ABSTRACTS of PUBLICATIONS

of Ch. Assistant Prof. Elisaveta Dimitrova Ivanova, PhD, Eng.

submitted for participation in a competition for an academic position "Associate Professor" in the field of higher education 5. Technical sciences,,

professional field: 5.5. "Transport, shipping and aviation",

specialty 02.01.03. „Mechanical engineering and machine elements"

I. PUBLICATIONS INCLUDED IN A REFERENCE ACCORDING TO A MODEL PROVING COMPLIANCE WITH THE MINIMUM REQUIREMENTS FOR OCCUPYING THE ACADEMIC POSITION "ASSOCIATE PROFESSOR", ACCORDING TO THE LAW ON THE DEVELOPMENT OF THE ACADEMIC STAFF IN THE REPUBLIC OF BULGARIA, 2018.

CRITERION A

INDICATOR 1. PhD thesis

Ivanova E., *Investigation of the influence of the type of the deformation process on the operational characteristics of the flexible couplings with a non-metallic element,* TU-Varna, 2016.

The stress state of the elastic element in the coupling, in accordance with its strength properties, determines its ability to withstand loads under certain operating conditions. The great diversity in the properties of elastic materials leads to the need for theoretical research, modeling of deformation processes and experimental confirmation of the expected results. Since the level of stress depends on the type of material (rubber or polyurethane), the presence of reinforcement, the presence of misalignment, the nature of the load, thermal conditions, fatigue of the material, etc., too often the task of choosing the type of coupling is a necessity by evaluating a larger number of factors simultaneously.

Static and dynamic couplings created at TU-Varna have been studied. The deformation process of the elastic elements is modeled. A model for determining the critical moment for loss of stability of a normally loaded elastic element has been created. Based on the couplings created at TU-Varna, a criterion for evaluation of flexible couplings is derived, reflecting their ability to withstand loads under certain operating conditions.

SCIENTIFIC-APPLIED AND APPLIED CONTRIBUTIONS of the PhD thesis are:

1. A theoretical model for the stress and strain state of an elastic element of a SEGE coupling has been created.

2. Modeling of the deformation processes of couplings with normally loaded elastic element (SEGKE) and tangentially loaded elastic element (Periflex) has been performed and the parameters for loss of stability have been determined.

3. The influence of the modulus of elasticity and Poisson's ratio of the tire, the modulus of elasticity and Poisson's ratio of the cord threads, as well as the speed of rotation on the load capacity of the couplings was determined.

4. The probabilistic results of the performed modeling of the stress and strain state of the elastic elements of couplings type SEGE, SEGKE and SEGME have been confirmed experimentally.

5.   Using the methodology used for the performed multifactor analysis, the influence on the load capacity of the flexible coupling and other operational factors such as radial and angular displacements, level of thermal conditions and others can be assessed.

CRITERION B

INDICATOR 2. Published habilitation thesis – monograph

> **E. Ivanova** "CAD / CAE technologies in engineering graphics in the process of efficient design"

The monograph provides an overview of the most popular CAD systems, which are widely used in engineering - research and production work. The basic principles and methods for designing 2D and 3D objects with the most popular CAD systems AutoCAD and SolidWorks are presented. A comparative analysis of work and possibilities for easy modeling and editing of models with the two CAD systems AutoCAD and SolidWorks for application in finding a solution to engineering and research problems. An assessment of appropriate software for its application in the innovative specialties introduced in Naval Academy, in the research work of doctoral students and in the design work of engineers has been made.

A modern approach is applied to study the loss of stability of elastic elements of flexible couplings for faster calculation of the occurring stresses and strains. The loss of stability of two types of flexible couplings Periflex and SEGKE was studied. The results of the simulation studies show that the height, the thickness of the tire and the diameter of the middle contact surface of the rubber are the geometrical parameters that increase the maximum operating torque of the coupling. For a SEGKE coupling with a rubber cord elastic element, the results show a nonlinear relationship between the increase in the angular deviations of the coupled shafts and the decrease in the critical torque of the coupling.

