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OPTIMIZATION OF THE STEERING BIPOD OF THE VEHICLE

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Abstract: conducted calculations of one of the most loaded parts of steering - bipod. The finite element method that is the basis of SolidWorks Simulation software is applied. Optimization of the bipod construction led to a decrease of its weight by 19.6% without deterioration of the strength parameters.

Keywords: SolidWorks Simulation, engineering analysis, finite element method, modeling, optimization.

The steering of the car is a unit responsible for the safety of everyone in the cabin. Therefore, its malfunctions are often the cause of serious accidents, which can affect other road users. Therefore, the driver should always respond to the smallest changes in the operation of the mechanisms of the machine: if the steering fails, the reaction must be immediate.

One of the busiest steering parts is a bipod. It is fixed at one end to the outer end of the steering shaft. Fastening is carried out on conical slots by means of a nut. For the correct installation of the bipod when assembling on the shaft make special labels or double slots. It provides the opportunity to mount the bipod on the shaft in only one position.

The main types of tension bipod - bending and torsion (it transmits torque from the steering mechanism to the steering trapezoid). Therefore, its calculation is a complex resistance, and the slots – the cut (the force taken on the steering bipod – 2436 N). Due to the complex geometry of the bipod, it is almost impossible to calculate the complex resistance.

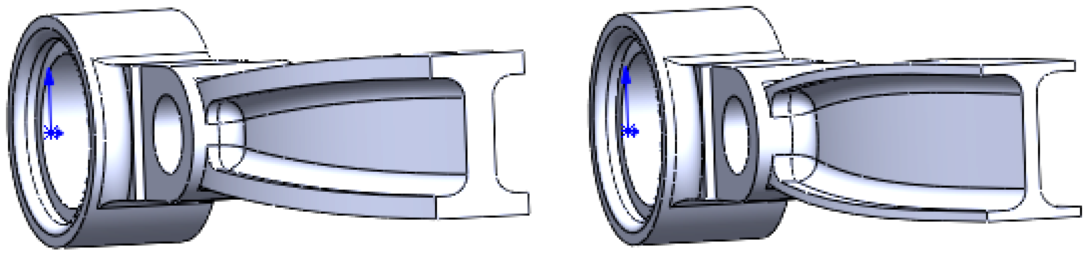
One of the methods that can be used to solve a given problem complexly is the finite element method (FEM). It is one of the most common numerical methods for calculating constructions.

The popularity of FEM is explained by the successful combination of a relatively simple algorithm with the possibility of applying it to the calculation of arbitrary complexity systems. A significant advantage of the method is the efficiency of the software created on the FEM algorithms [2].

One of the products underpinning FEM is SolidWorks Simulation - a powerful and easy-to-use software package for engineering calculations (specifying material properties, mounting, loading, model analysis, and reviewing results for any detail). At the end of the stage, the information is automatically stored and appears in the study tree. It remains available until the application is closed and restarted without the details document being closed.

SolidWorks Simulation includes many specialized solutions. They allow the analysis of most possible tasks for details and assemblies: linear static analysis; determining their own forms and frequencies; calculation of critical forces and forms of loss of stability; thermal analysis; joint thermostatic analysis; calculation of assemblies using contact elements; nonlinear calculations; design optimization; calculation of electromagnetic problems; determination of the durability of the structure; calculation of the flow of liquids and gases.

The objective of the study [1] was to calculate in SolidWorks Simulation the steering bipod of the car: since the minimum strength factor k = 11.3246 is greater than the allowable [k] = 2.0, it is possible to change the design of the bipod to save material. For example, the reduction of the thickness of the ribs: from an average of 14 mm to 7 mm, lateral from 11 mm to 5 mm (fig. 1). The obligatory next step is strength calculations of optimized bipod.



a b

Fig. 1. Steering bipod before (a) and after (b) optimization

Starting an optimized bipod calculation - selecting its material from the SolidWorks Simulation library: DIN 1.1191 (steel 45). This type of steel is the cheapest, heat-treatable. It is an excellent material for parts that require increased strength.

