Human activity in engineering is dated back to antiquity. The achievements in this field of science directly contributed to the immensely far-reaching civilizational development. Nowadays, the expansion of technology is focused on advanced solutions in the aspect of designing structures with a view to enhance their broadly defined properties. It is based on achieving the necessary load-carrying ability and the finest functionality, taking into consideration economical aspects. Such approach led to the development of thin-walled structures, characterized by relatively low mass and significant load-carrying ability, while shaped properly.

Shells, as thin-walled structural elements occupy an exceptional position in engineering, in particular in mechanics, civil engineering, marine engineering, architecture, aeronautics. Examples of such structures in the mentioned technical areas are roofs, pipes, liquid tanks, pressure vessels, silos, aircrafts, spaceships and submersible vehicles. The numerous applications of shell structures resulted in creation of many extremely valuable monographs and articles. Currently, the state of knowledge contained in the literature enables to specify the state of stress and strain in any arbitrary shell structure. However, the possibility of obtaining a solution depends on the geometry of the structure. The stress distribution can be determined when the principal radii of curvature are constant, which pertains, among other shapes, cylindrical and spherical shells, characterised by simple shape.

It follows from general reasoning that choosing any shape from among all possible, will result in obtaining a solution that is far from satisfactory. The inability to solve the problem for complex shapes implies to limit the analysis to the simple geometrical forms. Achieving a numerical solution with a use of the finite element method is possible for any shape. However, the method leads to the problem concerned with the description of the geometrical model of the structure as well as performing optimization process.

The aim of the following project is the analysis and optimization of the stress distribution in complex, axisymmetric shell structures loaded with pressure. Implementation of the Ritz method, resulting from the principle of stationary total potential energy of the system, will enable to present a possibility of obtaining the solution for selected complex shapes, considering bending and shear forces. The proposed approach, will explain how the shape of shell structures influences the bending effect. Further, parametric model describing the geometry of a component of pressure vessel will be developed. As a result of utilization of Matlab and Ansys software, the geometrical model will undergo an optimization process with a use of the genetic algorithm. Finally, the result obtained during the optimization will be verified in an experimental test, along with other models. Due to the overwhelming costs of manufacturing process using conventional methods, the shells will be manufactured using additive manufacturing. After developing the laboratory stand, the models will be tested with strain gauges. The obtained result will enable to compare the stress distribution in the optimized shell with the shell made of plastic.

The calculations carried out within the framework of existing theories, using the Ritz method will allow drawing important conclusions on the stress distribution in complex shell structures. This will enable to supplement knowledge in the concerned field of science. The research carried out within the project will prove that the appropriate shape of the shell structures leads to a significantly more favorable stress distribution. The acquired knowledge will allow to achieve much better results in the design process.