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APPLICATION OF MODERN MEANS OF COMPUTER SIMULATION IN THE DEVELOPMENT OF TECHNOLOGY MANUFACTURING FUEL TANK FLANGE OF CARBON FIBER

The article is devoted to the use of modern computer modeling tools in the development of the manufacturing technology of composite products using the example of creating a flange of a fuel tank for cryogenic components from carbon fiber. The results of numerical simulation of the process of laying out and shaping the geometry of the carbon fiber flange are given. Presents conclusions on the work done and an assessment of the results. [dx.doi.org/10.29010/085.5]

Keywords: *carbon fiber; fuel tank; modeling of the laying process; composite manufacturing technology.*

Introduction

One of the main features of composite materials [1] is that the material is obtained together with the design, and all its properties are formed and stabilized during the manufacture of the part. That is why for parts from composite materials – materials, design and technology are an integral part of each other. Therefore, an important step in creating products from composite material is the development of the production process.

Problem Formulation

When creating a carbon fiber flange, the technology was developed in a rigid form. The materials used are prepregs based on high-strength carbon fabric and epoxy resin. Considering the high complexity of the flange geometry and the large number of layers to be stacked, in the process of preparing the production, computer simulation was used for most of the working operations, which reduced the labor intensity, the amount of carbon utilization waste and the possibility to improve the quality of the material after its polymerization.

Model Formation

A numerical model for stacking fabric prepregs with regard to the reinforcement scheme and the layout scheme was created using the CATIA software package and the Composites Design module. In the process of creating a model, a three-dimensional model of the fuel tank flange is initially imported (Fig. 1), and its surfaces are transformed into mating surfaces and display fields, taking into account the formation of process zones (Fig. 2).

The next stage of the process simulation is an indication of the type of material in which all the technological parameters of the fabric are specified, and the

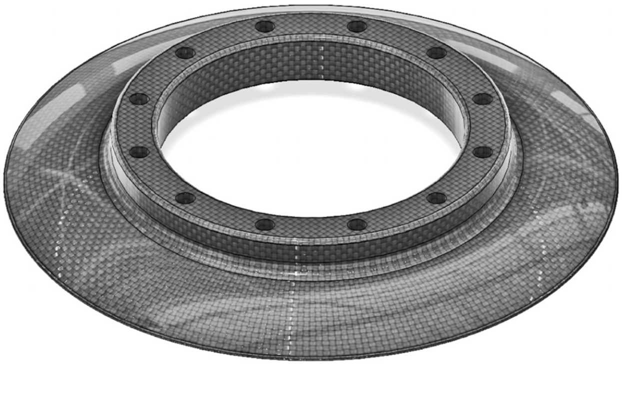

Fig. 1. 3D model of the fuel tank flange

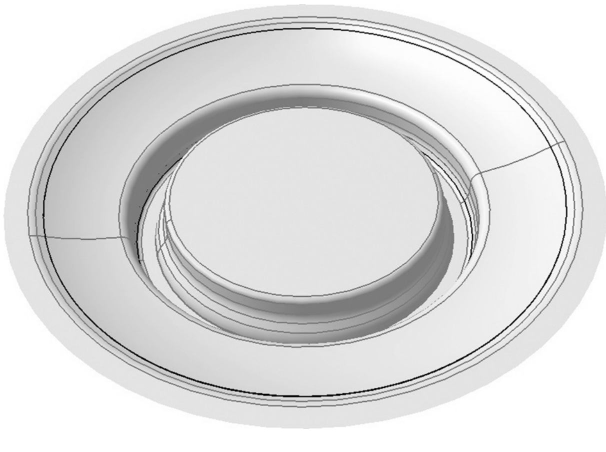

Fig. 2. Formed display field

Fig. 3. The process of laying the first and last layer in the module Composites Grid Design

starting point for calculating each layer is determined. To ensure satisfactory drapeability of the fabric and prevent folds of the individual layers, the trajectory and size of the technological cutouts are noted. Layer by layer, the layout of the part is modeled to form separate groups of layers to simplify the thickness setting process. At the end of the formation of the flange blank geometry, the resulting numerical model is rechecked (Fig. 3). In the process of performing the final analysis, clearly identifiable intermodal solutions and unacceptable package deformations, alternation of laying layers and directions of local coordinate systems. It should be noted that the correct choice of the starting point of the calculation most influences the correctness of the formation of the geometry, in particular, the power part of the flange of the flange.

