Australian Government
Civil Aviation Safety Authority

ADVISORY CIRCULAR
AC 139.C-07 v2.0

Strength rating of aerodrome pavements

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September 2025

Acknowledgement of Country

The Civil Aviation Safety Authority (CASA) respectfully acknowledges the Traditional Custodians of the lands on which our offices are located and their continuing connection to land, water and community, and pays respect to Elders past, present and emerging.

Artwork: James Baban.

Advisory circulars are intended to provide advice and guidance to illustrate a means, but not necessarily the only means, of complying with the Regulations, or to explain certain regulatory requirements by providing informative, interpretative and explanatory material.

Advisory circulars should always be read in conjunction with the relevant regulations.

Audience

This advisory circular (AC) applies to:

- aerodrome owners or operators
- aircraft owners/operators
- persons who specialise in pavement design
- consultants engaged to act on behalf of the aerodrome owner/operator
- the Civil Aviation Safety Authority (CASA).

Purpose

The purpose of this AC is to provide aerodrome owners or operators with guidance on pavement design. Specifically:

- the bearing strength of aerodrome pavements to ensure they can withstand the traffic of aeroplanes which the aerodrome facility is intended to serve
- rating the strength of pavements using the International Civil Aviation Organization (ICAO) strength rating method (ACR-PCR) introduced in November 2024.

For further information

For further information or to provide feedback on this AC, visit CASA's contact us page.

Unless specified otherwise, all subregulations, regulations, Divisions, Subparts and Parts referenced in this AC are references to the *Civil Aviation Safety Regulations 1998 (CASR)*.

Status

This version of the AC is approved by the National Manager, Flight Standards Branch.

Note: Changes made in the current version are not annotated. The document should be read in full.

Table 1: Status

Version	Date	Details
v2.0	September 2025	Reflects the 2024 transition from ACN-PCN to ACR-PCR and contemporary airport pavement thickness design practice.
v1.0	February 2021	This AC has been re-written and published to align with the re-write of the Part 139 MOS.
(0)	August 2011	The first Advisory Circular (AC) to be written on the strength rating of aerodrome pavements.

Contents

1 Reference material

1.1 Acronyms

The acronyms and abbreviations used in this AC are listed in the table below.

Table 2: Acronyms

Acronym	Description
AC	advisory circular
ACN	aircraft classification number
ACR	aircraft classification rating
AIP	Aeronautical Information Publication
AIS	Aeronautical Information Service
CASA	Civil Aviation Safety Authority
CASR	*Civil Aviation Safety Regulations 1998*
CBR	California bearing ratio
ERSA	En Route Supplement Australia
FAA	Federal Aviation Administration (of the USA)
FWD	falling weight deflectometer
ICAO	International Civil Aviation Organization
MOS	Part 139 Manual of Standards
MTOW	maximum take-off weight
OWE	operating weight empty
PCASE	pavement-transportation computer assisted structural engineering
PCN	pavement classification number
PCR	pavement classification rating
USA	United States of America
USACE	United States Army Corps of Engineers

1.2 Definitions

Terms that have specific meaning within this AC are defined in the table below. Where definitions from the civil aviation legislation have been reproduced for ease of reference, these are identified by 'grey shading'. Should there be a discrepancy between a definition given in this AC and the civil aviation legislation, the definition in the legislation prevails.

Table 3: Definitions

Term	Definition
Aircraft Classification Rating (ACR)	A number expressing the relative effect of an aircraft on a pavement for a specified standard subgrade category.
APSDS	A software application developed in Australia and commercially distributed by Pavement Science (formerly Mincad Systems) for aircraft pavement thickness determination.
California Bearing Ratio	The resistance of a soil to controlled penetration, usually when soaked, relative to that of a standard Californian limestone.
COMFAA	A software published by the Federal Aviation Administration (FAA) for calculating the Aircraft Classification Number (ACN) of an aircraft.
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.
FAARFIELD	Federal Aviation Administration (FAA) Rigid and Flexible Iterative Elastic Layered Design. A software published by the FAA, primary for calculating the required thickness of aircraft pavements, but also capable of calculating Aircraft Classification Rating (ACR) of an aircraft and the Pavement Classification Rating (PCR) or a nominated pavement.
ICAO-ACR	A software developed by the FAA, for ICAO, to calculating the Aircraft Classification Rating (ACR) of an aircraft.
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.
modulus of subgrade reaction (k-value)	The resistance of a subgrade to large scale vertical deformation when subject to a standard loading condition, usually performed in the field.
pavement concession	Permission granted by an aerodrome operator to an aircraft operator to operate to/from a runway with a PCR lower than the aircraft ACR.
Pavement Classification Rating (PCR)	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.
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.
passes	The number of times an aircraft moves over a particular cross section of pavement, which is related to the number of passes by the P-C-R.

Term	Definition
unrated	Used whereby there has been no technical or usage evaluation completed on the pavement strength and/or a PCR is not provided for publication within AIP ERSA.
unrestricted operations	Operations that may occur without restraint because the ACN is lower than the PCN.

1.3 References

Legislation

Legislation is available on the Federal Register of Legislation website https://www.legislation.gov.au/

Table 4: Legislation references

Document	Title
Part 139	Aerodromes
Part 139 Manual of Standards (MOS)	Part 139 (Aerodromes) Manual of Standards

International Civil Aviation Organization documents

International Civil Aviation Organization (ICAO) documents are available for purchase from http://store1.icao.int/

Many ICAO documents are also available for reading, but not purchase or downloading, from the ICAO eLibrary (https://elibrary.icao.int/home).

Table 5: ICAO references

Document	Title
ICAO Doc 9137	Airport Services Manual Part 2 - Pavement Surface Conditions, Fourth Edition, 2002
ICAO Doc 9157	Aerodrome Design Manual Part 3 – Pavements, Third Edition, 2022
ICAO Annex 14	International Standards and Recommended Practices, Annex 14 to the convention on International Civil Aviation – Aerodromes, Volume I

Other advisory references

Table 6: Other advisory references

Document	Title
COMFAA	Federal Aviation Administration, software, Version 3, 14 August 2014
FAA AC 150/5320-6D	Federal Aviation Administration, Advisory Circular, Airport Pavement Design and Evaluation, 7 July 1995
FAA AC 150/5320-6G	Federal Aviation Administration, Advisory Circular, Airport Pavement Design and Evaluation, 7 June 2021

Document	Title
FAA AC 150/5335-5D	Federal Aviation Administration, Advisory Circular, Standardized Method of Reporting Pavement Strength – PCR, 29 April 2022
FAA AC 150/5370-10H	Federal Aviation Administration, Advisory Circular, Standard Specifications for Construction of Airports, 21 December 2018
FAARFIELD	Federal Aviation Administration, software, version 2.1.1, 22 December 2023

2 Background

2.1 Aircraft and pavements

2.1.1 When first developed in the early 1900's, aircraft were light and were commonly operated from grassed paddocks. The DC-3 which was introduced in 1936 was the first aircraft to require a pavement from which to take-off and land. Since that time, aircraft have progressively become larger and heavier, placing more demands on the ground from which they operate.

2.1.2 Pavement failures in the 1960's prompted the United States Army Corps of Engineers (USACE) to develop formalised pavement thickness and strength design systems. The work[1] done by the USACE between the 1950's and the 1970's remains critical to modern aircraft pavement thickness design and the associated strength rating systems.

[1] See Appendix 1 for important detail on the history of strength rating for pavements.

3 Aircraft pavement strength

3.1 General

3.1.1 The strength of aircraft pavements is complex and depends on many factors. Some of these factors are theoretical and relate primarily to the designed strength of the pavement. Other factors are related to construction and material variability, and these affect the difference between the designed strength and the actual strength achieved during construction. This is also different to the actual strength of the pavement on any given day, which is affected by the temperature and moisture conditions, as well as the distress or failure in the pavement structure.

3.1.2 Because aircraft pavement strength rating primarily deals with the theoretical or designed strength of the pavement, that is the strength focussed on by this AC. Construction and environmental factors that can affect pavement strength are not considered.

3.1.3 The Part 139 Manual of Standards (MOS) prescribes only that the bearing strength of an aerodrome pavement must be capable of bearing the weights and aircraft movement frequencies of the types of aeroplanes which the runway is nominated to serve.

3.1.4 The Part 139 MOS maintenance requirements assess and report the availability of the runway for continued use. The aircraft load limit placed upon the pavement is the PCR and tyre pressure code published in ERSA. The aerodrome owner or operator sets this limit, usually with the assistance of a pavement engineer.

