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Volume 6, Chapter 14

Pavement Maintenance Plan

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1.0 PURPOSE

The purpose of this document is to provide guidelines and best practices to the Entity to manage a flexible Pavement Maintenance Plan. In addition, its purpose extends to promote industry-accepted standards and minimum requirements for the maintenance, inspection, repair, and rehabilitation of existing pavement assets (this shall conform to requirements detailed in Section 4.0 - Codes, Standards, and References, and any specific Entity maintenance requirements).

While these minimum requirements apply to common and typical pavement types, the Entity shall modify the requirements specific to its maintenance needs.

2.0 SCOPE

- This document is applicable to the following:
    - Pavement Surfaces of Urban/Rural Roads
    - Pavement Surfaces of Highways
    - Pavement Surfaces of Pedestrian and Bikes Trails
- This document covers and defines the Civil and Highway Engineering requirements for Existing Pavement assets through the following life cycle stages:
    - Maintenance
    - Survey
    - Condition Assessment
    - Repair
    - Rehabilitation
    - Reconstruction
- The maintenance requirements provided herein, or cited by reference, are based on the American Association of State Highway and Transportation Officials (AASHTO), US DOT maintenance manuals, industry standards, and best practices that should be embraced by the relevant Entity.
- This document provides the minimum technical requirements to be adopted by the Entity and/or Contractors to enable safety, quality, and cost effectiveness in the maintenance, repair, and rehabilitation of road assets that meet the needs and expectations of the relevant Entity.
- The Entity shall establish and develop set procedures for the continuous maintenance care and performance efficiency of pavements.

3.0 DEFINITIONS

Term	Definition
Design Life	The period for which the element has been designed, to withstand the combined effects of all the deteriorating forces to which, it may reasonably be expected to be exposed before it becomes more economical to replace the element than to repair it, assuming that regular Maintenance is undertaken.
Emergency Maintenance	Maintenance activity on a pavement, to rectify the danger to the public and restore pavement/pavement components serviceability after an emergency event.
Geographic Information System	A system displaying and providing the geographical information.
Inspection	The evaluation of the condition of an asset(s) through a formally defined and controlled process. The process shall include all relevant information, site inspection surveys, and analytical assessments where required by this document or any other Standard.

Term	Definition
Maintenance	The undertaking of planned or corrective action, or both, including repairs, to ensure that the condition of the asset continues to meet the required duty over the service life of the asset
Pavement	A durable surfacing of a road, highway, and trails or similar areas to transmit loads to the sub-base and underlying soil.
Pavement Maintenance Management System (PMMS)	A set of defined procedures for collecting, analyzing, maintaining, and reporting pavement data, to assist the decision makers in finding optimum strategies for monitoring pavement in serviceable condition in a given in each period for the least cost.
Planned Maintenance	Scheduled maintenance preventative or predictive intervention intended to ensure condition and functionality is preserved.
Rehabilitation	Rehabilitation restores the assets component integrity and cease the reason of the damage
Repair	Repair techniques are used to restore an asset to its healthy operating condition
Service Life	The service life of an asset, element or component is the total period during which the asset remains in use. Maintenance can extend service life of the asset
Acronyms	
AADT	Average Annual Daily Traffic
AASHTO	The American Association of State Highway and Transportation Officials
AMS	Asset Management System
AMANA	Body responsible for enacting planning regulations for Municipality
ARAMCO	Arabian American Oil Company
ASTM	American Society for Testing and Materials
CMMS	Computerized Maintenance Management System
CS	Condition State
DOR	Department of Roads
DOT	Department of Transportation
DOTD	Department of Transportation and Development
FHWA	Federal Highway Administration
HSSE	Health Safety, Security, and Environment
GIS	Geographic Information System
IRI	International Roughness Index
LCCA	Life Cycle Cost Analysis
LTTP	Long-Term Pavement Performance
MOMRA	Ministry of Municipal and Rural Affairs
MOT	Ministry of Transport
MOTI	Ministry of Transportation and Infrastructure
MUTCD	Manual on Uniform Traffic Control Devices
NMA&FM	National Manual of Assets and Facility Management
NHS	National Highway System
PCR	Pavement Condition Rating
PMMS	Pavement Maintenance Management System
PSI	Present Serviceability Index
RAMS	Risk Assessment and Method Statement
SAR	Saudi Arabia Railway
SHA	State Highway Administration
TCP	Traffic Control Persons
TSC	Transportation Systems Center
TTC	Temporary Traffic Control

Table 1: Definitions

4.0 REFERENCES

Maintenance, inspection, and repair of all roads, pavement components, elements, and the asset itself shall be based upon the requirements of this section and existing highways and roads Standards; these shall be from the Saudi Ministry of Transportation (MOT) and Ministry of Municipal and Rural Affairs (MOMRA) to ensure interoperability, AASHTO, or those of the authority having jurisdiction over the structure such as AMANA, Arabian American Oil Company (ARAMCO), and SAR as most appropriate for the individual application. Where the requirements stipulated by these standards are in conflict, the most stringent shall govern, unless otherwise noted herein and shall require the Entity's approval. A list of the adopted codes follows:

- Road Evaluation Manual - Ministry of Municipal and Rural Affairs (MOMRA) 2011
- Road Maintenance Manual - Ministry of Municipal and Rural Affairs (MOMRA) 2011
- Road Maintenance Management System Operation Manual - Ministry of Municipal and Rural Affairs (MOMRA) 2011
- General Specifications for Civil Works in Public Utility Extension Projects - Ministry of Municipal and Rural Affairs (MOMRA) 2004
- General Specifications of Urban Roads Construction (MOMRA) 2005
- AASTHO Maintenance Manual for Roadways and Bridges 2007.
- Kingdom of Saudi Arabia Ministry of Communications/Transportation (MOT) General Specifications for Road and Bridge Construction.
- Maintenance Manual, Department of Transportation, Washington State June 2017.
- Florida Department of Transportation – Maintenance Manual.
- Pavement Maintenance Best Practices Handbook by Minnesota Department of Transportation.
- Pavement Condition Surveys – Overview of Current Practices - Delaware Center for Transportation - June, 2013.
- Transportation Systems Center (TSC) 13-1: Inspector Manual for Hot-Mixed Asphalt and Portland Cement Concrete Pavement Construction.
- U.S. Department of Transportation Federal Highway Administration Practical Guide for Quality Management of Pavement Condition Data Collection.
- Pavement Assessment, Repair and Renewal Principles (including Erratum No. 1 dated June 2015 and Erratum No 2, dated January 2016).
- American Society for Testing and Materials (ASTM) D 6433-07 Standard Practice for Roads and Parking Lots Pavement Condition Index Surveys.
- ASTM E 1926-98 Standard Practice for Computing International Roughness Index of Roads from Longitudinal Profile Measurements.
- Manual on Uniform Traffic Control Devices (MUTCD)/Temporary Traffic Control (TTC) Elements.
- Introduction to Health and Safety in Construction by Phil Hughes, and Ed Ferrett.
- Kingdom of Saudi Arabia General Commission of Survey – Saudi Arabia National Spatial Reference System (SANSRS) – www.gasgi.gov.sa

The Entity/Contractor should also refer to the following relevant volumes/chapters/sections of the National Manual of Assets and Facilities Management (NMA&FM) for further guidance while compiling maintenance plan specific to roads and road pavements.

