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Improvement of the Mathematical Model for Determining the Length of The Runway at the Stage of Aircraft Landing

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Abstract

The main methods for determining the length of the runway at the landing stage are shown in the given article. The shortcomings of these methods are proved. Statistical data that shows the need of landing distance recalculation for calculation of the required length of the runway are provided. The advanced mathematical model for calculating the required length of the runway at the landing stage is shown.

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Keywords: runway, required length of the runway, landing distance, reverse, aircraft, post-landing run, coefficient of friction

1. Introduction

The pressing problem of European airfields and airfields of Ukraine consists in increasing the capacity of the airports that assumes reconstruction of airfields.

There are several ways of reconstruction:

- strengthening of the runway covering;

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- increasing the runway length;
- construction of new runways.

One of the factors that results in increasing the potential risk of aviation incidents are adverse weather conditions. Statistical data confirms that during the rainfall the number of aircraft crashes increases [1].

Landing in low visibility is perhaps one of the most "exciting" ways to operate an aircraft but is certainly the most demanding. Such progress in civil aviation was made possible by huge improvements in aircraft automatic control systems over the last 30 years coupled with stringent requirements for airfield equipment and crew qualification [2].

The complexity of the task is such that even in ideal conditions, a perfect landing is virtually impossible, while any deviation from the ideal adds to the actual landing distance.

Runway Conditions. The maximum landing mass and the landing speed depend on the runway braking conditions. If these have been inaccurately reported or if the runway is wet or contaminated when its condition was reported as being dry, the landing distance achieved will be increased. The presence of standing water, snow, slush or ice on the runway has a particularly serious effect on landing performance and if it cannot be cleared, it must be reported as accurately as possible. Special techniques must be used by pilots when landing on contaminated runways.

Weather Conditions. The maximum landing mass and landing speed is calculated based on the reported wind and temperature. Significant changes to the reported conditions will affect the landing distance achieved. Strong cross-winds, turbulence and wind shear make handling difficult and are likely to result in an increased landing distance [3].

2. Literature survey

The purpose of the given work was to research the influence of the value of coupling coefficient of aircraft chassis with the airfield covering on the value of the full path of braking under different weather conditions.

Aircraft operational performances, at landing or take-off, are strongly dependant on runway surface conditions. Bad weather conditions may severely degrade runway surface condition. For obvious safety reasons, when such events appear, methods and means must be implemented to characterize runway surface condition and to provide pilots with relevant information about how well the surface will perform [4].

In many cases, the landing distance of the aircraft defines the requirements to the runway length. The minimum landing distance is reached during landing at the minimum safety speed which would exclude stalling and provide the sufficient controllability and possibility of following the missed approach procedure. Usually, the landing speed makes up a certain share of stalling speed and the minimum evolutive speed for the aircraft landing configuration. Actually, the touchdown occurs in case of defined values of the thrust coefficient. The exact values of these dimensions depend only on the characteristics of the aircraft and don't depend on its weight, height above the sea level and wind.

To provide the minimum landing distance at a set landing speed, the forces acting on the aircraft are to provide the maximum negative speedup (slowdown) during the post-landing run. To achieve the maximum value of negative speedup, certain control actions may be required.

It is necessary to distinguish the steering procedures providing minimization of a landing distance, and usual steering of the post-landing run in the conditions of a considerable stock of the runway length. The minimum landing distance is reached due to providing the constant maximum of negative speedup, or, in other words, hard work of the braking system of the aircraft. On the other hand, the ordinary post-landing run in conditions of a considerable stock of the runway length allows intensive use of aerodynamic resistance for minimization of wear of brakes and tires. If the aerodynamic resistance is sufficient for reducing the speed of the aircraft, it can be used instead of brakes at an early stage of a post-landing run. Brakes and tires of the aircraft chassis wear out from constant intensive use while the aerodynamic resistance is available and has no wear. It is possible to use the aerodynamic resistance only for reducing the speed to 60–70% of landing. At a speed smaller than 60–70% from the landing one, the aerodynamic resistance decreases so that it becomes useless, and for further slowdown it is