УДК 378.147:629. 331

DOI 10.18372/2786-5487.1.17688

Oleksandr Rudyk

Ph.D., Associate Professor,

Khmelnytskyi National University,

Khmelnytskyi, Ukraine

yuhymovych@gmail.com

Markiyan Barnych,

undergraduate,

Khmelnytskyi National University,

Khmelnytskyi, Ukraine

mark.barnych@gmail.com

Oleksandr Humeniuk,

undergraduate,

Khmelnytskyi National University,

Khmelnytskyi, Ukraine

sanya.gymenyuk@gmail.com

Vadym Shchur,

undergraduate,

Khmelnytskyi National University,

Khmelnytskyi, Ukraine

dflsv123@gmail.com

SOLIDWORKS AS AN INNOVATIVE MEANS OF RESEARCHING AUTOMOTIVE ENGINEERING

Annotation. *The main directions of improving the reliability of automotive equipment during repair include the performance of disassembly and assembly work without damage to parts. And for this you need to use lifters, stands, pullers, racks and other devices and means of mechanization. Therefore, the possibilities of* *designing devices for automobile transport with the help of SolidWorks are considered: a crane lifting mechanism, a stand for straightening deformed stamped wheels of passenger cars, bearing removers, a device for compressing the springs of the front suspension of passenger cars, a device for mounting and dismounting brake drums, a two-post electrohydraulic lifter.*

***Key words**: SolidWorks, lifters, stands, pullers, racks.*

***Анотація.** До основних напрямків підвищення надійності автомобільної техніки при ремонті відноситься виконання розбірно-складальних робіт без пошкодження деталей. А для цього потрібно використовувати підйомники, підставки, знімачі, стійки та інші пристосування і засоби механізації. Тому розглянуто можливості проектування за допомогою SolidWorks пристроїв для автомобільного транспорту: механізму підйому крана, стенда для правки деформованих штампованих коліс легкових автомобілів, знімачів підшипників, пристрою для стиснення ресор передньої підвіски легкових автомобілів, пристрій для монтажу та демонтажу гальмівних барабанів, двостійковий електрогідравлічний підйомник.*

***Ключові слова:** SolidWorks, підйомники, стійки, знімачі, стійки.*

Introduction. The innovative form of organization of education provides for the introduction of innovations (innovations) in the goals, methods, means and content of education and upbringing, as well as in the organization of the activities of the teacher and student in the classroom. An innovative form of learning organization involves the activation of the student in the classroom through:

– application of new methods and means of training;

– changing the methods and content of the presentation of educational material;

– organization of the order of interaction between the teacher and the student.

To train a modern automotive engineer, it is necessary to provide him with such knowledge and skills that would help him successfully find a job after graduating from a higher educational institution. They hire specialists who have professional and communicative competence, know the methods of engineering calculations, and creatively approach the solution of tasks.

To form these qualities, teachers need to combine knowledge, skills and abilities in practice-oriented learning with an integrated approach, the purpose of which is to help the student apply the acquired knowledge and skills in independently solving problems, adapt to modern conditions.

The aim of the article is to reveal SOLIDWORKS as an innovative tool for automotive engineering research

Research results. To implement an integrated approach, teachers create an environment in the classroom that immerses students in a professional environment, contributes to the performance of certain professional functions, and allows them to practice their professional activities.

Recently, in the automotive industry, high quality and prompt renewal of the range of products have become the defining requirements. Their implementation is impossible without the introduction of CAD/CAM/CAE/CAPP/PDM technologies - systems of automated design of technical objects (CAD), technologies of their processing and engineering analysis [1, p. 22; 2, p. 700].

One of the best CAD software – SolidWorks – is a multifunctional system of solid parametric modelling, in which the possibilities of creating drawings and assemblies are realized. It contains a wide set of functions, including fast and reliable simulation modelling [3, p. 484].

The CAE-application of this CAD is SolidWorks Simulation, which allows you to perform calculations on the strength of parts and assemblies, critical forces and forms of loss of stability, nonlinear calculations, design optimization, etc. The program uses a geometric model of a SolidWorks part or assembly to form a calculation model. Integration with SolidWorks makes it possible to minimize operations associated with specific features of finite-element approximation [4, p. 40].