- Volume 2: Asset Management.
- Volume 3: Condition Assessment
- Volume 4: Financial Planning
- Volume 5: Operations Management
- Volume 6: Maintenance Management (Chapter 3 and Chapter 4)
- Volume 7: Work Control
- Volume 10: Health, Safety, Security, and Environment (HSSE)
- Volume 14: Emergency Management

5.0 RESPONSIBILITIES

- All staff and suppliers carrying out operations and maintenance activities shall be qualified and competent to undertake these tasks.
- The Entity and the specialized contractors/operators shall have an organizational structure with adequate staff with clear roles and responsibilities, who are competent to effectively oversee and monitor the operation and maintenance activities and works.
- The Entity and the specialized contractors/operators shall have a competence management system in accordance with the published guidance and Standards for the operation and maintenance of the assets.
- The Entity and the specialized contractors/operators shall have continuous and refresher training programs on developing and maintaining staff competence.
- Inspections of pavements shall be carried out by suitably experienced, competent and qualified staff.

6.0 GENERAL REQUIREMENTS

All staff and suppliers carrying out works in pavement asset areas shall be qualified and competent to undertake these tasks.

Prior to any pavement maintenance activities, the contractor/Entity shall consider conducting a risk assessment to identify, quantify, and control risk hazards related to maintenance activities. They shall create Risk Assessment and Method Statement (RAMS) documents, containing details of the hazards as well as a step by step safe working guide that employees, contractors, and others can follow.

Health and safety aspects shall be considered throughout the maintenance, inspection, condition assessment, repairs and rehabilitation of existing pavements and due account taken of the applicable health and safety regulations. While carrying out maintenance and inspection activities, the following health and safety aspects shall be considered:

- Working around heavy equipment.
- Working on highways.
- High traffic roads.
- Working around deep excavations and manhole-drainage openings
- Working on roads next to cliff rock fall areas.
- Impact to those persons not involved in the works but may be affected.

All activities including the maintenance, inspection, repairs, and rehabilitation of existing pavements must comply with current environmental legislation, approved codes of practice, and authoritative guidance literature issued by relevant statutory bodies and Entities.

The responsible contractor/Entity shall consider health and safety, safe access and egress, and traffic management for all customers and users during the maintenance, inspection, repair, and rehabilitation activities.

Safeguard the health and safety of users, employees, inspectors, and members of the general public. Temporary works required for the maintenance, inspection, repairs, and rehabilitation works shall be fully compatible with the continuing safe and reliable operation of the adjacent roads.

Principles of traffic control management shall be considered prior to and during any maintenance activity related to roads pavement including, but not limited to the following:

- Capacity Analysis – Lanes required, length of queues anticipated.
- Time restrictions – Peak hours, seasonal peaks.

- Limits to work areas.
- Capacity of detour routes.
- Work vehicle access and worker parking.
- Warning sign locations – Detours, long queues, and intersections.

Material waste from works activities should be disposed of in the correct manner with minimal / zero impact to the environment.

7.0 TEMPORARY TRAFFIC CONTROL (TTC)

TTC is required when traffic must be moved through or near street rehabilitation, maintenance or utility work, or adjacent to a roadway. This subsection is intended to provide guidelines for the protection of road users and workers during temporary period of pavement maintenance and rehabilitation including utility work and other maintenance activities. The TTC guidelines detailed in this subsection provide minimum standards based on a work area and street classification.

Traveling vehicles shall be guided in a clear and positive manner while approaching and traversing through a work area or detour, and under all circumstances, this positive guidance shall create a consistent visual image for road users. This may be achieved using signs, delineators, barricades, pavement markings, lighting devices, or Traffic Control Persons (TCPs), all used in a variety of combinations to achieve the safe movement of traffic around workers.

7.1 TTC General Requirements

The control of road users through a TTC work zone shall be an essential part of pavement maintenance, rehabilitation, and utility work. The following requirements provide guidance to assist road users and help protect workers in the vicinity of TTC zones:

- Road users and workers' safety in TTC zones should be an important and high priority element of every maintenance activity from planning to starting maintenance activities.
- Safety plans and guidelines shall be developed and implemented prior to maintenance works to ensure the safety of pedestrians, workers, drivers, and equipment and enforcement/emergency officials.
- Road user's movements should be inhibited as little as practical.
- Drivers, cyclists, and pedestrians should be guided in a clear and positive manner while approaching and traversing TTC zones and incident sites.
- Continuous and routine day and night time inspections of TTC equipment's shall be carried out.
- Each person whose actions affects TTC zone safety should receive training, appropriate to the activities and decisions they may be required to make.
- All TTC devices shall be removed as soon as practical, when they are no longer required. It is good practice to plan TTC before going into the field, and maintain a record of the control used
- The traffic management arrangement, to carry out maintenance work shall conform to the requirements detailed in MUTCD and any specific entity requirements
- Staff training to be undertaken to ensure all staff are familiar with the procedures employed
- PPE and visibility devices are to be in good order to maintain separation of staff from traffic areas / flow.
- Diversion routes to be checked prior to closure to ensure that measures in place are suitable and sufficient.
- Consideration of Traffic police (Muroor) attendance for imposing traffic rules during works.

7.2 TTC Zone

The TTC zone includes the entire section of roadway, between the first advance warning sign through the last traffic control device, where traffic returns to its normal path and conditions. Most TTC zones can be divided into four areas:

- The advance warning area is where drivers are informed of what to expect.

- The transition area is when redirection of the driver's normal path is required.
- The activity area is where the work takes place.
- The termination area is used to return traffic to the normal traffic path.

The below Figure 1 illustrates these four areas. For more details for traffic management on each TTC zone area, please refer to MUTCD.

