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DREJTOR EKZEKUTIV

Maksim Et'hemaj

REPUBLIKA E SHQIPERISE - MINISTRIA E INFRASTRUKTURËS DHE ENERGJISË - AUTORITETI I AVIACIONIT CIVIL - TIRANË

REPUBLIC OF ALBANIA

AUTORITETI I AVIACIONIT CIVIL

ALBANIAN CIVIL AVIATION AUTHORITY

AERODROME PAVEMENT STRENGTH GUIDANCE MATERIAL

ACAA-DAD-GM3-APS (Issue 01, Rev. 00)

Date: 18.12.2023

REPUBLIKA E SHQIPERISE - MINISTRIA E INFRASTRUKTURES DHE ENERGJISE - AUTORITETI I AVIACIONIT CIVIL - TIRANE

Approved by

Maksim Elhemaj

Executive Director of Albanian Civil Aviation Authority

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0. ADMINISTRATION

01. Record of Amendments

The table below describes the dates and reason for the different amendments of the current Guidance Material.
A vertical black line on the left-hand side of the page identify the changes with the previous version.

Issue No.	Revision No	Date	Amended by	Reason
01	00	18.12.2023		Initial Issue

02. Approval List

Action	Name and position	Date	Signature
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Accepted by:	Ms. Selma Pagria, Director of DAD	30.11.2023	
Reviewed by:	Mr. Elton Kacagjeli, Specialist SQSC Ms. Krista Garo, Head of SQSC Ms. Edlira Kraja, Director of DLS	14.12.23 14.12.23 14.12.23	
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03. Revision table

Page #	Issue No.	Revision No.	Date	Edited by

04. Distribution List

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05. Definitions & Acronyms

Term	Definition
ACN-PCN Method	A method to assign a pavement with a particular PCN value with an aircraft that has an ACN value equal to or less than the associated PCN.
Aerodrome	A defined area on land or water (including any buildings, installations and equipment) intended to be used either wholly or in part for the arrival, departure and surface movement of aircraft.
Aircraft Classification Number (ACN)	A number expressing the relative effect of an aircraft on a pavement for a specified standard subgrade strength. A component of the ICAO ACN-PCN method.
Aircraft classification rating (ACR) *(applicable as of 28 November 2024)*	A number expressing the relative effect of an aircraft on a pavement for a specified standard sub-grade strength. *Note: The aircraft classification number is calculated with respect to the centre of gravity (CG) position which yields the critical loading on the critical gear. Normally the aft most CG position appropriate to the maximum gross apron (ramp) mass is used to calculate the ACN. In exceptional cases the forward most CG position may result in the nose gear loading being more critical.*
Aircraft Stand	A designated area on an apron intended to be used for parking an aircraft.
Aggregate	General term for the mineral fragments or particles which, through the agency of a suitable binder, can be combined into a solid mass, e.g., to form a pavement.
All-up Mass/Weight	Aircraft maximum ramp or taxi mass, also referred as gross weight. (Not to be confused with MTOW)
Asphalt	Highly viscous binder occurring as a liquid or semi-solid form of petroleum, also referred as bitumen. May be found in natural deposits or may be a refined product.
Asphalt concrete	A graded mixture of aggregate, and filler with asphalt or bitumen, placed hot or cold, and rolled, also referred as asphaltic concrete or bitumen concrete.
Base course (or base)	The layer or layers of specified or selected material of designed thickness placed on a sub- base or subgrade to support a surface course.
Bearing strength	The measure of the ability of a pavement to sustain the applied load, also referred as bearing capacity or pavement strength.
Bound Base Material	Any material equivalent to a granular sub-base or better, which uses a cement or bituminous binder.
California Bearing Ratio (CBR)	An indication of the bearing capacity of a soil. It is determined by comparing the penetration load of a soil to that of a standard material. The method covers evaluation of the relative quality of subgrade soils but is applicable to sub-base and some base course materials.

Cement-Stabilised Soil	A relatively low-quality cement-bound material produced by the addition of the cement to a natural soil. Mixing can take place in situ or in a mixing plant.
Cohesive Soil	A soil which contains clay; forms a coherent mass. For determining relative compaction requirement, cohesive soils are taken as those with a Plasticity Index greater than or equal to 6%.
Composite Pavements	Pavements consisting of mixed rigid and flexible layers. These pavements are constructed using both cement concrete material and bituminous mixtures and normally assumed to act rigid pavement.
Coverages	The number of times an aircraft tyre passes over a particular point of a pavement surface, with the most frequently covered point on the pavement surface usually the point of interest.
Cumulative Damage Factor (CDF)	The (subgrade) cumulative damage factor (CDF) is the amount of the structural fatigue life of a pavement which has been used up. It is expressed as the ratio of applied load repetitions to allowable load repetitions to failure, or, for one airplane and constant annual departures.
Design Aircraft	The aircraft which imposes the most severe loading on the pavement.
Drylean Concrete	A low-strength Portland cement concrete generally used as a sub-base and/or base course under PQC or bituminous surfacing (see Rolled Dry lean Concrete) or as a working course. Water content and strength requirements are specified.
Equilibrium Moisture Content	The moisture content at any point in a soil after moisture movements have ceased.
Equivalent Coverages	The number of Coverages by one aircraft which has the same damaging effect on the pavement as a given number of Coverages by another aircraft.
Flexible Pavement	A pavement structure that maintains intimate contact with and distributes loads to the subgrade and depends on aggregate interlock, particle friction, and cohesion for stability.
Formation	The surface of the subgrade in its final shape after completion of the earthworks.
Frequency Trafficking	The level of Coverages for which the pavement is designed. There are three categories. High, Medium and Low.
Load Classification Group	A range of LCN values
Load Classification LCN Number	A number expressing the relative effect of an aircraft on a pavement or the bearing strength of a pavement.
Main Wheel Gear	The undercarriage leg used in ACN calculation.
Marshall Asphalt	An asphalt designed by the Marshall method to meet strict specification requirements in order to provide a durable, high stability flexible surfacing material.

Material equivalence factors	Values that allow the structural contribution of a thickness of one pavement material to be converted to an equivalent thickness of another material.
Maximum All-Up Weight	The higher of MTOW and MRW.
Maximum Ramp Weight	Maximum Take Off Weight plus any taxi/run-up fuel load.
Maximum Take Off Weight	The maximum aircraft weight allowable at take-off.
Mixed Traffic	A mixture of aircraft types using a pavement, all of which produce a calculable effect on the fatigue life of a pavement.
Mixed Traffic Factor	A figure used in converting Coverages by an aircraft with one ACN to equivalent Coverages by an aircraft with a different ACN. There are different MTF systems for Rigid (RMTF) and Flexible (FMTF) pavements.
Modulus of Subgrade Reaction (k)	The resistance of a subgrade to large scale vertical deformation when subject to a standard loading condition, usually performed in the field.
Movement Area	Pavements intended for use by aircraft, including runways, taxiways, aprons and other areas provided for the operation or maintenance of aircraft.
Multiple Slab Pavements	Pavements consisting of two or more concrete layers, with or without separating layers.
Non-cohesive soil	A granular soil; does not form a coherent mass. For determining relative compaction requirements, non-cohesive soils are taken as those with a Plasticity Index less than 6%.
Overlay	An additional layer or layers of structural pavements materials on an existing pavement either with or without intermediate base or sub-base courses, usually to strengthen the pavement or restore the profile of the surface.
Overload	Use of a pavement by aircraft with a classification (ACN) greater than the pavement classification (PCN).
Overslab	A concrete overlay.
Pass	An aircraft movement over a particular section of the pavement. Under certain conditions a pass may be taken as a movement by departing aircraft only.
Pavement	A structure consisting of a layer or superimposed layers of selected materials, whose primary purpose is to distribute the applied loads to the subgrade.
Pavement concession	Permission granted by an aerodrome operator to an aircraft operator to operate to/from a runway with a PCN lower than the aircraft ACN.
Pavement Classification Number (PCN)	A number expressing the bearing strength of a pavement for unrestricted operations by aircraft with aircraft classification number less than or equal to the pavement classification number. A component of the ICAO ACN-PCN method.
Pavement classification number rating (PCR)	A number expressing the bearing strength of a pavement for unrestricted operations.

Pass-to-coverage ratio **(P-C-R)**	The ratio between the number of aircraft passes and the number of aircraft coverages, affected by the wheel spacing and degree of aircraft wander across the width of the pavement, usually calculated for the pavement location that is most often covered, which is not the centreline.
Rigid Pavement	A pavement which distributes the load by means of its high flexural stiffness.
Sub-base course.	The layer or layers of specified selected material of designed thickness placed on a subgrade to support a base course.
Subgrade	The natural or made-up ground supporting the pavement also referred as the formation foundation.
Surface course.	The top course of a pavement structure, also referred as wearing course.
Take-off runway	A runway intended for take-off only.
Unrestricted operations	Operations that may occur without restraint because the ACN is lower than the PCN.

06. Abbreviations and Acronyms

Abbreviation or Acronym	Meaning
ACAA	Albanian Civil Aviation Authority
ACN	Aircraft Classification Number
ACR	Aircraft classification rating
AIP	Aeronautical Information Publication
AIS	Aeronautical Information Service
AO	Aerodrome Operator
CBR	California Bearing Ratio
CDF	Cumulative Damage Factor
DSWL	Derived single wheel load
EASA	European Union Aviation Safety Agency
FOD	Foreign object debris
FWD	Falling weight deflectometer
ICAO	International Civil Aviation Organization
K value	Modulus of Subgrade Reaction for Rigid Pavement
kN	Kilonewton
LEA	Layered Elastic Analysis
LRFD	Load and resistance factor design
LCN	Load Classification Group
MRGM	Maximum ramp gross mass
SARP	Standard and Recommended Practice
SMS	Safety Management System
SOP	Standard Operating Procedure
MO	Minister's Order
MTOW	Maximum Take-off Weight
OWE	Operating Weight Empty
PCA	Portland Cement Association
PCN	Pavement Classification Number
PCR	Pavement classification number rating
TP	Tyre Pressure

1. INTRODUCTION

1.1. Objective

The objective of this guidance material is to provide aerodrome operators with instructions on how to meet specific requirements in relation to reporting the strength of aerodrome pavements, and how to assess requests for operations when aircraft classification number or tyre pressure values exceed pavement strength parameters.

The purpose of an aerodrome pavement is to be capable of withstanding the traffic of airplanes which the aerodrome facility is intended to serve during take-off, land and manoeuvre on the movement area.

The aircraft/pavement classification system incorporated in this guide is the ICAO ACN-PCN method (applicable until 27 November 2024). This GM also introduces the up-to-date ACR-PCR method for reporting pavement bearing strength, a rating system that is due to come into effect on 28 November 2024.

Operators of aerodromes are required to rate the strength of the pavements using the ICAO accepted ACN-PCN method and publish the rating in the Albanian AIP.

1.2. Regulatory Framework

- Law No. 96/2020 “Air Code of the Republic of Albania”;
- Law No. 53/2022 “For the organisation and administration of the Civil Aviation Authority”;
- Decision of the Council of Ministers No. 1095/2020 “For the approval of the basic requirements in the field of civil aviation”
- Minister’s Order No. 130/2012 “Regulation for certification, registration of aerodromes and operation obligations and responsibilities falling on aerodrome operators”;
- Minister’s Order No. 170/2022 “Regulation for determining the requirements and administrative procedures related to the aerodromes in the Republic of Albania”;
- ICAO Doc 9157 – Aerodrome Design Manual, Part 3 “Pavements”;
- Annex 14, Volume 1 – Aerodromes Design and Operations;
- Easy Access Rules for Aerodromes (Regulation (EU) No 139/2014)

Law No. 96/2020 "Air Code of the Republic of Albania", Article 55 “Aerodrome Operator”, defines the provisions as follows:
The aerodrome operator guarantees the implementation of the conditions defined in the relevant regulations applicable to the safe landing and take-off of aircraft, security in aviation, the necessary services of ground handling of aircraft, as well as rescue services and firefighting measures.
Also, Article 53 “Construction of an Aerodrome” of Law No. 96/2020 “Air Code of the Republic of Albania” present provisions as follows:
For the planning and drafting of the technical documentation for the construction of an aerodrome, all applicable construction rules are applied, as well as the special rules for the construction of an aerodrome, which guarantee the fulfilment of operational safety requirements and aviation security requirements.

CAA approval for the construction of an aerodrome is not granted if the planned terrain is not suitable for the operation of the aerodrome, or there are other facts that prove that public safety is endangered.

Decision of the Council of Ministers No. 1095/2020 "For the approval of the basic requirements in the field of civil aviation", Annex 7 "Main requirements for airports" in point 1 "Physical characteristics, infrastructure and equipment", defines as follows:

1. Movement area

Aerodromes will have a designated area for landing and taking off aircraft, which meets
the following conditions:

a) the landing and take-off area must have suitable dimensions and characteristics for the aircraft intended to use the facility;

b) the landing and take-off area, where applicable, will have sufficient strength to support repeated operations of the target aircraft. Those areas not intended for repetitive operations should only be capable of assisting the aircraft;

c) the landing and take-off area must be designed to process water and prevent standing water from becoming an unacceptable hazard to aircraft operations;

Minister's Order No. 130/2012 "Regulation for certification, registration of aerodromes and operation obligations and responsibilities falling on aerodrome operators" in the Annex 1 "Manual of Standards for Airports" (MSA), Chapter 5, point A1 - 5.1.3.8 "Strength of Runway" explains how the bearing strength of the pavements should be reported on AIP using the ACN/PCN Method.

Minister's Order No. 170/2022 "Regulation for determining the requirements and administrative procedures related to the aerodromes in the Republic of Albania", Annex IV, Subdivision C - Aerodrome Maintenance, ADR.OPS. C.010 "Maintenance of Pavements, other land areas and drainage", in which is stated that:

b) The aerodrome operator must:

2.Maintain the surface of pavements, highways and platforms to prevent the formation of harmful irregularities.

Decision Nr.15 date 26.10.2022 of Executive Director "For acceptance of AMC, GM, CS issued by EASA".

The new ACR-PCR method is expected to be transposed in EASA regulatory framework with an ED Decision by the end of June 2024.

ICAO Annex 14, Volume 1 (9th edition, July 2022) requires that 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. For this SARPs concerning aerodrome design, evaluation, maintenance of pavements and reporting of their bearing strength are specified in this annex.

The recommendation in paragraph 2.6.1 & 2.6.2 (*applicable until 27 November 2024*), states that:

2.6.1 The bearing strength of a pavement shall be determined.

2.6.2 The bearing strength of a pavement intended for aircraft of apron (ramp) mass greater than 5 700 kg shall be made available using the aircraft classification number-pavement classification number (ACN-PCN) method by reporting all of the following information:

- pavement classification number (PCN);
- pavement type for ACN-PCN determination;
- subgrade strength category;
- maximum allowable tire pressure category or maximum allowable tire pressure value;
- evaluation method.

The recommendation in paragraph 2.6.1 & 2.6.2 *(applicable as of 28 November 2024)* states that:
2.6.1 The bearing strength of a pavement shall be determined.
2.6.2 The bearing strength of a pavement intended for aircraft of apron (ramp) mass greater than 5 700 kg shall be made available using the aircraft classification rating-pavement classification rating (ACR-PCR) method by reporting all of the following information:

- pavement classification rating (PCR) and numerical value;
- pavement type for ACR-PCR determination;
- subgrade strength category;
- maximum allowable tire pressure category or maximum allowable tire pressure value;
- evaluation method.

Guidance on reporting and publishing of PCNs and PCRs is contained in the Aerodrome Design Manual (Doc 9157, Part 3, Pavements, Third Edition 2022).

This guidance material for aerodrome pavement strength evaluation and report, provides the guidelines to assess the information on the strength of pavements in an airport which 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.

1.3. Requirements

Assessing and reporting the bearing capacity of airfield pavements have always been significant task in airport engineering, since they support the decision-making procedure, which is a core element of Airport Pavement Management Systems (APMS). The official reporting system utilized worldwide during the last four decades is the Aircraft Classification Number – Pavement Classification Number (ACN-PCN) system. However, recently an updated system has been introduced, aiming to overcome the defects of the ACN-PCN system that have been observed during its implementation. This system, referred as the Aircraft Classification Rating – Pavement Classification Rating (ACR-PCR), aims to incorporate the latest advances in airfield pavement design and evaluation and is expected to be fully applicable as of 28 November 2024.

