Research on the Evaluation Method of Civil Aircraft Roadway Floatation Characteristics

Feng Li

Shanghai Aircraft Design and Research Institude,Shanghai,201210,China

Corresponding author: lifeng5@comac.cc

Abstract. In this paper, ACN/PCN and ACR/PCR calculation methods are given for two types of paved roadway surfaces, rigid and flexible. The ACN/PCN method is replaced by the ACR/PCR method because of its limitations. The two methods are based on the same logic and purpose, with differences in computational models, pavement class number values, and overload percentages.The ACR/PCR method is used to compute any aircraft classification class for any mass on both rigid and flexible paved surfaces for the four standard soil-base strength types, and is of some practical engineering interest in guiding aircraft design.

Keywords: floatability, pavement, ACN, ACR

1 INTRODUCTION

Aircraft floatability, also known as ground passability, is a kind of evaluation of the ability of an aircraft to use the roadway surface of specified strength. Domestic research on the floatability of aircraft is not deep enough, and the traditional airport roadway design method can calculate the required roadway thickness of the aircraft. At present, in engineering practice, we mainly rely on the floatability calculation software introduced from abroad to estimate the floatability of the developed aircraft, typical software such as COMFAA.

Due to the limitations of the ACN/PCN methodology, which allows countries to use any design/assessment methodology of their choice, i.e., the methodology is not harmonized across countries; it is not based on fatigue principles and is not consistent with design principles; it does not accurately take into account "complex" landing gear configuration; and it does not take into account the distribution of the offset of the transverse position of the landing gear acting on the roadway surface. The ACR/PCR method provides an internationally recognized aircraft/road surface rating system that replaces the current ACN/PCN method. The two methods are based on the same logic and purpose, with differences in the computational models, roadway grade number values, and overload percentages.The ACR/PCR method was used to compute any aircraft classification class for any mass on both rigid and flexible roadways for the four standard soil base strength types.

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To calculate the ACN or ACR values for an aircraft on both rigid and flexible paved surfaces, the maximum and minimum unilateral main landing gear load-bearing percentages of the aircraft at a given tire pressure are known, as well as the weight of the aircraft and the strength of the roadbed. By analyzing the calculation method for the floating characteristics of aircraft pavement, it provides a reference for the work related to the airport adaptability of a certain type of aircraft[1-12].

2 ACN/PCN REPORTING SYSTEM

2.1 General Information

An aircraft having an ACN less than or equal to the PCN can operate without restriction on the pavement.Aircraft with an ACN greater than the PCN shall be operated at a restricted operating weight and/or frequency at that tire pressure.

2.2 ACN

This section provides ACN numerical calculation method prepared according to the ACN/PCN system as referenced in ICAO Annex 14, ”Aerodromes”, Volume 1 ”Aerodrome Design and Operations” Fourth Edition, July 2004, incorporating Amendments 1 to 6.

Numerically the ACN is two times the derived single wheel load expressed in thousands of kilograms. The derived single wheel load is defined as the load on a single tire inflated to 1.25 MPa (181 psi) that would have the same pavement requirements as the aircraft.

Computationally the ACN/PCN system uses PCA program PDILB for rigid pavements and S-77-1 for flexible pavements to calculate ACN values.

Figure 1 and Figure 2 give the ACN values for an airplane at different weights.