3.1.5 Should an aerodrome owner or operator agree, a more demanding aircraft than the runway was designed for, could be permitted to operate. However, the structural service life of the runway is likely to be adversely impacted, particularly when frequent operations occur. Any decision to allow such operations is a cost-benefit decision made by the aerodrome owner or operator, factoring in increased maintenance and/or rehabilitation earlier than was originally expected.

3.1.6 Runway shoulders, runway strips, stopways and RESAs have other strength requirements that are indirectly relatable to the strength of the associated runway. However, only runways are formally assigned a PCR, even though some aerodrome owners or operators informally assign strength ratings to these other pavement areas.

3.2 Flexible pavement strength

3.2.1 Flexible pavement strength is primarily determined by:

- subgrade bearing capacity (expressed as the CBR or elastic modulus)
- pavement layers and their thickness (the number and thickness of each material layer)
- pavement material types (different materials have different stiffnesses, which spread the load differently, usually indicated by the elastic modulus of the material).

3.2.2 When designing or rating the strength of the pavement, the traffic loading is also important. Traffic loading is characterised by:

- aircraft type (which determines the number and spacing of wheels)
- aircraft weight (including the portion of weight on each wheel, which is affected by the aircraft's centre of gravity)
- aircraft tyre pressure (usually standardised but can be adjusted)
- aircraft load repetitions (the number of times the wheels pass a certain section of pavement, characterised as coverages, passes or departures).

3.2.3 All these factors have different influences on pavement strength. Or conversely, the different factors have different influence on the thickness of pavement that is required for a given design scenario. For example, Figure 1 shows the relative influence of various (normalised to a 1-5 scale) factors on total flexible aerodrome pavement thickness. Each factor was normalised by setting the minimum reasonable value to 1 and the maximum reasonable value to 5. For example, subgrade CBR ranges from 3% (normalised to 1) to 15% (normalised to 5). Similarly, aircraft mass ranged from approximately the weight operating empty (WOE) (normalised to 1) up to the maximum takeoff weight (MTOW) (normalised to 5). The resulting curves are averages across a range of typical aircraft.

3.2.4 Subgrade CBR and aircraft mass are the most influential factors.

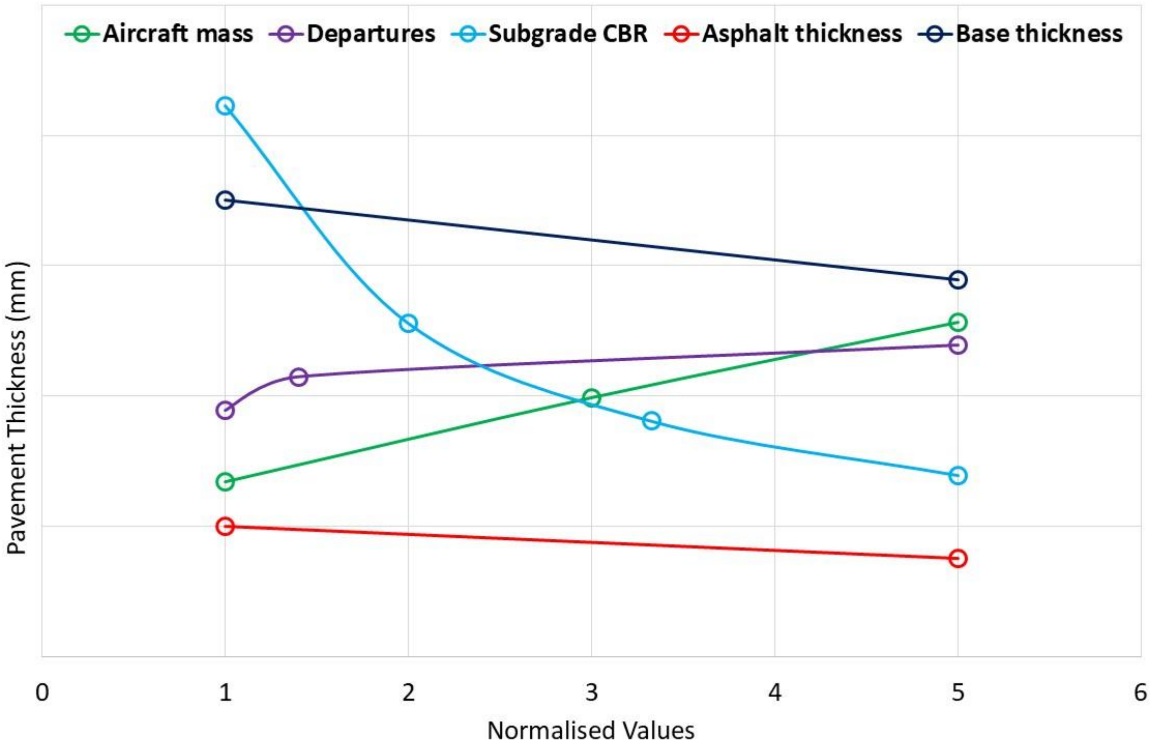

Figure 1: Flexible pavement factor influence on total pavement thickness

3.3 Rigid pavement strength

3.3.1 Rigid pavement strength (or thickness required) is also influenced by similar factors. Although the aircraft factors are the same, the pavement and material related factors differ:

- subgrade support (expressed as the k-value or elastic modulus)
- sub-base type (usually either granular or bound by cement)
- sub-base thickness (typically 150-250 mm)
- concrete strength (expressed as the flexural strength after 28 days of curing, typically 4.5-4.8 MPa)
- concrete slab thickness (the primary layer in the pavement structure).

3.3.2 Figure 2 shows the relative influence of various factors on the concrete thickness in a typical rigid aircraft pavement. The aircraft mass and the concrete strength are the most influential parameters. Unlike flexible pavements, the strength of rigid pavements is less influenced by the subgrade support.

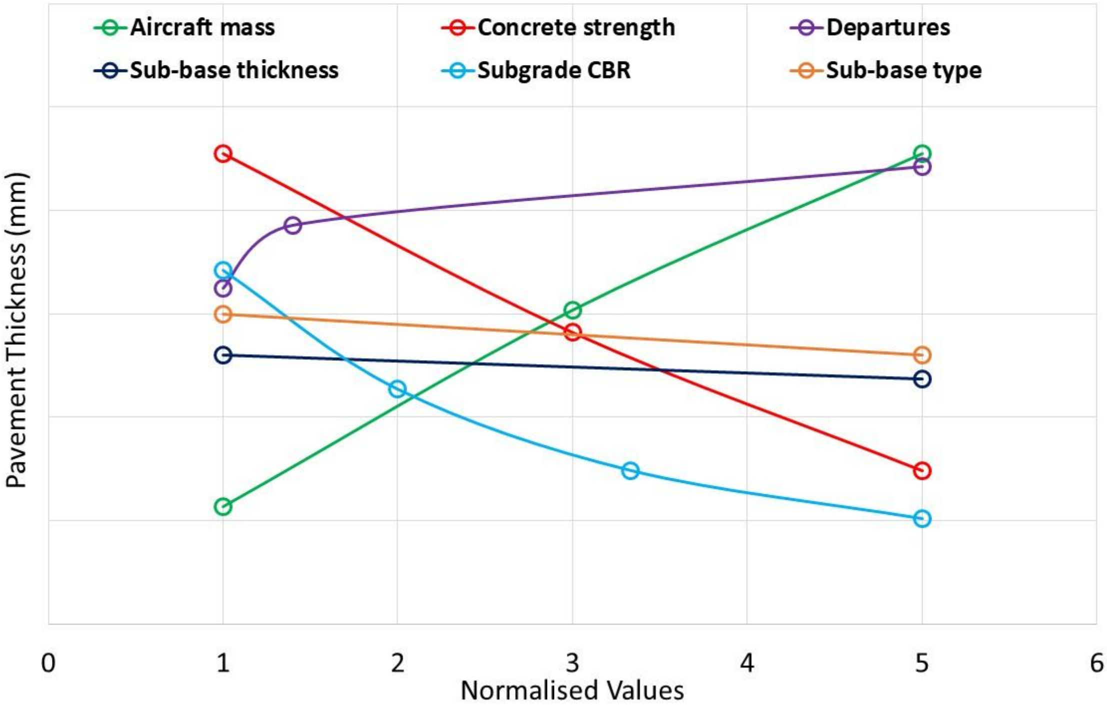

Figure 2: Rigid pavement factor influence on concrete thickness

Relative pavement strength

3.3.3 Aircraft pavement strength rating is primarily performed for runways. Each runway is given a strength rating that is published in the AIP ERSA. Publication of strength ratings for taxiways, aprons and other areas are not required (however may be published at the aerodrome owners or operators' discretion). Aerodrome owners or operators must understand the relative strength of these other pavements, so that aircraft can safely taxi and park.