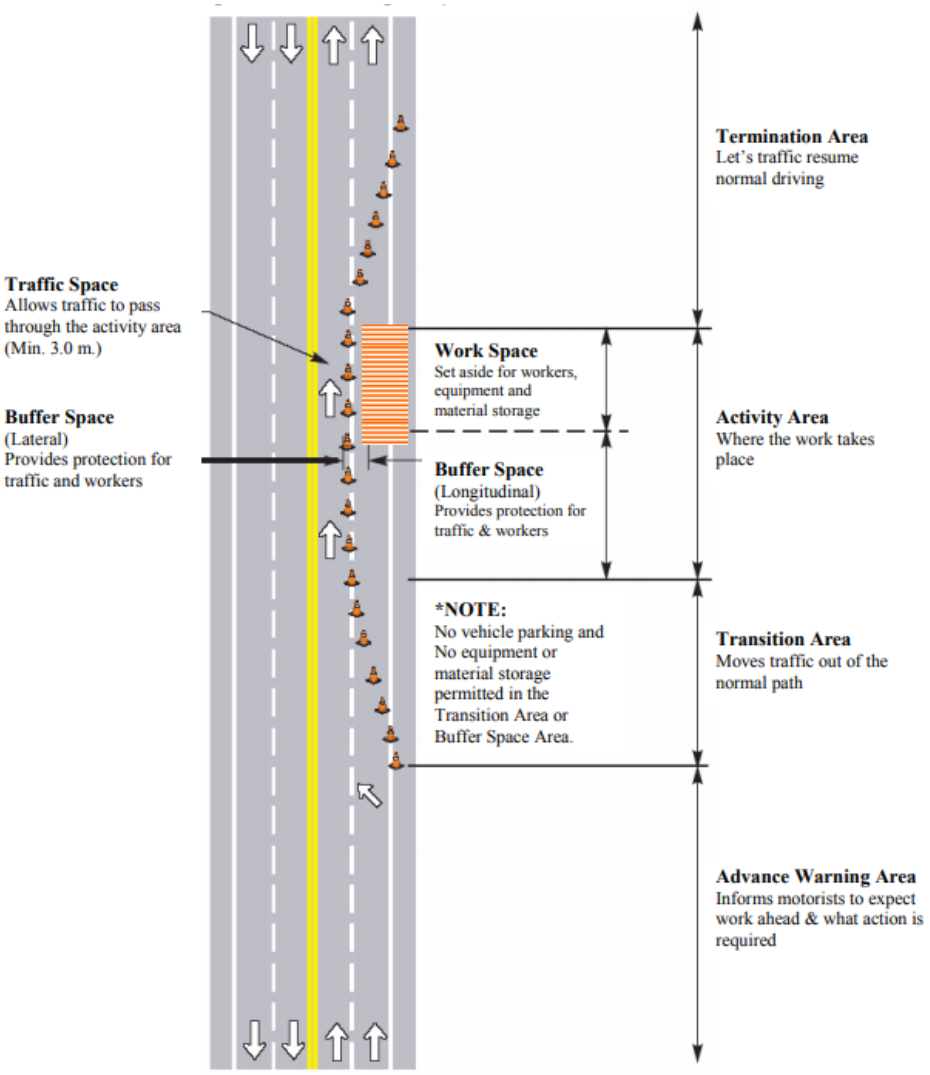


Figure 1: TTC Zone

8.0 PAVEMENT MAINTENANCE MANAGEMENT SYSTEM

The Entity should develop a computerized maintenance management system such as a Pavement Maintenance Management System (PMMS) in order to assist asset managers, manage and maintain its pavement assets. A PMMS is a set of defined procedures for collecting, analyzing, maintaining, and reporting pavement data to assist the decision makers in finding optimum strategies to maintain pavement to a serviceable condition over a given period within budgetary constraints. The PMMS should provide a detailed guide for appropriate asset management practices, processes, and activities specific to the pavement assets. When implemented, these will aid in efficiently managing the physical and operational attributes of the asset to prolong its life whilst maintaining defined levels of service.

The PMMS should be developed by the Entity and should contain the following key aspects and system framework as highlighted in Figure 2.

- Program Management
- Historical Asset Data
- Geographic Information System (GIS) database
- Pavement Inventory inclusive of roadway numbering/ reference system and segmentation
- Inspections (Pavement Condition data, Planned and Completed work items, Photographs, Drawings and reports)
- International Roughness Index (IRI)
- Condition Rating
- Assets Risk Analysis/Matrix
- Decision making, evaluation and strategic review of asset maintenance needs (do nothing, maintain, rehabilitation, reconstruction)
- Provides a system to develop optimum works programs and capture the cost of works against the pavement assets
- Cost benefit analysis assessments (economic use of personnel, equipment, and materials coupled with cost effectiveness analysis of various maintenance and rehabilitation strategies)
- Labor, materials, equipment, and cost tracking during execution.
- Schedule and deliver works

The detailed requirements for a comprehensive Asset Management System (AMS) are given in Volume 2: Asset Management. The Entity should consider the requirements detailed in Volume 2: Asset Management to develop its PMMS or a similar tool to manage its pavement assets

