Ewa Cichocka

Summary

"Influence of gyroscopic effects on light turboprop aircraft dynamics"

The subject of my doctoral dissertation focuses on the influence of gyroscopic effects on dynamic properties of light turboprop aircraft. Gyroscopic moments are generated by the turbopropeller power units and cause coupling between longitudinal and lateral dynamics.

The main purpose of this study was to investigate the influence of the gyroscopic effects on the dynamic stability and the response of aircraft to manoeuvres following either a rapid deflection of the control surfaces or wind gust.

As a representative of the General Aviation aircraft, for which calculations were carried out, a Polish turboprop aircraft I-31T was selected. The analyses were conducted for several different mathematical models of aircraft motion. They allowed to investigate the relationship between introduced simplifying assumptions and the aircraft response, including non-linear terms in equations of motion expressing the influence of inertial coupling.

There was carried out an analysis of the sensitivity of dynamic stability versus dimensionless aerodynamic derivatives, received from different data sources. The analytical and experimental methods (measurements in the wind tunnel for the scaled model and flight test of the I-23 prototype aircraft) were employed.

The results of numerical simulations were compared to the aircraft flight tests. There were also evaluated compliance of the dynamic characteristics obtained by the use of different computational packages. A number of calculations were conducted to assess trends in dynamic stability changes due to many other flight and aircraft parameters.

It was found that the gyroscopic moments are induced mainly by the propeller and their influence on dynamic stability of a light aircraft is negligible, whereas in manoeuvring flight the gyroscopic effects should be included into analyses, although for light aircraft they are not strong. Hence there were distinguished two types of gyroscopic effects depending on disturbances of steady flight. They were divided into: weak gyroscopic effects - corresponding to classical dynamic stability and strong gyroscopic effects - corresponding to rapid manoeuvres.

Conclusions include some findings about nature of the gyroscopic effects (i.e. sensitivity of flight stability versus turboprop power unit parameters) and practical recommendations for aircraft designers dealing with new configurations of General Aviation aircraft.