The following steps:

– definition of the bipod supports (simulated mixing of the slot opening with respect to the shaft) and application of loads (fig. 2);

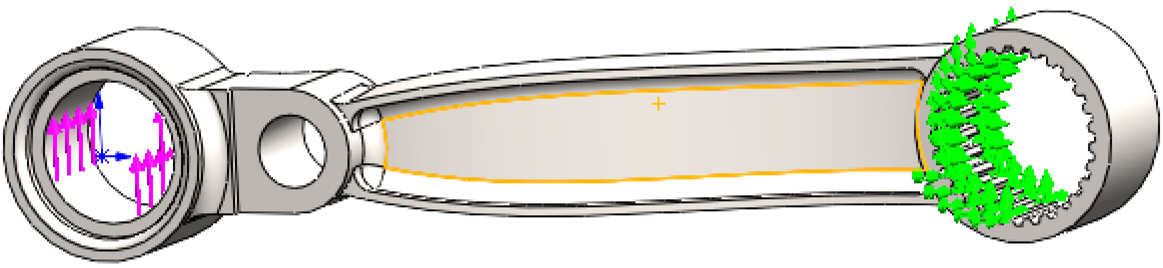


Fig. 2. Definition of bipod supports and application of loads

– creation of a mesh of solid-state model of bipod (fig. 3).

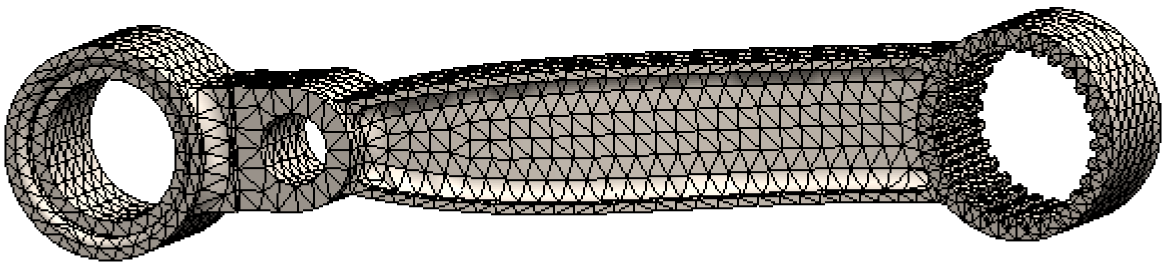
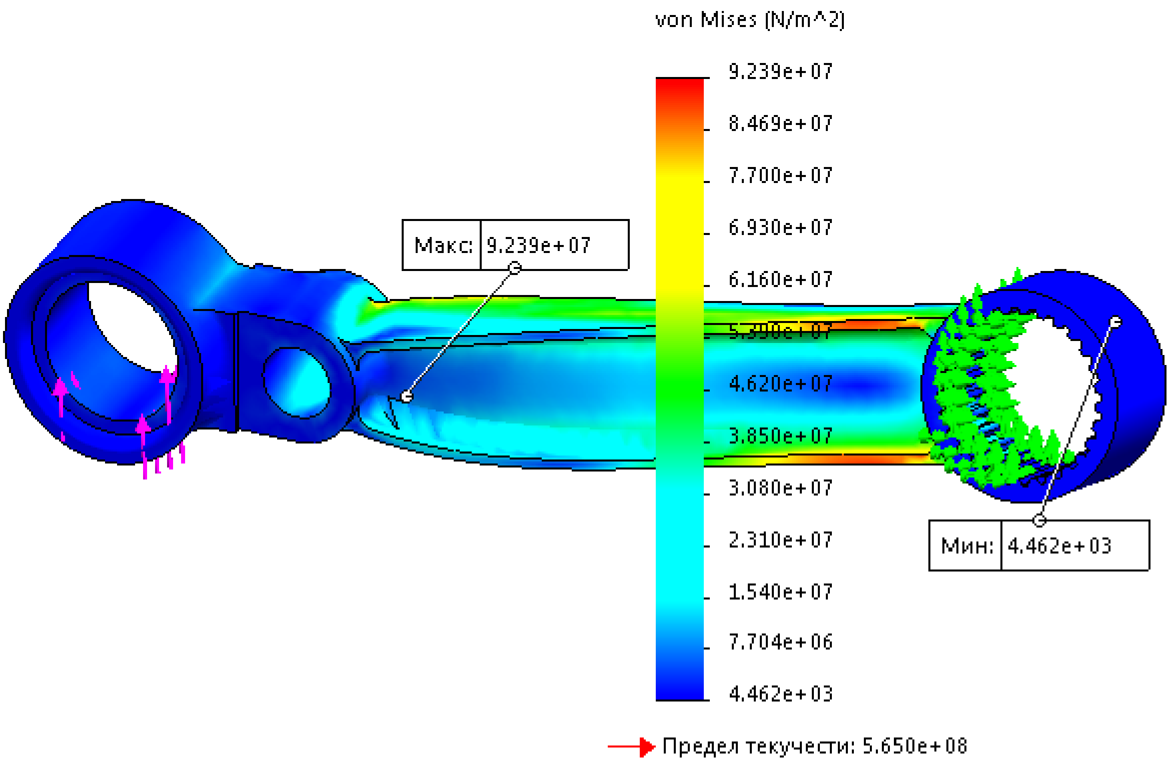