This rating method of classification made it possible to:

- enable aircraft operators to determine the permissible operating weights for their aircraft;
- assist aircraft manufacturers to ensure compatibility between airfield pavements and the aircraft under development;
- permit airport authorities to report on the aircraft they can accept and allow them to use any evaluation procedure of their choice to ascertain the loading the pavements can accept;

- enable the aerodrome operators to reevaluate and report the strength of the aerodrome pavements.

The aerodrome operator, based on Amendment 15 to Annex 14 of ICAO, Aerodromes, is required to rate the strength of the pavements using the ICAO accepted ACN-PCN method and to publish information on the strengths of all public use airport pavements in its own Aeronautical Information Publication.

1.4 Application

The use of the standardized method of reporting pavement strength applies only to pavements at public use airports with bearing strengths of 12,500 pounds (5,700 kg) or greater. The method of reporting pavement strength for pavements of less than 12,500 pounds (5,700 kg) is to only report the gross weight and gear configuration of the aircraft that can be accommodated.

1.5 Responsibility

1.5.1 The operator of a certified aerodrome shall ensure that the bearing strength of the aerodrome movement area pavements comply with the provisions and regulations as mentioned in paragraph 1.2.

1.5.2 It is the responsibility of the aerodrome operator to maintain the load bearing capacity of the pavement for the design or critical aircraft operating over the life of the pavement.

1.5.3 For a certified aerodrome the aerodrome operator is required to provide information on runways, including its strength rating, to be reported in the Aerodrome Manual for the aerodrome and for this information to be passed to Aeronautical Information Service (AIS) for notification in Albanian AIP.

1.5.4 Serviceability inspections and annual technical inspection required to be undertaken at all certified aerodromes (serviceability inspections and annual safety inspections at registered aerodromes) are meant to check for failure mechanisms in the pavement. Any significant deterioration of the surface of the pavement may be caused by weakening of the pavement material and/or subgrade, in which case, a review of the pavement strength rating may be necessary.

2. BACKGROUND

2.1 Airfield pavements consist one of the most important transportation infrastructures, since their key role is to ensure the safe operation of aircrafts utilizing an airport. The main goal of airfield pavements is to provide adequate load-carrying capacity, in order to ensure the appropriate operation of airport facilities. Otherwise, maintenance interventions and rehabilitation actions are time-consuming and may affect pavement serviceability with a significant impact on airport financial resources. As such, the implementation of a globally utilized system for classifying and reporting the bearing capacity of airfield pavements has always been an important issue in airport engineering, since it supports the decision-making process in terms of pavement management. The importance of the implementation of this system becomes even more profound, considering the introduction of new aircraft types and their ability to safely land on existing runway airfield pavements. Pavement strength ratings may be determined from initial pavement design and construction data, testing of in-situ pavements or observation of pavement behavior over extended periods of time.

2.2 In 1981 the International Civil Aviation Organization (ICAO) introduced a new method to identify the bearing strength of aerodrome pavements called the ACN-PCN method. This method for reporting the bearing strength of aerodrome pavements has been adopted in Albania. The ACN-PCN method is still used worldwide, since it is a practical tool for facilitating communication practices between airport authorities and aircraft manufacturers. Moreover, it is also useful in cases where there are limited resources dedicated to the management of airport pavements. As stated in this method may be beneficial when there are unexpected and emergency needs that have to be confronted considering the allowable traffic volume.

The simplicity of this system was outstanding, which justifies the duration of its applicability. However, there were indications that it contains several assumptions and inconsistencies that have to be considered carefully during its implementation. Moreover, since several different methods have been developed worldwide for determining the PCN value of an airfield pavement, a critical task arises, given that the PCN value could not be uniquely defined. Apart from the abovementioned deficiencies, it must be noted that the ACN-PCN method is based on traditional empirical design methods.

The development of advanced analytical theories for pavement analysis observed the last decades has been also incorporated in airfield pavement design and evaluation techniques. Since these theories are nowadays used in practice, the update of the system used for reporting the bearing capacity of airfield pavements was considered indispensable. With this in mind, the Aircraft Classification Rating – Pavement Classification Rating (ACR-PCR) method has been currently introduced by ICAO and is expected to be applicable as of November 2024.

3. AERODROME PAVEMENTS STRENGTH

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

3.1 Aerodrome Pavements

3.1.1. A pavement is a load carrying structure constructed on naturally occurring in-situ soil, referred to as the sub grade. 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.

3.1.2. 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 sub grade, so 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 sub grade and vice versa.
- The sub grade 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.

3.1.3. Pavements are classified as either **rigid or flexible** depending on their relative stiffness. A rigid pavement is not totally rigid, the terminology is merely an arbitrary attempt to distinguish between pavement types both of which deform elastically to some degree. In particular, it is common to speak of Portland Cement Concrete pavements as rigid and all other pavements (e.g. bound bituminous concrete or unbound natural) as flexible. A relatively stiff rigid pavement produces a uniform distribution of stress on the sub grade, whereas a flexible pavement deforms and concentrates its effect on the sub grade. Therefore, the difference between the two pavement types is one of degree rather than of fundamental mechanism.

- **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. The material used in the lower layers of a pavement may, for reason of economy and preservation of resources, be of lower quality than the material used in the upper pavement layers. *(Example of a flexible pavement cross-section is shown in Figure 1)*
- **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

sub grade. 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. *(Example of a rigid pavement cross-section is shown in Figure 1)*

It is also possible to have **composite pavements** comprising a bituminous concrete overlay on a cement concrete pavement or vice versa. The choice of which pavement type to adopt is made after consideration of the various matters such as pavement design, loading, tire pressure, resistance to mechanical and chemical damage, ride quality, antiskid properties, construction, routine maintenance, major maintenance and construction costs.

3.1.4. The basic function of an aerodrome pavement is to support the applied aircraft loading within acceptable limits of riding quality and deterioration over its design life. While subjected to aircraft loading the pavement is to:

- reduce sub grade stresses such that the sub grade is not overstressed and does not deform extensively;
- reduce pavement stresses such that the pavement courses are not overstressed and do not crack or deform excessively; and
- protect the pavement structure and sub grade from the effects of the environment particularly moisture ingress.

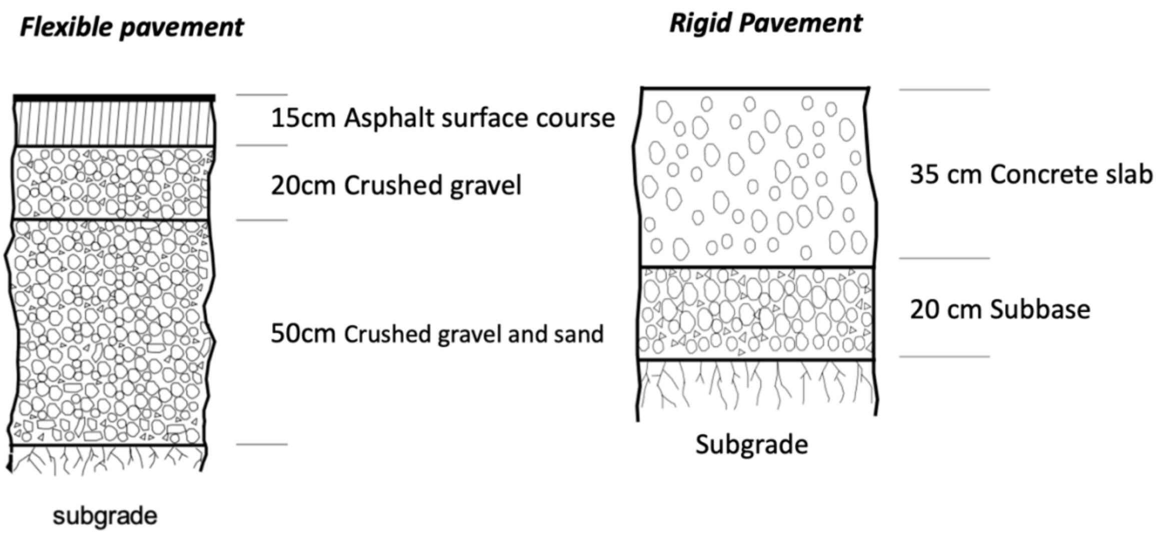

Figure 1 Flexible and Rigid pavement cross-section example

3.1.5. Performance requirements:

In general, concrete is preferred where there is likely to be venting of fuel, spillage of lubricating oils and hydraulic fluids, jet efflux gases from slow-moving high-performance jet engines, or areas subject to locked wheel turns. Concrete should therefore be used for the following pavement areas:

- Runway ends (typically for a distance of at least 150m);
- Sections of taxiways adjacent to runway ends;
- Holding areas;
- Aprons and hard standings;
- Hangar floors;
- Engine run-up platforms;
- Compass calibration bases;

3.1.6. Cost:

For many pavements this will be the main consideration and will depend on such diverse factors as the availability of materials in the locality and the bearing capacity of the natural subgrade on which the pavements are to be constructed. For rigid pavements there is a minimum thickness of concrete below which its use is impractical, and a maximum subgrade strength beyond which further increases in strength result in little saving of construction depth. On soils of good bearing value, flexible construction is likely to be more economical. The opposite is true for weak subgrades.

3.1.7. Other considerations:

The absence of joints in flexible pavements gives them better riding qualities for high speed operations than most types of rigid pavement. If the only realistic option is to construct a pavement on an unpredictable subgrade which is liable to long-term shrinkage or heave, a flexible pavement will generally be the best option. This is because a flexible pavement can cope with greater movement and remain serviceable; it can also be more cheaply and expediently overlaid to rectify the loss of shape.

3.2 Strength of Aerodrome Pavement

It is the responsibility of the aerodrome operator to maintain the load bearing capacity of the pavement for the design or critical aircraft operating over the life of the pavement.

A cost-effective means of ensuring aerodrome pavements are properly maintained is for the aerodrome operator to put in place a pavement management system. Various pavement management systems have been developed and documented. They all use either serviceability or distress parameters as a measure of pavement performance.

It has long been recognised that the severity of load-induced stresses in a pavement and subgrade depends on the gross weights of the aircraft using the pavement and the configuration, spacing and tyre pressures of their undercarriage wheels. The response of the pavement in resisting these stresses depends on its thickness, composition, the properties of materials used in its construction and the strength of the subgrade on which the pavement is built.

3.2.1 At a registered aerodrome, information on the pavement strength rating for each runway is to be provided when making an application for the registration of the aerodrome. This information should be published in AIP.

3.2.2 Serviceability inspections and annual technical inspection required to be undertaken at all certified aerodromes (annual safety inspections are required at registered aerodromes) are meant to check for failure mechanisms in the pavement. Any significant deterioration of the surface of the pavement, however caused (e.g. by weakening of the pavement material and/or sub grade), is discovered, a review of the pavement strength rating may be necessary.

3.2.3 Specifications on pavement strength are in accordance with the last amendment of Annex 14:

Strength of runways: The recommendation in paragraph 3.1.21 states that runway should be capable of withstanding the traffic of airplanes the runway is intended to serve.

Strength of taxiways: The recommendation in paragraph 3.9.12 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 a taxiway will be subjected to a greater density of traffic and, as a result of slow moving and stationary airplanes, to higher stresses than the runway it serves.

Strength of aprons: 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.

Strength of runway shoulders: The recommendation in paragraph 3.2.4 states that the portion of a runway shoulder between the runway edge and a distance of 30 m from the runway center line should be prepared or constructed so as to be capable, in the event of an airplane running off the runway, of supporting the airplane without inducing structural damage to the airplane and of supporting ground vehicles which may operate on the shoulder. *Note — Guidance on strength of runway shoulders is given in the Aerodrome Design Manual (Doc 9157), Part 1.*

Strength of runway turn pads: The recommendation in paragraph 3.3.8 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. *Note — Where a runway 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.*

3.2.4 Pavement life: Pavements are normally designed for a defined life and mix of traffic. The true-life expectancy of a pavement is a direct function of:

(a) environmental factors;
(b) quality of pavement material;
(c) traffic distribution;
(d) number of operations/repetitions of aircraft loading;
(e) aircraft characteristics - weight, tire pressure wheel configuration; and 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. REPORTING STRENGTH OF AERODROME PAVEMENTS

A pavement strength rating is a set of pavement parameters which can be applied to determine a maximum allowable aircraft operational weight. Its purpose is to protect the pavement and ensure a practical and economical life is maintained.

The simplest rating system is one which defines the maximum aircraft weight and/or tire pressure or the largest aircraft type which can operate unrestricted on the pavement. This system is only used for light aircraft (below 5,700 kg MTOM) aerodromes.

The ACN–PCN method of rating aerodrome pavements developed initially as a pavement strength rating method, not a pavement design method, and compares the damaging effect of an aircraft with a maximum ramp weight above 5,700 kg (ACN) with the supportive capability or bearing strength of the pavements on which they intend to operate (PCN).
ICAO introduced the method as a standard to identify the bearing strength of aerodrome pavements (ICAO Annex 14 Aerodromes, Volume I – Aerodrome Design and Operations) and was adopted by ICAO member States.
Recently an updated system has been introduced. This system, referred as the Aircraft Classification Rating – Pavement Classification Rating (ACR-PCR), aims to incorporate the latest advances in airfield pavement design and evaluation and is expected to be fully applicable as of 28 November 2024.
Unrated pavements are generally limited to aircraft of gross weight not exceeding 5,700 kg.

4.1. ACN-PCN Pavement Strength Rating System

4.1.1. General

The ACN-PCN system was introduced by the International Civil Aviation Organization (ICAO) in 1981 and Member States to ICAO are required to evaluate and publish the strength of airport systems using the ACN/PCN system. The national CAA publishes weight bearing limits in terms of ACN/PCN in an Aeronautical Information Publication for civil and international use. The intent is to provide planning information for individual flights or multi-flight missions which avoid either overloading of pavement facilities or refused landing permission.

The ACN-PCN system is fundamentally simple. In principle, every aircraft has a calculatable ACN value. That aircraft is permitted to operate in an unrestricted manner on any runway that has an equal (or greater) PCN value than the aircraft ACN. It is important to note that 'unrestricted' does not mean the pavement is necessarily able to support an infinite number of operations by that aircraft. Rather, it means that no special permission is required prior to each operation. When the aircraft ACN exceeds the runway PCN, the aircraft operator must obtain the aerodrome operator's permission before operating, a process known as obtaining a pavement concession.

The PCN to be reported is such that, the pavement strength is sufficient for the current and future traffic analysed, and should be re-evaluated if traffic changes significantly.

The system is designed to be simple in its operation. That requires significant simplifications that lead to anomalies when rating the strength of pavements that are designed with sophisticated modern pavement thickness design tools. These tools use more sophisticated mathematics to calculate the magnitude of the critical indicators of damage that determine the relative effect of different aircraft. As a result, some pavements that have been designed for a particular aircraft to operate, have subsequently been assigned a PCN value that does not allow that same aircraft to be operated in an unrestricted manner.

4.1.2. Analysis Methodology

The reporting of PCN is meant to provide airport operators with information enabling them to make quick decisions as to whether a specific aircraft should be allowed to operate on the airfield or parts thereof.
In this context it must be remembered that the aircraft ACN values, which should be compared to the pavement PCN value, are only reported for the discrete CBR values of 3 %, 6 %, 10 % and 15 %, and at two weight levels, the high level corresponding roughly to Maximum Take Off Weight and the low level to Operating Weight Empty.
To determine the ACN value at a specific weight in between these two values and for a CBR value different from the standard reporting values therefore requires a two-step interpolation process.
In order to simplify this process, pavement PCN values should only be reported at the abovementioned standard CBR values. This will make it possible for both airport and airline operators to determine the allowable operating weight of a specific aircraft from a simple one- step interpolation between the ACN values reported at the high and low weight levels respectively.
The PCN reporting process for a trafficked area divided into branches therefore has the following separate stages:

- Determine for each point in a branch it’s PCN-value, based on e.g. FWD/HWD measurements and analyses;
- For each point determine the allowable weight of a characteristic analysis airplane at the actual PCN value;
- Calculate mean and standard deviation of the reported weights of the characteristic analysis airplane, and select the characteristic weight percentile for reporting PCN;
- Determine the characteristic subgrade type on the area (A to C) by choosing the most frequent type. Then back-calculate the ACN value for the characteristic airplane at its characteristic weight and report as the PCN value.

