTS AND TEMPORARY REPAIRS TO RIGID (PORTLAND CEMENT CONCRETE) PAVEMENTS

DESCRIPTION

363-1.1 This specification provides a general guidance for the selection of bituminous materials to be used for the repair and patching of existing bituminous pavements that have been evaluated and identified through the Airport Pavement Management System (APMS) for removal and replacement action due to the type of existing distress identified. This material specification also addresses the temporary repair patches to PCC pavements using bituminous pavement. This material specification should be used when the standard 1/2-inch maximum aggregate size P-401 bituminous surface course is not readily available or is impractical to obtain in small quantities for patching. The patching bituminous pavement will be composed of mineral aggregate, mineral fillers and bituminous binder material mixed in a central mixing plant and generally conforming to the **[insert state]** Department of Transportation specifications for asphalt pavements.

MATERIALS

363-2.1 Aggregates. The maximum size for coarse aggregate in the mix should be 1/2-inch (12.5mm) for patches less than 2 inches in depth, and 3/4-inch (19mm) for patches 2 inches in depth or greater. The fine and coarse aggregate properties should conform to the DOT's material requirements based on plant job mixture formulas for the particular supplier's plant.

363-2.2 Bituminous Binder. The asphalt binder material will be chosen based on the project's geographical location and local climate conditions and approved by the State DOT for use within the different regions of the state.

363-2.3 Composition and Compaction Testing of Materials. The bituminous pavement will be considered acceptable for use where plant inspection is maintained by the State DOT and production samples are taken on a regular basis for conformance with State DOT standards based on the approved job mixture formula. For example, plants that have approved state DOT Superpave (SUperior PERforming Asphalt PAVEments) systems for 1/2-inch (12.5mm) and 3/4-inch (19mm) would be considered acceptable job mix formulas. The compaction of the mixture for large areas of repair patches that are machine placed should be tested in the field for density. The use of a Nuclear Density Gauge to monitor compaction efforts should be considered for paving in excess of 100 tons. The standard for acceptance testing is dependent on the minimum **[insert state]** compaction requirements for the specified mix based on the theoretical maximum densities (TMD) and/or the Marshal mix design method, whichever is applicable to the **[insert state]** standards.

CONSTRUCTION METHODS

363-3.1 General. The amount of bituminous pavement required to complete the work area patches should be ordered for arrival to the site based on the methods to be used for placement. The temperature of the mix should be within the binder manufacturer's recommended range for mixing and compaction. The size of the repairs should determine which placement method will be utilized. There are two methods of spreading and finishing the mixture. Hand spreading and finishing is commonly used for small patches and trench style repairs. Conventional small scale pavers and rollers should be used whenever the repair areas are large and of such a size and number that this equipment is effective.

363-3.2 Repair of Bituminous Pavements. The repair for bituminous pavement includes the following procedures.

a. Full-depth Repair of Bituminous Pavement and Base Course. Remove the surface and base as deep as necessary to reach a firm foundation. In some cases, a portion of the subgrade may also have to be removed. Saw cut the existing bituminous pavement making vertical square or rectangular cuts through the pavement. Replace the base material with material equal to that removed; however, if the base material has proved problematic, replace it with a more appropriate material. Compact each layer placed. Apply a tack coat, conforming to FAA specification P-603, to the vertical faces of the existing pavement. Place bituminous concrete and compact. If necessary, saw and seal the joints around the perimeter of the patch area.

b. Full-depth Repair of Bituminous Pavement. Saw cut and remove the affected area, at least 1 foot into the surrounding pavement. Make the saw cut faces straight and vertical. Compact and reshape base material as needed. Apply a light tack coat, conforming to FAA specification P-603, to the vertical faces of the existing pavement and to the existing base. Place bituminous material in the cutout area in lifts not to exceed 2 inches, compacted depth. Continue with subsequent lifts until the bituminous patch meets the existing grade of the surrounding pavement. Continue to compact the bituminous mixture with rollers suitable for the size of the repair area, until the surface is the same elevation as the surrounding pavement. If necessary, saw and seal the joints around the perimeter of the patch area.

c. Partial-depth Repair of Bituminous Pavements. Mill the identified area to provide a vertical face around the edge. The FAA recommends a minimum patch depth of 2 inches. Thoroughly clean the entire area. Apply a light tack coat, conforming to FAA specification P-603, to the area including the vertical face of the patch area. Spread the bituminous pavement in the prepared area to bring it to original grade when compacted. Deeper patches may require multiply lifts to allow proper compaction of each lift. Thoroughly compact the bituminous patch material with a roller or vibratory plate compactor.

363-3.3 Temporary Repair of PCC Pavements. The partial-depth repair of PCC pavements will include the following procedures. Make a vertical cut with a concrete saw 2 inches in depth and approximately 2 inches outside of the affected area. Remove all unsound concrete until sound, intact material has been reached (into at least 1/2-inch of visually sound concrete). The unsound pavement may be removed by means of milling 2-3 inches in depth. Remove the unsound concrete material with suitable hand tools such as air hammers, pneumatic drills, electric impact hammers, or grinding equipment and blow out the area with oil-free compressed air. Clean the area to be repaired with high-pressure water. Allow the patch area to dry completely. Treat the surface (all sides and bottom, except any joint face) with tack coat, conforming to FAA specification P-603, to ensure a good bond between the existing PCC pavement and the new bituminous pavement. Apply the tack coat before placing the bituminous patch. Place the bituminous concrete in layers not exceeding 2 inches. Compact each layer with a vibratory-plate compactor, roller, hand tampers, or mechanical rammers. If the repair crosses or abuts a working joint, saw and seal the joint as soon as possible after placement of the bituminous patch has cooled.

METHOD OF MEASUREMENT

363-4.1 The bituminous repairs will be measured by the **[square foot (square meter)][square yard (square meter)]** of material installed or area repaired.

BASIS OF PAYMENT

363-5.1 Payment for bituminous repairs will be made at the contract unit price bid per **[square foot (square meter)][square yard (square meter)]**. This price will be full compensation for furnishing all materials, for all preparation, delivering, and placing of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item **M-363**-5.1	Bituminous Pavement Repair – per **[square foot (square meter)][square yard (square meter)]**

TESTING REQUIREMENTS

ASTM D 2950	Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods

END ITEM M-363

(GENERIC SPECIFICATION #04)

ITEM P-M-461 HOT-APPLIED CRACK SEALANTS/FILLERS WITH FIBERS FOR FLEXIBLE (HOT-MIX ASPHALT) PAVEMENT OVERLAYS

DESCRIPTION

461-1.1 This work consists of milling, saw cutting, reshaping, cleaning, filling, repairing and reconstructing cracked flexible (Hot-Mix Asphalt) pavements in preparation of overlays, including the application of a stress absorbing membrane over the crack, as required, and installing pavement patches where necessary, in accordance with this specification and where directed by the Engineer. This specification is applicable to cracks wider than 1/4-inch.

a. Classification of Crack Repair. The various types of cracks and repairs are further classified as follows:

(1) Type 1 Crack Repair – Fiber Modified Crack Sealer. Applying the hot pumped asphalt crack filler containing polyester fibers will be as directed by the Engineer. Crack sealing should be flush to existing surface where practicable and any overband material should be as thin as practical and no more than 2 inches wide. An applicator shoe of appropriate size should be used. This method applies to cracks 1/4-inch to 1-inch wide.

(2) Type 2A Crack Repair – Mill and Inlay Repair for Cracks Greater Than 1-inch Wide. For pavements 5 inches or greater in depth, remove pavement by milling to a depth of 3 inches and a width of 24 inches, shape, clean, dry and fill crack with fiber-reinforced crack sealer, install a minimum 12-inch wide (minimum width is dependent on the manufacturer's recommendations) stress absorbing membrane centered over the crack, tack coat, install Hot-Mix Asphalt (HMA) pavement patch, tack coat surface, and overlay as required. The use of a stress absorbing membrane may be eliminated based on the engineer's evaluation of pavement conditions.

(3) Type 2B Crack Repair – Mill and Inlay Repair for Cracks Greater Than 1-inch Wide. For pavements less than 5 inches in depth, remove pavement by milling or saw cutting full-depth and a width of 24 inches. Compact base course, tack coat bottom and sides of trench, install HMA pavement patch, tack coat surface, and overlay as required.

MATERIALS

461-2.1 MEMBRANE. Stress absorbing membrane will conform to the following requirements:

Property	Value	Test Method
Thickness, in	0.135 (minimum)	ASTM D 1777
Strip tensile, lbs/in	60 (minimum)	ASTM D 882 (modified)
Puncture resistance, lbs	215	ASTM E 154
Permanence, Perms	0.01 (maximum)	ASTM E 96, Method B
Pliability – 1/4 inch Mandrel	No cracks in fabric or rubberized asphalt, 32°F (0°C)	ASTM D 146 (modified)

Primer will be compatible with membrane and will be supplied by membrane manufacturer.

****

If the engineer elects not to include a stress absorbing membrane, delete paragraph 461-2.1.

****

461-2.2 HMA PATCHING PAVEMENT. Bituminous pavement will conform to the requirements of the specified HMA for patching material as specified in generic specification Item M-363, Bituminous Pavement Repair for Patching Flexible (Bituminous) Pavements and Temporary Repairs to Rigid (Portland Cement Concrete) Pavements.

461-2.3 HMA PAVEMENT FOR OVERLAYS. The use of FAA Item P-401, Bituminous Surface Course, is recommended for overlay material. **[insert state]** Department of Transportation (DOT) approved HMA mixes may be used on a case by case basis for overlays where conditions warrant.

461-2.4 TACK COAT. Tack coat will conform to the requirements of ASTM D 2397, Type RS-1 or RS-1h. In addition, tack coat will also conform to the requirements of FAA specification P-603, Bituminous Tack Coat, if required.

461-2.5 FIBER REINFORCED ASPHALT CRACK SEALER MATERIAL. Fiber reinforced asphalt crack sealer materials will be short-length polyester fibers having the following properties:

Length	7 mm
Diameter	0.008 inch, plus or minus 0.001 inch
Specific Gravity, ASTM D 792	1.32 to 1.40
Melt Temperature, ASTM D 3418	480°F minimum
Ignition Temperature	1000°F minimum
Tensile Strength, ASTM D 2256	75,000 PSI, plus or minus 5,000 PSI
Break Elongation, ASTM D 2256	33%, plus or minus 9% when they are fully drawn

a. Asphalt Fiber Compound. Asphalt Fiber compound will be mixed at a rate of 6-8% fiber weight to weight of asphalt cement.

b. Asphalt Binder. The asphalt binder will consist of a blend of neat asphalt binder and chemically modified crumb rubber (CMCR) or other approved polymer modifiers that meet the following specifications:

(1) PG 64-XX or PG 70-XX after modification.

(2) Viscosity of not more than 3 PaS at 300°F.

(3) Modification at a minimum will consist of 5% CMCR and the maximum particle size for the CMCR will be 80 mesh (#80 sieve).

(4) The performance grade of the neat asphalt binder will not exceed a PG 58-XX.

(5) The asphalt supplier will provide testing for the neat asphalt binder and modified asphalt binder in accordance with AASHTO M 320.

CONSTRUCTION METHODS

461-3.1 WEATHER LIMITATIONS. No crack repair material will be applied in wet cracks, or where frost, snow or ice is present, or when the ambient temperature is below 40°F (4°C).

461-3.2 TIME LIMITATIONS. The Contractor will schedule his operations so that all crack filling and pavement repair will be performed within the schedules identified by the Engineer.

461-3.3 EQUIPMENT. Equipment used in the performance of the work will be subject to the approval of the Engineer and maintained in satisfactory working condition at all times.

Air compressor will be portable and capable of furnishing not less than 100 cubic feet of air per minute at not less than 90 pounds per square inch pressure at the nozzle. The compressors will be equipped with traps that will maintain the compressed air free of oil and water.

Manually operated, gas powered air-broom or self-propelled vacuum sweeper designed especially for use in cleaning pavements will be used to remove debris, dirt and dust from routed cracks. Hand sweeping and cleanup of debris, dirt, and dust may be used on small areas.

Hand tools consist of brooms, shovels, metal bars with chisel-shaped ends, and any other tools that may be satisfactorily used to accomplish the work.

The melting kettle used to melt the crack sealing compound will be a double boiler, indirect fired type. The space between the inner and outer shells will be filled with a suitable heat transfer oil or substitute having a flash point of not less than 600°F. The kettle will be equipped with a satisfactory means of agitating the crack sealer at all times. This may be accomplished by continuous stirring with mechanically operated paddles and/or by a continuous circulating gear pump attached to the heating unit. The kettle will be equipped with thermostatic control calibrated between 200 and 550°F (93 and 288°C).

Equipment for blowing clean, drying and rejuvenating sidewall of cracks will be a propane torch unit which operates at 3,000°F and gas velocity 3000 feet per second.

461-3.4 TYPE 1 CRACK REPAIR - FIBER MODIFIED CRACK SEALER. All cracks will be blown clean by high pressure air. All loose material and other material will be removed from the cracks and from the pavement surfaces. The cracks will be sterilized by use of propane torch to eliminate all vegetation, moisture and dirt.

No crack sealing material will be applied in wet cracks or where frost snow or ice is present nor when the ambient temperature is below 40°F (4°C).

Joint sealing material will be heated and applied at a temperature specified by the manufacturer and approved by the Engineer. Minimum application temperature will be 320°F.

Sealer will be delivered to the pavement surface through a pressure hose line and applicator shoe, size as specified.

All cracks will be sealed as specified herein, and the sealer will be well bonded to the pavement. A well bonded sealant cannot be readily pulled from the pavement by hand. For Type 1, cracks will be completely filled flush with the surface of the pavement. More than one application of crack sealer may

be necessary to fill cracks to required level. Any overband material will be kept to a minimum thickness of 1/8-inch or less and a minimum 2-inch width. Overbands will be rolled with a steel-wheel 1- or 2-ton roller to set the material while hot. Excess or spilled sealer will be removed from the pavement by approved methods and discarded.

461-3.5 TYPE 2A CRACK REPAIR – MILL AND INLAY REPAIR FOR CRACKS GREATER THAN 1-INCH WIDE. Type 2A crack repair for all cracks greater than 1-inch wide will include removing the existing pavement to a minimum depth of 3 inches and a minimum width of 24 inches, or as directed by the engineer, symmetrical about the centerline of the crack by milling. Prepare and fill crack using sealer and membrane treatment, tack coat bottom and sides of trench, place and compact HMA patch.

All milled pavement material will be legally disposed of offsite. Locations of cracks to be repaired will be located in the field by the Engineer.

A HMA pavement patch will be installed and compacted to a minimum density defined in the State DOT or FAA P-401 specification when tested with a nuclear gauge. The patch will closely match the adjacent pavement grade. The tack coat and HMA patch pavement will be as specified in paragraphs 461-2.4 and 461-2.2. The Engineer may elect not to use a stress absorbing membrane based on evaluation of pavement conditions.

****

If the engineer elects not to use a stress absorbing membrane, revise paragraph 461-3.5 to read:

"461-3.5 TYPE 2A CRACK REPAIR – MILL AND INLAY REPAIR FOR CRACKS GREATER THAN 1-INCH WIDE. Type 2A crack repair for all cracks greater than 1-inch wide will include removing the existing pavement to a minimum depth of 3 inches and a minimum width of 24 inches, or as directed by the engineer, symmetrical about the centerline of the crack by milling. Prepare and fill crack using sealer treatment, tack coat bottom and sides of trench, place and compact HMA patch.

All milled pavement material will be legally disposed of offsite. Locations of cracks to be repaired will be located in the field by the Engineer.

A HMA pavement patch will be installed and compacted to a minimum density defined in the State DOT or FAA P-401 specification when tested with a nuclear gauge. The patch will closely match the adjacent pavement grade. The tack coat and HMA patch pavement will be as specified in paragraphs 461-2.4 and 461-2.2."

****

461-3.6 TYPE 2B CRACK REPAIR – MILL AND INLAY REPAIR FOR CRACKS GREATER THAN 1-INCH WIDE. Type 2B crack repair for all cracks greater than 1-inch wide will include removing the existing pavement by milling or saw cutting full-depth and a minimum width of 24 inches, symmetrical about the centerline of the crack. Compact base course, tack coat bottom and sides of trench, install HMA pavement patch, tack coat surface, and overlay as required.

All milled or removed pavement material will be legally disposed of offsite. Locations of cracks to be repaired will be located in the field by the Engineer.

A HMA pavement patch will be installed and compacted to a minimum density defined in the State DOT or FAA P-401 specification when tested with a nuclear gauge. The patch will closely match the adjacent pavement grade. The tack coat and HMA patch pavement will be as specified in paragraphs 461-2.4 and 461-2.2. The Engineer may elect not to use a stress absorbing membrane based on evaluation of pavement conditions.

461-3.7 STRESS ABSORBING MEMBRANE. Membrane will be installed after crack filling or as specified herein. The pavement surface will be thoroughly cleaned and dried and will be prepared in accordance with the manufacturer's instructions prior to placement of the membrane.

The membrane will be installed in minimum widths of 12 inches and a maximum of 20 inches and will be centered over the crack within a two-inch tolerance.

The membrane will be installed straight and wrinkle-free with no curled or uplifted edges. Any wrinkles over 3/8 inches in width will be slit and folded down. Manufacturer's requirements for tacking or self-bonding of the membrane will be strictly followed. After the membrane has been placed, it will be pressed against the asphalt surface by means of a hand roller or other suitable equipment to insure proper bonding. Special attention should be given to insure that the edges and corners of the strips are bonded securely to the surface. Any strips with loose edges or corners should be re-bonded or replaced prior to placement of the HMA patch at the expense of the Contractor.

All membrane will be surface dry before placement of the HMA patch.

****

If the engineer elects to include a stress absorbing membrane, revise paragraph 461-3.7 to read:

"461-3.7 STRESS ABSORBING MEMBRANE. Not used."

****

461-3.8 MILLING. Milling as required will conform to industry standards.