A theoretical and computer model of an flexible coupling with a non-metallic elastic element SEGE has been developed and analyzed in the environment of Solid Works Simulation, as the influence of various factors on the deformation process of the coupling has been established. A theoretical method for calculating the critical angular velocity of the coupling is proposed. A simulation approach is applied to study the physico-mechanical properties and geometric dimensions of the elastic element, as well as the rotation speed and the critical rotation speed of the SEGE flexible coupling on the deformation process..

CRITERION G

INDICATOR 3. Publications in scientific journals referenced and indexed in world-famous databases with scientific information (**Scopus, Web of Science**).

> 1.   Ivanova E., Vasilev T. (2020) *Critical Speed of Flexible Coupling - Determining with CAE Software* // In: Mitrovic N., Milosevic M., Mladenovic G. (eds) In Book: Computational and Experimental Approaches in Materials Science and Engineering, CNNTech 2018, Lecture Notes in Networks and Systems, vol 90. Springer, Cham, Print ISBN978-3-030-30852-0, Print ISBN978-3-030-30852-0; https://www.scopus.com

An flexible coupling with a rubber element is considered, the working parts of which are half of all cylinders made together with a bearing ring. The elastic elements are loaded with pressure. The critical speed of rotation of the flexible coupling is related to the radial deformation that the elastic element receives during operation. By standard, metal thumbs, with their shape, must limit its radial

deformation. But in the process of work, under the action of torque and speed of rotation, it deforms and changes its overall size. The thumbs press on the loaded cylinders and deform them plastically at certain speeds and loads. As a result of this deformation, the elastic element loses working weight and needs to be replaced. The elastic elements of the couplings are made of various polymeric materials, the properties of which have a significant impact on the dynamic properties of the coupling.

The radial deformation of the loaded cylinders is determined. Critical velocities at which the rubber elastic element is pinched are defined, depending on the properties of the material used, using CAE software. It was found that the critical speed of rotation increases with increasing modulus of elasticity of the elastic element from 4 to 8 MPa and decreases with increasing material density from 1080 to 1900 kg / m^3. The results show that achieving the maximum rotational speed for the investigated elastic coupling without plastic deformation requires an elastomer with a modulus of elasticity E ≥ 6MPa and a density ρ≤1100 kg / m^3. The results of these tests will be used to correct some of the geometrical parameters of the elastic element or a more appropriate geometry of the metal pins to ensure the required load capacity of the coupling.

2.   Dikova T, Vasilev T, D Dzhendov, E Ivanova, *Investigation the fitting accuracy of cast and SLM Co-Cr dental bridges using CAD software*, Journal of IMAB, - Annual Proceeding (Scientific Papers), 2017 Jul-Sep;23(3):p. 1688-1696; ISSN: 1312 773X (Online), https://www.journal-imab-bg.org/issues-2017/issue3/vol23issue3p1688-1696.html

The aim of the present paper is to investigate the fitting accuracy of Co-Cr dental bridges, manufactured by three technologies, with the newly developed method using CAD software. The four-part dental bridges of Co-Cr alloys were produced by conventional casting of wax models, casting with 3D printed patterns and selective laser melting. The marginal and internal fit of dental bridges was studied out by two methods – silicone replica test and CAD software. As the silicone replica test characterizes with comparatively low accuracy, a new methodology for investigating the fitting accuracy of dental bridges was developed based on the SolidWorks CAD software. The newly developed method allows the study of the marginal and internal adaptation in unlimited directions and high accuracy. Investigation the marginal fit and internal adaptation of Co-Cr four-part dental bridges by the two methods show that the technological process strongly influences the fitting accuracy of dental restorations. The fitting accuracy of the bridges, cast with 3D printed patterns, is the highest, followed by the SLM and conventionally cast bridges. The marginal fit of the three groups of bridges is in the clinically acceptable range. The internal gap values vary in different regions – it is highest on the occlusal surfaces, followed by that in the marginal and axial areas. The higher fitting accuracy of the bridges, manufactured by casting with 3D printed patterns and SLM, compared to the conventionally cast bridges is a good precondition for their successful implementation in the dental offices and laboratories.