4.1.3. Aircraft Classification Number

4.1.3.1. Every aircraft has an ACN value that represents the relative damage caused to the pavement's subgrade and is dependent only upon the aircraft weight, tire pressure and the subgrade category of the pavement that it is operating on.
4.1.3.2. The inclusion of the subgrade category in the ACN seems unusual because the pavement is independent of the aircraft. However, the subgrade category is simply used as an indicator of the degree of interaction between the various wheels in multi-wheel landing gear. A pavement on a strong subgrade will be thin, meaning the degree of wheel interaction is low. In contrast, a weak subgrade requires a thick pavement which means that the wheels interact significantly at the depth of the subgrade. The effect of

pavement thickness, indicated by the subgrade category, is important for comparing the relative damage of different aircraft wheel arrangements.

4.1.3.3. The ACN value is always determined when the aircraft is loaded so that the center of gravity is in the most adverse location. These calculations are performed by the aircraft manufacturers and are contained in the airport planning manual for each aircraft type and variant.

4.1.3.4. ACN values increase linearly with the mass of the aircraft and are generally insensitive to tyre pressure. As a result, the ACN of a particular aircraft is readily shown in a graph that ranges from the OWE (Operating Empty Weight) weight to the MOM on the horizontal axis and ACN on the vertical axis. This is usually shown for the standard or maximum tyre pressure. Four lines are required for each graph, representing the four subgrade categories, and different graphs are required for flexible and rigid pavements. *An example is shown in Figure 2 for the B737- 800 on flexible pavements.*

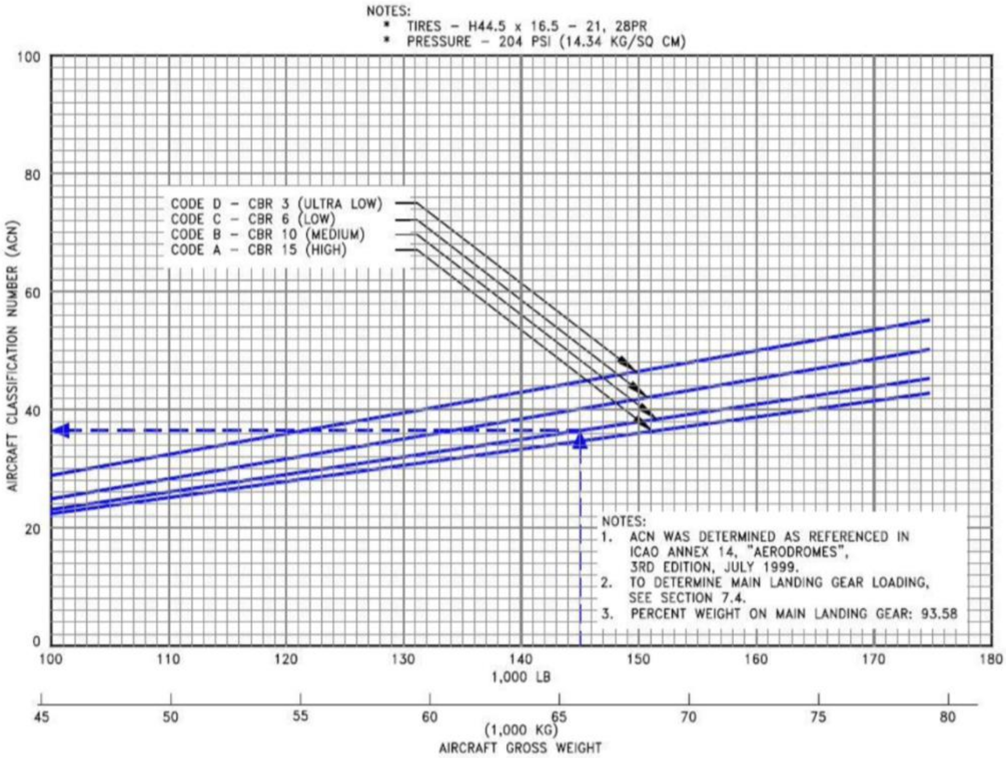

Figure 2. Example of an ACN graph in a flexible pavement for B737-800

4.1.3.5. The linear relationships between aircraft weight and ACN, allow for interpolation between the minimum and maximum values or equations for the calculations. In practice, different software is used to calculate the ACN of any aircraft at any operating mass and any tire pressure.

4.1.3.6. The technical definition of the ACN is twice the wheel load (in tons) which on a single wheel, inflated to 1.25 MPa, causes vertical pavement deflection (calculated at the top of the subgrade) equal to that caused by the actual multi-wheel aircraft gear, at its actual gear load and its actual tire pressure. In practice, ACN values for commercial aircraft typically range from 5 to 120.

4.1.3.7. For a particular aircraft at a specific mass and tyre pressure, there is only one flexible pavement ACN for each subgrade category. There is a second ACN for rigid pavements. The ACN value is exact and mathematically determined, meaning it is not open to interpretation or discretion. That is not the case for the PCN value.

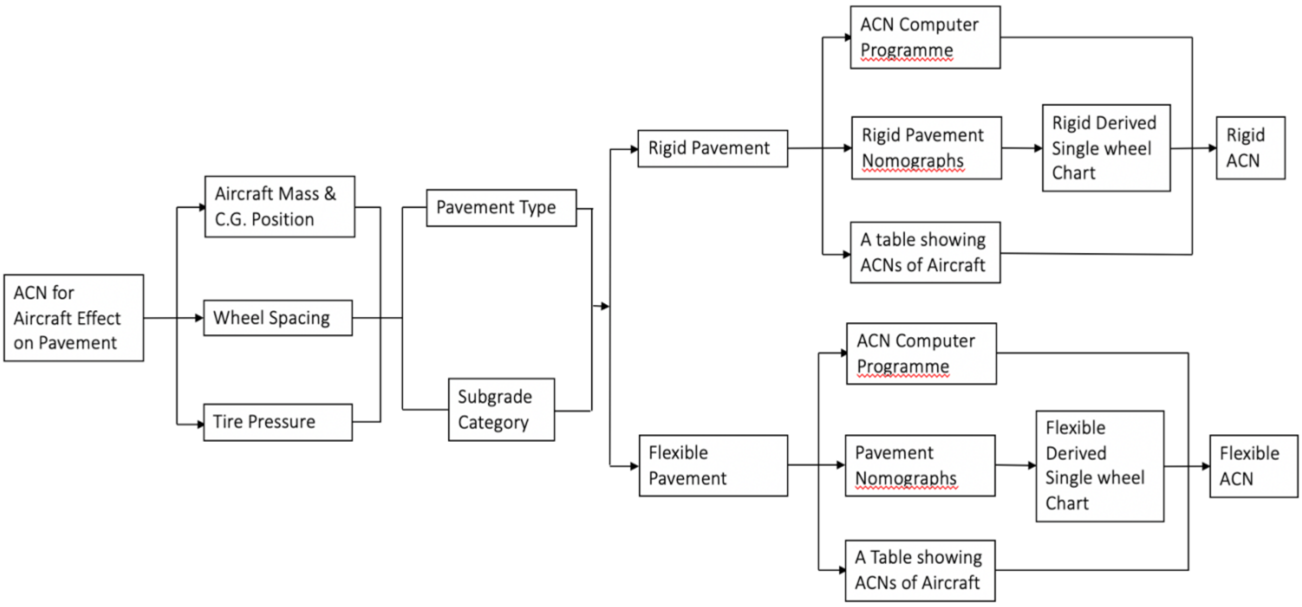

Figure 3. ACN calculation flowchart (ICAO, Doc.9157, Part 3-Pavements)

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

4.1.3.9. A typical ACN for a given aircraft is normally provided as follows:

Aircraft type: A320-100	Reference weight	Subgrade Class							
		Flexible Pavement				Rigid Pavement			
		A	B	C	D	A	B	C	D
Maximum Apron weight	83400 kg	45	48	53	59	50	55	57	59
Operating Empty weight	47000 kg	23	24	26	30	26	28	29	31

Table.1 A typical ACN for a given aircraft

4.1.4. Pavement Classification Number

4.1.4.1. In contrast to the ACN, the PCN is set by the airport owner with some discretion and is open to interpretation. The PCN is essentially a pavement management tool that allows airlines and aircraft operators that are welcome to operate without restriction, that is, without needing to seek specific permission due to pavement strength and overload.

4.1.4.2. An aerodrome operator might set its PCN conservatively to protect its pavement against damage. Another aerodrome operator might set its PCN aggressively to attract new aircraft operators, accepting the increased damage that these aircraft might cause. However, excessive increases in the PCN can lead to gross overloading of the pavement and can result in rapid or even single-load event failures of the pavement that are likely to render it unserviceable.

4.1.4.3. A PCN is reported in a five-part code associated to any section of the airport pavements (runway,

taxiways, aprons or ramps) and indicates its mechanical resistance with respect to excessive wear and tear.
Apart from the numerical value, notification is also required of the pavement type (rigid or flexible) and the subgrade support category. Additionally, provision is made for the aerodrome operator to limit the maximum allowable tire pressure. A final indication is whether the assessment has been made by a technical evaluation or from past experience of aircraft using the pavement.
The full PCN expression is best explained by example in Figure 4.

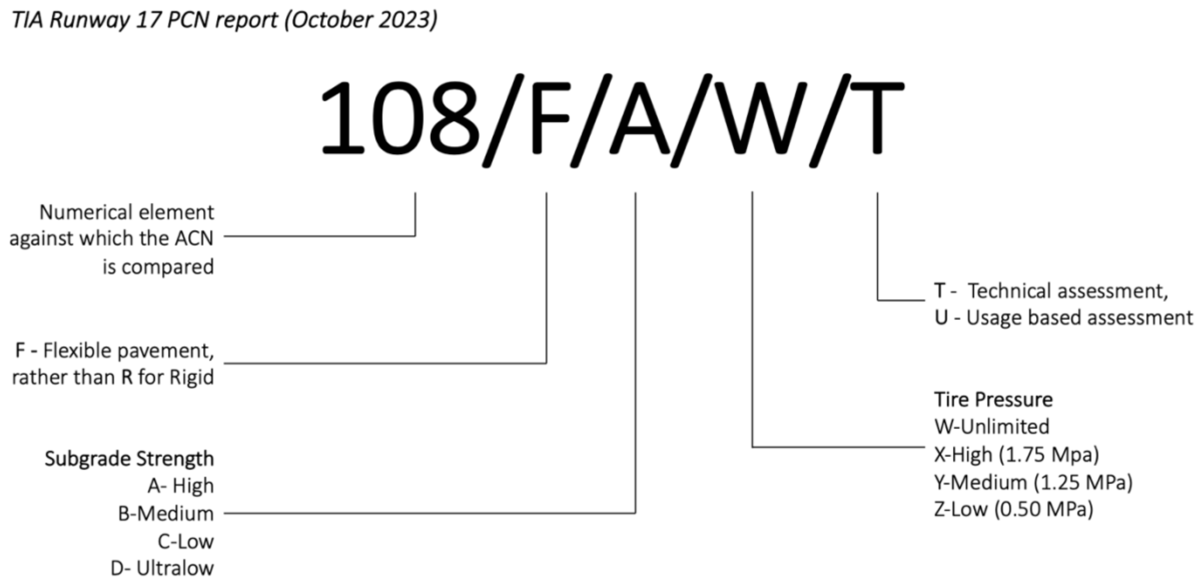

Figure 4. PCN reporting example (Tirana International Airport-Runway 17)

As an example, the PCN for Runway 17 at Tirana International Airport is: PCN 108/F/A/W/T ASPH

- 108 is the numerical element against which the ACN is compared.
- F indicates a Flexible pavement, rather than R for Rigid.
- A is the category of subgrade bearing strength, detailed in *Table 2.*
- W is the tire pressure category, detailed in *Table 3.*
- T indicates a Technical assessment, rather than U for a Usage based assessment.
- ASPH is the cover layer.

Subgrade Category	Flexible pavement Nominal CBR	Flexible pavement CBR Range	Rigid pavement Nominal k-value	Rigid pavement k-value range
A	15%	Greater than 13%	150 kPa/mm	Greater than 120 kPa/mm
B	10%	80 kPa/mm	80 kPa/mm	60-120 kPa/mm
C	6%	40 kPa/mm	40 kPa/mm	25-50 kPa/mm
D	3%	20 kPa/mm	20 kPa/mm	Less than 25 kPa/mm

Table 2: ACN-PCN Subgrade Categories

Tyre pressure Category	Tyre pressure limit
W	Unlimited

X	1.75 MPa
Y	1.25 MPa
Z	0.50 MPa

Table 3: ACN-PCN tire pressure categories

4.1.4.4. The Technical (T) or Usage (U) basis of determining the PCN intends that technical rating is associated with reverse engineering of the existing pavement to determine whether a particular aircraft is acceptable or not. In contrast, a usage- based assessment is made when a particular aircraft is known to operate regularly, without causing excessive pavement damage, and the PCN is set equal to the ACN of that aircraft.

4.1.4.5. To determine whether an aircraft can operate on an unrestricted basis, or whether a pavement concession is required, two checks are made:

- the ACN is no greater than the PCN.
- the tire pressure (or category) does not exceed the nominated pressure (or category).

4.1.5. Setting a Pavement Classification Number (PCN)

4.1.5.1. The most challenging element of the ACN-PCN system is the setting of an appropriate PCN for the runway in question. It may require some judgment. This reflects the aerodrome owners need to set the PCN at a value that allows reasonable aircraft operations to continue without the administrative burden of unwarranted pavement concessions, but at the same time, not setting the PCN too high, introducing unreasonable risk of excessive pavement damage.

4.1.5.2. An AO should set the PCN of its runway to a value that allows the aircraft that the aerodrome operator is comfortable to operate on a regular basis, and in an unrestricted manner. For many aerodromes, that is a simple case of:

- specifying the appropriate subgrade category based on historical records, the existing published strength rating, design assumptions or geotechnical assessment of the subgrade;
- determining the range of aircraft that regularly use the runway without causing excessive damage;
- calculating the ACN of each of the larger regular aircraft, ensuring that the ACN calculated is for the subgrade category that has been determined for the runway;
- setting the PCN to the highest of the ACN values;
- setting the tire pressure limit to the highest tire pressure of the regular larger aircraft.

4.1.5.3. It is not simple to determine the basis of 'regular usage'. For many aerodrome operators, identifying regular use is simple because they support flights by just one or two passenger aircraft type. Irregular use of larger military aircraft, firefighting aircraft or one-off freight charters would not normally be considered 'regular'.

By setting the PCN at a larger aircraft, which is a seasonal one, might lead to excessive pavement damage.

4.1.5.4. Where a specific design has been prepared for a new or upgraded runway, the design report should include a statement regarding the aircraft traffic adopted for pavement thickness design. In this case, the PCN could be set to the highest ACN of the regular aircraft in operation.

4.1.5.5. Where a specific design has not been prepared and the basis of the current strength rating is not known, reverse engineering of the existing pavement structure and the existing or future potential aircraft traffic can be used to determine the PCN, using the same principles that are applied to a new design, but adjusting the aircraft traffic to suit the existing pavement structure, rather than determining a structure that is adequate for the predicted aircraft traffic. This process generally includes:

- Inspection of the pavement by a pavement engineer, for signs of structural distress.
- Projections of historical, current and future aircraft traffic.
- Determination of representative pavement structures and subgrade bearing strength, for areas of uniform strength, which may require one or both of:
- Non-destructive testing of the pavement response to load o Intrusive investigation and sampling material for testing
- An analysis in design software to determine a level of traffic that is predicted to cause failure of the pavement over time.
- Setting the pavement PCN to the ACN of the most demanding aircraft that is 'just acceptable'.

Note: The Structural Investigation of Airfield Pavements is explained in Appendix 1.

4.1.5.6. In recent years, the response of pavements to dynamic loading has been increasingly measured using a falling weight deflectometer (FWD). These devices measure the deflection of the pavement at various distances from the point of loading with a variable mass dropped from a variable height to target a pre-determined dynamic load magnitude. This provides a cost-effective method for conducting many tests in a relatively short period and is non-destructive, avoiding the need to intrusively core or auger through the pavement and then reinstate the excavation.