461-3.9 CERTIFICATION. Manufacturer's certificates of all materials used will be required for the following materials:

a. Stress absorbing membrane

b. HMA pavement (aggregate, asphalt, etc)

c. Tack coat

d. Fiber reinforced crack sealer (asphalt fiber compound, asphalt binder, etc)

METHOD OF MEASUREMENT

461-4.1 CRACK REPAIR – TYPES 1, 2A AND 2B. The quantities of crack repair for Types 1, 2A, and 2B to be paid for will be the number of linear feet (meters) of crack repair, of the type specified, measured in place, completed and accepted by the Engineer.

461-4.2 STRESS ABSORBING MEMBRANE, INSTALLED. The quantity of stress absorbing membrane to be paid for will be the number of linear feet (meters) of membrane, installed in prepared Type 2A or Type 2B crack repair areas, measured in place, completed and accepted by the Engineer.

BASIS OF PAYMENT

461-5.1 CRACK REPAIR – TYPE 1. Payment for "Crack Repair, Type 1" will be made at the contract unit price per linear foot (meter). This price will be full compensation for cleaning, and filling the prepared crack with hot pumped applied asphalt with polyester fibers; rolling the overband, and for furnishing all materials, labor, equipment, tools, supplies and incidentals necessary to complete the work.

461-5.2 CRACK REPAIR – TYPE 2A. Payment for "Crack Repair, Type 2A" will be made at the contract unit price per linear foot (meter). This price will be full compensation for pavement milling, preparation and filling of crack, installing, tack coat, and HMA pavement patch as specified herein for pavements to be overlaid; and for furnishing all materials, labor, equipment, tools, supplies and incidentals necessary to complete the work.

461-5.3 CRACK REPAIR - TYPE 2B. Payment for "Crack Repair, Type 2B" will be made at the contract unit price per linear foot (meter). This price will be full compensation for pavement milling or saw cutting, compaction of base course, tack coat, and HMA pavement patch as specified herein for pavements to be overlaid; and for furnishing all materials, labor, equipment, tools, supplies and incidentals necessary to complete the work.

461-5.4 STRESS ABSORBING MEMBRANE, INSTALLED. Payment for "Stress Absorbing Membrane, Installed" will be made at the contract unit price per linear foot (meter). This price will be full compensation for the stress absorbing membrane, installed in prepared Type 2A or Type 2B crack repair areas, as specified herein; and for furnishing all materials, labor, equipment, tools, supplies and incidentals necessary to complete the work.

****

If the engineer elects not to include a stress absorbing membrane, delete paragraph 461-5.4.

****

Payment will be made under:

Item M-461-5.1	Crack Repair, Type 1 – per linear foot (meter)
Item M-461-5.2	Crack Repair, Type 2A – per linear foot (meter)
Item M-461-5.3	Crack Repair, Type 2B – per linear foot (meter)
Item M-461-5.4	Stress Absorbing Membrane, Installed – per linear foot (meter)

****

If the engineer decides not to include a stress absorbing membrane, delete pay item M-461-5.4.

****

TESTING REQUIREMENTS

ASTM D 146	Standard Test Methods for Sampling and Testing Bitumen-Saturated Felts and Woven Fabrics for Roofing and Waterproofing
ASTM D 792	Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D 882	Standard Test Method for Tensile Properties of Thin Plastic Sheeting
ASTM D 1777	Standard Test Method for Thickness of Textile Materials
ASTM D 2256	Standard Test Method for Tensile Properties of Yarns by the Single-Strand Method
ASTM D 3418	Standard Test Method for Transition Temperatures and Enthalpies of Fusion and Crystallization of Polymers by Differential Scanning Calorimetry
ASTM E 96, Method B	Standard Test Methods for Water Vapor Transmission of Materials
ASTM E 154	Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover

MATERIAL REQUIREMENTS

ASTM D 2397	Standard Specification for Cationic Emulsified Asphalt

END OF ITEM M-461

(GENERIC SPECIFICATION #05)

ITEM M-462 COLD-APPLIED JOINT AND CRACK SEALANTS FOR FLEXIBLE (BITUMINOUS) PAVEMENTS

DESCRIPTION

462-1.1 This item consists of providing and installing a resilient and adhesive **[joint][crack]** sealant, cold-applied, capable of effectively sealing **[joints][cracks]** in flexible (hot-mix asphalt) pavements up to 1 inch in width. This item includes the removal of existing, loose, or damaged sealant material where applicable, preparation of the **[joints][cracks]**, and the complete installation of the sealant material.

MATERIALS

462-2.1 The sealant selection will be made based on local climate conditions. The sealant material will be a cold-applied sealant conforming to the requirements of ASTM D 977, ASTM D 7226, ASTM D 2939, and ASTM D 244. The sealant material will also meet the performance characteristics of ASTM D 6690 (or AASHTO M 324), as listed in Table 1 for the classification type specified below:

a. *Type I* – A joint and crack sealant capable of maintaining an effective seal in moderate climates. The material is tested for low temperature performance at -18°C (-64.4°F) using 50% extension.

b. *Type II* – A joint and crack sealant capable of maintaining an effective seal in most climates. The material is tested for low temperature performance at -29°C (-84.2°F) using 50% extension.

c. *Type III* – A joint and crack sealant capable of maintaining an effective seal in most climates. The material is tested for low temperature performance at -29°C (-84.2°F) using 50% extension. Special tests are included.

****

The Engineer will select the materials to be used for the sealant and delete the paragraphs from 462-2.1a to 462-2.1.c that do not apply.

****

Table 1. Sealant Requirements per Classification Type

	*
Cone Penetration at 25°C (77°F), per ASTM D 5329	90 max
Bond, non-immersed, per ASTM D 5329	*
Bond, water immersed, per ASTM D 5329	*
Resilience, %, per ASTM D 5329	*
Oven Aged Resilience, %, per ASTM D 5329	*
Asphalt Compatibility, per ASTM D 5329	Pass[B]

[A] The development of at any time during the test procedure of a crack, separation, or other opening over 6mm (0.24 in) deep, in the sealant or between the sealant and the concrete block will constitute failure of the test specimen. The depth of crack, separation or other opening will be measured perpendicular to the side of the sealant showing the defect.

[B] There will be no failure in adhesion, formation of an oily exudate at the interface between the sealant and asphaltic concrete of other deleterious effects on the asphaltic concrete or sealant when tested at 60°C (140°F).

****

The Engineer will specify the applicable sealant requirements. Asterisks denote insertion points.

Table 1. Sealant Requirements per Classification Type

	Type I	**Type II**	**Type III**
Cone Penetration at 25°C (77°F) per ASTM D 5329	**90 max**	**90 max**	**90 max**
Bond, non-immersed per ASTM D 5329	**Two out of three 25.4mm specimens pass [A] 5 cycles at 50% ext at -18°C (-64.4°F)**	**Three 12.7mm specimens pass [A] 3 cycles at 50% ext at -29°C (-84.2°F)**	**Three 12.7mm specimens pass [A] 3 cycles at 50% ext at -29°C (-84.2°F)**
Bond, water immersed per ASTM D 5329	**--**	**--**	**Three 12.7mm specimens pass [A] 3 cycles at 50% ext at -29°C (-84.2°F)**
Resilience, % per ASTM D 5329	**--**	**60 min**	**60 min**
Oven Aged Resilience, % per ASTM D 5329	**--**	**--**	**60 min**
Asphalt Compatibility per ASTM D 5329	**Pass [B]**	**Pass [B]**	**Pass [B]**

[A] The development of at any time during the test procedure of a crack, separation, or other opening over 6mm (0.24 in) deep, in the sealant or between the sealant and the concrete block will constitute failure of the test specimen. The depth of crack, separation or other opening will be measured perpendicular to the side of the sealant showing the defect.

[B] There will be no failure in adhesion, formation of an oily exudate at the interface between the sealant and asphaltic concrete of other deleterious effects on the asphaltic concrete or sealant when tested at 60°C (140°F).

****

462-2.2 Backer Rod. The backer rod will be compatible with the sealant. The backer rod will be non-reactive and non-adhesive with the pavement or the sealant. The backer rod will conform to the requirements of ASTM D 5249. The backer rod diameter will be 25 percent larger than the nominal width of the **[joint][crack]**.

CONSTRUCTION METHODS

462-3.1 Time of Application. [Joints][Cracks] will be sealed as soon after completion of the pavement preparation as feasible and before the pavement is opened to traffic, including construction equipment. The pavement temperature must be above 40°F (4°C) at the time of installation of the cold-applied **[joint][crack]** sealing material.

462-3.2 Preparation of Joints in Flexible Pavements

a. Removal of Existing Joint Sealant. All existing joint sealants will be removed by routing. Routed joints should be 3/4-inch wide by 3/4-inch in depth. Any remaining sealant / debris will be removed by use of a hot lance and compressed air free of oil and water. In some instances, re-sawing the joints may be required. This is only recommended in areas where the existing joint faces cannot be thoroughly cleaned to satisfactorily promote the effectiveness and adherence of the new sealant. If re-sawing the existing joints is required, immediately after sawing, the joint faces will be cleaned by use of a hot lance and compressed air free of oil and water. Should wet cut sawing equipment be used, the joint will be allowed sufficient time to dry prior to sealing.

b. Sealing. Immediately before sealing, the joints will be thoroughly cleaned of all remaining laitance and other foreign material. Cleaning will be accomplished by use of a hot lance. Upon completion of cleaning, the joints will be blown out with compressed air free of oil and water. Only air compressors with operable oil and water traps will be used to prepare the joints for sealing. The joint faces will be allowed to cool to the ambient temperature and will be surface dry when the seal is applied. Backer rod material may be installed in the joint opening prior to sealing to control depth and sealant usage.

462-3.3 Preparation of Cracks in Flexible Pavements

a. Routing. All cracks will be cleaned of any debris or laitance by use of a hot lance and compressed air free of oil and water. In some instances, routing the cracks may be required. If routing of the cracks is required, a 3/4-inch wide by 3/4-inch in depth bit will be used to create the sealant reservoir. Immediately after routing, the resulting debris will be completely removed from the crack and adjacent area by use of a hot lance and compressed air free of oil and water, and by use of other tools as necessary. Should wet cut sawing equipment be used, the crack will be allowed sufficient time to dry prior to sealing.

b. Sealing. Immediately before sealing, the cracks will be thoroughly cleaned of all remaining dust and debris. Cleaning will be accomplished by use of a hot lance. Upon completion of cleaning, the cracks will be blown out with compressed air free of oil and water. Only air compressors with operable oil and water traps will be used to prepare the cracks for sealing. The joint faces will be allowed to cool to the ambient temperature and will be surface dry when the seal is applied. Backer rod material may be installed in the crack opening prior to sealing to control depth and sealant usage.

462-3.4 INSTALLATION OF SEALANTS. [Joints][Cracks] will be inspected for preparation and will be approved by the Engineer before sealing is allowed. Sealants will be installed in accordance with the manufacturer's requirements. The installation of sealants in prepared **[joints][cracks]** will be flush with the existing pavement surface. Excess material will be removed by squeegee or other approved methods.

METHOD OF MEASUREMENT

462-4.1 The sealant material will be measured by the **[gallon (liter)][pound (kg)][linear foot (meter)][lump sum]** of sealant in place, completed, and accepted.

BASIS OF PAYMENT

462-5.1 Payment for sealing material will be made at the contract unit price bid per **[gallon (liter)][pound (kg)][linear foot (meter)][lump sum]**. This price will be full compensation for furnishing all materials, for all preparation, delivering, and placing of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item **M-462**-5.1	**[Joint][Crack]** Sealant – per **[gallon (liter)][pound (kg)][linear foot (meter)][lump sum]**

TESTING REQUIREMENTS

ASTM D 244	Standard Test Methods and Practices for Emulsified Asphalts
ASTM D 2939	Standard Test Methods for Emulsified Bitumens Used as Protective Coatings
ASTM D 7226	Standard Test Method for Determining the Viscosity of Emulsified Asphalts Using a Rotational Paddle Viscometer

MATERIAL REQUIREMENTS

ASTM D 977	Standard Specification for Emulsified Asphalt
ASTM D 5249	Standard Specification for Backer Material for Use with Cold- and Hot-Applied Joint Sealants in Portland Cement Concrete and Asphalt Joints
ASTM D 6690	Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements

END ITEM M-462

(GENERIC SPECIFICATION #06)

ITEM M-564 REPAIR OF PAVEMENT DISTRESSES IN RIGID (PORTLAND CEMENT CONCRETE) PAVEMENTS

DESCRIPTION

564-1.1 This item consists of repairing pavement distresses (e.g., cracks, spalls, corner breaks, etc.) in rigid (Portland Cement Concrete) pavements, as well as patching of small areas (less than 5 square feet) of PCC pavements. This work consists of: saw cutting, chipping, and removing the existing unsound PCC pavement; cleaning and preparing the area for the repair materials. This work also includes placing, vibrating, and finishing the repair material to reconstruct the PCC pavements, in accordance with this specification.

MATERIALS

564-2.1 The repair method and material will be of the type specified below for the appropriate application, as outlined in Table 1 – Repair Material Usage Matrix.

Table 1. Repair Material Usage Matrix

PAVEMENT DISTRESS	**TYPE 1** (Conventional)	**TYPE 2A** (Pre-packaged w/ Aggregate)	**TYPE 2B** (Pre-packaged w/o Aggregate)	**TYPE 3** (Rapid Setting, Early Strength)
CORNER BREAKS	Permanent	Permanent	n/a	Permanent
DURABILITY "D" CRACKING	Permanent	Temporary/ Emergency	Temporary/ Emergency	Temporary/ Emergency
SCALING, MAP CRACKING AND CRAZING	Permanent	n/a	n/a	n/a
JOINT SPALLING	n/a	Permanent	Permanent	Permanent
CORNER SPALLING	n/a	Permanent	Permanent	Permanent
PATCHING, SMALL (less than 5 square feet)	n/a	Permanent	Permanent	Permanent
PATCHING, LARGE AND UTILITY CUTS	Permanent	n/a	n/a	Temporary/ Emergency
SHATTERED SLAB / INTERSECTING CRACKS	Permanent	n/a	n/a	n/a
BLOWUPS	Permanent	n/a	n/a	n/a

a. Type 1 – Conventional Concrete Mixture. The conventional concrete mixture will conform to FAA specification P-501 for materials. This repair method is considered a permanent, long term repair as it is typically used for large repair areas requiring 3 cubic yards or more of mix supplied by a local concrete mixing plant.

b. Type 2A – Pre-packaged Cementitious Mixture with Aggregate. The pre-packaged, one-component, cementitious mixture will have a minimum compressive strength of 5,000 psi in 7 days when tested in accordance with ASTM C 39. Bond strength will be 2,000 psi in 7 days when tested in accordance with ASTM C 882. The aggregate will conform to the requirements of ASTM C 33. This repair method may be used for either permanent or temporary/emergency repairs dependent on the distress type, as noted in Table 1. Preparation of materials (mixing with potable water, blending, etc) will be per manufacturer's requirements for the product.

c. Type 2B – Pre-packaged Cementitious Mixture without Aggregate. The pre-packaged, one-component, cementitious mixture will have a minimum compressive strength of 5,000 psi in 7 days when tested in accordance with ASTM C 39. Bond strength will be 2,000 psi in 7 days when tested in accordance with ASTM C 882. If the repair size requires the addition of coarse aggregate, the aggregate to be added maximum size will be 3/8-inch and will conform to the requirements of ASTM C 33. The aggregate will be blended into the pre-packaged mixture per the manufacturer's requirements. This repair method may be used for either permanent or temporary/emergency repairs dependent on the distress type, as noted in Table 1. Preparation of materials (mixing with potable water, blending, etc) will be per manufacturer's requirements for the product.

d. Type 3 – Rapid Setting and Early Strength Gaining Cementitious Mixture. The rapid setting and early strength gaining cementitious mixture will have a minimum compressive strength of 2,000 psi in 2 hours and 5,000 psi in 1 day when tested in accordance with ASTM C 109. Bond strength will be 2,000 psi in 7 days when tested in accordance with ASTM C 882. This repair method may be used for either permanent or temporary/emergency repairs dependent on the distress type, as noted in Table 1. Preparation of materials (mixing with potable water, blending, etc) will be per manufacturer's requirements for the product.

564-2.2 Nonabsorbent Board. The nonabsorbent board will be used as a joint form for the joint reservoir to be protected. The nonabsorbent board will be a standard 1/2-inch asphalt impregnated fiber-board. For joint widths greater than 1/2-inch, the width of the nonabsorbent board will be adjusted to fit the larger joint width.

564-2.3 Curing Compound. The curing compound will be a white pigmented impervious membrane conforming to the requirements of ASTM C 309. The curing compound will be of such character that the film will harden within 30 minutes after application.

CONSTRUCTION METHODS

564-3.1 Time of Application. The ambient temperature and concrete surface temperature will be within the range specified by the manufacturer's requirements for that product at the time of application.

564-3.2 Repair of Distresses in PCC Pavements.

a. Corner Breaks / Shattered Slabs / Blowups. These are considered structural failures and require full-depth repairs. The procedures for repairing these types of distresses are as follows:

(1) Make full-depth saw cuts at constructed joints. The FAA recommends that full-depth cuts be made at a distance of at least 2 feet beyond the limits of the break. Make the saw cuts so the repair area is rectangular. For corner cracks, cut the repair area square.

(2) Use appropriate-sized impact equipment (e.g., jackhammer) to remove material within the limits of the saw cuts. When using a hoe-ram or removing the concrete by lifting, make a second saw

cut inside the perimeter cuts to provide expansion. Remove by hand any loose materials that remain. During the repair, try to minimize any disturbance to the subgrade soils or base materials.

(3) Restore subgrade or subbase materials to the base elevation of the panel being repaired.

(4) Use tie-bars consisting of #4 deformed bars (#5 bars for pavements more than 12 inches thick) in the faces of the parent panel. Install by drilling into the face and using an epoxy bonding agent. Use equidistant spacing of the bars, but do not install them more than 24 inches apart. When spacing bars, do not allow their ends to overlap with those of other tie-bars or dowels.