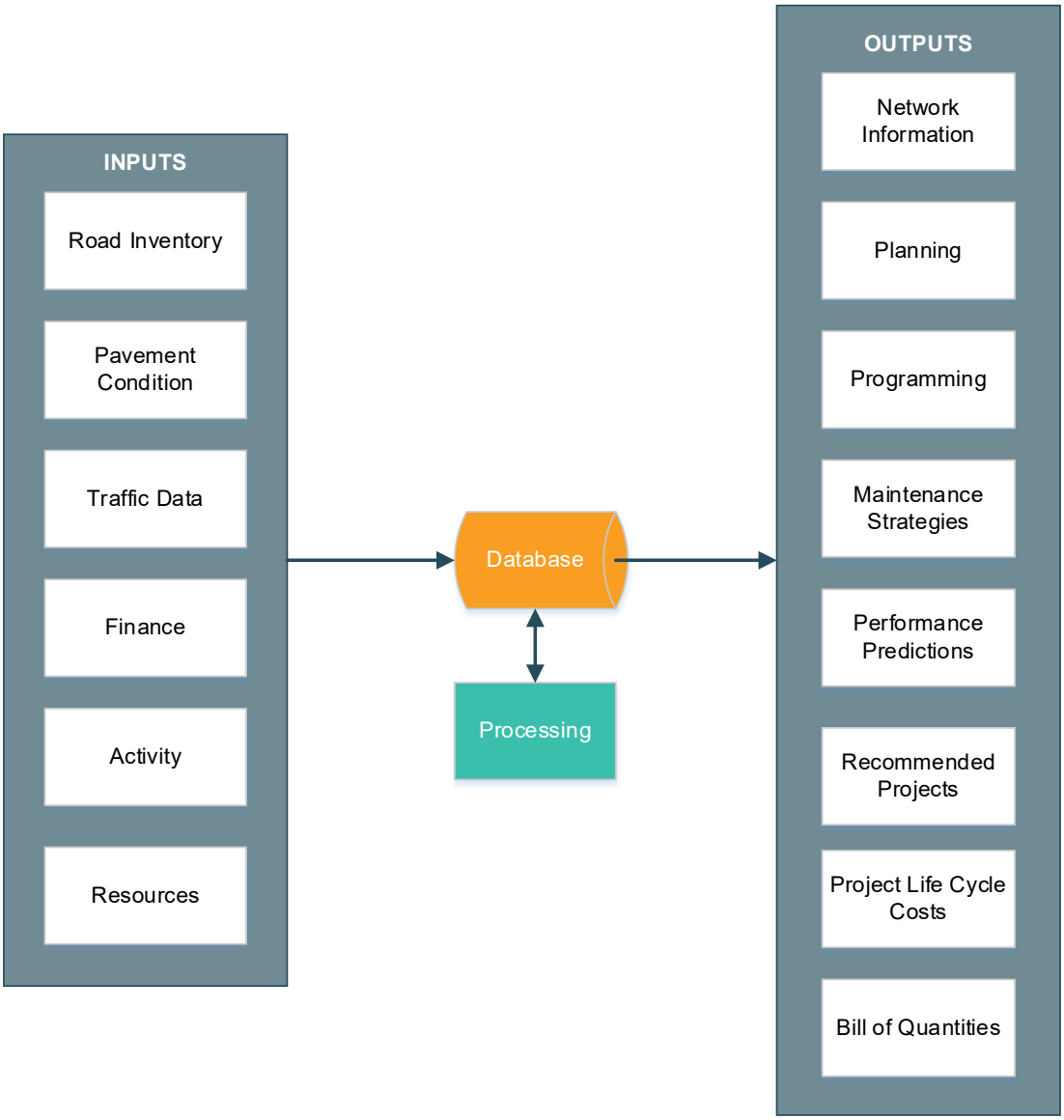


Figure 2: PMMS System Framework

9.0 PAVEMENT MAINTENANCE

Maintenance of pavements is necessary to provide safe, efficient, and convenient roads for travel. In addition, to prevent road closure for emergency repairs that could have been reasonably avoided, Inspection and maintenance of pavement layers is important to preserve the asset in serviceable condition and prolong its design and service life. Responsible Entities shall establish and develop their own procedures for maintenance and performance efficiency of roads. Typically, the road maintenance shall be carried out in accordance with the principles highlighted in Figure 3. This subsection only covers the pavement and road surface aspects of the asset.

The Entity shall consider the following key components in the maintenance plan for the effective maintenance of the pavement:

- Development of pavement maintenance planning tool, in order to assist asset managers in the management of pavement assets.
- Geographic Information System (GIS) database.
- Pavement Inventory inclusive of roadway numbering/ reference system and segmentation.
- Effective planned maintenance program.

- Road condition assessment schedule (network level, project level) and reporting.
- Effective corrective maintenance.
- Plant and equipment availability.
- Utilization of manpower.
- Seasonal restrictions.
- Adverse weather.

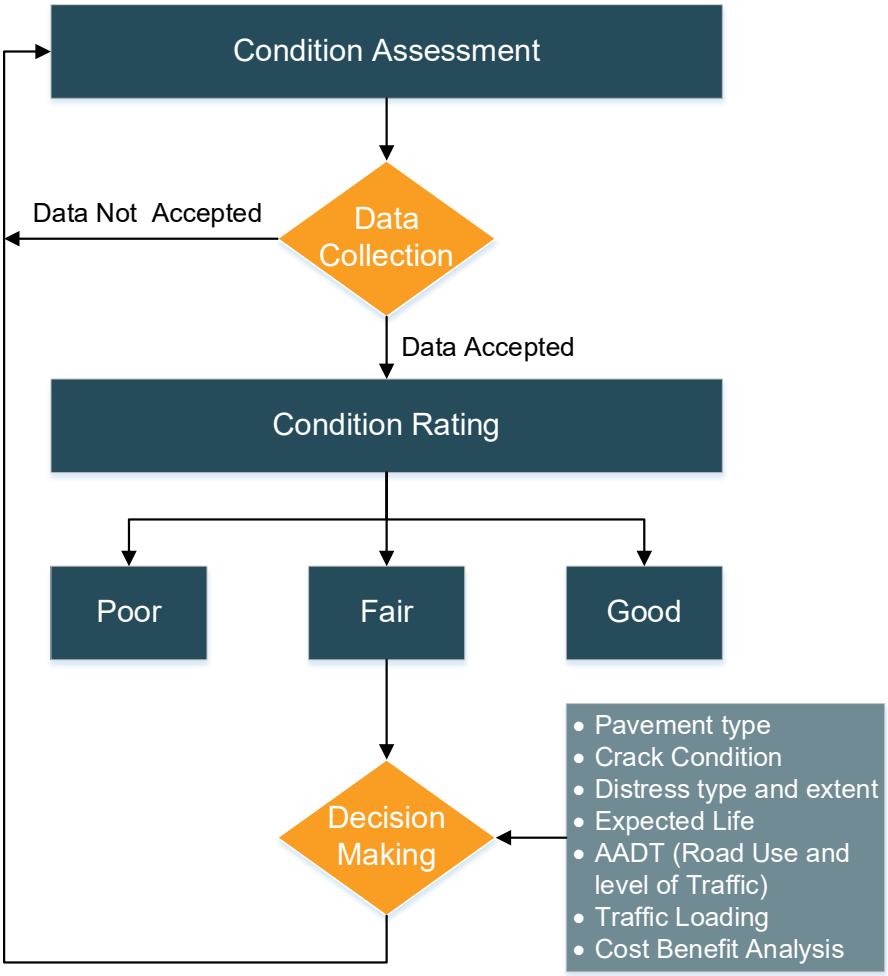


Figure 3: Pavement Operation and Maintenance Process

9.1 General

- Maintenance work shall be undertaken to ensure assets meet their required duty for the Design Life of the asset.
- Assets that fail to meet the required duty shall have operational restrictions imposed upon them or be withdrawn from service.
- Contingency planning should be considered.

9.2 Maintenance Work

- Maintenance work shall be planned or reactive including repairs to damage and defects.
- Maintenance work shall be justified on the principles of whole lifecycle asset management.
- Maintenance action shall be based on the condition assessment and reporting for existing pavement.

9.3 Pavement Distress Types and Treatment

Damage and distress of pavements will become apparent in different ways. Several factors contribute to the appearance of pavement distress. For example, an overlay with excess asphalt or poorly graded or inadequately fractured paving material may not have adequate particle interlock; thus pushing, rutting, and humps may develop. Excessive amounts of asphaltic cement or tars in the mix, excess application of a bituminous sealant, or low air void content results in pavement bleeding. Refer to **Attachment 1** for further details on distress types and severity levels.