4.1.5.7. Various software applications are available that estimate the modulus of each pavement layer based on the measured deflections and different distances from the load point. Some software go further to provide an estimated PCN at each test point. However, the software relies on a nominated or assumed pavement composition, including the type and thickness of each layer, so some intrusive testing is still required. Furthermore, case studies have shown that the estimate PCN values range from unrealistically low to unreasonably high and the recommended PCN value is generally lower than is determined from reverse engineering of the measured pavement thickness and material characteristics from an intrusive investigation.

4.1.5.8. Despite these limitations, FWD surveys provide invaluable information on the consistency of pavement structures to loading and are a valuable element of a comprehensive pavement investigation for strength rating determination.

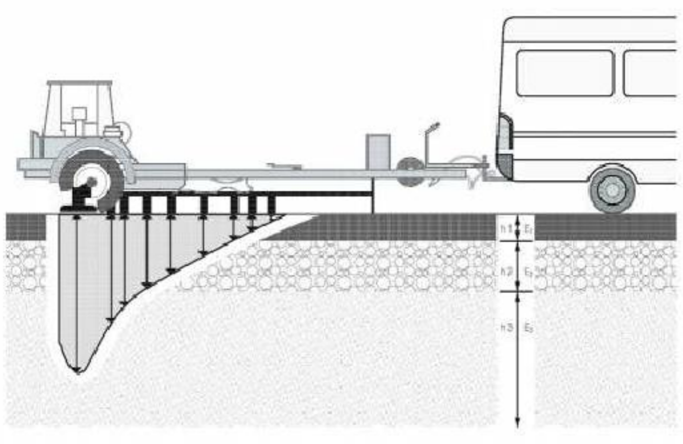

Figure 5. Schematic FWD survey

Once the numerical PCN value is determined, the setting of the tire pressure limit is generally much simpler. The tire pressure limit is intended to protect the runway surface against near-surface shear stresses. In reality, well designed and constructed surfaces are unlikely to be damaged by high tire pressures, with only minor scuffing of the surface caused by dual and triple axles more likely for more fragile surfaces.

4.2. ACR-PCR Pavement Strength Rating System

4.2.1. General

The ACR-PCR pavement strength rating system is a new classification system that ICAO has approved in 2019. Implementation by all member States, must occur between July 2020 and November 2024. Until the system is adopted the aerodrome operator is still required to publish the PCN in accordance with regulation.

The Aircraft Classification Rating - Pavement Classification Rating (ACR-PCR) system has been developed to operate in a similar manner to ACN-PCN. That is, the ACR of an aircraft is compared to the PCR of a runway.

If the PCR exceeds the ACR, then the aircraft can operate without restriction. However, when the ACR exceeds the PCR, a pavement concession is required. Also similar to the ACN-PCN system, the tire pressure limit check is also required, and this is effectively unchanged.

The main differences between ACN-PCN and ACR-PCR relate to the basis on which the equivalent wheel load is determined, and include:

- standard tire pressure
- standard pavement structures
- subgrade categories
- calculated indicator of relative damage.

4.2.2. Determination of the Aircraft Classification Rating (ACR)

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

The standard wheel, to which other landing gear are converted, now has a 1.50 MPa tire pressure to better reflect large modern aircraft.

4.2.3. Subgrade Category

The ACR-PCR method adopts four standard levels of subgrade strength for rigid and flexible pavements. These standard categories are used to represent a range of subgrade conditions as shown in Table 4.

Subgrade Strength Category	Subgrade Support E (Elastic Modulus) MPa	Represents E (Elastic Modulus) MPa	Code Designation
High	200 MPa	E ≥150	A
Medium	120 MPa	E ≥ 100 <150	B
Low	80 MPa	100> E ≥ 100	C
Ultra-Low	50 MPa	E < 60	D

Table 4. Standard Subgrade Conditions for ACR Calculations

Operational Frequency

Operational frequency is defined in terms of coverages that represent a full-load application on a point in the pavement Aircraft seldom travel in a perfectly straight path or along the exact same path. The path is modeled by a statistically normal distribution to account for aircraft wander. It may take several trips or passes along the pavement for a specific point on the pavement to receive a full-load application from the aircraft. It is easy to observe the number of passes an aircraft may make on a given pavement, but the number of coverages must be mathematically derived based upon an established pass-to-coverage ratio for each aircraft.

4.2.4. Rigid and Flexible ACR

For rigid and flexible pavements, the aircraft landing gear support requirements are determined by the layer elastic method for each subgrade support category.

The flexible standard pavement structure has greater asphalt thickness and now depends on the number of wheels in the landing gear being considered. The standard wheel, to which other landing gear are converted, now has a 1.50 MPa tire pressure to better reflect large modern aircraft.

Layer	ACN-PCN layer thickness	ACR-PCR layer thickness for 1-2 wheels	ACR-PCR layer thickness for 3 or more wheels
Asphalt surface	75 mm	76 mm	127 mm
Crushed rock base	150mm	As required	As required

Uncrushed gravel sub-base	As required	Not used	Not used
Subgrade	Infinite	Infinite	Infinite

Table 5. ACR-PCR Standard Flexible Pavement Structure

Layer	**ACN-PCN thickness**	**ACR-PCR thickness**
Concrete base	As required	As required
Crushed rock sub-base	Combined with subgrade	200mm
Subgrade	Infinite	Infinite

Table 6. ACR-PCR Standard Flexible Pavement Structure

Note: Table 5 shows the two flexible pavement structures. The rigid pavement structure is not affected by the number of wheels in the landing gear, as shown in Table 6.

The ACR-PCR system actually uses the elastic modulus of the subgrade (expressed in MPa) to reflect the input into modern pavement thickness design software. Table 7 shows equivalent CBR values using a simply linear conversion of CBR being 10% of the corresponding modulus value (in MPa).
The use of elastic modulus avoids the need to estimate k-values for rigid pavements, which simplifies the ACR-PCR system for rigid pavements. The category D increase from CBR 3 to CBR 5 reduces the representativeness of the system for aerodromes that have old and poor natural subgrades with very low CBR values.

Subgrade Category	**ACN - PCN system**		**ACR - PCR system**	
	Nominal CBR	**CBR Range**	**Nominal CBR**	**CBR Range**
A	15	13 and above	20	15 and above
B	10	8-12	12	10-14
C	6	4-8	8	6-9
D	2	4 and below	5	5 and below

Table 7. Flexible pavement ACN-PCN and ACR-PCR subgrade categories

Note: The ACR-PCR subgrade CBR values are equivalent to the subgrade modules values and ranges actually used, allowing a comparison of the two systems.

4.2.5. ACR Calculation.

Using the parameters defined for each type of pavement section, a mathematically derived single wheel load is calculated to define the landing gear/pavement interaction. The derived single wheel load implies equal stress to the pavement structure and eliminates the need to specify pavement thickness for comparative purposes.

This is achieved by equating the thickness derived for a given aircraft landing gear to the thickness derived for a single wheel load at a standard tire pressure of 1.5 MPa. The ACR is defined as two times the derived single wheel load (expressed in hundreds of kilograms).

Because aircraft can be operated at various weight and center of gravity combinations, ICAO adopted standard operating conditions for determining ACR values.

Aircraft manufacturers publish maximum weight and center of gravity information in their Airplane Characteristics for Airport Planning (ACAP) manuals. The ACR is determined at the weight and center of gravity combination that creates the maximum ACR value. Tire pressures are assumed to be those recommended by the manufacturer for the noted conditions.

- To standardize the ACR calculation for flexible pavement the derived single wheel load is calculated at a constant pressure of 1.50 Mpa relative to a total thickness *t* computed for 36,500 passes of the aircraft.
- To standardize the ACR calculation for rigid pavements, a standard stress is stipulated as σ = 2.75 Mpa. Note the working stress used for the design has no relationship to the standard stress used for pavement strength reporting.
- The sole mathematical model used in the ACR-PCR method is Layered Elastic Analysis (LEA). The LEA model assumes that the pavement structure, whether flexible or rigid, can be represented by homogeneous, elastic, isotropic layers arranged as a stack. Each layer *i,* in the system is characterized by an elastic modulus E_i, Poisson's ratio v_i, and uniform layer thickness t_i. Due to the linear elastic nature of the model, individual wheel loads can be summed to obtain the combined stress and strain responses for a complex, multiple-wheel aircraft gear load.

4.2.6. How are ACRs determined?

ICAO Aerodrome Design Manual, Part 3, Pavements, Third Edition, Appendix 2, provides procedures for determining the Aircraft Classification Rating (ACR).

ACR Rigid pavement:

The rigid pavement ACR procedure relates the derived single wheel load at a constant tire pressure of 1.50 MPa to a reference concrete slab thickness *t*. (Figure 5) It takes into account the four subgrade categories detailed in Table 4 and uses a standard concrete stress of 2.75 MPa. The fact that a standard concrete stress is used, no information concerning pavement flexural strength or number of coverages is needed for rigid ACR computation.

A cross-section as shown in Table 8 for Linear Elastic Analysis might be used.

Layer Description	Designation	Thickness (mm)	E (MPa)	v
Surface course (PCC)	Layer 1	Variable	27'579	0.15
Base course (fractioned aggregate)	Layer 2	200	500	0.35
Subgrade	Layer 3	infinite	Table 4	0.40

Table 8. Cross-section for Linear Elastic Analysis

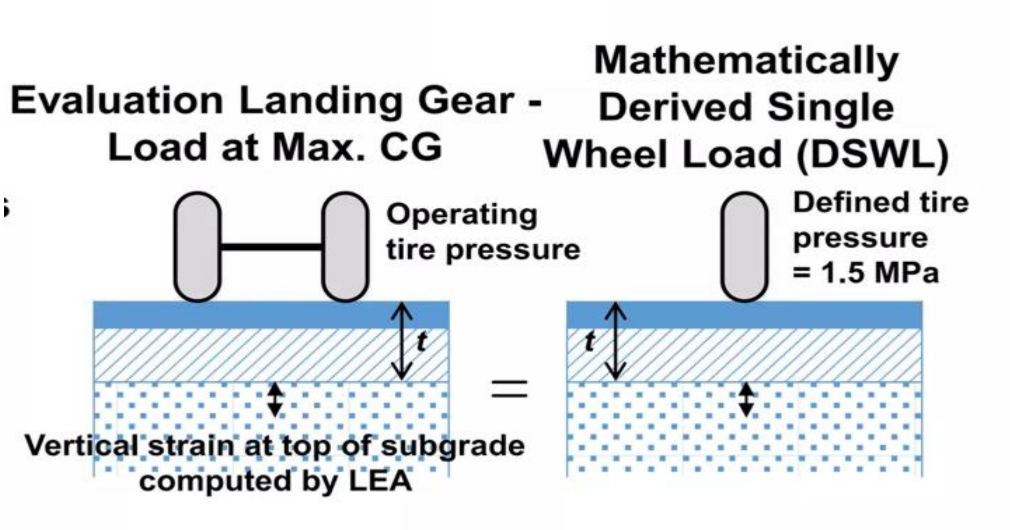

Figure 6. Derived Single Wheel Load (DSWL)

The steps to determine rigid ACR are explained as follows:

1. Reference Pavement Structure

- Reference thickness for the given aircraft mass
- E-value subgrade
- Standard concrete reporting

2. Evaluation Gear

- ACR value computed for a single truck in the main landing gear.

3. Stress Evaluation Points

- Evaluation points is equal to the number of wheels in the evaluation gear
- The resulting *t* is the reference thickness for ACR.

4. DSWL Calculation

Using the above reference thickness *t* , must be calculated the Derived Single Wheel Load (DSWL). *Evaluation points is equal to the number of wheels For evaluation of stresses under the single wheel load, is used one evaluation point located at the bottom of Layer 1, directly below the center of the wheel.*

5. Modified DSWL Calculation for Lightweight Aircraft.

Using the above reference thickness *t* , must be calculated the Derived Single Wheel Load (DSWL). *For some lightweight aircraft, the required reference thickness t is less than the minimum allowable thickness.*

(i) Determine the value of stress 2.75 MPa corresponding to the minimum allowable concrete thickness (50.8 mm).

(ii) Calculate DSWL for the selected subgrade using the minimum concrete thickness of 50.8mm of the reference structure. Maintaining a constant tire pressure of 1.50 MPa, the single wheel load magnitude is adjusted until the maximum horizontal stress at the bottom of Layer 1 is equal to the stress value determined using the minimum thickness.

6. ACR Calculation.

The aircraft classification rating, at the selected mass and subgrade category, is two times the derived single wheel load in 100 kg. The numerical value of ACR may be rounded to the nearest multiple of ten for reporting.

ACR for Flexible Pavements:

The flexible pavement ACR procedure relates the derived single wheel load at a constant tire pressure of 1.50 MPa to a reference total thickness *t* computed for 36,500 passes of the aircraft. It takes into account the four subgrade categories.

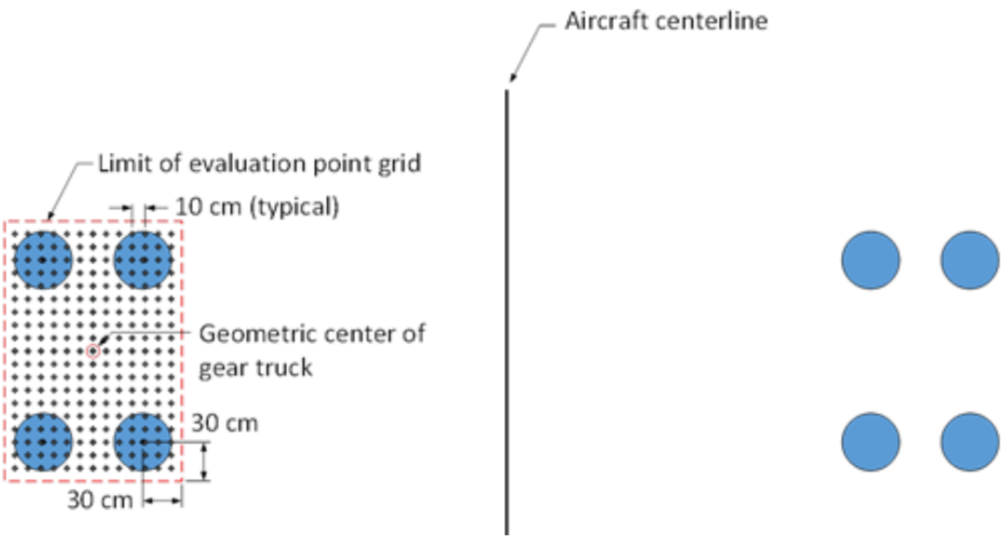

Figure 7. Grid Definition for simple main landing gear

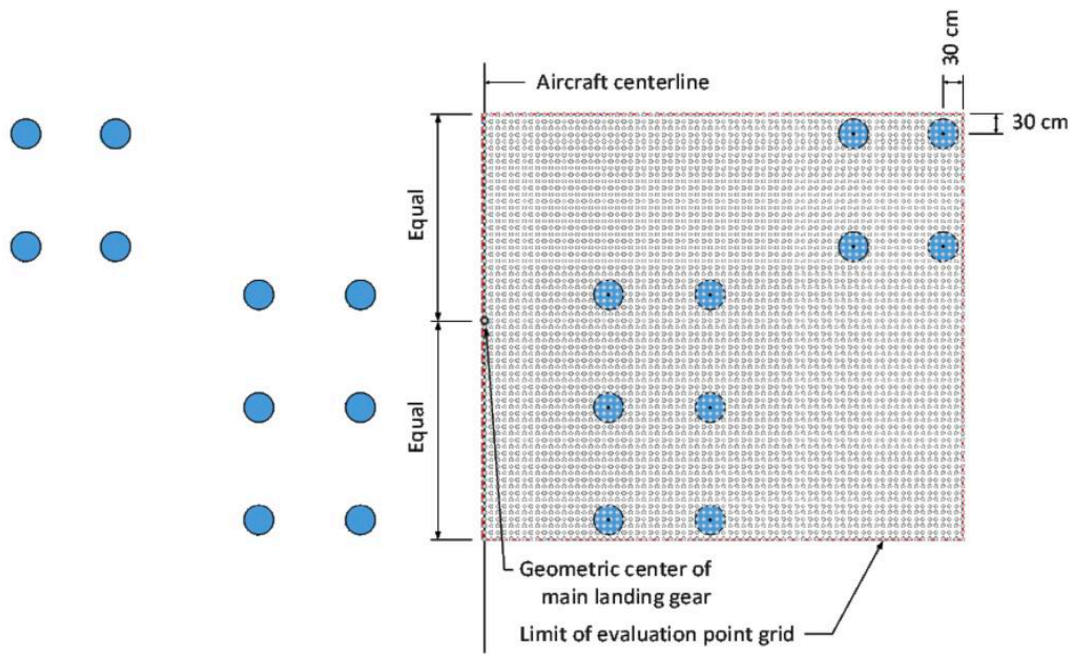

Figure 8. Grid Definition for Complex Aircraft main landing gear

The steps for the calculation of Flexible ACR are shown below:

1. Reference Pavement Structure

- Reference thickness for the given aircraft mass
- Define the material of several layers *(Elastic modulus E, Poisson's ratio v)*
- LEA model assumes the minimum allowable thickness of the layer (base course) is 25.4mm.