(5) Use 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. Dowels are installed by drilling and epoxying. Dowel bars will spaced at least one bar spacing away from faces parallel to the dowel bar. Space dowel bar ends at least one bar spacing apart at corners of intersecting joints. Oil exposed dowel bar ends prior to backfilling with concrete.

(6) Install nonabsorbent board within the limits of the joint seal reservoirs along the adjacent concrete panels. When repairing multiple panels, restore the joint seal reservoirs with the nonabsorbent filler board.

(7) Fill the repair area with concrete, being sure to consolidate the concrete along the limits of repair. Exercise caution when working adjacent to existing concrete faces, particularly during consolidation, and watch for segregation of the concrete. Finish the surface to match existing surface when practical.

(8) After the concrete cures, remove the nonabsorbent board by sawing. Reinstall joint seal material per specification M-361 or M-362.

b. Durability "D" Cracking. This type of distress usually requires repairing the complete slab since "D" cracking will normally reappear adjacent to the repaired areas. Temporary/emergency repairs can be made using the technique noted in paragraph 564-3.2.a (Corner Breaks/Shattered Slabs/Blowups). Another temporary/emergency repair, which is not a preferred method but is a rapid repair, is the partial depth repair by milling 2-3 inches in depth by 3-4 feet in length and width and filling the patch area with a high quality HMA.

c. Scaling, Map Cracking, and Crazing. If the distress is severe and produces FOD, the repair method is to remove and replace the area. Permanent repairs can be made using the technique noted in paragraph 564-3.2.a (Corner Breaks/Shattered Slabs/Blowups).

d. Joint Spalling and Corner Spalling. The procedure for the repair of spalls is as follows:

(1) Make a vertical cut with a concrete saw 2 inches in depth and approximately 2 inches outside of the spalled area. Saw cuts will be straight lines forming rectangular areas.

(2) Remove all unsound concrete until sound, intact material has been reached (into at least 1/2-inch of visually sound concrete). Break out the unsound concrete with air hammers or pneumatic drills and blow out the area with oil-free compressed air.

(3) Clean the area to be repaired with high-pressure water. Allow patch area to dry completely if required by the patch material specification.

(4) Treat the surface (all sides and bottom, except any joint face) with a neat cement grout mixture to ensure a good bond between the existing and new concrete. It is important to maintain the joint through the full depth of the spall repair and prevent a bond between the patch and the adjacent slab, thereby eliminating point-to-point loading. Apply the grout immediately before placing the patch mixture and spread with a stiff-bristle broom or brush to a depth of 1/16 inches. The use of liquid bonding agents will be acceptable if recommended by the manufacturer's requirements.

(5) Place the nonabsorbent board in the joint groove and vibrate or tamp the new mixture into the old surface.

(6) After edging the patch, finish it to a texture matching the adjacent area. After a proper cure period, remove the nonabsorbent board by sawing. Reinstall joint seal material per specification M-361 or M-362.

(7) When there are adjacent spall repair areas within a slab, the minimum distance between repair areas is 1-1/2 feet. Therefore, when repairs areas are less than 1-1/2 feet apart, combine the repair areas into one repair. Similarly, when the repair areas are greater than 1-1/2 feet apart, maintain separate repair areas.

e. Patching, Small (less than 5 square feet). Patching repairs can be made using the technique noted in paragraph 564-3.2.d (Joint Spalling and Corner Spalling). For full-depth repairs, follow technique noted in paragraph 564-3.2.f (Patching, Large or Utility Cut).

f. Patching, Large or Utility Cut. The procedure for patching a large or utility cut areas of PCC pavement is as follows:

(1) Make a full-depth vertical cut with a concrete saw at the limits of the area to be patched (approximately 6 inches outside of each end of the broken area).

(2) Break out the concrete with pneumatic tools, and remove concrete down to the subbase/subgrade material.

(3) Add subbase material, if necessary, and compact.

(4) In reinforced pavement construction, use joint techniques to tie the new concrete to the old reinforced material. Dowel any replacement joints, and build them to joint specifications. Follow procedures in paragraph 564-3.2.a(4) or 564-3.2a.(5) as appropriate.

(5) Dampen the subgrade and the edges of existing PCC pavement. Place conventional concrete on the area to be patched. Finish the concrete so the surface texture approximates that of the existing pavement.

(6) Immediately after completing finishing operations, properly cure the surface with curing compound.

(7) After a proper cure period, fill the open joints with joint sealant per specification M-361 or M-362.

****

Delete the paragraphs from 564-3.2a to 564-3.2f that do not apply.

****

METHOD OF MEASUREMENT

564-4.1 The repair will be measured by the **[cubic yard (cubic meter)]** for large areas and by the **[square foot (square meter)]** for small areas for the material in place, completed, and accepted.

BASIS OF PAYMENT

564-5.1 Payment for repairs will be made at the contract unit price bid per **[cubic yard (cubic meter)][square foot (square meter)]**. This price will be full compensation for furnishing all materials, for all preparation, delivering, and placing of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item M-564-5.1	Type 1 – per **[cubic yard (cubic meter)][square foot (square meter)]**
Item M-564-5.2	Type 2A – per **[square foot (square meter)]**
Item M-564-5.3	Type 2B – per **[square foot (square meter)]**
Item M-564-5.4	Type 3 – per **[cubic yard (cubic meter)][square foot (square meter)]**

TESTING REQUIREMENTS

ASTM C 39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C 109	Standard Test Method for Compressive Strength of Hydraulic Cement Mortars(Using 2-in. or [50-mm] Cube Specimens)
ASTM C 882	Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear

MATERIAL REQUIREMENTS

ASTM C 33	Standard Specification for Concrete Aggregates
ASTM C 309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete

END ITEM M-564

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APPENDIX C. GENERIC TYPICAL DETAILS

This appendix provides guidance in the installation of materials and repair procedures through generic typical details. The generic typical details include such items as: repair of cracks, corner breaks, joint spalls, corner spalls, and blowups in rigid pavement; patching in rigid pavement; temporary patching of rigid pavement with flexible pavement; and repair of cracks in flexible pavement.

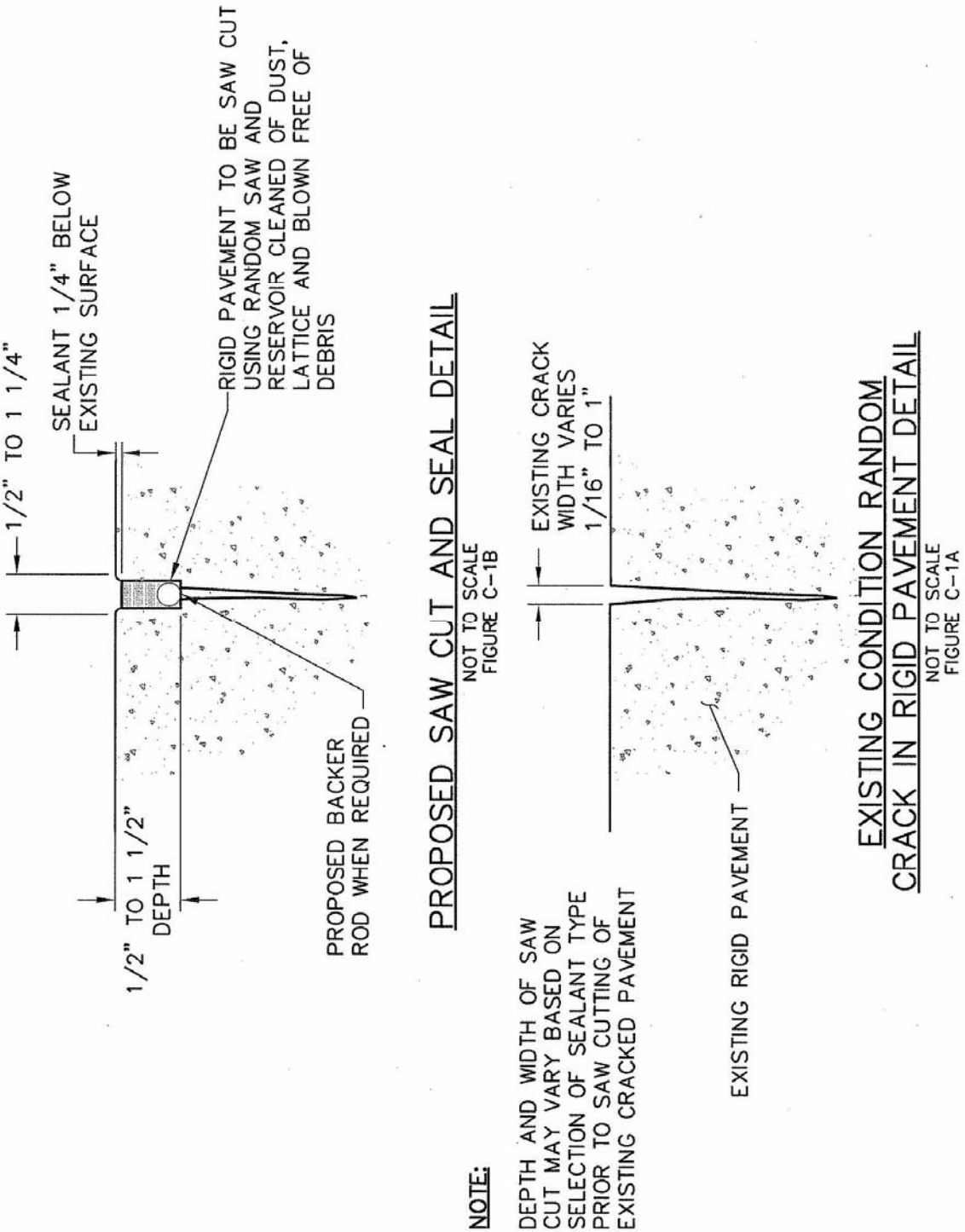
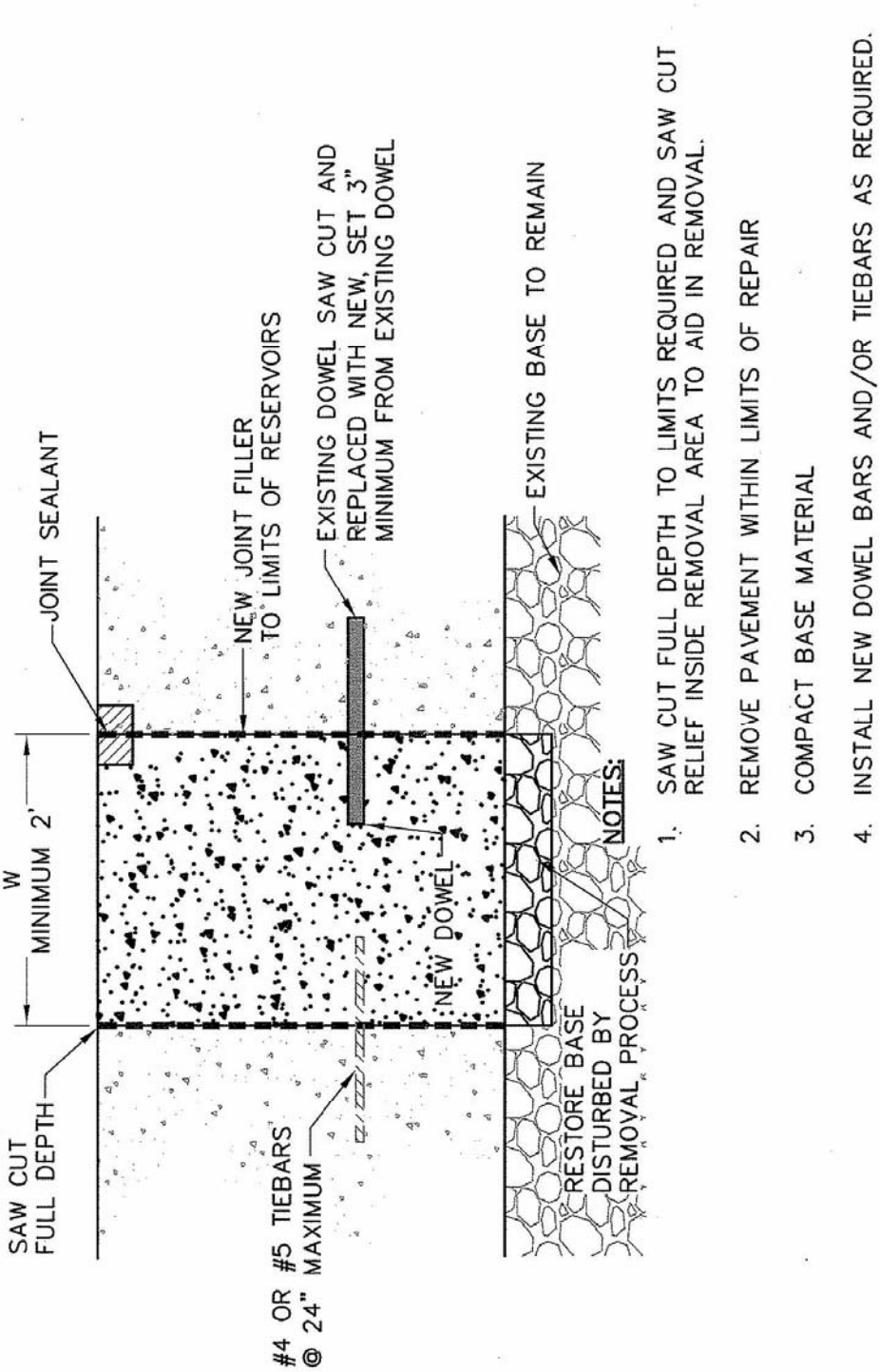


Figure C - 1.A. Existing Condition Random Crack in Rigid Pavement Detail
Figure C - 1.B. Proposed Saw Cut and Seal Detail



NOTES:

1. SAW CUT FULL DEPTH TO LIMITS REQUIRED AND SAW CUT RELIEF INSIDE REMOVAL AREA TO AID IN REMOVAL.
2. REMOVE PAVEMENT WITHIN LIMITS OF REPAIR
3. COMPACT BASE MATERIAL
4. INSTALL NEW DOWEL BARS AND/OR TIEBARS AS REQUIRED.
5. PLACE REPAIR MATERIAL AND FINISH SURFACE
6. AFTER CURING SAW ALL JOINTS AND SEAL