Fig. 3. Reflection mesh on a solid body

The results of the calculations are shown in fig. 4.



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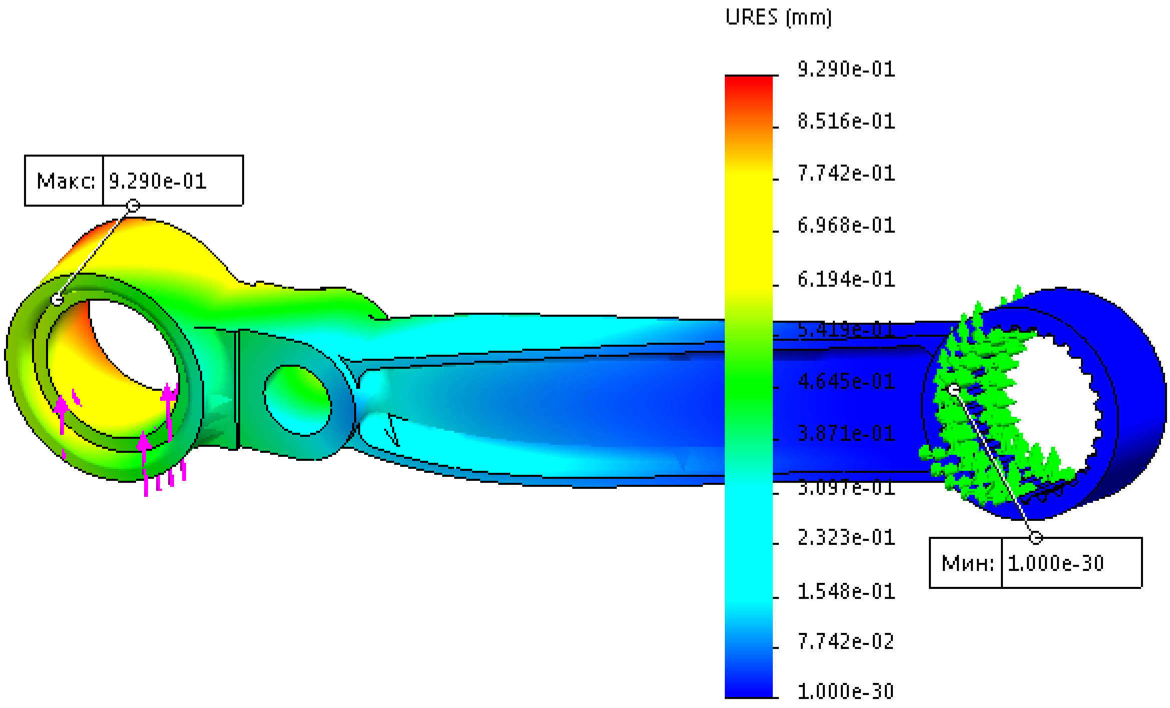

