

INFORMATION PAPER

INTERNATIONAL CIVIL AVIATION ORGANISATION
REGIONAL OFFICE, BANGKOK

WORKSHOP ON AIRPORT PAVEMENT DESIGN AND EVALUATION
MACAO CHINA, 4-6 MARCH 2015

ICAO POSITION AND ACTIVITIES
PRESENTED BY ICAO SECRETARIAT

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ICAO POSITION AND ACTIVITIES – DESIGN, REPORTING AND MAINTENANCE OF PAVEMENTS

1. Introduction

This paper describes the current requirements in ICAO concerning the design, evaluation, and maintenance of pavements and reporting of their bearing strength. ICAO was established in 1944 as a specialized agency of the United Nations with a mandate to promote the safe and orderly development of International Civil Aviation throughout the world. To achieve the highest practicable degree of uniformity worldwide, ICAO has developed international Standards and Recommended Practices (SARPs) to facilitate and improve air safety, efficiency and regularity. Annex 14, Volume I contains these SARPs concerning aerodrome requirements which includes airport pavements.

2. Existing specifications and guidance material related to aerodrome pavements

2.1 Design of pavements

An aerodrome pavement should be able to support the loads imposed by the aircraft without excessive distortion or failure. It should be firm, stable, smooth and free from debris. It must provide adequate skid resistance and must be usable in all seasons and weather conditions. The ability of the pavement to perform the above functions for given aircraft traffic depends upon the foundation or sub grade, the quality of construction materials and workmanship, the design and proportioning of materials in different layers of the pavement system and the thickness of the layers of the pavement system.

2.1.1 Specifications contained in Annex 14, Volume I (Sixth Edition 2013):

Runway: The recommendation in paragraph 3.1.21, states that a runway should be capable of withstanding the traffic of aeroplanes the runway is intended to serve. In addition specifications related to pavement design on surface irregularities, friction characteristics, surface texture depth and surface grooving/scoring are contained in paragraphs 3.1.22 to 3.1.27.

Runway shoulders: The recommendation in Paragraph 3.2.5 states that a runway shoulder should be prepared or constructed so as to be capable, in the event of an aeroplane running off the runway, of supporting the aeroplane without inducing structural damage to the aeroplane and of supporting ground vehicles which may operate on the shoulder.

Runway turn pads: The recommendation in Paragraph 3.3.9 states that the strength of a runway turn pad should be at least equal to that of the adjoining runway which it serves, due consideration being given to the fact that the turn pad will be subjected to slow moving traffic making hard turns and consequent higher stresses on the pavement. Further the note under this Para states that where a turn pad is provided with flexible pavement, the surface would need to be capable of withstanding the horizontal shear forces exerted by the main landing gear tires during turning maneuvers. In addition

specifications related to surface irregularities and friction characteristics are contained in paragraphs 3.3.10 and 3.3.11.

Shoulders for runway turn pads: The recommendation in Paragraph 3.3.13 states that a runway turn pad shoulder should be capable of withstanding the occasional passage of the aeroplane it is designed to serve without inducing structural damage to the aeroplane and to the supporting ground vehicles that may operate on the shoulder.

Stop ways: The recommendation in Paragraph 3.7.3 states that a stop way should be prepared or constructed so as to be capable, in the event of an abandoned take-off, of supporting the aeroplane which the stop way is intended to serve without inducing structural damage to the aeroplane. In addition specification related to friction characteristics is contained in paragraph 3.7.4.

Taxiways: The recommendation in Paragraph 3.9.13 states that the strength of a taxiway should be at least equal to that of the runway it serves, due consideration being given to the fact that the taxiway will be subjected to a greater density of traffic and as a result of slow moving and stationary aeroplanes, and consequent higher stresses than the runway it serves. Specification on surface irregularities and friction characteristics is contained in paragraphs 3.9.14 and 3.9.15.

Apron: The recommendation in Paragraph 3.13.3 states that each part of an apron should be capable of withstanding the traffic of the aircraft it is intended to serve, due consideration being given to the fact that some portions of the apron will be subjected to a higher density of traffic and as a result of slow moving or stationary aircraft, to higher stresses than a runway.

De-icing/anti-icing pads: The recommendation in Paragraph 3.15.8 states that deicing/anti-icing pad should be capable of withstanding the traffic of the aircraft it is intended to serve, due consideration being given to the fact that the deicing/anti-icing pad (like an apron) will be subjected to a higher density of traffic and as a result of slow moving or stationary aircraft, to higher stresses than a runway.

2.1.2 Guidance material: The Aerodrome Design Manual, Part 3, Pavements (Doc 9157), chapter 4 includes guidance on the design of aerodrome pavements. This material is based on the practices of 4 States namely- Canada, France, United Kingdom and United States. In addition Chapter 5 of this manual describes the methods used for improving the surface texture. This Document was published in 1984 and is under revision.

