



WORKING PAPER

ASSEMBLY — 42ND SESSION

TECHNICAL COMMISSION

Agenda Item 24: Aviation Safety and Air Navigation Priority Initiatives

**DEFINING A FRAMEWORK FOR PREVENTIVE PAVEMENT
MAINTENANCE AT AERODROMES: CHALLENGES,
OPPORTUNITIES, AND THE EXPERIENCE OF THE
ISLAMIC REPUBLIC OF IRAN**

(Presented by Iran (Islamic Republic of))

EXECUTIVE SUMMARY

Pavement preventive maintenance plays a critical role in reducing the lifecycle cost of pavements by shifting from reactive, emergency-based interventions to proactive, data-driven strategies. Given the high capital investment in airfield pavements and their fundamental role in aerodrome safety and operability, implementing a structured preventive approach yields substantial benefits, ranging from enhanced safety and environmental sustainability to cost efficiency and operational predictability. This working paper explores the challenges and opportunities associated with implementing a preventive pavement maintenance framework, presenting the regulatory experience developed and deployed by the Civil Aviation Authority (CAA) of Iran. While Annex 14 — *Aerodromes* of the ICAO standards emphasizes the importance of preventive management, there is no practical guideline to implement. This paper proposes a comprehensive structure tailored to movement areas in aerodromes.

Action: The Assembly is invited to:

- create a workgroup to develop a framework, detailed technical guidelines and regulations to implement pavement preventive maintenance in a universal format;
- feasibility study by the workgroup for the mandatory reporting of pavement condition index (PCI) from airports to CAA (like pavement classification rating (PCR) and the global reporting format for assessing and reporting runway surface conditions (GRF) and etc.); and
- define the training requirement of related personnel accountable for conducting pavement preventive maintenance.

<i>Strategic Goals:</i>	This working paper relates to <i>Every Flight is Safe and Secure</i> .
<i>Financial implications:</i>	
<i>References:</i>	Annex 14 — <i>Aerodromes</i> , Volume I — <i>Aerodrome Design and Operations</i> Doc 9157, <i>Aerodrome Design Manual</i> , Part 3 — <i>Pavements</i> ASTM-D-5340-03

1. INTRODUCTION

1.1 This working paper first illustrates the advantages and challenges associated with the implementation of the pavement preventive management approach. It then presents the regulatory framework developed by Iran Civil Aviation Authority (CAA) to implement this methodology, including clearly defined minimum requirements of pavement condition necessary to ensure safe operations within aerodromes. Finally, the paper highlights the secondary benefits derived from the systematic collection of data obtained through the preventive maintenance process.

2. ADVANTAGES OF APPLYING PAVEMENT PREVENTIVE MAINTENANCE

2.1 *Safety enhancement.* Pavement preventive maintenance in movement areas, would lead to reduce foreign object debris (FOD) risks, ensure smooth aircraft operations during take-off, landing, and taxiing and also Improve skid resistance, minimizing hydroplaning risks.

2.2 *Environmental benefits.* Preventive maintenance reduces the need for heavy reconstruction, which this led to less material use, Less energy consumption and less emissions and construction waste.

2.3 *Pavement life expansion.* Preventive maintenance slows down the rate of pavement deterioration by addressing minor issues (e.g., small cracks, surface wear) before they evolve into major structural problems. This helps maximize the lifespan of the pavement, often by several years.

2.4 *Minimizing the disruption to airport operations.* Preventive maintenance can often be scheduled during off-peak hours and requires less downtime than major repair projects, which minimizes disruption to flight schedules and also Avoids extended closures of runways or taxiways.

2.5 *Improvement of asset management.* The preventive maintenance approach, benefit from a data-driven approach. This leads to better forecasting of maintenance needs, efficient resource allocation and develops a Justification for funding and budgeting in resource allocation for decision makers.

2.6 *Cost-effectiveness during design life of the pavement.* Preventive treatments are significantly cheaper than major rehabilitation or full reconstruction. Investing in low-cost, timely maintenance (e.g., crack sealing, surface treatments) avoids high future costs from emergency repairs or pavement failures.

3. CHALLENGES OF APPLYING PAVEMENT PREVENTIVE MAINTENANCE

3.1 *Regulation requirement.* Although Annex 14 — *Aerodromes*, Chapter 10, 10.2.1 highlights the need for a preventive maintenance program, it lacks a clear and comprehensive definition of the framework required for its implementation. This gap often results in subjective interpretations, where reactive measures are mistakenly regarded as preventive actions. Establishing a well-defined framework, supported by explicit regulations, would help shift the assessment of pavement conditions from a subjective to an objective process, promoting uniform application across all airports. It is essential that national regulations clearly specify acceptable, tolerable, and unacceptable thresholds for overall pavement performance indicators, as well as the permissible levels for each specific type of distress.

3.2 *Training of the personnel.* One of the primary elements that must be considered in the implementation of a preventive approach is the training of personnel involved in pavement preventive maintenance. This requirement applies to two key areas: the survey and monitoring of pavement distress (pavement condition assessment), and the execution of remedial actions (applying pavement maintenance and repair action). The training is particularly critical in relation to the personnel responsible for survey, as their role constitutes the first step in the preventive management process. Subsequent actions rely entirely on the accuracy and quality of the inspection data which has been collected at this stage. A thorough understanding of the types of pavement distresses, methods for assessing the severity and quantity of these distresses, proper data recording, and the establishment of a data-driven decision-making system, as well as the ability to propose appropriate repair and rehabilitation, are all essential competencies that pavement inspectors must be adequately trained in.

