COMPARISON STUDY OF AIRCRAFT CLASSIFICATION NUMBER – PAVEMENT CLASSIFICATION NUMBER OF THE AIRPORT RIGID STRUCTURES

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Rezumat. *Lucrarea prezintă metoda ACN-PCN si procedura de comparare a PCN-ului unui aeroport cu ACN-ul avionului. Pentru a evita deteriorarea accelerată și costurile de întreținere excesive și pentru protejarea integrității suprafețelor de mișcare și asigurarea duratei de viață optimă, Organizația Aviației Civile Internaționale (OACI) utilizează metoda de clasificare a sarcinii ACN / PCN pentru raportarea rezistenței suprafețelor de mișcare aeroportuare. Conform acestui standard mondial, aeronavele pot funcționa în condiții de siguranță pe suprafețele de mișcare aeroportuare dacă ACN-ul lor este mai mic sau egal cu capacitatea portantă a suprafețelor de mișcare aeroportuare PCN.*

Abstract*:The paper presents the ACN-PCN method and the procedure of comparing the PCN of an airport with the PCN of the aircraft. In order to avoid accelerated damage and excessive maintenance costs and to protect the integrity of the moving surfaces and to ensure the optimum lifespan, the International Civil Aviation Organization (ICAO) uses the ACN / PCN task classification method for reporting the resistance of airport moving surfaces. According to this global standard, aircraft can safely operate on airport moving surfaces if their ACN is less than or equal to the carrying capacity of PCN airport moving surfaces.*

Keywords: Aircraft Classification Number (ACN), Pavement Classification Number (PCN), Safety, Airport Runway.

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1. Introduction

Air transport is an alternative to traditional modes of transport, respectively rail, auto and naval. At the beginning of the twentieth century, the innovative concerning of some personalities to make aircraft, which by their own means to rise from the ground, to overcome gravity and to fly, turned into a special and real competition.

Personalities from our country, such as engineer Traian Vuia and engineer Aurel Vlaicu, through their inventions, had a special contribution to the realization of the first propeller-driven aircraft. Engineer Henri Coandă built the first jet aircraft, which was presented at the Paris International Aeronautics Show in 1910.

The improvement of aircraft has led to the development of the aeronautical industry. With the development of the aeronautical industry, the necessary infrastructure was developed. Thus, the first airports were built starting with 1909, and the need to ensure all functional facilities, respectively airport movement areas, passenger and freight buildings, ancillary facilities, etc., led to the continuous improvement of the airport system.

The development of air transport also imposed the need for regulations in this regard, so on December 7, 1944 the International Civil Aviation Organization (ICAO / ICAO) was established to plan and develop international air transport to ensure an increase in safety and order.

ACN - is the classification number of the aircraft that characterizes each aircraft.

PCN - the airport movement area classification number - is the number that expresses the load-bearing capacity of an airport road structure used without operating restrictions compared to a reference traffic.

The ACN - PCN method is recommended by (ICAO) to determine and publish the load-bearing capacity values of airport road structures intended for airplanes with a mass greater than 5700 kg. ICAO is the International Civil Aviation Organization.

Airport movement surfaces can be rigid, made of cement concrete slabs, or elastic made of asphalt mixtures.

The PCN classification number consists of:

- the number of PCNs expressed in full;
- type of airport road structure (R for rigid or F for flexible);
- load-bearing capacity category of foundation soil coded according to size with A, B, C, D;

- the maximum permissible pressure for the tires of the main landing gear of the airplanes, marked in size with W, X, Y, Z,
- method of assessing the number of NCPs coded with:
    - T – Technique, based on samples extracted from the concrete of the work (cores) and the foundation soil under them;
    - U - Empirical, based on experience.

The paper presents the way in which the bearing capacity of airport movement surfaces from cement concrete slabs is determined by the ACN - PCN method.

2. ACN-PCN method

For the calculation it is necessary to know the following characteristics of the foundation ground and the rigid airport road structure: [1]

- the reaction modulus of the foundation soil, K_0 and / or the reaction modulus at the surface of the foundation layer, K;

- the thickness of the cement concrete slab, H;

- the tensile stress in the permissible bending of the concrete, σt.

These characteristics are established as follows:

- for new rigid airport road structures, according to "Design norm for rigid airport road structures" NP 034 -99; [2]

- for existing rigid airport road structures, according to the "Norm for the design of cement concrete reinforcement of rigid airport road structures" NP 038-99. [3]

The calculation of the PCN number is performed in two hypotheses:

a. General calculation

The PCN number is determined only on the basis of the characteristics of the rigid airport road structure. The calculation is used when no traffic data are known (types of aircraft, masses, number of movements).

b. Optimized calculation

In determining the number of NCPs, both the characteristics of the rigid airport road structure and the planned air traffic shall be taken into account at the same time.