The selection of the treatment type varies based on the distress type and other factors such as:

- Existing pavement type
- Crack condition
- Type and extent of distress
- Roadway use and level of traffic
- Climate and Environmental factors
- Traffic loading
- Cost of treatment
- Expected life
- Availability of qualified staff and contractors
- Availability of quality materials
- Time of year of placement
- Facility downtime
- Pavement noise
- Surface friction
- Skid resistance

Refer to **Attachment 2** for more details on the typical types of treatments for different types of pavement distress. The Entity shall develop a detailed maintenance manual which shall cover the distress types and severity together with the applicable treatments, specific to the Entities' road assets.

9.4 Planned Maintenance

Planned maintenance is performed to improve and extend the functional life of a pavement. It is a strategy of surface treatments and operations intended to retard progressive failures and reduce the need for routine maintenance and service activities.

The Entity/contractor shall conduct planned maintenance activities to a set schedule, in order to prevent defects affecting the pavement from becoming established. The Entity shall consider planned maintenance activities to have long-term benefits for the pavement. Planned maintenance helps to reduce the costs and disruption associated with emergency repairs and 'knock-on' effects of disruption to other planned works.

Planned maintenance activities should be classified into two groups: Scheduled and Response.

- **Scheduled**: The Entity/contractor should conduct activities on a scheduled interval basis
- **Response**: The Entity/contractor should conduct activities that shall be identified through the Condition Assessment Process

The activity schedule mentioned in **Attachment 3** shall be carried out as a part of Planned Maintenance by the relevant Entity. The list, which is shown in **Attachment 3**, is not exhaustive and simply represents a collection of typical activities. The relevant Entity/Contractor shall also develop an individual program and set of activities and interval to develop its Planned Maintenance plan and maintenance manual. The reference included in the table provides the best practice to execute the Planned Maintenance activity, however, the Entity should develop its own practice to carry out these activities.

9.5 Reactive/Emergency Maintenance

Emergency Maintenance is performed during an emergency, such as a blowout or severe pothole that needs to be repaired immediately. This also describes temporary treatments, designed to hold the surface together until more permanent repairs can be performed.

- The Entity/Contractor shall develop an Emergency Maintenance plan to cater for the unscheduled and unplanned maintenance such as that caused by vehicle impacts or fires, or to mitigate the consequences of other extreme events that may arise during the asset's life
- This is usually reported through a service call when a component or a system has been perceived to be not working appropriately or is not fit for purpose
- The consequent inspection after the service call can result in two actions:
    - If the problem is affecting the service life of the road's pavement and posing threat to the users, then emergency response and corrective action is required immediately
    - If the problem is not critical then a routine planned maintenance response may be adequate
- The response can include the major repair/rehabilitation of the asset or asset component to protect life and property to moderate/major repair requiring qualified and skilled labor

The Entity should also refer to the requirements detailed in the National Manual of Assets and Facilities Management Volume 14 – Emergency Management, for further details regarding emergency response procedures during hazardous events.

It is advisable that a stock of materials be strategically located by region to respond to emergencies so that effective repairs and reinstatement can be in place with minor disruptions to public use.

9.6 Road Markings and Traffic Paint

The Entity/contractor shall carry out maintenance on following items as part of preventative or predictive (schedule and responsive) and emergency maintenance:

- White and yellow traffic lines.
- White and yellow thermoplastic traffic lines of Epoxy.
- Raised road markers constructed of ceramic, prismatic, cat eye (large, small and solar).
- Delineators

The maintenance works shall also conform to the requirements detailed in Section 4.0 - References, any specific Entity maintenance requirements, General Specifications of Urban Roads Construction (MOMRA) (division 16) 2005 and MOT General Specifications for Road and Bridge Construction (part 9).

10.0 PAVEMENT CONDITION ASSESSMENT

This subsection describes the condition assessment and reporting requirements for pavement. It is the Entities' responsibility to detail the scope required for the relevant condition assessment undertaken.

Conducting condition assessments of pavements provide the necessary inputs for the PMMS or similar asset management tool. The Entity shall develop a comprehensive pavement survey program according to the needs of its pavement assets. The output of the survey can then be utilized by the Entity to make informed decisions about relevant courses of action as well as for the development of financial budgets for the repairs and extended maintenance required based upon the results of the survey.

10.1 General

- Condition assessment of pavement assets shall be carried out for the following purposes:
    - Confirm that assets are safe for desired operations.
    - Provides information necessary for the managed maintenance of assets.
    - Provides the information necessary to assess the condition of the assets in a consistent and accurate manner.
    - Provides information enabling the asset register to be maintained as an accurate record of the physical features of the assets.
    - Provides defects, the causes and effects of damage, and deterioration and vulnerable structures.
- Condition assessment reports and forms shall be retained for the life of the asset.
- No condition assessment shall commence unless the inspector has reviewed previous inspection reports, asset registers, and asset files to establish as far as possible information about the asset, its previous condition, and likely hazards.
- The inspector as part of his planning must be fully aware of access arrangements, so there are no delays to the inspections.
- It is the Entities' responsibility to detail the scope required for the relevant survey undertaken. The information that is necessary to provide to stakeholders must be clearly identified from the outset to ensure, so far as reasonably practicable, that further costs are not incurred

10.2 Purpose of Roads Survey

- To obtain required information promptly from the site to maintain smooth and safe traffic by adequate maintenance.
- To know the pavement surface condition and identify the portion required for maintenance.
- To find locations of serious potholes in order to prevent accident of the road user and third parties.
- To evaluate severity of the distress of the pavement, to prioritize the repair plan and to select the most urgent section to repair.

10.3 Types of Roads Surveys

10.3.1 Manual Surveys

Manual surveys are carried out by walking or travelling at a slow speed and noting down the defects of existing road segments. The defects and distresses are recorded manually on inspection report or more recently on the computers and handheld devices.

10.3.2 Automated Surveys

In this type of survey, the vehicles are fitted with equipment such as lasers, high-speed cameras, and computers to collect the pavement data and features, distress and defect data as well as their severity. These vehicles capture images of the transverse and longitudinal profile of the roadway at highway speed, which are processed with the use of fully or semi-automated methods to help assess pavement condition.

Vehicles that are designed to inspect roads surfaces shall have the ability to measure and conduct the following:

- Damage of asphalt surfaces such as spalling, roughness, potholes, rutting, and cracks.
- IRI.
- Falling weight deflect meter.
- Thickness of pavement.
- Surface distress.
- Skid resistance.
- Surface friction.

Prior to use of automated surveys the equipment should be in date for its calibration so that the results obtained can be utilized. Where a Computerized Maintenance Management System (CMMS) system is in place for the Entity these vehicles should be added as an asset with their own maintenance plan and calibration routine added to the maintenance schedule.

