STRUCTURAL DYNAMICS OF A GIROCOPTER - NUMERICAL APPROACH IN SOME EMERGENCY CASES

Adam Dacko **Łukasz Lindstedt** **Cezary Rzymkowski** **Mirosław Rodzewicz**

Warsaw University of Technology
Faculty of Power and Aeronautical Engineering
Institute of Aeronautics and Applied Mechanics
Nowowiejska 24, 00-665 Warsaw, POLAND

adam.dacko@meil.pw.edu.pl luclin@meil.pw.edu.pl czarek@meil.pw.edu.pl miro@meil.pw.edu.pl

Abstract: The goal of the study was assessment of dynamic effects of deployment of parachute rescue system for a small gyrocopter. Such extreme dynamic cases cover both direct deployment of parachute and hard landing.

Three connected areas of analysis were covered - dynamic effects of auxiliary rotor braking system, structural response of an aircraft and biomechanic effects, including possible injuries of the crew.

Both multi-body and FEM models were used. The gyrocopter Finite Element analysis (performed in MSC.NASTRAN) covered nonlinear statics, buckling and the eigenvalue extraction. Special attention was given to transient dynamic response. Nonlinear transient analysis of "hard landing" allowed for estimation of dynamic characteristics of the landing gear components, resulting in strength analysis and stiffness estimation of redesigned composite highly elastic "legs". Analysis of transient dynamic effects of sudden braking of the rotor before the main parachute deployment gave information on extent of possible blade damage. Dynamic effects of structural response of the fuselage to deployment of the main parachute were also analyzed.

Multibody analysis (run in MADYMO) covered both kinematic and dynamic global behavior of the structure in mentioned cases. Important was pilot/passenger injury risk assessment for different flight and emergency landing scenarios. The MADYMO, providing an advanced numerical model of FAA Hybrid III dummy, allows to calculate the loads affecting the human body (like forces, accelerations and deformations in different body regions) as well as a number of injury criteria (for assessment of injury risk).

Keywords: FEM, MBA, transient dynamics, nonlinearity, parachute, landing, injuries, dummy