2. Base Layer Modulus

The base layer is subdivided into smaller sub-layers and a modulus value is then assigned to each sub-layer using a recursive procedure :

(i) Determine the number of sublayers N. *(If the base layer is less than 38.1 mm, then N=1.)*
(ii) Determine the thickness of each sub-layer.
(iii) Assign a modulus value E to each sub-layer
(iv) Modify the modulus assignment for the top two sub-layers if thickness is between 127 mm and 254 mm.

3. Evaluation Gear

The ACR value is computed using all wheels in the main landing gear (wheels in the nose landing gear are not included). Main landing gears are evaluated at the mass and c.g. that produces the highest total main gear loading on the pavement.

4. Strain Evaluation Points

Within the LEA model, strain is the maximum vertical strain computed on the top surface of the subgrade (lowest) layer. In the **ICAO-ACR computer program**, strains are computed at specific evaluation points based on the geometry of the evaluation gear. Evaluation points are placed directly below the center point of each wheel, and at the points defined by a regular rectangular grid spaced at 10-cm intervals, and oriented parallel to the principal axes of the gear. (fig. 5 and fig.6)

5. DSWL Calculation

Using the pavement requirement data published by the manufacturer, calculate the reference thickness t for the given aircraft mass, E-value of the subgrade, and 36,500 passes of the aircraft.

(i) Determine the reference pavement structure;
(ii) Evaluate resulting thickness t is the reference thickness for ACR.

6. Modified DSWL Calculation for Lightweight Aircraft.

The required reference thickness *t* is less than the minimum allowable thickness.

For some lightweight aircraft, the required reference thickness t is less than the minimum allowable thickness.

(i) Determine the value of maximum vertical strain on top od subgrade with layer thickness 25.4mm.
(ii) Calculate DSWL for the selected subgrade using the minimum thickness of of the reference structure.

6. ACR Calculation.

The aircraft classification rating, at the selected mass and subgrade category, is two times the derived single wheel load in 100 kg. The numerical value of ACR may be rounded to the nearest multiple of ten for reporting.

4.2.7. ACR Calculation

The aircraft classification rating, at the selected mass and subgrade category, is two times the DSWL in 100 kg. The numerical value of ACR may be rounded to the nearest multiple of ten for reporting.

Aircraft normally have their tires inflated to the pressure corresponding to the maximum gross mass without engine thrust, and maintain this pressure regardless of the variation in take-off masses.

4.3. Determination of PCR Numerical Value.

4.3.1. General

The strength of a pavement is reported in terms of the load rating of the aircraft which the pavement can accept on an unrestricted basis. The term unrestricted operations in the definition of PCR does not mean unlimited operations. Unrestricted refers to the relationship of PCR to the aircraft ACR, and that it is permissible for an aircraft to operate without weight restriction when the PCR is greater than or equal to the ACR. The term unlimited operations do not take into account pavement life.

The PCR to be reported is such that the pavement strength is sufficient:

- for the current and future traffic analyzed;
- should be re-evaluated if traffic changes significantly.

Note: A significant change in traffic would be indicated by the introduction of a new aircraft type or an increase in current aircraft traffic levels not accounted for in the original PCR analysis.

4.3.2. Determination of Numerical PCR Value.

Determination of the numerical PCR value for a particular pavement can be based upon one of two procedures:

1. Using aircraft method;
2. Technical evaluation method.

ICAO procedures permit member states to determine how PCR values will be determined. Either procedure may be used to determine a PCR, but the methodology used must be reported as part of the posted rating.

4.3.2.1. Using Aircraft Method to Determine PCR.

The Using Aircraft Method is a procedure where ACR values for all aircraft currently permitted to use the pavement facility are determined and the largest ACR value is reported as the PCR. This method:

- Is easy to apply and does not require detailed knowledge of the pavement structure;
- The subgrade support category is not a critical input when reporting PCR based on the Using Aircraft Method.
- The recommended subgrade support category when information is not available should be Category B;
- Is assumed that the pavement structure has the structural capacity to accommodate all aircraft in the traffic mix, and that each aircraft is capable of operating on the pavement structure without weight restriction.

Note: Use of the Using Aircraft Method is discouraged on a long-term basis.

4.3.2.2. Technical Evaluation Method to Determine PCR

The accuracy of a Technical Evaluation Method is better than that produced with the Using Aircraft procedure but requires additional information. Pavement evaluation may require a combination of on-site inspections, load-bearing tests, and engineering judgment.

It is common to think of pavement strength rating in terms of ultimate strength or immediate failure criteria. A decrease in the serviceability of a pavement is commonly attributed to increases in surface roughness or localized distress, such as rutting or cracking.

The strength of a pavement section will vary depending on the aircraft traffic composition and number of operations combined with type of pavement structure and subgrade support conditions. The technical evaluation method addresses these and other site-specific variables to determine reasonable pavement strength.

For a given pavement structure and given aircraft, the allowable number of operations (traffic) will decrease as the intensity of pavement loading increases (increase in aircraft weight).

To determine a technical PCR requires information on:

(1) aircraft traffic composition and frequency;

(2) thickness, material type and strength of each layer of pavement structure and

(3) elastic modulus of subgrade.

The recommended Procedure for Technical Evaluation (T) of PCR, considers characteristics of the pavement structure and aircraft traffic forecast over the life period selected. The life period should reflect the design life for new pavements and the remaining life for in-service pavements. The PCR should be valid only for this usage period.

A new evaluation is required after pavement rehabilitation or when traffic changes as compared to the initial traffic.

The steps this procedure involves, are shown below and in the flowchart following. Note ***i* is an index value with an initial value 1.**

Note: The purpose of steps 10-12 is to take into account certain cases with a large number of annual departures of a short/medium range aircraft (such as B737) and a small number of long-range aircraft (e.g. B777). If this wouldn't be taken into consideration, the smaller aircraft would generally be identified as critical, with the result that the PCR would require unreasonable operating weight restrictions on larger aircraft (unreasonable because the design traffic already included the large aircraft).

Step 1.
Collect all relevant pavement data (layer thicknesses, elastic moduli and Poisson's ratio of all layers, using or projected aircraft traffic) using the best available data sources.

Step 2.
Define the aircraft mix by aircraft type, number of departures (or operations consistent with pavement design practices), and aircraft weight that the evaluated pavement is expected to experience over its design or estimated remaining structural life.

Step 3.
Compute the ACRs for each aircraft in the aircraft mix at its operating weight and record the maximum ACR aircraft.
Note: ACR computations must follow the procedure in paragraph 4.2.5

Step 4.
Compute the maximum CDF of the aircraft mix and record the value.
Note: the CDF is computed with any damage/failure model consistent with the procedure used for pavement design.

Step 5.
Select the aircraft with the highest contribution to the maximum CDF as the critical aircraft.

Step 6.
Adjust the annual departures of the critical aircraft until the maximum aircraft CDF is equal to the value computed of the maximum CDF. Record the equivalent annual departures of the critical aircraft.

Step 7.
Adjust the critical aircraft weight to obtain a maximum CDF of 1.0 for the number of annual departures obtained at step (6).

Step 8.
Compute the ACR of the critical aircraft at its MAGW. The value obtained is designated as PCR(i).

Step 9.
If AC(i) is the maximum ACR aircraft from step 3, then skip to step 13. If not continue to Step 10.

Step 10.
Remove the current critical aircraft AC(i) from the traffic list and re-introduce the other aircraft not previously considered as critical aircraft. The new aircraft list, which does not contain any of the previous critical aircraft, is referred to as the reduced aircraft list. Increment the index value ($i = i+1$).

Step 11.
Compute the maximum CDF of the reduced aircraft list and select the new critical aircraft AC(i).

Step 12.
Repeat steps 5-9 for AC(i). The PCR to be reported is the maximum value of all computed PCR(i). The critical aircraft is the aircraft associated with this maximum value of PCR(i).

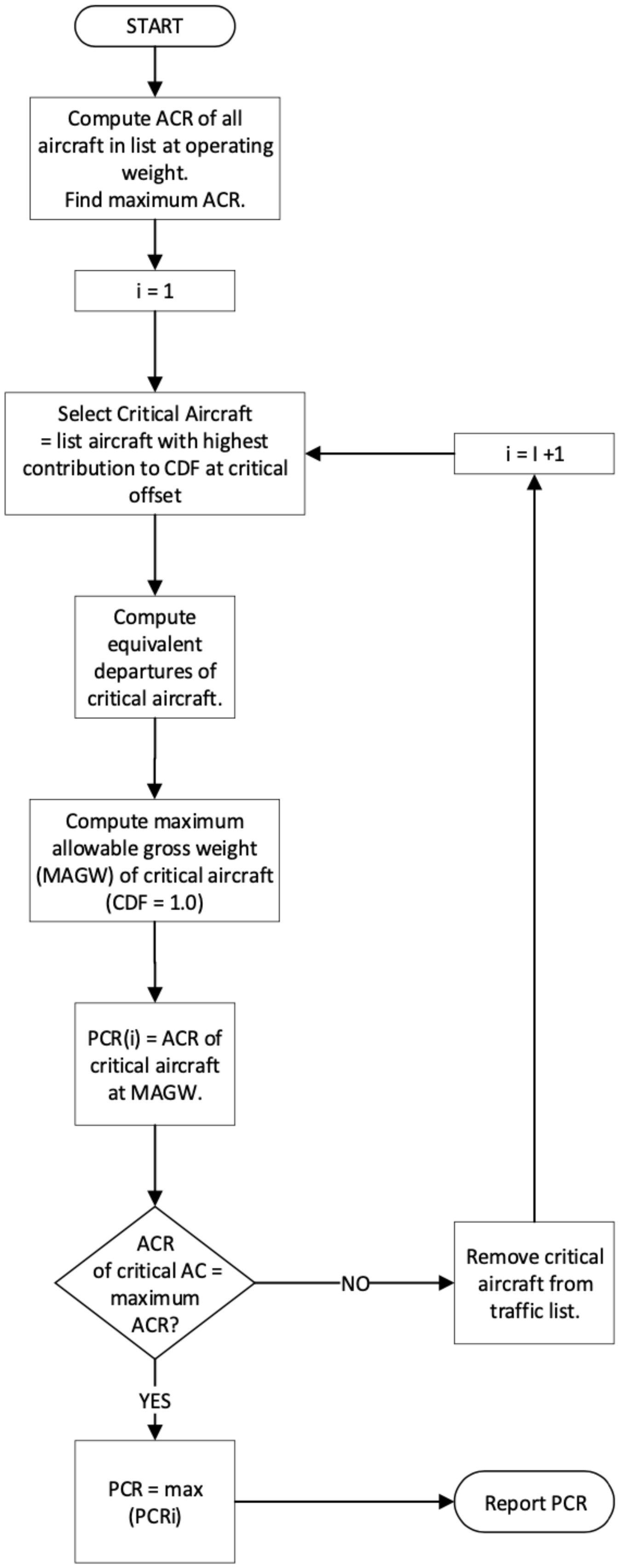

Figure 9. Flowchart of recommended PCR computation procedure *(ICAO, doc.9157.part 3)*

4.4. Reporting the PCR

The PCR system uses a coded format to maximize the amount of information contained in a minimum number of characters and to facilitate computerization.

The PCR is reported as a five-part code where the following codes are ordered and separated by forward slashes:

Numerical PCR value / Pavement type / Subgrade category / Allowable tire pressure / Method used to determine the PCR.

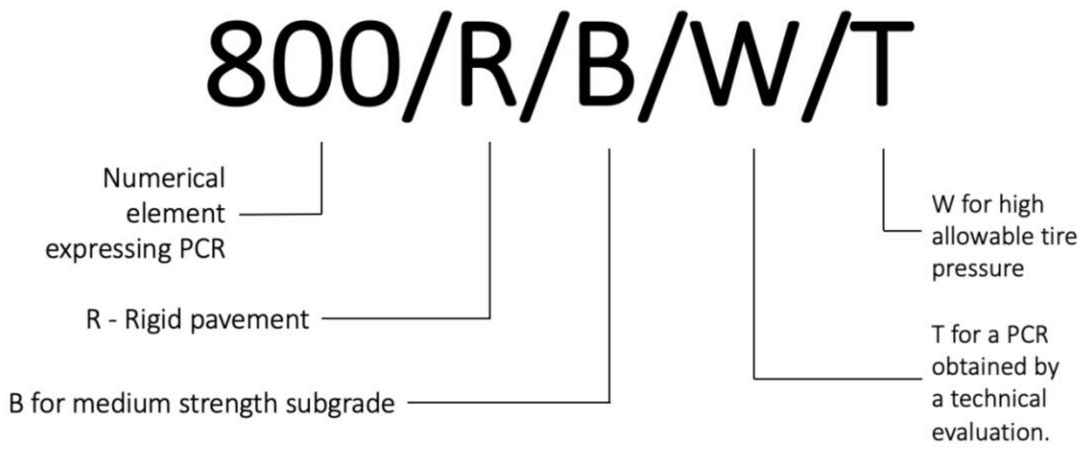

Figure 10. Example PCR Reporting

Subgrade Categories are explained in Table 4, and type pavements are explained in paragraph 3.1.

4.4.1. Tire Pressure

For the purpose of reporting in table nr.7, there is the lists of the allowable tire pressure categories identified by the ACR-PCR system. The tire pressure codes apply equally to rigid or flexible pavement sections; however, the application of the allowable tire pressure differs substantially for rigid and flexible pavements.

Category	Code	Tire Pressure Range
Unlimited	W	No pressure limit
High	X	Pressure limited to 1.75 MPa
Medium	Y	Pressure limited to 1.25 Mpa
Low	Z	Pressure limited to 0.50 Mpa.

Table 9. Tire Pressure Codes for Reporting PCR

4.4.1.1 Tire Pressures on Rigid Pavements.

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

4.4.1.2. Tire Pressures on Flexible Pavements.

Tire pressures may be restricted on asphaltic concrete (asphalt), depending on 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. Mixtures utilizing lower quality materials and construction standards can show distress under tire pressures of 0.7 MPa or less. Although these effects are independent of the asphalt layer thickness, pavements with well-placed asphalt of 15 cm can generally be rated with code X or W, while thinner pavement of poorer quality asphalt should not be rated above code Y.

Once a PCR value and the coded entries are determined, report the value in the Airport Master Record. The PCR data will be disseminated by the Aeronautical Data Team through aeronautical publications such as the Chart Supplements and the Aeronautical Information Publication (AIP). An aircraft's ACR can then be compared with published PCR's to determine if pavement strength places any weight or tire pressure restrictions on the aircraft operating on that pavement.

5. PAVEMENT OVERLOADS AND CONCESSIONS FOR THE ACN-PCN METHOD OF REPORTING PAVEMENT STRENGTH

Applicable until 27 November 2024

5.1. General

As described above, when the ACN exceeds the PCN value, a strength-based pavement concession is required prior to the aircraft operating. Similarly, where the tire pressure exceeds the nominated tire pressure limit (or category) then a tire pressure pavement concession is required. The same requirements apply to the ACR-PCR system.