The main directions of improving the reliability of automotive equipment during repair include the performance of disassembly and assembly work without damage to parts. And for this you need to use lifters, stands, pullers, racks and other devices and means of mechanization. Therefore, as an example of the use of SolidWorks Simulation in the educational process, the authors [4, p. 40] considered the strength calculation of the hub of the crane lifting mechanism (fig. 1). It was established that the maximum stresses and the resulting displacement are less than permissible (fig. 2), that is, the calculations guarantee the strength of the hub.

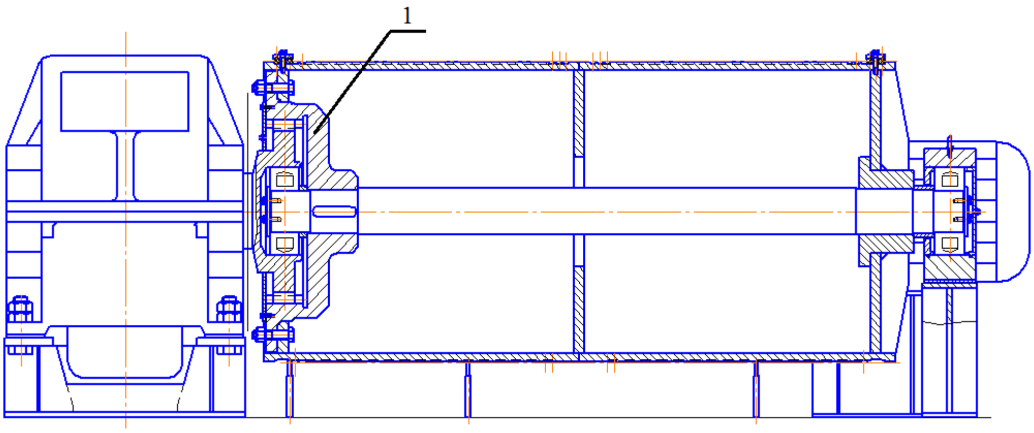
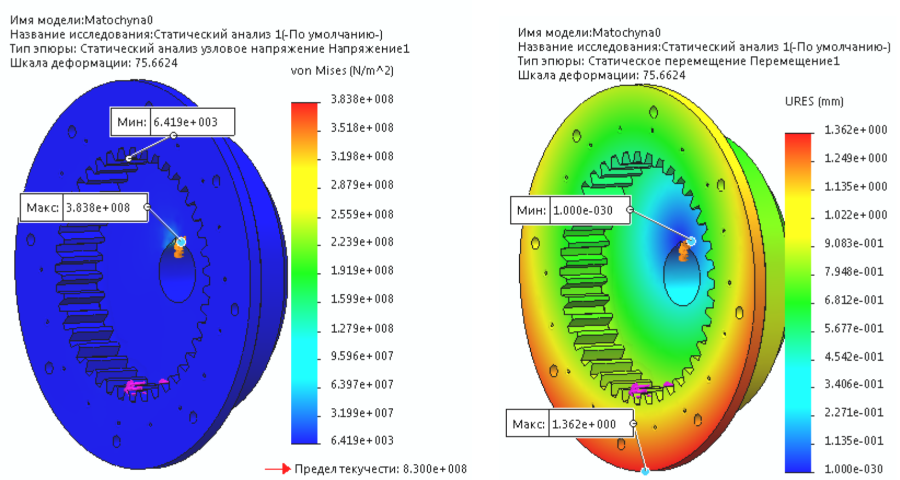


Fig. 1. Crane lifting mechanism (1 – toothed hub)



a b

Fig. 2. Contour graphs of total von Mises stresses (a) and URES displacements (b) of the hub

In the work [5, p. 219] designed a stand for straightening deformed stamped discs of passenger car wheels along the rim and its base (fig. 3), for which a study of the stress-deformed state of the power propeller was carried out (the results of the calculations are displayed in the form of a colour gradient, which shows the distribution of the calculated parameters by changing colour – fig. 4). Since the maximum von Mises nodal stresses and the resulting displacement URES do not exceed the permissible values, the calculations guarantee the static strength of the screw.