As a result of the modeling process, a graphical representation of a composite package consisting of 74 layers was obtained. In the initial approximation, the gain scheme $[0/45/90/-45]_n$, was chosen, which was eventually adopted. In general, the composite package is divided into three groups, the first of which is full face layers, the second – the formation layers of the collar (skirt) of the flange and the third – the formation of the feather of the flange (Fig. 4).

Stacking management ? ×

Entity Level: Plies Group / Sequence / Ply / Cut Piece — Display: Columns... — Filters: Rows... ON OFF — Review — Check Contours: 3D Contours Full Check

	Plies Group	Sequence	Ply/Core	Material ID	Orientation Name	Rosette	Surface	Draping	3D Contour
1	Plies Group.2	Sequence.1	Core.1	S1454_G803	0	Rosette.1	NA	NA	NA
2	Plies Group.2	Sequence.1	Ply.1	S1454_G803	45	Rosette.1	Объединение.1	OK	OK
3	Plies Group.1	Sequence.1	Core.1	S1454_G803	90	Rosette.2	NA	NA	NA
4	Plies Group.1	Sequence.2	Ply.1	S1454_G803	-45	Rosette.2	Объединение.1	OK	OK
5	Plies Group.1	Sequence.1	Core.1	S1454_G803	0	Rosette.2	NA	NA	NA
6	Plies Group.1	Sequence.3	Ply.1	S1454_G803	45	Rosette.2	Объединение.1	OK	OK
7	Plies Group.1	Sequence.1	Core.1	S1454_G803	90	Rosette.2	NA	NA	NA
8	Plies Group.1	Sequence.4	Ply.1	S1454_G803	-45	Rosette.2	Объединение.1	OK	OK
9	Plies Group.1	Sequence.1	Core.1	S1454_G803	0	Rosette.2	NA	NA	NA
10	Plies Group.1	Sequence.5	Ply.1	S1454_G803	45	Rosette.2	Объединение.1	OK	OK
11	Plies Group.1	Sequence.1	Core.1	S1454_G803	90	Rosette.2	NA	NA	NA
12	Plies Group.1	Sequence.6	Ply.1	S1454_G803	-45	Rosette.2	Объединение.1	OK	OK
13	Plies Group.1	Sequence.1	Core.1	S1454_G803	0	Rosette.2	NA	NA	NA
14	Plies Group.1	Sequence.7	Ply.1	S1454_G803	45	Rosette.2	Объединение.1	OK	OK
15	Plies Group.1	Sequence.1	Core.1	S1454_G803	90	Rosette.2	NA	NA	NA
16	Plies Group.1	Sequence.8	Ply.1	S1454_G803	-45	Rosette.2	Объединение.1	OK	OK
17	Plies Group.1	Sequence.9	Core.2	S1454_G803	0	Rosette.2	NA	NA	NA
18	Plies Group.1	Sequence.9	Ply.2	S1454_G803	45	Rosette.2	Объединение.1	OK	OK
19	Plies Group.1	Sequence.10	Core.3	S1454_G803	90	Rosette.2	NA	NA	NA
20	Plies Group.1	Sequence.10	Ply.3	S1454_G803	-45	Rosette.2	Объединение.1	OK	OK
21	Plies Group.1	Sequence.11	Core.4	S1454_G803	0	Rosette.2	NA	NA	NA
22	Plies Group.1	Sequence.11	Ply.4	S1454_G803	45	Rosette.2	Объединение.1	OK	OK
23	Plies Group.1	Sequence.12	Core.5	S1454_G803	90	Rosette.2	NA	NA	NA
24	Plies Group.1	Sequence.12	Ply.5	S1454_G803	-45	Rosette.2	Объединение.1	OK	OK
25	Plies Group.1	Sequence.13	Core.6	S1454_G803	0	Rosette.2	NA	NA	NA
26	Plies Group.1	Sequence.13	Ply.6	S1454_G803	45	Rosette.2	Объединение.1	OK	OK
27	Plies Group.1	Sequence.14	Core.7	S1454_G803	90	Rosette.2	NA	NA	NA