Regardless of whether ACN-PCN or ACR-PCR is the basis for the strength rating, a pavement concession is effectively an overload that has the potential to reduce the structural life of the pavement. Various jurisdictions provide guidance regarding the magnitude and frequency of pavement concession that should be permitted.
This guidance material draws the attention to some information that can be used by aerodrome operators to aid in establishing such criteria using the ICAO standards and recommended practice despite existence of other methods developed by states.

The ICAO Doc 9157, Aerodrome Design Manual, Part 3 Pavements, contains more information on the subject, including background explanation as well as an insight on how several states have approached the subject. These are regarded as acceptable means of compliance to controlling overloading the pavements and are generally best practices in the industry which can be applied to ensure pavement preservation.

5.2. Overload guidance

5.2.1 Different guidance is proposed on the reasonable frequency of aircraft movements under a pavement concession, based on the ratio of the ACN to the PCN, or the ACR to the PCR.
5.2.2 Unlike pavement design and strength rating, pavement concessions can consider the actual or prevailing strength of the pavement at the time of the proposed overload operation. In general, pavements are stronger when the subgrade is drier and the bituminous layers (i.e. asphalt) are colder.
5.2.3 In contrast to pavement strength overloads, tire pressure related pavement concessions are less likely to be detrimental. For most surfaces in reasonable condition, the pavement strength is a much greater factor than the tire pressure. Therefore, rejection of tire pressure related pavement concession requests is rarely justified. In fact, most tire pressure related pavement concessions result from the under-rating of the surface due to an historical tie to a specific aircraft tire pressure, which has been exceeded by new aircraft models or variants, but the tire pressure limit not being updated.
5.2.4 When assessing an application for a pavement concession the aerodrome operator should consider various affecting elements. (as described in paragraph 5.5).

5.3. Overload operations

5.3.1. The aerodrome operator shall decide the pavement overload which is allowable for the aerodrome, and also adopt an appropriate overload policy. This requires consideration of the pavement strength and condition, aircraft frequency and weight, pavement inspection and management procedures, and other commercial and political considerations.

5.3.2. The following are recommended pavement overload guidelines:

- occasional movements on a flexible pavement by aircraft with an ACN not exceeding 10% of the reported PCN shall not adversely affect the pavement;
- occasional movements on a rigid pavement by aircraft with an ACN not exceeding 5 % of the reported PCN shall not adversely affect the pavement;
- where the pavement structure is unknown a limitation of 5 % shall apply;
- the annual number of overload movements shall not exceed approximately 5% of the total annual aircraft movements;
- overload movements are not being permitted on pavements exhibiting signs of distress or failure;
- overloading shall be avoided during periods when the strength of the pavement or subgrade could be weakened by water; and
- The condition of the pavement shall be regularly reviewed.

5.3.3. These overload guidelines are appropriate and provide a balance between commercial demand and risk management for the aerodrome operator. The guidelines are conservative and make them appropriate for the major aerodromes receiving a large number of aircraft movements by heavy aircraft.

5.3.4. An overload by aircraft with an ACN up to but not exceeding 10 % of the reported PCN is generally considered acceptable provided:
(i) the pavement is more than twelve months old;
(ii) the pavement is not showing signs of distress; and
(iii) overload operations do not exceed 5 per cent of the annual departures and are spread throughout the year.

5.3.5. An overload by aircraft with an ACN greater than 10 % or more than 10% but not exceeding 25% of the reported PCN requires regular inspections of the pavement by a competent person and there should be an immediate curtailment of such overload operations as soon as distress becomes evident.

5.3.6. An overload by aircraft with an ACN greater than 25 % but not exceeding 50 % of the reported ACN may be undertaken under special circumstances including:

- scrutiny of available pavement construction records and test data by a qualified pavement engineer; and
- A thorough inspection by a pavement engineer before and on completion of the movement to assess any signs of pavement distress.

5.3.7. Overloads by aircraft with an ACN greater than 50% of the reported PCN shall only be undertaken in an emergency.

5.3.8. Overloads not exceeding 100 % shall only be considered in the case of small airplanes operating into aerodromes which do not show signs of pavement distress and where the pavement and subgrade material is not subject to moisture ingress.

Overload Operations by aircraft	**Are overload operations allowable?**	**Actions by AO**	
		Before overload operations	**After overload operations**
10% < ACN < 25% of the reported PCN	Yes	Carry out an engineering analysis to determine the extent of overload operations.	- Carry out regular inspections of the pavement by competent personnel; - Stop overload operations immediately as soon as distress becomes evident;
25% <ACN < 50% of reported PCN	Yes, but subjected to an engineering analysis	- Carry out an engineering analysis to determine the extent of overload operations. - Include a critical examination of available pavement construction records and test data by a qualified pavement engineer. - Carry out a thorough inspection by a pavement engineer to assess any signs of pavement distress.	Carry out a thorough inspection by a pavement engineer on completion of the movement
ACN > 50% of reported PCN	Only allowed in an emergency		

Table 10. Actions by aerodrome operator for the different limits of overload operations

5.4. Tire Pressure Overload

The tire pressure produces the intensity of the load on the pavement. The primary consideration for excess tire pressure operations is the risk of undue damage to the surfacing. The consequences of pavement damage as a result of overstressing of the surfacing layers are likely to be less serious than a deep-seated structural failure. Nevertheless, an engineer must carefully weigh the problems of carrying out maintenance work in the event of damage before allowing occasional excess tire pressure operations for the sake of maintaining operational flexibility.

5.4.1. The following notes are for guidance:

5.4.1.1. Occasional movements by aircraft with tire pressures over the maximum authorized for unrestricted use of the pavements are unlikely to have significant effect on the performance of the pavement.

5.4.1.2. Concrete pavements are not subject to surface indentation by high tire pressure aircraft.

5.4.1.3. Bituminous surfacing of other than high stability Marshall asphalt or with less than 100mm amount of Marshall asphalt are liable to indentation by high pressure tires. The of indentation depends on the following factors:

- The stability of blacktop surfacing is temperature dependent and therefore they are more liable to indentation by high pressure tires on hot days.
- Although ready for use within hours of laying, bituminous surfacing continues to harden for some months. This depends on the type of mix and the climatic conditions. The full stability of surfacing is not realized for several months after laying.
- Indentation is more likely to occur on a bituminous surface when aircraft are parked on it. Metal plates can be used to spread the load beneath the tires of parked aircraft, they will protect a low stability black- top surfacing.

5.4.1.4. Shallow pavements comprising less than 100mm of bituminous surfacing on low-grade granular bases (i.e. CBR <80%) are liable to structural damage by high tire pressure aircraft, particularly where the aircraft are parked. In practice this situation will effectively represent a combination of overload and excess tire pressure and will therefore need to be carefully considered.

5.5. Inspection and monitoring regime.

5.5.1 Where overload operations are conducted, the aerodrome operator must put in place a regime to inspect the relevant pavement condition regularly by competent personnel.

5.5.2 The aerodrome operator should monitor the pavement condition closely for a period of several weeks or until it is verified that deterioration of the pavement is not occurring. Any significant deterioration of the surface of the pavement may be caused by weakening of the pavement material and/or subgrade, in which case, a technical review of the pavement strength rating may be required. If necessary, increased maintenance and or/rehabilitation earlier than was originally intended should be considered.

The aerodrome operator should periodically review the criteria for overload operations as excessive repetition of overloads can cause severe shortening of pavement life or require major rehabilitation of pavement.

5.6. Pavement Concessions

5.6.1 Normally an airplane with an ACN value greater than the PCN of the aerodrome pavements or operating with a tire pressure greater than that, which the pavement is rated for, will not be permitted to operate at the aerodrome unless a pavement concession has been approved by the aerodrome operator for the period of operations. A pavement concession given to the aircraft operator formalizes the acceptance of the heavier aircraft and sets conditions under which the operation will be accepted.

5.6.2 In combination with the overload guidelines described earlier the aerodrome operator shall also consider the following when assessing an application for a pavement concession:

5.6.3 The safety of the operation, where overloading of the pavement is so severe that damage to aircraft is likely and the safety of the occupants is in doubt a pavement concession is not to be approved.

5.6.4.

a. The probability of pavement damage is related to these factors:

- basis of pavement design;
- report on pavement evaluation and condition;
- data on aircraft usage;
- reports on damage caused by previous operations (overload operations should not normally be permitted on pavements exhibiting signs of distress or failure);
- the social and economic importance of the operation: are alternative aircraft available
- the urgency of the operation (ex. urgent medical evacuation, flood, disaster relief);
- are the operations of significant commercial importance to the community.

b. The consequence of any pavement damage:

- the cost of repairs to any pavement damage;
- the resources available to repair any damage;
- the disruption to routine operations caused by any damage or repairs; and

c. other considerations:

are the physical characteristics of the aerodrome movement area suitable for the intended operations of the overloading aircraft (for example, parking and manoeuvrability).

6. PAVEMENT OVERLOAD EVALUATION BY THE ACR-PCR SYSTEM.

Applicable as of 28 November 2024

6.1. ICAO Pavement Overload Evaluation Guidance.

In the life of a pavement, the current or the future traffic might load the pavement in such a manner that the assigned pavement rating is exceeded. ICAO provides a simplified method to account for minor pavement overloading in which the overloading may be adjusted by applying a fixed percentage to the existing PCR.

The ICAO procedure for overload operations is based on minor or limited traffic having ACRs that exceed the reported PCR. Loads that are larger than the defined PCR will shorten the pavement design life, while smaller loads will use up the life at a reduced rate. With the exception of massive overloading, pavements in their structural behaviour are not subject to a particular limiting load above which they suddenly or catastrophically fail. As a result, occasional minor overloading is acceptable with only limited loss of pavement life expectancy and relatively small acceleration of pavement deterioration.

The following guidelines are recommended when evaluating overloads:

a) For flexible or rigid pavements, occasional traffic by aircraft with an ACR not exceeding 10 % above the reported PCR should not adversely affect the pavement. For example, a pavement with PCR=750 can support some limited traffic of aircraft with ACR=800.
b) The annual number of overload traffic should not exceed approximately 5 % of the total annual aircraft traffic. There is no exact guidance for choosing a number of operations that represents 5 %.
c) Overloads **should not normally be permitted** on pavements already exhibiting signs of structural distress, during periods of thaw following frost penetration, or when the strength of the pavement or its subgrade could be weakened by water.
d) When overload operations are conducted, the airport owner should regularly inspect the pavement condition.
e) Periodically the airport owner should review the criteria for overload operations.
f) Excessive repetition of overloads can cause a significant reduction in pavement life or accelerate when a pavement will require a major rehabilitation.

These criteria provide a consistent, repeatable process the airport owner can use to monitor the impact of these overload operations on the pavement in terms of pavement life reduction or increased maintenance requirements. This discusses methods for making overload allowances for both flexible and rigid pavements that will clearly indicate these effects and will give the authority the ability to determine the impact both economically and in terms of pavement life.

6.2. Overload Guidance.

The overload evaluation guidance applies to flexible and rigid pavements that have PCR values that were established by the technical method. Pavements that have ratings determined by the Using Aircraft

Method can use the overload guidelines provided very frequent pavement inspection procedures are followed.

The adjustments for pavement overloads start with the assumption that some of the aircraft in the traffic mix have ACRs that exceed the PCR. If a technical analysis was performed, then most of the necessary data already exists to perform an examination of overloading.

The recommended PCR is not adequate for the traffic mix when the Total CDF>1. Airports have three options when evaluating what pavement strength rating to publish:

1. Let the PCR remain as derived from the technical evaluation method, but retain local knowledge that there are some aircraft in the traffic mix that can be allowed to operate with ACRs that exceed the published PCR or at a reduced weight to not exceed the PCR.
2. Provide for an increased PCR by adding an overlay or by reconstruction to accommodate aircraft with higher ACRs.
3. Adjust the PCR upward to that of the aircraft with the highest ACR but recognize the need to expect possible severe maintenance. This will result in earlier and increased costs for reconstruction or overlay projects. This is in essence changing the PCR rating to a using rating, and potentially reducing the remaining pavement life.

6.3. Limitations of the ACR-PCR System.

The ACR-PCR system is only intended as a method that airport operators can use to evaluate acceptable operations of aircraft. It **is not intended** as a pavement design or pavement evaluation procedure, nor does it restrict the methodology used to design or evaluate a pavement structure.

There is no mathematical correlation between the previous ICAO pavement strength reporting ACN-PCN and the new ICAO ACR-PCR system.

6.4. Last Considerations

It is noted that the ACR numerical value is expressed in hundreds of kilograms, while the ACN value is expressed in tones, so ACR is higher than corresponding ACN by approximately one order of magnitude. This was intentionally defined in order to avoid confusing the two systems during the period of transition.

From the estimation of the PCN and PCR values of the runway flexible airfield pavement of two airports, it occurred that the PCR approach may be more conservative compared to PCN, in terms of the amount of aircraft loading that the pavement can carry. The above observations may create a useful path for further investigation, which can be extended, considering also different pavement cross-sections, aircraft fleets and material characteristics in order to be able to strengthen the above finding.

Various analysis showed that since the ACR-PCR is structured to be based on failure of the subgrade, the variation of the damage of the asphalt concrete layers cannot be depicted. However, it is believed that particular focus should be given on the asphalt concrete failure mode, since it may be crucial in terms of airfield pavement performance.

Since this is a transfer period until the full implementation of the updated ACR-PCR system, this consideration could be useful in terms of airfield pavement decision-making practices.

7. PAVEMENT MANAGEMENT PROGRAMME (PMP)

In Annex 14, Volume I, Chapter 10, a requirement for a maintenance programme has been established, including preventive maintenance, making, by inference, the implementation of a **pavement maintenance programme (PMP)** mandatory.

Extending the pavement life through a regular programme, for a constantly changing aircraft fleet, requires more sophisticated maintenance techniques, such as a PMP. As preventive maintenance, it will be desirable to implement a PMP where appropriate, to maintain aerodrome pavements/facilities in a condition that does not impair the safety, regularity or efficiency of air navigation.

A PMP is a set of defined procedures for collecting, analysing, maintaining and reporting pavement data, to assist decision-makers in finding optimum strategies for maintaining pavements in safe serviceable condition over a given period of time for the least cost.

A PMP should take into account:

a) inspection procedures and condition assessment;
b) maintenance protocols and procedures;
c) management and oversight of completed works; and
d) staff competence needed (human factors).

Depending on the complexity of the paved areas in an aerodrome, a PMP would contain as a minimum the following functionalities:

a) pavement inventory (pavement condition evaluation, pavement history, traffic, costs); and
b) pavement condition assessment.

Additional functionalities could include:

a) modelling to predict future conditions — analysis (serviceability rating, performance predictions, economic analyses-budgeting/programming);

b) pavement performance report (past and future);

c) pavement maintenance and repair (planning, scheduling, budgeting and analysing alternatives);

d) and project planning.

8. APPENDIXES

8.1. Appendix A. Structural Investigations of Airfield Pavements

1. INTRODUCTION

General

This Appendix contains detailed guidance and advice on undertaking structural investigation on airfield pavements to provide the pavement and subgrade inputs to reverse design. Separate sections in this Appendix deal with the main activities that the pavement engineer will have to consider. Starting with planning the investigation, the Appendix goes on to describe the different types of surveys that are available providing guidance on when they should be used and how the results should be interpreted. This Appendix should be used when planning any form of structural maintenance on MOD airfield pavements.

2. PLANNING THE INVESTIGATION

2.1 The need for a pavement investigation

2.1.1 Investigations to provide information for reverse design are carried out at "project" level, following a process of identifying projects at a network level (i.e. several airfields or a large number of pavements at a single airfield) (Figure 1). A structural investigation and pavement evaluation may be a project in its own right, e.g. to determine the residual life following a change in use, or may be a component of a much larger project, e.g. to strengthen a pavement.