2.2 Evaluation and reporting of pavement bearing strength

2.2.1 Information on the strength of pavements in an airport is required by all users to decide on the type of aircraft and its operating mass to operate at the airport and to safeguard pavement integrity thus assisting optimum service life. In the past, the strength of pavements was reported differently by States which resulted in misinterpretations by the users. In 1977, ICAO developed a single standardized method of reporting pavement strengths, called the Aircraft Classification Number- Pavement Classification Number (ACN-PCN) method and in 1981 introduced the ACN-PCN method into the ICAO Annex 14, Volume I.

2.2.2 The ACN and PCN are defined as follows:

Aircraft Classification Number (CAN): A number expressing the relative effect of an aircraft on a pavement for specified standard sub grade category

Pavement Classification Number (PCN): A number expressing the bearing strength of a pavement for unrestricted operations.

The ACN-PCN method is meant only for reporting pavement strength data in the Aeronautical Information Publication (AIP) and is not intended for the design and evaluation of pavements. The elements of the ACN-PCN method and the codes to be used in reporting pavement data in the Aeronautical Information Publications (AIP) are dealt with in paragraph 2.6.3 to 2.6.8 of Annex 14, Volume I.

Specifications: Annex 14, paragraph 2.6.1 specifies that the bearing strength of a pavement shall be determined. Annex 14 specifies two different methods for reporting the pavement strength – 1) applicable for aircraft of apron (ramp) mass greater than 5700kg and 2) for aircraft of apron (ramp) mass equal to or less than 5700kg.

Paragraph 2.6.2 specifies that the bearing strength of a pavement intended for aircraft of apron mass greater than 5700kg shall be made available using the ACN-PCN method by reporting all of the following information (Example of reporting PCN information is: 80/R/ B/ W/ T).

- Numerical PCN value- This is a relative indication of the load carrying capacity of a pavement in terms of a standard single wheel load (1.25Mpa).

- Pavement type- Pavement may be either

Rigid(R) – single stiff layer to support and distribute load (cement concrete slab) or

Flexible (F)-multiple layers to distribute load (bituminous wearing surface and base course, crushed stone base course, granular sub base courses etc).

Composite pavements (overlays) are reported as the type which most accurately reflects the structural action.

- Sub-grade category- High strength-A, Medium strength-B, Low strength- C and ultra-low strength- D

- Maximum tire pressure allowable – Unlimited: no pressure limit-W; High: pressure limited to 1.75MPa-X, Medium: pressure limited to 1.25 MPa- Y, Low: pressure limited to 0.50 MPa- Z

- Method used to determine the PCN value- PCN value can be determined in two ways

1) Using aircraft experience [representing a knowledge of the specific type and mass of aircraft satisfactorily being supported under regular use] -U and

2)-Technical Evaluation [PCN based on technical study of pavement characteristics and application of pavement behavior technology]-T

The PCN reported shall indicate that an aircraft with an ACN equal to or less than the reported PCN can operate on the pavement subject to any limitation on the tire pressure, or aircraft all-up mass for specified aircraft types.

2.2.3 Determination of ACN: The method of calculating an aircraft classification number (ACN) is specified by ICAO. The ACN of an aircraft shall be determined in accordance with the standard procedures associated with the ACN-PCN method and is given in the Aerodromes Design Manual, Part 3. For convenience several aircraft types currently in use have been evaluated on rigid and flexible pavements founded on the four sub grade categories (A,B,C and D) and the results tabulated in the manual. Official ACN values are published by aircraft manufacturers in the documents detailing the characteristics of their aircraft.

2.2.4 Mathematically Derived Single Wheel Load: The concept of a mathematically derived single wheel load has been employed in the ACN-PCN method as a means to define the landing gear/pavement inter-action without specifying pavement thickness as an ACN parameter. This is done by equating the thickness given by the mathematical model for an aircraft landing gear to the thickness for a single wheel load at a standard tire pressure of 1.25MPa. The single wheel load so obtained is then used without further reference to the thickness; this is so because the essential significance is attached to the fact of having 'same applied stress to the pavement', rather than the magnitude of the thickness. The ACN of an aircraft is numerically defined as two times the derived single wheel load. The derived single wheel load is a function of the sub grade strength.

2.2.5 Overload operations: Para 2.6.7 recommends, that criteria must be established to regulate the use of pavement by an aircraft with an ACN higher than the PCN reported for that pavement. This is intended to prevent premature failure of pavements due to indiscriminate overloading. Attachment A, section 20 of Annex 14, Volume I details a simple method for regulating overload operations. Aerodrome Design Manual Part 3- Pavements includes the descriptions of more detailed procedures for evaluation of pavements and their suitability for restricted overload operations.

2.2.6 Procedure for pavements meant for light aircraft: Para 2.6.8 specifies that the bearing strength of a pavement intended for aircraft of apron (ramp) mass equal to or less than 5700kg shall be made available by reporting a) maximum allowable aircraft mass: and b) maximum allowable tire pressure.
Example- 4000kg/0.50MPa

2.2.7 Guidance material: Detailed background information on the procedures for reporting the aerodrome pavement strength using ACN-PCN method is contained in Chapter 1 of the Aerodrome Design Manual, Part 3, Pavements (Doc 9157). Included in chapter 2 and chapter 3 of this manual is Guidance on regulating overload operations and the techniques that could be employed for evaluation of pavements.

2.3 Maintenance of Pavements

2.3.1 Specification and Guidance material: Annex 14, chapter 10, paragraph 10.1.1 recommends that a maintenance programme including preventive maintenance where appropriate should be established at an aerodrome to maintain facilities in a condition which does not impair the safety, regularity or efficiency of air navigation. Preventive maintenance is programmed maintenance work done in order to prevent failure or degradation of facilities. Facilities are intended to include such items as – pavements, visual aids, fencing, drainage systems and buildings. The design and application of the maintenance programme should observe Human Factors principles.

There are three ICAO Manuals which include guidance on matters related to the maintenance of pavements. These are Airport services Manuals (Doc 9137),

Part 2- Pavement surface conditions,
Part 8- Airport Operations Services and
Part 9 - Airport Maintenance Practices.

Part 2 includes guidance on measuring and expressing friction characteristics and improving them where necessary. Part 8 provides guidance to airport management on the organization of airport's operational and maintenance services. Part 9 includes detail guidance on the broader subject of maintenance of pavements and drainage systems.

Specific Annex 14 provisions: Provisions for maintenance of pavements are related to several aspects including clearance of debris, runway surface friction characteristics and pavement overlays.

Clearance of debris: Debris left on pavements could cause damage to tires, propellers and engines and effect aircraft operating costs and affect safety of aircraft operations. Debris includes a wide range of objects-stones, sand, vegetation, fragments of pavements from deteriorated pavement, mechanical parts from equipment, litter of paper, plastic, wood and any loose material. To guard against this regular inspection and cleaning of movement areas are required Para 10.2.1 states that the surface of pavements (runways, taxiways, aprons and adjacent areas) shall be inspected and their conditions monitored regularly as part of an aerodrome preventive and corrective maintenance programme with the objective of avoiding and eliminating any loose objects/debris that might cause damage to aircraft or impair the operation of aircraft systems.

Para 10.2.7 recommends that when a taxiway is used by turbine engine aeroplanes the surface of the taxiway shoulders should be maintained so as to be free of any loose stones or other objects that could be ingested by the aeroplane engines. Details of procedures and equipment used for clearance of debris are available in the Airport services Manual Part 2 and Part 9 (Doc 9137).

Surface irregularities: Para 10.2.2 states, that the surface of a runway shall be maintained in a condition such as to prevent formation of harmful irregularities. Harmful irregularities may be caused by failures in the surface texture which can affect the surface characteristics of the pavement, including depression in longitudinal or transverse grade and abnormalities such as cracking or faulted joints. Some guidance on this is contained in attachment A to Annex 14, Volume I, Section 5.

Runway surface friction characteristics: Para 3.1.23 states that, the surface of a paved runway shall be so constructed as to provide good friction characteristics when the runway is wet. Para 10.2.5 recommends that corrective maintenance action should be considered when the friction characteristic for either the entire runway or a portion thereof are below a maintenance planning level specified by the State. Further Para 10.2.8 states that the surface of a paved runway shall be maintained in a condition so as to provide good friction characteristics and low rolling resistance. Snow, slush, ice, mud, dust, standing water oil, rubber deposits and other contaminants shall be removed as rapidly and completely as possible to minimize accumulation. Details of procedures and equipment for the clearance of contaminants are given in Airport Services Manual, Part 2- Pavement Surface condition (Doc 9137). Guidance on evaluating the friction characteristics of a runway is provided in Attachment A, Section 7 of Annex 14, Volume I.

2.4 ICAO Future work Programme

- a) Total rewrite of ICAO Document 9157- Aerodrome Design Manual, Part 3, Pavements- estimated completion date is end of 2015;
- b) Unpaved surface requirements- structural bearing strength of unpaved shoulders and RESAs. Revision to ADM Part 1- Runways
- c) Revised ICAO overload guidance for Annex 14, Volume I- The introduction of new and heavier aircraft require current ICAO provisions for permitting overloading operations on runways and movement areas to be reviewed
- d) New ACN/PCN procedures -The 30-year old ACN/PCN pavement reporting system needs to be redeveloped in light of new and emerging technologies in pavement engineering; and
- e) Introduce the requirement of a Pavement Management System (PMS) in ASM Part 9 Airport Maintenance Practices, Chapter 1 (Annex1) and later in Attachment A, Vol. I, Annex 14 (Annex 2).