The general calculation method was used to determine the number of PCNs of the movement surface.

2.1 Foundation ground reaction modulus

- The reaction modulus of the earth, K_0, is equal by definition, using the relation [3]:

$$K_0 = 70 / w \tag{1}$$

where:

- w is the average deformation, expressed in cm, of a plate 75 cm in diameter, placed on the ground and loaded with a pressure of 70 kPa.

In the case studied, the reaction modulus of the soil at a depth of 50 cm was determined as follows:

- the earth was excavated, leveled, a layer of sand was placed, a circular metal plate with a diameter of 600 mm was placed, the loading piston equipped with a pressure measuring device was placed, three comparators were placed to measure the settlement between plate and frame of reference (Fig. 1);

- a load of 10 kPa was applied until the settlement stabilized; C0 was read, the loading was continued until 70 kPa, until the settlement stabilized; C1 was read

Foundation ground reaction modulus is calculated using the formula:

$$K_0 = \frac{60}{C_1 - C_0} \cdot \frac{60}{75} \tag{2}$$

Fig. 1. Finding ground reaction modulus using LUKAS plate.

In order to determine the modulus of reaction K, the thickness of the foundation layer and the material used must be known. The equivalent thickness is calculated and together with the reaction modulus of the earth K is determined from the diagram, shown in the Figure 2.

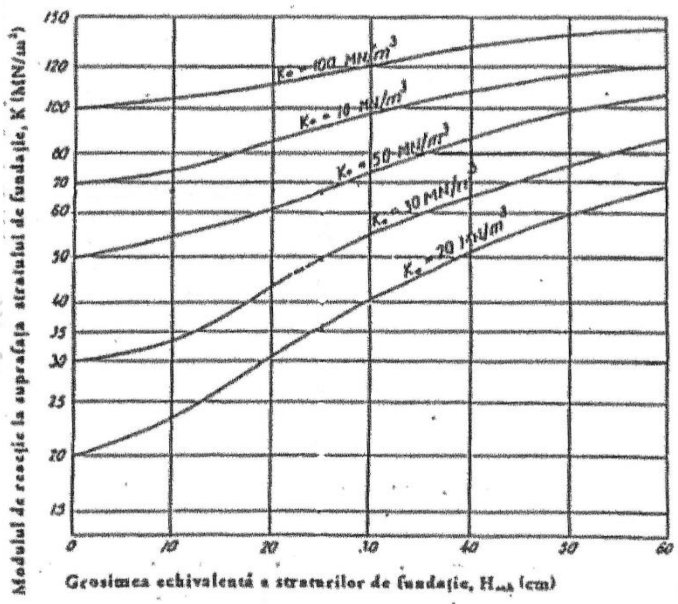

Fig. 2. Determination of the value of the reaction modulus at the surface of the foundation layer, depending on the equivalent thickness and the foundation ground reaction modulus K_0

If the thickness of the foundation layers is not known, cores with a diameter of 200 mm are taken (Fig. 3), after which the granular material is removed to ground level and the thickness of the layers is measured (Fig. 4).

Fig. 3. Carrying samples with a diameter of 200 mm.

Fig. 4. Loosening the ballast with the crowbar, removing the ballast to ground level and measuring the thickness of the foundation layer

2.2 Thickness of the cement concrete slab

The thickness of the cement concrete slab was determined as the average of the heights of the cores with a diameter of 100 mm extracted from the cement concrete slabs (Fig. 5).

Fig. 5. Sampling of carrots with a diameter of 100 mm and their measurement.

2.3 Tensile strength in permissible bending of concrete

The bending tensile strength of the concrete in the slabs of the moving surface, the cores with a diameter of 100 mm were processed, cut to size, measured and tested for splitting. After calculating the tensile strength by splitting, the bending tensile strength equivalent to 28 days shall be determined.

The permissible tensile strength of concrete bending according to NP 038: 1999 is: [3]

$$\sigma_{adm} = \frac{Rti90}{Cs} xCss \qquad (3)$$

where:

- Rti 90 = 1,1 x Rti 28;
- Rti 28 is the bending strength of concrete at 28 days;
- Cs – safety factor depending on the type of transfer device provided in the construction or expansion joints and it can take values:

Cs =1,8 for construction and expansion joints with studs, for construction joints with groove and spring (if a maximum of two unfavorable conditions occur);

Cs =2,6 for joints without the transfer devices, and for construction joints with groove and spring (having at least two unfavorable conditions);

- Css - structural state coefficient, having values assessed by visual examination of the state of degradation, of the existing cement concrete coating, according to the specific technical regulation:

Css = 0.35 - highly cracked / structurally degraded tiles and degraded joints;

Css = 0.75 - tiles with cracks, but without general degradation, tiles with broken corners or some with structural cracks;

Css = 1.00 - tiles in good condition, without structural degradation.