3.3.4 In general, the strength of the runway, taxiway(s) and apron(s) are all the same, taking into account minor differences associated with different degrees of aircraft traffic channelisation and doubling of aircraft passes associated with backtracking on runways where required.

3.3.5 The following pavement areas are not regularly trafficked but may be trafficked from time to time and as such they are generally not constructed with the same strength:

- Runway shoulders (required to support an aircraft running onto the shoulder without causing structural damage to the aircraft).
- Runway strip (avoids differences in bearing strength that present a hazard to aircraft that depart the runway).
- Stopway (support at least one pass of an aircraft for which the runway is intended to service, without causing structural damage to the aircraft).
- Taxiway (should be at least as strong as the runway that it supports).
- Apron (should support the aircraft it is intended to support).

3.3.6 Only limited guidance is available regarding the practical requirements for designing these associated pavement areas.

3.3.7 Historically, Australian aerodromes simply designed shoulders and other irregularly trafficked areas to be approximately half the thickness of the pavement they support. It is also logical to tailor the layer thicknesses and materials to provide a cost-effective solution that is also relatively simple to construct at the transition from the full strength pavement to the reduced strength pavement, by avoiding small steps between adjacent layers.

3.3.8 As an example, the flexible thickness of a pavement, calculated using COMFAA, for various numbers of passes of a B737-800 and various subgrades, are shown in Table 7. The number of 20 passes was used to approximate 15 passes as recommended in the USA because 1 annual departure (equal to 20 passes over a 20-year design life) is the lowest traffic frequency that can be entered into COMFAA. As a result, pavement thicknesses for 1 pass, required by MOS Part 139 for the stopway, cannot be determined by this method.

Table 7: Various pavement thickness for the B737-800

Subgrade condition	10,000 passes	20 passes	1 pass
CBR 3	1,138 mm	373 mm	Not computable
CBR 6	743 mm	252 mm	Not computable
CBR 10	531 mm	187 mm	Not computable
CBR 15	406 mm	147 mm	Not computable

3.3.9 The 20 pass pavement thicknesses are around 35% of the 10,000 pass thicknesses, which is generally similar to the half-thickness approach adopted by Australian airports in the past. However, if the runway was heavily trafficked, with say 100,000 passes of the critical aircraft over the life, then the 20 pass thicknesses would be unchanged, so that would reduce when expressed as a percentage of the greater full pavement strength thickness.

3.3.10 When determining the thickness of these non-full strength pavements, occasional larger aircraft types, such as those that declare the airport as an alternate, should not be included. However, for lighter aircraft traffic, heavy ground vehicles, such as refuelling trucks and firefighting tenders, should be included as they can traffic these pavements regularly.

3.3.11 In practice, to simplify construction, the runway shoulder thickness is also appropriate for the stopway, taxiway shoulders and apron shoulders. However, for airport pavements designed for very light aircraft, emergency vehicles and refuelling trucks may determine the minimum strength required for the full strength pavements, and they may also operate on the shoulders, so the full strength thickness should be retained in the shoulders in these circumstances.

3.3.12 Since the graded portion of a strip is provided to minimise the hazard to an aircraft running off the runway, the ICAO design manual recommends that the graded strip should be prepared in such a manner as to provide drag to an aircraft, and below the surface it should have sufficient bearing strength to avoid damage to the aircraft. Aircraft manufacturers consider that a depth of 15 cm is the maximum depth to which the nose gear may sink without collapsing. This provision may be reasonable for new construction but is onerous to retrofit for existing runways.

4 ACR-PCR pavement strength rating system

4.1 General

4.1.1 The ACN-PCN system was introduced by the International Civil Aviation Organization (ICAO) in 1981. As a member State of ICAO, Australia followed this system for aerodrome pavement strength rating since that time. Previous versions of Part 139 MOS required the operator of a certified aerodrome to provide to the aeronautical information service (AIS) provider the strength rating of the runway pavement calculated using the ACN-PCN pavement rating system, for publication in the AIP-ERSA.

4.1.2 In 2015, it became apparent that there were examples where the PCN of a newly constructed runway had been determined using the FAA's method detailed in AC 150/5335-5, but was assigned a PCN that did not allow one or more of the aircraft for which the runway was designed to support or operate in an unrestricted manner. Investigation of these anomalies determined that the cause of the anomalous PCN ratings was the differences in the assumptions and models used in the determination of ACN values, and therefore PCN values under the FAA method, compared to the more sophisticated modelling approaches used in modern layered elastic mechanistic-empirical design methods, to design those same pavements.

4.1.3 To address these anomalies, ICAO developed a replacement for ACN-PCN, which eventually became known as ACR-PCR (Aircraft Classification Rating/Pavement Classification Rating) which became effective in 2020 and applicable on 28 November 2024. The main aim of the new system was to reduce the differences between modern aircraft pavement thickness design methods, and the strength rating procedure subsequently applied to those pavements, in order to significantly reduce the potential for runways to be assigned a strength rating that does not allow their critical design aircraft to operate in an unrestricted manner.

4.1.4 On 28 November 2024, Australia commenced a transition to the new ACR/PCR system over a 12 month period (until 27 November 2025) to introduce the publication of the aerodrome PCR (for pavements rated for aircraft above 5,700 kg MTOW) within AIP ERSA or the publication of a maximum weight (in kg) and maximum tyre pressure (in MPa) for those pavements rated at, or less than, 5,700 kg MTOW. In addition, for those aerodromes that did not report their PCR, pavements were published in AIP ERSA as 'unrated'.

4.2 The ACR-PCR system

4.2.1 Just like ACN-PCN, the ACR-PCR system is fundamentally simple in its application. In principle, every aircraft has a calculatable ACR value. That aircraft is permitted to operate in an unrestricted manner on any runway that has an equal (or greater) PCR value than the aircraft ACR. 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 ACR exceeds the runway PCR, the aircraft operator must obtain the aerodrome operator's permission before operating, a process known as obtaining a pavement concession.

4.3 Aircraft classification rating

4.3.1 Every aircraft is associated with a precise ACR value that represents the relative damage caused to the pavement structure and is dependant only upon the aircraft weight, tyre pressure and the subgrade category of the pavement that it is operating on.

4.3.2 The inclusion of the subgrade category in the ACR 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.

4.3.3 The ACR value is always determined when the aircraft is loaded so that the centre 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.

4.3.4 Conveniently, ACR values increase linearly with the mass of the aircraft and are generally insensitive to tyre pressure. As a result, the ACR of a particular aircraft is readily shown in a graph that ranges from the OWE weight to the MTOW on the horizontal axis and ACR 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 that are explained and detailed later, and different graphs are required for flexible and rigid pavements. An example is shown in Figure 3 for the B737-800 on flexible pavements.

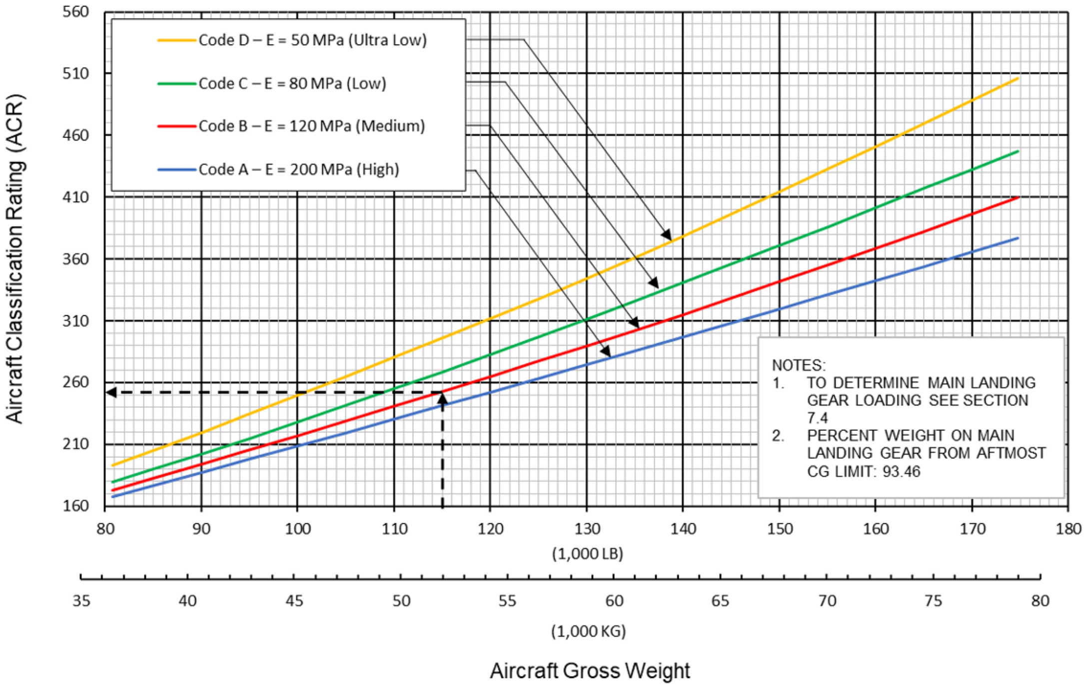

Figure 3: Example of flexible pavement ACR chart for B737-800

4.3.5 The linear relationships between aircraft weight and ACR allow for interpolation between the minimum and maximum values or equations for the calculations. In practice, software such as ICAO-ACR or PCASE is used to calculate the ACR of any aircraft at any operating mass and any tyre pressure.