10.4 Survey Frequency

The Entity/service provider shall develop a regular and frequent data collection system to accurately assess the condition of its road assets considering factors such as the type of road (such as main or branch) and the volume of traffic represented by Average Annual Daily Traffic (AADT). Table 2 provides the data types collected and frequency of collection for various highway agencies in United States. This is advised best practice, however, the Entity shall develop its own frequency to collect adequate data to meet its road asset requirements.

Agency	Condition Data Collected	Frequency
British Columbia Ministry of Transportation and Infrastructure (MOTI)	Surface distress, rut depth, and IRI	Primary system every 2 years; secondary system every 2 to 4 years; and selected side roads every 4 years
Colorado Department of Transportation (DOT)	Cracking, rut depth, and IRI	Annually
Florida DOT	Surface distress, faulting, rut depth, and IRI	Annually
Idaho DOT	Surface distress, rut depth, and IRI	Annually
Indiana DOT	Surface distress, rut depth, and IRI	Annually
Iowa DOT	Cracking, rut depth, faulting, D-cracking, joints spalling, and IRI	Every 2 years
Kentucky Transportation Cabinet	Surface distress, faulting, rut depth, and IRI	Annually
Louisiana Department of Transportation and Development (DOTD)	Cracking, patching, faulting, rut depth, and IRI	Annually
Long-Term Pavement Performance (LTTP)	Surface distress, faulting, rut depth, and longitude profile	Every 2 years
Maryland State Highway Administration (SHA)	Cracking, rut depth and IRI	Annually
Nebraska Department of Roads (DOR)	Surface distress, faulting, rut depths, and IRI	Annually
New Mexico DOT	Surface distress and faulting	Annually
North Carolina DOT	Surface distress, faulting, rut depth, and IRI	Annually on interstate and primary roads
Oklahoma DOT	Surface distress, faulting, rut depth, and IRI	NHS every year and non-NHS every 2 years
Oregano DOT	Surface distress, faulting, rut depths, and IRI	Annually
Pennsylvania DOT	Surface distress, faulting, rut depth, and IRI	Annually

Agency	Condition Data Collected	Frequency
Virginia DOT	Surface distress, rut depth, and IRI	Annually
Washington DOT	Surface distress, faulting, rut depth, and IRI	Annually

Table 2: Condition Survey Data Collection and Frequency

10.5 Pavement Condition Rating (PCR)

The effective management of the existing pavement network is based on the accurate condition assessment of the road network as highlighted in the following process flow.

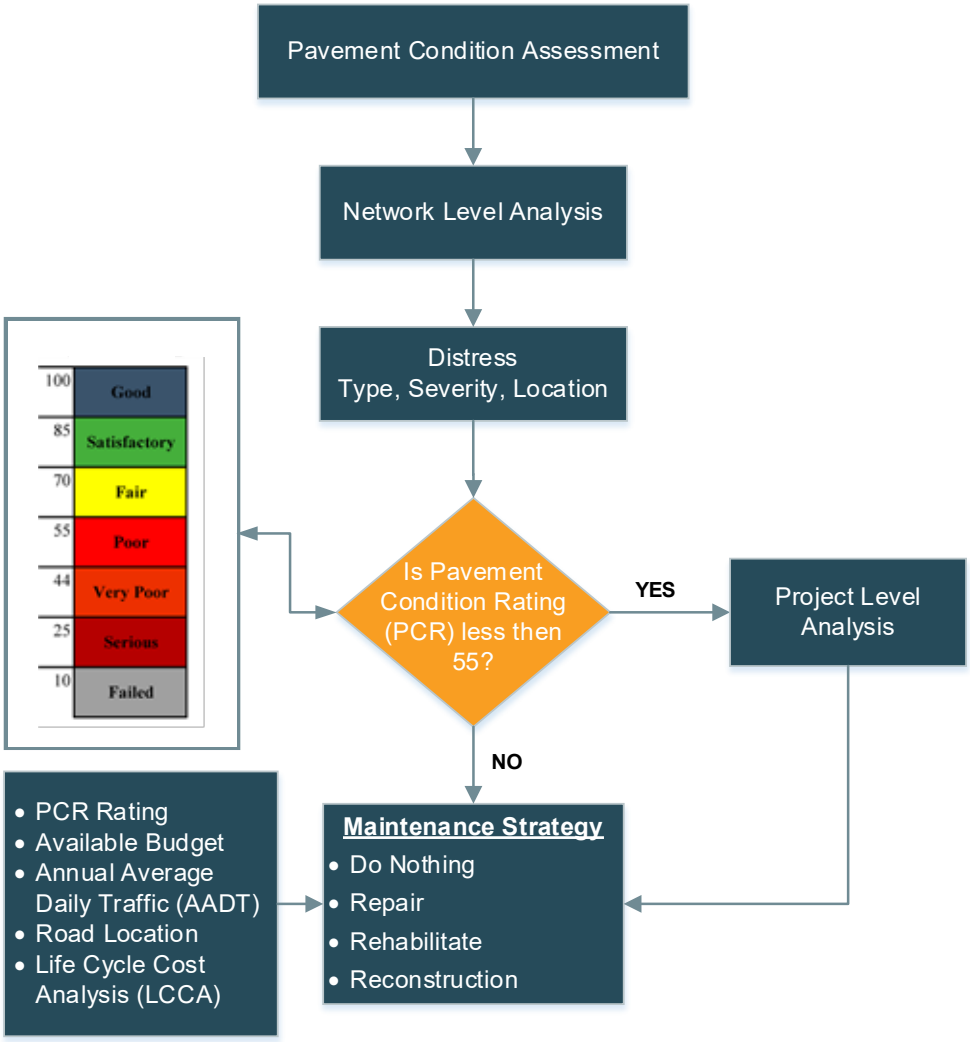


Figure 4: Pavement Condition Assessment Process

The inspection period and frequency for road might vary from segment to another, depending on the type of road (such as main or branch) and the volume of traffic represented by AADT to gather the suitable data for pavement condition assessment (Refer Section 10.3.2). When required project level analysis should be carried out by manual surface distress surveys as highlighted in Figure 4. Project level analysis may also include geotechnical investigations, strength testing, coring, and laboratory testing, in addition to manual surface distress surveys for assistance in appropriate selection of rehabilitation treatments.

The Entity/service provider shall also establish a systematic method such as PCR with a scale similar to that highlighted in Figure 4 to carry out the condition assessment of its road assets.