Based on these characteristics, the single wheel load with a tire pressure of 0.6 MPa is determined by RSI, using the sizing diagrams of the rigid airport road structures presented in "NP 044/2000 - *Norm for the evaluation of the load-bearing capacity of the rigid airport road structures* ", Practical Guide "ITAC or ICAO no. 9157- Part 3". Single wheel load with a tire pressure of 0.6 MPa, RSI is the characteristic value of the load-bearing capacity of the rigid airport road structure. [1]

2.4 PCN number calculation

The PCN number is calculated with the relation:

$$PCN = RSI \text{ x } G(K_0)/c_F \qquad (4)$$

where:

- RSI is the single wheel load isolated, expressed in t and determined from the diagrams, according to the above parameters [4] [5];

- G (K_0) is a coefficient determined according to the reaction modulus of the foundation earth, K_0 (MN / m3) and the load-bearing capacity category of the foundation earth from the diagram presented in "NP 044/2000 - Norm for the evaluation of the load-bearing capacity of rigid airport road structures" (see Fig. 6);

- cF is a weighting coefficient determined according to the role of the airport area.

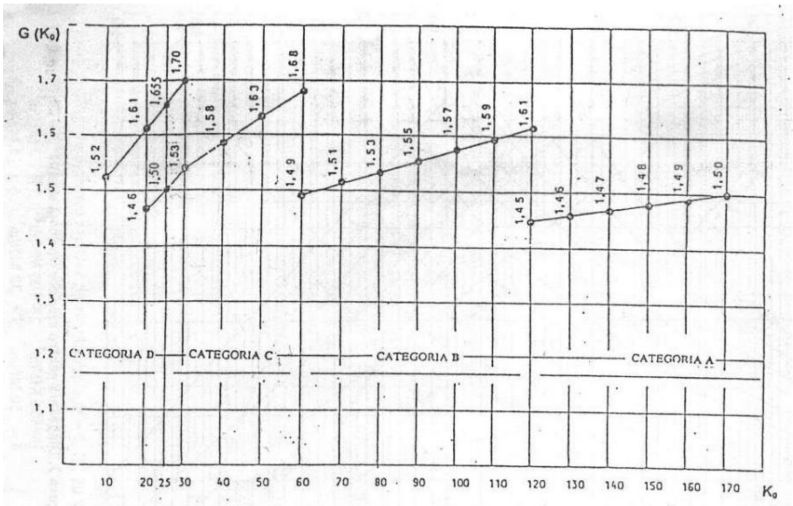

Fig. 6. Obtaining the values of the coefficient G, based on the earth reaction modulus, K_0

The analyzed movement surface is characterized by the following parameters:

- the reaction modulus of the foundation earth K_0 = 70,0 MN/m^3;
- ballast foundation layer thickness h_{bal} = 30,0 cm;
- h_{echiv} = 0.75x30.0 = 22.5 cm;
- the reaction modulus K = 90,0 MN/m^3;
- the thickness of the existing cement concrete slab H_{dala} = 27,0 cm;
- weighting coefficient c_F = 1,0 (for the running track);
- safety coefficient C_S = 2,6;
- structural state coefficient C_{ss} = 1,0;
- permissible tensile strength in concrete bending :
  - Rti 28 = 7,14 MPa;
  - Rti 90 = 7,14 x 1,1 = 7,85 MPa;
  - σ_{adm} = 7,85 / 2,6 x 1,0 = 3,02 MPa.

In the diagram from the Figure 7, draw a horizontal line from the value H_{dala} = 27.0 cm, which intersects the curve of K = 90.0 MN / m^3 at point A. Raise the vertical from point A which intersects the line of σ_{adm} = 3,02 N/mm2 at the RSI point. By interpolation, the RSI value = 27.5 t is determined.