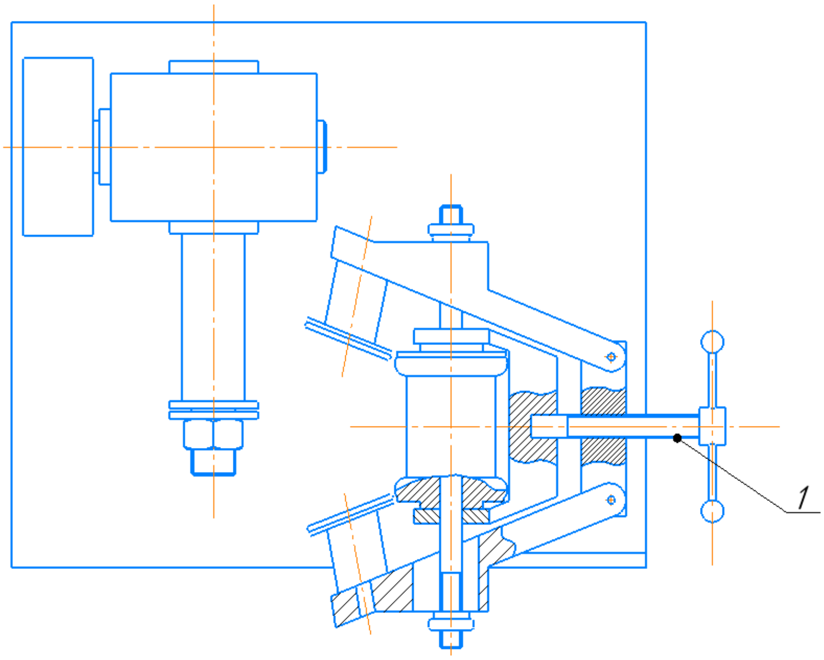
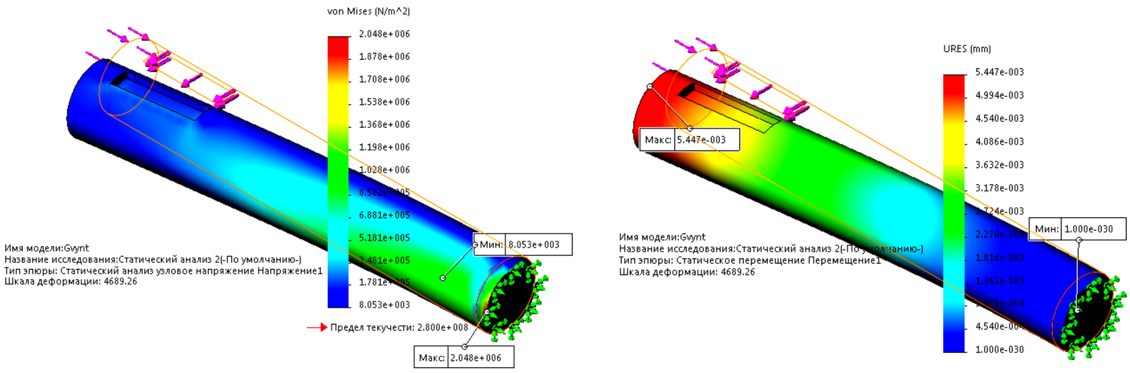


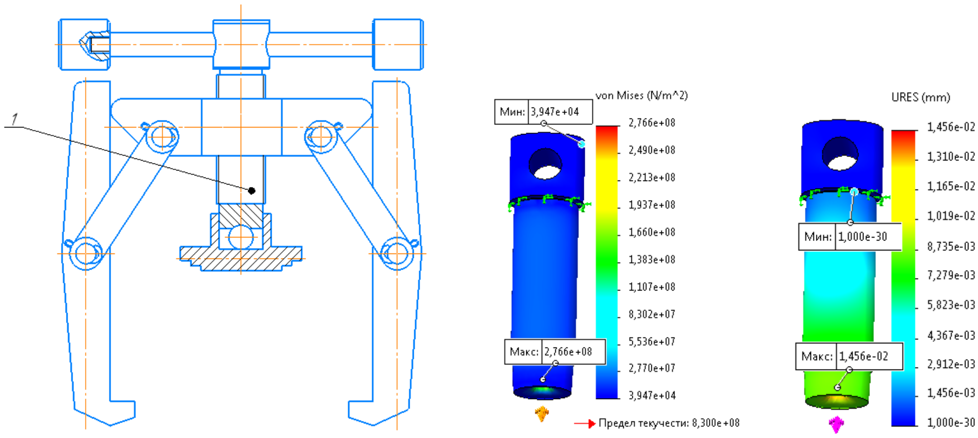
Fig. 3. Stand for straightening deformed stamped discs of car wheels (1 – power screw)



