



## OPINION STATEMENT

on the dissertation for obtaining the educational and scientific degree "**Doctor**" in: area of higher education 5. Technical Sciences, professional field 5.13 "**General Engineering**", scientific specialty "**Technology, Mechanization and Automation of the Woodworking and Furniture Industry**"

**Author of the PhD thesis:** Master's degree Eng. Rostislav Bozhidarov Bozhkov, part-time PhD student at the Department of Furniture Production at the University of Forestry, Sofia

**Topic of the PhD thesis:** "INFLUENCE OF MATERIAL PROPERTIES ON THE SOFTNESS OF UPHOLSTERED FURNITURE"

**Member of the scientific jury:** Prof. Dr. Eng. Nelly Nikolova Staneva, University of Forestry, Department of "Furniture Production", field of higher education 6. Agricultural Sciences and Veterinary Medicine, professional field 6.5. Forestry, scientific specialty "Technology, Mechanization and Automation of the Woodworking and Furniture Industry", appointed as a member of the scientific jury by order No. ZPS-228/23.04.2025 by the Rector of the University of Forestry.

### 1. Relevance of the Problem

The topic of the dissertation is actual and significant in the field of technological processes of upholstered furniture. The deformation behavior of upholstery structures in upholstered furniture is of particular importance for ensuring convenience, comfort and safety during operation.

Flame-retardant polyurethane foams are increasingly used, which meet European standards for protecting human health and are mandatory in the production of upholstered furniture for public buildings, public transport and others. Of great importance are the studies of the deformation behavior of upholstery structures made of flame-retardant polyurethane foams, as well as in combination with conventional polyurethane foams and other materials. The relevance of the dissertation is mainly in the study of the influence of the density and thickness of polyurethanes on the value of the criteria characterizing their deformation behavior in the upholstery structure.

### 2. Level of Understanding of the Problem and Creative Interpretation of the Literature Review

The PhD student candidate has studied a total of 82 literary sources, including 23 in Cyrillic, 51 in Latin and 8 standards – BDS, BDS EN ISO and ASTM.

An analysis of the studies of the structure-determining parameters of the upholstery of upholstered furniture – density and thickness of the individual layers of material, type of base, type of spring part, filling and facing part was made. The deformation behavior of the upholstery was analyzed.

At the end of the literature review, the candidate has formulated 3 main conclusions related to the influence of the properties of the materials used in the structure of upholstered furniture, the unresolved issues regarding the structure of upholstered furniture made of modern materials, as well as the lack of mathematical models for describing the influence of the properties of the materials.

The conclusions made are the basis for formulating the goal and main tasks of the dissertation work.



### **3. Aim, Objectives, Hypotheses, and Research Methods. Correspondence of the Chosen Research Methodology with the Stated Aim and Objectives of the Dissertation**

As a result of the conclusions made, the purpose of the dissertation was formulated: "Investigation of the change in the softness indicators and deformation characteristics of the upholstery when changing the physical-mechanical and elastic properties, thickness and number of materials used in the construction of the spring part of the upholstery structure."

To achieve the goal of the dissertation, the doctoral student has set himself 5 main tasks.

The main starting materials were selected: a solid base of coniferous spruce wood, lined on one side with birch plywood; spring package "Bonnell" and "Pocket"; conventional (N 3030 and N 3540) and flame-retardant polyurethane foams (CME 3025 and CME3530).

Initially, studies were conducted to determine the elastic properties and behavior under load of the main materials, testing 10 pcs. test bodies with different thicknesses from 20 to 140 mm and upholstery insert with 1, 2 and 3 layers. The results were used to determine the levels of change of the factors in the planned experiments conducted subsequently.

A stand was used to determine the initial softness, total deformation and softness coefficient.

Six basic upholstery structure schemes were formed and 10 test specimens were made from each. Multifactorial planned experiments were conducted. The results of the studies were processed variationally and statistically using the programs QstatLab 6 and SPSS 20. Mathematical models were derived using the regression analysis method.

The experimental studies were conducted in the laboratory of "Upholstery Technology" at the Department of "Furniture Production" of the Faculty of Forest Industry, University of Forestry.

### **4. Visualization and Presentation of the Obtained Results**

The text part of the dissertation is illustrated with 42 figures and graphs, as well as 16 tables, well-formatted and of good quality. They provide a good idea of the methods used, the results obtained and their interpretation.

### **5. Discussion of the Results and Used Literature**

The PhD student has fully completed the tasks set and with the obtained theoretical and experimental results the goal of the dissertation work has been achieved. Based on the conducted research and their analysis, the PhD student has drawn 9 main conclusions. Most of the literature used is after 2000. It is specialized and reflects previous and contemporary world achievements in the field of the researched topic.

