REVIEW

in a competition for acquiring the academic position of "Associate Professor" in the Field of higher education 5. Technical Sciences Professional direction 5.1. Mechanical Engineering, Scientific specialty "Structural mechanics, strength of materials", promulgated in SG № 53 /12.06.2020 for the needs of Technical University of Gabrovo

Reviewer: Professor Nikolay Dimitrov Minchev, DSc

1. General description of the submitted materials

The only candidate in the competition is Vladimir Petrov Dunchev – Ch. Assistant Professor PhD in the Department of Technical Mechanics at the Faculty of Mechanical Engineering and Instrumentation in the Technical University of Gabrovo. Vladimir Petrov Dunchev was born on March 28, 1986 in Gabrovo. He graduated from the University of Architecture, Civil Engineering and Geodesy, majoring in Construction of Buildings and Facilities in 2011. In 2015 he defended his PhD thesis in Applied Mechanics on the topic: "Information and computing system for offering and optimal design of metal structures of bridge cranes". Since 2015 he has been an Assistant, and since 2017 he has been Ch. Assistant Professor in Construction Mechanics, Strength of Materials in the Department of Technical Mechanics.

In the competition for acquiring the academic position of "Associate Professor" the candidate participates with a total of 35 scientific works, divided into groups of indicators according to the national requirements of ZRASRB/2018, as follows: Abstract of PhD dissertation on topic: "Information and calculation system for offering and optimal design of metal structures of bridge cranes" [A.1]; 8 scientific publications for acquisition of PhD degree; 10 related scientific publications in international scientific journals with Impact Factor, indexed by the Web of Science, on the topic: "Increasing the fatigue strength of metal structural elements through static surface plastic deformation" [B.1-B.10]; 1 scientific publication in international scientific journals that are referenced and indexed in world-famous databases of scientific information [G.1]; 13 scientific publications in unreferred journals with scientific review or in edited collective volumes [G.2 - G.14]; two textbooks in electronic format [U.1, U.2]. All scientific works are in the field of competition. 26 scientific papers other than those included in the PhD procedure are reviewed. Of these, a total of 11 are scientific articles in international scientific journals with Impact Factor, indexed by Web of Science, 10 - scientific articles in scientific journals in Bulgaria, three scientific reports at scientific conferences and two textbooks in

electronic format. The candidate participates in the competition with eight sole scientific papers and he is the first author in six scientific publications.

2. General characteristics of the research, applied research and teaching activity

The object of special attention are the related scientific publications, equivalent to a monographic work [B.1 - B.10]. They are dedicated to the global problem of increasing the fatigue strength of metal structural elements. For this purpose, static mechanical surface treatment methods were used, the advantage of which is the ability to control the parameters of the respective process in correlation with the studied characteristics of Surface Integrity (SI) (roughness, microhardness, residual stresses, microstructure). Using this advantage, the monograph is based on the idea of predicting and managing the fatigue behavior of the respective elements by studying and modeling the basic characteristics of SI. The object of research are the processes diamond burnishing and burnishing with a toroidal deforming roller. The efficiency of the diamond burnishing process in the aspect of fatigue strength increasing of external rotary elements made of high-strength aluminum alloy 2024-T3, low-alloy structural steel 41Cr4 and high-alloy austenitic steel AISI316Ti [B.1– B.4, B.6, B.7, B.9] and burnishing with toroidal deforming roller process was studied [B.10].

An in-depth comparative analysis of the influence of the tangential contact type (sliding friction/rolling contact) on SI and the fatigue behavior of 41Cr4 steel specimens subjected to diamond burnishing and burnishing with a toroidal deforming roller was made [B.8]. On this basis, a conclusion was made about the thermo-mechanical nature of the diamond burnishing process, while roller burnishing and deep rolling processes can be considered optimal in terms of "minimum generated entropy". For 2024-T3 aluminum alloy by fractographic analysis it was found that fatigue cracks are formed at the boundary between the affected surface layer and the bulk material, which confirms the effect of modification of the surface layer after diamond burnishing [B.1, B.3]; The efficiency of the diamond burnishing process for increasing the fatigue strength of joint bar holes as elements in the rail-end units in the railway is substantiated [B.4]. It has been provev that the number of passes is a reliable criterion for achieving a stabilized cycle of surface layers subjected to burnishing, which is directly correlated with fatigue limit maximizing [B.5].

