POSSIBILITIES OF PROGRAM SOLIDWORKS SIMULATIION AT AN ESTIMATION OF SAFE PROPERTIES OF BUMPERS

ВОЗМОЖНОСТИ ПРОГРАММЫ SOLIDWORKS SIMULATION ПРИ ОЦЕНКЕ БЕЗОПАСНЫХ СВОЙСТВ БАМПЕРОВ

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Abstract: *Collisions of vehicles are the most mass kind of road and transport incidents agree statisticians in the Russian Federation. The bumper is the first element of a design of the car which co-operates with an obstacle. Bumpers are supposed to keep damage away from safety-related equipment such as headlights and taillights and protect vehicle parts such as hoods, fenders, and exhaust and cooling systems that are expensive to repair. When bumpers are poorly designed, these car body parts sustain most of the damage in parking-lot collisions and other low-speed impacts. Modern development of a science and the computer techniques is capable at a preliminary stage to replace expensive tests now. Engineers can reach considerable successes in the decision of challenges thanks to application CAD/CAE of technologies. The work purpose is revealing of zones of pressure concentration and specification of boundary values of speeds at bumper test.*

***KEYWORDS**: CRASH SIMULATION, ENERGY ABSORPTION, FINITE ELEMENT ANALYSIS, SOLIDWORKS SIMULATION*

1. Introduction

Cars began to represent potential danger to associates and participants of movement practically from the moment of the creation. It is not obviously possible to avoid road and transport incidents completely. Therefore the car is improved in a direction of decrease in probability of failure and minimisation of its consequences. Means of passive safety represent the big interest now. Protection as driver and passengers, and cars from damages by means of external elements of a design is especially important. Bumper application provides it. The bumper is the device of the car in the form of a bar, which is located in front (often and behind) and guarantees certain safety to the driver and passengers. Protection of a body of the car against damages is one of the primary goals of a bumper. Definition of its safe characteristics is the important problem.

Modern development of a science and computer technics considerably facilitates work of the engineer. So, use of methods of mathematical modelling (in particular, a method of final elements) allows simplifying the decision of challenges to save time and money. Methods of mathematical modelling of blow are capable to replace methods of experimental researches. The role of these methods has sharply increased in connection with progress in the field of creation of computer facilities and the corresponding software. Now the method of final elements is the standard at the decision of problems of mechanics of a firm body by means of numerical algorithms. World motorcar giants have the most powerful computer means for addition of natural experiments with virtual tests. These programs allow lowering expenses for carrying out of a large quantity of tests both separate knots of the car, and the car as a whole. Manufacturers use following settlement systems for carrying out of virtual tests: *ANSYS*, *LS-DYNA*, *Abaqus*, *PAM-Crash* (*ESI Group*) and others. All of them are based on application of methods of final elements [2].

The purpose of the present report is definition of zones of a bumper which test considerable loadings, by means of use of program SolidWorks Simulation.

2. Preconditions and means for resolving the problem

In 1993, SolidWorks founder Jon Hirschtick recruited a team of engineers with the explicit purpose of making 3D CAD technology more accessible. They did it by developing the first 3D CAD technology that ran on the Windows platform and didn't require expensive hardware and software to operate. 1995 marked the first release of SolidWorks® software. Within two months, it was winning accolades for ease-of-use, allowing more engineers than ever before to take advantage of 3D CAD in bringing their product designs to life. Today, DS SolidWorks offers a complete toolset to create, simulate, publish, and manage data, maximizing the innovation and productivity of engineering resources. All of these solutions work together to allow organizations to design products better, faster, and more cost-effectively. The SolidWorks focus on ease-of-use allows more engineers, designers and other technology professionals than ever before to take advantage of 3D in bringing their designs to life.

SolidWorks offers a suite of simulation packages that let you set up a virtual real-world environment to test your product designs. Test against a broad range of parameters throughout the design process—like durability, dynamic response, heat and pressure, even fluid dynamics—to evaluate performance and make decisions to improve product quality and safety. Simulation lowers cost and speeds time to market by reducing the number of physical prototypes you need before going into production.

SolidWorks SimulationXpress is a first-pass analysis tool that comes with every SolidWorks Standard and Professional software packages, giving the ability to do basic stress analysis on individual parts.