Entity Preview

OK Отмена

Fig. 4. Built-in control and layout control module

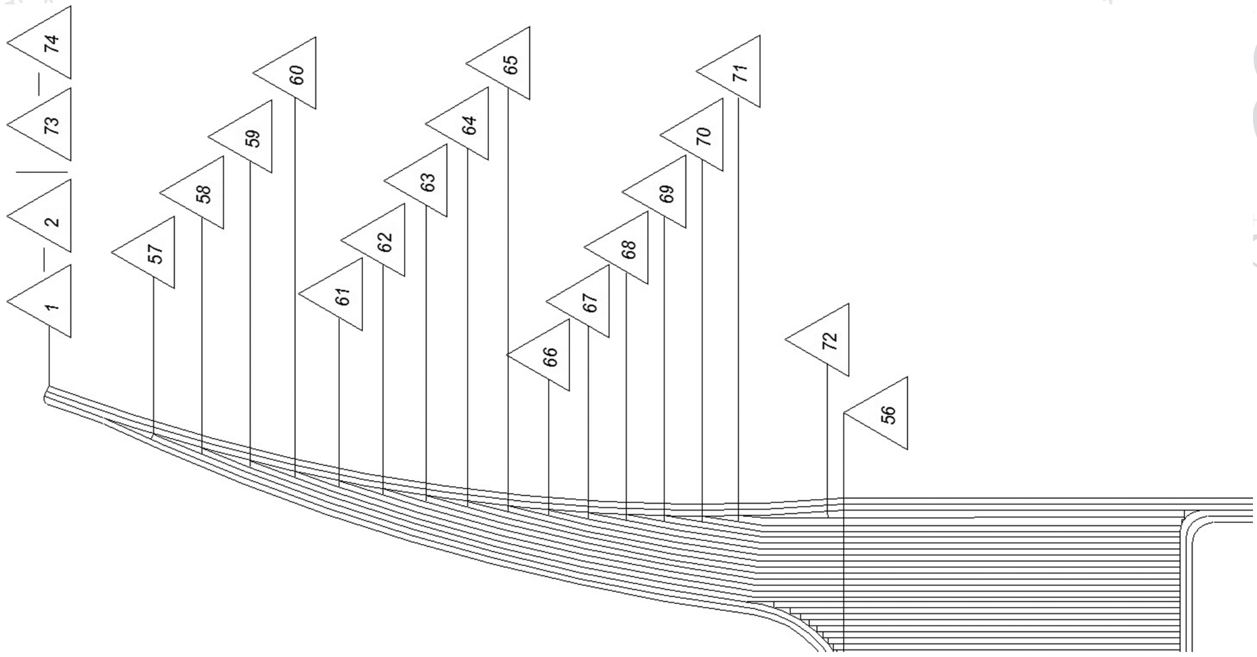

Fig. 5. The result of an automated process of combining blanks

As a result, for the execution of cutting and correct installation with compliance with reinforcement schemes, a set of technological documentation is provided, including the technological process, cutting cards and an album of parts display. If during the development of the technological process and determining the sequence of calculations according to the obtained model of complexity, then in the creation of cutting and combining maps of all the layers to make the pattern. Especially if, in one technological cycle, preparing and cutting prepreg packages into several parts.

To perform the contour generation for the pattern, the Autodesk 360 Fusion CAM module was used. All necessary geometrical parameters of each layer are easily imported from CATIA software. Significantly facilitated the process of combining and labeling the elements is the fact that the flange is geometrically a body of rotation, simplifying the geometry of the blanks to the disks and rings.

The result of the automated process of combining blanks (Fig. 5), in cases of mass production, is transmitted to a split CNC machine, and for individual parts, cutting templates are prepared. The developed set of technological documentation is used to implement and control the process of laying a package of parts on the equipment.

