

# **REVIEW**

## **of a dissertation for the acquisition of the educational and scientific degree "doctor" (PhD)**

**Field of higher education** – 5. Technical Sciences

**Professional field** – 5.1. Mechanical engineering

**Doctoral program** - "Construction Mechanics, Strength of Materials"

**Author:** Eng. Petya Hristoforva Daskalova, MSc

**Topic:** „Enhancement of the fatigue life of fastener holes in D16AT aluminium alloy using a modified Split Mandrel Cold Working method “

**Reviewer:** Prof. Nikolay Dimitrov Minchev D.Sc. – Technical University-Sofia pursuant to Order № 3-01-19/21.01.2026 of the Rector of the Technical University of Gabrovo.

### **1. Relevance of the problem developed in the dissertation**

High-strength aluminium alloys are widely used in the aviation industry, where the assembly of aircraft structural elements is performed through fastener holes (FH). During operation, dynamic stresses cause fatigue of the material around the FH.

An effective approach to increasing the fatigue life of aluminium structures with fastener holes is the cold expansion of the holes. Cold hole expansion hole (CEH) methods are of essential importance for enhancing fatigue life. This explains the interest of researchers in these methods and the drive toward their improvement.

The thesis is dedicated to evaluating the effectiveness of the Modified Split Mandrel Cold Working (MSMCW) method, which ensures constant interference across a relatively wide tolerance of the initial hole diameter. This gives me reason to consider that the dissertation is addressed to a topical and significant problem.

**2. A thorough literature review has been conducted, demonstrating the author's high level of literary awareness and familiarity with the field.**

**3. The objective set in the dissertation is achievable using the author's selected methodology.**

#### **4. Brief analytical characteristics of the dissertation**

Chapter One provides an introduction to the topics related to increasing the fatigue life (FL) of structural elements with FH. Modern methods for enhancing the FL of structural elements with FH are analysed in depth. The aim and the objectives of the dissertation are clearly formulated.

Chapter Two presents the essence and implementation of the modified method for cold hole expansion, compared against the baseline SMCW method. The stages of the technological cycle, geometric analysis, as well as the tools and the device for MSMCW implementation, are presented.

Chapter Three provides a quantitative and qualitative assessment of the effectiveness of the MSMCW method regarding the main characteristics of interference fit (SI), which have a decisive role in improving the fatigue life of structural elements with FH.

The material under investigation is the high-strength aluminium alloy 2024-T3. In evaluating the effectiveness of the MSMCW method, the influence of the pre-processed hole diameter scattering on the distribution of residual stresses (RSs) after CEH has been investigated. Analysis of the evolution in the distribution of hoop residual stresses after CEH confirms the method's effectiveness in creating a zone of beneficial compressive RS around the hole. The impact of the pre-processed hole diameter scattering on the final RSs distribution has been examined. The microstructure in axial sections and the influence of the MSMCW method on microhardness in transverse and axial sections have also been studied.

Chapter Four provides an experimental evaluation of the effectiveness of the MSMCW method for increasing the FL of sheet structural elements with FH made of aluminium alloy 2024-T3, with a view toward aircraft manufacturing applications. The study was conducted under conditions of relatively large scattering in the diameters of the pre-processed holes. Experimental results are presented, and the repeatability of the results has been analysed.

**5. According to the reviewer,** the contributions are well-defined and accurately reflect the results obtained in the dissertation. The applied contributions require editing (and could potentially be omitted).

**6. Five publications have been produced based on the dissertation,** one of which is a solo-authored paper. A citation report is presented, showing that one publication (No. 2 in the list) has been cited seven times. This is an exceptional result for a dissertation, especially prior to its official defense.

#### **7. Remarks**

Typically, the introduction (literature review) in a dissertation account for approximately 20% of the total content. In this case, it exceeds 50%. This ratio could be improved by a more detailed presentation of the experimental studies and their results.

This remark is of a formal nature.

#### **8. Significance of the results for science and practice**

Results of essential significance have been obtained regarding the enhancement of the fatigue life of fastener holes through the MSMCW method. The significance of these results is further evidenced by citations from foreign authors.

## **9. Conclusion**

The reviewed dissertation represents a complete and in-depth study in a scientific field where the Gabrovo school, centered around Prof. Jordan Maximov DSc, holds leadership positions and international recognition. Significant results have been obtained. The practical orientation and implementation make a strong impression. All of this gives me reason to believe that Petya Hristoforova Daskalova deserves to be awarded the educational and scientific degree 'Doctor'.

Gabrovo

16 February 2026

Reviewer:

/signature/

/ Prof. Nikolay Dimitrov Minchev, DSc /