4.3.6 The technical definition of the ACR is twice the wheel load (in 100 kg units) which on a single wheel, inflated to 1.50 MPa, induces vertical pavement strain (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 tyre pressure. In practice, ACR values for commercial aircraft typically range from 50 to 1,200. This is around 10 times higher than ACN values, which was intentional and aims to reduce the potential for confusing ACN and ACR values.

4.3.7 For a particular aircraft at a specific mass and tyre pressure, there is only one flexible pavement ACR for each subgrade category. There is a second ACR 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 PCR value.

4.4 Pavement classification rating

4.4.1 In contrast to the ACR, the PCR is set by the airport owner with some discretion and is more open to interpretation. The PCR is essentially a pavement management tool that provides detail to aircraft operators that, provided the ACR is equal to, or less than, the PCR; they are welcome to operate without restriction on the frequency of those operations. That is, at any operational frequency, without needing to seek specific permission due to pavement strength and overload.

4.4.2 An aerodrome owner or operator might set its PCR value lower to protect its pavement against damage. Another aerodrome owner or operator might set its PCR value higher to attract new aircraft operators, accepting the increased damage that these aircraft might cause. However, excessive increases in the PCR 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.

4.4.3 A PCR is reported in a five-part format. 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 owner or operator to limit the maximum allowable tyre pressure. A final indication is whether the assessment has been made by a technical evaluation or from experience of aircraft using the pavement.

The full PCR expression is best explained by example. As an example, the PCN for both runways at Brisbane Airport is PCR 1250/F/D/X/T.

- 1250 is the numerical element against which the ACN is compared.
- F indicates a Flexible pavement, rather than R for Rigid.
- D is the category of subgrade bearing strength, detailed in Table 8.
- X is the tyre pressure category, detailed in Table 9.
- T indicates a Technical assessment, rather than U for a Usage based assessment.

Table 8: ACR-PCR subgrade categories

Subgrade Category	Representative Modulus (MPa)	Modulus range (MPa)	Approximate equivalent CBR (%)
A	200	Equal to and above 150	20
B	120	Equal to and above 100 but less than 150	120
C	80	Equal to and above 60 but less than 100	80
D	50	Less than 60	50

Table 9: AIP tyre pressure categories

Tyre pressure category	Tyre pressure limit
W	Unlimited
X	1.75 MPa
Y	1.25 MPa
Z	0.50 MPa

4.4.4 Australia has transitioned to the ICAO method for listing tyre pressure categories as described in AIP ERSA INTRO. Weight and tyre pressure limits may still be published in KG and MPA where an aerodrome requires such. However, if an aerodrome lists a PCR value, consideration should be given to then applying the tyre pressure category as defined in Table 9.

4.4.5 The Technical (T) or Usage (U) basis of determining the PCR is often confusing. A technical rating is usually 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 PCR is set equal to the ACR of that aircraft. More detail on setting the usage based PCR value for a particular pavement is provided in ICAO ADM Doc 9157, Part 3, Aerodrome design pavements.

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

- the ACR is no greater than the PCR
- the tyre pressure (or category) does not exceed the nominated pressure (or category).

4.4.7 This practical implementation of the ACR-PCR system is no different to that of the ACN-PCN system, that airports and aircraft have utilised over the last forty years.

4.5 Differences between ACR-PCR and ACN-PCN

4.5.1 The change from ACN-PCN to ACR-PCR was aimed to incorporate modern airport pavement design methods into the assignment of ACR values, and therefore PCR values, to reduce anomalies between aircraft pavement thickness design and the subsequent runway strength rating.

4.5.2 The main mathematical differences between the calculation of an ACN and an ACR are:

- strain used as the relative damage indicator, rather than deflection
- actual pavement materials and composition are considered explicitly, rather than being converted to a standard pavement composition
- load repetitions, tire pressures, and pavement structures are more comparable to typical modern airport pavement structures
- elastic modulus is used as the subgrade bearing capacity characteristic, replacing CBR for flexible pavements and the modulus of subgrade reaction (k-value) for rigid pavements
- rigid and flexible pavement subgrade categories use the same elastic modulus ranges and characteristics values for subgrade characterisation.

4.5.3 The change in subgrade categories under ACR-PCR means that some runways will move from one subgrade category to another, for the same characteristic subgrade CBR value (Figure 4). For example, runways with CBR 5%, 9%, 13%, and 14% will move from category C to D, from B to C, from A to B, and from A to B, respectively.

4.5.4 The practical impact of this is unlikely to be significant and many airports may prefer to retain their subgrade category under ACN-PCN, in determining their PCN under ACR-PCR.

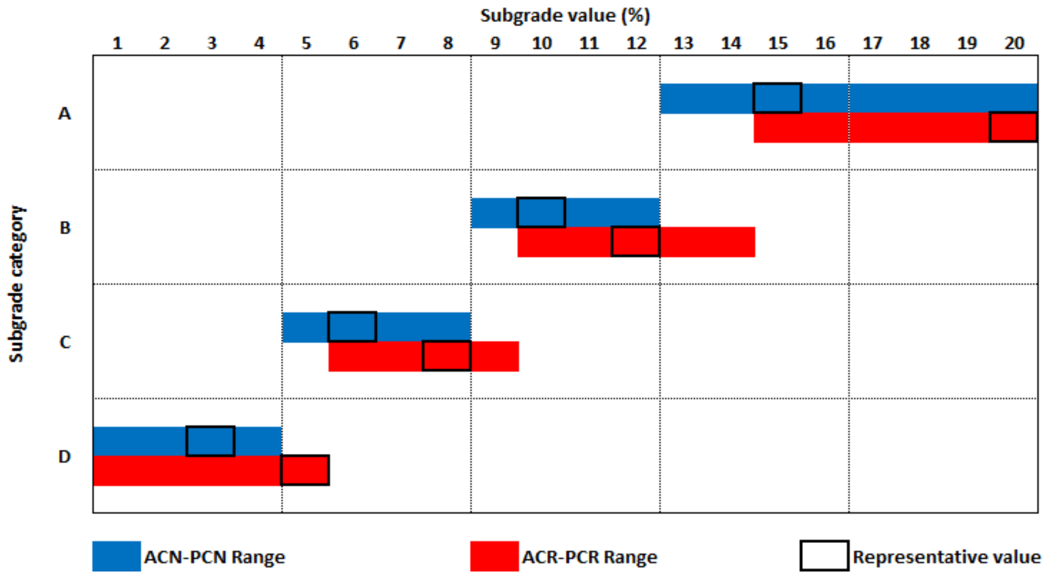

Figure 4: Flexible subgrade category ranges for ACN–PCN and for ACR–PCR

4.6 Limitations of ACR-PCR

4.6.1 The change to ACR-PCR will significantly reduce anomalies between aircraft pavement thickness design and subsequent runway strength rating. However, despite some claims to the contrary, ACR-PCR will not:

- increase the knowledge of pavement thickness, material characteristics, and bearing capacity, only geotechnical investigations and non-destructive pavement testing can achieve that
- reduce greenhouse gas emissions, because ACR-PCR does not impact pavement thickness, construction and the embodied carbon on pavement materials
- prevent underestimation of pavement strength that is associated with ACN–PCN, because ACN-PCN was not prone to underestimation of pavement strength
- result in an extended pavement design life, because ACR-PCR does not change the pavement structure designed or constructed
- provide reduced pavement thicknesses for new pavement construction, because ACR-PCR does not change the pavement structure designed or constructed
- improve pavement life prediction, because it is not a predictive tool
- provide more sustainable airport pavements, because ACR-PCR does not impact pavement thickness, pavement service life, or the construction and the embodied carbon on pavement materials.

4.7 Setting a pavement classification rating

4.7.1 Similar to ACN-PCN, the most challenging element of the ACR-PCR system is the setting of an appropriate PCR for the runway in question. It is the primary element that allows discretion and may require some judgment. This reflects the aerodrome owners need to set the PCR 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 PCR too high, introducing unreasonable risk of excessive pavement damage.