The PCR system shall be based on the requirements and frequency for the condition survey detailed in American Society for Testing and Materials (ASTM) and American Association of State Highway and Transportation Officials (AASHTO). The pavement condition is based on the different types of distress and severity, ride quality, structural capacity, and friction.
Defects and distress types with appropriate severity levels typically (L-Low, M- Medium, and H-High) should be considered while deducing PCR system. Refer **Attachment 1** for further details on the common distress types and severity level and **Attachment 2** for typical treatment types for the common pavement defects.

Typically following pavement distress types should be considered during pavement condition assessment:

- Alligator Cracking (Fatigue)
- Block Cracking
- Bleeding
- Depression
- Edge Cracking
- Longitudinal and Transverse Cracking
- Patching and Utility Cut Patching
- Rutting
- Shoving
- Potholes
- Roughness and International Roughness Index (IRI)
- Present Serviceability Index (PSI)
- Skid resistance
- Surface friction

11.0 ATTACHMENTS

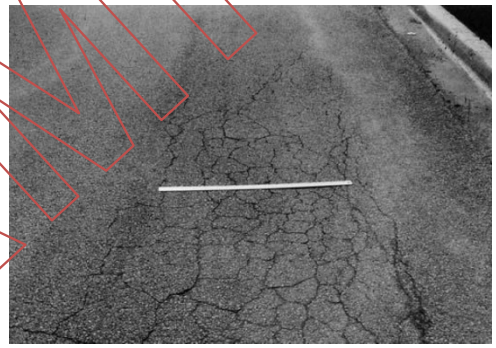
1. Attachment 1 – Pavement Distress Identification and Severity
2. Attachment 2 – EOM-ZMO-TP-000134 Pavement Distress Treatment Matrix
3. Attachment 3 – EOM-ZM0-TP-000093 – Pavement Maintenance Activities Checklist

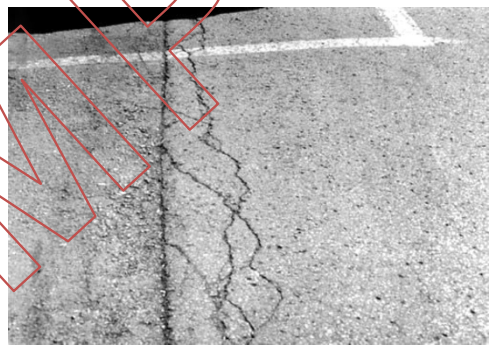
Attachment 1 – Pavement Distress Identification and Severity

	Distress Type	Description	Severity		
			Low	Moderate	High
1	Cracking: Alligator or Fatigue	Occurs due to repeated traffic loadings and takes the form of interconnected cracks in early stages of development and then develops into many-sided, sharp-angled pieces. In later stages, it takes the form of chicken wire or alligator pattern.	Connecting cracks that are not spalled or sealed.	Interconnecting cracks forming a complete pattern and it may be slightly sealed or spalled.	Moderately or severely spalled interconnecting cracks that form a complete pattern. When subjected to traffic, pieces may move.
2	Cracking: Block	It is a type of crack that divides the pavement into rectangular pieces that range in size from 0.1 to 10 square meters.	Cracks with average width of 6 mm, or sealed cracks with sealant cracks in good condition.	Cracks with average width of 6 mm to 20 mm, or cracks with average width of 20 mm and adjacent to low severity random cracking.	Cracks with average width greater than 20 mm, or cracks with average width of 20 mm and adjacent to high severity random cracking.
3	Cracking: Edge	Crescent shaped cracks or continuous cracks that intersect pavement edge and located within 0.5 meter of the pavement edge. This also include longitudinal cracks outside the wheel path and within 0.5 meter of the pavement edge.	Cracks with no breakup or loss of material.	Cracks with some breakup and loss of material that represents 10 percent of the length of the affected portion of the pavement.	Cracks with breakup and loss of material more than 10 percent of the length of the affected portion of the pavement.
4	Cracking: Longitudinal	Cracks parallel to the pavement centerline.	Cracks with an average width of 6 mm, or cracks with sealant material in good condition and an average length that cannot be determined.	Cracks with an average width between 6 mm and 20 mm, or cracks with an average width of 20 mm and adjacent to low severity random cracking.	Cracks with an average width higher than 20 mm, or cracks with an average width of 200 mm and adjacent to high severity random cracking.
5	Cracking: Transverse	Cracks that are perpendicular to the pavement centerline and are not located over joints in underlying concrete pavement.	Cracks with an average width of 6 mm, or cracks sealed with sealant material in good condition and an average width that cannot be determined.	Cracks with an average width between 6 mm and 20 mm, or cracks with and average width of 20 mm and adjacent to low severity random cracking.	Cracks with an average width higher than 20 mm, or cracks with an average width of 20 mm and adjacent to high severity random cracking.

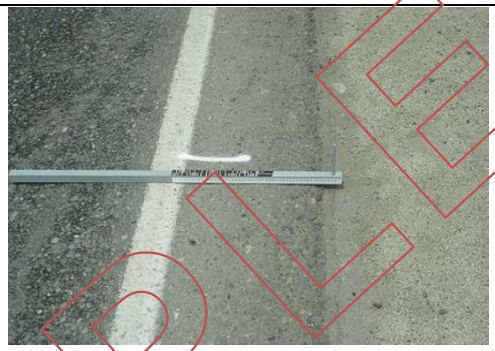
	Distress Type	Description	Severity		
			Low	Moderate	High
6	Cracking at joints: Reflection	Cracks that occur over joints in concrete pavements.	Unsealed cracks with an average width of 6 mm, or cracks sealed with sealant material in good condition and an average width that cannot be determined.	Cracks with an average width between 6 mm and 20 mm, or cracks with an average width of 20 mm and adjacent to low severity random cracking.	Cracks with an average width higher than 20 mm, or cracks with an average width of 20 mm and adjacent to high severity random cracking.
7	Bleeding	Excess bituminous binder occurring on the pavement surface that might create a shiny, glass like, reflective surface. It is usually found in the wheel paths.	An area of pavement surface discolored relative to the reminders of the pavement by excess asphalt.	An area of pavement surface that is losing surface texture due to excess asphalt.	An area where excess asphalt gives the pavement surface a shiny appearance and obscure the aggregates and tire marks may be evident in warm weather.
8	Patch/Patch Deterioration	Portion of pavement surface, greater than 0.1 square meter, that has been removed and replaced or additional material applied to the pavement after original construction.	Patch has most low severity distress of any type.	Patch has moderate severity distress of any type.	Patch has high severity distress of any type.
9	Lane-to-shoulder drop off	It occurs when the outside shoulder settles as a result of pavement layer material differences, and results in notable difference in elevation between the traveled surface and the outside shoulder.	No severity levels are applicable. It could be defined by categorizing the measurements taken. It is important to keep a record of the measurement taken because it is more accurate and repeatable than the severity level.		
10	Polished Aggregate	Surface binder eroded to expose coarse aggregate.	No severity levels are applicable. However, the reduction of surface friction can be an indicator of the degree of polishing.		
11	Potholes	Bowel shaped holes of different sizes in the pavement surface. The minimum plan dimension is 150 mm.	Less than 25 mm deep	25 to 50 mm deep	More than 50 mm deep
12	Raveling and Weathering	Wearing away of the pavement surface in high quality hot mixed asphalt. It is caused by the dislodging of aggregate particles and loss of asphalt binder.	Some loss of fine aggregate is visible, and the aggregate or binder has begun to wear away but not progressed significantly.	The surface texture is becoming rough and pitted. Loose particles exist and loss of fine aggregate and some loss of coarse aggregate.	Aggregate and binder have eroded and the surface texture is very rough and pitted due to the loss of coarse aggregate.

