EVALUATION OF THE CARRYING CAPACITY OF THE AIRPORT MOVEMENT AREAS APPLYING THE ACN/PCN METHOD

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The thesis describes the current state of the evaluation of bearing capacity of airport movement area. The work is divided into four chapters. The first chapter focuses on general definitions and basic concepts of airfields and roads and continues to describe the materials needed for the construction of the airport road. The second chapter deals with a specific focus on the airport roads. It describes basic functions and requirements needed to meet all the standards necessary for their construction. A brief overview of the methods of assessing load capacity with closer focus on the method of ACN / PCN is found in the third chapter. The content of the fourth chapter is the most important because of the calculation of concrete pavements using Westergaard´s method. At the end of the chapter is the calculation using the selected critical aircraft B737 - 400.

K e y w o r d s: Airport movement area, carrying capacity, method ACN/PCN, Westergaard method, airport pavement with CB cover, runway, taxiway, apron.

1 INTRODUCTION

Airport roadway fulfils several important tasks in the air transportation. Aviation safety, which consists in ensuring carry capacity and surface properties of the roadway, is one of its most important tasks. Safety requirements place high demands on the quality of airport roadways. Airport roadway must be therefore designed and its construction implemented so as not to jeopardize the ability of the roadway to transmit a single or repeated load from all types of aircraft throughout its service life. At the same time we must not forget the fact that the roadway surface must resist the external effects and side effects of stress.

Draft creation and execution of the construction of the airport roadway is a complex and a difficult process. In addition to meeting all the technical parameters, airport roadway must also satisfy very strict criteria set by the International Civil Aviation Organization (ICAO).

Today, on the basis of the gained knowledge we are able to design and built the airport roadways, so all the requirements are met, whether are these technical, operational economic, ecological or aesthetic.

2 EVALUATION OF THE AIRPORT ROADWAYS

All roads belonging to either air or road infrastructure are exposed to ever increasing traffic load and thermal stress. Tensions arising from the effect of these stresses as well as methods for their calculation are the basis for the assessment of proposed, but also already existing roads.

When evaluating the roadway to LPP is taken into account the state of the roadway surface, straightness and surface roughness and roadway carrying capacity.

3 CARRYING CAPACITY OF THE ROADWAY

Carrying capacity is the roadway's ability to transmit the load off the roadway into the roadway bed so as not to breach the roadway as a whole or any of its structural layers.

Carrying capacity of roadway on the runway, taxiways and parking and handling areas must conform to the maximum load caused by the aircraft, the operation of which is expected to be at the airport. Such a plane is called the critical aircraft and inferred load is critical load. During dimensioning and assessing airport roadway the load can be considered in the calculation as the maximum, equivalent or standardized load. Roadway load from the aircraft depends on:

- the total weight of the aircraft,
- the type of the landing gear,
- the number of wheels on the main landing gear leg,
- spatial arrangement of wheels in a landing gear and
- tyre inflation.

Carrying capacity of airport roadways is carried on the basis of load tests of experimental measurements or by theoretical calculations.

4 CALCULATION OF ROADWAY CONSTRUCTION AT (PPL) BY WESTERGRAAD

Calculation of stress by Westergraad is one of the first and still most widely used solutions, which is based on the assumption that the elastic isotropic CB board lies on a flexible bearer, which load induced stress is directly proportional to the vertical deformation of the plate. The load is transferred to the circular touch plane. Later Westergraad modified formulas for elliptical footprint of the wheel. Formulas were defined to calculate the stress of the individual load and the temperature:

- in the middle of the plate
- the lateral edge of the plate,
- the longitudinal edge of the plate and
- in the corner of the plate.

If we want to calculate the tension in the CB cover using mathematical methods, we must assume that the CB plate is imposed on the basis layers, which physical - mechanical properties are known.

Westergraad used at his calculations one important simplification. He considered the so-called.

Winkler basis, which means that the subbase can not transmit skidding stresses. If we use the Winkler foundation, then reaction to the load is constant and the proportion increases with the acting force that is equal to k^{th} multiple of deflection, where" k "is the module of subbase reaction. In the calculation, Westergraad assumed permanent contact of the concrete plate with the subbase.

Load for aircraft designed in present is transferred to the front so-called nose and main landing gear legs , which can be depending on actual types and the total weight several (at least two). Front wheel usually carry about 10% of weight. The stress generated in the CB cap is caused by the action of factors that can be divided into main and side factors.

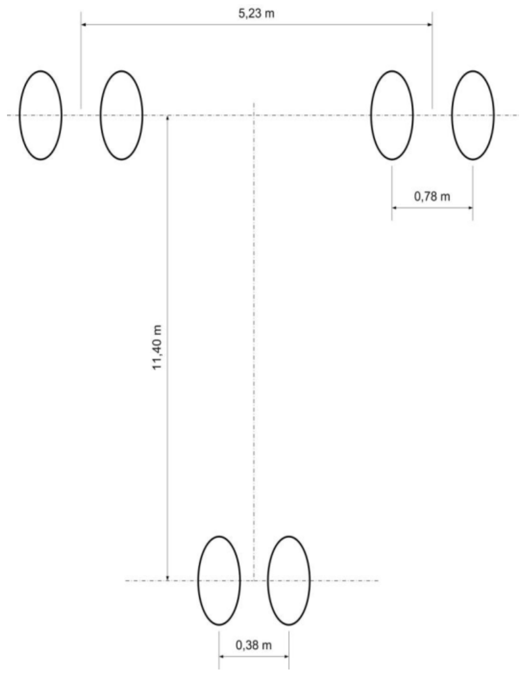

Figure 1 Schematic landing gear B 737–400

The main factor is the load from the aircraft, respectively effects that are caused by loading an aircraft undercarriage leg. Among the main factors, we also include the difference in temperature between the upper and lower surface of the CB plate.
Side effects include change in the plate temperature, shrinkage of concrete at the time of solidification, a change of the average dampness of the plates and movements of the subbase layers.