INDICATOR 4. Publications in journals with scientific review, not referenced in world-famous databases of scientific information

1. Ivanova, E., Angelov, N., *Characteristic features of the AUTO CAD design program //* Marine Scientific Forum, Ship Energy, Mechanics, Ship Repair – Naval Academy - Varna, book 3/2011, p.105-111, ISSN1310-9278;

The article presents some practical guidelines for making working drawings using Auto CAD. The software through the menus for drawing, editing, sizing, mode buttons, drawing through layers, through coordinates and drawing points allows quick and accurate adjustment of the drawing, which facilitates engineering design

2. Ivanova, E., Dikova, Ts., *Basic operations when working with the AUTO CAD program* // Marine Scientific Forum, Ship Energy, Mechanics, Ship Repair – Naval Academy -Varna, book 3/2011, p.112-117, ISSN1310-9278

The article presents the basic operations and techniques of drawing and design with Auto CAD software. Knowledge of the basic operations and techniques of drawing and design allows for easy and accurate visualization of details in the necessary projections - views, sections, sections and other images.

3. Ivanova, E., Dikova, Ts., *Application of the AUTOCAD program when drawing drawings* // Marine Scientific Forum magazine, Ship Energy, Mechanics, Ship Repair – Naval Academy -Varna, book 3/2011, p.118-122, ISSN1310-9278

This publication presents the practical application of the basic Auto CAD commands for drawing and editing. The aim is to assist future designers in their work for quick and easy visualization of technical objects. The presented drawing technique with AUTO CAD proves that the automation of drawing and design work is possible only by technical staff who have mastered the theory and methodology for proper execution of design documentation.

4. Angelov, N., Ivanova, E., *AUTODESK INVENTOR in the training of students in "INFORMATION TECHNOLOGIES* // Marine Scientific Forum, Ship Energy, Mechanics, Ship Repair – Naval Academy -Varna, book 3/2011, p.151 -154, ISSN1310-9278

The report presents some methodological problems in the implementation of Autodesk Inventor in the training of students at Naval Academy "N. Vaptsarov" - Varna, Bulgaria.

5. Vasilev, T., Dikova, Ts., Dzhendov,D., Ivanova, E. *Simulations of cast and selective laser melted dental bridges with chewing load* // Scripta Scientifica Medicinae Dentalis, vol. 2, No 2, 2016,p7-17,Medical University of Varna, ISSN2367-7236(print), ISSN2367-7244(online)

The aim of the present paper is to evaluate and compare the strength properties and deformation characteristics of cast and Selective Laser Melted (SLM) Co-Cr dental alloys by using CAD/CAE software. The Solid Works Simulation software is used for simulation of chewing load of the virtual 3D model of a four-part dental bridge. Two Co-Cr dental alloys, cast and SLM were used in this study. During the simulation process by means of linear static analysis the displacements, strains, stresses, and reaction forces under the effect of the applied load were calculated. As a result, the equivalent von Mises stresses, Factor of Safety (FOS) and displacements were evaluated in this study.

It was established that the highest values of the equivalent von Mises stresses of cast and SLM bridges are situated in the connectors between the teeth, i.e. the zones with the lowest areas of the cross sections. They are in the range 95-162 MPa, which is lower than the stress limits for the both materials. The minimum FOS of both materials is higher than 1. In the cast bridges it is 1.32-2.64 in the zones with the highest load, while in the SLM samples it is 2.61-5.68. As FOS shows the reserve strength of the material for the applied load, it is obvious that the SLM bridge possesses twice as high reserve strength. This allows optimization of the construction, economy of material and possibility for manufacturing of objects with porous structures.

6. Vassilev, T., Sabeva, V., Ivanova, E. *Distribution of the power load in the ropes of "Delta 3D rope printer"* // scientific journal Mechanics, Transport, Communications, article №1416, volume 15, issue 1/2017, p.VII-1-VII-6/2017, ISSN1312-3823 (print), ISSN 2367-6620 (online)

