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Measuring of a Nose Landing Gear Load during Take-Off and Landing

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Abstract: This article provides information about in-flight measurement of a small sport aircraft. The strain gauges were used as sensors for load monitoring on the nose landing gear structure. To obtain overall forces the calibration procedure was necessary to do. After the calculation of strain gauge coefficients the equations for calculating of total force, total force direction and individual force components were determined. During test flights the data acquisition system was installed into the aircraft. The data from strain gauges were collected together with other flight parameters like speed, altitude and data from inertial measurement unit which determine the exact movements of the aircraft before landing. The data recorded during fifty-six flights were analysed to obtain loads acting in the aircraft structure. These results were compared with calculated values.

Introduction

Generally, in-flight testing is a very important part of aircraft development. Its results are necessary for aircraft certification and helpful for further aircraft development. Landing gear is one of the most important components of the aircraft. It is used for aircraft take-off, landing, taxiing, parking and steering on the ground. Measuring of the landing gear loads during flight tests is necessary in order to verify the structural design loads, which were used for landing gear design. The same data provide useful information for landing gear fatigue analysis.

Specimen

The landing gear load was measured on a small two-seated sport aircraft with maximum take-off weight of six hundred kilograms. For purpose of measurement, the aircraft nose landing gear leg and aircraft itself were equipped with twenty strain gauges, two pressure transducers, GPS receiver, inertial measurement unit and two independent data acquisition systems. Data from this equipment were needed for description of the take-off and landing conditions as speed, height, positional angles, angular velocities and accelerations in three perpendicular directions.

Four full Watson's bridges were used to measure of nose leg ground load. Each of these bridges is composed of four active strain gauges. In order to determine the load based on the responses of strain gauge bridges, it was necessary to perform the calibration.

Calibration

Calibration means finding the relation between the measured responses of strain gauge bridges and external load. Calibration was done in test laboratory at the Brno University of Technology before the test flights program started. The result of the calibration is matrix of calibration coefficients. Only on the basis of knowledge of these calibration coefficients can be determine the force resultant magnitude and direction, which acts on the landing gear during take-off and landing.

These parameters were measured directly during test flight to determine the landing gear load:

- axial force in one section of nose landing gear leg arm structure
- two perpendicular bending moments in one section of nose landing gear leg arm structure
- torque moment in one section of nose landing gear leg arm structure
- nose wheel steering angle

After the test flights, based on measured values, matrix of calibration coefficients and the lending gear geometry, the magnitude and direction of force resultant was calculated.

Flight tests and results

Fifty-six test flights with various take-off and landing conditions were done. Some flights were performed on concrete runway and some flights on grass runaway. Landings first on the main landing gear as well as landing on three points simultaneously were performed. To achieve the maximum nose landing gear ground reaction, the mass configuration of the airplane was a maximum take of weight and forward centre of gravity position in all cases.

The results of measurement are the load spectrum for different flight techniques and conditions and especially the values of maximal magnitude of force resultant and its direction which acts on the landing gear during take-offs and landings. A typical landing spectrum of nose gear ground load is shown in Fig. 1.

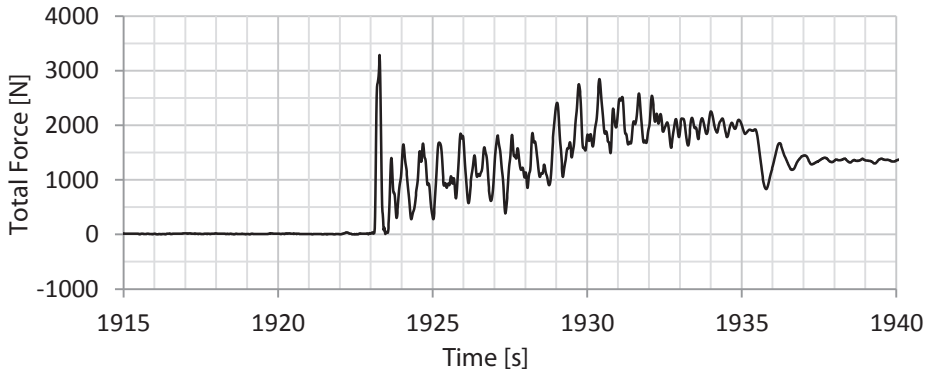

Fig. 1: Typical landing spectrum of nose gear ground load

Conclusion

As a part of in-flight measurement, characteristic spectra of light sport aircraft nose landing gear ground load were obtained. The measured data can be used to validate the methods of load calculation as well as for fatigue analysis of this type of aircraft structural components.

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