CORNER BREAK REPAIR DETAIL – SECTION

NOT TO SCALE
FIGURE C–2

Figure C - 2. Corner Break Repair Detail - Section

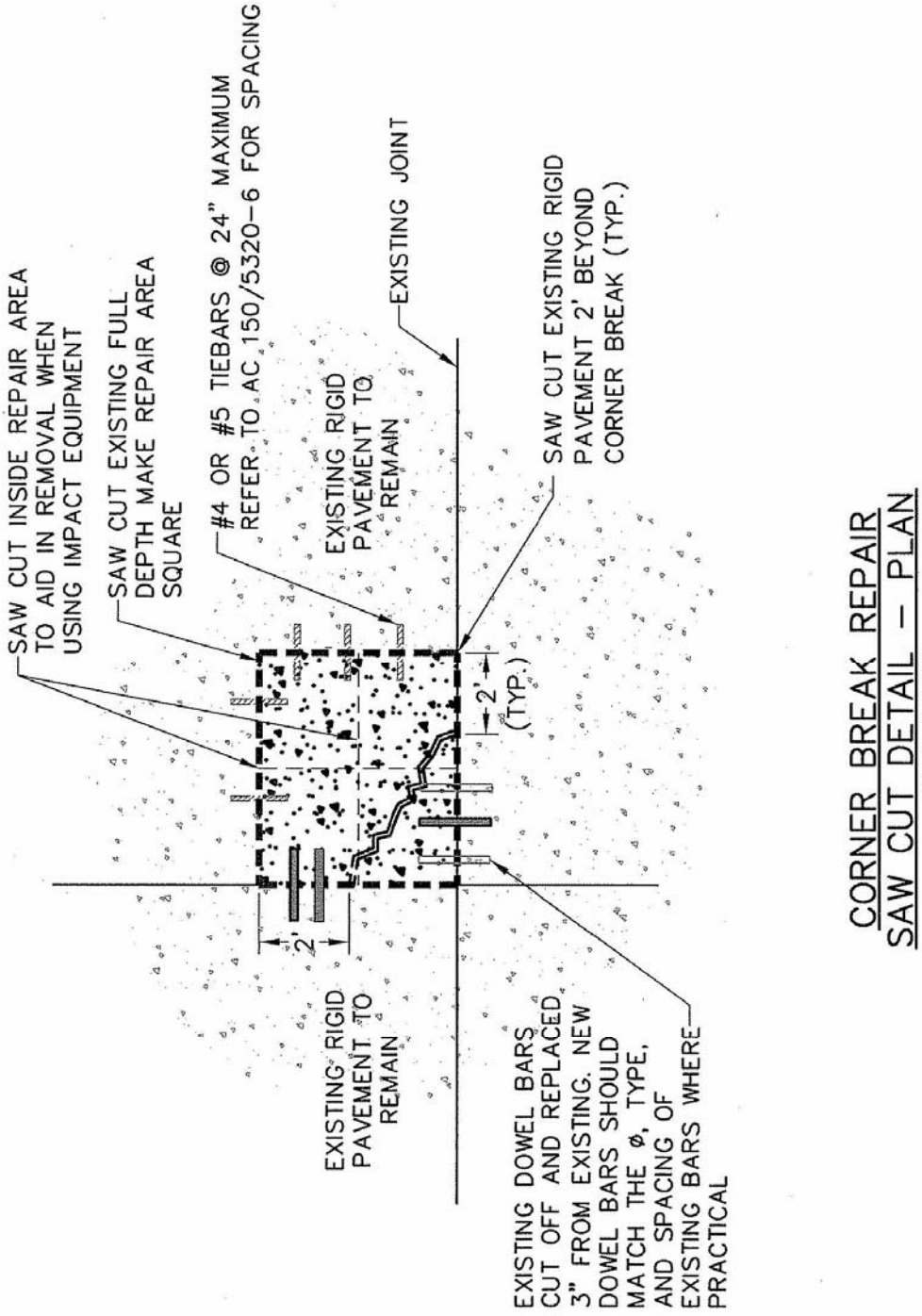


Figure C - 3. Corner Break Repair Saw Cut Detail - Plan

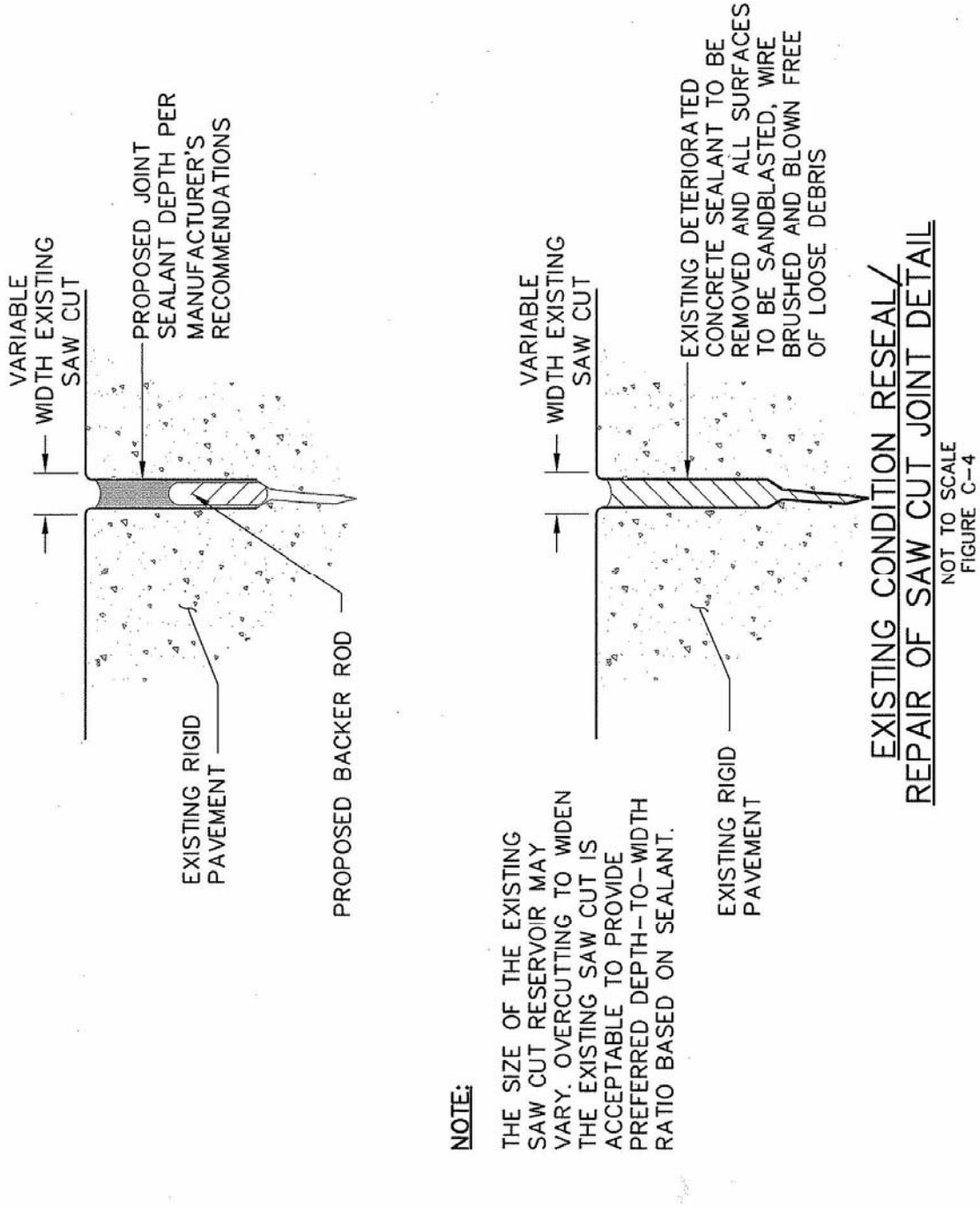


Figure C - 4. Existing Condition Reseal/ Repair of Saw Cut Joint Detail

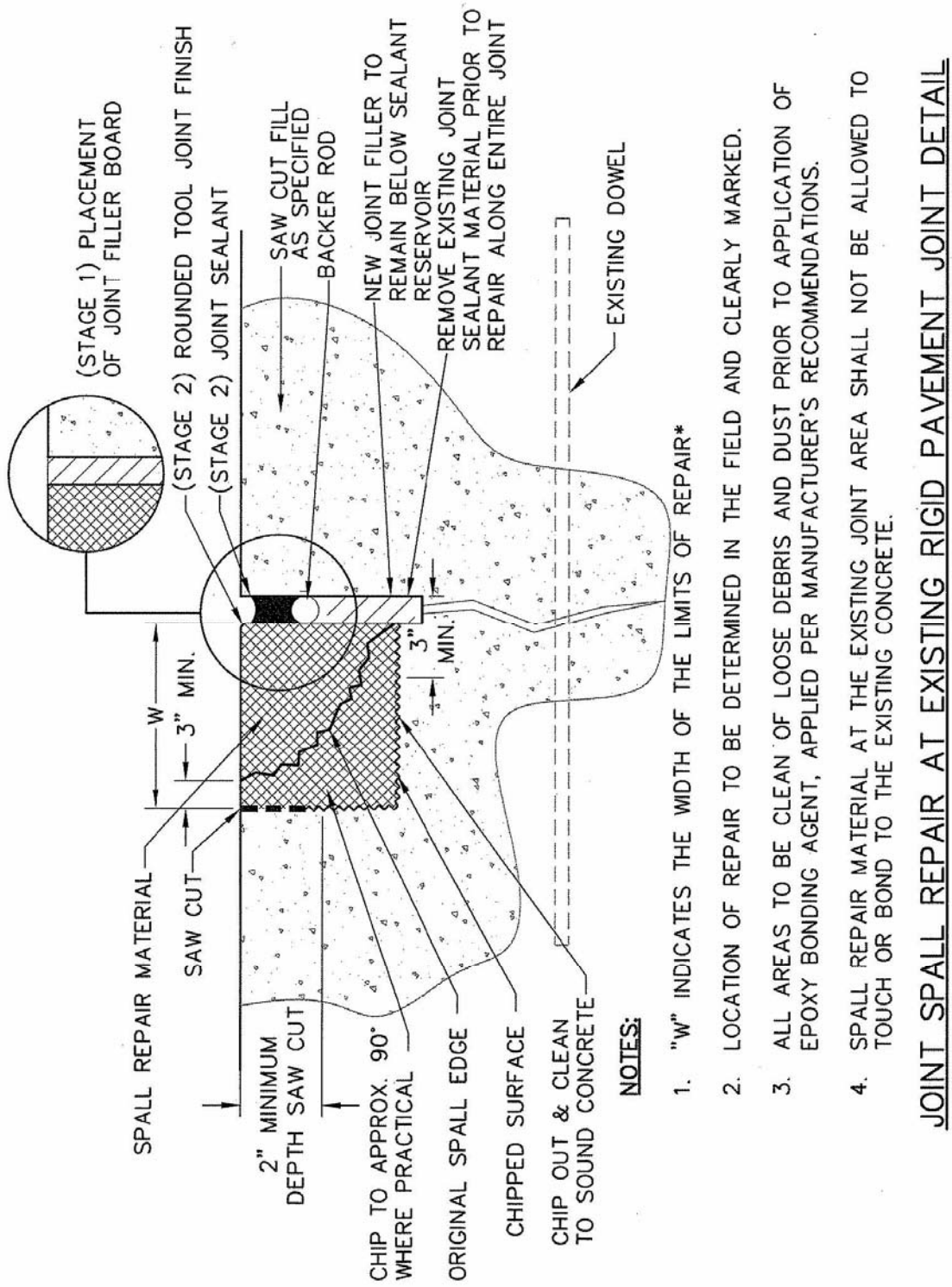
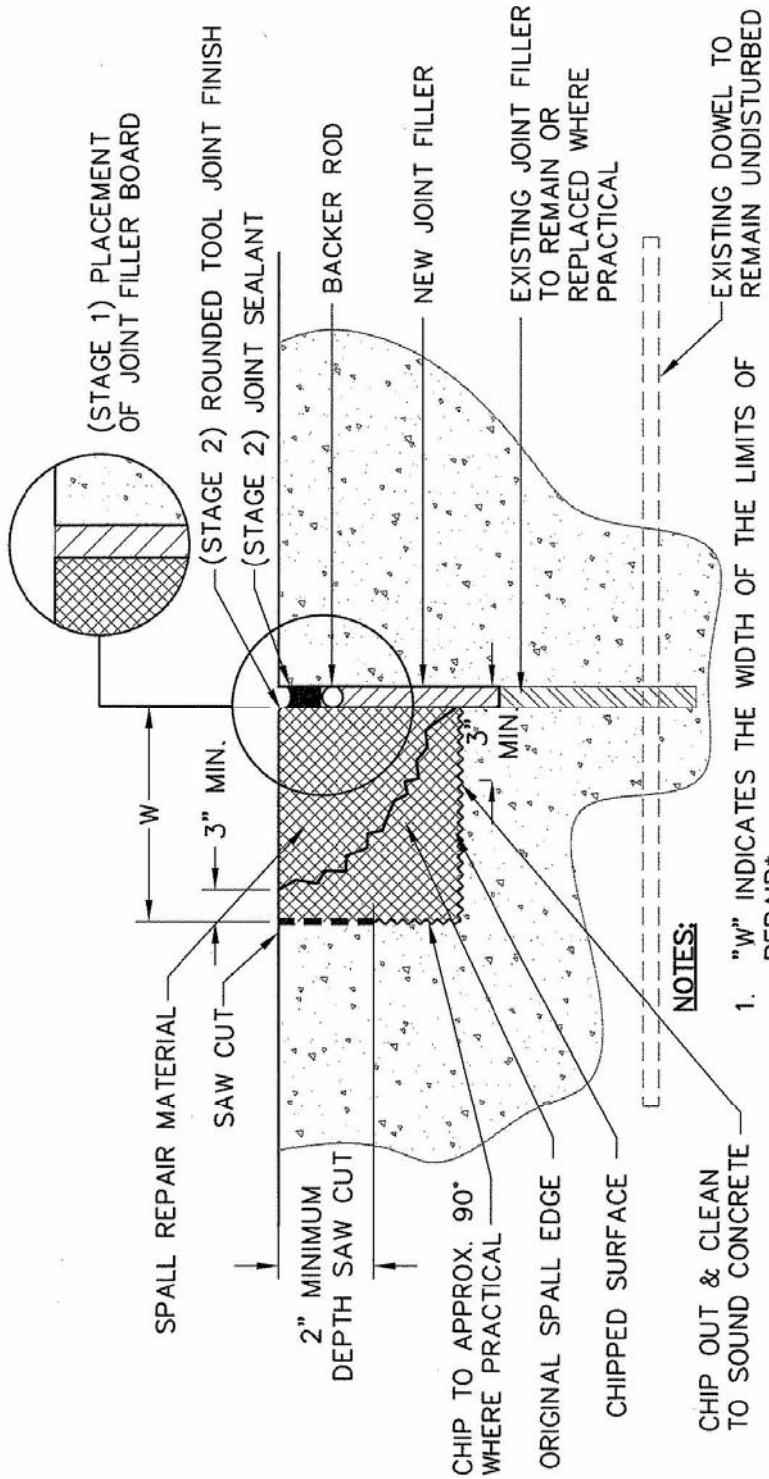


Figure C - 5. Joint Spall Repair at Existing Rigid Pavement Joint Detail



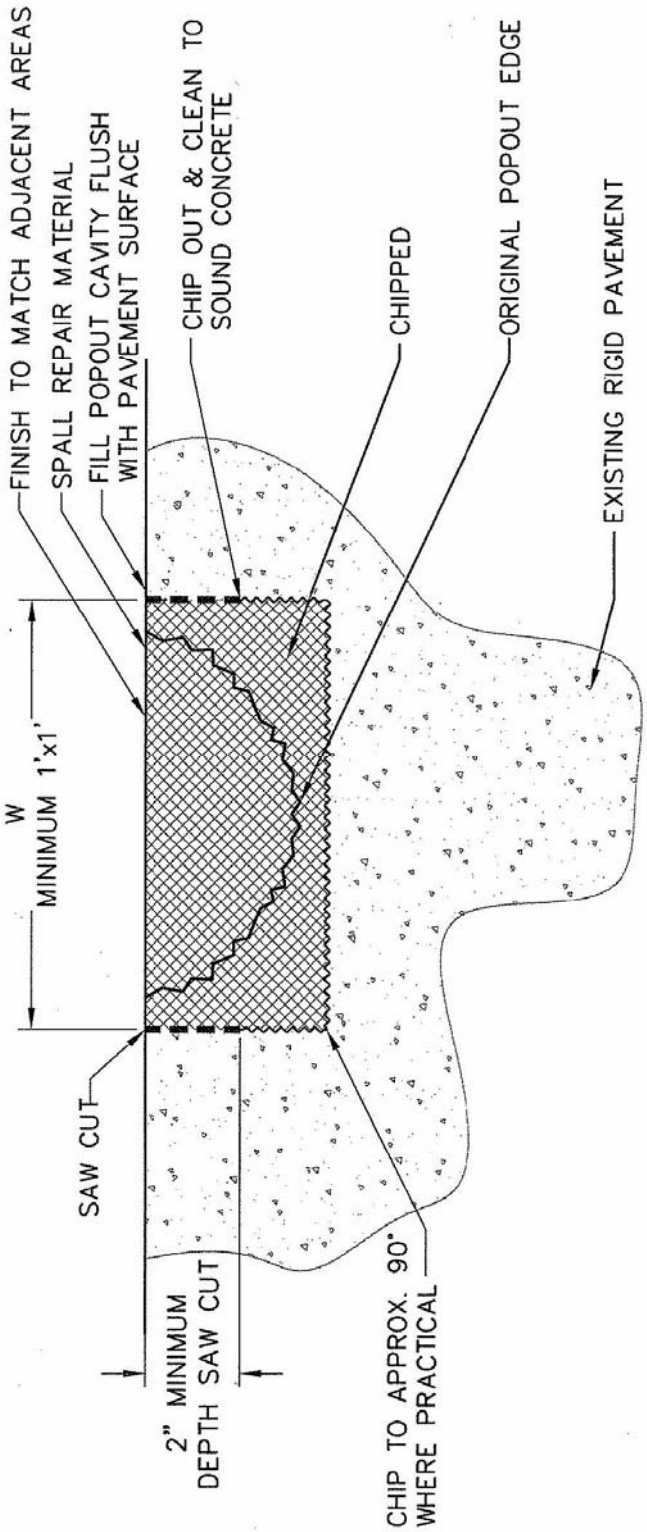
NOTES:

1. "W" INDICATES THE WIDTH OF THE LIMITS OF REPAIR*
2. LOCATION OF REPAIR TO BE DETERMINED IN THE FIELD AND CLEARLY MARKED.
3. ALL AREAS TO BE CLEAN OF LOOSE DEBRIS AND DUST PRIOR TO APPLICATION OF EPOXY BONDING AGENT, APPLIED PER MANUFACTURER'S RECOMMENDATIONS.

SPALL REPAIR AT EXISTING RIGID PAVEMENT ISOLATION JOINT DETAIL

NOT TO SCALE
FIGURE C-6

Figure C - 6. Spall Repair at Existing Rigid Pavement Isolation Joint Detail



NOTES:

1. "W" INDICATES THE WIDTH OF THE LIMITS OF REPAIR*
2. LOCATION OF REPAIR TO BE DETERMINED IN THE FIELD BY THE ENGINEER.
3. ALL AREAS TO BE CLEAN OF LOOSE DEBRIS AND DUST PRIOR TO APPLICATION OF EPOXY BONDING AGENT, APPLIED PER MANUFACTURER'S RECOMMENDATIONS.