When designing CB airport roadways, we take into account only the main effects. We focus mainly on the stress caused by the load through the wheels of the aircraft and the stress from the temperature difference between the upper and lower surface of the plate.

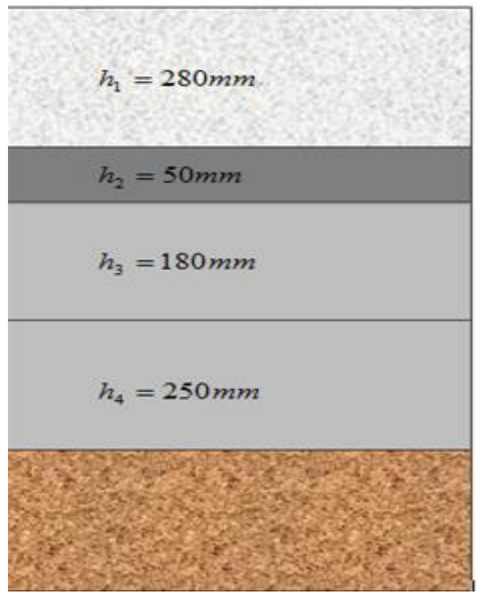

Figure 2. Proposal tracks CB construction of airport road

5 DESIGN OF THE VPD ROADWAY CONSTRUCTION AND ITS CALCULATION

In my work I focus on construction design and calculation of the airport roadway with CB cover. In the calculations I used the evaluation of the stress from load by the plane and thermal stress in the middle and on the edge of the plate for plane B 737-400, whose total weight is 68,250 kg inflating tyre pressure p = 1.28 MPa, weight transmitted to the front wheel 6800 kg (10% of the total) and weight falling on one wheel 15362.5 kg.

When calculating the stress from the load by the plane and stress from thermal load is first necessary to calculate:

- radius of the circular loading plane $a = 0{,}195m$, where $a = \sqrt{\dfrac{P}{\pi \cdot p \cdot 10^3}}$

- equivalent radius of the loading plane $b = 0{,}184$, where $b = \sqrt{1{,}6 \cdot a^2 + h^2} - 0{,}675 \cdot h$

- radius of the relative stiffness of the plates $l = 0{,}875m$, where $l = \sqrt[4]{\dfrac{E \cdot h^3}{12 \cdot (1 - \mu^2) \cdot k}}$

♦ value of the radius of the relative stiffness under thermal stress $l_T = 0{,}8m$, where

$$l_T = \sqrt[4]{\frac{E_T.h^3}{12 \cdot (1-\mu^2) \cdot k}}$$

♦ coefficient $C_x = 1{,}1$

After calculating beforementioned data will be the individual stresses by Westergraadových formulas calculated this way :

stress from the load from the plane in the middle of the plate:

$$\sigma_{r,s} = 0{,}275 * (1+\mu) * \frac{p}{h^2} * \log \frac{E.h^3}{k * a^4} + \frac{3}{64} * (1+\mu) * \frac{p}{h^2} * \left(\frac{a}{l}\right)^2$$

$$\sigma_{r,s} = 2{,}28\,\mathrm{MPa}$$

stress from the load from the plane on the edge of the plate:

$$\sigma_{r,p} = 0{,}572 \cdot \frac{\mathrm{p}}{\mathrm{h}^2} \cdot \left[4 \cdot \log\left(\frac{l}{b}\right) + \log b\right]$$

$$\sigma_{r,p} = 2{,}21MPa$$

stress from the thermal straining for the middle of the plate:

$$\sigma_T = \frac{E_T \cdot \alpha_T \cdot \Delta T}{2 \cdot (1-\mu^2)} \cdot (C_x + \mu \cdot C_y)$$

$$\sigma_T = 2{,}94MPa$$

stress from the thermal straining for the longitudinal edge:

$$\sigma_{T,x} = \frac{E_T.\alpha_T \cdot \Delta T}{2} \cdot C_x$$

$$\sigma_{T,x} = 2{,}49MPa$$

6 ASSESSMENT OF THE DESIGN OF THE CONSTRUCTION OF THE AIRPORT ROADWAY

The proposal will comply when maximum tensile stress from the bending load is less than the strength of the CB cover in tensile bend. In this case, is the critical load stress in the middle of the plate. According to the calculations and assessment of the proposed airport roadway for a specified load (B 737-400) conforms the roadway with the CB cover. The ratio of stress and strength in tensile bending is equal to the required smallest value of 1.15.

7 CONCLUSION

Based on the assessment of the proposal by Westergaard formulas and calculations tensions in the middle and on the edge of the CB airport roadway, were met criteria and requirements for airport roadway that suits declaration roadway construction classification number for PPL:

PCN45/R/B/X/T

In case of a request for use of the airport runway by aircrafts of higher weight a new proposal for construction of airport pavements will be carried out, and in particular by increasing:

- CB roadway thickness,
- increasing subbase bearing capacity or increasing the module subbase reactions, or increasing the thickness of the subbase layer.

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