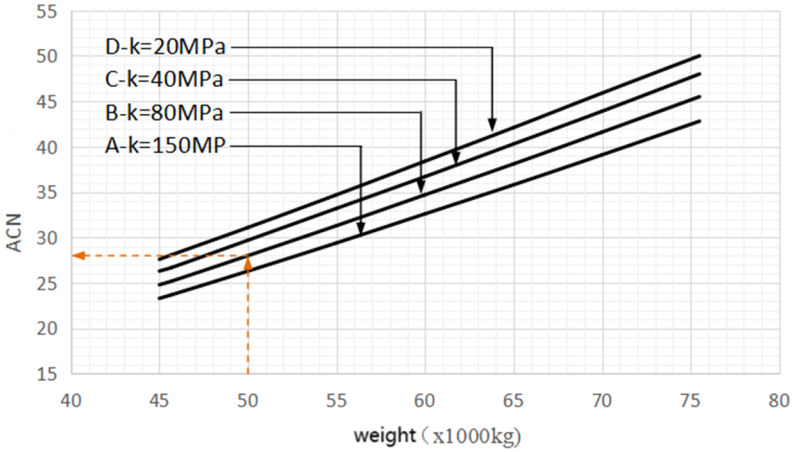

Fig. 1. ACN rigid pavement.（MRW 60000kg,CG 37%MAC）

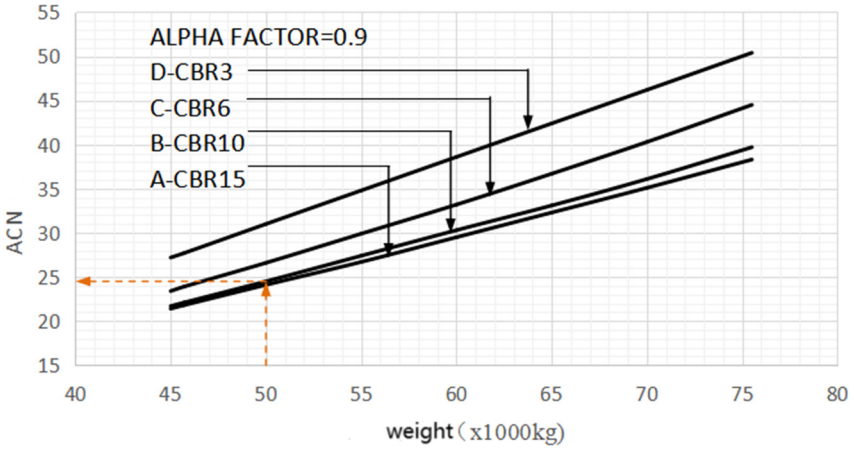

Fig. 2. ACN flexible pavement.（MRW 60000kg,CG 37%MAC）

2.3 PCN

The Airport Authority must decide on the method of pavement analysis and the results of their evaluation,as shown in Table 1.

Table 1. PCN analysis method.

pave-ment type	subgrade category		tire pressure cate-gory	evaluation method
rigid	high	k = 150 MN/m^3 (550 pci)	W-- No pressure limit X-- High pressure limited to 1.75 MPa (254 psi) Y-- Medium pres-sure limited to 1.25 MPa (181 psi) Z-- Low pressure limited to 0.5 MPa (73 psi)	technical using aircraft
	medium	k = 80 MN/m^3 (300 pci)		
	low	k = 40 MN/m^3 (150 pci)		
	ultra low	k = 20 MN/m^3 (75 pci)		
flexible	high	CBR 15		
	medium	CBR 10		
	low	CBR 6		
	ultra low	CBR 3		

3 ACR/PCR REPORTING SYSTEM

3.1 General Information

This section gives the numerical calculation of ACR as per the Airport Design Manual, 3rd Edition (2022) published by ICAO as mentioned in the ICAO.ACR is the Aircraft Class Rating (ACR) and PCR is the corresponding Pathway Class Rating (PCR).

An aircraft having an ACR less than or equal to the PCR can operate without restriction on the pavement.Aircraft with an ACR greater than the PCR shall be operated at a restricted operating weight and/or frequency at that tire pressure.

3.2 ACR

Numerically, the ACR is twice the equivalent single wheel load (in hundredweights). Equivalent single wheel load is defined as the load of a single tire inflated to 1.50 MPa (218 psi), which in this case has the same road surface requirements as the aircraft.

Computationally, the ACR/PCR method uses the ICAO-ACR program recommended by the International Civil Aviation Organization (ICAO) to calculate ACR values on rigid and flexible road surfaces.

Knowing the values of ACR for airplanes at different weights, as an approximation, use a linear interpolation in order to get the ACR at the required operating weight.

Figure 3 and Figure 4 give the ACR values for an airplane at different weights.