SolidWorks Flow Simulation takes the complexity out of computational fluid dynamics. Can quickly and easily simulate fluid flow, heat transfer, and fluid forces that are critical to the success of design. Simulate liquid and gas flow in real world conditions, run "what if" scenarios, and quickly analyze the effects of fluid flow, heat transfer, and related forces on immersed or surrounding components. Design variations can be compared to make better decisions, resulting in products with superior performance. Specific modules simplify the specialized analysis of HVAC and electronic cooling.

Included with the SolidWorks Premium 3D CAD design package, SolidWorks Simulation provides core simulation tools to test designs and make the decisions to improve quality. The full integration creates a short learning curve and eliminates the redundant tasks required with traditional analysis tools. Component materials, connections, and relationships defined during design development are fully understood for simulation. Products can be tested for strength and safety, and the kinematics fully analyzed. Further, a wide variety of geometry types are supported so you can simulate the real world performance of solid, thin-walled, and structural features [3].

The estimation of reliability of a bumper design is made by test. This test represents imitation of the car collisions with a rigid barrier. We use program Solid Simulation for virtual creation of test.

Base variant of a universal bumper of the car is the model which was offered by scientists from Belgium [1]. The bumper geometry has been taken from an industrial design practice with a mesh density that is both acceptable for the predictions of an interest and also feasible in terms of computational effort. The geometry consists of a constant cross section made of 2 chambers where all corners and fillets are removed, in order to avoid small elements during the meshing process. Subsequently, an assembly is made to connect the bumper, the longitudinal beams through brackets. Rigid connections are used to connect the brackets to the longitudinal beams. The given assemblage is constructed with use of program SolidWorks (figure 1). General parameters of assembly are shown in figure 2 (values of the sizes are resulted in metres). The profile length of the amplifier of a bumper makes 175 mm, the thickness of a wall of the first section makes 2,895 mm, the second section - 2,446 mm (figure 3).

