USING SOLIDWORKS FOR FIXTURE CALCULATIONS FOR CAR FRONT SUSPENSION REPAIR

Rudyk Oleksandr Yuhymovych,
Drobot Olga Savivna,
Ph.D., associate professors
Burban Olexii Vitaliyovych,
Nowatskyi Bohdan Oleksandrovych,
Masters students
Khmelnytskyi National University
Khmelnytskyi, Ukraine

Introductions. Car suspension is one of the most complex and important mechanisms of a car, which is responsible not only for comfort, but also for driving safety, controllability and stability of the car on the road. It provides the car with better controllability, protection against blockages in turns, smoothes the passage of pits and bumps. That is why it is very important to repair the suspension in a timely manner, carefully monitor its condition and, if necessary, replace worn components.

Most suspensions include parts such as springs and shock absorbers. It doesn't matter where the spring is installed, it will always maintain the maximally compressed state. As a result, this part is responsible for ensuring the necessary properties of the undercarriage, as well as damping body vibrations, absorbing and accumulating mechanical energy.

A spring is a part that has a spiral shape and consists of several turns. It is elastic enough to soften any jolts of the car body during movement. When driving over pits or bumps, the wheel briefly loses contact with the road, and the spring, compressing or straightening, returns it to work and absorbs the energy of the impact. During the collision of the wheel and the surface of the road, the entire mass of the body goes down, and it is the spring that should mitigate the consequences of this contact. Due to this, the car body does not copy the profile of the road, but moves smoothly around the unevenness.

Compression springs are designed to reduce length under load. The coils of such springs do not touch each other without load. The end turns are pressed against the neighboring ones, and the ends of the springs are ground.

When repairing the front suspension, it is necessary to remove and install the springs. To achieve this goal, a special tool is needed – a spring puller: since the spring is always in a compressed state, it must be fixed in order to remove it. For this, a compression device is used [1]: the purpose of this work was to check the strength parameters of the most loaded part of this device (the screw) using SolidWorks 3D-parametric modeling system application – SolidWorks Simulation [2-5].

The continuation of this study is the determination of the performance of the lower plate of the designed device [6]: calculations ensure its static strength. But for a final conclusion regarding the efficiency of the device for compressing the springs of the front suspension, it is necessary to carry out similar calculations for its other parts.

Aim. The purpose of the work is to use SolidWorks Simulation to determine the performance of the upper plate of the device for compressing the springs of the front suspension of cars.

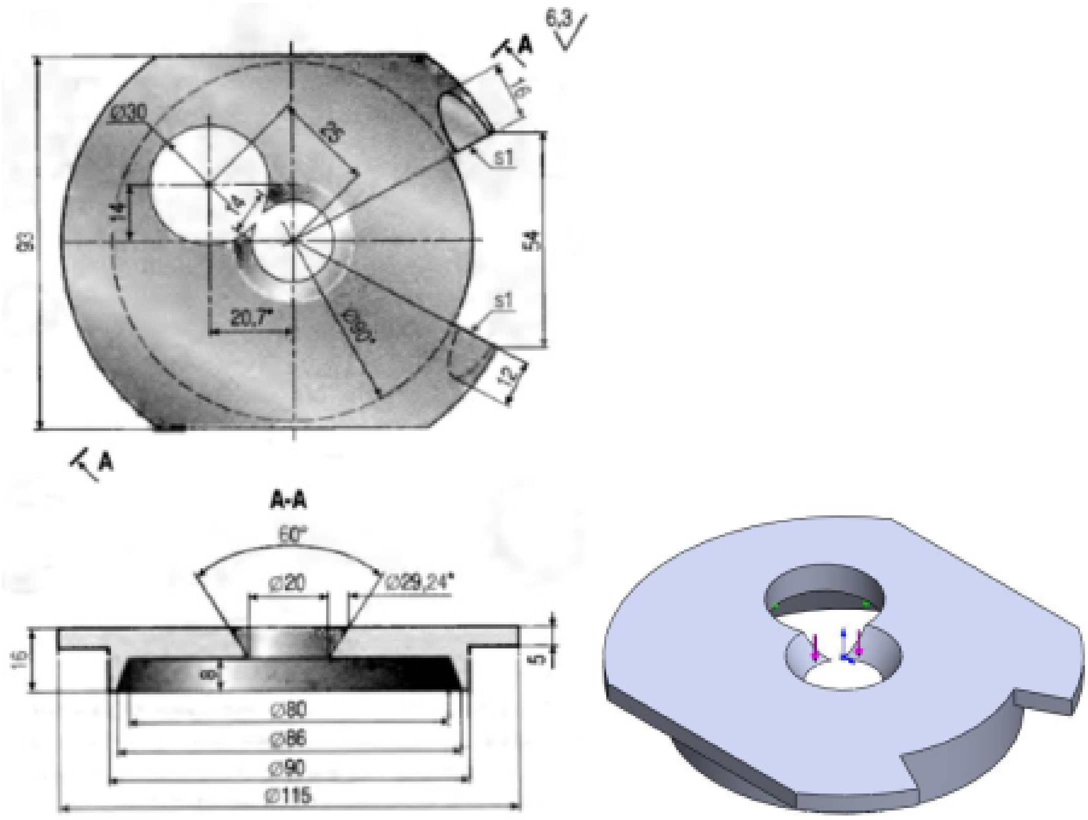
Materials and methods. For faster creation of new models of machine parts, automated design systems are being developed, which allow creating 3D-models of these parts [3].