a b

Fig. 4. Distribution of equivalent stresses according to the 4th hypothesis of strength (a) and displacements (b) of the 3D screw model

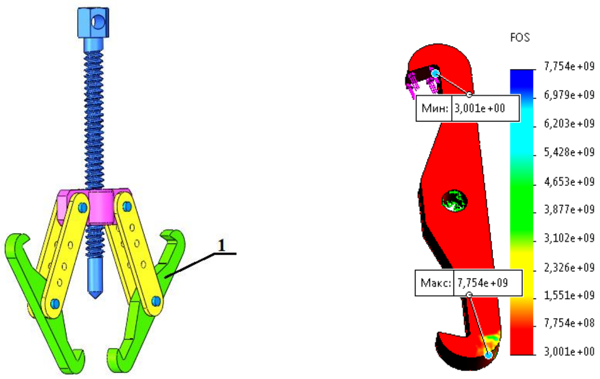
An example of the use of SolidWorks Simulation for calculations can be a study of the performance of one of the parts of the bearing puller (fig. 5, a) – the power screw: the maximum parameters of the static analysis: stress in the screw, σ = 2.766e+08 N/m^2; the resulting displacement h = 1.456e-02 mm (fig. 5, b), which is less than the permissible [2, p. 700].



a b c

Fig. 5. Bearing remover (a: 1 – power screw) and contour graphs of total von Mises stresses (b) and URES displacements (c) of the power screw

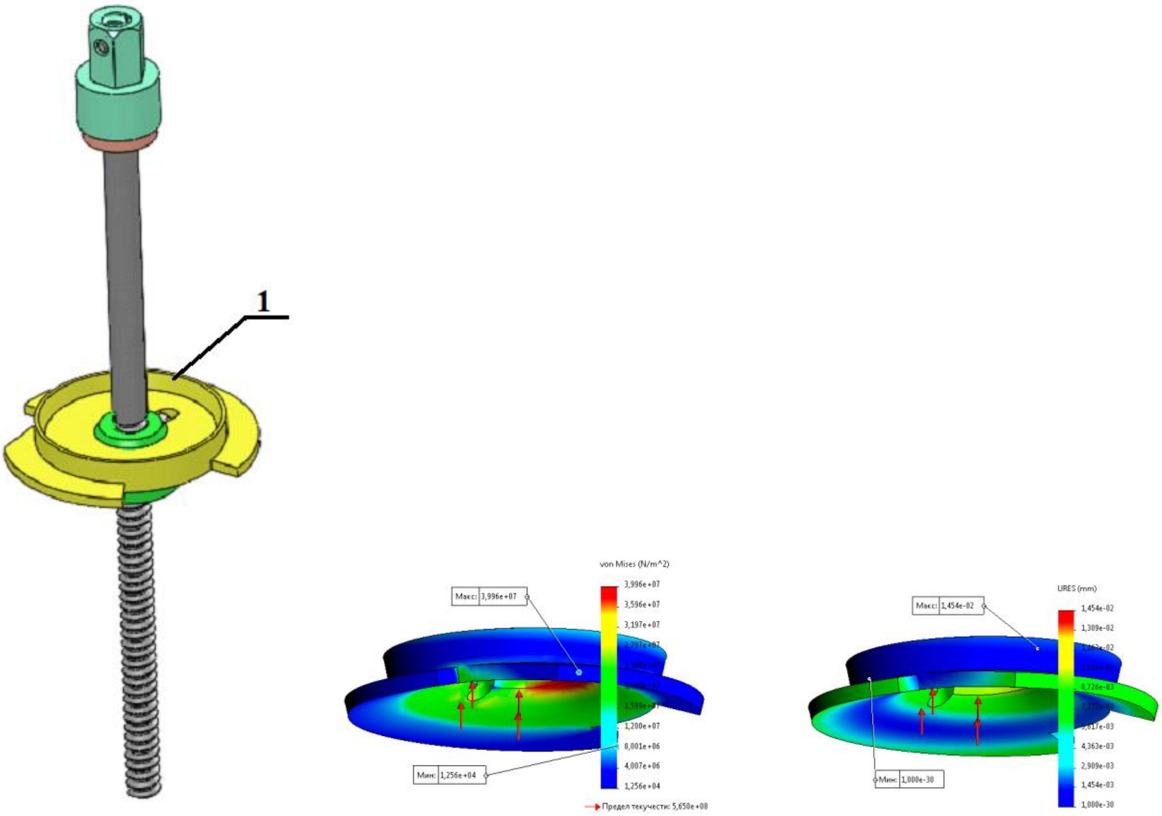
The research task [6, p. 249] concerned the determination of the maximum force that can be applied to the grip of a universal bearing puller (fig. 6) with an allowable margin of strength [n] = 3. It was established that the force that would not lead to safety violations is 1978 N (for one delight).



a b

Fig. 6. Universal bearing puller (a: 1 – gripper) and safety margin of the gripper (b)

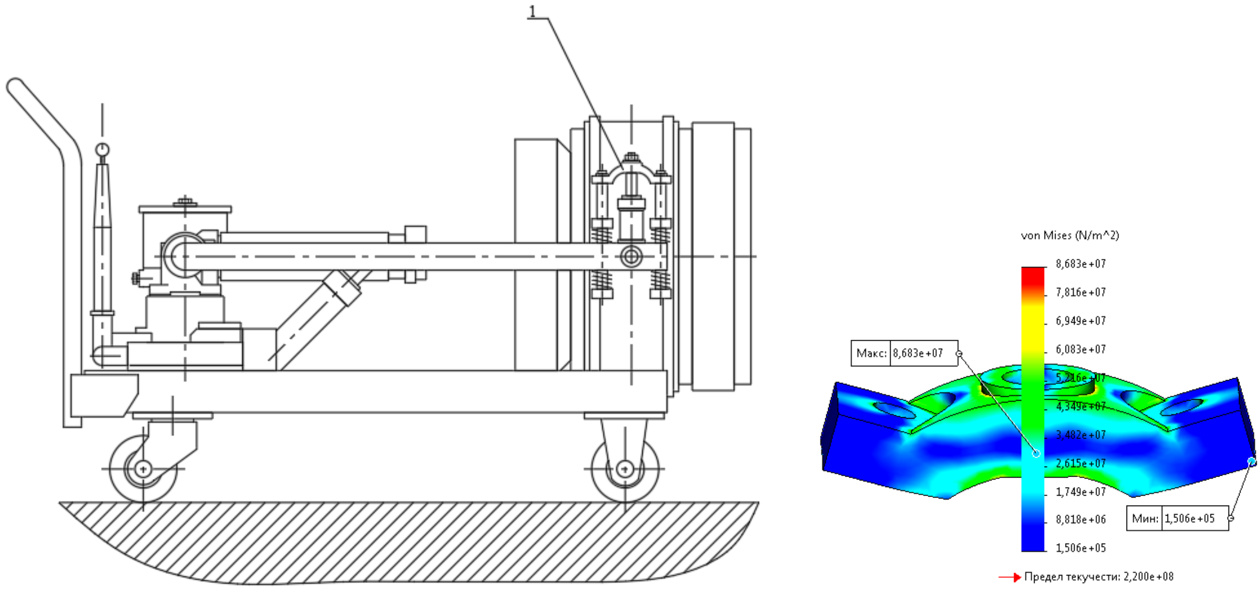
The purpose of the study [7, p. 141] – check the strength parameters of the lower plate of the special device (fig. 7, a) for compression of the front suspension springs passenger car. The results of the static analysis are shown in fig. 7, b, c. The established safety factor n = 14.14, which is more than permissible.