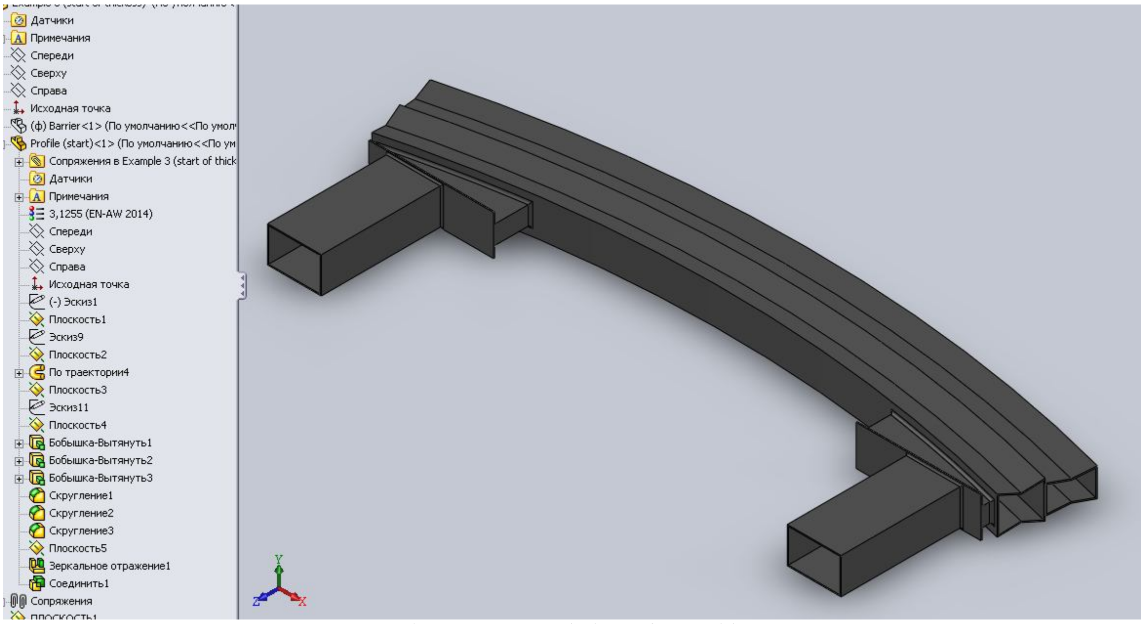

Figure 1 - General view of assembly

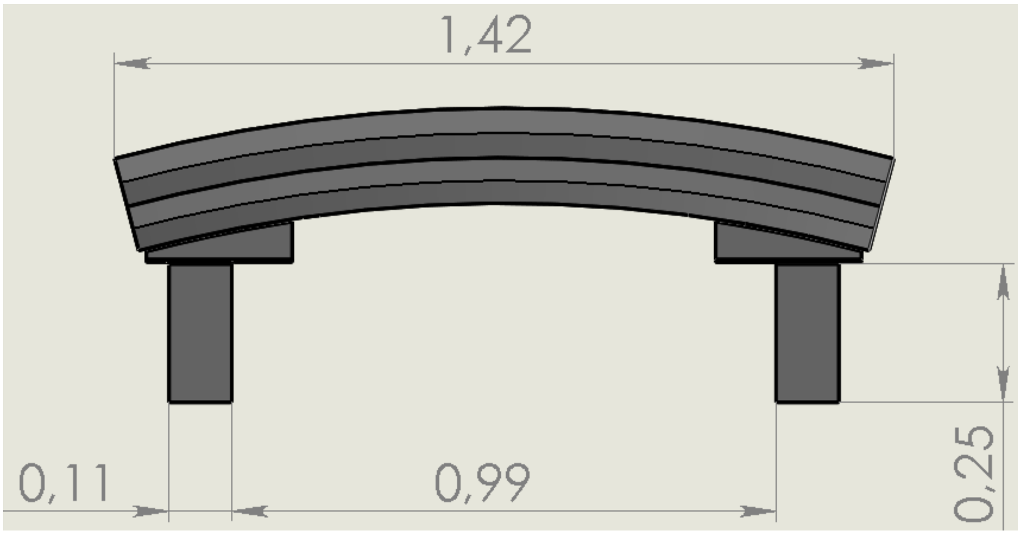

Figure 2 - The top view of system of a bumper

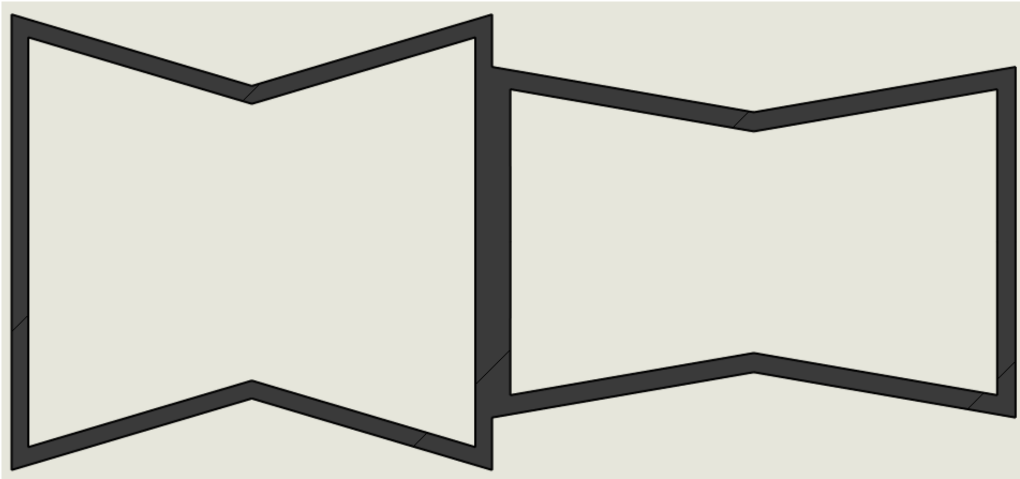

Figure 3 - General view of a profile of the amplifier:
first section - on the right; second section – at the left

3. The decision of a considered problem

Program SolidWorks possesses the big library of materials in which there are also data about their properties. The material of bumper system is aluminium, a barrier - a steel. The weight of a bumper makes 10,6 kg, weight of a barrier - 1166,4 kg.
Modelling of collision of a bumper with a motionless obstacle (a rigid barrier) is definition of characteristic zones of object. These areas test considerable is intense-deformation loadings. It is important to reveal these zones to define their influence on a design as a whole. The model of collision of system of a bumper with a rigid barrier with the grid put on objects is represented in figure 4. In this drawing by arrows directions of vectors of speed and acceleration of free falling are shown. Overlapping between model and an obstacle makes 100 %. Contact is simulated without penetration between co-operating objects at blow. Speeds of collision of a bumper with a barrier belong to a range of 0-120 km/h. The majority of cars is maintained in this interval of speeds.