4.7.2 In essence, an aerodrome owner or operator should set the PCR of its runway to a value that allows the aircraft that the aerodrome owners or operator is comfortable to operate on a regular basis, and in an unrestricted manner. For many aerodromes, that is a case of:

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

4.7.3 The challenge is to determine the basis of 'regular usage'. For many aerodrome owners or 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'. Another example would be a domestic aerodrome that regularly caters for B737/A321 aircraft, but also supports chartered, or seasonal, limited international flights from a A330/B767 aircraft. The aerodrome owner or operator may be tempted to set the PCR at the ACR of the larger aircraft, but the pavement may only be adequate for limited operations of that aircraft. Therefore, the increased administrative burden associated with pavement concessions for the larger aircraft are likely to be justified by the increased control against excessive pavement damage that may result, in the event that the A330/B767 operations increase in frequency over time.

4.7.4 In some ICAO member States, such as the USA, so as to limit the judgment required to be made by any particular airport, a consistent and repeatable method for determining the strength rating of a runway is desired. As a result, the FAA originally developed a method for PCN determination using COMFAA. The method is similar to the generalised steps outlined above, but with the addition of algorithms for determining the appropriate PCN for runways traffic by complex aircraft traffic mixes and was detailed in AC 150/5335-5C (1995). The algorithm was subsequently adapted by the FAA for the determination of PCR, using the FAA FAARFIELD software, as detailed in the updated AC 150/5335-5D (2022), and this is very similar to the process detailed in ICAO ADM Part 3. The main difference between the FAA method and the ICAO methods for PCR determination is the software used to perform the analysis. The FAA specifies FAARFIELD, while ICAO remains silent on the software, so as to be applicable to the many member States of ICAO.

4.7.5 Furthermore, the FAA software FAARFIELD now includes the calculation of the PCR value of any pavement, following the FAA's prescriptive method detailed in AC 150/5335-5 or the similar method detailed in ICAO ADM Part 3 - Pavements.

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

4.7.7 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 PCR, 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
  - intrusive investigation and sampling material for testing.
- iterative analysis in design software to determine a level of traffic that is predicted to cause failure of the pavement over time
- setting the pavement PCR to the ACR of the most demanding aircraft that is 'just acceptable'.

4.7.8 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.

4.7.9 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 goes further to provide an estimated PCR 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 PCR values range from unrealistically low to unreasonably high and the recommended PCR value is generally lower than is determined from reverse engineering of the measured pavement thickness and material characteristics from an intrusive investigation.

4.7.10 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.

4.7.11 Any given airport needs to determine which method to adopt. For new pavement design or significant upgrades, using FAARFIELD to determine the thickness, the FAARFIELD determination is more appropriate. However, for many regional airports transitioning from PCN to PCR, or wanting to determine the most appropriate PCR for their runway, the generic steps in detailed at 4.7.2 of this AC are most applicable when a Technical assessment is sought, or in 4.7.7 when a Usage based assessment is accepted. In fact, for most runways at regional airport with a simple aircraft traffic mixes, containing just one critical or dominant aircraft, along with a range non-critical aircraft, the steps detailed at 4.7.2 will return the same PCR value as the ICAO ADM Part 3 - Pavements, method.

4.7.12 The distinction between the methods required for a Usage based PCR and a Technical PCR is important. Since ICAO has published a PCR determination method, which it did not publish previously for PCN, there is a perception that the ICAO method must be strictly followed in order to include a “T” Technical in the published PCR expression. However, that is not true. Any assessment that uses a design-based analysis and assessment of a characteristic pavement structure is considered to be technical and warrants a “T” in the PCR expression.

4.7.13 In the future, ICAO may introduce an “R” for Rational, to identify technical methods of PCR determination that are not strictly in accordance with the ICAO method.

4.7.14 Regardless of the method of determining the PCR, it should be rounded up to the next 10, for example, a PCR of 734 would be rounded to PCR of 740. That is consistent with PCN values, which were reported to the nearest whole number, and means that when aircraft operations compare the PCR to their ACR value, which they often calculate to the nearest whole number, rounding the PCR down (to the nearest 10) will not inadvertently trigger any rounding-based pavement concession requests.

4.7.15 Once the numerical PCR value is determined, the setting of the tyre pressure limit is generally much simpler. The tyre pressure limit is intended to protect the runway surface against nearsurface shear stresses. In reality, well designed and constructed surfaces are unlikely to be damaged by high tyre pressures, with only minor scuffing of the surface caused by dual and triple axles more likely for more fragile surfaces. Furthermore, most runways are provided with airport-quality sprayed seals or airport-quality asphalt mixtures, generally using a modified bituminous binder. This means that tyre pressures limits can generally be set to the tyre pressure (tyre pressure category as defined in Table 10) of the aircraft whose ACR is selected as the basis of the PCR, or any other regular aircraft that has a lower ACR, but a higher tyre pressure. Table 10 provides indicative tyre pressures that are generally appropriate for various runway surfaces.

Table 10: Indicative tyre pressure limits for different surface types

Surface type	Tyre pressure limit	ICAO Tyre Pressure Category	Typical aircraft
Low quality sprayed seal	0.5 MPa	Z (Max 0.50MPa)	General Aviation aircraft only
Reasonable quality sprayed seal without sanded lockdown treatment	0.75 MPa	Y (Max 1.25MPa)	General Aviation aircraft and C-130 Hercules
Road asphalt without modified binder	1 MPa	Y (Max 1.25MPa)	Fokker 100
Good quality sprayed seal with sanded lockdown treatment	1.5 MPa	X (Max 1.75MPa)	B737 - 800/A321 - 200
Reasonable quality airport asphalt	1.75 MPa	X (Max 1.75MPa)	All known commercial aircraft
Good quality airport asphalt with modified binder	Unlimited	W (Max Unlimited)	All known commercial and military aircraft
Concrete, although this has not been used in Australian civil aerodromes for runways	Unlimited	W (Max Unlimited)	All known commercial and military aircraft. (Note jet fighters often operate with very high tyre pressures)

5 Pavement overloads and concessions

5.1 General

5.1.1 As described above, when the ACR exceeds the PCR value, a strength-based pavement concession is required prior to the aircraft operating. Similarly, where the tyre pressure exceeds the nominated tyre pressure limit (or category) then a tyre pressure pavement concession is required. This is no different than the requirement under the ACN-PCN system. In fact, any ACN-PCN based overload guidance and analysis is equally valid and applicable to ACR-PCR.

5.1.2 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. However, like setting the PCR value, it is often trade-off between the revenue likely to be generated, the importance of the aircraft operation, and the risk to the pavement.

5.2 Overload guidance

5.2.1 Different jurisdictions provide guidance on the reasonable frequency of aircraft movements under a pavement concession, based on the ratio of 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. Therefore, an overload during cold dry conditions will have less practical impact on the pavement than the same overload will have on a hot day after a period of heavy rain and inundation. However, it is not practically viable to quantify the difference.

5.2.3 In contrast to pavement strength overloads, tyre 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 tyre pressure. Therefore, rejection of tyre pressure related pavement concession requests is rarely justified. In fact, most tyre pressure related pavement concessions result from the under-rating of the surface due to an historical tie to a specific aircraft tyre pressure, which has been exceeded by new aircraft models or variants, but the tyre pressure limit not being updated.

5.2.4 When assessing an application for a pavement concession the aerodrome owner or operator should consider the following:

- the safety of the operation:
  - where overloading of the pavement is so severe that damage to the aircraft is likely, and the safety of the occupants is in doubt, a pavement concession is not to be approved.
- the probability of pavement damage:
  - 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
  - are operations one-off, short term or long term

  - local conditions (for example, recent prolonged rainfall causing loss of subgrade strength).
- the social and economic importance of the operation:
  - are alternative aircraft available
  - the urgency of the operation (for example, urgent medical evacuation, flood, disaster relief)
  - are the operations of significant commercial importance to the community
  - are the operations essential or desirable militarily.
- the consequence of any pavement damage:
  - cost of repairs to any pavement damage
  - resources available to repair any damage
  - disruption to routine operations cause by any damage or repairs.
- 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.

5.3 Relationship between overload and damage

5.3.1 The amount of damage caused to the structure of a pavement is not linearly related to the ACR value. It is also a complex combination of the total movements of the critical aircraft that the pavement was designed for and the number of wheels in the overload aircraft's main wheel gear. As shown in Figure 5 (flexible pavements) and Figure 6 (rigid pavements), the damage increases rapidly as the ACR value increases. For a flexible pavement, a 10% overload (i.e. ACR 110% of PCR) is equivalent to 2.6 to 14.9 non-overload operations (i.e. ACR = PCR) while a 50% overload (i.e. ACR 150% of PCR) is equivalent to 22 to 615 non-overload operations. That is why pavement concessions, when the ACR exceeds the PCR by more than 50%, should only be considered in emergency situations.