a b c

Fig. 7. Device for compressing the springs of the front suspension passenger car (a: 1 – lower plate) and the diagram of the distribution of nodal stresses of the plate (b) and displacements (c)

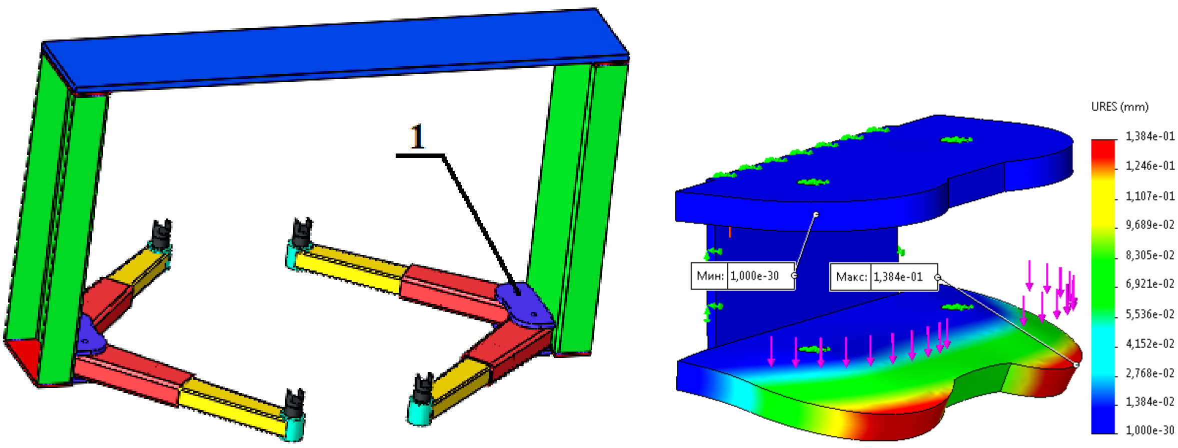
The authors [8, p. 23] determined the maximum force that can be applied to the crossbar of the device for mounting and dismounting truck brake drums (fig. 8, a). The results of the static analysis are displayed in the form of a color gradient, which shows the distribution of the calculated stress fields by changing the color (fig. 8, b). The maximum force on the crossbar, which will not lead to safety violations, will be 5200 N.



a b

Fig. 8. Device for mounting and dismounting brake drums (a: 1 – cross member) and the resulting nodal Von Mises stresses of the cross member (b)