It is known that that the automated design systems are divided into two types: low-level programs allow creating both ordinary collections of parts and structural units, as well as 3D-analogs. Beginners create 3D-models with the programs of the present category, from which, after a little training, they get the details of this part. These programs allow you to analyze model details by simulating the action of the load, obtaining diagrams of stresses, displacements, deformations, and safety margin. Advanced programs allow the same maintenance as the previous programs, but, unlike them, ensure the full life cycle of the models.

SoidWorks is a system for automated design of a modern chicken. The large list of instruments in this program also includes an application – SolidWorks Simulation - a design analysis system that is fully integrated with SolidWorks. The

SolidWorks Simulation program provides modeling solutions for linear and non-linear static and dynamic analyses; application for a good load; analyzes of frequency, accuracy, fatigue, optimization; temperature typical analysis [4].

To solve the problem, a 3D-model of the upper plate was created in the SolidWorks environment (fig. 1).

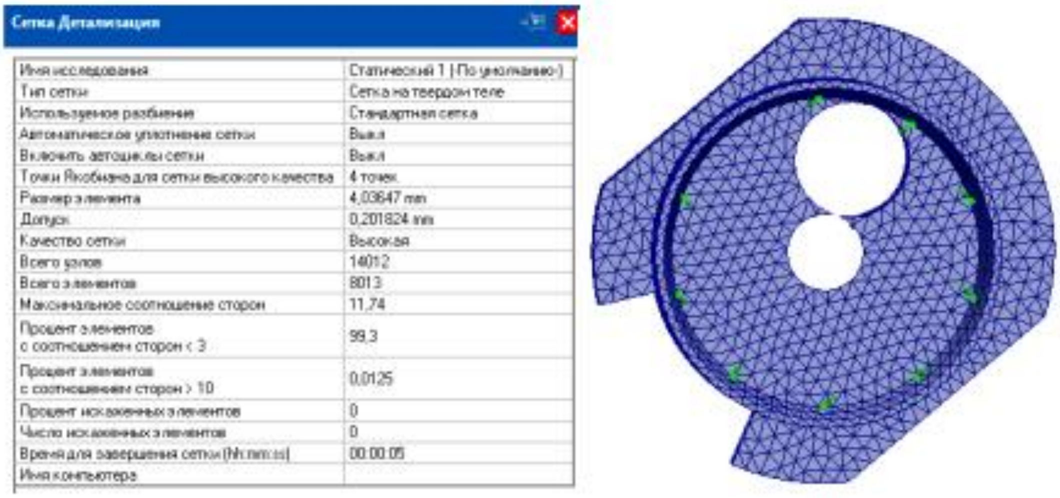


a b

Fig. 1. Drawing (a) and 3D-model (b) of the upper plate with an applied load

Results and discussion. In the SolidWorks Simulation application, a static analysis of this model was carried out using the finite element method to obtain a picture of the stress-strain state [5, 6]. The material from which it is made was originally intended for this purpose (steel 45 GOST 535-88). Then boundary conditions were imposed (fixing the model and specifying the area of load application – fig. 1, b).