5.3.2 Furthermore, the effect of overload is far greater for rigid pavements than for flexible pavements. The effect of the same overload is on average, three times more severe on a rigid pavement than on a flexible pavement, but depending on overload magnitude, the number of critical aircraft departures in the pavement thickness design, and the number of wheels in the overload aircraft's main wheel gear, the typical effect is 1.3 to 9.9 times more severe for rigid pavements than for flexible pavements.

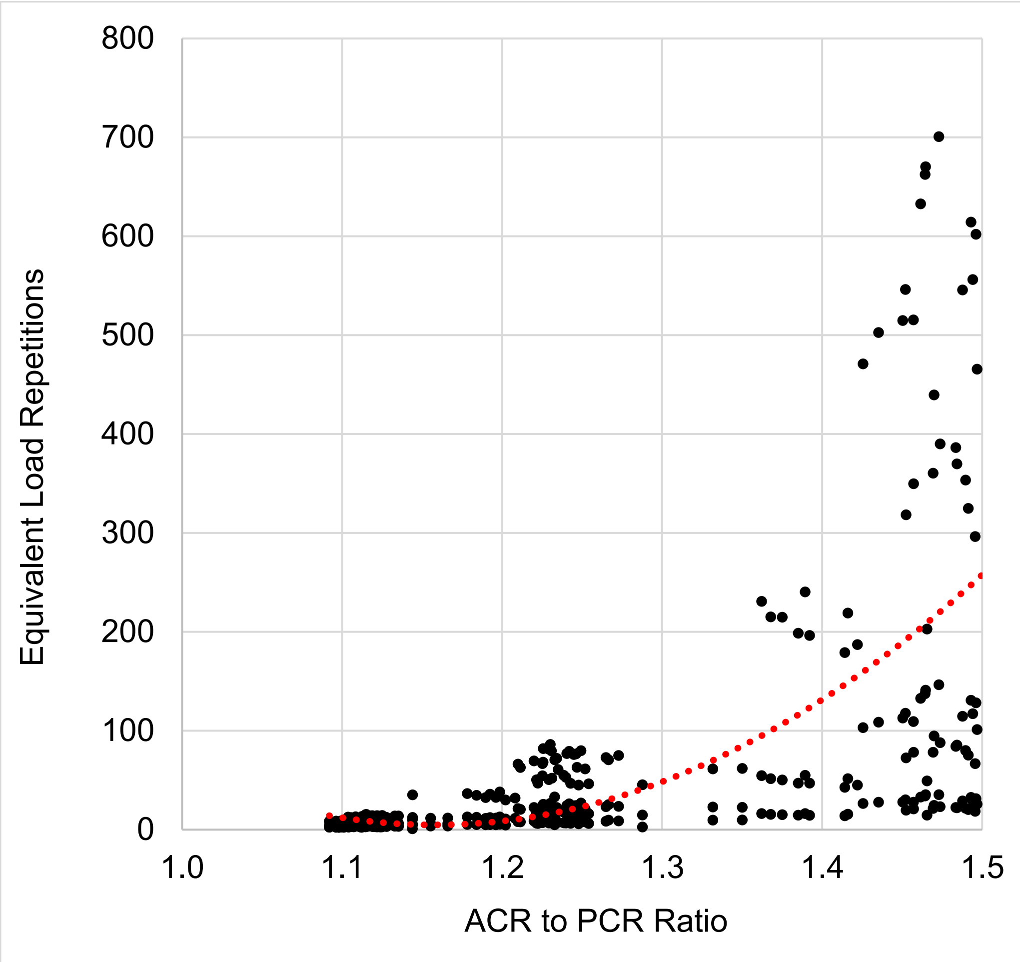

Figure 5: Relationship between overload magnitude and structural pavement damage

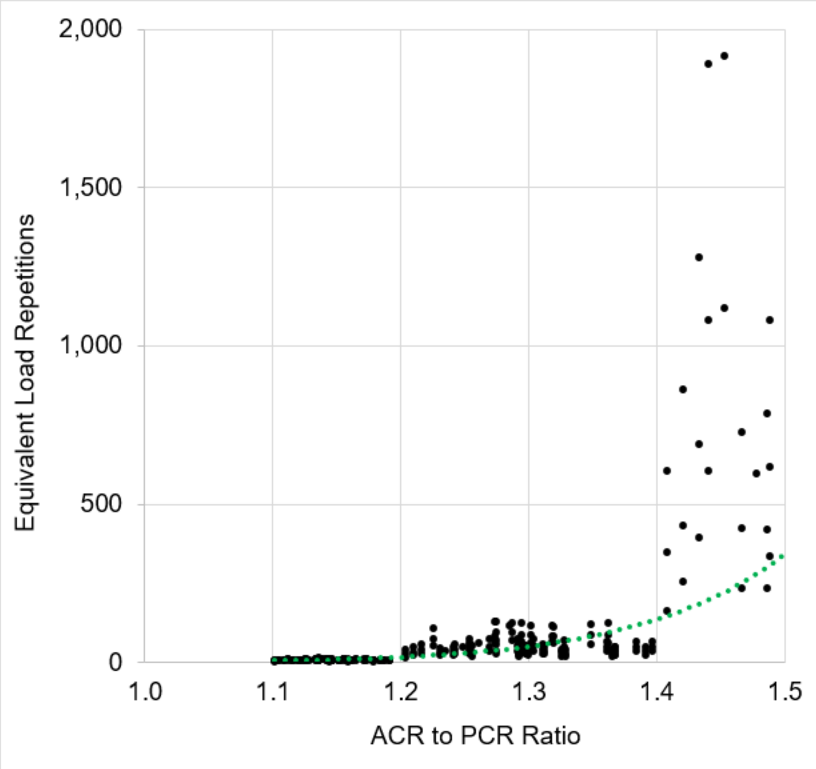

Figure 6: Relationship between overload magnitude and structural pavement damage

5.4 Monitoring overloaded pavement condition

5.4.1 Pavements subject to overload conditions may deteriorate at an increasing rate. Consequently, the condition of such pavements should be monitored more frequently, to determine the early onsite of any deterioration.

5.4.2 Pavements that are found to be deteriorating under overload operations should be maintained to keep them in a safe and operational condition. The pavement concession allowing the overload operation should also be reviewed and potentially rescinded.

5.4.3 The appropriate frequency of pavement inspections and condition monitoring for overloaded pavements depends on many factors including the nature of the overload and the prevailing weather.

5.4.4 For minor overloads, an annual or six-monthly inspection may be appropriate. However, for large magnitude overloads, such as when the ACR value is more than 50% greater than the PCR value, condition assessment should be before/after each overload operation.

5.4.5 It is well known that moisture ingress weakens pavement materials and subgrades. Therefore, the frequency of overload pavement condition inspection should also be increased after significant rain events, because that is when rapid deterioration is most likely to occur.

Appendix A
Background and History

A.1 Work by the USACE

A.1.1 The USACE aerodrome pavement design methods were based on the results of full-load trafficking tests conducted on large-scale (i.e. not full-scale) test pavements by the USACE (Figure 7) through the 1950s to the 1970s. These were first considered to be mainly single wheel configurations but were later extended to aircraft with multiple wheels and heavier gear loads, such as the C-5 Galaxy.

A.1.2 The USACE established an empirical relationship between aircraft loads, subgrade CBR and the required pavement thickness to cater for 5,000 coverages. The curve generated from the variable data is a line of best-fit that represented the outcome of the 37 tests completed up to 1971, which was around the time the Boeing 747 came into service. The resulting empirical design method was known as S-77-1 (Figure 9).

