Abstract

The work concerns the issues of purposeful design of critical airspeeds in composite load bearing structures of flying objects. These speeds are conditioned by the occurrence of undesirable aeroelastic phenomena resulting from the interaction of inertia forces, elastic forces and aerodynamic forces acting on the aircraft structure. As part of the work, the influence of geometric and material properties of fibrous composites on the flutter, divergence and aileron reversal speed was considered. Factors, such as material type, the number and orientation of the composite layers or fibre-to-resin ratio, determine the mechanical properties of the composite. From discussed properties, the main focus was on the stiffness properties of composite structures. As shown in the work, the critical airspeeds can be significantly modified, by these features.

The methodology undertaken in the study took into account: Identification of the quantities determining the critical airspeeds, resulting from the occurrence of aeroelastic phenomena. Theoretical and numerical considerations on the influence of geometric and material features of fibrous composites on their mechanical properties. Experimental verification of the results of these considerations based on studies of selected cases. Computer simulations with the use of a proprietary computer program, allowing to determine the influence of the discussed properties on the flutter speed, torsional divergence and aileron reverse.

The obtained results demonstrate the enormous potential of using fiber composites to increase critical flight speeds. It was shown here that not only the changes in the stiffness of the composite structure were important here, but also the fundamental importance of the anisotropic properties of the composites was demonstrated. The effects of the bending-torsional coupling resulting from these properties make it possible to shift the operational limitations related to the occurrence of aeroelastic phenomena to higher speeds. Thus, increasing the level of safety, which is invariably one of the most important factors taken into account in the aircraft design process.

The conducted works also inspire to expand the discussed issues in future research. It is indicated here that it is necessary to take into account additional factors in the design of critical flight speeds of composite airframe structures. These include: varied wing geometry, imperfections of the produced composite, post-buckling states. In addition, an issue with high application potential is the possibility of designing aircraft performance by deliberately tailoring its deformation under the influence of aerodynamic loads. This, in turn, can be achieved through the proper selection of geometric and material features of composite structures.