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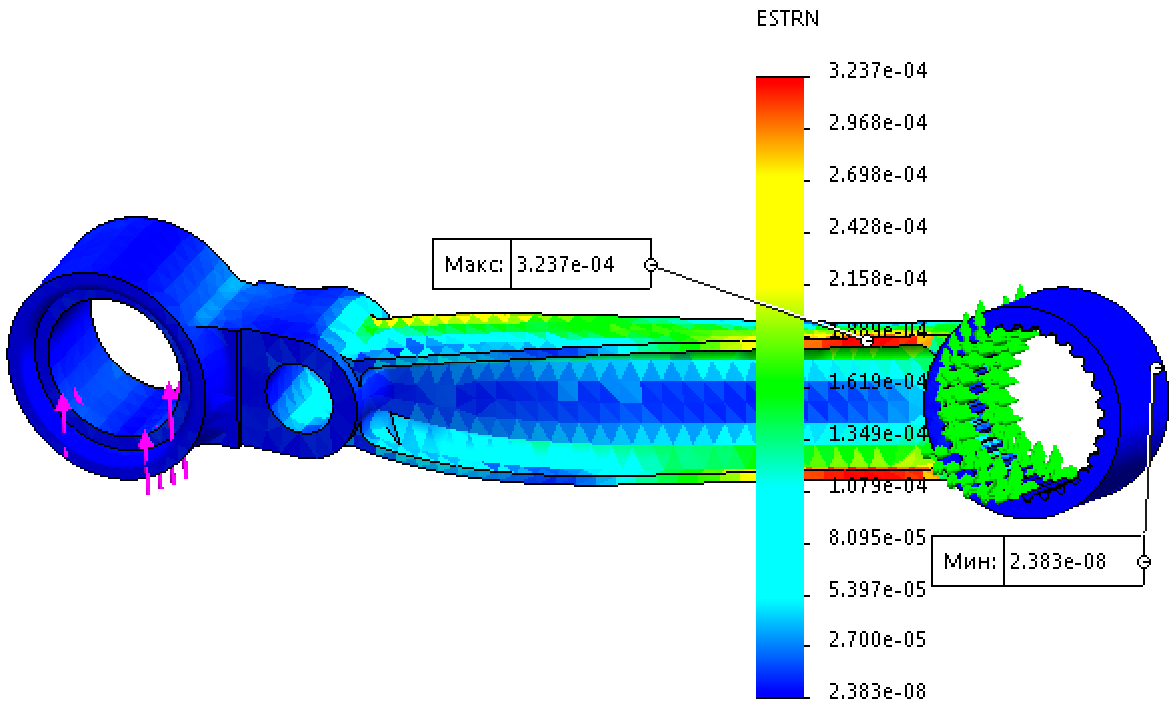

c

Fig. 4. Outline graphs of total von Mises stresses (a), total displacements of URES (b), equivalent deformation (c) of bipod

Thus, the maximum total von Mises occur at node 1265 and are 923.9 MPa; the maximum resulting displacement of the URES bipod is formed at node 18403 and is 0.9290 mm; the maximum equivalent deformation of ESTRN occurs in element 9355 and is 0.0003237; the minimum factor of safety margin of FOS is at node 1265 and is k = 6.115. Since the minimum coefficient of safety margin optimized bipod k> [k] = 2,0, then its efficiency is guaranteed. At the same time its weight decreased by 19.6%.

Therefore, the use of SolidWorks Simulation made it possible to optimize the bipod design and avoid unnecessary costs for unnecessary material.

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