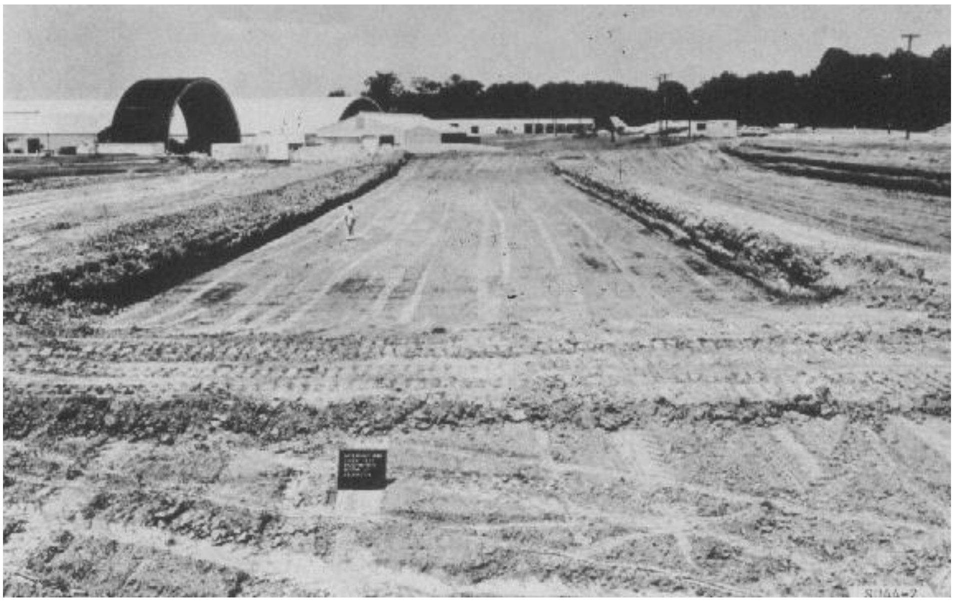

Figure 7: Example of US Army USACE pavement test section

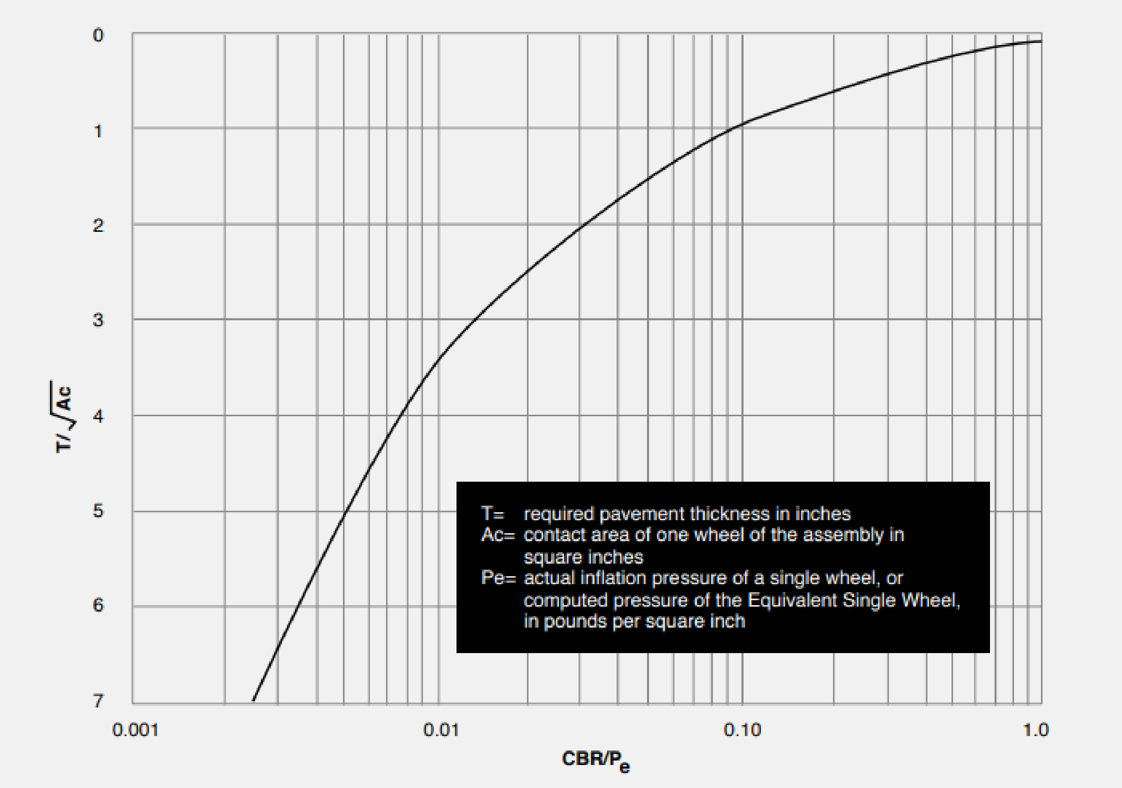

Figure 8: USACE original design curve

A.1.3 Because the S-77-1 is an empirical design method, its use to design much thicker pavements, for larger aircraft with greater wheel loads and repetitions, introduced a degree of uncertainty. Consequently, recent FAA design methods attempt to take into account both the test pavement data, as well as the observed performance of full-depth pavements under actual service conditions at airports in the USA.

A.1.4 Further testing has also been carried out by the FAA to quantify the pavement damage caused by newer larger aircraft such as the B777 and A380. These tests have resulted in adjustments to the S-77-1 curve and method.

A.1.5 The works undertaken by the USACE, and later by the FAA, form the basis of the calculations of relative damage caused by different aircraft that is still relied upon for the current aircraft pavement strength rating system. It also remains the basis of most modern aircraft pavement design methods, including those in FAARFIELD (from the USA) and APSDS (commercially developed in Australia).

A.1.6 Similar work has been repeated for rigid aircraft pavements and S-77-1 includes similar relationships between:

- aircraft loading and repetitions
- underlying material support
- concrete flexural strength
- concrete slab pavement thickness.

A.2 S-77-1 design method

A.2.1 The S-77-1 design method, as updated and republished by the FAA, remains the best empirical representation of the relationships between aircraft loading, subgrade bearing capacity (i.e. CBR), aircraft repetitions and pavement thickness. Many modern pavement software are calibrated to the S-77-1 relationship, despite being far more sophisticated and precise in their calculations.

A.2.2 Despite various charts being published over the years, the most practically usable form of S-77-1 is the computerised version embedded in the FAA software known as COMFAA. The main use of COMFAA is to determine the Aircraft Classification Number (ACN) of any aircraft at any operating mass and tyre pressure combination, for use in the aircraft pavement strength rating system, which is described in detail below and as shown for the B737-800 in **Error! Reference source not found.**. The software allows any number of passes (expressed as annual departures over 20 years) by any aircraft to be entered to determine the required pavement thickness, based on the S-77-1 empirical relationships.

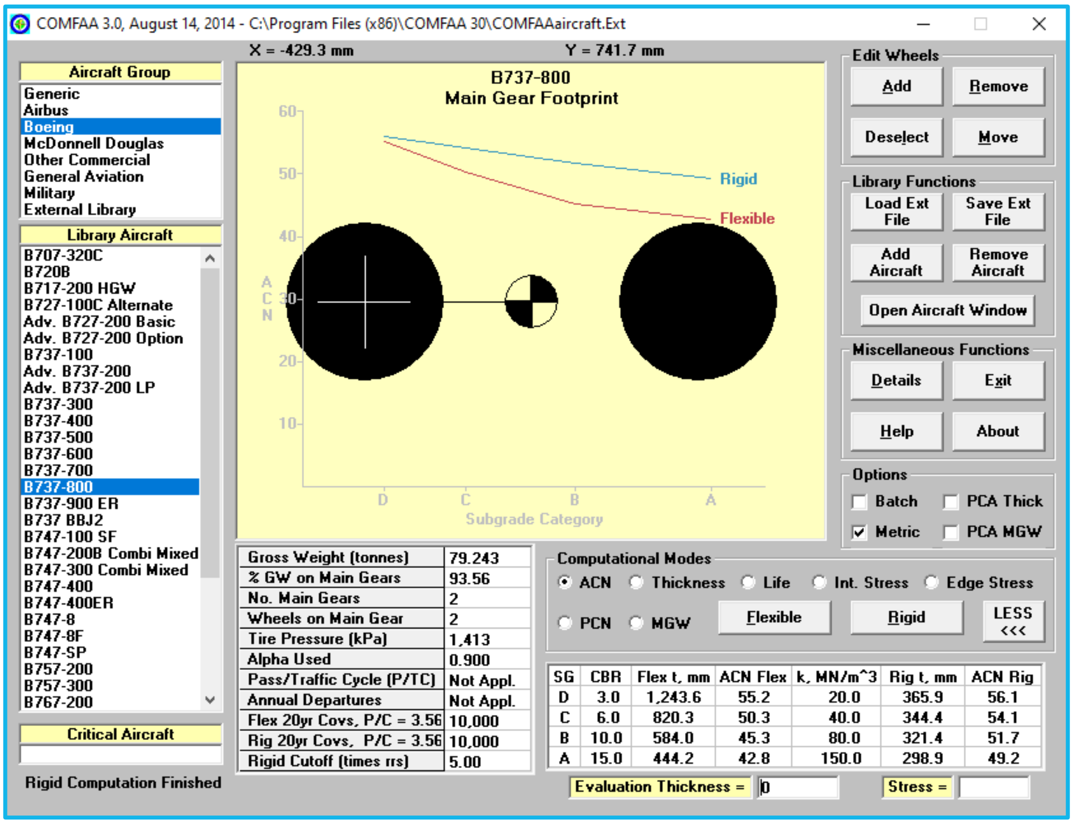

Figure 9: Example of COMFAA calculations for B737-800

A.2.3 When determining a S-77-1 pavement thickness for any given aircraft and subgrade condition, it is important to understand the few limitations. The first relates to rigid pavement subgrade support and the second relates to flexible pavement composition.

