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Development of CAD Structure for Design of Aerostatic Complex

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Abstract

To solve the problem of AC aerodynamically shaped envelope design the integrated system of design was developed that allows minimizing human involvement in routine operations of modeling and calculation of design parameters.

Keywords: CAD, CAE, system structure, aerostatic complexes.

1. Introduction

None of modern engineering industries can deal with daily usage of CAD/CAE systems. Airship industry is not an exception as it is on the threshold of innovative technologies. Nevertheless this industry is not a well-developed branch if we consider usage of specialized CAD/CAE systems [Melnyk et al., 2013, Husynin, 2010].

2. Structure of the system of through designing

Aerostatic complex (AC) is a transportation system the effect of which is based on a combination of Archimedean properties and reactive strength [Brusov et al., 1989, Piyavskiy et al., 1974]. The main purpose of design of AC is a reduction of cost and simplification of cargo delivery.
Design of such AC consists of three main components [Raymar, 2002]:

- aerodynamically shaped envelope;
- engine;
- on-board equipment.

Absence of at least one of the components makes the process of design incomplete. The end-to-end engineering/designing systems for AC design are a three-component structure, each element of which is mandatory one and each is a separate system of the integrated design. Accordingly to this a design is carried out consistently within the system.

Taking into consideration the purpose of a device the basic and crucial requirement for AC is a toughness and reliability of the aerodynamically shaped envelope with a minimal impact on its target quality. Therefore a design of the complex generally begins from design of aerodynamically shaped envelope. Only after the designed envelope meets all the requirements of sturdiness, reliability and economy, design of power systems and on-board equipment starts.

3. Integrated designing system as part of an end-to-end engineering/designing system

Integrated system of envelope design is very crucial in the design of AC. It determines the main characteristics of the designed complex.
To achieve the constructive requirements the design is carried out in the cycle. An exit from design flow occurs when efficiency requirements set at the beginning of design process or by a designer if these requirements are not met.
Design of an envelope is carried out in accordance with the classical scheme.
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To achieve the constructive requirements the design is carried out in the cycle. An exit from design flow occurs when efficiency requirements set at the beginning of design process or by a designer if these requirements are not met.
Design of a envelope is carried out in accordance with the classical scheme:

- geometry analysis;
- framework synthesis;
- evaluation of results.

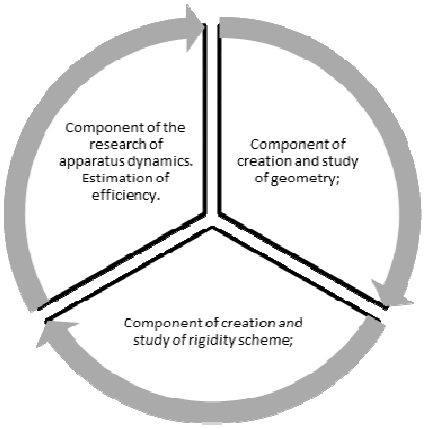

Fig. 1. Structure of the system of AC integrated design

Based on the proposed structure presented in Fig. 1 it was designed an architecture of integrated software system for design of the aerodynamically shaped envelope, which is directly derived from the structure of the system.
Component of development and study of geometry is represented by the following blocks:

- development of geometrical models;
- aerodynamic modelling;
- separation of stress places.

Component of development and study of rigidity scheme consists of the following blocks:

- synthesis of rigidity scheme;
- placement of aerodynamic profiles.

Component of development of system dynamics is implemented in the following blocks:

- determination of mass-dimensional characteristics;
- determination of the dynamic characteristics.

Each block of architecture is a small subroutine implemented by a set of multiple functions. Access to the results of the unit is granted only to a block which needs them for further work.

4. An Application that Implements an Integrated System of Hull Designing

An application for a aerodynamically shaped envelope design is based on the graphics core of SolidWorks using functions of SolidWorks API.
Three dimensional geometrical model of the envelope of the projected system is formed out automatically by the designer (Fig. 2) using one of the components of the software module for analysis of aerodynamic characteristics.

