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Streszczenie rozprawy doktorskiej

Temat pracy: **„Analiza właściwości nośnego wirnika śmigłowca z uwzględnieniem efektów aeroelastycznych"**

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Abstract:

The subject of the dissertation is an analysis of helicopter main rotor including aeroelasticity effects. It is devoted to developing and validation of new computational methods.

Modern helicopter rotor blades design requires taking into account complex aeroelastic phenomena because of their significant impact on the rotor performance and the safety of helicopter operations. Sophisticated computational fluid dynamics and structural dynamics models, available on the market, when coupled together enable such analysis with very high fidelity. However, the computational cost of this type of simulation is usually very high and for this reason it cannot be used in an interactive design process or an optimization run. Complex Fluid Structure Interaction (FSI) models are excellent tools for verification purposes, but the design process requires simpler methods with lower computational costs while maintaining relatively high accuracy and capabilities.

The presented work focuses on development of a new efficient method for calculating helicopter rotor loads, deformations and performance. It uses the well-known Navier-Stokes equations aerodynamic solver - ANSYS Fluent, and modified Virtual Blade Model (based on Blade Element Theory and actuator disk approach) for rotor flow calculation. The dedicated structural dynamics solver, based on an equivalent beam model of a blade and Finite Difference Method, was developed and coupled with the CFD solver using User Defined Functions in ANSYS Fluent software. The connection of the two reduced order models ensured high capabilities in comparison with simulation time.

The accuracy of the created module has been validated with the wind tunnel test data of an IS-2 helicopter rotor model and an UH-60A helicopter rotor, for both hover state and forward flight cases. The method was also verified based on an analysis of the hypothetical Ormiston rotor, which was developed especially for the testing of computational packages. The comparisons showed good agreement of the data in hover and low-speed cases, but also revealed new research possibilities to improve the accuracy of simplified module in high-speed forward flight cases. As part of the research a second computational module, based on explicit flow modeling around the blades, was also developed. This allowed for a more complete verification of the simplified method, identification of its usability range, and an accurate estimation of the influence of blade deformations on rotor performance.

The proposed simplified aeroelastic helicopter rotor model combines most of the advantages of using three-dimensional Navier-Stokes solver with relatively low computational costs and high accuracy, confirmed by wind tunnel tests. Therefore, it can be successfully used in helicopter rotor blades design and optimization process provided that its current limitations are respected.