With the use of 3D printing technology by layer extrusion, it is possible to print on construction sites, although the printers are significant in size and size equipment. The main reason for the large dimensions of the existing structures of 3D printers for construction sites are the arising stresses from the bending forces that the structure must absorb. Under a proposed new 3D printer circuit ("delta 3D rope printer"), high bending stresses are transformed into normal tensile stresses. At present, the printer has been developed as a conceptual design, for this reason it is necessary to theoretically determine the effort in the ropes on which to hang the extruder (load). Accurate determination of the forces in the ropes is necessary to determine the load of the individual elements, their deformation, as well as to determine the diameter of the ropes. The methods used to determine the forces in the ropes are classical, the first of which is the creation of a system of equations for a statically definable system of forces, and the second is the solution of the system of equations using Kramer's formulas. In the course of theoretical research it was found that the forces in the ropes are different for each coordinate of the intersection point between the three bearing branches of the printer. This leads to different deformations in the pylons and different sagging of the load, for which it is necessary to make additional studies. By analyzing the obtained graphic dependences, a figure can be determined, for which it is known that the efforts in the ropes fall within a certain interval.

7. Vasilev, T., Dikova, T., Dzhendov, D., Ivanova, E, *NEW METHODOLOGY FOR MEASURING THE FITTING GAP OF FIXED PARTIAL DENTURES USING CAD SOFTWARE*// International Scientific Conference Material Science. Non-Equilibrium Phase Transformations-Sofia: Scientific Technical Union of Mechanical Engineering Industry 4.0,Year I, Issue1, 2017, p. 88-91; 2535-0218 (print), 2535-0226 (online)

The necessity of precise estimation of the gap between the crowns-retainers and abutments of dental bridges requires the development of new methods for their measurement. The introduction of rapid prototyping technologies, including 3D scanning and printing, enables trouble-free creation of virtual models of complex objects in terms of form. The determining of the gap between the bridges and abutment structures in CAD systems leads to difficulties mainly due to their complex shapes. The new methodology, based on engineering CAD software, was developed in this study, which overcome these difficulties. By applying the proposed approach for virtual adjusting between the dental constructions, it is possible to determine the gap between the bridge-retainers and the abutments in enclosed spaces, which are alternatively determined by indirect methods. The main advantages of the new methodology are: 1) complete tracking of the variation of the distance between the surfaces of the bridge-retainers and the abutments; 2) measurement of distances between the surfaces along the three axes and perpendicular; and 3) higher accuracy of the measurements.

8. Ivanova, E., Vasilev, T., Hristov, H., *Study the influence of rotation speed on deformation process for flexible coupler with rubber elastic element*// International Scientific Journal „Machines,Technologies,Materials" - Sofia: Scientific Technical Union of Mechanical Engineering Industry 4.0 Year XI, Issue 7/2017, p.336-339; ISSN WEB 1313-0226 (print),ISSN1314-507X (online)

When operating with flexible couplers with a rubber elastic element according by standard BDS 16420:86, a plastic deformation of the tire is observed after a certain period of time. To investigate the deformation process of the elastic element and to determine the main parameters that affect it, it is necessary to develop a computer model and observe the deformation process when changing the

factors of greatest impact. For CAE program in witch is analysing the model is choosing Solid Work Simulation. The results obtained in the study give a clear picture of how the deformations obtained are influenced by the parameters characterizing the operation mode. These results will be used in the design of a elastic element with which the coupler design will operate flawlessly for a longer period of time

9. Vasilev T., Dikova T., Ivanova E., *METHODOLOGY FOR DESIGNING OF APPLIANCE FOR BENDING TEST OF FOUR-PART DENTAL BRIDGES*// International Scientific Conference Industry 4.0. - Sofia: Scientific Technical Union of Mechanical Engineering Industry 4.0, Year.1,Volume 1/1, December 2017, p. 125-128; ISSN (Print) - 2535-0153, ISSN (Online) - 2535-0161

The four-part dental bridges from 1st premolar to 2nd molar are the most loaded during the chewing process. In addition, they are characterized by complex geometry of the teeth surface and complicated way of load distribution. The aim of the present paper is to develop a methodology for designing of appliance for bending test of four-part dental bridges that achieves the load of the bridge bodies close to the actual load. The using of CAD software allowed determining the shape and sizes of the pistons, the distance between the centers in the two main directions and the angle, at which the device must be located relative to the test specimen. The designed device provides contacts between the spherical tips of the punches and the teeth - bridge bodies in the most loaded areas in occlusion and a loading scheme that only produces normal stresses in the bridge construction during bending. As a result, appliance for bending test of four-part dental bridges was designed, produced and used in the next experiment.