The main research approaches in scientific works are the experimental approach and the FEM approach. The experimental studies are based on pre-planning and planning of the experiment, rotational bending fatigue tests with cycle asymmetry coefficient R = -1, microstructural analysis, fractographic analysis, regression analysis, one-objective and multi-objective optimizations and X-ray diffraction analysis. In order to evaluate the influence of the diamond burnishing, roller burnishing, and deep rolling process parameters on the stressed and strained state in the surface layers, numerical simulations based on one-way coupled [B.5] and fully coupled thermo-mechanical 3D FE models [B.2, B.6, G.14] were used. An in-depth

review of various strategies for building finite element models of static mechanical surface treatment processes has been made [G.5].

Using a combined approach, including an experimental intendation test and inverse finite element analysis, temperature-dependent constitutive models of the surface layers of 2024-T3 aluminum alloy [G.6], CuAl8Fe3 bronze [G.9] and AISI316Ti high- austenitic alloy steel [G.12], subjected to diamond burnishing, were developed. Except the classic one-objective and multi-objective optimizations, the following have been substantiated and developed: a new multi-objective optimization procedure for obtaining compromise optimal values for both objective functions and diamond burnishing governing factors, providing a compromise between low roughness and high fatigue limit [B. 7]; a cost-effective optimization approach for increasing the fatigue strength of diamond-burnished metal components by controlling some of the SI characteristics [B.9].

Indisputable integral criterion for the efficiency of the studied processes in terms of increasing the fatigue strength are the experimentally obtained series of S-N curves [B.1, B.2, B.6, B.10]. In this way, the correlation between the characteristics of SI, respectively the different combinations of governing factors (which lead to different processes) on the one hand, and the fatigue behavior on the other hand, was proved. In the context of the same scientific problem, the fatigue curves of 35HGS steel samples have proven the advantage of the ionic nitriding process compared to quenching and grinding [G.2]. Experimental and numerical studies have confirmed the potential of the diamond burnishing process in terms of improving SI on CuAl8Fe3 bronze samples [G.8], AISI316Ti high-alloy austenitic steel [G.12], 41Cr4 low-alloy structural steel [G.10, G.11] and low, medium and high carbon steels [G.4].

As far as it is not directly related to the scientific problem of modifying the surface layers and increasing the fatigue strength, the study of the dynamic response of the "main beam-hoist-load" system caused by the movement of the hoist-rope-load system is relatively autonomous [G.1].

The candidate has participated in the following research projects: two national projects, funded respectively by the Operational Program "Science and Education for Smart Growth" and the National Fund "Research"; five university projects funded by the Research Fund. Thematically, university research projects are focused on the problem of increasing the fatigue life of metal structural elements. According to the attached reference, Ch. Assistant Professor PhD V. Dunchev has contributed to the modernization of the material and technical base in the Department of Technical Mechanics.

Ch. Assistant Professor PhD V. Dunchev has led lectures on Strength of Materials, Mechanics I, Mechanics II and Mechanics, as well as laboratory and seminar exercises in the same disciplines and the disciplines Theoretical Mechanics, Technical Mechanics and Applied Mechanics. A part of the candidate's scientific publications are co-authored with defended and current PhD students in the Department of Technical Mechanics, which confirms his commitment to the teaching process of PhD students.

3. Basic scientific, scientific-applied, and applied contributions

Of great importance are the ***scientific contributions*** in the following categories:

Proving with new means of significant new aspects of already existing scientific fields, problems, theories, hypotheses, etc.

1). For materials that are hardened under the cyclic deforming action, the hypothesis is substantiated and proved experimentally that in order to maximize the fatigue limit it is necessary the surface layer to reach a stabilized cycle [B.5];

Obtaining and proving new facts

2). It has been proven that different governing factors combinations lead to different static burnishing processes (smoothing, mixed and deep), characterized by different Surface Integrity (SI), which corresponds to different fatigue life and fatigue limit, which allows to manage and predict fatigue behavior by managing SI [B.1, B.3, B.7, B.10].