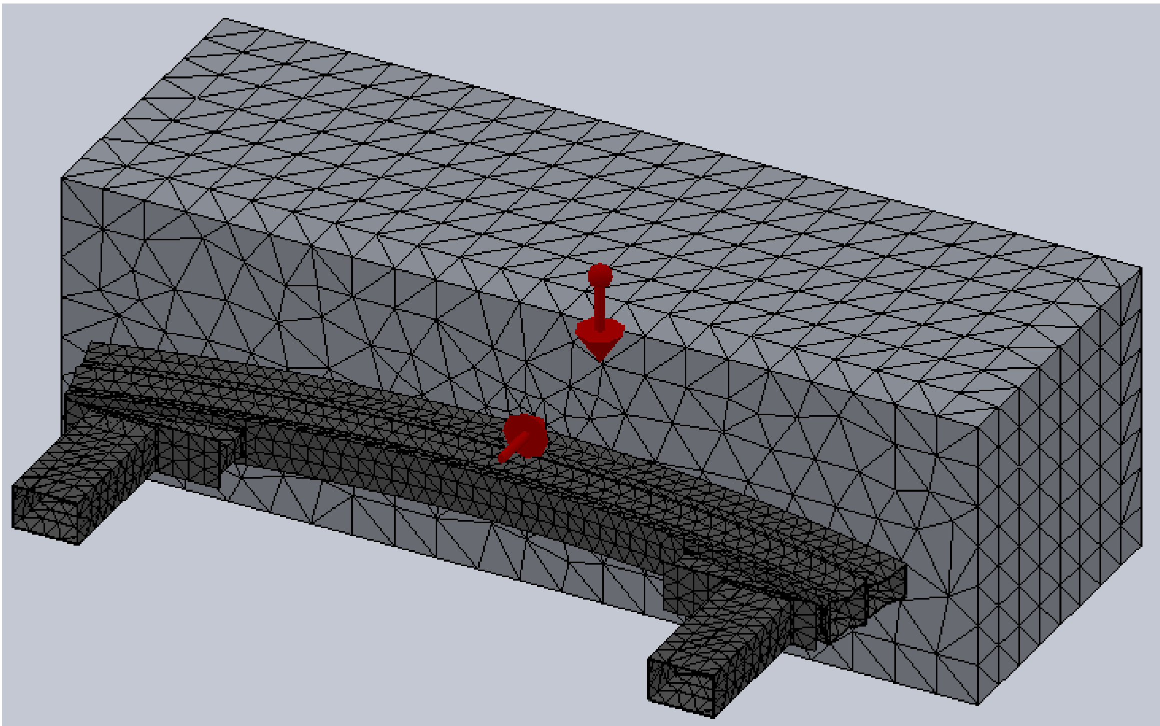

Figure 4 - View of assembly with the grid put on objects

The size of final elements has been picked up by the program automatically from a reason of an optimum choice between accuracy and decision time. The size of a final element of a barrier has made 0,075764 m, bumper systems - 0,0378822 m. The resulted assemblage consists of 33834 elements and 32005 knots.

4. Results and discussion

Results of the intense-deformed condition of assemblage are 3 critical zones:

zone a - area directly in a contact place;
zone b - extreme areas of the amplifier of a bumper;
zone c - a deviation of the ends of longitudinal beams.

These zones are especially brightly expressed on the epure the equivalent deformations, represented on figure 5.Grey colour notes an arrangement of objects before interaction in this figure. Speed made 112 km/h at the moment of blow. The maximum equivalent pressure on von Mises reaches values 407279456 N/m^2 which corresponds to value of speed in 16 km/h. Energy of blow is equivalent 104,69 J.