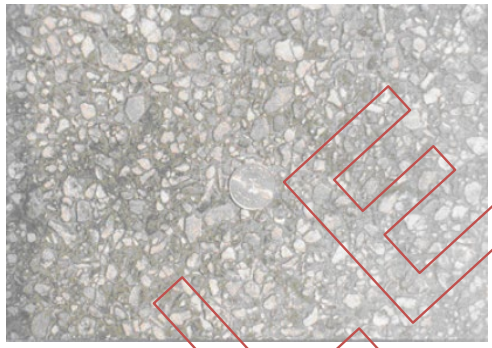
	Distress Type	Description	Severity		
			Low	Moderate	High
13	Rutting	Longitudinal surface depression on the wheel path that may have associated transverse displacement.	No severity level is applicable. However, it can be defined by categorizing the measurement taken, and it is necessary to keep a record of the measurement taken because it is more accurate and repeatable than severity levels. .		
14	Shoving	Longitudinal displacement of a localized area of the pavement that caused by braking or accelerating vehicles. It is usually located on hills, curves, or at intersections and may have associated vertical displacement.	No severity level is applicable. However, severity can be defined by the relative effect of shoving on ride quality.		

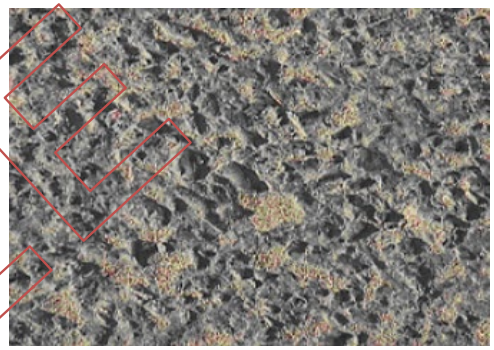
	Distress Type	Severity		
		Low	Moderate	High
1	Cracking: Alligator or Fatigue			

	Distress Type	Severity		
		Low	Moderate	High
2	Cracking: Block			
3	Cracking: Edge			

	Distress Type	Severity		
		Low	Moderate	High
4	Cracking: Longitudinal & Transverse			
6	Cracking at joints: Reflection			
7	Bleeding			

	Distress Type	Severity		
		Low	Moderate	High
8	Patch/Patch Deterioration			
9	Lane-to-shoulder drop off			

	Distress Type	Severity		
		Low	Moderate	High
10	Polished Aggregate			
11	Potholes			

	Distress Type	Severity		
		Low	Moderate	High
12	Raveling and Weathering			
13	Rutting			

	Distress Type	Severity		
		Low	Moderate	High
14	Shoving			

Attachment 2 – EOM-ZMO-TP-000134 Pavement Distress Treatment Matrix

Type of distress	Severity Level	Treatment												
		Full-depth crack repair	Clean and seal	Saw and seal	Rout and seal	Crack filling	Patching	Chip seal or seal coat	Thin hot mix overlay	Fog seal	Seal coat	Double chip seal	Slurry seal	Micro-surfacing
Cracking: Alligator or Fatigue	Low							X						
	Moderate						X							
	High						X							
Cracking: Transverse	Low		X		X			X						
	Moderate		X		X	X		X						
	High	X				X	X	X						
Cracking: Longitudinal	Low		X		X	X								
	Moderate	X	X		X	X								
	High	X				X	X							
Cracking: Block	Low		X		X			X						
	Moderate							X	X					
	High					X	X		X					
Cracking at joints: Reflection	Low		X		X									
	Moderate		X		X	X								
	High		X			X	X		X					
Potholes	Low						X							
	Moderate						X							
	High						X							
Patch deterioration	Low													
	Moderate						X							

Type of distress	Severity Level	Treatment												
		Full-depth crack repair	Clean and seal	Saw and seal	Rout and seal	Crack filling	Patching	Chip seal or seal coat	Thin hot mix overlay	Fog seal	Seal coat	Double chip seal	Slurry seal	Micro-surfacing
	High						X							
Rutting	Low						X						X	X
	Moderate						X		X				X	X
	High						X		X					X
Shoving	Low													
	Moderate						X							
	High						X							
Bleeding	Low										X	X	X	X
	Moderate										X	X	X	X
	High								X		X	X	X	X
Polished Aggregate	Low										X	X	X	X
	Moderate								X		X	X	X	X
	High								X		X	X	X	X
Raveling	Low									X				
	Moderate									X	X			
	High						X		X		X	X	X	X

Attachment 3 – EOM-ZM0-TP-000135 – Pavement Maintenance Activities Checklist

PROJECT NAME:	DRAWING REF Numbers.	REV.

No.	INSPECTION ITEM	CHECKED SATISFACTORY		
		N/A	YES	NO
1.0	**SITE ACTIVITIES (WEEKLY ROUTINE)**			
1.1	Taking out and removal of debris	☐	☐	☐
1.2	General Cleaning works	☐	☐	☐
1.3	Occurrence of any surface defects	☐	☐	☐
1.4	Roadside vegetation cleaning works	☐	☐	☐
2.0	**SITE ACTIVITIES (MONTHLY ROUTINE) or (IF REQUIRED AS PER SITE CONDITION)**			
2.1	Surface failures	☐	☐	☐
2.2	Standing water removal	☐	☐	☐
2.3	Potholes patching	☐	☐	☐
2.4	Cracks repairing and sealing	☐	☐	☐
2.5	Joints repairs	☐	☐	☐
2.6	Rutting repairs	☐	☐	☐
3.0	**LIST SITE CONDITION AND DEFECTS**			
4.0	**LIST SPECIFIC PM NOTES**			
5.0	**LIST CORRECTIVE/FOLLOW UP ACTIONS**			

No.	Reviewer's Comments	Resolution

Originator's Name/Signature and Date:	Checker's Name/Signature and Date: