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# AUTOMOTIVE PARTS DESIGN SOFTWARE

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**Abstract.** *The informative and programmatic providing of processes of проєктування details of cars is the application of computer-aided design considered on an example for automation of works of industrial enterprise on the stages of designer and technological preproduction of SolidWorks and her addition of SolidWorks Simulation for possibility of replacement of expensive and scarce steel of 18HGT for making of cog-wheel of billow of back bridge of car UAZ-31512 on more cheap and more accessible in repair shops steel 45. After reassignmentof material to the cog-wheel of billow conducted her fixing and appendix of loading. Conducted dividing of model of cog-wheel of billow the repeated calculations into eventual elements; resulting forces and moments defined; built the matrix of inflexibility, carried out the synthesis of certainly-element model taking into account the terms of her fixing in key points and untied the got system of equalizations of algebra; components of the stress-deformation state of model defined.*

**Keywords***: car, rear axle, gear shaft, material replacement, SolidWorks Simulation.*

Among all information technologies a computer-aided design occupies the special place. Next to the use of CAE-systems (Computer-aided engineering) automation of engineering calculations and analysis of CAD-systems (Computer-Aided Design) is used automated designing. Data from CAD-systems are sent to CAM-systems (Computer-aided manufacturing) of computer-assisted preproduction. The common name of such programs is automated design systems (ADS) or CAD/CAM/CAE-systems designs[1]. One of the most common tools used by ADS and 3D modeling is the SolidWorks software [2, 3]. The package allows you to create parts for future 3D printing. This protects the designer from errors that inevitably appear in the process of drawing product projections manually.

The main purpose of SolidWorks is to provide an end-to-end process of design, engineering analysis and preparation for the production of products of any complexity and purpose, including the creation of interactive documentation and the provision of data exchange with other systems.

One fully computer-integrated from SolidWorks the program there is the system of analysis of constructions of SolidWorks Simulation, which provides the decision of design linear and nonlinear static and dynamic analyses; to the analysis

of frequency, firmness, temperature, fatigue; tests on the shock loading, and also to the analysis of optimization.

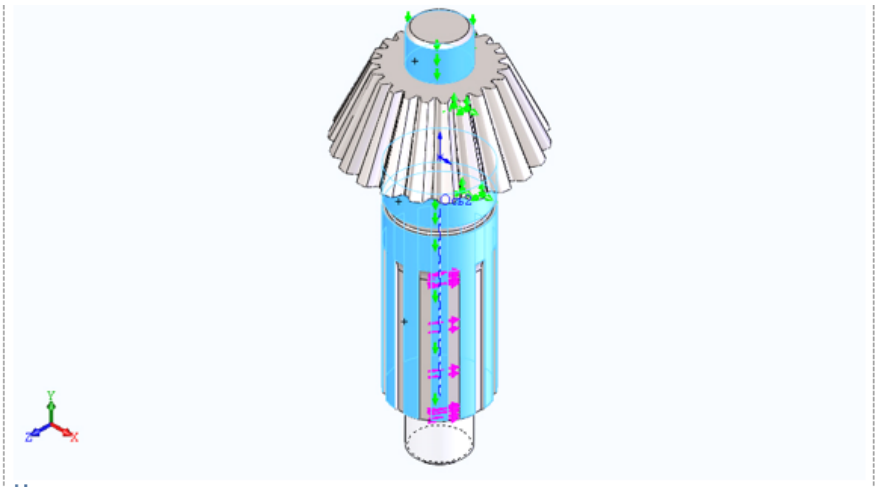
As an example, the authors of the system [4] using SolidWorks Simulation conducted a static analysis of the gear-shaft (steel 18KHGT GOST 4543-71) of the rear axle of the UAZ-31512 car. DIN 1.7147 steel (20MnCr5 – analogue of 18KHGT steel) was selected from the SolidWorks library. When analyzing the simulation results, it was established that the minimum safety factor of the gear-shaft is $n_{min}$ = 3.021, which is much more than the permissible [n] = 1.5. Therefore, the purpose of this work was to determine the possibility of replacing this material with a cheaper and more accessible one in repair shops, for example, steel 45 (its analogue is AISI 1045 Steel, cold drawn).

After reassigning the gear-shaft material, the model was fixed and loads were applied to it (fig. 1). By repeated calculations in SolidWorks Simulation:

– split the gear-shaft model into finite elements (fig. 2);

– determined the resulting forces and moments (fig. 3);

– constructed a stiffness matrix, synthesized a finite-element model taking into account the conditions of its fixation at nodal points;



Нагрузки и крепления

| Имя крепления | Изображение крепления | Данные крепления |
|---|---|---|
| Ролик/ползун-1 | | Объекты: 3 грани<br>Тип: Ролик/ползун |

Результирующие силы

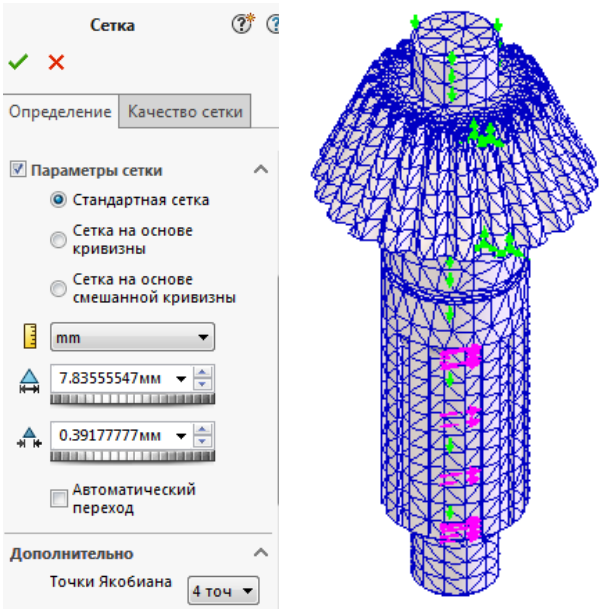
| Компоненты | X | Y | Z | Результирующая |
|---|---|---|---|---|
| Сила реакции(N) | 0 | 143,784 | 0 | 143,784 |
| Реактивный момент(N.m) | 0 | 0 | 0 | 0 |

| | | |
|---|---|---|
| Зафиксированный-1 | | Объекты: 1 грани<br>Тип: Зафиксированная геометрия |

Результирующие силы

| Компоненты | X | Y | Z | Результирующая |
|---|---|---|---|---|
| Сила реакции(N) | -2 820,13 | -144,187 | 4 884,03 | 5 641,6 |
| Реактивный момент(N.m) | 0 | 0 | 0 | 0 |

Figure 1 - Fixing the gear-shaft model and applying loads to it




a b

Figure 2 - Grid parameters (a) and its display on the gear-shaft model (b)

**Силы реакции**

| Выбранный набор | Единицы | Сумма X | Сумма Y | Сумма Z | Результирующая |
|---|---|---|---|---|---|
| всей модели | N | -2 820,13 | -0,401657 | 4 884,03 | 5 639,76 |

**Моменты реакции**

| Выбранный набор | Единицы | Сумма X | Сумма Y | Сумма Z | Результирующая |
|---|---|---|---|---|---|
| всей модели | N.m | 0 | 0 | 0 | 0 |

**Силы свободных тел**

| Выбранный набор | Единицы | Сумма X | Сумма Y | Сумма Z | Результирующая |
|---|---|---|---|---|---|
| всей модели | N | -0,749229 | -0,088512 | 9,01292 | 9,04444 |

**Моменты свободных тел**

| Выбранный набор | Единицы | Сумма X | Сумма Y | Сумма Z | Результирующая |
|---|---|---|---|---|---|
| всей модели | N.m | 0 | 0 | 0 | 1e-33 |

Figure 3 - Resultant forces and moments

– solved the resulting system of algebraic equations;

– determined the components of the stress-strain state of the gear-shaft model (fig. 4).

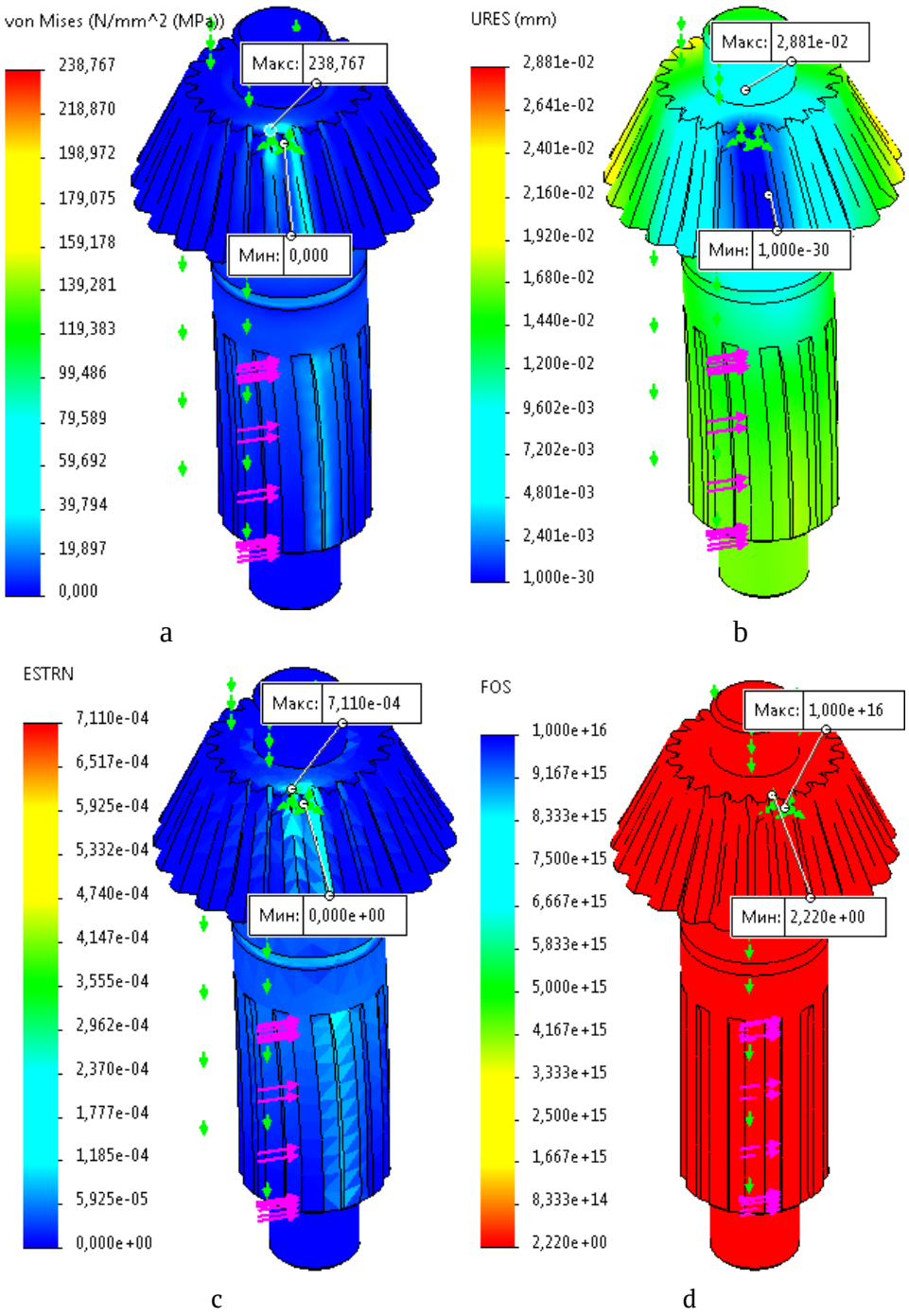



Figure. 4 - Plots of summary von Mises stresses (a), displacements URES (b), equivalent strains ESTRN (c), margin of safety FOS of the gear-shaft

Since the minimum margin of safety for a gearshaft made of steel 45 is n = 2.22, in the case of replacing steel 18KhGT with the manufacture of a gear shaft made of steel 45, the margin of safety is sufficient.

## REFERENCES / ЛІТЕРАТУРА

1. Rudyk O.Yu. SolidWorks – CAD/CAE-система технічних вузів / O. Yu. Rudyk, P. V. Kaplun // Science, society, education: topical issues and development prospects. Abstracts of the 2nd International scientific and practical cowaynference. SPC "Sci-conf.com.ua". – Kharkiv, Ukraine, 2020. – Pp. 249-253. – URL: http://elar.khnu.km.ua/jspui/handle/123456789/8631

2. 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

3. Rudyk O. The use of SolidWorks for the training of highly qualified specialists / O. Rudyk, P. Kaplun, V. Gonchar // Actual problems in the education system: general secondary education institution – pre-university training – higher education institution: coll. of science Proceedings of the VIII All-Ukrainian Scientific and Practical Conference, February 17, 2022, Kyiv, National Aviation University. – K.: NAU, 2022. – P. 699-706. – URL: https://jrnl.nau.edu.ua/index.php/APSE/issue/view/879

4. Rudyk O. Yu. Application of information technologies in the study of vehicles / O. Yu. Rudyk, D. L. Pershko // Materials Vseukr. science and practice Internet Conf. "Resource-oriented learning in higher education: problems, experience, prospects" / incl. N. V. Kononets, V. O. Balyuk. – Poltava: AKUP PDAA, 2016. – C. 126-130. – URL: http://elar.khnu.km.ua/jspui/handle/123456789/8559

## ПРОГРАМНЕ ЗАБЕЗПЕЧЕННЯ ПРОЄКТУВАННЯ ДЕТАЛЕЙ АВТОМОБІЛІВ

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**Abstract.** *Інформаційне та програмне забезпечення процесів проєктування деталей автомобілів розглянуте на прикладі застосування системи автоматизованого проектування для автоматизації робіт промислового підприємства на етапах конструкторської та технологічної підготовки виробництва SolidWorks та її додатка SolidWorks Simulation для можливості заміни дорогої та дефіцитної сталі 18ХГТ для виготовлення вал-шестерні заднього моста автомобіля УАЗ-31512 на дешевшу і доступнішу у ремонтних майстернях сталь 45. Після перепризначення матеріалу вал-шестерні провели її закріплення та прикладення навантажень. Повторними розрахунками провели розділення моделі вал-шестерні на скінченні елементи; визначили результуючі сили та моменти; побудували матрицю жорсткості, здійснили синтез скінченно-елементної моделі з урахуванням умов її закріплення у вузлових точках і розв'язали одержану систему алгебраїчних рівнянь; визначили компоненти напружено-деформівного стану моделі.*

**Keywords**: *автомобіль, задній міст, вал-шестерня, заміна матеріалу, SolidWorks Simulation.*