TYPICAL POPOUT SPALL REPAIR DETAIL

NOT TO SCALE
FIGURE C-7

Figure C - 7. Typical Popout Spall Repair Detail

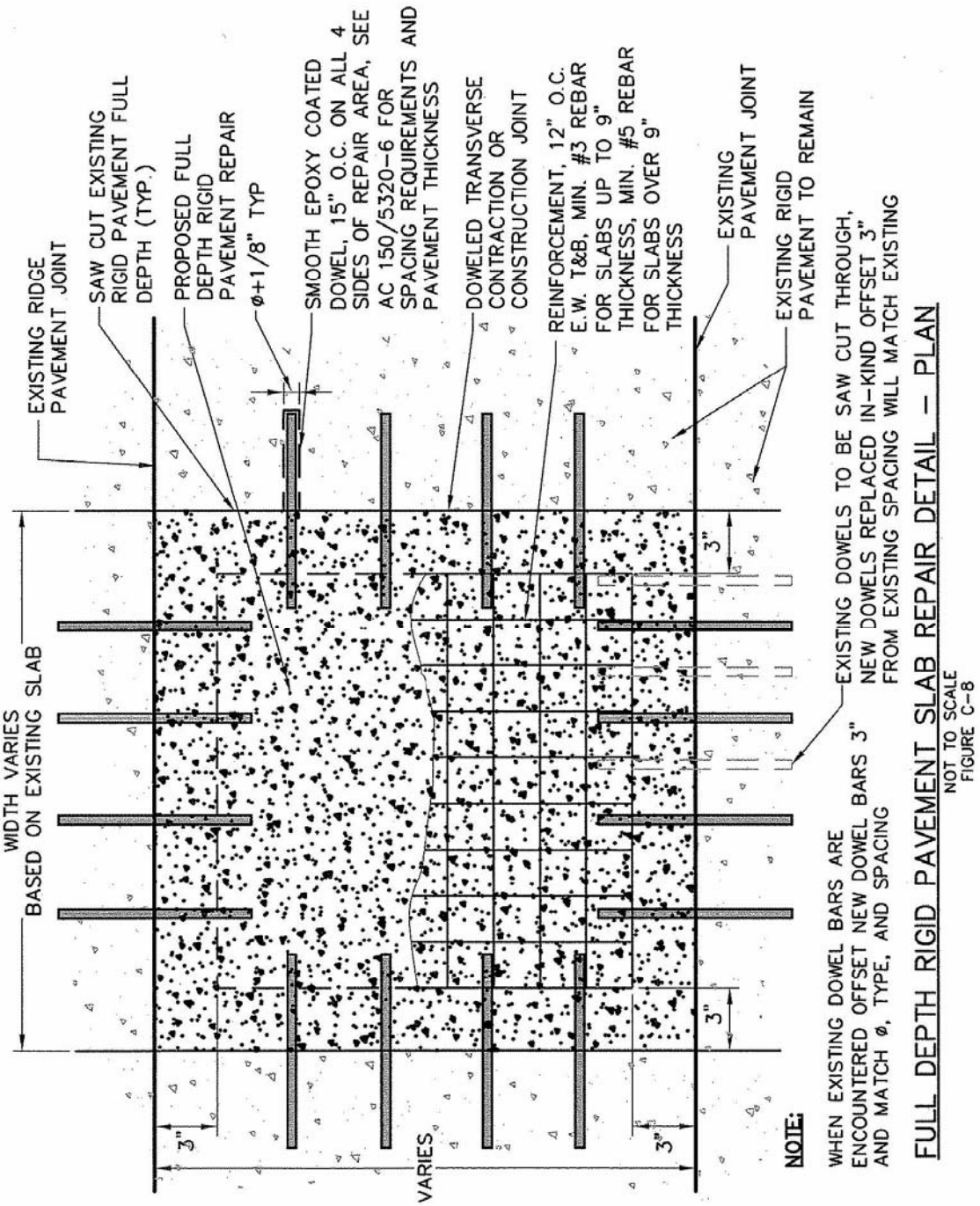


Figure C - 8. Full Depth Rigid Pavement Slab Repair Detail - Plan

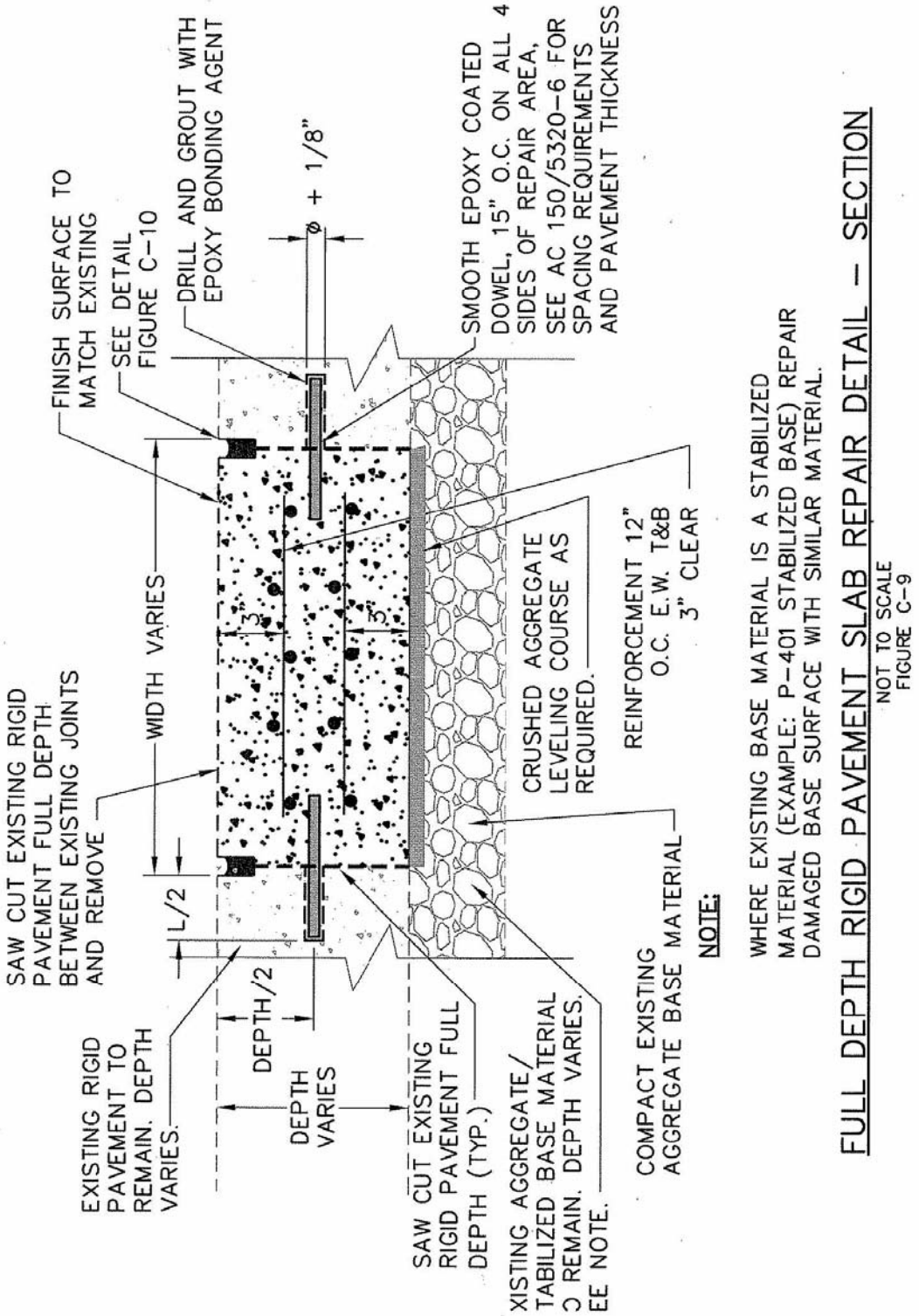
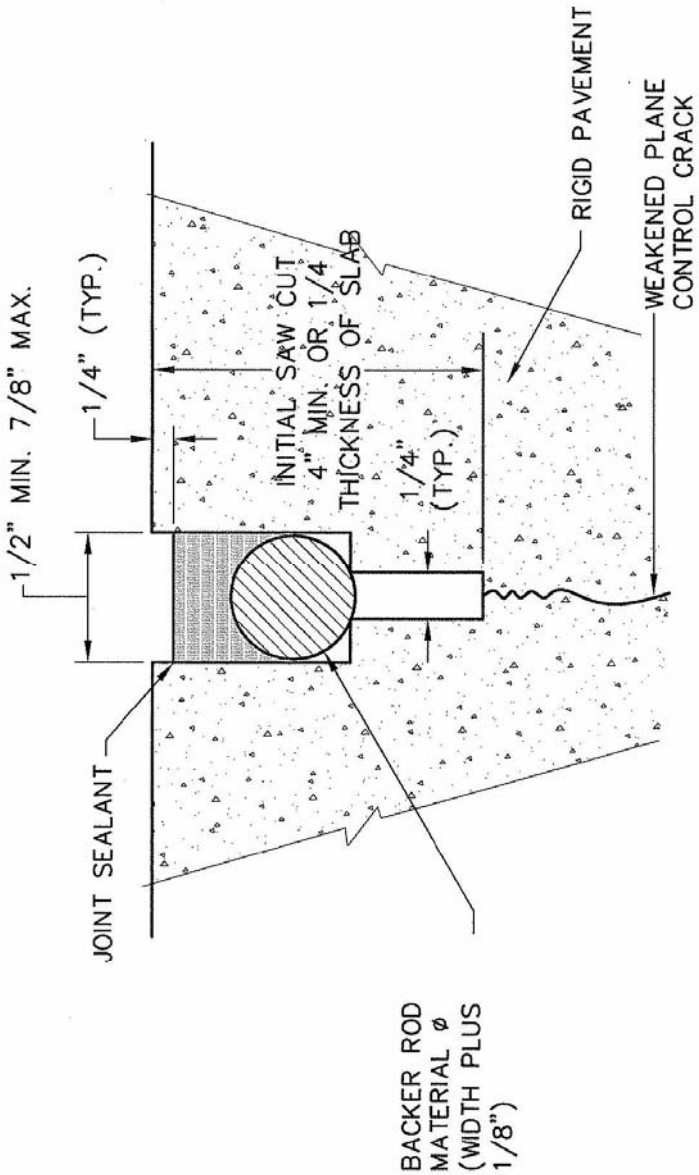


Figure C - 9. Full Depth Rigid Pavement Slab Repair Detail - Section



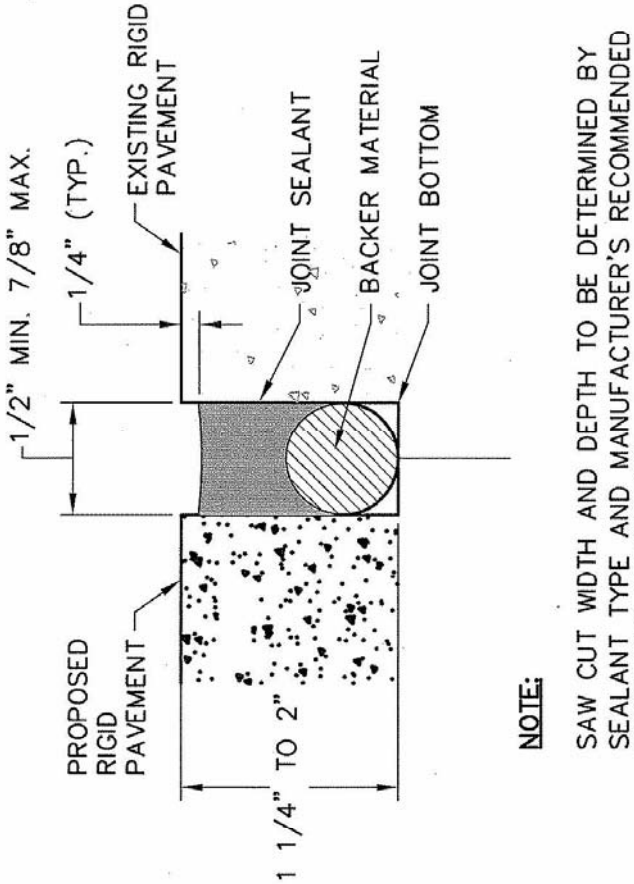
NOTES:

1. INITIAL SAW CUT OF NEW CONCRETE SLAB CONTRACTION JOINT SHOULD BE MADE AS SOON AS PRACTICAL BASED ON MATERIAL SET TIME.
2. SAW CUT WIDTH AND DEPTH TO BE DETERMINED BY SEALANT TYPE AND MANUFACTURER'S RECOMMENDED RESERVOIR DIMENSIONS.

SAW CUT CONTRACTION JOINT DETAIL

NOT TO SCALE
FIGURE C-10

Figure C - 10. Saw Cut Contraction Joint Detail



NOTE:

SAW CUT WIDTH AND DEPTH TO BE DETERMINED BY SEALANT TYPE AND MANUFACTURER'S RECOMMENDED RESERVOIR DIMENSIONS

SAW CUT DETAIL
RIGID PAVEMENT/RIGID PAVEMENT INTERFACE LARGE SLAB(S) REPAIRS
NOT TO SCALE
FIGURE C-11

Figure C - 11. Saw Cut Detail Rigid Pavement/Rigid Pavement Interface Large Slab(s) Repairs

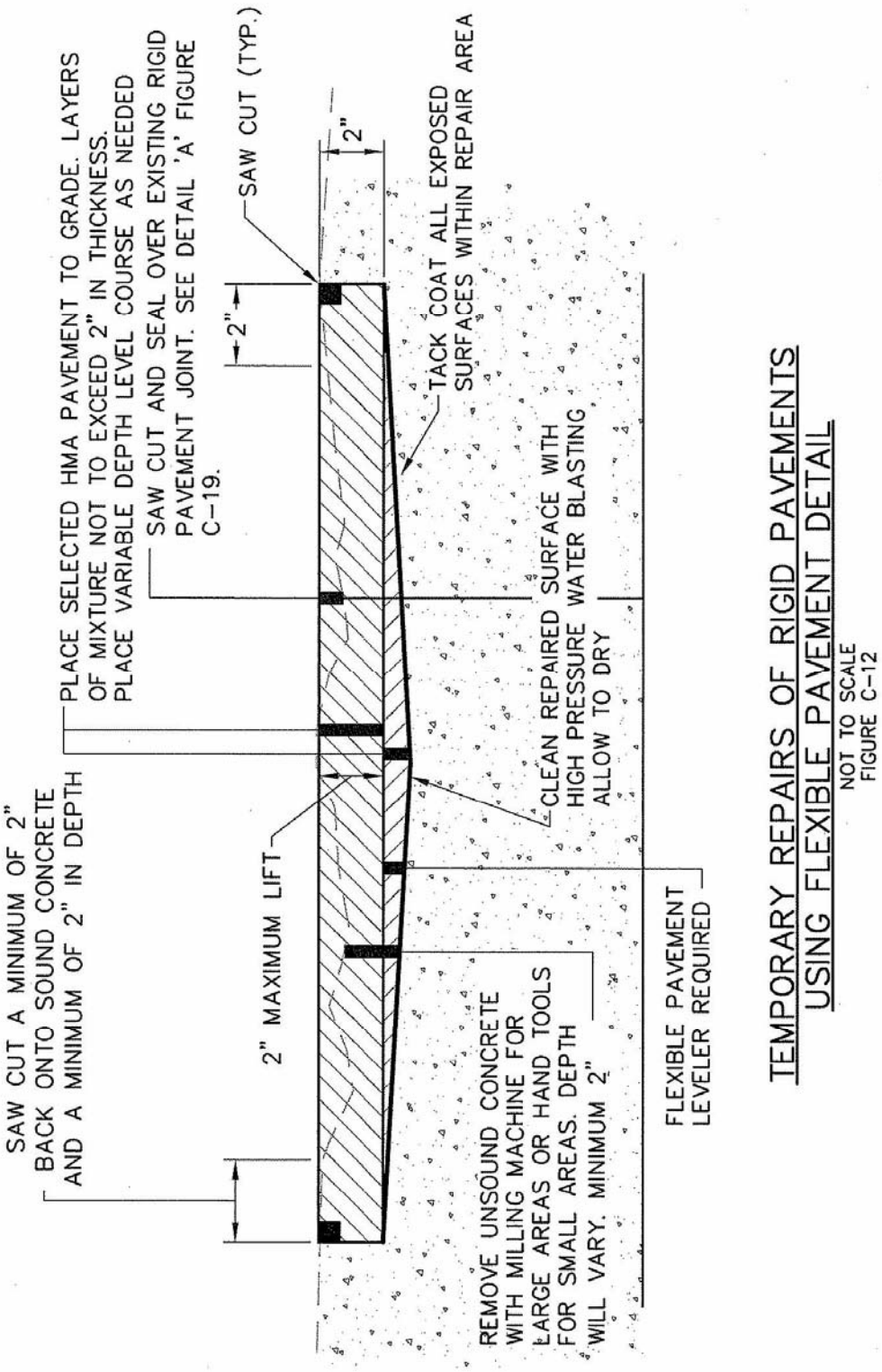


Figure C - 12. Temporary Repairs of Rigid Pavements Using Flexible Pavement Detail