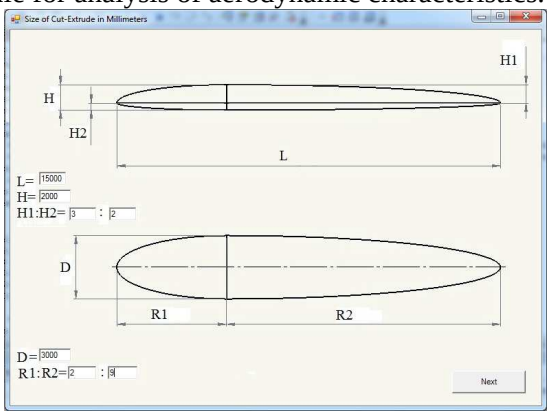

Fig. 2. Entering the main parameters of dirigible envelope

During the study the investigated parameters are: values of pressure, ie the pressure on the outside of the envelope. For this length of the studied model is automatically divided into sections depending on the specific curvature of the envelope at this point. At the ends of the segments are placed planes with reference geometry in the form of models incisions (Fig. 3).
The obtained values of pressure (Fig. 4) along the length of each incision and geometry of this incision serve as inputs for constructing the cross stiffness element (frames). Design of frames is carried out automatically by appropriated software modules (Fig. 5).

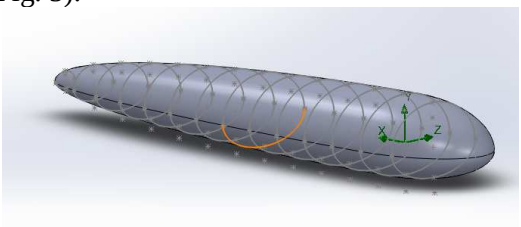

Fig. 3. Model with reference geometry

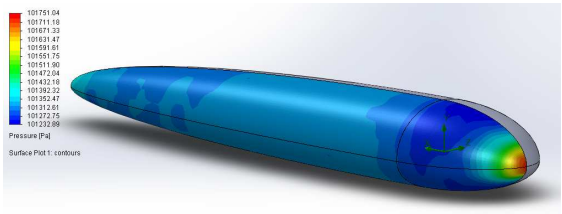

Fig. 4. The analysis of aerodynamic characteristics

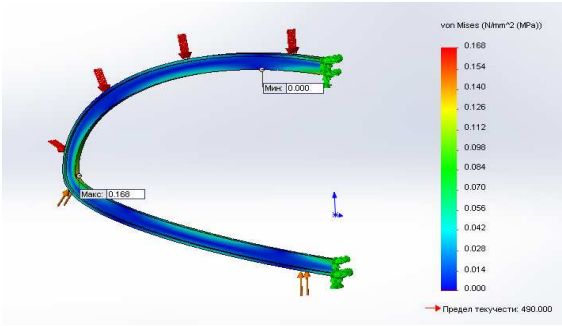

Fig. 5. Designing of frames

All generated structural elements are automatically assembled into a single model (Fig. 6). The mass of the resulting model and its geometrical characteristics appear as the main purpose of all routines. These parameters allow processing of design to proceed to the next stage.

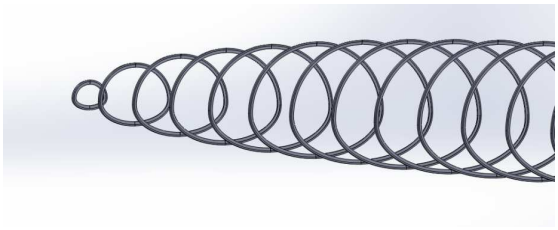

Fig. 6. Frame model

5. Conclusions

Problem of AC aerodynamically shaped envelope design lays in finding of a compromise between its high durability, reliability, compactness, maneuverability, weight, and capacity [Piyavskiy et al., 1974]. To solve the problem the integrated system of design was developed that allows minimizing human involvement in routine operations of modeling and calculation of design parameters.
Block structure of the system allows simplifying its development and maintenance, because in a case of necessity any block can be modified separately or replaced without making changes in the system as a whole entity.

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