In confirmation of the work done, the process of manufacturing a preform from a carbon fiber flange was carried out by molding into a rigid form. To avoid the occurrence of non-impregnation zones, inconsistency of the molding of parts, a polymerization mode has been developed, taking into account both the complex shape and the total heat capacity of the parts and molds. After polymerization and cooling, the workpiece is pressed out and subjected to mechanical processing, which exists in the drilling of mounting holes and removal of technological allowances (Fig. 6).

Conclusions

The task of creating carbon fiber parts with a complex geometry is much easier using computer modeling tools. The use of modern software systems Catia and Autodesk 360 Fusion can effectively develop technologies for the production of complex composite parts. They also allow the design process to predict the behavior of the material when planning the implementation of technical approaches and

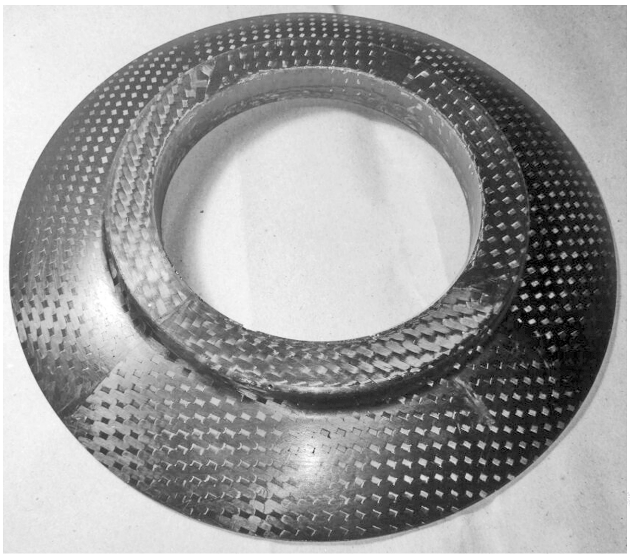

Fig. 6. Manufactured carbon fiber fuel tank flange

results, which significantly improves the quality and reduces the possible number of structural defects and rejection of parts.

References

[1] Gagauz P.M., Gagauz F.M., Karpov Ya.S., Krivenda S.P. Design and construction of products from composite materials. Theory and practice: textbook / P.M.Gagauz, F.M.Gagauz, Ya.S.Karpov, S.P.Krivenda; General ed. Ya.S.Karpova – X.: National Aerospace. University . Kharkiv Aviation Institute, 2015 – 672 p.

[2] https://support.ansys.com/staticassets/ANSYS/Conference/PalmBeach/downloads/IntegratedDesignandAnalysisofCompositeStructures/

[3] http://fusion-360.ru/

УДК 620.22:004.4

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ПРИМЕНЕНИЕ СОВРЕМЕННЫХ СРЕДСВ КОМПЬЮТЕРНОГО МОДЕЛИРОВАНИЯ ПРИ РАЗРАБОТКЕ ТЕХНОЛОГИИ ИЗГОТОВЛЕНИИ ФЛАНЦА ТОПЛИВНОГО БАКА ИЗ УГЛЕПЛАСТИКА

Статья посвящена применению современных средств компьютерного моделирования при разработке технологии изготовления изделий из ПКМ на примере создания фланца топливного бака для криогенных компонентов топлива из углепластика. Приведены результаты численного моделирования процесса выкладки и формообразования геометрии фланца из углепластика. Представлены выводы по проделанной работе и оценка полученных результатов. [dx.doi.org/10.29010/085.5]

Ключевые слова: *углепластик; топливный бак; моделирования процесса выкладки; технология изготовления ПКМ.*

Литература

[1] Гагауз П.М., Гагауз Ф.М., Карпов Я.С., Кривенда С.П. Проектирование и конструирование изделий из композиционных материалов. Теория и практика: учебник / П.М.Гагауз, Ф.М.Гагауз, Я.С.Карпов, С.П.Кривенда; под.общ.ред. Я.С.Карпова – Х.: Нац. аэрокосм. ун-т им. Н.Е.Жуковского, 2015 – 672 с.

[2] https://support.ansys.com/staticassets/ANSYS/Conference/PalmBeach/downloads/IntegratedDesignandAnalysisofCompositeStructures/

[3] http://fusion-360.ru/