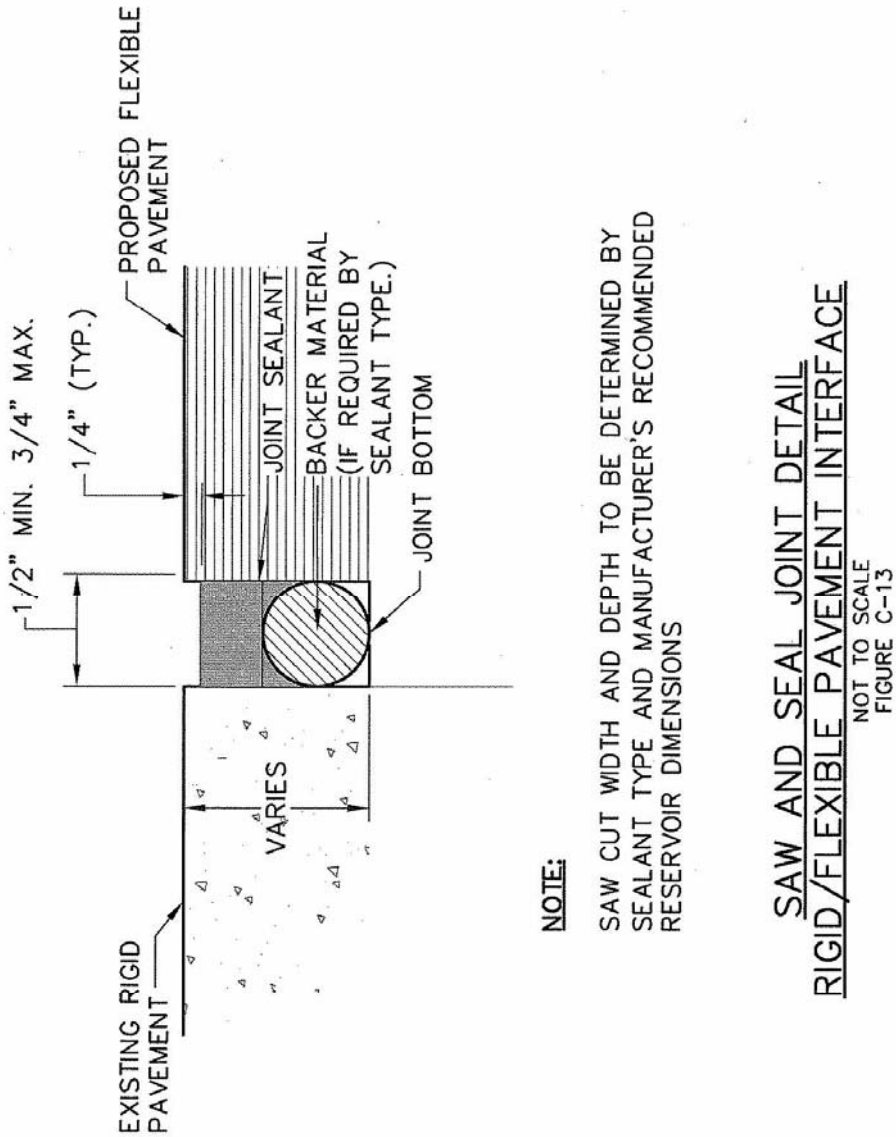


Figure C - 13. Saw and Seal Joint Detail Rigid/Flexible Pavement Interface

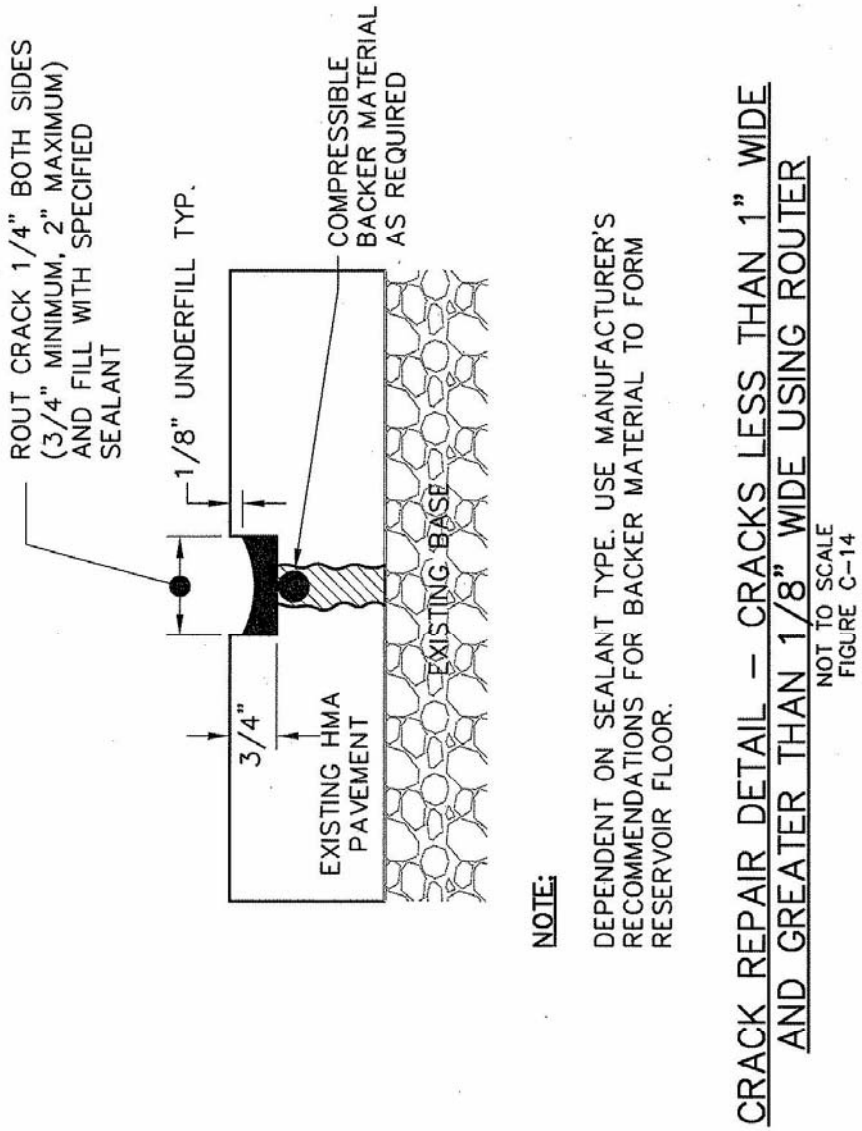


Figure C - 14. Crack Repair Detail – Cracks Less Than 1" Wide and Greater Than 1/8" Wide Using Router

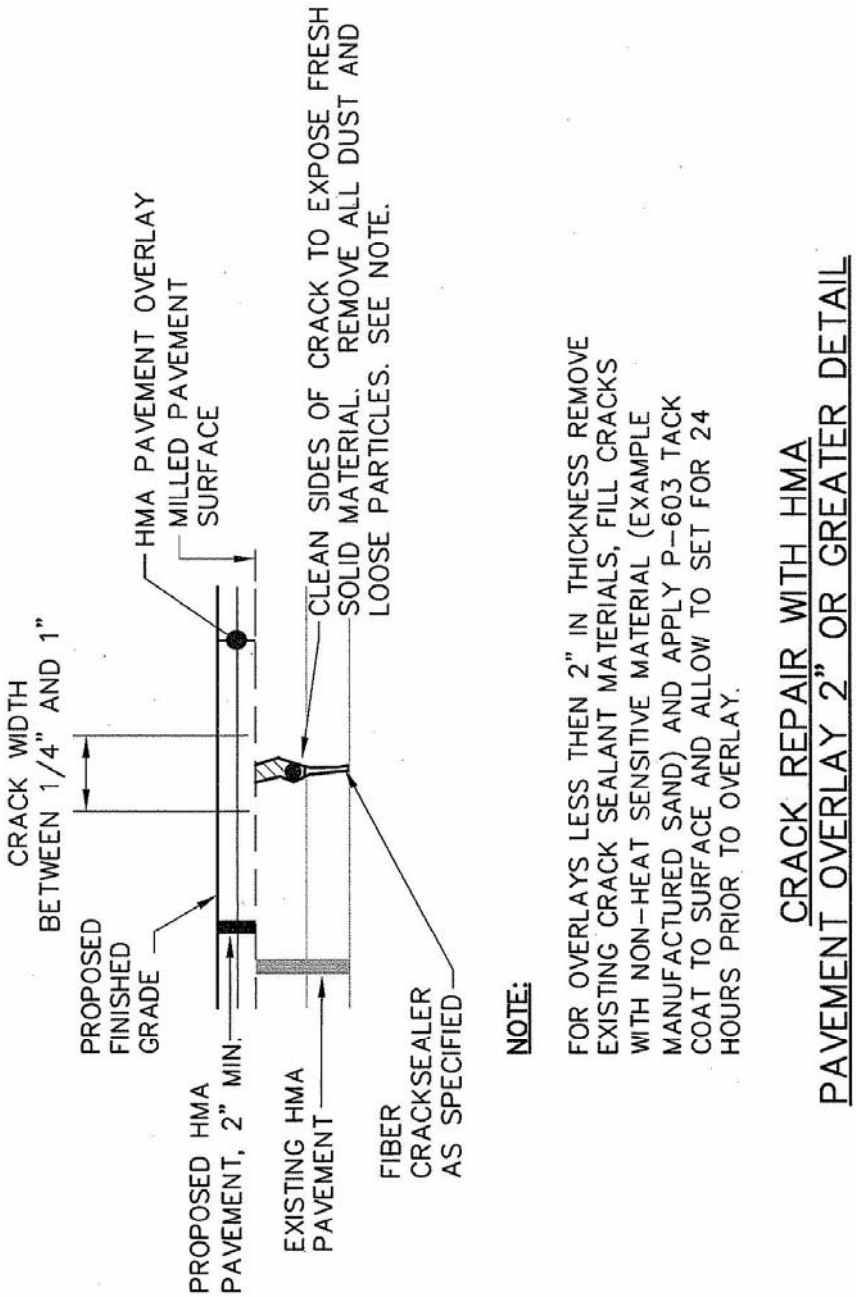


Figure C - 15. Crack Repair With HMA Pavement Overlay 2" or Greater Detail

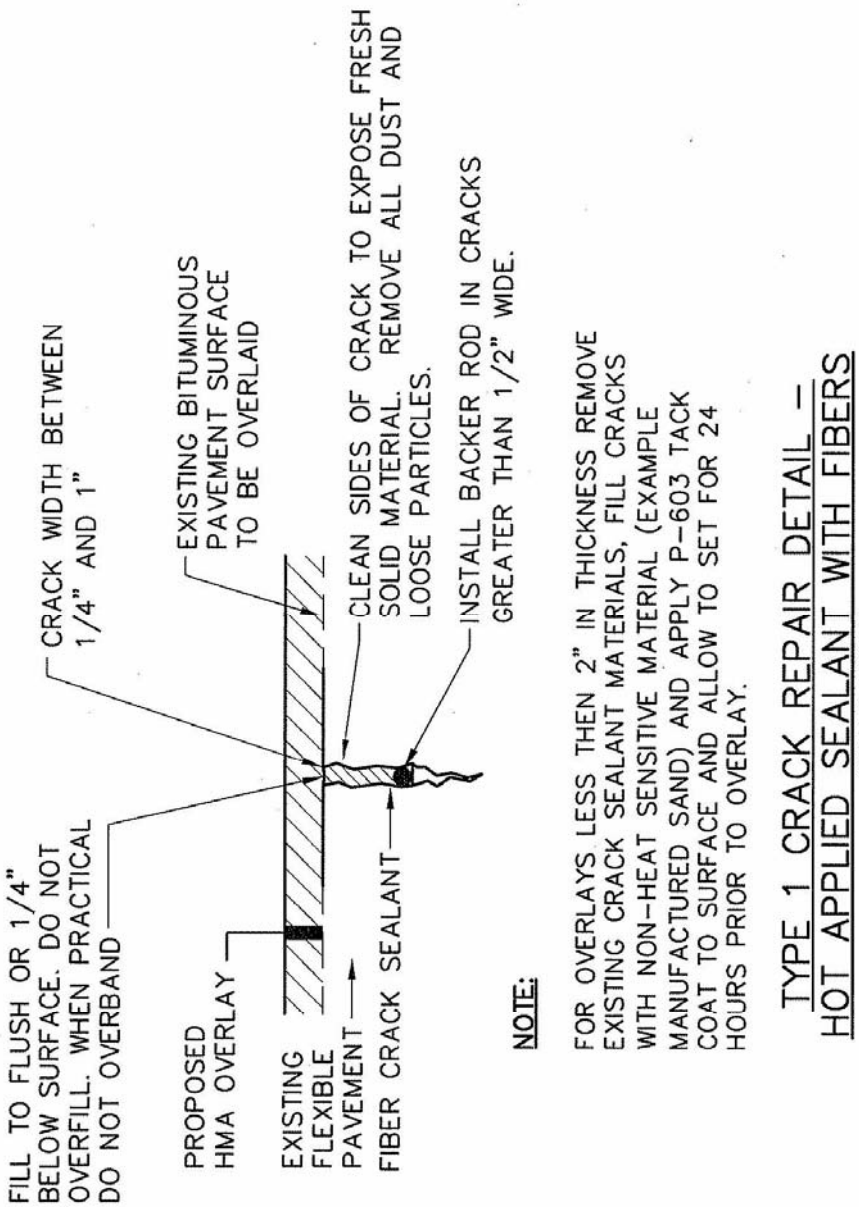
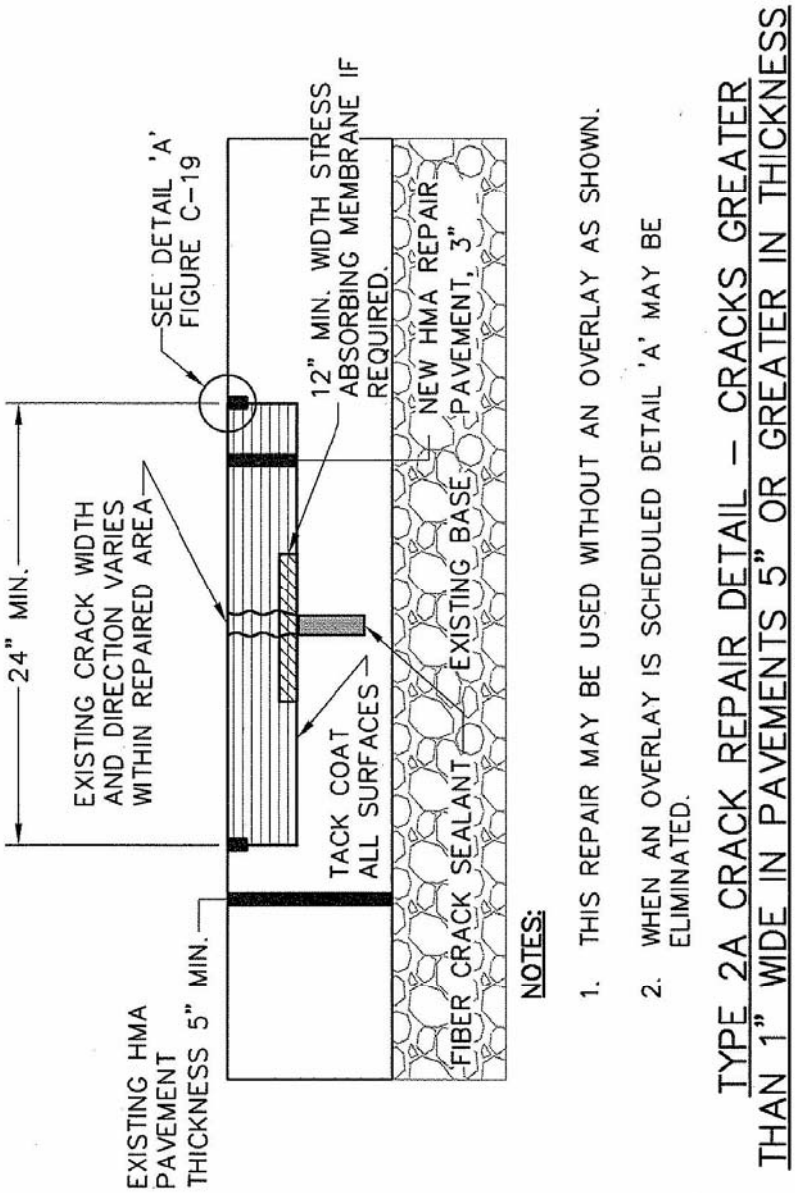


Figure C - 16. Type 1 Crack Repair Detail – Hot Applied Sealant With Fibers



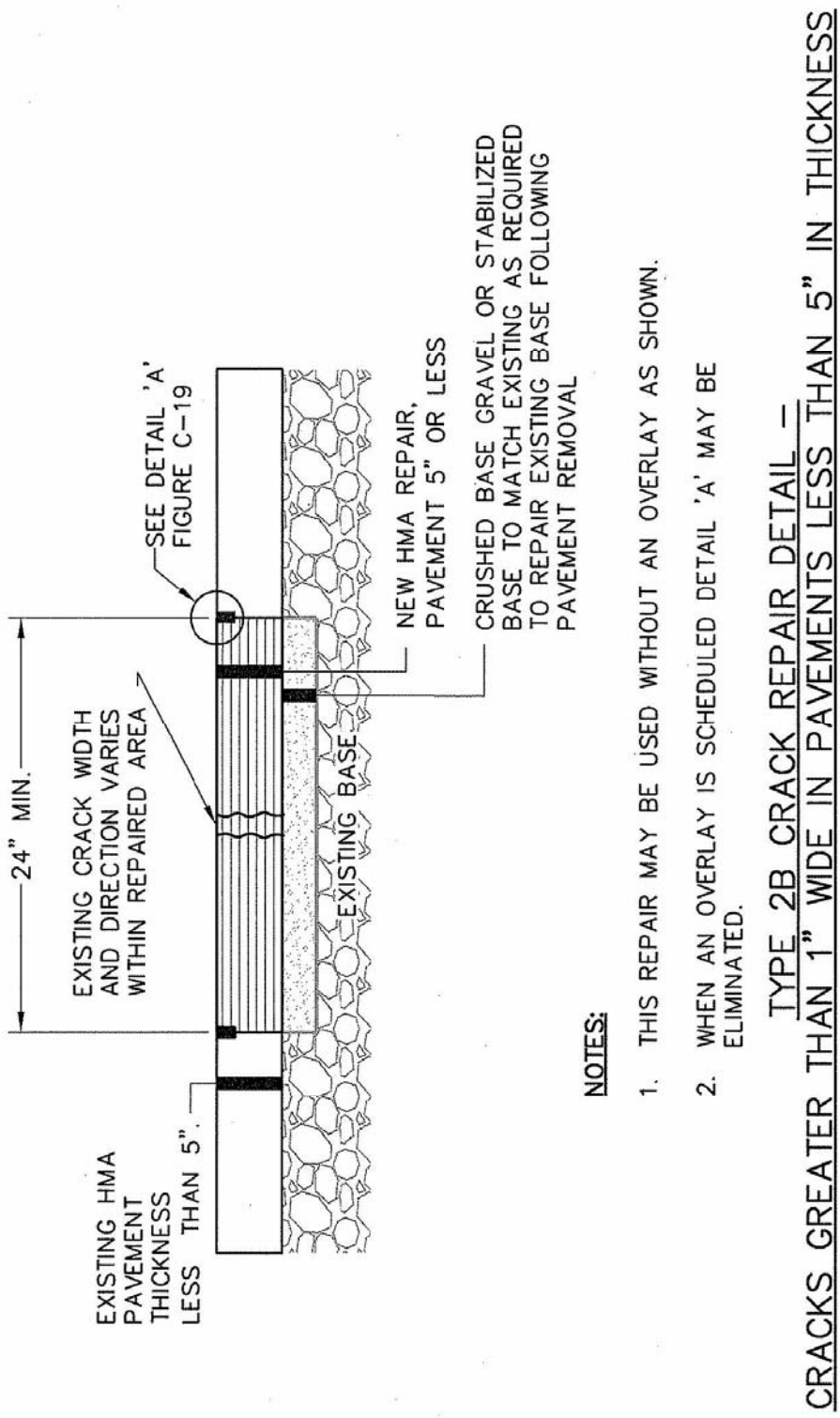
NOTES:

1. THIS REPAIR MAY BE USED WITHOUT AN OVERLAY AS SHOWN.
2. WHEN AN OVERLAY IS SCHEDULED DETAIL 'A' MAY BE ELIMINATED.

TYPE 2A CRACK REPAIR DETAIL – CRACKS GREATER THAN 1" WIDE IN PAVEMENTS 5" OR GREATER IN THICKNESS

NOT TO SCALE
FIGURE C-17

Figure C - 17. Type 2A Crack Repair Detail – Cracks Greater Than 1" Wide in Pavements 5" or Greater in Thickness



NOTES:

1. THIS REPAIR MAY BE USED WITHOUT AN OVERLAY AS SHOWN.
2. WHEN AN OVERLAY IS SCHEDULED DETAIL 'A' MAY BE ELIMINATED.

TYPE 2B CRACK REPAIR DETAIL –
CRACKS GREATER THAN 1" WIDE IN PAVEMENTS LESS THAN 5" IN THICKNESS

NOT TO SCALE
FIGURE C-18

Figure C - 18. Type 2B Crack Repair Detail – Cracks Greater Than 1" Wide in Pavements Less Than 5" in Thickness

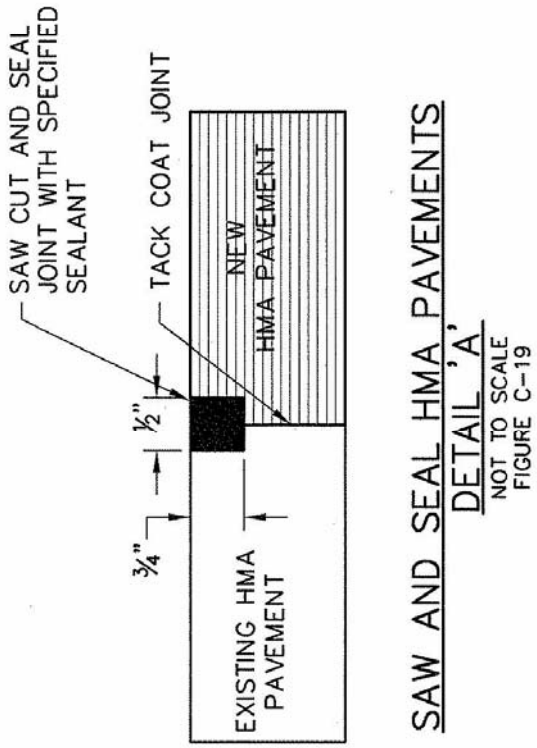


Figure C - 19. Saw and Seal HMA Pavements Detail 'A'

APPENDIX D. BIBLIOGRAPHY

1. *Joint and Crack Sealing and Repair for Concrete Pavements*, TB012P, American Concrete Pavement Association, Skokie, IL, 1993.