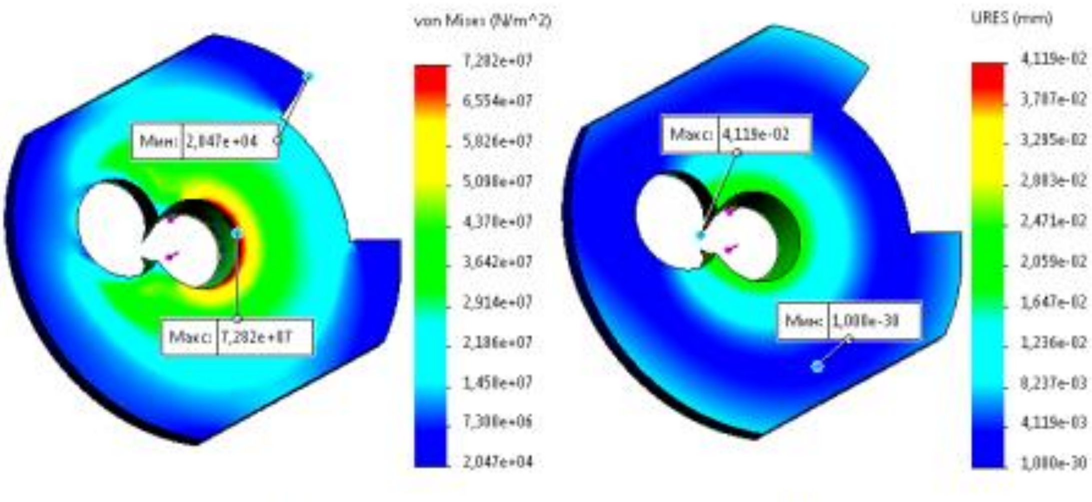
The next steps are the creation of a finite-element model of the upper plate: the deformable body (structure) is divided into finite elements (fig. 2). They can have different shapes and sizes. As a result of splitting, a mesh is created from the borders of the elements, the intersections of which form nodes. Additional nodal points can be created on the borders and inside the elements. An ensemble of all finite elements and nodes is the basis of a finite element model of a deformable body. The discrete model should cover the area of the object under study quite well.



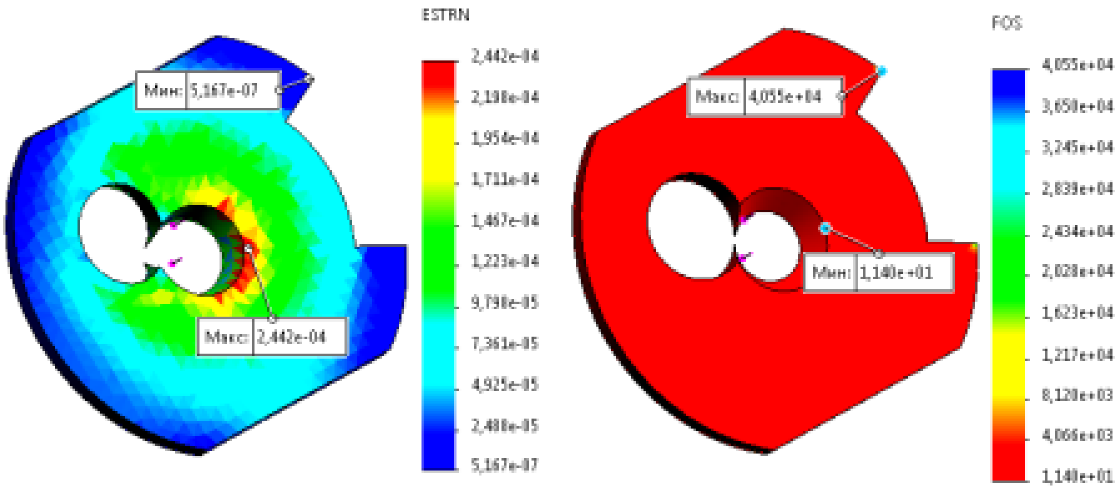
a b

Fig. 2. Parameters of the finite element mesh of the upper plate (a) and its reflection on a solid body (b)

At this stage, all preparatory operations are completed and you can proceed directly to the calculation. SolidWorks Simulation automatically builds the following graphs that characterize the stress-strain state of the upper plate after loading: Von Mises stresses, URES displacements, ESTRN-equivalent deformations, and the safety factor FOS (fig. 3).



a b



c **d**

Fig. 3. Plots of the distribution of nodal stresses (a), displacements (b), equivalent strains (c), safety factor (d) of the upper plate

The maximum stress experienced by the upper plate is 7.782×10^7 Pa. This value does not exceed the yield point of its material – steel 45 (8.3×10^8 Pa). Therefore, the loading of the upper plate occurs in the zone of elastic deformations, that is, after removing the load that caused the deformation, the latter disappears.