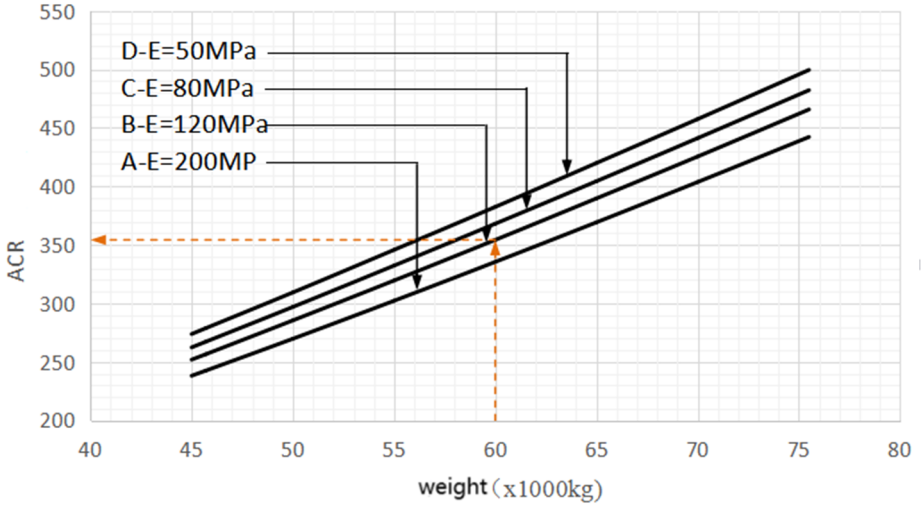

Fig. 3. ACR rigid pavement.（MRW 60000kg,CG 37%MAC）

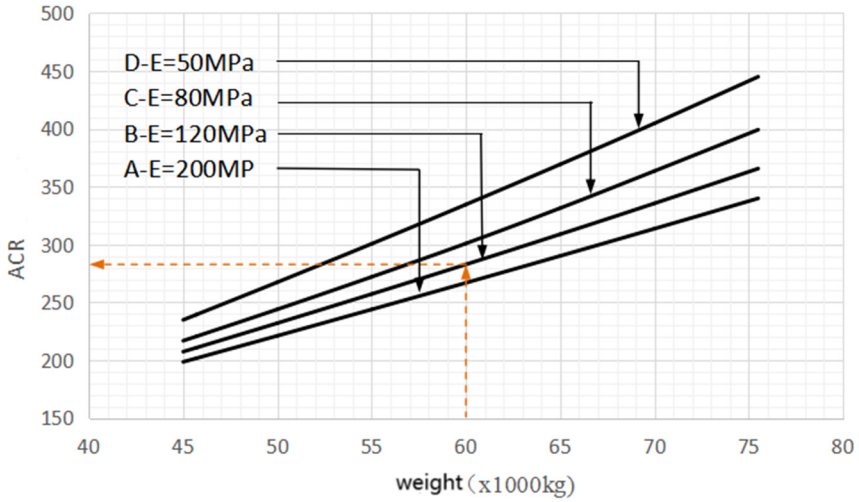

Fig. 4. ACR flexible pavement.（MRW 60000kg,CG 37%MAC）

3.3 PCR

The Airport Authority must decide on the method of pavement analysis and the results of their evaluation,as shown in Table 2.

Table 2. PCR analysis method.

pave-ment type	subgrade category		tire pressure category	evaluation method
rigid flexible	high	E=200MPa (29008psi)	W-- No pressure limit X-- High pressure limited to 1.75 MPa (254 psi) Y-- Medium pressure limited to 1.25 MPa (181 psi) Z-- Low pressure limited to 0.5 MPa (73 psi)	technical using aircraft
	me-dium	E=120MPa (17405psi)		
	low	E=80MPa (11603psi)		
	ultra low	E=50MPa (7252psi)		

4 SUMMARY

In this paper, two methods are given to analyze the floatation of aircraft under rigid and flexible paved surfaces. Through the analysis of the calculation method of the floating characteristics of the aircraft road surface, it provides a reference for the work related to the adaptability of aircraft airports.

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