2. *Diamond Grinding and Concrete Pavement Restoration*, TB008P, American Concrete Pavement Association, Skokie, IL, 2000.

3. *Slab Stabilization Guidelines for Concrete Pavements*, TB018P, American Concrete Pavement Association, Skokie, IL, 1994.

4. *Stitching Concrete Pavement Cracks and Joints*, SR903P, American Concrete Pavement Association, Skokie, IL, 2001.

5. *Concrete Pavement Rehabilitation, Guide for Load Transfer Restoration*, JP001P, American Concrete Pavement Association, Skokie, IL, 1998.

6. *The Concrete Pavement Restoration Guide*, TB020P, American Concrete Pavement Association, Skokie, IL, 1998.

7. *Concrete Pavement Repair Manual*, JP002P, American Concrete Pavement Association, Skokie, IL, June, 2003.

8. *Concrete Crack and Partial-Depth Spall Repair Manual*, JP003P, American Concrete Pavement Association, Skokie, IL, 2003.

9. *SHRP H 349 Concrete Pavement Repair Manuals of Practice, Materials and Procedures for the Repair of Joint Seals in Concrete Pavements, Materials and Procedures for Rapid Repair of Partial-Depth Spalls in Concrete Pavements*, Strategic Highway Research Program–National Research Council, Washington, DC, 1993.

10. *SHRP H 348 Asphalt Pavement Repair Manuals of Practice, Materials and Procedures for Sealing and Filling Cracks in Asphalt-Surfaced Pavements, Materials and Procedures for the Repair of Potholes in Asphalt-Surfaced Pavements*, Strategic Highway Research Program–National Research Council, Washington, DC, 1993.

11. *Maintenance of Joints and Cracks in Concrete Pavemen*t, IS188.01P, Portland Cement Association, Skokie, Illinois 60077, 1976.

12. *Asphalt in Pavement Maintenance*, MS-16, Third Edition, The Asphalt Institute, Lexington, KY 40512, 1997.

13. *The Basic Asphalt Emulsion Manual*, MS-19 Third Edition, The Asphalt Institute, Lexington, KY 40512, 1998.

14. *Asphalt Overlays for Highway and Street Rehabilitation*, MS-17, Third Edition, The Asphalt Institute, Lexington, KY 40512, 2000.

15. *Maintenance and Repair of Surface Areas*, TM 5-624, MO-1 02, AFR 85-8, Departments of the Army, Navy, and Air Force, Washington, DC, 1977.

16. *Pavement Rehabilitation Materials and Techniques*, Synthesis of Highway Practice 9, National Cooperative Highway Research Program, Washington, DC, 1972.

17. *Sealing Joints and Cracks, Thin Resurfacing, and Locating Voids Under Concrete Slabs*, Transportation Research Record 752, Transportation Research Board, Washington, DC, 1980.

18. Report No. DOT/FAA/PM-87/8, Micro-PAVER, *Concept and Development, Airport Pavement Management System. 1988*

19. Report No. CEEDO-TR-77-44-VOL-1, *Development of a Pavement Maintenance Management System, Volume I: Maintenance and Repair Guidelines for Airfield Pavements*, Construction Engineering Research Laboratory, Champaign, IL, December 1977.

20. *Report No. CEEDO-TR-77-44-VOL-2, Development of a Pavement Maintenance Management System, Volume II: Airfield Pavement Distress Identification Manual*, Construction Engineering Research Laboratory, Champaign, IL, December 1977.

21. Report No. CEEDO-TR-77-44-VOL-3, *Development of a Pavement Maintenance Management System, Volume III: Maintenance and Repair Guidelines for Airfield Pavements*, Construction Engineering Research Laboratory, Champaign, IL, September 1977.

22. Report No. CEEDO-TR-77-44-VOL-4, *Development of a Pavement Maintenance Management System, Volume IV: Appendices A through I, Maintenance and Repair Guidelines for Airfield Pavements*, Construction Engineering Research Laboratory, Champaign, IL, September 1977.

23. Report No. FAA-RD-75-110-II, *Methodology for Determining, Isolating, and Correcting Runway Roughness*, Civil Engineering Research Facility, University of New Mexico, Albuquerque, NM, June 1977

24. Document No. D6-81746, *Runway Roughness Measurement, Quantification, and Application–The Boeing Method*, Boeing Commercial Airplane Group–Airport Technology Organization, Seattle, Washington, 2002.

25. Report No. FAA-RD-80-55, *Procedures for Condition Survey of Civil Airports*, U.S. Army Engineer Waterways Experimental Station, Vicksburg, MS, May 1980.

26. AC 150/5320-5, *Airport Drainage*.

27. AC 150/5320-6, *Airport Pavement Design and Evaluation.*

28. AC 150/5320-12, *Measurement, Construction, and Maintenance of Skid Resistant Airport Pavement Surfaces*.

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

30. AC 150/5380-7, *Airport Pavement Management System*.

APPENDIX B

CAUSE OF DISTRESS TABLES

Table B-1. Cause of pavement distress, asphalt-surfaced pavements.

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

[1]PCC: portland cement concrete

Table B-2. Cause of pavement distress, portland cement concrete pavements.

Distress Type	Probable Cause of Distress
Blow-Up	Incompressibles in the joints
Corner Break	Load repetition combined with loss of support and curling stresses
Cracks	Combination of load repetition, curling stresses, and shrinkage stresses
Durability Cracking	Concrete's inability to withstand environmental factors such as freeze-thaw cycles
Joint Seal Damage	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
Patching (Small and Large)	N/A
Popouts	Freeze-thaw action in combination with expansive aggregates
Pumping	Poor drainage, poor joint sealant
Scaling	Over finishing of concrete, deicing salts, improper construction, freeze-thaw cycles, poor aggregate, and alkali-silica reactivity
Settlement	Upheaval or consolidation
Shattered Slab	Load repetition
Shrinkage	Setting and curing of the concrete
Spalling (Joint and Corner)	Excessive stresses at the joint caused by infiltration of incompressible materials or traffic loads; weak concrete at the joint combined with traffic loads

APPENDIX C

INSPECTION PHOTOGRAPHS

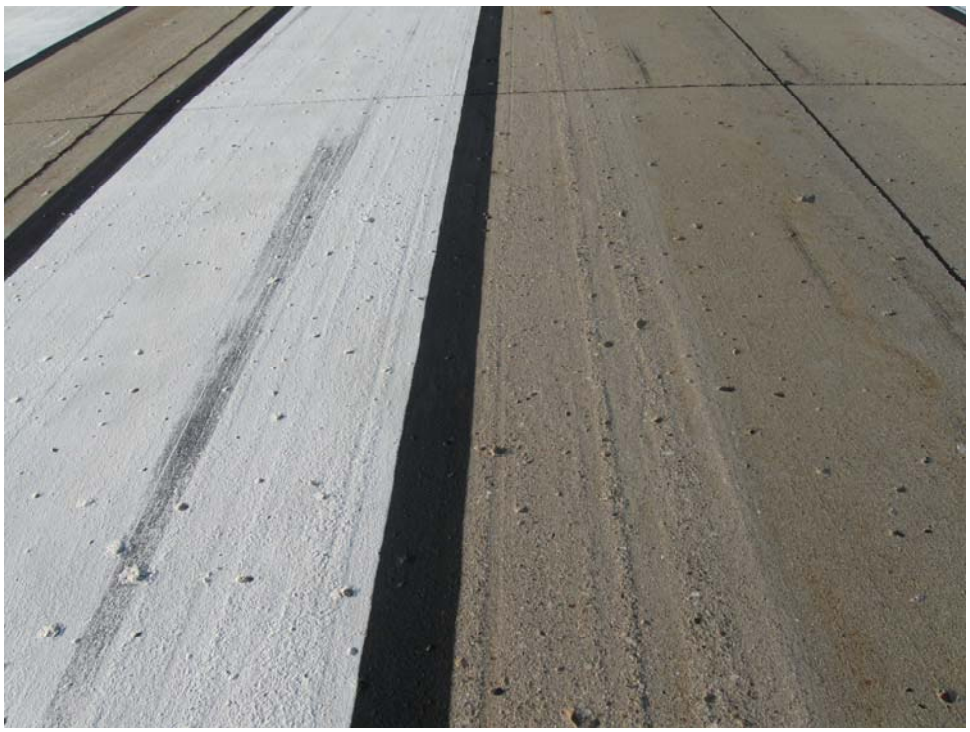
R18LE-01. Overview.

R18LE-01. Popouts and patching.

R18LE-02. Overview.

R18LE-02. Popouts.

R18LE-03. Overview.



R18LE-03. Popouts.

R18LE-03. Shattered slab and patching.

R18LE-04. Overview.

R18LE-05. Overview.

R18LE-06. Overview.

T01LE-01. Overview.

A01LE-01. Overview.

A01LE-02. Overview.

APPENDIX D

INSPECTION REPORT

Re-inspection Report

IA2009
Report Generated Date: 1/18/2010
Site Name:

Network: LRJ Name: LE MARS MUNICIPAL AIRPORT

Branch: A01LE Name: APRON 01 AT LE MARS Use: APRON Area: 46,110.00SqFt

Section: 01 of 2 From: BUILDING To: TAXIWAY 01 Last Const.: 5/1/1980
Surface: PCC Family: UnKnown Zone: Category: Rank: P
Area: 25,500.00SqFt Length: 144.00Ft Width: 151.00Ft
Shoulder: Street Type: Grade: 0.00 Lanes: 0
Section Comments:

Last Insp. Date 9/16/2009 Total Samples: 5 Surveyed: 2
Conditions: PCI:30.00 |
Inspection Comments:

Sample Number: 003 Type: R Area: 24.00Slabs PCI = 40
Sample Comments:

63 LINEAR CRACKING	L	12.00 Slabs	Comments:
68 POPOUTS	N	4.00 Slabs	Comments:
72 SHATTERED SLAB	L	7.00 Slabs	Comments:
74 JOINT SPALLING	M	1.00 Slabs	Comments:
62 CORNER BREAK	L	1.00 Slabs	Comments:
63 LINEAR CRACKING	L	4.00 Slabs	Comments:
74 JOINT SPALLING	L	1.00 Slabs	Comments:
64 DURABILITY CRACKING	L	1.00 Slabs	Comments:

Sample Number: 005 Type: R Area: 16.00Slabs PCI = 15
Sample Comments:

68 POPOUTS	N	6.00 Slabs	Comments:
72 SHATTERED SLAB	L	2.00 Slabs	Comments:
63 LINEAR CRACKING	L	7.00 Slabs	Comments:
74 JOINT SPALLING	L	7.00 Slabs	Comments:
63 LINEAR CRACKING	M	7.00 Slabs	Comments:
74 JOINT SPALLING	H	4.00 Slabs	Comments:

Re-inspection Report

IA2009
Report Generated Date: 1/18/2010
Site Name:

Network: LRJ Name: LE MARS MUNICIPAL AIRPORT

Branch: A01LE Name: APRON 01 AT LE MARS Use: APRON Area: 46,110.00SqFt

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Section: 02 of 2 From: HANGERS To: APRON 01 SECT 01 Last Const.: 5/1/1984
Surface: PCC Family: UnKnown Zone: Category: Rank: P
Area: 20,610.00SqFt Length: 190.00Ft Width: 96.00Ft
Shoulder: Street Type: Grade: 0.00 Lanes: 0
Section Comments:

Last Insp. Date 9/16/2009 Total Samples: 8 Surveyed: 2
Conditions: PCI:73.00 |
Inspection Comments:

Sample Number: 003 Type: R Area: 20.00Slabs PCI = 76
Sample Comments:

63 LINEAR CRACKING	L	3.00 Slabs	Comments:
72 SHATTERED SLAB	L	2.00 Slabs	Comments:

Sample Number: 005 Type: R Area: 20.00Slabs PCI = 70
Sample Comments:

66 SMALL PATCH	L	6.00 Slabs	Comments:
68 POPOUTS	N	2.00 Slabs	Comments:
66 SMALL PATCH	L	6.00 Slabs	Comments:
66 SMALL PATCH	M	1.00 Slabs	Comments:
67 LARGE PATCH/UTILITY	L	1.00 Slabs	Comments:
75 CORNER SPALLING	L	1.00 Slabs	Comments:
75 CORNER SPALLING	M	1.00 Slabs	Comments:
62 CORNER BREAK	M	1.00 Slabs	Comments:

Re-inspection Report

IA2009
Report Generated Date: 1/18/2010
Site Name:

Network: LRJ Name: LE MARS MUNICIPAL AIRPORT

Branch: R18LE Name: RUNWAY 18/36 AT LE MARS Use: RUNWAY Area: 365,524.01SqFt

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Section: 01 of 6 From: RUNWAY END 18 To: RUNWAY SECT 02 Last Const.: 5/1/1980
Surface: PCC Family: UnKnown Zone: Category: Rank: P
Area: 73,363.00SqFt Length: 852.00Ft Width: 75.00Ft
Shoulder: Street Type: Grade: 0.00 Lanes: 0
Section Comments:

Last Insp. Date 9/16/2009 Total Samples: 19 Surveyed: 3
Conditions: PCI:77.00 |
Inspection Comments:

Sample Number: 006 Type: R Area: 24.00Slabs PCI = 80
Sample Comments:

68 POPOUTS	N	8.00 Slabs	Comments:
63 LINEAR CRACKING	L	1.00 Slabs	Comments:

Sample Number: 011 Type: R Area: 24.00Slabs PCI = 73
Sample Comments:

74 JOINT SPALLING	L	3.00 Slabs	Comments:
66 SMALL PATCH	L	1.00 Slabs	Comments:
74 JOINT SPALLING	M	1.00 Slabs	Comments:
75 CORNER SPALLING	M	2.00 Slabs	Comments:
63 LINEAR CRACKING	L	3.00 Slabs	Comments:
68 POPOUTS	N	1.00 Slabs	Comments:

Sample Number: 016 Type: R Area: 24.00Slabs PCI = 79
Sample Comments:

68 POPOUTS	N	7.00 Slabs	Comments:
63 LINEAR CRACKING	L	1.00 Slabs	Comments:
74 JOINT SPALLING	L	1.00 Slabs	Comments:

Re-inspection Report

IA2009
Report Generated Date: 1/18/2010
Site Name:

Network: LRJ Name: LE MARS MUNICIPAL AIRPORT

Branch: R18LE Name: RUNWAY 18/36 AT LE MARS Use: RUNWAY Area: 365,524.01SqFt

Section: 02 of 6 From: RUNWAY SECT 01 To: RUNWAY SECT 03 Last Const.: 6/1/1964
Surface: PCC Family: UnKnown Zone: Category: Rank: P
Area: 225,000.01SqFt Length: 3,000.00Ft Width: 75.00Ft
Shoulder: Street Type: Grade: 0.00 Lanes: 0
Section Comments:

Last Insp. Date 9/16/2009 Total Samples: 38 Surveyed: 4
Conditions: PCI:65.00 |
Inspection Comments:

Sample Number: 005 Type: R Area: 24.00Slabs PCI = 73
Sample Comments:

63 LINEAR CRACKING	L	2.00	Slabs	Comments:
65 JOINT SEAL DAMAGE	L	24.00	Slabs	Comments:
68 POPOUTS	N	5.00	Slabs	Comments:
66 SMALL PATCH	L	7.00	Slabs	Comments:
74 JOINT SPALLING	L	1.00	Slabs	Comments:
75 CORNER SPALLING	L	1.00	Slabs	Comments:

Sample Number: 015 Type: R Area: 24.00Slabs PCI = 72
Sample Comments:

68 POPOUTS	N	6.00	Slabs	Comments:
65 JOINT SEAL DAMAGE	L	24.00	Slabs	Comments:
63 LINEAR CRACKING	L	6.00	Slabs	Comments:
67 LARGE PATCH/UTILITY	L	1.00	Slabs	Comments:

Sample Number: 025 Type: R Area: 24.00Slabs PCI = 74
Sample Comments:

68 POPOUTS	N	9.00	Slabs	Comments:
63 LINEAR CRACKING	L	4.00	Slabs	Comments:
65 JOINT SEAL DAMAGE	L	24.00	Slabs	Comments:

Sample Number: 035 Type: R Area: 24.00Slabs PCI = 42
Sample Comments:

63 LINEAR CRACKING	L	17.00	Slabs	Comments:
63 LINEAR CRACKING	M	3.00	Slabs	Comments:
68 POPOUTS	N	3.00	Slabs	Comments:
74 JOINT SPALLING	H	1.00	Slabs	Comments:
75 CORNER SPALLING	M	2.00	Slabs	Comments:
67 LARGE PATCH/UTILITY	L	1.00	Slabs	Comments:
67 LARGE PATCH/UTILITY	M	1.00	Slabs	Comments:
65 JOINT SEAL DAMAGE	L	24.00	Slabs	Comments:

Re-inspection Report

IA2009
Report Generated Date: 1/18/2010
Site Name:

Network: LRJ Name: LE MARS MUNICIPAL AIRPORT

Branch: R18LE Name: RUNWAY 18/36 AT LE MARS Use: RUNWAY Area: 365,524.01SqFt

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Section: 03 of 6 From: RUNWAY SECT 02 To: RUNWAY END 36 Last Const.: 5/1/1980
Surface: PCC Family: UnKnown Zone: Category: Rank: P
Area: 14,256.00SqFt Length: 155.00Ft Width: 80.00Ft
Shoulder: Street Type: Grade: 0.00 Lanes: 0
Section Comments:

Last Insp. Date 9/16/2009 Total Samples: 6 Surveyed: 2
Conditions: PCI:76.00 |
Inspection Comments:

Sample Number: 001 Type: R Area: 24.00Slabs PCI = 68
Sample Comments:

68 POPOUTS	N	8.00 Slabs	Comments:
72 SHATTERED SLAB	L	2.00 Slabs	Comments:
66 SMALL PATCH	L	1.00 Slabs	Comments:
63 LINEAR CRACKING	L	1.00 Slabs	Comments:
65 JOINT SEAL DAMAGE	L	24.00 Slabs	Comments:

Sample Number: 004 Type: R Area: 16.00Slabs PCI = 89
Sample Comments:

68 POPOUTS	N	3.00 Slabs	Comments:

Re-inspection Report

IA2009
Report Generated Date: 1/18/2010
Site Name:

Network: LRJ Name: LE MARS MUNICIPAL AIRPORT

Branch: R18LE Name: RUNWAY 18/36 AT LE MARS Use: RUNWAY Area: 365,524.01SqFt

---

Section: 04 of 6 From: END OF RUNWAY To: RUNWAY 18LE-03 Last Const.: 5/1/1996
Surface: PCC Family: UnKnown Zone: Category: Rank: P
Area: 7,905.00SqFt Length: 155.00Ft Width: 50.00Ft
Shoulder: Street Type: Grade: 0.00 Lanes: 0
Section Comments:

Last Insp. Date9/16/2009 Total Samples: 4 Surveyed: 1
Conditions: PCI:85.00 |
Inspection Comments:

Sample Number: 001 Type: R Area: 18.00Slabs PCI = 85
Sample Comments:

63 LINEAR CRACKING	L	3.00 Slabs	Comments:
74 JOINT SPALLING	L	1.00 Slabs	Comments:

Re-inspection Report

IA2009
Report Generated Date: 1/18/2010
Site Name:

Network: LRJ Name: LE MARS MUNICIPAL AIRPORT

Branch: R18LE Name: RUNWAY 18/36 AT LE MARS Use: RUNWAY Area: 365,524.01SqFt

---

Section: 05 of 6 From: . To: . Last Const.: 7/1/2007
Surface: PCC Family: UnKnown Zone: Category: Rank: P
Area: 22,500.00SqFt Length: 300.00Ft Width: 75.00Ft
Shoulder: Street Type: Grade: 0.00 Lanes: 0
Section Comments:

Last Insp. Date 9/16/2009 Total Samples: 6 Surveyed: 2
Conditions: PCI:97.00 |
Inspection Comments:

Sample Number: 03 Type: R Area: 24.00Slabs PCI = 100
Sample Comments:
<NO DISTRESSES>

Sample Number: 06 Type: R Area: 24.00Slabs PCI = 94
Sample Comments:
68 POPOUTS N 2.00 Slabs Comments:

Re-inspection Report

IA2009
Report Generated Date: 1/18/2010
Site Name:

Network: LRJ Name: LE MARS MUNICIPAL AIRPORT

Branch: R18LE Name: RUNWAY 18/36 AT LE MARS Use: RUNWAY Area: 365,524.01SqFt

---

Section: 06 of 6 From: . To: . Last Const.: 7/1/2007
Surface: PCC Family: UnKnown Zone: Category: Rank: P
Area: 22,500.00SqFt Length: 300.00Ft Width: 75.00Ft
Shoulder: Street Type: Grade: 0.00 Lanes: 0
Section Comments:

Last Insp. Date 9/16/2009 Total Samples: 6 Surveyed: 2
Conditions: PCI:100.00 |
Inspection Comments:

Sample Number: 02 Type: R Area: 24.00Slabs PCI = 100
Sample Comments:
<NO DISTRESSES>

Sample Number: 05 Type: R Area: 24.00Slabs PCI = 100
Sample Comments:
<NO DISTRESSES>

Re-inspection Report

IA2009
Report Generated Date: 1/18/2010
Site Name:

Network: LRJ Name: LE MARS MUNICIPAL AIRPORT

Branch: T01LE Name: TAXIWAY 01 AT LE MARS Use: TAXIWAY Area: 10,832.00SqFt

Section: 01 of 1 From: APRON 01 To: RUNWAY 18/36 Last Const.: 5/1/1980
Surface: PCC Family: UnKnown Zone: Category: Rank: P
Area: 10,832.00SqFt Length: 195.00Ft Width: 40.00Ft
Shoulder: Street Type: Grade: 0.00 Lanes: 0
Section Comments:

Last Insp. Date 9/16/2009 Total Samples: 1 Surveyed: 1
Conditions: PCI:24.00 |
Inspection Comments:

Sample Number: 001 Type: R Area: 24.00Slabs PCI = 24
Sample Comments:

72	SHATTERED SLAB	M	2.00 Slabs	Comments:
72	SHATTERED SLAB	L	1.00 Slabs	Comments:
63	LINEAR CRACKING	L	5.00 Slabs	Comments:
74	JOINT SPALLING	M	1.00 Slabs	Comments:
74	JOINT SPALLING	H	1.00 Slabs	Comments:
74	JOINT SPALLING	L	1.00 Slabs	Comments:
68	POPOUTS	N	2.00 Slabs	Comments:
72	SHATTERED SLAB	L	3.00 Slabs	Comments:
72	SHATTERED SLAB	M	2.00 Slabs	Comments:
63	LINEAR CRACKING	L	6.00 Slabs	Comments:
63	LINEAR CRACKING	M	1.00 Slabs	Comments:
68	POPOUTS	N	6.00 Slabs	Comments:

APPENDIX E

WORK HISTORY REPORT

Work History Report

Pavement Database:

Network: LRJ **Branch**: A01LE (APRON 01 AT LE MARS) **Section:** 01 **Surface:** PCC
L.C.D.: 05/01/1980 **Use:** APRON **Rank** P **Length:** 144.00 Ft **Width:** 151.00 Ft **True Area:** 25,500.00 SqF

Work Date	Work Code	Work Description	Cost	Thickness (in)	Major M&R	Comments
06/02/2007	JS-LC	Joint Seal (Localized)	$0	0.00	False	
06/01/2007	CS-PC	Crack Sealing - PCC	$0	0.00	False	
05/01/1980	NC-PC	New Construction - PCC	$0	0.00	True	

Network: LRJ **Branch**: A01LE (APRON 01 AT LE MARS) **Section:** 02 **Surface:** PCC
L.C.D.: 05/01/1984 **Use:** APRON **Rank** P **Length:** 190.00 Ft **Width:** 96.00 Ft **True Area:** 20,610.00 SqF

Work Date	Work Code	Work Description	Cost	Thickness (in)	Major M&R	Comments
06/02/2007	CS-PC	Crack Sealing - PCC	$0	0.00	False	
06/01/2007	JS-LC	Joint Seal (Localized)	$0	0.00	False	
05/01/1984	NC-PC	New Construction - PCC	$0	0.00	True	

Network: LRJ **Branch**: R18LE (RUNWAY 18/36 AT LE MARS) **Section:** 01 **Surface:** PCC
L.C.D.: 05/01/1980 **Use:** RUNWAY **Rank** P **Length:** 852.00 Ft **Width:** 75.00 Ft **True Area:** 73,363.00 SqF

Work Date	Work Code	Work Description	Cost	Thickness (in)	Major M&R	Comments
06/02/2007	CS-PC	Crack Sealing - PCC	$0	0.00	False	
06/01/2007	JS-LC	Joint Seal (Localized)	$0	0.00	False	
05/01/1980	NC-PC	New Construction - PCC	$0	0.00	True	

Network: LRJ **Branch**: R18LE (RUNWAY 18/36 AT LE MARS) **Section:** 02 **Surface:** PCC
L.C.D.: 06/01/1964 **Use:** RUNWAY **Rank** P **Length:** 3,000.00 Ft **Width:** 75.00 Ft **True Area:** 225,000.01 SqF

Work Date	Work Code	Work Description	Cost	Thickness (in)	Major M&R	Comments
06/02/2007	CS-PC	Crack Sealing - PCC	$0	0.00	False	
06/01/2007	JS-LC	Joint Seal (Localized)	$0	0.00	False	
06/01/1964	NC-PC	New Construction - PCC	$0	0.00	True	

Network: LRJ **Branch**: R18LE (RUNWAY 18/36 AT LE MARS) **Section:** 03 **Surface:** PCC
L.C.D.: 05/01/1980 **Use:** RUNWAY **Rank** P **Length:** 155.00 Ft **Width:** 80.00 Ft **True Area:** 14,256.00 SqF

Work Date	Work Code	Work Description	Cost	Thickness (in)	Major M&R	Comments
06/02/2007	JS-LC	Joint Seal (Localized)	$0	0.00	False	
06/01/2007	CS-PC	Crack Sealing - PCC	$0	0.00	False	
05/01/1980	NC-PC	New Construction - PCC	$0	0.00	True	

Network: LRJ **Branch**: R18LE (RUNWAY 18/36 AT LE MARS) **Section:** 04 **Surface:** PCC
L.C.D.: 05/01/1996 **Use:** RUNWAY **Rank** P **Length:** 155.00 Ft **Width:** 50.00 Ft **True Area:** 7,905.00 SqF

Work Date	Work Code	Work Description	Cost	Thickness (in)	Major M&R	Comments
06/02/2007	CS-PC	Crack Sealing - PCC	$0	0.00	False	
06/01/2007	JS-LC	Joint Seal (Localized)	$0	0.00	False	
05/01/1996	NC-PC	New Construction - PCC	$0	0.00	True	

Network: LRJ **Branch**: R18LE (RUNWAY 18/36 AT LE MARS) **Section:** 05 **Surface:** PCC
L.C.D.: 07/01/2007 **Use:** RUNWAY **Rank** P **Length:** 300.00 Ft **Width:** 75.00 Ft **True Area:** 22,500.00 SqF

Work Date	Work Code	Work Description	Cost	Thickness (in)	Major M&R	Comments
07/01/2007	NC-PC	New Construction - PCC	$0	0.00	True	

Work History Report

Pavement Database:

Network: LRJ **Branch**: R18LE (RUNWAY 18/36 AT LE MARS) **Section:** 06 **Surface:** PCC
L.C.D.: 07/01/2007 **Use:** RUNWAY **Rank** P **Length:** 300.00 Ft **Width:** 75.00 Ft **True Area:** 22,500.00 SqF

Work Date	Work Code	Work Description	Cost	Thickness (in)	Major M&R	Comments
07/01/2007	NC-PC	New Construction - PCC	$0	0.00	True	

Network: LRJ **Branch**: T01LE (TAXIWAY 01 AT LE MARS) **Section:** 01 **Surface:** PCC
L.C.D.: 05/01/1980 **Use:** TAXIWAY **Rank** P **Length:** 195.00 Ft **Width:** 40.00 Ft **True Area:** 10,832.00 SqF

Work Date	Work Code	Work Description	Cost	Thickness (in)	Major M&R	Comments
06/02/2007	CS-PC	Crack Sealing - PCC	$0	0.00	False	
06/01/2007	JS-LC	Joint Seal (Localized)	$0	0.00	False	
05/01/1980	NC-PC	New Construction - PCC	$0	0.00	True	

Summary:

Work Description	Section Count	Area Total (SqFt)	Thickness Avg (in)	Thickness STD (in)
Crack Sealing - PCC	7	377,466.01	.00	.00
Joint Seal (Localized)	7	377,466.01	.00	.00
New Construction - PCC	9	422,466.01	.00	.00

APPENDIX F

MAINTENANCE POLICIES AND UNIT COST TABLES

Table F-1. Localized preventive maintenance policy, asphalt-surfaced pavements.

Distress Type	Severity Level	Maintenance Action
Alligator Cracking	Low	Monitor
	Medium	AC Patch
	High	AC Patch
Bleeding	N/A	Monitor
Block Cracking	Low	Monitor
	Medium	Crack Seal
	High	Crack Seal
Corrugation	Low	Monitor
	Medium	AC Patch
	High	AC Patch
Depression	Low	Monitor
	Medium	Monitor
	High	AC Patch
Jet Blast	N/A	AC Patch
Joint Reflection Cracking	Low	Monitor
	Medium	Crack Seal
	High	Crack Seal
Longitudinal and Transverse Cracking	Low	Monitor
	Medium	Crack Seal
	High	Crack Seal
Oil Spillage	N/A	AC Patch
Patching	Low	Monitor
	Medium	AC Patch
	High	AC Patch
Polished Aggregate	N/A	Monitor
Raveling and Weathering	Low	Monitor
	Medium	AC Patch
	High	AC Patch
Rutting	Low	Monitor
	Medium	Monitor
	High	AC Patch
Shoving	Low	Monitor
	Medium	AC Patch
	High	AC Patch
Slippage Cracking	N/A	AC Patch
Swelling	Low	Monitor
	Medium	Monitor
	High	AC Patch

Table F-2. Localized preventive maintenance policy, portland cement concrete pavements.

Distress Type	Severity Level	Maintenance Action
Blow-Up	Low	Slab Replacement
	Medium	Slab Replacement
	High	Slab Replacement
Corner Break	Low	Crack Seal
	Medium	Full Depth PCC Patch
	High	Full Depth PCC Patch
Cracks	Low	Monitor
	Medium	Crack Seal
	High	Slab Replacement
Durability Cracking	Low	Monitor
	Medium	Full Depth Patch
	High	Slab Replacement
Joint Seal Damage	Low	Monitor
	Medium	Joint Seal
	High	Joint Seal
Patching	Low	Monitor
	Medium	Full Depth PCC Patch
	High	Full Depth PCC Patch
Popouts	N/A	Monitor
Pumping	N/A	Monitor
Scaling	Low	Monitor
	Medium	Partial Depth PCC Patch
	High	Slab Replacement
Settlement	Low	Monitor
	Medium	Grinding
	High	Slab Replacement
Shattered Slab	Low	Crack Seal
	Medium	Slab Replacement
	High	Slab Replacement
Shrinkage	N/A	Monitor
Spalling (Joint and Corner)	Low	Monitor
	Medium	Partial Depth PCC Patch
	High	Partial Depth PCC Patch

Table F-3. Unit costs for preventive maintenance actions.

Maintenance Action	Unit Cost
AC Patch – AC Pavement	$12.50/sf
Crack Sealing – AC Pavement	$2.14/lf
PCC Patch – Spall Repair (partial depth)	$32.00/sf
PCC Patch – Full Depth	$14.30/sf
Crack Sealing – PCC Pavement	$2.57/lf
Joint Resealing – PCC Pavement	$2.57/lf
Grinding – PCC Pavement	$0.31/sf
Slab Replacement – PCC Pavement	$14.30/sf

Table F-4. Unit costs (per square foot) based on PCI values.

Pavement Type	PCI Values										
	0	10	20	30	40	50	60	70	80	90	100
Asphalt	$8.88	$8.88	$8.88	$8.88	$8.88	$4.20	$4.20	$4.20	$0.00	$0.00	$0.00
PCC	$14.81	$14.81	$14.81	$14.81	$14.81	$7.00	$7.00	$7.00	$0.00	$0.00	$0.00

APPENDIX G

YEAR 2010 LOCALIZED MAINTENANCE DETAILS

Table G-1. Year 2010 localized maintenance details.

Branch	Section	Distress Type[1]	Severity	Distress Quantity	Unit	Maintenance Action	Estimated Cost[2]
A01LE	02	Shattered Slab	L	8	Slabs	Crack Sealing - PCC	$465
		Corner Break	M	4	Slabs	Patching - PCC Full Depth	$1,918
		Small Patch	M	4	Slabs	Patching - PCC Full Depth	$160
		Corner Spall	M	4	Slabs	Patching - PCC Partial Depth	$358
R18LE	01	Joint Spall	M	5	Slabs	Patching - PCC Partial Depth	$1,143
		Corner Spall	M	11	Slabs	Patching - PCC Partial Depth	$952
	03	Shattered Slab	L	6	Slabs	Crack Sealing - PCC	$394

[1]L & T Cracking = Longitudinal and Transverse Cracking.

[2]Cost estimates are shown in 2010 dollar amounts. These estimates are based on broad statewide numbers and should be adjusted to reflect local costs.

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