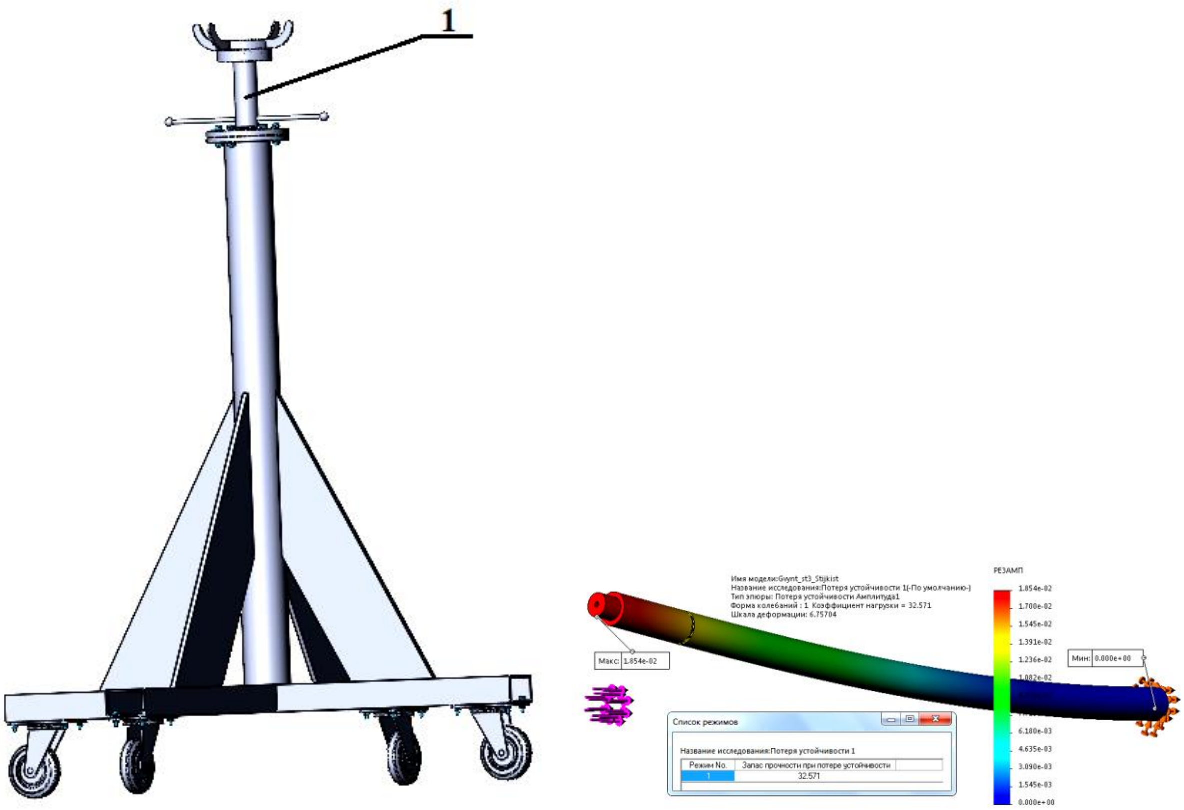
The purpose of the study [9, p. 162]: determination of the maximum weight of the car, which will not lead to the destruction of the bracket of the two-post electro-hydraulic lifter – fig. 9, a (with clear implications for safety at the service station): the minimum allowable margin of strength of the bracket [n] = 5 corresponds to a force of 27,600 N.



a б

Fig. 9. Two-post electro-hydraulic lifter (a: 1 – bracket) and the resulting nodal movements of the bracket (b)

In the designed transmission rack, which is designed for lifting and moving loads during assembly and disassembly of assemblies and units from cars (fig. 10, a), the authors [10, p. 250] the possible loss of stability of the power propeller was determined. When analysing the simulation results, it was established that the margin of safety for a possible loss of stability is n = 32.571, that is, the loss of stability of the power propeller does not occur (fig. 10, b).



a b

Fig. 10. Transmission rack (a: 1 – screw) and the resulting amplitude and margin of safety at loss of screw stability (b)

Conclusions. Therefore, it is advisable to train highly qualified specialists using the SolidWorks CAD/CAE system: at the stage of building a 3-D model, use SolidWorks; then, moving to the real design, apply SolidWorks Simulation or another application. This organization of work allows in the process of learning to build a construction model at a qualitatively new level and to prepare students for the use of modern engineering tools.

References

1. Рудик О. Ю. SolidWorks як інноваційний засіб вивчення дисциплін автомобільного профілю / О. Ю. Рудик, О. В. Диха. С*истемні технології, № 3 (128) 2020.* – С. 21-35. URL: https://journals.nmetau.edu.ua/index.php/st/article/view/178/92 (дата звернення: 10.02.2023).

2. Рудик О. Застосування SolidWorks для підготовки висококваліфікованих фахівців / О. Рудик, П. Каплун, В. Гончар. *Актуальні проблеми в системі освіти: заклад загальної середньої освіти – доуніверситетська підготовка – заклад вищої освіти: зб. наук. праць матеріалів VIII Всеукраїнської науково-практичної конференції, 17 лютого 2022 р.,* м. Київ, Національний авіаційний університет. – К. : НАУ, 2022. – С. 699-706. URL: https://jrnl.nau.edu.ua/index.php/APSE/issue/view/879 (дата звернення: 10.02.2023).

3. Диха О. В. Застосування SolidWorks Simulation для підготовки фахівців автомобільного профілю / О. В. Диха, О. Ю. Рудик // *Збірник тез доповідей ІІ-ї Міжнародної науково-технічної конференції «Перспективи розвитку машинобудування та транспорту – 2021»*. Вінниця: ВНТУ. 2021. С. 484-485. URL: http://elar.khnu.km.ua/jspui/handle/123456789/10992 (дата звернення: 10.02.2023).

