Static study of the most loaded elements of the differential "ELocker" when it is locked

Oleksandr Ostroverkh*

National Technical University «Kharkiv Polytechnic Institute», Ukraine

**Corresponding author's e-mail: ostrov.sasha@gmail.com*

Abstract

Currently, the world has created a large number of programs and software packages that implement the finite element method (FEM). It is the most common method of solving a wide range of scientific and engineering problems. This is due to the simplicity of the concepts of FEM, its inherent logic and efficiency of application. SOLIDWORKS, namely its COSMOSWorks Designer module, has been selected as a software package for design and research. The developed and researched model became a rotary plate of a differential with lock "ELocker". The conducted researches allowed to determine the characteristic stress concentrators on the working surface of the rotary plate. According to the results of the calculation, the maximum displacement and deformation equivalent, as well as the minimum strength factor were determined. The temperature regime of loading does not cause fears

Keywords: finite element method, differential, plate, model, strength

1 Introduction

The calculation of parts and assemblies of mechanisms are an important component of their design and construction. Modern computer technologies allow to carry out complex calculations of the geometrical sizes of details and knots depending on a number of factors: operating conditions, operating modes, material. Currently, the world has created a large number of programs and software packages that implement the finite element method; it is the most common method of solving a wide range of scientific and engineering problems. This is due to the simplicity of the concepts of FEM, its inherent logic and efficiency of application. The key idea of FEM is as follows: a continuous medium (structure as a whole) is replaced by a discrete one, by dividing it into domains (finite elements), in each of which the behavior of the medium is described by a separate set of functions representing stresses and displacements in the specified domain. The end elements are connected by nodes. Interaction of finite elements with each other is carried out only through nodes. The elements are arranged in a certain way depending on the design of the object and are fixed in accordance with the boundary conditions. Finite elements allow to adequately describe all variety of designs and details. The finite element method refers to the variational methods of the theory of elasticity and allows us to estimate the stress-strain state of flat and bulk structural elements. [1, 2].

2 Review

In this work, the design and study of the differential swivel plate with the "ELocker" lock was carried out, namely the working surface on which the pusher briefly passes during the interlocking. The studies were conducted in the SOLIDWORKS software complex, using the COSMOSWorks Designer module [3]. As a result, stress concentrators on the working surface of the plate were determined, the safety margin of the part and the maximum movement with the equivalent of deformation, the minimum safety factor and the temperature loading mode were found.

3 Solution

The rotary plate was chosen as the studied model, namely the working surface on which the pusher briefly passes during the activation of the lock [4]. The plates has three corrugated recesses for a more uniform and smooth engagement of the movable coupling with the gear of the half-axis with the locking ring, when turning the lock on and off. The model of the rotary plate is made in the SOLIDWORKS program, the material is alloy steel, fixed on the edge adjacent to the electromagnet, the external load is applied in the direction perpendicular to the working edge. Next, the creation of a grid, the division of the part into finite elements that are used to build a discrete model of a real body. It should be noted that the use of a small grid allows to obtain fairly accurate results, on the other hand, the use of large elements reduces the computational work. The results of the static nodal voltage (fig. 1) show that the maximum value occurs at the trailing edge adjacent to the electromagnet and at the bottom of the wavy edge. The maximum value is 370.85 MPa, which is a safe value at the yield strength of 620MPa.

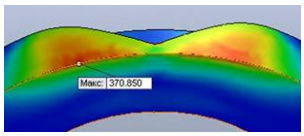

FIGURE 1 Static nodal voltage

The maximum movement in the longitudinal direction is 0.032 mm, which is not a significant deviation and does not affect the performance of the whole mechanism. The maximum value of movement occurs at the moment of inclusion of blocking that is at movement of the pusher and entering into coupling of a coupling and a gear wheel of a half-axis (fig. 2).

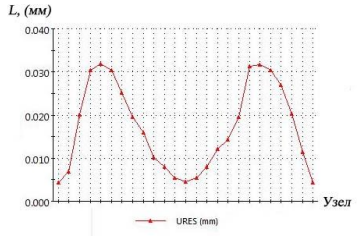

FIGURE 2 Result of static displacement sounding

The equivalent deformation value, which is equal to 0.001 mm, was also calculated. A distinctive feature is the voltage concentrator, which arises on the reverse side of the work surface.

When calculating the equivalent deformation, the minimum value of the margin of safety occurs not on the working surface of the edge, but on the reverse side, which is adjacent to the electromagnet (Fig. 3).

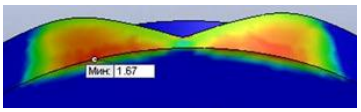

FIGURE 3 developed coefficient spare start

Temperature calculation with the application of heat flux to the working surface of the part, showed that the maximum value equal to 222.8 ° C occurs when the lock is turned off (the pusher is in the lower working zone), so the effect of jamming the pusher is excluded, as it is possible only when the lock.

4 Conclusions

The developed model describes the behavior of the real structure with a sufficiently high degree of accuracy. The study shows the characteristic stress concentrators on the working surface of the turntable. The executed model meets the requirement of a safety margin. Based on the results of the calculation, the maximum displacement was determined and the deformation equivalent was found. The minimum safety factor takes into account the fact that the adjacent electromagnet when locked acts as a reinforcing element of the structure, the current value of the safety margin is acceptable. The temperature regime of the load is not a concern, as the maximum thermal power that can occur is determined by the force of the spring that pushes the coupling and the pusher, and the power of the electromagnet needed to overcome this force, when you turn on the lock.

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[3] Официальный сайт SOLIDWORKS **E-resouce:** https://www.solidworks.com/ru

[4] Официальный сайт EATON **E-resouce:** http://www.eaton.ru/ru/ru-ru.html