Public Authority for Civil Aviation

GUIDANCE FOR

OVERLOADING OF PAVEMENTS AT AERODROMES

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Foreword

This document outlines the general criteria and guideline to be followed by an aerodrome operator on the use of pavements by aircraft with an Aircraft Classifications Number (ASN) higher than the reported Pavement Classification Number (PCN) of an aerodrome pavement.

This manual is effective from 15 October 2018.

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ACRONYMS

ACN – Aircraft Classification Number

PCN – Pavement Classification Number

CBR – California Bearing Ratio

ICAO – International Civil Aviation Organization

P – Actual Load

P_o – Allowable Load

MTOW - Maximum Take-Off Weight (kg)

OWE - Operating Weight Empty (kg)

TP - Tire Pressure (MPa)

DEFINITIONS

Aircraft Classification Number (ACN) – A number expressing the relative damaging effect of aircraft on a pavement for a specified standard subgrade strength.

The airplane manufacturer provides the official computation of an ACN value. Computation of the ACN requires detailed information on the operational characteristics of the airplane such as maximum aircraft center of gravity, maximum ramp weight, wheel spacing, tire pressure, and other factors.

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

The PCN numerical value is determined from an allowable load rating. An allowable load rating is determined by applying the same principles as those used for pavement design. The process for determining the allowable load rating takes factors such as frequency of operations and permissible stress levels into account. Allowable load ratings are often stated in terms of airplane gear type and maximum gross airplane weight, as these variables are used in the pavement design procedure.

1 PURPOSE OF THIS GUIDANCE DOCUMENT

The purpose of this document is to provide aerodrome operators with guidance on how to meet specific requirements in relation to the bearing strength of aerodrome pavements. Operators of regulated aerodromes are required to provide pavements on which aircrafts can operate safely and they are required to rate the strength of the pavements using the ICAO accepted ACN-PCN method. This document briefly explains the ACN-PCN method and offers guidelines on what degree of overloading can be considered acceptable for an aerodrome pavement.

This guidance document is aimed at persons who have an interest in the strength of aerodrome pavements such as:

- Aerodrome service providers
- Persons who specialize in aerodrome pavement design;
- Aerodrome regulators and technical specialists employed by the aerodrome operator to carry out safety inspections and technical inspections at regulated aerodromes; and

2 AERODROME PAVEMENTS

The purpose of an aerodrome pavement is to provide a durable surface on which aircraft can take-off, land and maneuver safely on the movement area of an aerodrome.

2.1 What is a Pavement?

A pavement is a load carrying structure constructed on naturally occurring in-situ soil, referred to as the subgrade. The pavement may be composed of a number of horizontal courses termed bound or unbound as described below:

- An unbound course being composed of materials, which are granular, mechanically stabilized or treated with additives to improve their properties other than strength, such as plasticity. Under load the unbound course behaves as if its component parts were not bound together, although significant mechanical interlock may occur.

- A bound course is one in which the particles are bound together by additives such as lime, cement or bitumen, so that under load the course behaves as a continuous system able to develop tensile stresses without material separation.

Pavement courses are also known by their location and function within the pavement structure as described below:

- The surface course provides a wearing surface and provides a seal to prevent entry of water and air into the pavement structure and subgrade preventing weathering and disintegration.
- The base course is the main load carrying course within the pavement.
- The sub-base course is a course containing lesser quality material used to protect and separate the base course from the subgrade and vice versa.

As mentioned above, the subgrade is the natural in-situ material on which the pavement is constructed. The use of select fill material may help improve the natural in-situ material and can also be a cost effective way to build up formation level.

2.2 Types of Pavements

2.2.1 Flexible Pavement

A flexible pavement is a structure composed of one or more layers of bound or unbound materials and may either be unsurfaced (unsealed) or surfaced with bituminous concrete or a sprayed bituminous seal. The intensity of stresses within the pavement from aircraft loads diminishes significantly with depth. The quality requirements of the materials used in any of the pavement layers is dependent on its position within the pavement. Typical flexible pavement design is shown in Figure 1.

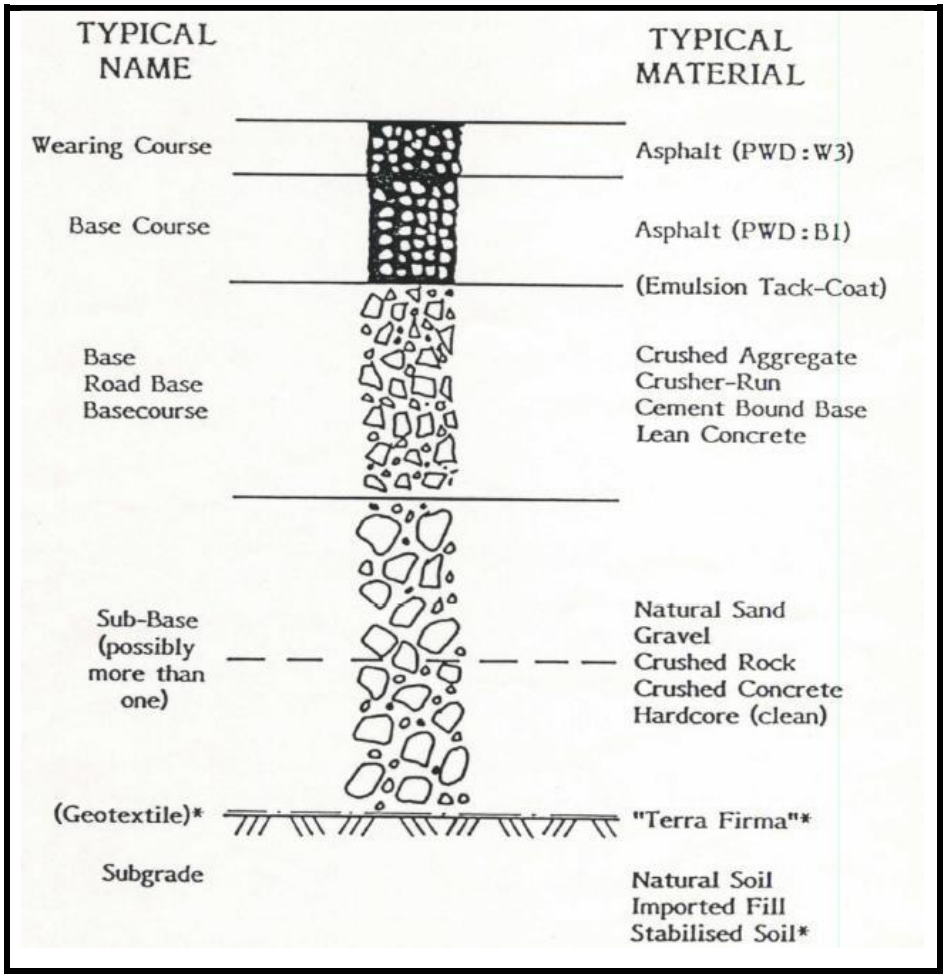

Figure 1: Flexible Pavement

2.2.2 Rigid Pavement

A rigid pavement is a structure comprising a layer of cement concrete (either steel-reinforced or unreinforced) which may be supported by a sub-base between the cement concrete and the subgrade. Unlike a conventional layered flexible pavement where both the base and sub-base layers contribute significantly to its structural properties, the major portion of the structural capacity of a rigid pavement is provided by the concrete base layer itself. This is because the high rigidity of the concrete slab distributes the load over a large area resulting in low stresses being applied to the underlying layers. Typical rigid pavement design is shown in Figure 2.

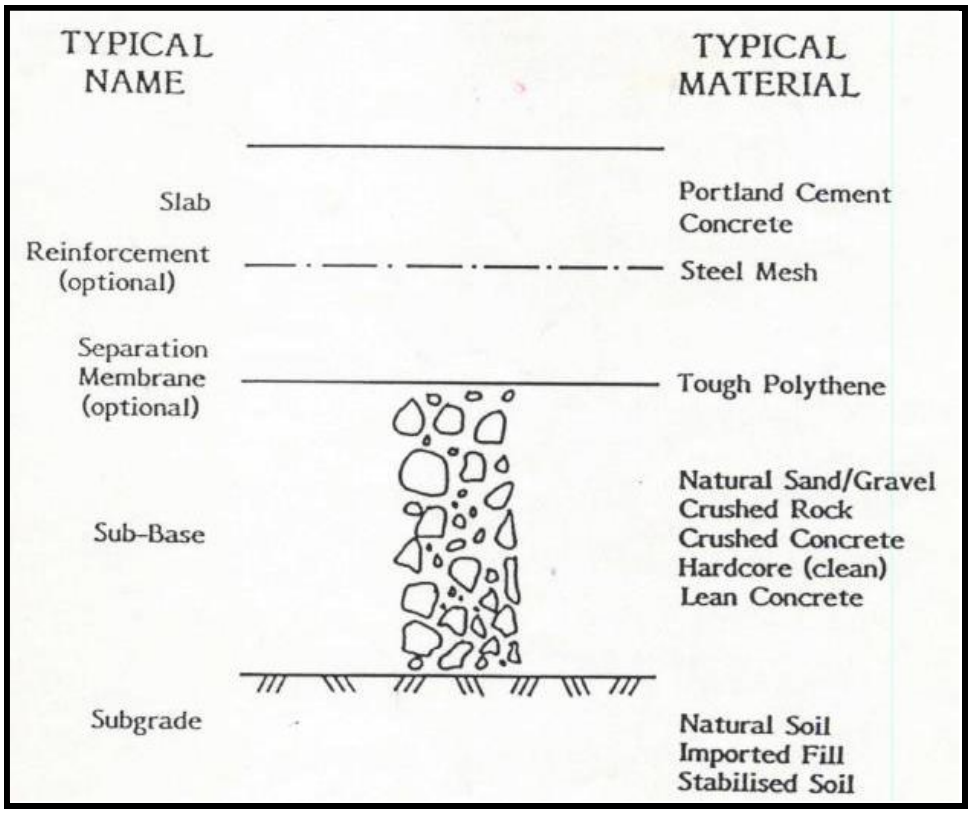

Figure 2: Rigid Pavement

3 SUBGRADE STRENGTH RATING

The ACN-PCN method adopts four standard levels of subgrade strength for rigid pavements and four levels of subgrade strength for flexible pavements.

3.1 Subgrade category

In the ACN-PCN method eight standard subgrade values (i.e. four rigid pavement k values and four flexible pavement CBR values) are used, rather than a continuous scale of subgrade strengths. The grouping of subgrades with a standard value at the mid-range of each group is considered to be entirely adequate for reporting. The subgrade strength categories are identified as high, medium, low and ultra-low and assigned the following numerical values given in Table 1:

	Flexible Pavement		Rigid Pavement	
Code	CBR Standard	CBR Range	k Standard (MN/m3)	k Range (MN/m3)
A (high)	15	>13	150	>120
B (medium)	10	8 to 13	80	60 to 120
C (low)	6	4 to 8	40	25 to 60
D (ultra-low)	3	<4	20	<25

Table 1: CBR and k values for different subgrade categories

3.2 Tire Pressure

The results of pavement research and re-evaluation of old test results shows that except for unusual pavement construction (i.e. Flexible pavements with a thin asphaltic concrete cover or weak upper layers), tire pressure effects are secondary to load and wheel spacing and may therefore be categorized in four groups for reporting purposes as: unlimited, high, medium and low and assigned the following numerical values given in Table 2:

Maximum allowable tire pressure category	Range (MPa)	Code
Unlimited	No limit	W
High	Limited to 1.75	X
Medium	Limited to 1.25	Y
low	Limited to 0.5	Z

Table 2: Maximum allowable tire pressure category

3.2.1 Tire Pressures on Rigid Pavements

Airplane tire pressure will have little effect on pavements with Portland cement concrete surfaces. Rigid pavements are inherently strong enough to resist tire pressures higher than currently used by commercial airplanes and can usually be rated as code W.

3.2.2 Tire Pressures on Flexible Pavements

Tire Pressures may be restricted on asphaltic concrete, depending upon the quality of the asphalt mixture and climatic conditions. Tire pressure effects on an asphalt layer relate to the stability of the mix in resisting shearing or densification. A poorly constructed asphalt pavement can be subject to rutting due to consolidation under load. The principal concern in resisting tire pressure effects is with stability or shear resistance of lower quality mixtures.

3.3 Operational Frequency

Operational frequency is defined in terms of coverage that represents a full-load application on a point in the pavement. Coverage must not be confused with other common terminology used to reference movement of airplanes. As an airplane moves along a pavement section it seldom travels in a perfectly straight path or along the exact same path as before. As the airplane moves along a taxiway or runway, it may take several trips or passes along the pavement for a specific point on the pavement to receive a full-load application. The number of coverage must be mathematically derived based upon the established pass-to-coverage ratio for each airplane.

3.4 Pavement Life

The life expectancy of a pavement is a direct function of:

- Environmental factors
- Quality of pavement material
- Traffic distribution
- Number of operations/repetitions of aircraft loading
- Aircraft characteristics - weight, tire pressure wheel configuration
- Overload operations

At some stage in the life cycle of the pavement failure modes will start appearing. The pavement is a structure and like all structures which are exposed to repeated loadings will eventually fail. The pavement distress can be arrested by following planned maintenance practices in accordance with an established pavement management system.

4 PAVEMENT OVERLOAD

Aerodrome pavements are designed and consequently rated to be able to withstand a specific number of repetitions or loadings by the critical or design aircraft without needing major pavement maintenance. There may be times when aircraft imposing more severe loadings than that which the pavement was designed for will seek approval to operate. These operations will not be permitted without the approval of the aerodrome operator. If required, a list of aircraft, which may impose severe pavement loading at an aerodrome to be made available to the authority concerned for granting approval for aircraft operations (landing clearance) in order to be aware of any restrictions (aircraft) at a particular aerodrome.

Pavements can sustain some overload, that is, pavement ratings are not absolute.

4.1 OVERLOAD GUIDELINES

Different pavement overload criteria have been used by various civil aviation organizations. The aerodrome operator should adopt a criterion that is compatible with the pavement management system in place at the aerodrome.

4.2 OVERLOADING STANDARDS FOR AERODROME IN THE SULTANATE OF OMAN

a) Occasional movements on a flexible pavement by aircraft with an ACN not exceeding 10 percent of the reported PCN should not adversely affect the pavement

b) Occasional movements on a rigid pavement by aircraft with an ACN not exceeding 5 percent of the reported PCN should not adversely affect the pavement

c) Where the pavement structure is unknown a limitation of 5 percent should apply

d) The annual number of overload movements should not exceed approximately 5 percent of the total annual aircraft movements

e) Overload movements are not be permitted on pavements exhibiting signs of distress or failure

f) Overloading should be avoided during periods when the strength of the pavement or subgrade could be weakened by water

g) The condition of the pavement should be regularly reviewed

5 ACNS FOR SEVERAL AIRCRAFT TYPES

For convenience, several aircraft types currently in use have been evaluated on rigid and flexible pavements founded on the four subgrade strength categories in CAR-139, Chapter 2, paragraph 2.6.6 b), and the results tabulated in the Aerodrome Design Manual (Doc 9157), Part 3.

For any other aircraft, it is advice to obtain the relevant information from the aircraft operator / manufacture or from any other source of information such as Transport Canada (www.tc.gc.ca).

6 REFERENCES

- CAR 139, Aerodrome Certification, Design and Operations
- ICAO, Aerodrome Design Manual Part 3 – Pavements, Doc 9157-AN/901
- Civil Aviation Safety Authority, Australia, Strength Rating Of Aerodrome Pavements, Advisory Circular