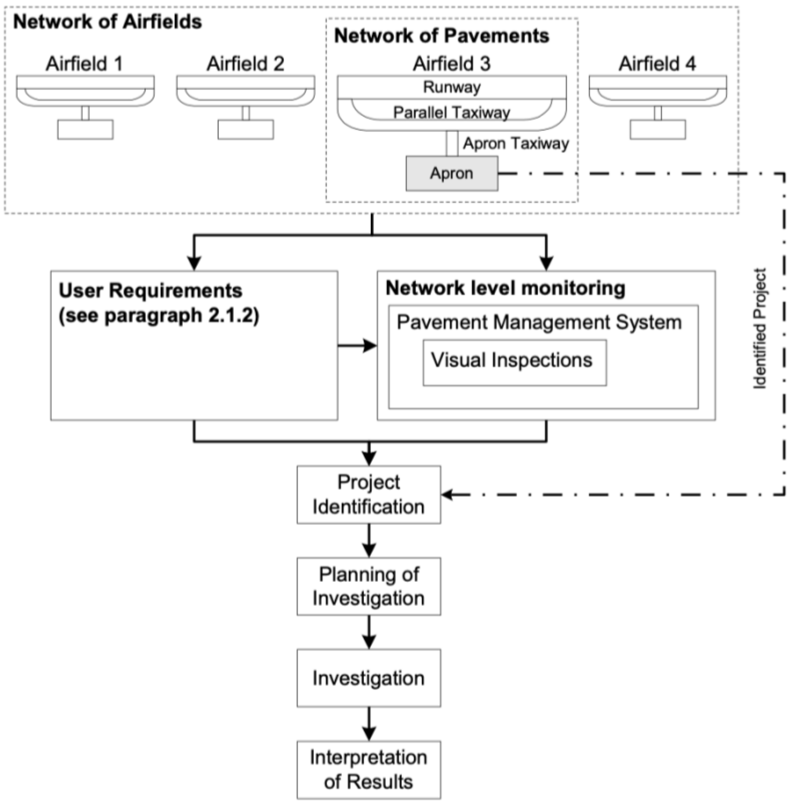

Figure 11. Identification of projects

2.1.2 The identification of a project may be based on:

- a user requirement, e.g. a change in use, a change in the frequency of use, or reinstatement of a disused pavement,
- a method of network level monitoring, e.g. a Pavement Management System or regular investigations, to identify pavement maintenance or rehabilitation requirements.

2.2 Components of a structural investigation

2.2.1 Once a project has been identified it is good practice to undertake a structural investigation to obtain the information required for an accurate reverse design and design of any strengthening requirements.

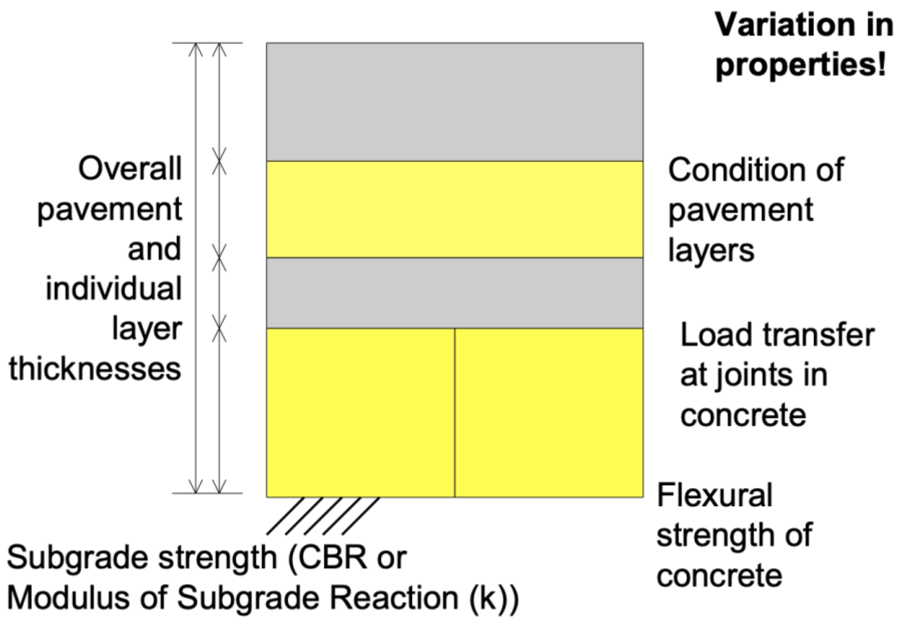

Figure 12. Information required from structural investigations

2.2.2 A structural investigation may comprise:

- Data collection.
- A visual inspection.
- Destructive testing by coring or trial pits.
- Subgrade strength tests in core holes or trial pits, usually by Dynamic Cone Penetrometer (DCP).
- Non-destructive testing by Falling Weight Deflectometer (FWD) or Ground
- Penetrating Radar (GPR).
- Compressive strength tests on recovered concrete samples.

2.2.4 In planning an investigation the following points should be considered:

- Before undertaking a structural investigation all available data on the construction history, maintenance records and previous use should be collected.
- A visual inspection must always be undertaken.

- Destructive testing by coring or trial pits is always necessary, to obtain thicknesses for direct use or for calibration of GPR results, to allow subgrade strength tests, and to recover concrete samples for strength testing. Coring is the preferred option, but cores are not practicable in thick unbound constructions when trial pits are necessary.
- Non-destructive testing cannot provide accurate measurements of subgrade strength, therefore subgrade strength tests through cores or trial pits are necessary.
- Destructive testing of operational pavements is difficult. Usually only a limited number of tests is practicable, which can give misleading results.
- Airfield pavements and subgrades are typically very variable. In this situation, a large number of relatively accurate test results is more useful than a small number of very accurate results. Homogenous sections can only be detected by frequent tests, such as FWD tests or a GPR survey. FWD and GPR tests can be used to reduce the required number of cores or trial pits.
- The accuracy of destructive testing can be improved by selecting representative locations through statistical analysis of deflection measurements by FWD (see Section I4). However, this process requires adequate time for analysis of the FWD results before the core locations are selected, and if there are services under the pavement the optimum test locations may not be accessible.
- If core locations have to be fixed before the investigation to allow for services clearances the best way of ensuring that the information on pavement thicknesses is representative is to carry out a GPR survey, and to use the core information to calibrate the results.
- FWD testing is the only method of measuring load transfer at joints.
- Information from cores or trial pits, or FWD results, is too coarse or difficult to analyze for the accurate detection of hidden construction changes. GPR provides the best method of investigating varying construction.
- The use of layer thicknesses determined from GPR measurements may significantly improve the accuracy of the analysis of FWD results.
- The DCP is the preferred method of testing for the strength of unbound bases and sub-bases and the subgrade as it provides continuous readings with depth, allowing the thickness and strength of each layer to be established without the need to excavate the layers and test at discrete points.

Homogenous sections

a. A key part of the structural investigation is the identification of homogenous sections of pavement behavior. A homogenous section is one that cannot be further sub-divided in sub-sections with significantly different means. Multiple homogenous sections may occur within a single Construction Location, as factors such as layer thicknesses and condition and subgrade strength vary (Figure 13).
b. The planning of the investigation should take account of the expected variation and the need to detect homogenous sections; i.e. if the subgrade is expected to be very variable FWD testing is desirable to detect changes in the subgrade.

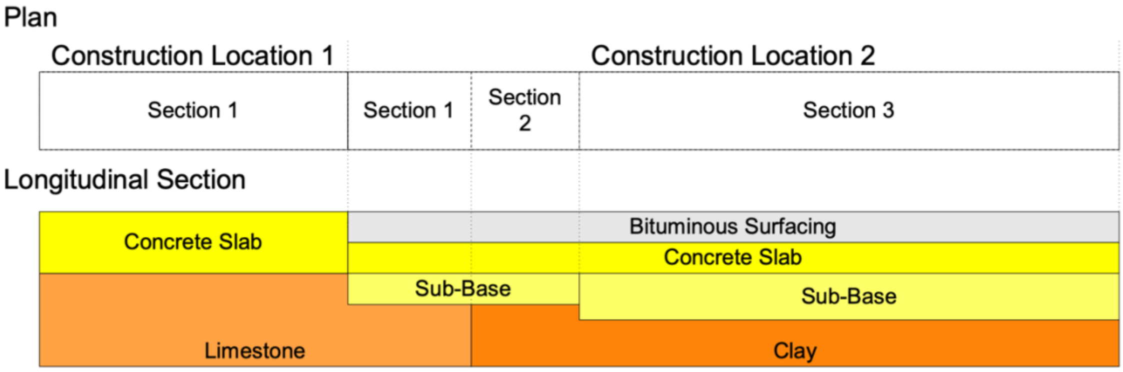

Figure 13. Homogenous sections

2.4 The Plan

2.4.1 The plan for a structural investigation should take account of:

- The area to be investigated;
- Operational restrictions and access periods;
- The likelihood of services and requirements for service clearances;
- The known information about the pavement;
- The likely variability of the pavement;
- Whether concrete strength is required;
- Whether the pavement is jointed concrete and if the load transfer at joints is to be measured.

2.4.2 The plan should comprise:

- The type of testing;
- The number of lines to be tested and their location;
- The frequency of the tests.

An overview of recommended test locations and frequency of testing is shown in Figure 14.

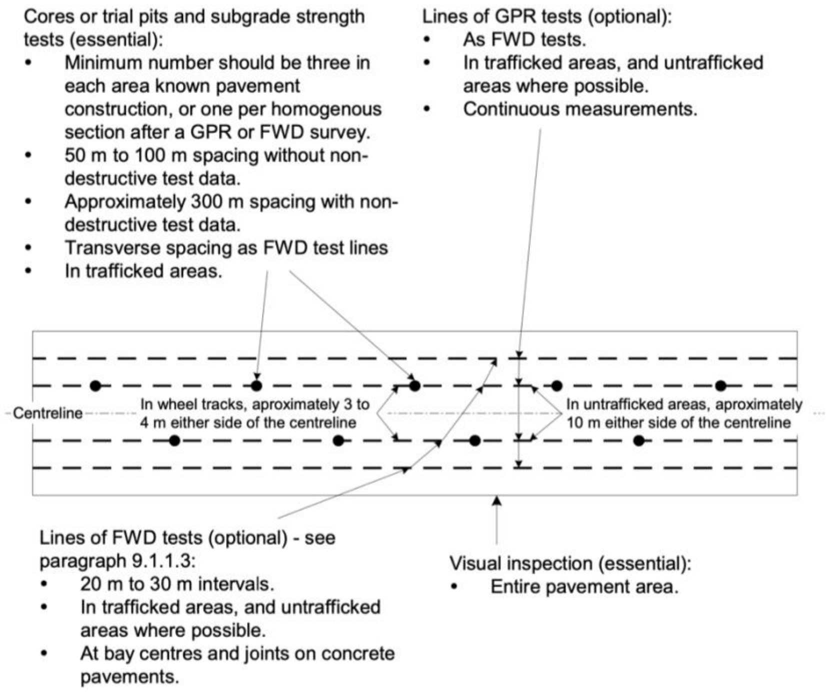

Figure 14. Test locations and frequency

2.5 Other tests methods

2.5.1 There are several other test methods that may be used in some circumstances, including:

- Other deflection measuring methods, such as the Deflection (Benkelman) Beam, which may be used as a substitute for the FWD for a simple deflection survey to determine homogenous sections and representative test locations if access by FWD is not practicable;
- Alternative subgrade strength tests, including in situ CBR, plate tests and MEXE Penetrometer which may be used if a Dynamic Cone Penetrometer is not available.
- The use of GPR for the detection of cracks, voids or debonding;
- The use of trial pits to look for the location and cause of failures;
- Laboratory tests for the properties of bituminous materials.

3. VISUAL INSPECTIONS

3.1 General

3.1.1 A detailed visual inspection is an essential component of a structural investigation.

3.1.2 Before undertaking the inspection the following should be determined as far as possible to give an indication of what to look for and where to look for it:

- The nominal pavement construction and the age of the various layers.
- The aircraft use to date, including the track dimensions of the major user aircraft.

If no details are available an inspection can still yield useful evidence on the construction.

3.1.3 The most important areas of a pavement for a structural inspection are those regularly trafficked by aircraft. Although structural deterioration, due to ageing of asphalt or similar processes, can take place uniformly across a pavement, the most important information for design and evaluation purposes is how the pavement is behaving under aircraft loading, and what the condition is of the areas regularly trafficked. If there is a centerline or nose wheel marking on the pavement, 75% of load applications can be expected to occur within bands about 2m wide centered on the centerline of each main undercarriage strut. Without markings for the nose wheel to follow trafficking, may be much more uniformly distributed across the pavement and the inspection will have to cover a wider area in detail.

3.1.4 The whole width of the pavement should be inspected to determine whether there are significant differences between trafficked and untrafficked areas. Distress features which occur uniformly across a pavement are unlikely to have been caused by aircraft use and some other reason should be looked for.

3.1.5 Failure of a pavement as a whole is not caused by structural failure at one individual point in the pavement. The inspection should note the proportion of the area within the wheel tracks that shows signs of structural distress for comparison with the failure criterion of structural failure over approximately 30%-50% of the areas regularly trafficked by aircraft.

3.2 Concrete surfaces

3.2.1 The failure mechanism of a concrete pavement is cracking; followed by deterioration of the cracks due to movement or weathering. In situations where there is little weathering action (e.g. hangar floors) or where a very stiff support to the top concrete slabs restricts deflection (e.g. multiple slab construction) cracks may exist for long periods before they become a maintenance problem. For this reason, it is helpful to have adequate information on historical aircraft use, since cracks could be present in the wheel tracks of an aircraft that no longer uses the pavement and was different in size to the existing user aircraft; these cracks can be difficult to explain without the relevant knowledge.

The survey should note the presence and amount of the following:

- Corner cracks – and their relation to expansion joints or very open transverse joints. Longitudinal halving cracks (i.e. parallel to the direction of the concrete lanes) – and whether they appear to start at joints or the bay center. Transverse cracks;
- Quartering cracks;
- Delta cracks;
- Multiple cracked bays.
- The relation between aircraft wheel paths and the type of cracking.

3.3 Bituminous surfaces

Pavements with bituminous surfaces fall into two categories:

3.3.1. Bituminous materials overlying concrete (composite pavements). Bituminous materials overlying unbound granular bases and sub-bases or relatively weak cement-bound materials (e.g. Drylean Concrete or Cement-Stabilized Soil) or full depth bituminous constructions (flexible pavements).

3.3.2 The failure mechanism in flexible pavements is rutting with associated heave due to shear failure of the subgrade or unbound pavement layers, or full depth cracking of the bituminous surfacing. The heave will be accompanied by ‘alligator cracking'. A structural survey should check the following:

- Rut depth.
- Height of heave.
- The width of the rut (between the highest point of the heaved areas).
- The presence of alligator cracking.
- Longitudinal cracking in the wheel paths.
- Other forms of cracking, such as block cracking.

3.3.3 A composite pavement with a relatively thick overlay of bituminous materials will, in the long-term, behave like a flexible pavement, and the distresses described above should be noted.

3.3.4 A composite pavement with a relatively thin overlay of bituminous materials will, in the long-term, behave like a concrete pavement. The inspection should note the underlying bay layout and any of the crack features, if they are reflecting through the bituminous surfacing.

3.3.5 It is sometimes difficult to tell the difference between asphalt lane joints and reflective cracks from longitudinal construction joints in concrete slabs. Bituminous overlays are usually constructed with an overlap of around 1m over the longitudinal concrete joints. The asphalt lane joints are likely to be straighter and more continuous than the reflective cracks.

3.4. Other distresses

- Other structurally related distresses that should be noted are:
- Mud pumping, which may occur in all types of pavement. Mud pumping may be directly visible in certain conditions, or detectable by staining of the pavement surface around joints and cracks.
- Blistering of bituminous surfaces - small transient domes on the surface of the pavement that form in hot weather conditions, or associated cracking in the form of a cross at the center plus an additional crack around some or all of the circumference. Blistering or the presence of the symptomatic cracking should be noted.

4. INTERPRETATION OF RESULTS FROM SITE INVESTIGATIONS

4.1 General 4.1.1 This section describes how the results of a site investigation should be interpreted to determine the inputs required for an evaluation of the pavement strength and residual life by reverse design, and for the design of rehabilitation or strengthening measures.
4.1.2 The process is summarized in Figure 15

4.2 Visual inspection
4.2.1 General
4.2.1.1 The results of the visual inspection should be used to:

- Assist in the assessment of condition factors for evaluation and the design of strengthening requirements.
- Assess material and pavement condition
- Provide a reality check for the reverse design.