The scientific-applied contributions can be grouped in the following thematic areas:

I. Investigation and modeling of characteristics of Surface Integrity (SI) (roughness, microhardness, residual stresses, microstructure) in metal structural elements, depending on the parameters of different burnishing, thermal - and chemical-thermal processes [B.1 - B.10, G.2, G.3, G.4, G.7, G.8, G.10, G.11, G.13];

II. Investigation and modeling of fatigue strength, fatigue limit and fatigue life of metal structural elements subjected to various burnishing processes, thermal- and chemical-thermal processes [B.1, B.2, B.4, B.6, B.8, B.10, G.2];

III. The optimal and compromise optimal values of the governing factors of burnishing processes are defined, obtained on the basis of both classical one-objective and multi-objective optimizations, as well as new multi-objective optimization procedures [B.2, B.4, B.7, B. 9, G.8];

IV. One-way coupled and fully coupled (thermo-mechanical) 3D finite element models of different burnishing processes were developed [B.2, B.5, B.6, G.14];

V. New facts about the physical and mechanical condition of the surface layers of metal structural elements subjected to various burnishing processes have been obtained and proved. [B.1, B.3, B.5, B.8, G.11];

VI. Temperature-dependent constitutive models of the surface layers of various structural materials, subjected to diamond burnishing for application in related thermo-mechanical finite element analyzes of rotational components, have been developed [G.6, G.9, G.12];

VII. Applying a new engineering method for separating the variables in the differential equation of the elastic line of Bernoulli-Euler beam, a solution of the compiled mechano-mathematical model of the system "main beam-hoist-load" is obtained, which justifies a new dynamic coefficient taking into account the oscillations, caused by the movement of the „hoist-rope-load“ system [Г.1];

I accept the formulation of the applied contributions according to the author's reference of the candidate's contributions. Except the Wöhler curves, the obtained databases for the fatigue limit and the characteristics of SI after diamond burnishing of various structural materials, with the possibility of technical applications in engineering practice are: Tool set, implementing a new hardening technology for processing of joint bar holes in the rail-end units [B.4]; Special device for burnishing with toroidal deforming roller, with the possibility to control the burnishing force and the deforming roller geometry [B.8, B.10].

4. Significance of contributions to science and practice

Scientific, scientific-applied and applied contributions enrich scientific knowledge and practices regarding the effectiveness of various burnishing processes for increasng the fatigue strength and fatigue life of structural elements of different groups of structural materials with tough-plastic behavior. Ch. Assistant Professor PhD Vladimir Dunchev belongs to the research team created under the leadership of Prof. Jordan Maximov, DSc, whose scientific production maintains a world level in the field of scientific problem. Indisputable proof of the level of scientific production is the large number of scientific articles (11 articles) published in international scientific journals with Impact Factor, indexed by Web of Science, as well as the significant number of citations in international scientific journals with Impact Factor - 15 citations. According to this group of indicators (group D) the candidate exceeds the minimum scientometric requirements for acquiring the academic position of "Associate Professor" three times.

5. Assessment of the candidate's personal contribution

Of the peer-reviewed scientific works, eight are sole, and Ch. Assistant Professor PhD Vladimir Dunchev is the first author in six scientific works. This proves the candidate's ability for both individual work and team work. The reference in google scholar citation shows that Ch. Assistant Professor PhD Vladimir Dunchev has h-index = 5, which confirms the acquisition of fame in the scientific community in the field of scientific problem.

6. Critical notes

I have no critical remarks of a principled nature.

7. Conclusion

The assets of Ch. Assistant Professor Vladimir Petrov Dunchev by groups of indicators meets the minimum national requirements for the academic position of "Associate Professor" according to ZRASRB/2018, especially convincingly in Group B, where he participates with 10 related scientific publications published in international scientific journals with Impact Factor, indexed by the Web of Science.

On this basis, taking into account his research, applied research and teaching activities, I propose:

Ch. Assistant Professor Vladimir Petrov Dunchev to take the academic position of "Associate Professor" at the Technical University of Gabrovo, in the field of higher education 5. Technical Sciences, professional field – 5.1. Mechanical engineering, scientific specialty "Structural mechanics, strength of materials".

02.12.2020 **REVIEWER: /signature/**
/Prof. Nikolay D. Minchev, DSc/