1. Objective of the project

The overall objective of the project is to create a computer, three-dimensional models of the laminate made of glass fiber in epoxy resin, which accurately reflects the areas and the nature of occurring damage, induced by low velocity impacts and compression after impact. Subsequently, in order to verify the correctness of the implemented assumptions, criteria and numerical algorithms it is intended to perform similar experimental studies. The low velocity impacts usually have their source in a random events, which can never be fully anticipated. The project implementation will allow to create a database of the observed damage and to make the distinction of its nature between important and irrelevant, for the work of thin-walled structures. Additionally, the observed degradations of the impacts can be divided into effects that will affect, in important or negligible extent the global behavior of structures under consideration in the nominal state of the predefined loads.

2. Research to be carried out

The realization of the project tasks assumes the low velocity impact research of thin-walled composite structures and then subjecting the analyzed plates to compression after impact. But in order to begin to the preparation of the numerical models, the elementary knowledge of material parameters, describing the behavior of the laminate on the border between the laminate layers, is essential. For this purpose the experimental tests of fundamental fracture mechanics tests, in different load modes, will be carried out. Knowing the parameters of the analyzed material, the three-dimensional computer models, which will be used in further numerical calculations, will be developed. The areas and the types of the occurring damage, determined from numerical simulations, will be compared with the actual state of degradation of the laminate. In order to accurately compare the behavior of the analyzed structures and the predicted results of numerical calculation, the author intends to use the digital image correlation technique and the ultrasonic technique. The digital image correlation system will allow to create the layered maps of the recorded displacements and deformations of the investigated structures, whereas, the non-destructive ultrasonic tests will allow to look inside the analyzed laminates and this technique will be used to create the cross-sectional images of the destruction of the analyzed composite, without the necessity of the destruction of the investigated research samples.

3. Reasons for choosing the research topic

The thin-walled composite components are currently widely used in many responsible structures, such as: airplanes, cars, helicopters blades or turbines, or even in highly efficient sports equipment. Due to the high strength properties in relation to the weight, the application of the thin-walled composite materials allows to ensure a minimum weight of the design and to optimize the geometrical and material parameters. These factors determine the ever-growing use of these materials in modern designs.

However, it should be noted that composites in contrast to steel or aluminum are significantly less resistant to accidental impacts, among which the most dangerous are those which are not visible from the outside and cause the internal damage. This failure of the material could lead to a significant reduction in the mechanical properties of the composite structure. Therefore, from the point of view of safety design an important issue is the ability to determine the influence of such an impacts on the behavior of the entire structure.

Although the proposed studies have mainly cognitive character, understanding of the degradation process of composite structures - the initiation and the propagation of the damage in a complex states of the stresses is important in terms of the defects tolerance issues in composite structures.