10. Ivanova, E., Vassilev, T.*, Influence of the physic - mechanical properties of the elastic element on the deformation process of the SEGE coupling* // Mechanical Engineering and Mechanical Engineering, year XIII, book 1/2018, p105-108, ISSN1312-8612

Flexible coupling according to BDS 16420-86 is investigated with a computer model. It is analyzed by Solid Works Simulation. A change in the density of the elastomer is set in the range of 1 to 2 g/cm3. In order to make a full assessment of the impact of the individual physico-mechanical properties on the deformation process of the coupling, a planned experiment is made. Torque T and Shore hardness of the rubber were accepted as factors affecting the deformation. The plan is being executed for different speeds of rotation. Centrifugal forces on flexible cylinders were reported.

11. Vassilev, T., Ivanova, E. *Geometric and kinematic dependences of a rope delta 3D printer for construction sites* // Mechanical Engineering and Mechanical Engineering year XIII, book 1/2018, 2018, p.91-95, ISSN1312-8612

It is possible to print construction sites using the technology for 3D printing of construction mixtures by layer extrusion.. The proposed design for a 3D printer, called a delta 3D printer, has so far carried out research on the force load of the individual elements, deformations, as well as the prerequisites for creating a prototype printer. In order to create this type of printer, whether it is a prototype or a real model, it is necessary to determine the geometric and kinematic relationships between the actuator (extruder) and the auxiliary elements (supporting ropes). The data obtained is required when selecting the printer drive, as well as the software to create a driver.

12. Ivanova,E., Tenev,S., Vasilev,T., *The theoretical model for determinig critical rotation speed flexible coupling type SEGE*, Scientific Bulletin of Naval Academy, Romania, Vol. XXI 2018, pg. 326-329., ISSN: 2392-8956; ISSN-L: 1454-864X.

It is explored an elastic coupling with a rubber element, the working parts of which are half of all cylinders made with a carrying a ring. The elastic elements are subjected to compression. On the non-loaded cylinders a centrifugal force acts to cause their radial displacement. Due to the relatively slow relaxation of the rubber component in the reverse or impact load is in danger of not loaded cylinders can be pinched between the metal claws of semi couplings. It is determined the radial displacement of these cylinders. Are defined critical speeds, in excess of which is derived pinching the rubber elastic element

13. Ivanova,E., Vasilev,T., *Influence of Elastic Element Design Parameters on Buckling Effect for Different „Periflex" Shaft Couplings*, Scientific Bulletin of Naval Academy, Romania, Vol. XXI 2018, pg. 335-341, ISSN: 2392-8956; ISSN-L: 1454-864X.

In the article has made research into the buckling resistance of flexible shaft coupling with toroidal elastic element. It is made a comparison between four different designs of "Periflex" coupling, the received data are preparing and systemizing. The obtained data show how the construction parameters of the elastic element influence to the critical buckling torque. The data obtained can be used to design a shaft coupler that will transmission a higher torque with used of smaller quantity of material.

14. Ivanova,E., *Research loss of stability of flexible coupling SEGKE in case of angular compensation*, I-st International Conference –Naval Academy /2018, pg. 39-43 ISBN 978-619-7428-31-5;

In case of imperfect assembly, the jointed machine shafts cause a load which affects the machine operation mode. The rubber elastic element of coupling SEGKE contains internal reinforcing cords. This construction allows the coupling to have torsion resistance and axial flexibility.

The axial deformations of the flexible member produce additional axial forces at the place of connection with the metal flange. Critical moment values were calculated where a flexible element lost resistance through a computer experiment using Solid Works. The computer model is based on one full revolution of the elastic coupling. Calculation is made if the misalignment is up to 5 degrees..