4. Боровик О.В. Застосування SolidWorks Simulation у навчальному процесі / О. В. Боровик, О. Ю. Рудик, В. С. Паска. *Актуальні проблеми в системі освіти: заклад загальної середньої освіти – доуніверситетська підготовка – заклад вищої освіти: зб. наук. праць матеріалів V Всеукраїнської науково-практичної конференції, 18 квітня 2019 р., м. Київ, Національний авіаційний університет*. К. : НАУ, 2019. С. 39-42. URL: http://iiot.nau.edu.ua/images/docs/conference/aktualni_problemy/Збірка_Конференція_2019.pdf (дата звернення: 10.02.2023).

5. Рудик О. Впровадження SolidWorks у систему неперервної освіти / О. Рудик, Р. Андрійчук. *Актуальні проблеми в системі освіти: загальноосвітній навчальний заклад – доуніверситетська підготовка – вищий навчальний заклад : зб. наук. праць III Всеукр. наук.-практ. конф., 27 квітня 2017 р., м. Київ, Національний авіаційний університет*. К. : НАУ, 2018. С. 218-221. URL: http://elar.khnu.km.ua/jspui/handle/123456789/6466 (дата звернення: 10.02.2023).

6. Rudyk O. Investigation of a universal puller of bearings with SolidWorks /O. Rudyk, P. Kaplun, V. Honchar. *Інформаційні технології в металургії та машинобудуванні. ITMM'2022: тези доповідей міжнародної науково-практичної конференції (Дніпро, 18 травня 2022 р.) / Міністерство освіти і науки України, Український державний університет науки і технологій, Дніпропетровський національний університет імені О. Гончара, Національний технічний університет «Дніпровська політехніка» та ін.* Дніпро: НМетАУ, 2022. С. 248-251. URL: https://journals.nmetau.edu.ua/index.php/itmm/issue/view/122/91 (дата звернення: 10.02.2023).

7. Rudyk O. Yu. Application of SolidWorks is for professional preparation of specialists / O. Yu. Rudyk, P. V. Kaplun, V. A. Goncha. *II Міжнародна науково-практична інтернет-конференція «Ресурсно-орієнтоване навчання в «3D»: доступність, діалог, динаміка»: збірник тез доповідей (електронне видання) (м. Полтава, 22–23 лютого 2022 року)*. Полтава : ПУЕТ, 2022. С. 140-146. URL: http://elar.khmnu.edu.ua/jspui/handle/123456789/12794 (дата звернення: 10.02.2023).

8. Rudyk O. Yu. Use of SolidWorks for determination of working device for installation and disassembly of brake drums / O Yu. Rudyk, F. O. Ziabkin. *Modern scientific research: achievements, innovations and development prospects. Proceedings of the 8th International scientific and practical conference. MDPC Publishing. Berlin, Germany, 2022*. Pp. 21-27. URL: https://sci-conf.com.ua/viii-mezhdunarodnaya-nauchno-prakticheskaya-konferentsiya-modern-scientific-

research-achievements-innovations-and-development-prospects-23-25-yanvarya-2022-goda-berlin-germaniya-arhiv/ (last accessed 2023/02/10).

9. Rudyk O. Yu. Computer simulation of the electrohydraulic lift with the help SolidWorks Simulation / O. Yu. Rudyk, O. V. Shepilo. *The world of science and innovation. Proceedings of the 10th International scientific and practical conference. Cognum Publishing House. London, United Kingdom. 2021*. Pp. 160-167. URL: https://sci-conf.com.ua/x-mezhdunarodnaya-nauchno-prakticheskaya-konferentsiya-the-world-of-science-and-innovation-5-7-maya-2021-goda-london-velikobritaniya-arhiv/ (last accessed 2023/02/10).

10. Рудик О. Ю. SolidWorks – CAD/CAE-система технічних вузів / О. Ю. Рудик, П. В. Каплун. *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://sci-conf.com.ua/ii-mezhdunarodnaya-nauchno-prakticheskaya-konferencziya-science-society-education-topical-issues-and-development-prospects-20-21-yanvarya-2020-goda-harkov-ukraina-arhiv/ (last accessed 2023/02/10).