### **6. Contributions of the Dissertation**

In the last part of the dissertation, Eng. Bozhkov summarizes the results of the research conducted, claiming that the following scientific and applied (3) and applied contributions (1) have been achieved:

#### **Scientific and applied contributions**

1. The values of the main indicators of softness of the upholstery structure have been established - initial softness; total deformation of the backrest; total deformation of the seat; coefficient of softness of the backrest and coefficient of softness of the seat for six different types of upholstery structure, the spring part of which is built from a spring package "Pocket", conventional polyurethane foams - N 3030, N 3540, flame-retardant polyurethane foams - CME 3025, CME 3530, upholstery insert and polyester wadding.

2. Based on the experimental results, graphical relationships between the loading force and the deformation behavior of the studied upholstery structures have been derived.

3. The established values and the degree of influence of the studied materials on the softness indicators of the upholstery can be used as a basis for determining the optimal option in the construction of a specific type of upholstery structure, according to its functional purpose.



## **Applied Contributions**

1. The studied upholstery structures can be implemented in the single, serial and mass production of seats and backrests of modern upholstered furniture complying with BDS 8962-90 "Furniture for Sitting and Lying Down. Softness Testing Method" and BDS 7669-89 "Furniture. Upholstery. Technical Requirements".

## **7. Assessment of the Degree of Personal Contribution of the PhD Student to the Contributions**

Engineer Rostislav Bozhkov was enrolled as a part-time PhD student on 15.01.2020 (Order No. ZSR-505/20.02.2019) in the scientific specialty "Technology, Mechanization and Automation of the Woodworking and Furniture Industry" with a deadline for completing the PhD studies on 15.01.2024.

I evaluate the research conducted, analysis of the results, conclusions and scientific-applied and applied contributions obtained with the development of the dissertation thesis as the result of the personal participation of the PhD student under the guidance of his scientific supervisor.

## **8. Critical Remarks and Questions**

I have the following comments about the dissertation:

1) The test specimens for testing the deformation behavior under load of the starting materials used for the spring part are not shown.

2) The standard for the method for testing the softness of the polyurethanes and spring packages used, as well as the description of the test specimens, are given in the chapter "Results", and not as is generally accepted in the chapter "Methods of Experimental Research". The chapter "Results" also contains many repetitions of some descriptions concerning the methodology.

3) Some literary sources such as numbers 43, 46, 70, 71, 72, 74, 80 are not correctly bibliographically written.

4) There are no recommendations regarding the application of the studied upholstery structures.

The above comments do not belittle the results and contributions achieved and reflected in the dissertation.

## **9. Published Articles and Citations**

A total of 4 publications have been made on the dissertation, 3 of which are independent. No citations are listed.

## **10. Evaluation of the Publications on the Dissertation: Number, Nature of the Editions in which They Are Printed. Reflections in Science - Use and Citation by Other Authors**

The publications present the main results of the research from the dissertation work. The three independent publications are in a proceedings of the International Scientific Congress "Machines, Technologies, Materials", which is in the National Reference List of Contemporary Bulgarian Scientific Publications with Scientific Review of NACID. One of the publications is in print in the journal "Management and Sustainable Development" and is not included in the report on the fulfillment of the minimum national requirements under article 2b, paragraph 2 and 3 of the RASB Law - State Newspaper No. 17 of 25.02.2020, app. in State Newspaper No. 21 of 12.03.2021. The total number of points that Eng. R. Bozhkov has under group of indicators "G" is 60 with minimum requirements of 30 points.

The presented summary of the PhD thesis objectively reflects the structure and content of the thesis.

## CONCLUSION:

Based on the research methods learned and applied by the PhD student, the correctly conducted experiments, the generalizations and conclusions made, I believe that the presented dissertation meets the requirements of the Law on Academic Staff Development in the Republic of Bulgaria (ZRASRB) and the Regulations of the University of Forestry for its application, which gives me reason to evaluate it **POSITIVELY**.

I would like to propose that the esteemed Scientific Jury also vote positively and award Eng. Rostislav Bozhidarov Bozhkov the educational and scientific degree "**Doctor**" in the professional field **5.13 General Engineering**, scientific specialty "**Technology, Mechanization and Automation of the Woodworking and Furniture Industry**".

**Date:** 26.06.2025  
Sofia

**PREPARED BY:** .....  
(Prof. Dr. Eng. Nelly Nikolova Staneva)