15. Ivanova, E., *Research on the Influence of the geometric dimensions of flexible coupling on the deformation process using CAE software*, Proceedings of the Doctoral Scientific Conference, Naval Academy, Varna, 67стр., 2019, ISBN 978-619-7428-45-2(print), ISBN978-619-7428-45-2 (on line),
http://www.naval-acad.bg/wp-content/uploads/2020/04/SBORNIK-DOKTORANTSKA-KONFERENCIA.pdf

The present article deals with FEM analysis of flexible coupling with rubber elastic element. Working parts of coupling are half of all cylinders made with carrying ring. Fingers press the loaded cylinders and deform them plastically. As a result of this deformation, the elastic element loses a work stable and needs to be replaced. The radial deformation, which receives the elastic element in the working process, depends to a large extent on the speed of rotation of the coupler and the modulus of elasticity and density of the material of the elastic member. Creates different configurations of a standard flexible coupling, being corrected some of the geometric parameters of the elastic member by using CAE software. Simulation tests are looking for the appropriate geometric dimensions of the elastic element to ensure the required coupling load.

16. Ivanova, E., *Basic properties of nonmetallic materials affecting the performance of flexible couplings*, XVIII International Scientific Congress "Machines. Technologies. Materials 2021", Winter Session, Scientific- Technical Union of Mechanical Engineering - Industry 4.0., Bulgaria, 114-118стр. ; ISSN (Print) - 2535-0021, ISSN (Online) - 2535-003X; http://mtmcongress.com/winter/sbornik/1-2021.pdf

The elastic element is the most responsible element in the construction of flexible couplings. Ensuring trouble-free operation of the coupling and long service life is associated with the need to know all the factors that affect the elastic properties and the stress-strain state of the couplings. The aim of the paper is to give an overview of the main properties of non-metallic materials, influencing the performance of flexible couplings. It has been found that fatigue resistance depends on the deformation mode. It improves with decreasing amplitude or strain, and the influence of frequency is relatively weak. Depending on the mode of deformation, it is advisable to choose the type of elastomer used.. Depending on the amount of sulfur, fillers and vulcanization conditions, different rubber properties are obtained, having a very wide range of changes in mechanical properties. The great variety of elastic materials and the specifics of the mode of operation of different mechanical systems justify the need for experimental study and confirmation of the degree of influence of various factors on the performance of flexible couplings.

17. Ivanova,E., *Factors influencing on the performance of elastic couplings,* VI International Scientific Conference "Industry 4.0"- Summer session, ISSN 2534-8582 (Print), ISSN 2534-997X (Online) (под печат)

In modern mechanical engineering, flexible couplings are characterized by a great structural variety, which is mainly expressed in the variety of shapes of the flexible elements. Differences in the shape of the flexible coupling elements and the type of connections, along with the properties of the elastic material, have a significant impact on the dynamic properties of the coupling. For the correct choice of flexible coupling it is necessary to know all main characteristic of it (compensating properties, linearity of the characteristic, damping ability, stiffness, energy consumption, etc.). The aim of the article is to make a review of various factors that affect the performance of the elastic couplings - the type of elastomer, elasticity, structural and functional features of the structure

CRITERION E Published University textbook

1. **Ivanova E.,** Engineering Graphics - Part I, Naval Academy - Varna, 2019, 102 pages.

The textbook consists of a theoretical part and course assignments for each practical lesson. The theoretical part is divided into lectures on each topic. The topics are developed according to the approved curriculum of cat. "Technical Mechanics" of the Faculty of Engineering at Naval Academy - Varna.

The theoretical part includes all topics for design and ways of depicting the details in the working drawings and the way of forming these drawings. The material in the lectures is in accordance with the current national and international standards, which students must know and be able to work with them in their future work. Some standards and reference materials are given in the development for training purposes. The material is supported by the necessary number of examples for better learning and understanding.

After each topic there are control questions to check the absorption of the material. Course assignments have also been developed, supported by examples of how to implement them. Students must be able to independently prepare working drawings of the given details and solve the project tasks, applying the acquired knowledge.

A test has been prepared to check the acquired knowledge, which they must do after the end of the training course.

The textbook is intended for students majoring in "Ship Machinery and Mechanisms" at Naval Academy "N. Vaptsarov" - Varna. It can also be used by all students from other technical and mechanical engineering specialties in the school, who study "Engineering Graphics", the preparation and application of "Design Documentation".