A.2.4 Unlike flexible pavements, rigid aircraft pavement subgrade support is expressed by a parameter known as the modulus of subgrade reaction, commonly referred to as the 'k-value'. This is shown in Figure 10 as 'k' in the ACN table in the bottom-right corner. In contrast, the flexible pavement ACN values are based on CBR as the indicator of subgrade support. In more modern methods, the k-value has been largely replaced by an elastic modulus, for consistence with layered elastic pavement thickness design software. Elastic modulus (MPa) can be estimated from CBR by multiplying the CBR (%) by 10.

A.2.5 Even before the adoption of elastic modulus, the k-value test had proven to be cumbersome and expensive and was rarely performed. Therefore, a conversion between CBR, which is simple and easy to measure in the laboratory, and k-value was often preferred. Different jurisdictions publish significantly different conversions, with indicative values shown in Table 11.

Table 11: Indicative k-values compared to CBR values

CBR (%)	Modulus (MPa)	k-value (kPa/mm or MN/m3)
3	30	27
4	40	34
5	50	40
6	60	43
8	80	48
10	100	54
15	150	60

A.2.6 Further to that above, there is an additional complication relating to the effect of the sub-base layer, which is commonly located between the concrete slab and the prepared subgrade. The k-value is usually measured at the top of the subgrade. However, COMFAA does not directly account for the benefit associated with the sub-base material or thickness. Rather, the k-value must be selected to account for the combined support offered by the subgrade and the sub-base layer(s).

A.2.7 Regarding flexible pavements, the S-77-1 thickness calculated by COMFAA are based on a standard composition of pavement. The standard composition is shown in Figure 10 but is not commonly used for the construction of Australian aerodrome pavements. Where an existing pavement thickness is measured by geotechnical investigation, the thicknesses must be converted to an equivalent thickness based on the S-77-1 structure, using material equivalence factors. Jurisdictions publish different materials equivalence factors and Table 12 provides indicative factors for common materials. The materials designations (e.g. P-401) are standard FAA materials specification references, as detailed in AC 150/5370-10 although there are comparable materials available in Australia.

A.2.8 These equivalence factors were originally developed by the FAA based on the results from the full-scale pavement tests to failure. They were previously published with the FAA pavement design requirements detailed in AC 150/5320-6D (1995). However, these were no longer published when the FAA moved away from chart-based design guidance. Since then, statistical analysis of parametric runs of APSDS were used to determine equivalence factors implied by APSDS.

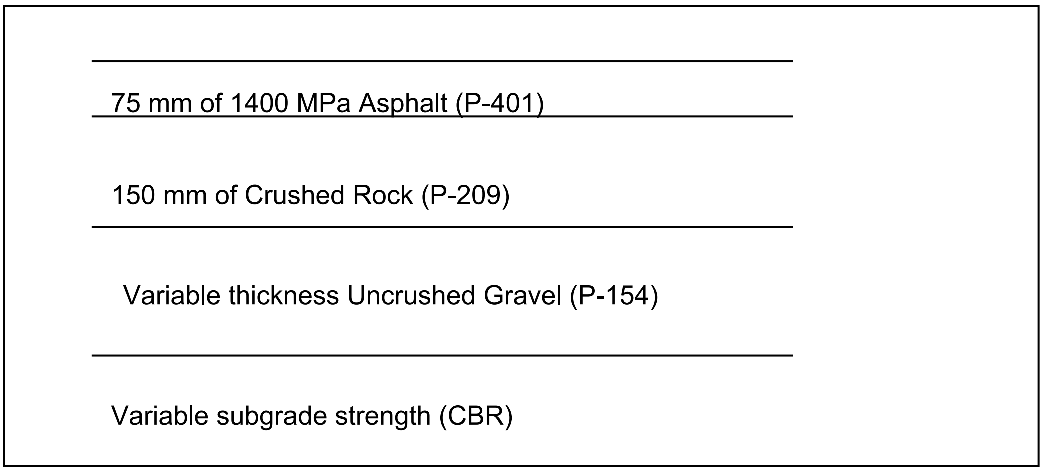

Figure 10: Standard S-77-1 pavement composition

A.2.9 For example, 100 mm of asphalt is structurally equivalent to 1.3 × 100 mm = 130 mm of crushed rock. Similarly, 200 mm of crushed rock is structurally equivalent to 1.2 × 200 mm = 240 mm of uncrushed gravel.

Table 12: Indicative common materials equivalence factors

1 mm of this material	Is equivalent to the following thickness (mm)	Of this material
Asphalt (P-401)	1.3	Crushed rock (P-209)
Crushed rock (P-209)	1.2	Uncrushed gravel (P-154)
Asphalt (P-401)	1.6	Uncrushed gravel (P-154)

A.3 Modern airport pavement design

A.3.1 With the increase in personal computing power and availability, aircraft pavement design methods have evolved to rely on mechanistic empirical and layered elastic methods. The mechanistic empirical element means that stresses are strains induced at critical locations within the pavement are calculated in a mechanistic manner, and then related to an empirical relationship between that magnitude of stress or strain and the number of repetitions of that loading until a pre-determined failure condition is expected to be reached.

A.3.2 This approach to modern airport pavement thickness design is embedded in the Australia tool for flexible pavements, known as APSDS, as well as the FAA's software FAARFIELD. FAARFIELD includes an aircraft library that can be selected from, characterises aircraft repetitions as annual departures (take-offs) over the pavement's structural design life, allows different aircraft to be included in an aircraft traffic mix or spectrum, does not distinguish between the thickness required for runways, taxiways or apron pavements, and characterises the subgrade material with an elastic modulus value.

A.3.3 Although FAARFIELD is a useful tool for aircraft pavement thickness design, it also has some challenges when being applied to the Australian context. Australian materials and specifications are different to those used in the USA. For example, the USA does not use sprayed seals and FAARFIELD does not allow flexible pavements to be designed without at least 50 mm of asphalt surface.

A.3.4 One of the benefits of the latest version of FAARFIELD (2.1.1) is that it automates the determination of the pavement strength rating of any nominated or designed pavement structure. As detailed below, this effectively automates the processes detailed in the FAA's AC 150/5320-6G, which is similar to the process recommended by ICAO in ADM Part 3 - Pavements.

A.4 Development of aircraft pavement rating system

A.4.1 In parallel with the work done by the USACE to design aerodrome pavement structures in a more reliable manner, aircraft continued to evolve. As aircraft became heavier and their wheel loads increased, pavements needed to be constructed or upgraded to be stronger than they were before.

A.4.2 One significant step in aircraft growth was the DC-8-50, first introduced in 1958. At the time, this 159 t aircraft was the most damaging commercial aircraft available, with 19 t wheel load on 1.35 MPa tyre pressure and with close wheel spacing. This aircraft had significant impact on airport pavements and triggered considerable pavement strength upgrades.

A.4.3 To prevent aircraft from being developed that increased demand for higher strength pavements, the FAA implemented a policy to restrict the development of new aircraft that stressed pavements more than a 159 t, DC-8-50 aircraft. This was achieved by limiting FAA funding of new pavement developments to the cost of a pavement structure required by the DC-8-50 aircraft. The FAA policy was rescinded in 1995, resulting in a new phase of steadily increasing aircraft weights and tyre pressures over time.

A.4.4 As aircraft got larger, the difference between 'large' and 'small' aircraft became greater. It is clear, that despite the size of the most demanding of the commercial aircraft in operation, many airports only required pavements strong enough to accommodate much smaller aircraft loadings. That necessitated a system for rating and advertising the strength of the aerodrome pavements at any given airport, so that aircraft operators would be able to determine whether the pavements would be able to accommodate the loadings associated with their particular aircraft. Otherwise, many smaller airports would need pavements that were designed for the most demanding aircraft, which would be unlikely to ever operate from that airport.

A.4.5 To allow an internationally consistent system for advising the strength of a particular aircraft pavement, ICAO developed and implemented a system known as Aircraft Classification Number-Pavement Classification Number, or more commonly as ACN-PCN. The ICAO ACN-PCN system was introduced in 1981 and as a member State of ICAO, Australia uses the ACN-PCN pavement strength rating system.

A.4.6 The ICAO ACN-PCN system was subsequently replaced by a new system that uses analysis methods that are more consistent with modern aircraft pavement thickness design methods, to reduce anomalies between pavement design and pavement strength rating. The new ICAO system was introduced in 2020 and became effective in 2024 and is known as Aircraft Classification Rating - Pavement Classification Rating, or ACR-PCR.