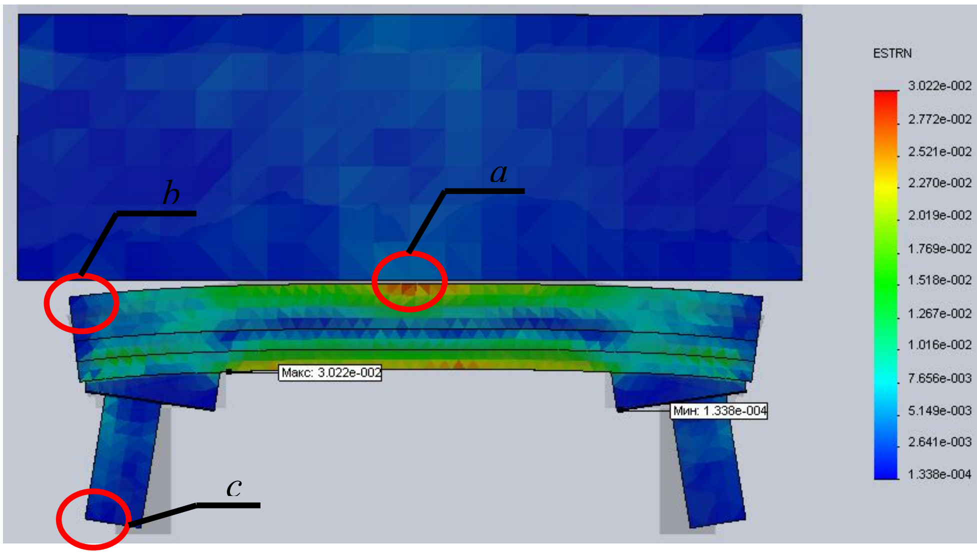

Figure 5 - View of the equivalent deformations epure

The given value of pressure exceeds limiting value - a limit of fluidity of a material. Distribution of equivalent pressure is shown in figure 6. This critical value is reached in a zone of connection of an arm with the second section of the amplifier of a bumper. Equivalent pressure reach values 24,416*10^7 N/m^2 in a zone of direct collision. Besides program SolidWorks allows to define change of movings, speeds, accelerations of the chosen areas of a design. These data it represents in the form of schedules.

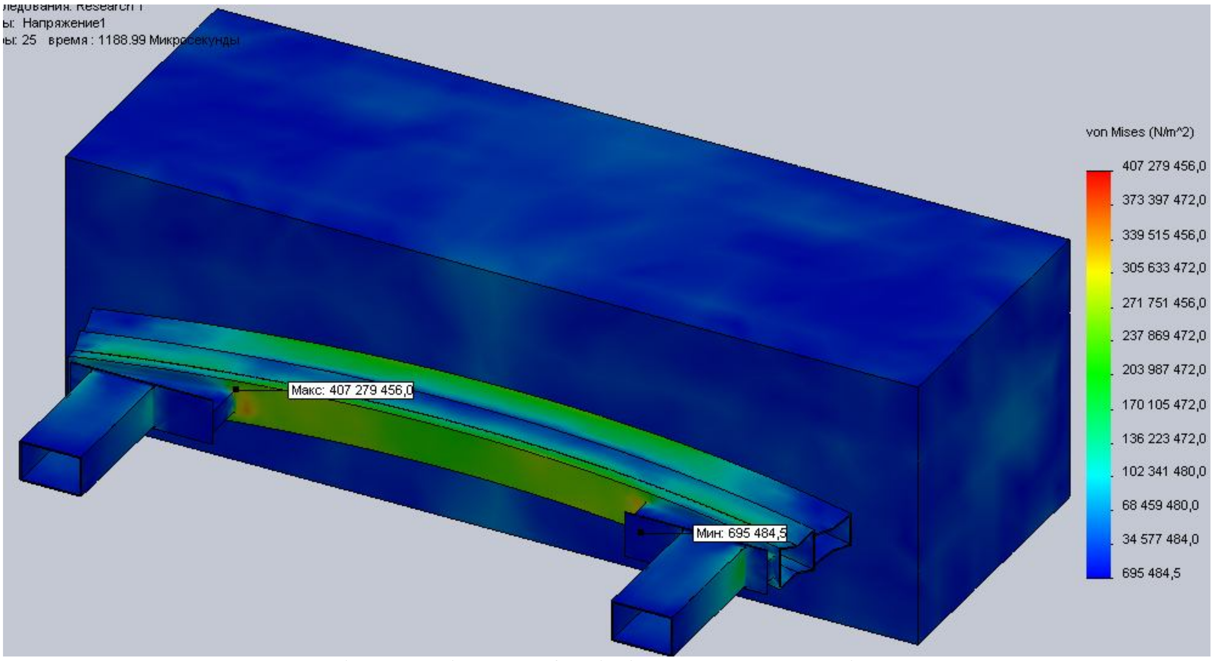

Figure 6 – The epure of equivalent pressure on von Mises

5. *The conclusion*

The received results prove, that the further researches of system of a bumper (collision with a barrier) are necessary for spending in a range of speeds to 16 km/h. It is necessary to consider also influence of inertial loadings which are transferred by the car to a bumper.

6. *The literature*

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