Analysing the displacement distribution graphs, we can see that the maximum displacement of the cross sections of the upper plate at the moment of maximum load is 4.119×10^{-2} mm. After the calculation is completed, a report file is automatically generated in SolidWorks Simulation, which displays all stages of the strength calculation.

Conclusions. Thus, the strength parameters of the upper plate ensure its static strength (minimum safety factor n = 11.4, which is greater than the permissible [n] = 3). But for a final conclusion regarding the efficiency of the device for compressing the springs of the front suspension, it is necessary to carry out similar calculations for its other details

LIST OF REFERENCES

1. Рудик О. Ю. Дослідження працездатності пристосування для стиску

пружин передньої підвіски // О. Ю. Рудик, О. О. Гуменюк, Д. А. Барчишин // Розвиток сучасної освіти і науки: результати, проблеми, перспективи. Том Х:Ефекти участі в розвитку науки та освіти на відстані/ [Ред.: Я. Ґжесяк, І. Зимомря, В. Ільницький]. Конін – Ужгород – Херсон: Посвіт, 2021. – С. 299-302. – Режим доступу: http://elar.khnu.km.ua/jspui/handle/123456789/10221

2. Rudyk O. Yu. Application of SolidWorks is for professional preparation of specialists / O. Yu. Rudyk, P. V. Kaplun, V. A. Gonchar // Resource-oriented learning in "3D": accessibility, dialogue, dynamics: a collection of abstracts of reports of the 2rd International Scientific and Practical Internet Conference (Poltava, February 22-23, 2022). – Poltava: PUET, 2022. – Pp. 140-146. – URL: http://elar.khmnu.edu.ua/jspui/handle/123456789/12794

3. Rudyk O. Yu. SolidWorks as an innovative means for studying the disciplines of automobile profile / O. Yu. Rudyk, O. V. Dykha // «System technologies» 3 (128) 2020. – Pp. 21-35. – URL: https://journals.nmetau.edu.ua/index.php/st/article/view/178

4. Rudyk O. Yu. Application of SolidWorks in the educational process / O. Yu. Rudyk N. S. Mariin, S. I. Yaroshchuk // Proceedings of the IV All-Ukrainian scientific-practical Internet conference "Resource-oriented learning in "3D": accessibility, dialogue, dynamics "/ incl. N. V. Kononets, V. O. Balyuk. – Poltava: KUEP PDAA, 2020. – Pp. 96-100. – URL: http://acup.poltava.ua/wp-content/uploads/2020/02/Збірник-2020-0203.pdf

5. Rudyk O. Yu. Optimization of the steering bipod of the vehicle / O. Yu. Rudyk, V. V. Gerega, N. R. Tymchenko // Scientific achievements of modern society. Abstracts of the 7th International scientific and practical conference. Cognum Publishing House. Liverpool, United Kingdom. 2020. – Pp. 187-192. – URL: http://sci-conf.com.ua/vii-mezhdunarodnaya-nauchno-prakticheskaya-konferentsiya-scientific-achievements-of-modern-society-4-6-marta-2020-goda-liverpul-velikobritaniya-arhiv/?utm_source=eSputnik-promo&utm_medium=email&utm_campaign=MATERIALY_Liverpul_&utm_content=761175902

6. Rudyk O. Yu. Application of SolidWorks is for professional preparation of specialists / O. Yu. Rudyk, P. V. Kaplun, V. A. Gonchar // Resource-oriented

learning in "3D": accessibility, dialogue, dynamics: a collection of abstracts of reports of the 2rd International Scientific and Practical Internet Conference (Poltava, February 22-23, 2022). – Poltava: PUET, 2022. – Pp. 140-146. – URL: http://elar.khmnu.edu.ua/jspui/handle/123456789/12794