3.3 *Equipment.* Although more advanced approaches require the use of remote sensors or laser-based scanning devices, the absence of such tools does not hinder the pavement inspection process. Reliance on visual inspection methods by trained inspectors (using basic tools such as distance measuring devices, camera, and simple positioning device—is sufficient for conducting surface audits and can adequately support the pavement inspection process.

3.4 *Disruption of the traffic flow during inspections.* During inspection and survey of manoeuvring areas, whether inspections are conducted visually or using surface scanning vehicles, surfaces need to be closed. However, because of its monthly frequency of inspection, it can be scheduled during periods when the surfaces are closed (due to repairs, other inspections, operational reasons and etc.) or when traffic is minimal. Moreover, the use of digital surface scanning equipment significantly reduces the required surface closure time for inspections.

4. DEVELOPMENT OF PREVENTIVE PAVEMENT MANAGEMENT REGULATIONS

4.1 Determining type, severity and quantity of distress and calculation of pavement condition index (PCI)

4.1.1 In developing regulations for preventive pavement management, it is essential first to define the various types of pavement distresses and establish clear criteria for determining their extent and severity. Accordingly, based on ASTM-D-5340-03 standards, diagnostic criteria for each distress type—including measurement of quantity (both linear and areal) and classification of severity (low, medium, and high)—have been established.

4.1.2 The defined distress types include 16 categories for flexible pavements (including alligator cracking, bleeding, block cracking, bumps and sags, corrugation, depression, jet blast erosion, joint reflection cracking, longitudinal and transverse cracking, oil spillage, patching, polished aggregate, ravelling, rutting, shoving, weathering) and 15 categories for rigid pavements (including: blow-up, corner breaks, durability cracking (d-cracking), faulting, joint seal damage, joint spalling, linear cracking, map cracking, patching, pop-outs, pumping, scaling, shattered slab, shrinkage cracks, surface spalling)

4.1.3 In the proposed regulations, the full and comprehensive survey of these distresses is mandatory; the use of random sampling methods) despite it is recommended in the American Society for Testing and Materials (ASTM) standards (is not considered acceptable. Conducting a complete survey, would lead to reduces data uncertainty and associated operational risks, and effectively narrowing the margin of error.

4.1.4 Distress survey should be conducted for each segment, with considering type, severity and quantity of each distress and based on calculations, it represented as a PCI which shows the overall condition of pavement for each segment.

5. CRITERIA FOR MINIMUM OPERATIONAL CONDITIONS FOR MOVEMENT AREA:

5.1 It is necessary to define regulatory thresholds as risk mitigation measure in movement area to constrain the level of risk. These thresholds are defined both separately (for each type of distress) and cumulatively (PCI for each segment)

5.2 *Minimum operational condition using each segment's PCI.* The development of these indices takes into account the sensitivity, type, and operational speed of the surface areas. Three categories of indices are defined based on operational speed zones:

- a) high-speed zones – including Runways, high-speed exit taxiways;
- b) medium-speed zones – including Taxiways; and
- c) low-speed zones – including Aprons and stands.

5.2.1 For each segment, acceptable, tolerable, and unacceptable thresholds for PCI defined as shown in Figure1. This criterion ensures the overall function of pavement is in safe condition.

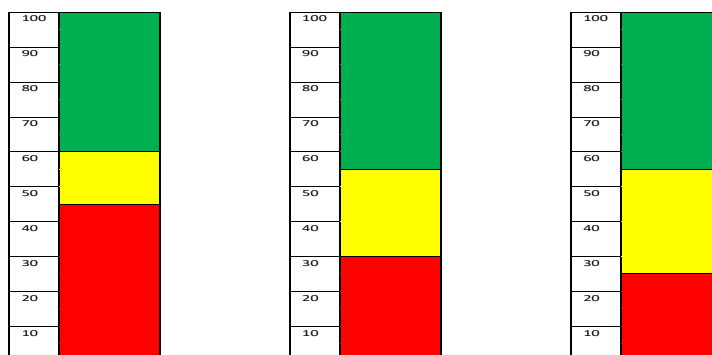


Figure 1. Acceptable(green), tolerable(yellow) and unacceptable PCI for High speed(left) medium speed(yellow) and low speed(right) surfaces.

5.3 *Distress severity restrictions.* For each type of surface distress, the following severity classifications are applied:

- a) low severity: acceptable;
- b) medium severity: tolerable; and
- c) high severity: unacceptable.

5.3.1 These limitations ensure that besides each distress considered in the overall PCI and its restriction, also each distress of the pavement separately remains within acceptable limits and the risk of operation on distressed pavement maintains in tolerable limits.

6. CONCLUSION

6.1 There are two facts that underscore the growing need for more emphasize on preventive pavement maintenance methods:

- a) The high efficiency and multiple advantages of these methods: as mentioned these benefits including reduced maintenance costs and time, improved pavement performance, and environmental benefits—demonstrate their strategic value. A 35 to 60 per cent reduction in pavement maintenance costs is a substantial outcome that cannot be overlooked.
- b) The fundamental nature of these methods is based on visual inspection, which does not require advanced equipment or complex technology. Instead, trained personnel equipped with basic tools can collect valuable information to support pavement maintenance decision-making. Furthermore, many of the challenges associated with visual inspection methods are manageable and can be effectively addressed in practice.

6.2 In the proposed approach, existing standards and definitions are adapted, in conjunction with defined threshold limits for each individual distress and overall PCI of each segment to develop a quantitative, performance-based assessment framework. This framework enables proactive maintenance planning, reduces the risk of severe pavement failures, and directly contributes to enhancing operational safety.

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