4.2.2 Condition factors
4.2.2.1 The type and amount of cracking in concrete pavements can be related to the Condition Factors for evaluation and overlay design of composite and multiple slab pavements.

4.2.3 Pavement and material condition
4.2.3.1 A number of distresses recorded by a visual inspection are an indication of the structural condition or behaviour of the pavement or individual layers, including the following:

- Cracks in rigid pavements and rutting and/or cracking in flexible pavements in the wheel track areas indicate the onset of structural failure;
- Measurement of rutting and associated heave can be used to assess the condition of flexible pavements;
- Rut width compared to the track of the most damaging user aircraft may provide an indication of where failure is occurring in a flexible pavement with unbound granular layers. The narrower the rut width the higher in the pavement the problem is likely to be;
- Significant rutting without associated heave suggests densification of bituminous layers, unbound granular materials or the subgrade due to inadequate compaction for the loading. With time the densification will cease as the relative density of the layer becomes adequate for the

loading, but until that point there is no cure other than to remove the layer, or put on a thick overlay to reduce stresses in the layer to a more acceptable level;

- Cracking in a bituminous surfacing which has an underlying concrete construction may be a reflection of the bay pattern of the concrete or may indicate that the underlying bays have undergone some structural cracking;
- Some forms of cracking can occur in bituminous surfaces for non-structural reasons. These can usually be found randomly distributed over the pavement area, not just in the wheel tracks. The most common of these is “block” or “age” cracking, which produces a block pattern formed by short longitudinal and transverse cracks. These are caused by a combination of the binder stiffening with age and temperature effects in the bituminous layers. Although not related to structural behaviours they will reduce the structural capacity of the bituminous layers;
- Mud-pumping indicates the presence of a saturated fine-grained subgrade and relatively large deflections under loading causing fine material to pump up through joints or cracks in the pavement. In a flexible pavement the mud-pumping will indicate full-depth cracking of bituminous layers. If unbound granular layers are present mud-pumping indicates contamination by fine materials with a probable loss of structural capacity. If a bound base/sub-base is supposed to be present in the pavement mud-pumping will indicate severe deterioration of that layer;
- Blisters are probably formed by the heating of water vapor trapped in asphalt layers with a high void content, which have been overlaid with impervious asphalt layers. If the voids are large and interconnected (e.g. open macadams) blistering does not occur as the water vapor has room for expansion; and once the overlay becomes thick enough blistering will be reduced because of the insulating properties of the overlaying asphalt. Once the crack occurs the blistering ceases to occur, but may recommence if the surface is overlaid, sealing the cracks. Unless the layer causing the blistering is removed there is no proven cure other than to puncture blisters as they occur. It may be possible to prevent the recurrence of blistering by laying an open textured material on top of the existing surface before overlaying in dense bituminous materials. Although unsightly there is no evidence that most blisters or the associated cracking significantly affect serviceability or pavement life. In the event of this defect occurring, the need or otherwise to carry out major remedial/refurbishment work will depend on its extent and severity and also the nature of aircraft operations.

4.2.4 Reality check

4.2.4.1 When a pavement structural investigation and evaluation has been undertaken, a reality check should be carried out against the visual inspection. If there is an obvious mismatch the information on use should be re-assessed, and then if necessary, the interpretation of the structural testing and the reverse design should be re-done.

4.2.4.2 Pavement condition must be related to previous use. For instance, if a pavement classified as PCN 50/F/A fails under regular ACN 40 (Flexible High Subgrade) use only, then the classification is obviously wrong, and the pavement will need strengthening as well as restoration of fatigue life if future PCN 50/F/A use is intended.

4.3 Coring or trial pits

4.3.1 Layer thicknesses measured in cores or trial pits should be used to determine the pavement thicknesses for reverse design, as follows:

- If there are several cores or trial pits in a section of pavement, calculate a design thickness from the mean plus one half standard deviation of the thicknesses for each layer (if several bituminous layers are grouped in the pavement construction, the overall thickness of the group should be calculated);
- If the core or trial pit location has been selected as representative of a section by analysis of FWD results, use the layer thicknesses from that core or trial pit for the whole of the section;
- If the core or trial pit measurements have been used to calibrate GPR results, use the GPR results.

4.4. Subgrade strength tests

Dynamic Cone Penetrometer

4.4.1.1 A Dynamic Cone Penetrometer test can be used to:

- Assess regions of homogenous behavior with depth;
- Assess the depth and strength of unbound bases and sub-bases;
- Assess the strength of the subgrade, and detect weak layers within the depth of the test;
-

4.4.1.2 The CBR should generally be taken as the lowest in a layer. When several results in a pavement section are available the design value may be calculated as the mean minus one half standard deviation of the results for a layer. Care should be taken to eliminate outliers, i.e. high or very low strengths. If there are a few tests with a wide scatter, a simple visual assessment will be safer than a statistical analysis; generally selecting the lowest result or a result close to the lowest.

4.4.1.3 The thickness of unbound bases and sub-bases should be determined by plotting CBR against depth to find the thickness of materials with CBRs greater than the minimum values required for Granular Base (100%) and Granular Sub-base (30%)

4.4.1.4 For flexible pavements, if there is a significant depth of subgrade above the depth at which the lowest CBR occurs, with a strength greater than the design CBR, but not great enough to be treated as Granular Sub-base, it may be treated as subgrade improvement.

4.4.2 Other tests are shown in the flowchart Figure 15, below.

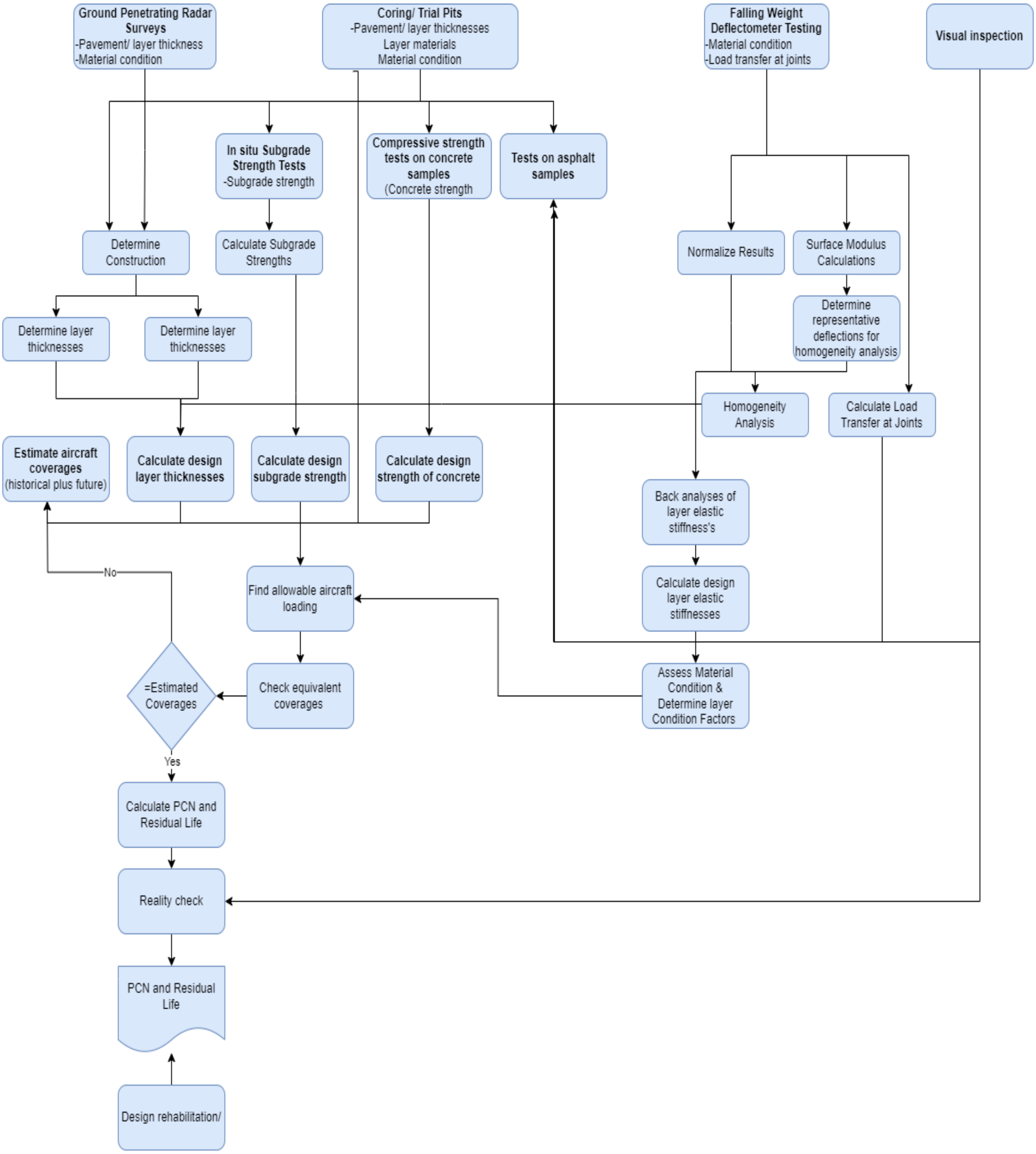

Figure 15. Standard techniques for structural investigations and interpretation and integration of test results.

5. Reporting

5.1. A report on a pavement investigation should include the following:

- The results of prior data collection.
- A description of the investigation, including the pavements tested, the components of the investigation and test frequencies.
- The results of the visual inspection.
- A summary of the results, including the Construction Locations and homogenous pavement sections determined, the design values for the layer thicknesses, layer elastic stiffnesses, subgrade strengths, concrete strengths and load transfers at joints.
- A commentary on any features of the testing, including material conditions in cores and subgrade types.

5.2. Appendices should be included for relevant tests giving:

- A description of the test methods, methods of statistical analysis for homogeneity and back-analysis procedures including a description of back-analysis software.
- Previous construction records, if known.
- FWD test measurements.
- Results of any statistical analysis for determination of homogenous pavement sections.
- Results of any back-analysis of FWD measurements, including layer elastic stiffnesses, measured and calculated deflection basins and Absolute Mean Deviation and Root Mean Square deviation for each test.
- Results of load transfers calculated from FWD tests.
- Core logs.
- Results of compressive strength tests on cores.
- Dynamic Cone Penetrometer tests measurements, or measurements from other test methods.
- Subgrade strength results determined from the test measurements.
- Construction records as determined by the investigation.
- Drawings showing the pavements tested, test locations, Construction Locations and Homogenous Sections.

8.2. Appendix B. Assessing the bearing strength of unrated pavements

1. General

1.1. Where the aerodrome pavements consist of a natural surface or a gravel surface of low bearing capacity and a pavement strength rating cannot realistically be assigned to the pavement, the entry in the AIP usually should be reported as 'unrated'. The unrated pavement fills the gap where the strength of the pavement has never been determined using either a technical evaluation or from aircraft usage. This is normally applicable to non-certified aerodromes where testing for soft wet surfaces is the simplified method of assessing the suitability of the runway pavement.

1.2. The following guidelines describe the method of assessing the bearing strength of unrated pavements. At a certified aerodrome, the results of the assessment should be translated to the pavement strength rating as defined by the ACN-PCN method. Where an assessment suggests the pavement is suitable for aircraft in excess of 5700 kg this should be followed up by a technical evaluation to more accurately define the bearing strength limitations of the pavement.

2. Assessing the bearing strength of unrated pavements.

2.1. The bearing capacity of unrated pavements is depended on such factors as the type of material used to construct the pavement, the moisture condition and degree of compaction of the pavement material. Unrated pavements are generally suitable for regular operations under 'dry to depth' conditions.
2.2. Under dry to depth conditions, the bearing capacity of the surface may be considerably greater than under wet conditions and this will allow the nominated aircraft types to operate.

2.3. After rain the natural material has a high moisture content on the surface and to some depth, the pavement is obviously not dry to depth. After prolonged rainfall the natural material may have high moisture content to considerable depth. After a short dry period, a surface crust can form while the underlying material can still be wet and of inadequate strength. In this situation a more detailed investigation is required to determine if the pavement is dry to depth.

3. Assessment of dry to depth conditions

Guidelines for the assessment of dry to depth conditions of a pavement area set out below.

3.1. Assessment is based on the use of road vehicles to simulate aircraft loading as indicated below, but because aircraft wheel loads and tyre pressures are often higher, as a general rule, than the test vehicle, the results of these tests must be assessed in conjunction with a knowledge of the effects of aircraft and road vehicle wheels on the particular pavement surface.
3.2. All up weight of aircraft (kg) - Test vehicle:

- 2000 and below - utility, four-wheel drive, station wagon or equivalent
- 2001 to 3400 - a truck with a 1.5 ton load
- 3401 to 5700 - a trick with a 3 ton load.

3.3. The test vehicle should be driven at a speed not exceeding 16 km/ph in a zig-zag pattern covering the full length and width of the runway (including runway end safety areas) with particular attention being given to suspect areas and areas which are known to become wet sooner or remain soft longer than other areas. If any doubt exists, the test vehicle should be driven backwards and forwards two or three times over the suspect area.

3.4. Addition to the vehicular test, the pavement surface should be tested with a crowbar in at least two or three places along the length of the pavement to ensure that a dry looking surface crust does not exist over a wet base. Additional tests can be carried out in other suspect areas particularly where stump holes have been filled or where deep filling has been carried out.

4. Assessing the results of the tests

4.1. If the tire imprint of the test vehicle exceeds a depth of 25mm below the normal hard surface of the pavement, then the area is not suitable for operations by the aircraft appropriate to the test vehicle. In addition, if the surface deflection resulting from the test vehicle loading is such that there is no rebound in the surface after the test vehicle passes, the area is not considered suitable for the aircraft appropriate to the test vehicle.

4.2. Where personal knowledge may also indicate that a particular pavement surface is not suitable for aircraft when the imprint depth is less than 25 mm, in such cases the lesser depth shall be used.

4.3. If the results of any of the tests indicate that the bearing strength of any part of the pavement is inadequate, the affected area is to be declared unserviceable, and a NOTAM issued.

4.4. When no suitable test vehicle is available to simulate aircraft wheel loading and when, in the opinion of the person responsible, the serviceability of the runway surface is in doubt, the strip is to be closed to aircraft operations for the duration of the sub-standard conditions.

5. Aircraft suitability for unrated pavements

The load limitations for unrated pavements have been assessed, based on engineering judgement, to be as shown in the following diagram/ Figure 16.

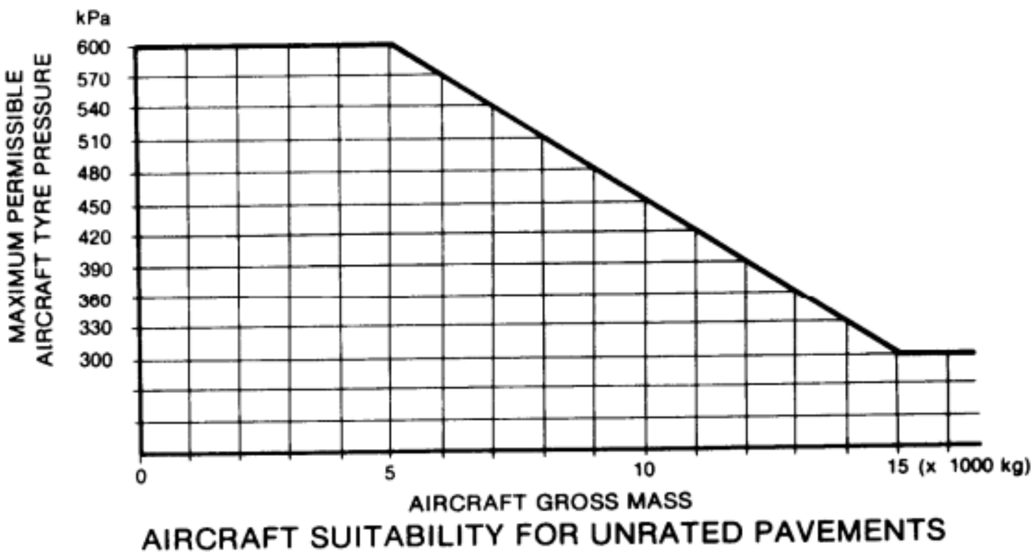

Figure 16. Aircraft suitability for unrated pavements