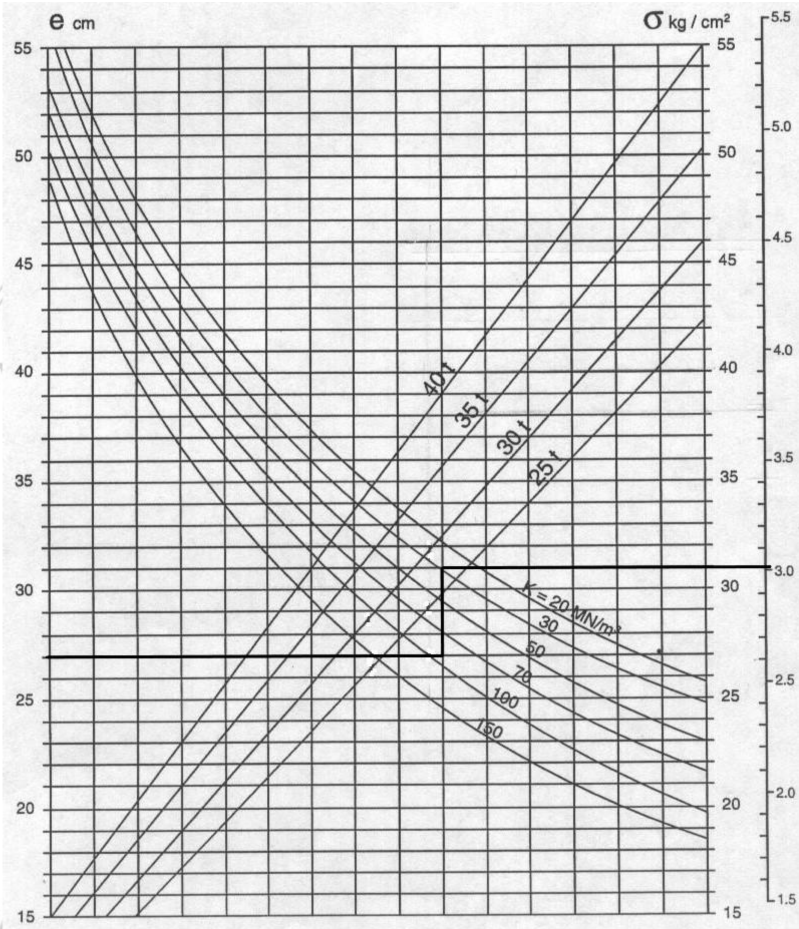

Fig. 7. Determination of the load on the single insulated wheel depending on the thickness of the concrete slab and the permissible tensile strength of the concrete

The value of the coefficient G(K_0) pentru K_0 = 70,0 MN/m^3, este 1,51.

PCN = RSI x G(K_0)/c_F = 27,5 x 1,51 / 1,0 = 41,5 ≈ 42 t

The reaction module of the foundation earth being K_0 = 70,0 MN/m^3, value between 60 MN / m^3 <K_0 ≤ 120 MN / m^3, ***results category B of the bearing capacity of the foundation earth.***

In this case, the publication of the PCN number is as follows:

PCN 42 R / B / W / T

3. Conclusions

The development of air transport also imposed the need for regulations in this regard, so on December 7, 1944 the International Civil Aviation Organization (ICAO / ICAO) was established to plan and develop international air transport to ensure an increase in safety and order.

The ACN-PCN method consists in comparing the PCN of an airport with the ACN of the aircraft. For the calculation of the PCN of the moving surfaces, it is necessary to know the characteristics of the foundation ground and the rigid airport road structure[6], [7].

The calculation by the ACN-PCN method requires the knowledge of the characteristics of the foundation earth (K_0 or K) and the rigid airport road structure, respectively the thickness of the cement concrete slab and the allowable tensile stress of the concrete bending σt.

The calculation of the PCN number is performed in two hypotheses, namely the general calculation based only on the characteristics of the rigid airport road structure without knowing traffic data and the optimized calculation that takes into account both the characteristics of the rigid airport road structure and the planned air traffic.

Determining the number of PCNs of airport road structures, rigid or elastic, leads to a real assessment of the admissibility of aircraft, characterized by the ACN number, enabling the traffic operator to such an admissibility planning, leading to a longer service life. close to that projected at minimum costs.

R E F E R E N C E S

[1] Normative for the evaluation of the load-bearing capacity of the rigid airport road structures. – Indicative NP 044-2000

[2] Design norm for rigid airport road structures - indicative NP 034 -99;

[3] Norm for the design of cement concrete reinforcement of rigid airport road structures - indicative NP 038-99

[4] ICAO Doc 9157-AN/901 Part 3;

[5] Instruction technique sur les aérodromes civils ITAC

[6] en.wikipedia.org – internet source

[7] Cojocaru R., Radu A. & Budescu M. - *Modelling of airport rigid pavement for complex configuration of landing gears and for a large spectrum of cement concrete*, Advanced Engineering Forum, 2013.